Water Scarcity and Possible Conflicts in East Africa: The Example of Kenya

A Master's Thesis submitted for the degree of
"Master of Science"

supervised by
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Vienna, 05.06.2012

Affidavit

I, **ZORAN RUŠNOV**, hereby declare

1. that I am the sole author of the present Master's Thesis, "WATER SCARCITY AND POSSIBLE CONFLICTS IN EAST AFRICA: THE EXAMPLE OF KENYA", 63 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 05.06.2012

Signature

Acknowledgement

I would like to thank my parents for supporting me throughout my studies. As well I would like to thank my Supervisor, Prof. Kreuzinger for his efforts helping me with the Thesis.

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Abbreviations

ASAL	Arid and Semi-Arid Land
FAO	Food and Agricultural Organization
LDC	Least Developed Country
MAM	March-April-May
NBI	Nile Basin Initiative
OKACOM	Okavango River Basin Water Commission
OND	October-November-December
SADC	Shared African Development Cooperation
SST	Sea water temperature
UN ECOSOC	United Nations Economic and Social Council
UNEP	United Natation Environment Program
WASREB	Water Service Regulatory Board

Abstract

This paper treats the upmost important topic of the new evolving phenomenon, conflicts caused by changes in climate patterns, hence climate change conflicts. It is about 19 countries that make up East Africa and hence focuses on Kenya as an example for this part of the continent. The combination of changes in precipitation and increase in temperature with a steeply rising population shows at hand of a few examples how water scarcity can affect the inhabitants of Kenya and how the latter are responding when their crucial source of water is endangered by external forces of geogenic and anthropogenic nature.

An insight into the climatological conditions, such as precipitation and evaporation is presented taking into account all East African countries. Further their demographics are presented, showing the prognosis on population growth as well as the importance of agriculture as a main source of income.

Though the paper concentrates on Kenya as an example for the East of Africa. Seven Kenyan cities are chosen, of which the rain and evaporation data of the last 30 years is presented in order to show the intervariability of the latter. Further demographics and the large variety of ethnic groups are displayed. The paper shows how already occurring conflicts around water bodies amongst Kenyans and with neighboring country Ethiopia, due to water scarcity, are taking their first victims, and by that certain possible conflict scenarios according to the change in climatological patterns and population growth are presented as well as potential solutions for this problem.

1. Introduction

1.1 Background

By the year 2025, according to the UNEP Vital Water Graphics, more than 2.8 billion people are going to face water scarcity spread through 48 countries in the world. The term water stress is defined as having an annual water supply of fewer than 1700m³ of water per person, whereas water scarcity is defined by less than 1000m³ of water per person, indicating not only nutritional deficiency but also sanitary.

According to the atmospheric scientist Dr. Anyah, the Eastern part of Africa is forecasted to be hit most by the climate change effects, such as droughts. Three countries, namely Ethiopia, Somalia and Kenya, are going to experience water scarcity of a high degree, bringing even more famine then already existing. Those three countries have an average population growth rate of 2,5% per year which also indicates that the rise in population will bring about even more people with water needs that have to be taken care of. Another crucial factor that is needed to be taken into account is that effects of climate change, in this case extreme droughts and the decrease of inner land lake levels, will lead not only to a poor harvest and insufficient water access but also conflicts rising among those ethnic groups who used to share trans boundary water sources.

Nomadic people from southern Ethiopia and northern Kenya are following the water source, which are tremendously decreasing due to droughts caused by climate change effects. In certain cases Ethiopian tribes cross borders in order to pursue their water needs, by that clashing into Kenyan tribes. Armed protection from both sides has become a normal circumstance amongst those trying to defend their water sources. Furthermore the Ethiopian government is seeking to construct the biggest hydropower project in sub Saharan Africa which will result in a decrease of water flow affecting 800,000 on that water relying people both from Kenya and Ethiopia. (yale, 2010)

1.2 Purpose and Objective

This paper gives an insight in the severity of upcoming water scarcity that is going to affect a large amount of the world population, with the example of droughts and by that resulting famine in East Africa. Further this paper will also inhabit the conflicts that are most likely going to arise out of the desperate need for the most essential life elixir, water. Examples such as the disputes between the certain groups

depending on the trans boundary water sources will serve as a proof for first climate change conflicts and their development in the near future.

Moreover this paper will provide information on the water use, agriculture, industry and sanitary of selected east African countries and how this water use might develop, taking into account climate change effects and conflicts.

However the primary goal of this paper is to show how climatological changes such as rain, evaporation and temperature increase in combination with population growth will affect water availability in East Africa in total, though focusing on Kenya.

1.3 Research Question& Hypothesis

RQ: Will the decrease in water availability in Kenya, due to deterioration in climatological conditions and population growth, cause conflicts amongst Kenyans and/or even transboundary conflicts?

1.4 Research Design& Methodology

The research was conducted was mainly based on literature reviews, such as scientific journals and articles. The most relevant data on climatological changes, such as checking for precipitation values of over 30 years was found in scientific reports. By the utilization of the TU web access on scientific journals the author had the opportunity to implement acknowledged scientific articles, especially on the climatological chapter. Concerning the data taken for the demographics, several different United Nations data sets were taken as a basis and then compared in order to obtain validated data. Food and Agricultural Organization's (FAO) also proved to be a stable provider of data when it comes to information on agricultural information as well as it's statistics on water, AQUASTAT, that has been used in order to compare water demand by sectors in East African countries. Further, in order to obtain information on passing conflicts on water, East African local journal's articles were taken as well as internationally known magazines on this topic such as the International river.org. In total it can be said that the data used for this paper comes from acknowledged sources, for the political/ demographic part as well as for the scientific one.

2. East Africa

East Africa was chosen, due to the fact that this part of Africa is forecasted to be hit most and hardest by climatological changes, according to Dr. Anyah, an atmospheric scientist and professor at the University of Connecticut. Natural disasters like droughts and the increase in temperature will have heavy effects on the water availability on those that are anyways living below the bare minimum.

2.1 Climatic Conditions

In order to show by which climatologic factor East Africa is tackled by, the paper gives a brief insight into the climate zones, precipitation, evaporation and runoff in order to display how the changes during the past decades will and effect the environment, hence the population.

2.1.1. Climate zone

According to the UN geographic scheme East Africa consists out of 19 countries, from the Ethiopian highlands, the sub-regional islands Comoros and the Seychelles to Zimbabwe, as can be seen in Figure 1. According to the Köppen climate classification system, East Africa is divided into three climate categories. Most of the land of Ethiopia and Somalia and parts of Kenya are found to be a hot desert climate, which is described by constant sunshine accompanied by maximum temperatures of 45°C. The rest of the territory is described as hot semi-arid climate, characterized by dry, hot summers and rather wet winters. Going further south, countries like Tanzania, parts of Kenya are featured by tropical savanna climate, which is described as wet and dry seasons, whereas each one can be longer lasting and more intensive than the other. (Britannica, 2011)

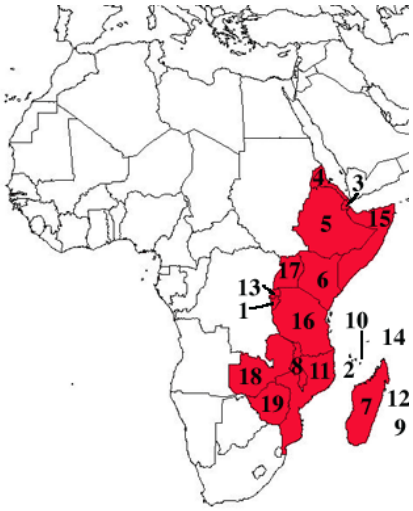

Figure 1:19 countries of East Africa, celtnet.com

Further this part of Africa can be classified into 3 different regions. Starting in the North, this region is characterized by its lake abundance incorporating Kenya, Uganda, Tanzania, Burundi and the little country of Rwanda. Going further to the right on the map the Horn of Africa appears, which includes Ethiopia, Eritrea, Sudan, Djibouti and Somalia. This region is rather covered with steppe, semi deserts and grasslands known for its deviation between floods and droughts. The third one are the islands of Comoros and the Seychelles. When comparing the Northern region and the Horn of Africa huge differences exist in the vegetation that is to be found. While the northern region is rather accompanying more forests the Horn of Africa displays far more arid areas. (Britannica, 2011)

Looking at the air temperature of the eastern part of Africa, one thing that is observed are differing values in different regions, hence the higher the altitudinal belt the lower the temperature. As for example Ethiopians differentiate between the *Bercha*, which is the “hot land” up to 1500 m having an average yearly temperature of 26°C and the *Weyna Dega*, the wine land that is to be found between 1800m and 2500m height, having an average yearly temperature of 15°C-18°. Kenya serves as another example for the highly differing temperatures within one country’s territory. When looking at temperatures in its coastal town, Mombasa, temperatures of up to 30°C are recorded, whereas in heights of 2,085m lowest temperatures of nearly 10°C are recorded, serving yet as another example of Eastern Africa’s great variability of climates.(Pfeiffer S. 2001)

The seasonal variability of temperatures in Eastern Africa amounts only to 5°C, due to its equatorial position. Therefore it can be said since the variability is only 5°C,

which is less than the daily temperature deviation, the coldest days in Eastern Africa rather depend on the cloudiness and not the altitude of the sun.

2.1.2. Precipitation

Nevertheless the most important climatic factor in East Africa is the precipitation, which is highly varying from its aridity in the Horn of Africa to the rain forest areas such as in Kenya and Tanzania. As in some places in Somalia an average yearly precipitation of 100mm is noted, areas such as in rain forests in the Western province of Kenya have measured a yearly precipitation of 2000mm. These highly varying differences are to be brought back to the fact of altitude.(Pfeiffer S. 2001)

Since most of the countries in East Africa are experiencing rotationally a dry or a wet season, the latter are divided up on hygric seasons, which describe the contrast between rainy and arid times, being a brand mark for the wet-dry tropics. There are four different hygric seasons, rotationally dry and wet. The first one, including only January and February, is a dry season, followed by the long lasting rainy season which goes from March to May. After that again a dry season is following from June to September and finally a short wet season form October to mid-November/ beginning of December. Even though mean daily rainfall in the last wet season of the year is lower than the one of the longer lasting rainy season, the yearly variability of precipitation of this short rainy season is much higher. Therefore the importance of sufficient rain, especially in the short wet season is of essential needs to those that are dependent on that water for their crops and livestock. (Pfeiffer S. 2001)

In 1999 the phenomena of the Indian Ocean dipole was discovered, which describes the Sea surface temperature (SST) anomaly on the equatorial eastern and western end of the Indian Ocean. These temperature anomalies of the sea water cause the differing of the precipitation on the one side over Australia and Indonesia and on the other side in East Africa. It has been discovered that when there is a warming in the Western Indian Ocean and the Eastern Pacific, the rain fall in the short wet season was extraordinarily above average. Moreover it was observed that rain fall in those seasons was high during the El Nino Southern oscillation warm phases. Therefore it can be said, that the interannual variability of the short rainy season in East Africa is caused due to the fluctuation of SST which brings about either less or more convection over the sea and thereby differing precipitation. (Black E. 2004)

A study conducted by NASA in 2008, has implied that since the 1980s the long lasting rainy season in East Africa has declined by 15%. Further this decline has its roots in the differing transport of moisture between the land and the sea, which is caused due to rising SST of the Indian Ocean. Highly effected areas are those that are extremely arid such as Somalia, parts of Ethiopia, Zimbabwe, Malawi, Zambia, Tanzania and Kenya. Moreover it was found out that precipitation over land was declining steadily though precipitation over ocean was constant, which in turn brings even drier air to the East coast of Africa, establishing more ground for long lasting extreme droughts. Further the study has shown that those decreases in rain fall will continue to occur and may leave even the double amount of people in famine. (NASA 2008)

Another study conducted by the American Meteorology Service, has simulated anomalies of rainfalls in East Africa, with examples of Uganda, Kenya and Tanzania, over the last 100 years, as can be seen in Figure 2.

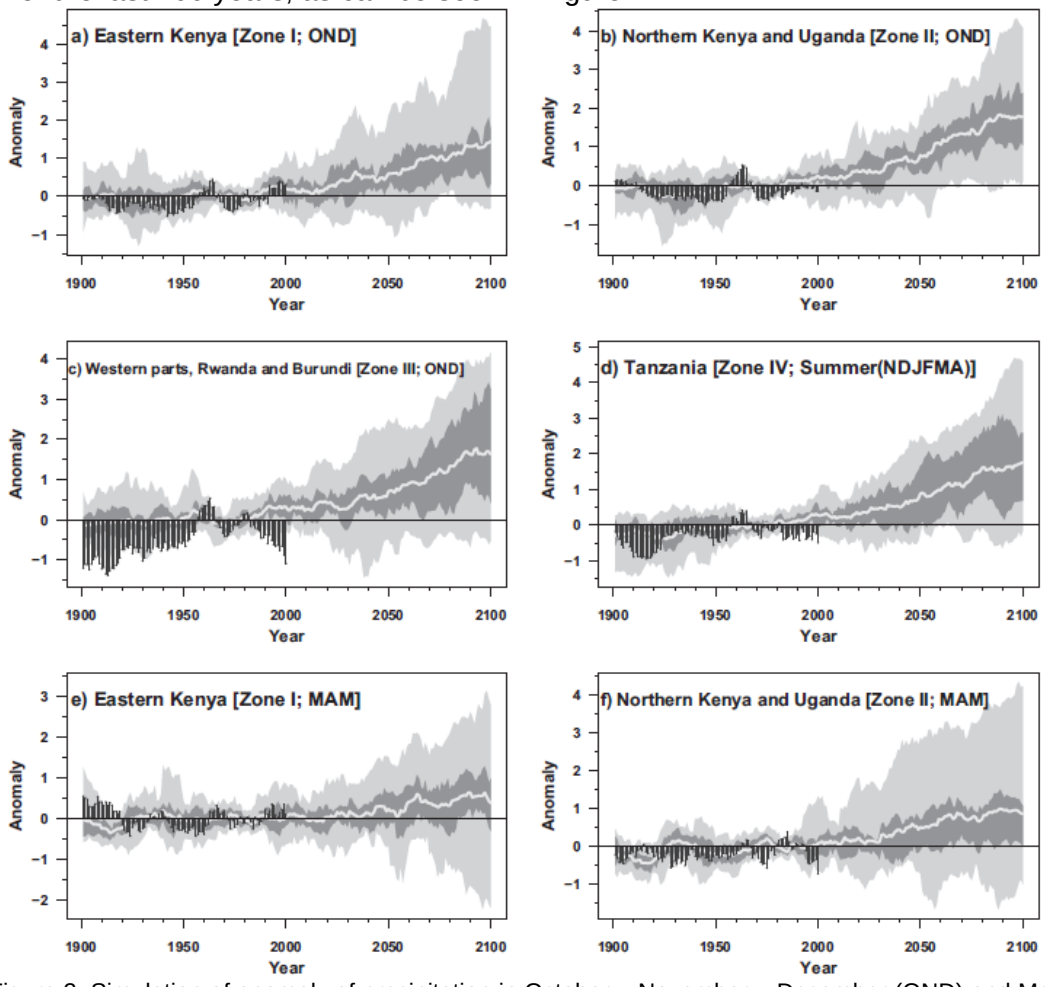

Figure 2: Simulation of anomaly of precipitation in October – November – December (OND) and March – April – May (MAM), East Africa, Mxolisi E.S., Geert J. can Oldenborgh, Bart van den Hurk, Maarten van Aalst 2010

The goal of the study was to show the change in rainfall distribution over the last century. The mean precipitation and the intensity of the 10 year wettest happening were simulated with multi model data sets showing that the latter are steadily increasing, ensuring higher rainfall in short rainy seasons, whereas the latter are only responsible for 24% of the total rainfall and the long rainy season for the remaining 76%. Nevertheless this would mean that increased rainfalls in the next years would result, again, in harsh living conditions for the people living in the affected area. Floods, which will demand disaster management and reconstruction methods, will also carry risks of damages to health of the affected people, such as water borne diseases. (Mxolisi E.S.et al, 2010)

As can be seen from figure 2 changes in precipitation are diagnosed to have an increasing deviation the further the forecast goes in the timeline. However there are different model types, when it comes to analyzing precipitation, though most of them are producing the same values until 2050.

The two examples showed that there is a change in the rain pattern, even though one study presented the fact that there is less rain in total in East Africa since 1980, the other one simply showed that rain will increase though only in the short rainy season which is making up only a fifth of the total rain, in the 5 countries taken as an example for East Africa.

2.1.3. Evaporation

Only the real variability in water resources can be given when evaporation is included into a study, since it is a one of the major parts of the hydrologic cycle. Therefore it has to be taken into account that: Precipitation minus Evaporation provides a rough picture of the water availability in a country. In order to give a full insight into the importance of the latter, firstly the explanation has to be given.

Evaporation is, "*the process by which an element or compound transitions from its liquid state to its gaseous state below the temperature at which it boils; in particular, the process by which liquid water enters the atmosphere as water vapour. Evaporation, mostly from the sea and from vegetation, replenishes the humidity of the air. It is an important part of the exchange of energy in the Earth-atmosphere system that produces atmospheric motion, and therefore weather and climate. The*

rate of evaporation depends on the temperature difference between the evaporating surface and the air, the relative humidity, and wind".[1]

Evaporation from open water surfaces can be connected to economic, hence essential importance to humans living conditions in East Africa. The latter is being a major constituent when researching on irrigation techniques, sufficient water amount for crops and catchment area research. (Woodhead T., 1968)

However the most important aspect of evaporation is that it is as precipitation an important indicator on climatological changes. In the case of low precipitation and above average evaporation, droughts may occur. In order to be able to measure these increases or decreases of water evaporating, experts such as agriculturalist and hydrologists agreed upon a certain type of measurement method, namely the Penman equation. In this method air temperature, relative humidity, solar radiation and wind velocity are included into the equation in order to tell how much water has evaporated from an open water source. However there are also other methods used such as the energy balance method where the needed energy is calculated for water to transit from liquid into gaseous state. (Valiantzas J.D., 2006)

Eastern Africa's houses three large lakes, namely Lake Victoria, Lake Tanganyika and Lake Malawi. The area of those three lakes is situated in the Great Rift Valley. The Valley is to be found on an altitude between 400m and 2,000m with a varying landscape including mountains and volcanoes. (UNEP, 2010)

As for example, the largest water body in Africa, the Lake Victoria is of supportive aid to more than 30 million people, which is forecasted to double until 2050, that are dependent on its water for irrigation and feed of livestock. According to the UNEP report Africa's Lakes this water body has lost 1m of its water level in the past 20 years. Reasons for that might be in higher evaporation due to increased deforestation in that area, population growth and last yet of upmost importance the construction of dams. Similar scenarios are observed in the other two lakes of the Great Rift Valley; increasing evaporation rates due to harsher anthropogenic conditions and rise in harder geogenic circumstances. (UNEP, 2010)

Another problem evaporation brings about, is that water used for irrigation is also lost due inefficient irrigation techniques, where a lot of water is evaporating. Especially in East Africa, where the arid soil under the high temperatures is losing a

[1] Britannica: http://www.britannica.com/EBchecked/topic/1516731/evaporation

lot of water due to evaporation. Most of the countries in Eastern Africa have to handle this problem, though the call for new irrigation technology is in some cases far too costly. (R. Purcell, 1997)

2.1.4. Evapotranspiration

Since precipitation was looked at in order to see how much water is coming onto a territory one has also to look of evaporation and evapotranspiration. The latter is an important part of the hydrological cycle. Considering the amount of evaporated water via plants is crucial for the water cycle as well as for those who are trying to adapt their irrigation system to the most efficient approach. Therefore it is important to look at how much water is evaporating through plants in order to be able to improve irrigation techniques. Kept in mind that 70% of the world's fresh water reserves are used for agricultural purposes, in East Africa 75% is used for the latter, evapotranspiration is a very important factor in this study. (E.E. Maeda, D.A. Wiberg, P.K.E.Pellikka, 2010)

"Evapotranspiration (ET) is a term used to describe the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere. Evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies. Transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. Evapotranspiration is an important part of the water cycle."[2]

[2] Frederic P. Miller, Agnes F. Vandome, John McBrewster, 2010 Evapotransipiration

2.1.5. Runoff

The water cycle consists out of several steps, whereas the runoff represents the movement of land water to the seas, hence from transported by rivers, streams and lakes. Further it can be rainwater that is not sucked into the ground flowing downhill in water bodies. It is of importance due to the fact that it is responsible for transportation of nutrients which are essential for the vegetation, through which it may flow and it refills rivers and lakes which are of importance for irrigation.

However runoff can have also a rather bad influence on its environment and can entail crucial problems for water quality. Since runoff doesn't only bring about nutrients on its way, it also can carry excessive and loose soil with it, which may be deposited into rivers. Moreover runoff water is also flowing through streets and crops where several types of chemical toxicants and containments of fertilizers, such as Phosphorus, are taken up by the latter. Especially in the case of integrated Phosphorus in runoff water, can be of hazard to animals, thereby deteriorating the chance of livestock breeding. One of the worst effects fertilizer residues in runoff water is that it enhance eutrophication, which is lowering water quality by increasing algae growth and thereby oxygen depletion of the water, resulting in bad quality and the decline of aqua life. (Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., 2008)

When looking at reports of international organizations, such as the IPCC or the FAO, Eastern Africa is predicted to experience an increase in runoff. However the rise in runoff quantity, which is predicted by the director of the Walker Institute for Climate System Research, is said to be appearing in the rainy season in East Africa. This would mean that this excessive amount of water that is flowing in the wet season won't be delivered in the dry season, resulting in droughts.

Additionally in East African countries like Kenya, deforestation is contributing to increased runoffs. This is due to the fact that Kenyan government has to cope with population growth needing extra soil to be able to harvest bigger crops. For that the already small forest areas in Kenya are cut off, resulting drying up of the ground which in turn creates ground that is not able to take up water. (A.A. Sirage, 2009)

2.2. Demographics

In order to show how population growth will affect East African living conditions, the latter has to be presented in forecasted view in order to display to its reader the importance and consequences that may occur due to growth in population and urbanization.

2.2.1. Population

As already mentioned East Africa consists out of 19 countries, which are geographically very diverse. From the arid lands in the Horn of Africa, rainforests in Kenya to Mozambique's tropical coulisse, in this part of Africa countries are differing not only through its ethnic groups but also through its scenery. It covers an area of approximately 3,6 million square kilometers and has a population of 331 million people, resulting in the most populated region in Africa. Further according to the UNFPA population report, this area has an average population growth of 2,6% per year, which will make it even harder for the latter to self-supply it's habitants with food and water. This annual increase of population would mean that until 2050 East Africa's population will double in size, having the fastest increasing population in the world after South East Asia, representing the third biggest population block worldwide. The fastest growing country in this region is said to be Ethiopia with a shift from 84 million in 2011 to 174 million people in 2050, becoming the second biggest country population wise in Africa, by that surpassing Egypt as can be seen in Figure 3. Further in the latter more than the half of the country is aged between 15 and 29, having a median age of 18.7 years, which bears within a great potential for a strong economic working force. However the country with the biggest population increase is Malawi and it has a foreseen annual growth of 3,2%, which is behind Niger's growth the biggest in percental terms. (Crossette B., 2011)

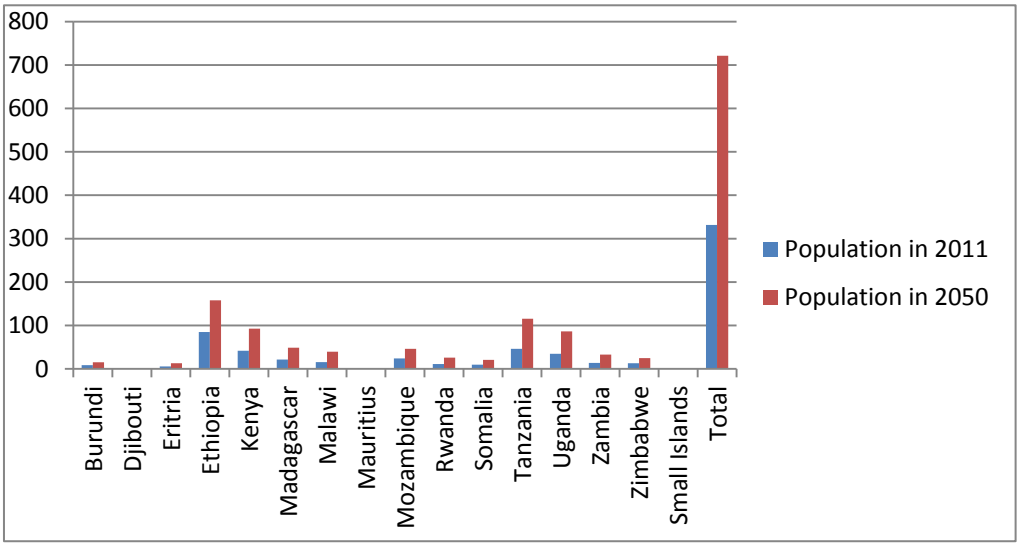

Figure 3 Population in million East Africa, UNFPA report 2011

Further all of the East African countries, despite the islands, have a high adolescent birth rate. In more detail, studies have shown that in those countries out of 1000 women more than 100 are at the age of 15 to 19. Some counter measures were taken against this rather young parenthood, such as in Mozambique where the bride is not allowed to be younger than 18 years. This has the reason due to the fact that in Mozambique but also in other countries of East Africa, fathers try to get their daughters married as soon as possible. In most cases those girls are married to older man, indicating with her low age a low level of education and due to that in order to gain security in the marriage more children are beard since this might be deemed as the single role of the women in the marriage. Moreover the UNFPA report 2011 indicated that girls/women form the age of 15 to 49 are not sufficiently involved in family planning and that the topic of using preservatives is leading to conflicts in relationships due to the negating of the latter by the husband. (ibid)

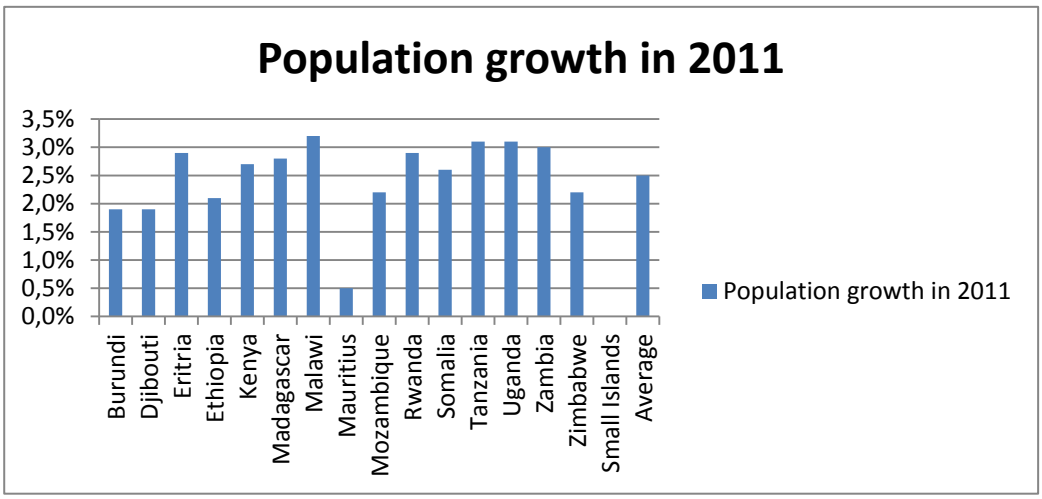

Figure 4 Population growth East Africa 2011, UNFPA report 2011

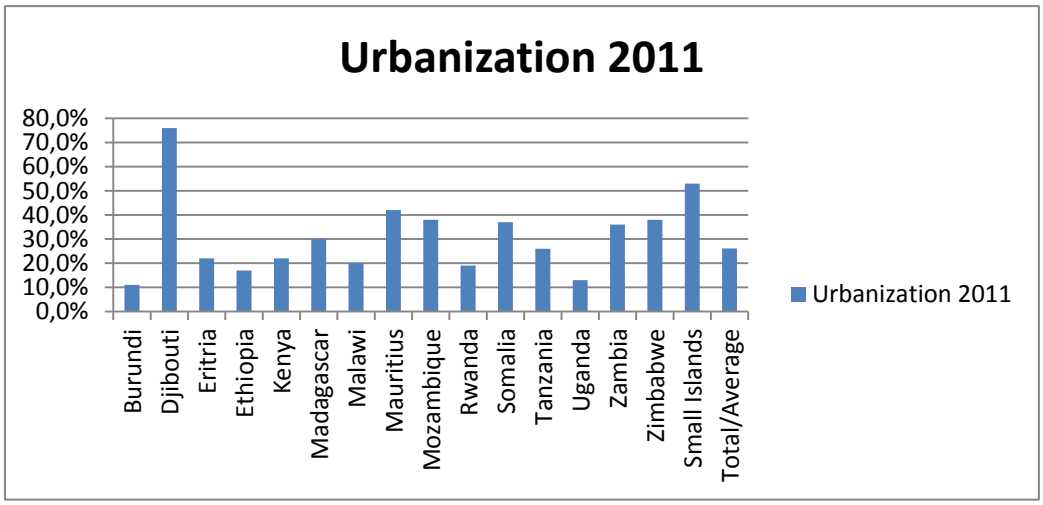

Figure 5: Urbanization East Africa 2011, UNFPA report 2011

The projected rise of the population in the next 38 years will bring about a total of 721 million people, only in the East of Africa, if the population growth will continue as it does at the moment. This would mean that countries will have to cope with enormous pressure that has to be counteracted on, from food supply to regulating the growth by not harming the essential environment for nutrition. However on the other hand it has to be said that this population growth also brings about chances of economic uprisings, since the potential working force is present and that in a young and large quantity.

Nevertheless half of the 19 East African countries are noted to be under the Least Developed Countries (LDC), characterized by inter alia having less than 905$ per person per year. Therefore as poverty is already dispersing over this part of Africa, a lot will have to be done only to maintain that situation with a population of 711 million people in 2050. Moreover in some of the East African countries the tremendously high urbanization number leads to even tougher living conditions for those that are housing in cities. Though to better the situation for its people, east African countries will have to boost their economies and cooperate in order to fulfill the wish to come out of poverty. (LDC, 2010)

2.2.2. Ethnic groups

Africa consists out of some couple of thousand ethnic groups and thereby an equivalent number of different linguistic dialects are spoken. The number of ethnic groups in Eastern African countries varies from country to country. Whereas countries like Tanzania have 120 different ethnic groups, that differ in culture,

dialect/language and social organization, countries like Burundi or Rwanda only count a few, between 2 and 3. (Britannica, 2011)

However these couple of thousand ethnic groups are sub groups of 14 classified African “cultural families”. When looking at the East African countries the territory can be subdivided into four main different ethnic groups, then are further subdivided into several different sub groups.

Firstly, the semitics, which are mostly known for Arabic and Hebrew but as well incorporate Amharic, is an ethnic group in Ethiopia which counts up to 20 million people, representing the second biggest ethnic group in Ethiopia. Being part of the biggest representative group with 30 million people in Ethiopia the Omoro, are a part of the Cushitic ethnic group, which also includes the Somali people, representing the biggest ethnic group in Somalia with 18 million people. Thirdly, the Bantu ethnic group having over 500 different languages and dialects, which are mostly hard to differentiate, is represented in 9 out of the 19 east African countries with the language Swahili being spoken by approximately 75 million people. This language is used amongst ethnicities not sharing the same language as a lingua franca. Other languages included in the Bantu languages are Zulu, which is spoken in Mozambique, Zambia and Zimbabwe reaching approximately 10 million speakers and Shona a language spoken by 13 million people mainly in Zimbabwe. The last one is the Sudanic language family, incorporating languages spoken by, for example, the Massai in Kenya, as well as by ethnic subgroups in Tanzania, Eritrea, Ethiopia and of course as the name implies in the Sudan. (Britannica 2011)

Even though some of these ethnic groups, as the Bantu which has hundreds of subgroups, share a similar cultural background and mutual intelligibility, conflicts and political violence are not left out amongst those. As for example during elections in Kenya 2007 riots were held on the streets due to the fact that it was believed that the largest ethnicity in Kenya, the Kikuyus, has been treated better by the government than the other ethnic groups. Another example for severe conflicts with devastating consequences was the Rwanda war in the mid-90s where the two ethnic groups, the Hutus and Tutsi, which share the same religion, language and history, have engaged into a war that brought up 800,000 dead people within three months. This is the best example for conflicts that can arise among ethnic groups that share same values and cultural aspects.

2.3. Main water requirements& sectors

In order to present the overall situation on water availability and consumption in the East of Africa, several water demanding sectors are looked at in order to show the distribution of the latter. Further this part should show to its reader how water demand is already high in certain sectors, and how this demand will rise due to population growth.

2.3.1. Water demand by sectors

According to AQUASTAT, water database of the FAO, water demand in East Africa is mainly focused on the agricultural demand. Due to arid climates, a lot of water is needed in order to wet the fields sufficiently by man hand. If the cultivation would be left solely to the nature, meaning without any modern irrigation process, then crops would only be worth harvesting every five years, due to the arid climate.as shown in Figure 6. Those numbers range from the year 2000 to 2005, where are a data set of one country might not be from the same year, nevertheless showing representative values of the individual secotrs. As can be seen in the figure agriculture is dominating the water demand in this part of Africa. Countries like Burundi, Somalia, Ethiopia and Eritrea are having the biggest demand for water in agriculture. When looking at municipal water demand, which includes water withdrawn by habitants. Rwanda is leading in this part with a little bit more than 40%. As can be seen in Figure 6 industry's water demand is completely neglected, this is due to the fact that agriculture prevails. The reason for that is not only that most East African countries are needing all the water for crops needed by domestic utilization but as well for crops that can lead to large export gains of products such as coffee, vegetables, fruits and flowers.

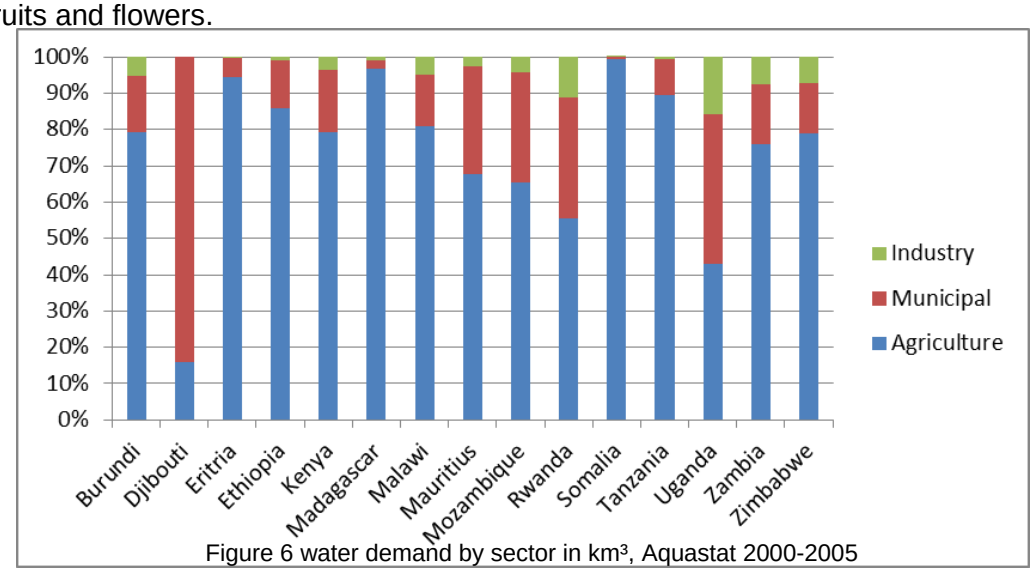

Figure 6 water demand by sector in km³, Aquastat 2000-2005

2.3.2. Effects of Urbanization

East African capitals and bigger cities are more and more urbanized. Most of the cities possess slums, peri urban areas which lack sanitation, water access as well as electricity. As could have been seen in chapter on demographics only 26,1% of the people in East Africa are living in urban areas. However this figure is supposed to rise sharply in the upcoming year. As can be seen in figure 7 urbanization rates are rather high, with an average of 4,4% of people moving towards cities on a yearly basis. Already at the moment in those slums people are dying due to lack of safe drinking water and sanitation circumstances. Therefore since in the upcoming years the number of those living in slums will increase, even worse living conditions will arise. Additionally at the moment those that are living in slums are paying more for water than those that have household water access, 5-7 times more. This is due to the fact that dwellers illegally access water pipes and sell this water then to a high price to people living in urban slums. (M.O. Maoloo, 2005)

Since there are as well no sanitation practices in place in those places open defecation is the only way for 33% of East Africans. This is in turn then a reason why sicknesses such as cholera, malaria and yellow fever derive. Therefore if combining the growth of people moving to city areas in combination with the population growth and the poor water access, a big basis for the wide spread sicknesses is established. (Kennedy G., 2007)

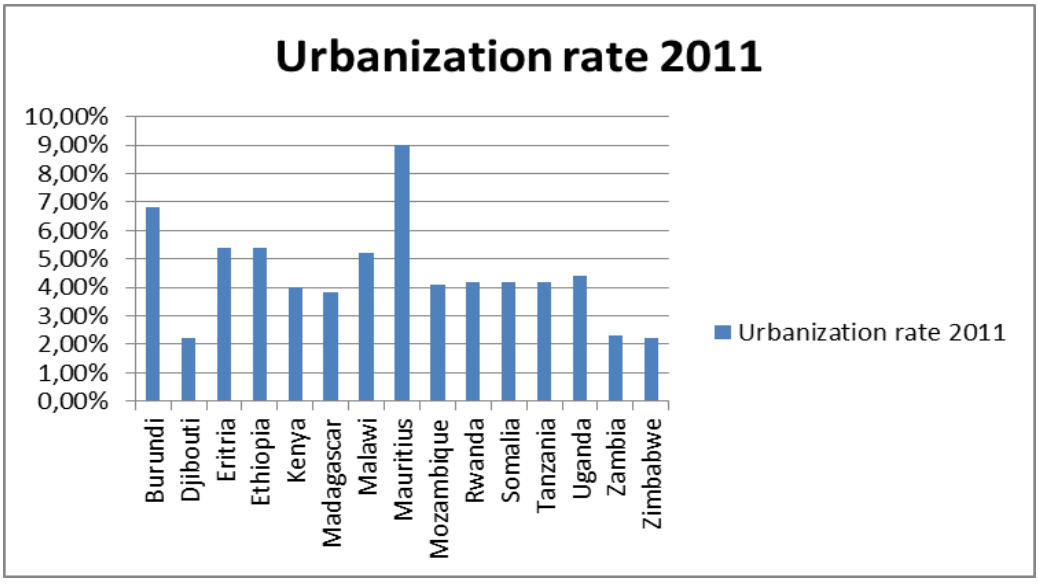

Figure 7 urbanization 2011, UNIDO 2011

2.3.3. Agriculture

As Eastern African soil and weather circumstances vary from country to country, agricultural conditions do as well. Never the less agriculture represents an important source of income as well as a big part of the countries' GDP as can be seen in Figure 8.

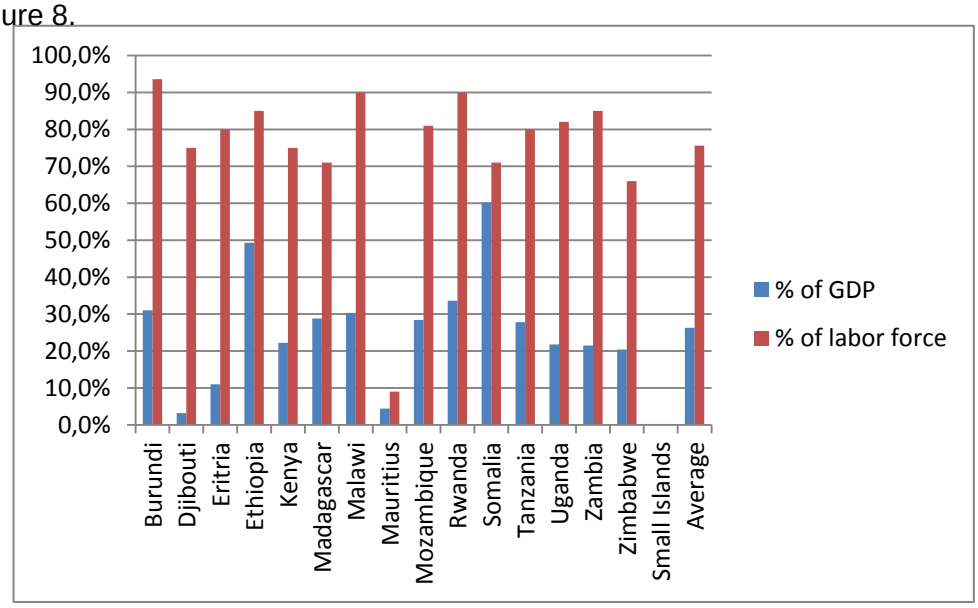

Figure 8 East African Countries' Agricultural performance in percental terms of GDP and Labor force – excluding Mayotte, Reunion and Seychelles, CIA Factbook 2012

Countries like Mauritius and Burundi have the smallest share of agricultural input in their GDP, with 3,2% in Djibouti and 4,4% in Mauritius, due to the fact that their economy relies more on the tourism and service industry. However in terms of labor force Djibouti aligns well with the rest of East Africa, having a high part employed in agriculture. Even though Somalia lies in one of the most arid zones of East Africa, the biggest source of its GDP is agriculture with 60,2%. Burundi, one of the smallest countries in this area has 93,6% of its people employed in the agricultural sector, providing for more than 9 million people an income. (CIA Factbook, 2012a)

Even though these numbers seem to leave the impression that East African people are well taken care of in terms of food security, since nearly everybody is working in the agricultural sector, this is definitely not the case, as can be seen in Figure 8. It shows how countries such as Ethiopia and Somalia are experiencing severe food emergency as can be seen in Figure 9 and Kenya where food crisis and stress are visible. According to the Famine Early Warning System, only 40-50% of the basic nutritional needs are covered of households in the Horn of Africa, especially in the region of Somalia. Moreover international food aid can't reach all regions due to insecurity caused by political violence. (FEWS 2011)

This part of Africa is for decades experiencing nutritional deficiency, due to several reasons; the lack of water, insufficient investment in rural infrastructure, inefficient use of fertilizers, population growth and as already described in previous sections the meteorological circumstances.

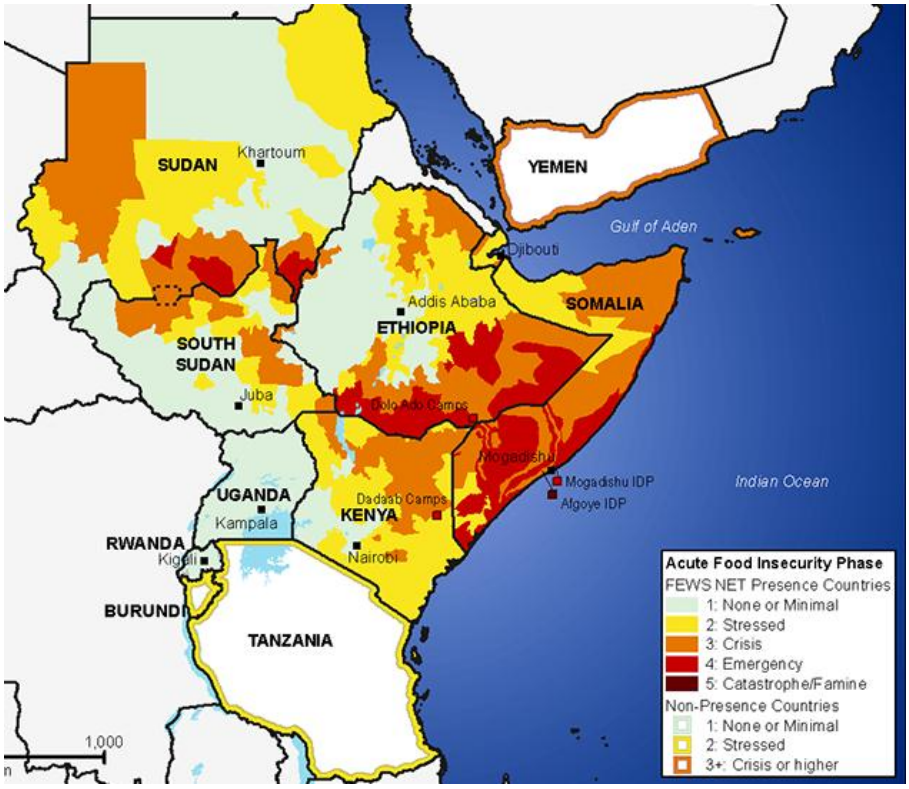

Figure 9 East Africa food insecurity, FEWS.com

Another important factor that is disrupting expected agricultural outcomes in East Africa are conflicts and riots. As already mentioned, riots took place in Kenya in 2007, due to alleged negligence of certain ethnic groups after presidential elections. These riots have endangered hundreds of crop fields of farmers and further destroyed over 300,000 tons of maize. (Kennedy G., 2007)

Moreover the increasing urbanization rate in East Africa, which comes to 3,4% per year is also a negative implication on the agricultural status. The more people move away from the rural areas, where crops are maintained, to the city areas the less people will take care of the latter. An example is provided in Mozambique, where most people living in cities are purchasing 83% of their total food, whereas people living in rural areas only buy 30% of their food. (Kennedy G. 2007)

Areas with the best predisposition for good crop production have also the highest population densities. In East Africa the most developed agriculture is to be found in Kenya. This is due to the fact that the latter has a well-organized network of rural

infrastructure as well as a profound technical and research system. However, as in many other east African states, only 9% of the total cultivatable land could be properly used with the country's irrigation potential. Out of those 9% only 2% are irrigated. A similar case is to be found in Tanzania, where a potential of 20% of the total cultivatable land is present and only 3,75% are utilized. Reason for the low usage of the arable land is partly because of soil degradation, desertification and deforestation that take place in those countries. Since the population has increased farmers over cultivated the lands which lead to over grazing and thereby decreasing crop yields. (GTZ, 2006)

3. The Example of Kenya

Kenya as the exemplary country was chosen due to the fact that this region will be especially prone to the change in seasonal rainfall and more frequent occurrence of droughts due to effects caused by climate change, such as the increase in temperature and sea level rise causing as well an increase in SST. (Black E. 2004) Another reason, though not the main, that Kenya was chosen as an example for Eastern Africa is that data found, especially scientific data, was the most easily accessible and gatherable comparing to other Eastern African countries.

These changes will with a high possibility affect key industries that countries like Kenya are highly dependent on. Agriculture, Energy use, industry, health and especially water availability might be endangered by bad climatological circumstances.

This part of the paper will focus on Kenya only. The analysis of the climatic conditions such as Climate Zones, Precipitation, Temperature change, Evaporation and Runoff as well as Droughts and Floods will be looked at in order to show a trend that depicts change in Kenyan climatic patterns. The second part of this chapter will show the demographical aspect of Kenya. Speaking of the severance of population growth and urbanization as well as the ethnic groups and important sectors that might be or already are affected by climate change, the goal is to show how severe the changes in nature can be for a country in combination with a rising habitat. The third and last part of this chapter will be dealing with conflicts specifically; those that already occurred and those that might occur due to the change in climatic conditions. It will be presented how conflicts could be present among Kenyans as well as trans boundary ones.

Finally the objective of this chapter about Kenya is to provide its readers with an insight in the scientific as well the socio economic circumstances Kenyans will and do face at the moment and in the future, particularly in water scarce regions and how these will have severe consequences for the population due to low adaptive capacity to climate changes, especially effecting rural populations.

3.1 Climatic Conditions

Climatic conditions are observed in order to show the severe consequences that might occur due to caused droughts that might reduce water availability in the upcoming time.

3.1.1. Climate Zones

Kenya is located at latitude of 5°South and 5° North and at the longitude between 34° and 42° East, situated in the East of Africa. The climate zones of Kenya vary from tropical on the coast lines of the country to semi-arid in the interior of the latter.

The climatic zones can be subdivided into four parts due to the differing height. First of all there is the Indian Ocean Coast, which is as the name indicates the part of Kenya located at the coast, defined by its rather humid and warm weather conditions. In one of the most known and popular cities of the Kenyan coast, Mombasa, temperatures are recorded that range in rather lower fields such as 21 °C in the summer months such as August to 24° in March and April. In this are rainfall reaches about 1000mm which is quite high considering that a couple of hundred kilometers away rainfall is not even reaching the half of this amount. (Climate Zone, 2004)

Second zone that can be characterized is Northern Kenya which is the most dry area on the country's territory. It is characterized by immensely high temperatures being in the range of 33°C to 35°C maximum and 22°C to 25°C minimum. This part of Kenya is not having massive rain such as the coastal region has. The recorded precipitation in this area is rather varying from 300mm to 500mm, which is quite low comparing to the coastal region. (Climate Zone, 2004)

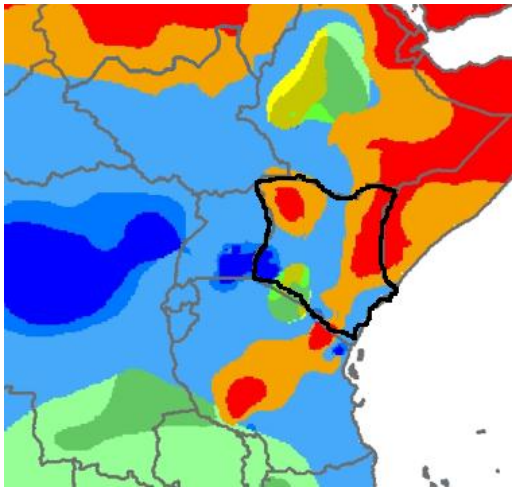

Figure 10 Koppen 2011

The Kenyan Highlands, which are situated in the West and center of the country, are to be found on 1200 to 2100 meters altitude. This region's climate is home to the country's capital Nairobi at a height of 1660m, where the summers are warm not hot with 20 to 25°C and winters are comfortably cool reaching 10°C to 14°C. The average rainfall of this region is reaching 1000mm to 1250mm annually. However there are is the region with the most rain recorded in this area is found in Kisumu with an average rainfall between 1700mm to 2000 mm. (Climate Zone, 2004)

The last climate zone that is Kenya subdivided into are the mountains, which are situated up to 5199m height, which is the top of the highest mountain in Kenya, Mount Kenya, being home to the coldest area in Kenya, where as well snow and frost is present. (Climate Zone, 2004)

As described in this part Kenya has a immensely diverse climate due to the difference in altitude and coastal proximity of regions ranging from cool temperatures in the mountains to arid hotness in the interior of the country.

3.1.2. Precipitation

Since precipitation is one of the most important indicators of climate change as well as for wellbeing of the agricultural dependent Kenyan economy the author has looked at 7 different weather stations in Kenya at weather records of the last 30 years since this is the minimum time frame where a certain climatological change can be shown with severity.

As already described in the first chapter of this paper, where East African seasons were explained, Kenya as well has two rainy seasons and two dry seasons. The dry seasons are from mid-December to March with the weather being rather hot and dry, the other one is from June to August where the weather is prevailingly cool and dry. Previously mentioned rainfall may vary from 200mm per year to 2150mm per year as can be seen in figure 4. However 2/3 of Kenya's territory has less than 500mm of precipitation per year whereas 79% receives only 700 mm per year, underlined by the fact that variability in rain is highest in the semi-arid and arid areas of Kenya. (R.Butterfield, 2009)

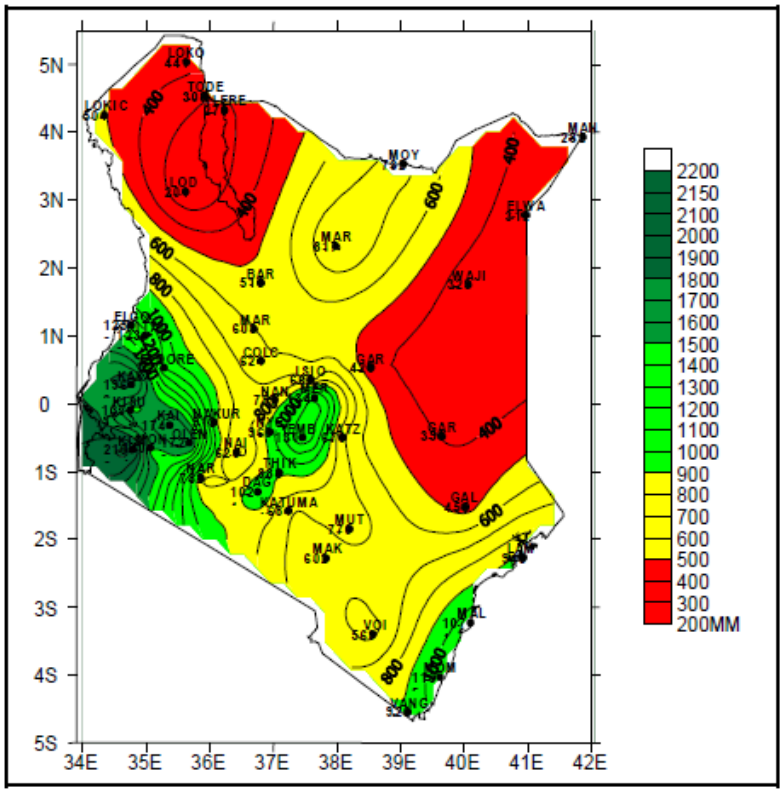

Figure 11 Mean annual rainfall Kenya, R. Butterfield 2009

The thereby resulting outcomes are of course more frequently reoccurring floods and droughts, which are such as in 1999 effecting 23 million people brought by El Nino. Therefore it is important to take a deeper look at the precipitation values over a specific time period at 7 weather stations representing all climate zones of Kenya, which include tropical, savanna, arid, semi-arid and Mediterranean. (R.Butterfield, 2009)

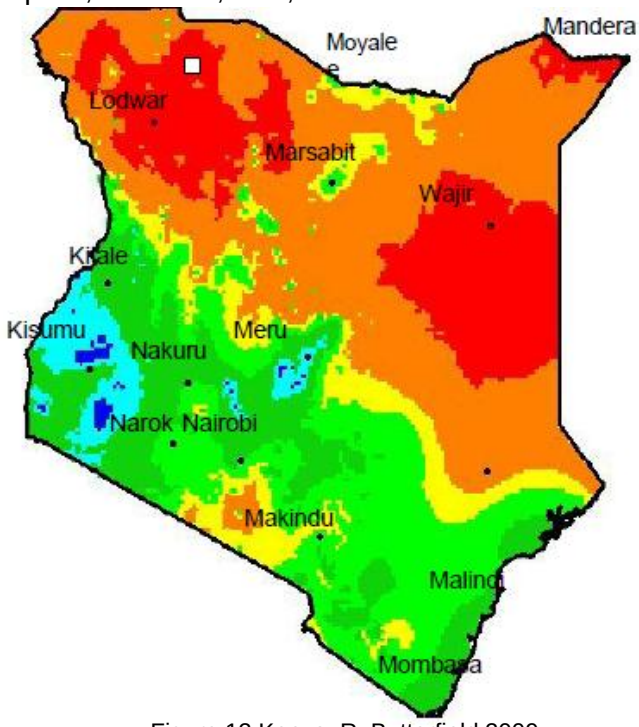

Figure 12 Kenya, R. Butterfield 2009

These weather stations consist out of cities that are divided into different climate zones, namely two cities in an arid climate zone, one in a semi-arid, two in a tropical and one each from Mediterranean and savanna climate.

Looking firstly at the city of Lodwar, situated in the North West of Kenya, a little town with the population of only 17,000 and the capital of the Turakana district is lying in a semi-arid climate, where the rainfall recorded during a time span of 30 years can be seen in Figure 13. (R.Butterfield, 2009)

Records are showing swayings from the 1960 until the year 2008. Experiencing a peak every three years, such as from 1960 to 1963, to every 10 years such as in the seventies, the highest rainfall value for this region was recorded in 1983 with a annual rainfall of 650mm. The biggest low was during the 90ies where rainfall values even below 100mm per year were measured. After a recovery in 1996 precipitation it started to decline tremendously again after 2007 with only close over 100mm. Further it has to be noted that the monthly variation in rain in Lodwar has as well decreased especially in the long rainy season. Whereas from the 60ies to the 80ies almost 60mm was recorded in the long rainy season, only 35mm were recorded from the 80ies to the first decade of the second millennia. (ibid)

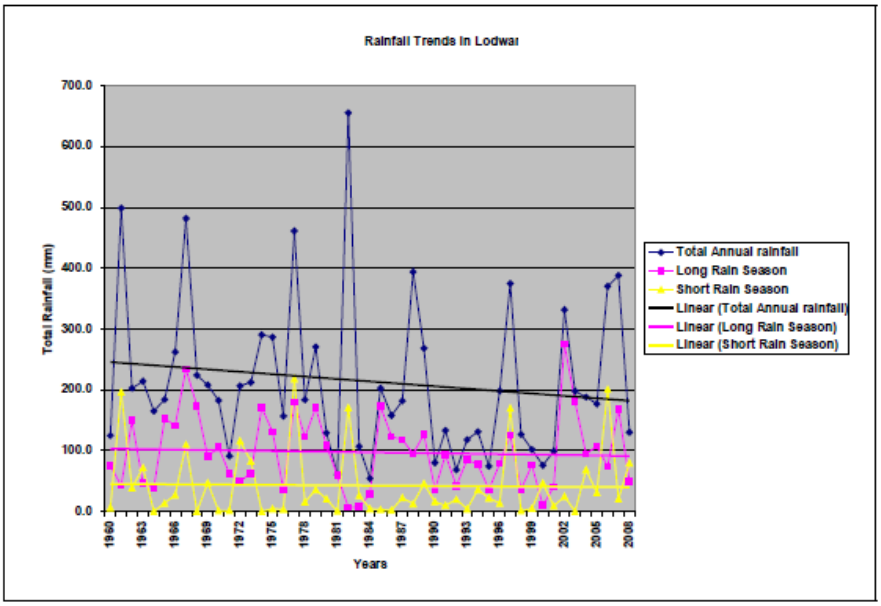

Figure 13 Lodwar, rainfall 1960-2008, R. Butterfield

As can be seen in Figure 12 Mandera is in the North East of Kenya, bordering Ethiopia and Somalia. Not only that this city is struggling with an arid climate, it is as well dealing with unemployment and Somali refugee waves.

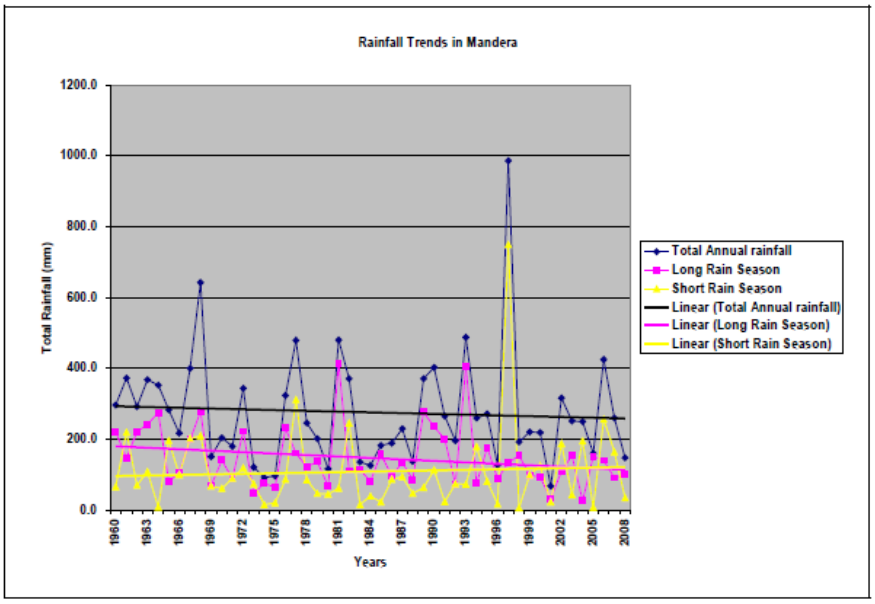

Figure 14 Madera rain fall 1960-2008, R. Butterfield

However when looking at the rainfall data, it can be said that even in the 60ies precipitation was low. Some highs are recorded such as in 1968 where more than 600mm was measured as well as in 1997 where almost 1000mm were recorded. Other than that the upper values are rather located around 500mm. However the lower values which are prevailing, in this time frame 30 out of 38 years, are measured at approximately 250mm.

Nevertheless when looking at monthly variation in rainfall comparing again from the sixties to the eighties comparing with the last 20 years than no obvious difference can be diagnosed.

A bit southerly on the map the city called Wajir is taken as another example for arid climate precipitation values. The latter is the capital of this region, represented by a small population of 32,200 people. As Mandera and many other North Kenyan cities this town is populated as well with Somali refugees as well as indigenous Somalis.

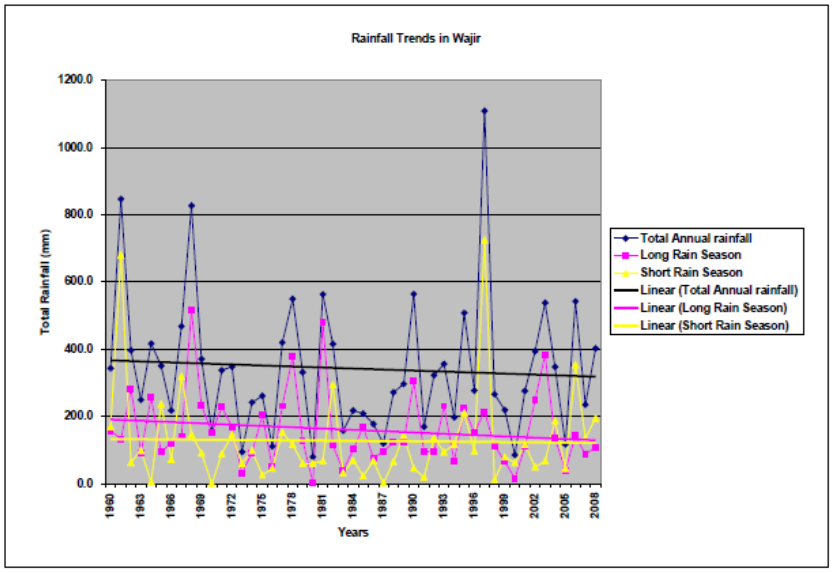

Figure 15 Wajir rain fall 1960-2008, R. Butterfield

Precipitation values from Wajir are the most fluctuating ones from the seven stations picked for rainfall evaluation. As can be seen in figure 8 annually recorded rainfalls had extreme highs as well as lows. The lowest value measured in the last 48 years was below 100mm though the highest was far above 1000mm. This is showing high uncertainties in the precipitation behavior. Since Wajir's dry land is confronted with floods on a regular basis due to intensive rainfall several thousands of people are effected and in need of humanitarian aid, whereas the last one occurred in November 2011.Regarding the monthly variation in rain no significant changes are recorded comparing the 20 year periods.

After looking at semi-arid and arid places in Kenya, a city in the tropical part of Kenya; namely Kisumu is shown. This town is situated in the South West and is the third biggest city Kenya's population wise. Further the city is located at Lake Victoria, Africa's largest lake.

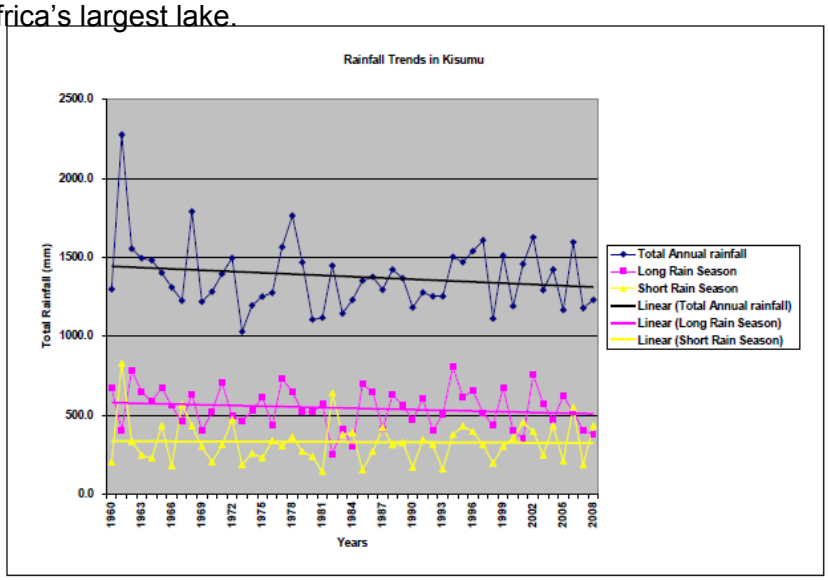

Figure 16 Kisumu rain fall 1960-2008, R. Butterfield

At first sight can be seen that rainfall values are much higher in tropical climates. The peak recorded in 1962 with 2250mm has never been measured again. Swayings from 1700mm/year to 1000mm show similarly like in Wajir high variability in the rain pattern. When looking at monthly variability, slight aberrations can be seen comparing two 20 year periods.

Another tropical city in Kenya is Mombasa. Being the second largest city of Kenya Mombasa, has nearly a million inhabitants. Situated in the South East of Kenya and being a coastal city, it is a tourist attraction ever since. However Mombasa is mostly important due to its economic location, being the single largest seaport for trade.

Similar rainfall variations as in Kisumu can be observed in Mombasa. As in the 60ies there was a low of 900mm a peak was recorded in 1997 of over 2000mm. However when looking at the linear total rainfall line a constant behavior of precipitation is observed. Looking at the monthly deviation of rain it can be said that Mombasa is the only out of the seven stations, that has increased monthly rainfall over the last two decades.

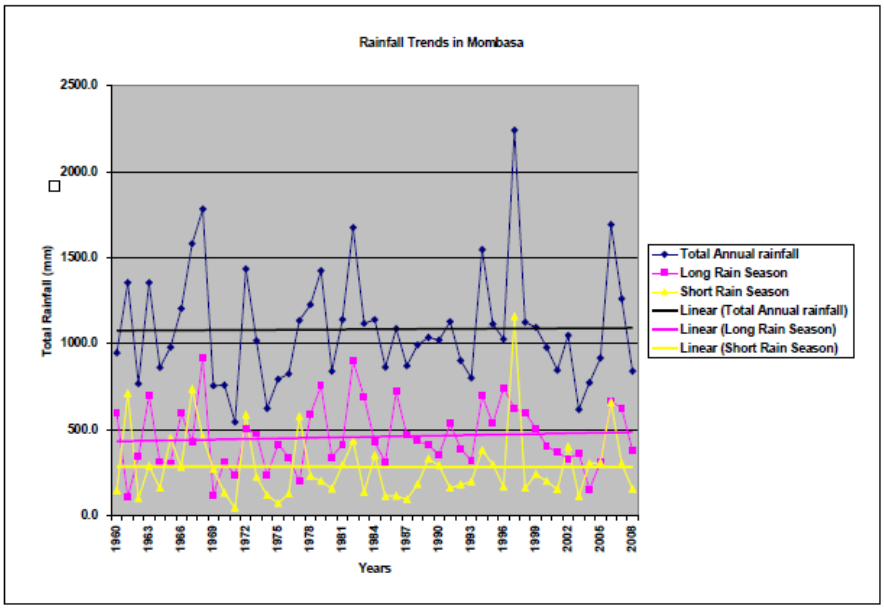

Figure 17 Mombasa rainfall 1960-2008, R. Butterfield

The next city in the South West, Narok, with a population of 40,000 people of which the majority is of Massai culture. As many Kenyan cities, Narok strongly depends on tourism income, due to the density of National parks in this area. Besides that most countries wheat agriculture is taking place in this area. Proving a point concerning climatic diversity, Narok is said to be in a Mediterranean climate zone. A strong variability of annual rainfall can be detected in this city. Again a peak is seen in the

early 60ies with 1350mm, from then on rainfall was steadily declining even though ups and downs in values was observed. Lows in values with nearly only 400mm have been frequent. As the Linear total rainfall line indicates rain is decreasing in this area.

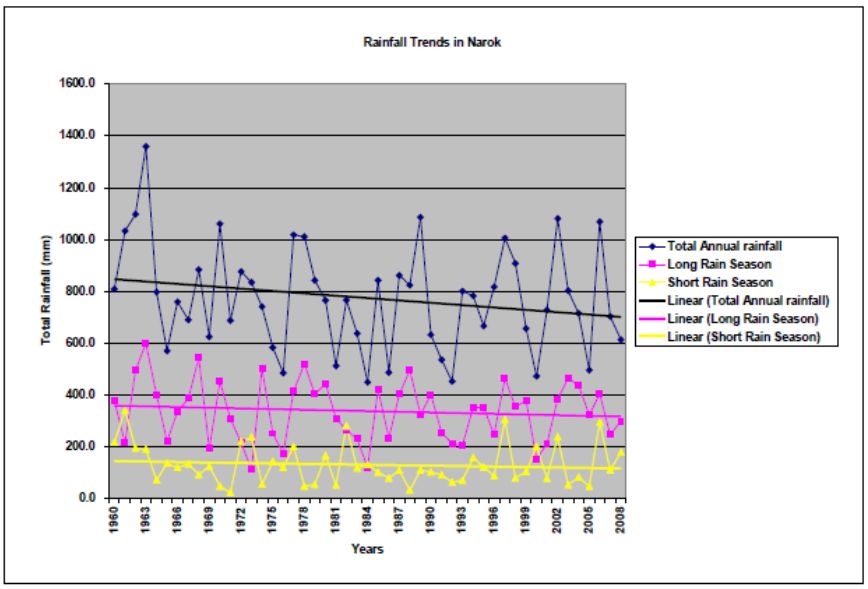

Figure 18 Narok rain fall 1960-2008, R. Butterfield

Looking at the monthly variability of rain in Narok's decrease in the long rainy season can be detected as well as in the short rainy season.

Last station providing rain data is found in a savanna climate. The name of the town is Makindu and it is located in the South East of Kenya. This town is close to the Tanzanian border and was home to Indian workers from colonial times when railroads were constructed there. The rainfall data of Makindu is as well showing high fluctuations in values in the last 48 years. Experiencing peaks in the 60ies with over 1200mm and a low in 2006 with almost only 200mm, Makindu's rainfall trend was worst in the 70ies with 5 years of 400mm of rain as can be seen in figure 12. Concerning the monthly variation in rain fall, rather high decreases in the long rainy season have been observed going from 120mm to only 80mm in the comparison of the last 4 decades.

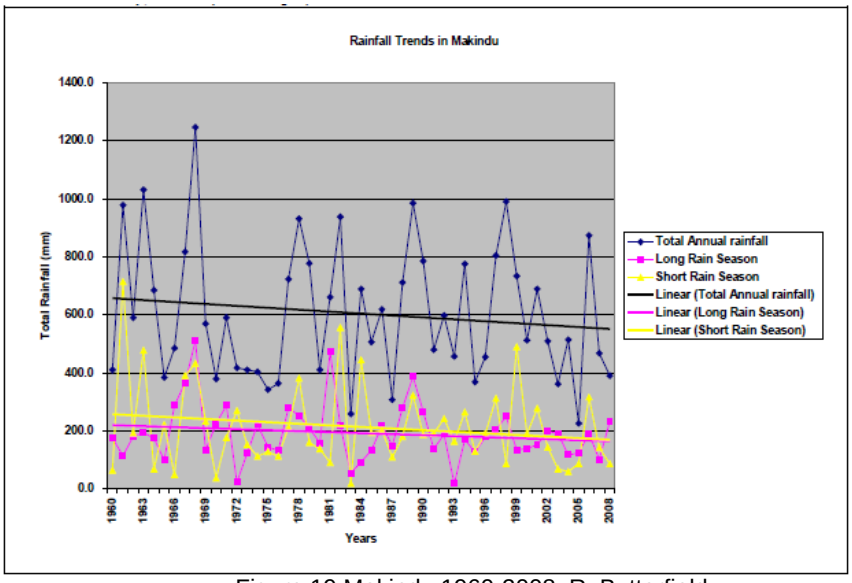

Figure 19 Makindu 1960-2008, R. Butterfield

When looking at the measures of the seven weather stations certain conclusions can be drawn. Firstly in all of them, excluding Mombasa, rain in the long lasting rainy season is declining, though in the short rainy season increasing. Further it can be said that those all of the seven weather stations are showing variable precipitation values through the years. Nevertheless according to the study by Buttersfield, a rise in intensity in rain is to be expected which means that dry areas are going to be prone to floods in short rainy seasons and droughts in long rainy seasons. By observing the graphs it can be concluded that rainfall has decreased from the seventies to the nineties of this century followed by a recovery. However if this recovery is sought to be appearing in intense rainfall then this would have no positive effect on the environment, hence the population. Moreover when looking at the temperature trend in Wajir and Kisumu in figure 13 and 14 a certain increase can be detected. Mean annual temperature is forecasted to increase between 0,8-0,9°C in all of Kenya by 2030 and 1,5-1,6°C by 2050, according to the IPCC mid-range emission scenario.

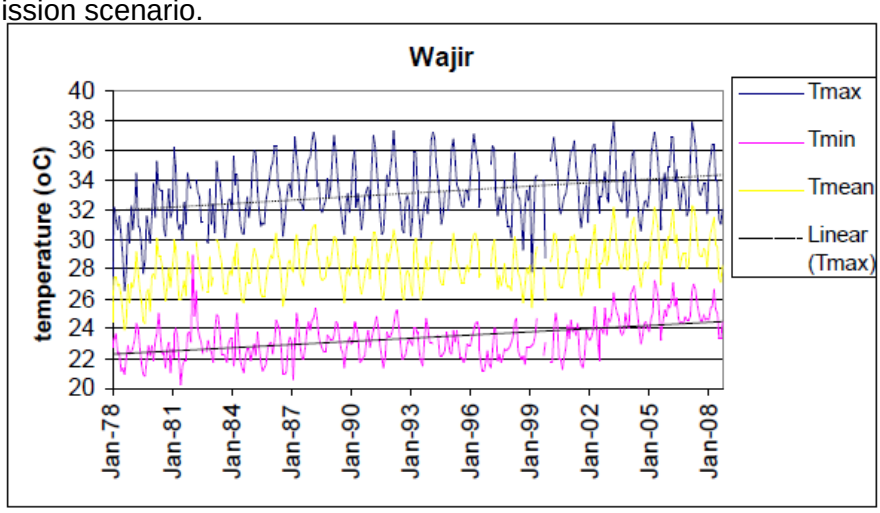

Figure 20 Wajir temperature trend 1978-2008, R. Butterfield 2009

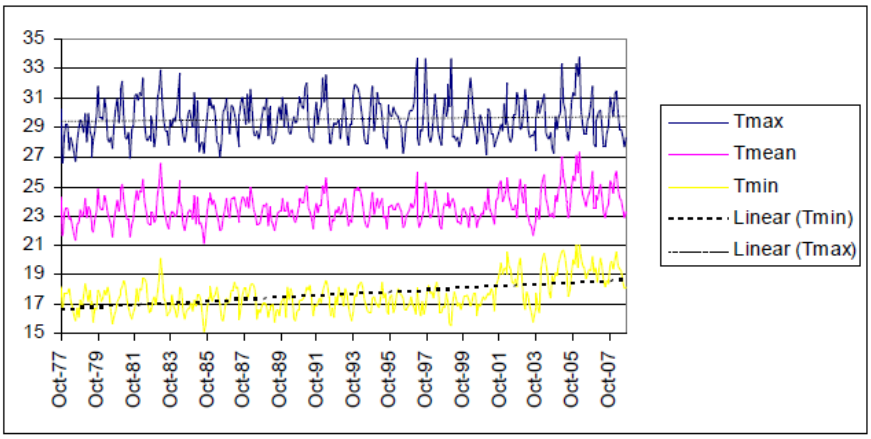

Figure 21 Kisumu temperature trend 1978-2008, R. Butterfield 2009

Further the prediction indicates that there will be a precipitation change that will annual increase by 7-9% by 2030 and 13,3-18,8% by 2050. However the precipitation change does not mean more water or easier accessible water for the Kenyan population at all. One has to consider the evapotranspiration, which will be majorly enhanced by the temperature increase that will bring about sever decline in water availability. Therefore water management and the importance of climate adaptation should be of highest priority in Kenya when overlooking the current environmental circumstances.

3.1.3. Evapotranspiration

The same seven stations are taken for measuring evapotranspiration as for the rain stations in order to be able to directly compare incoming rain with outgoing transpiring water from plants in the same region. In order to be able to display correctly calculated Evapotranspiration numbers, public software such as Climawat 2.0 and Cropwat 8.0 were used. Daily evapotranspiration values were provided by Climawat and then converted into monthly per day averages by Cropwat. These values then were projected to a yearly basis in order to be able to compare them with yearly precipitation values.

As can be seen in Figure 22 all of the seven station's precipitation values measured over a time period of 30 years are exceeded by the evapotranspiration values taken in the same time span. As already mentioned the North of Kenya is in a rather dry and arid climate. Therefore precipitation as presented is rather low. However the biggest evapotranspiration values are measured in this region. When looking at the average rainfall of the last 30 years in this town an average of 210mm/year are observed. Though the evapotranspiration in this region amounts to more than the tenfold, with 2424mm/year in average. Similar values are taken in Mandera and Wajir, as well two cities located in the arid North of Kenya, which is explaining the

dry soil. The other locations, located in different climates are not that affected by the high evaporation rates as the North is. Looking at Narok that is situated in the area of the capital namely the center, the city is experiencing a Mediterranean climate though the evaporation rate is high. However this does not affect much the living conditions as opposed to those living in the North. For the cities in the tropical climate such as Mombasa and Kisumu, precipitation is only a bit less then evaporation.

For the cities in the North this means, that with increasing temperatures and thereby increasing evapotranspiration water stress is a possible consequence. Those people that are already suffering of water shortage are going to experience even harsher conditions, especially when one considers that most of the water is needed for agriculture. As there is going to be more water evaporating less will be kept in the fields and therefore a chance of low crop yields.

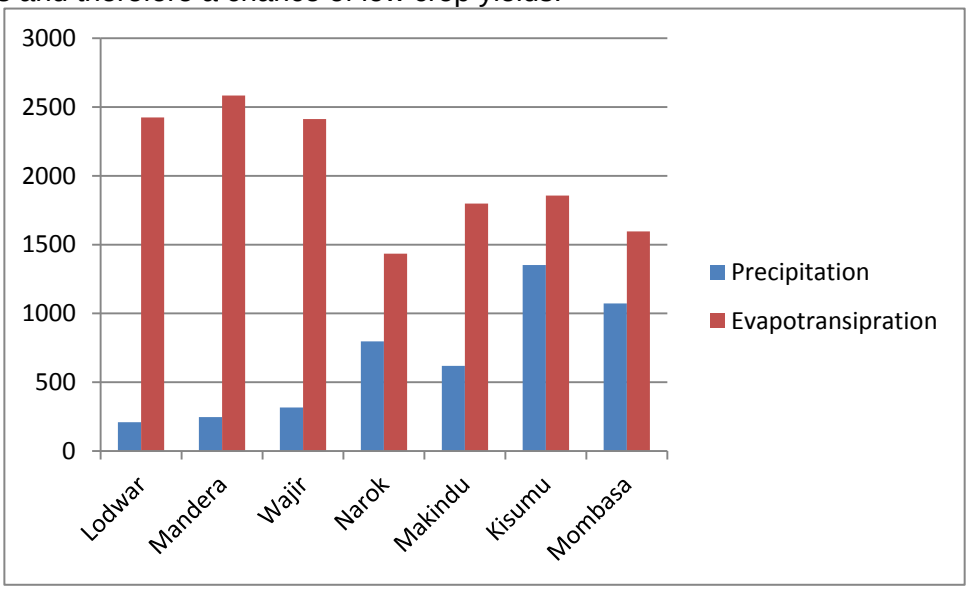

Figure 22 Evapotranspiration and Precipitation in mm/year average 1970-2000, Climwat 2012

Considering that temperature will most likely increase worldwide, according to the IPPC mid-range emission scenario, by 1.5°C by 2050, evapotranspiration will be favored and by that reducing the availability of water. Even areas in Kenya where the rain is said to be increased will most likely not end up having a surplus due to higher evapotranspiration rates and insufficient water conservation practices. Especially the areas in the North will be prone, if temperature will rise as predicted, since their already arid climate will be far worse tackled as it is today. The Northern population as well as their livestock will have to cope with even harsher living condition than they already do.

Though not only the evaporated water from the plants is giving people reason to worry, the more threatening thing for most Kenyans, especially for those in the North such as in the Turkana district, where the correspondent lake for the last decades has lost in volume bearing existential problems for those that are dependent on it's water for drinking and livestock feeding.

3.1.4. Deforestation

Deforestation has experienced a sharp rise in the East African country in the last decades. Kenya is said to have only 6,1% of its total area covered by forest, which is about 3,5 million ha. During 1990 and 2010 Kenya has lost 241,000 ha of its forest which amounts to 6,5% of its forests. Most of them are situated in the tropical climate meaning in the South East and the center of the country.(FAO, 2010)

Those reductions in forest land in Kenya bear as well negative aspect for the water bodies, such as the Lake Nakuru. The latter was observed to loose water quantity since the deforestation undertakings in the Mau forest in 2009. Further due to the fact that forest was cut off, erosion developed which has led to deterioration of soil fertility around the lake itself. (A.A. Sirage, 2009)

Another for the environment harmful effect of deforestation besides the killing of animals is the fact that by deforesting an area more the surface is changed in a manner where surface runoff is enhanced and by that water quality of proximate water bodies are worsened. One of the reasons for massive deforestation in Kenya is the tremendous population growth which will be mentioned later. In order to be able to supply the growing population with food forest areas are taken for cultivation, though not considering the mismanagement that bears the loss of moisture, the cooling affect on the temperature and the CO2 reduction. (A.A. Sirage, 2009)

Therefore it is even more crucial what happens to those 6,5% of area since they can be quite influential on the climate as well as the flora& fauna and most importantly the humans.

Figure 23 Deforestation in Kenya, Greenpeace

3.1.5. Droughts and floods

Droughts are the most common natural hazards in Kenya, appearing in the North and Northeast parts of Kenya, even though floods occur seasonally but in various parts of the country not only in the ASAL zone. Heavy droughts were taking place since the mid 70ies the latest being in 2004 affecting about 2-3million people. However the worst drought occurred in 2000 when the consequences of the latter affected 4,4 million people, bringing starvation and insufferable heat. These droughts are appearing on a cyclic basis, usually every ten years. Though when looking at the last 10 to 15 years the frequency has increased. As already mentioned the drought prone areas are to be found in the North and Northeast covering 36 districts. Again one of the most tackled districts is the Turkana district, with 450,000 people being affected by the consequences of the drought as recorded in 2000, bringing about dryness that destroys every plant life, forcing people to wander for days in order to gain some water. (P.A. de la Porte, 2004)

Floods are not that common as droughts are in the most parts of Kenya. The most by floods affected regions are in West Kenya as well as around the Tana River. Though slums in big cities such as in Nairobi are not spared of the consequences of floods, due to the fact that the self-made houses near the river, are not stable enough to stand the water masses. The worst droughts have taken place in the mid 60ies and the end of the 90ies, where the effects of the El Nino were dominating the weather in this part of the world. Those floods are caused by geogenic occurrences as well as anthropogenic like manipulation of water bodies, drainage or basins. Floods as well occurred when there were average rains, though due to deforestation

surface water runoff was increased and flooded certain areas, costing the country millions of shillings for reconstruction. (P.A. de la Porte, 2004)

Both floods and droughts come with devastating consequences for the population are sought to be counteracted against as long as there is time to do so.

In order to conclude the climatological part about Kenya firstly it needs to be said that this country is offering a great variety of climates and nature scenarios. From tropical to arid, Kenya is one of Africa's most multifaceted countries in the East of Africa. However 80% of its territory is covered in rather dry and arid climate decreasing living conditions for its population. When looking at the precipitation values especially of the Northern part of Kenya, huge fluctuations in rain measurements are observed that are of big concern due to high dependency on water in an arid surrounding. Cities like Wajir, Lodwar and Mandera, all located in the North, will have to cope with even harder weather conditions, if the IPCC Mid-range scenario will become reality. The increase in temperature by 1.5°C can have severe consequences underlined by massive droughts and heavy rains in the upcoming time. One must also keep in mind that those people living in the North are not only dependent on water for the casual household use, they as well need the water supply for their livestock which is their biggest capital for nourishing their families.

Further the already immensely high evapotranspiration in the North of Kenya, which is in the three previously mentioned cities almost tenfold as high as their precipitation values, is explaining the dry and arid climatic conditions. Though if those are said to be increased by the temperature rise in combination with heavier rain than those places will experience even lower water availability due to deficient water storage.

Deforestation is leading to heavy destruction of the needed fauna for the cooling of the temperature as well for the lowering of CO2 by photosynthesis that is in turn not letting warmth exit the earth's atmosphere and by that reheating. Though the greed of politicians is turning Kenya's anyways small scale forests into grazed lands that are in turn drying out and being then prone to floods.

All in all the climatic conditions were never ideal, though are said to become even more devastating, putting more burdens on the Kenyans especially those living in the arid climate, which is making up 80% of Kenyan territory.

3.2. Demographics

This part of the paper presents the importance of the highly increasing population of Kenya, which is alerting regarding the already poor water distribution in the country. Further the author is going to provide an insight into the different ethnic groups and their position in the Kenyan society, since this is deemed as important when considering the distribution of public goods such as water.

3.2.1. Population growth

The State of Kenya possesses more than 580,000km² of area, as already presented with a fascinating diversity in flora and fauna, a surface that is slightly smaller than that one of France. (CIA Factbook, 2012)

After decolonization in 1969 its population was counting only 10.9 million people. In less than 30 years, the population almost tripled to 28,7 million people. Today Kenya's population has risen to 43 million. As could have been seen in the section on East Africa in this paper, Kenya has one of the highest population growth rates in in this part of Africa. According to the UN ECOSOC prognosis the population growth rate will reach its maximum in the next couple of years with a little bit over 3% however this will be sufficient to establish a population of nearly 100 million people until 2050 as can be seen in Figure 15.(KNBS, 2008)

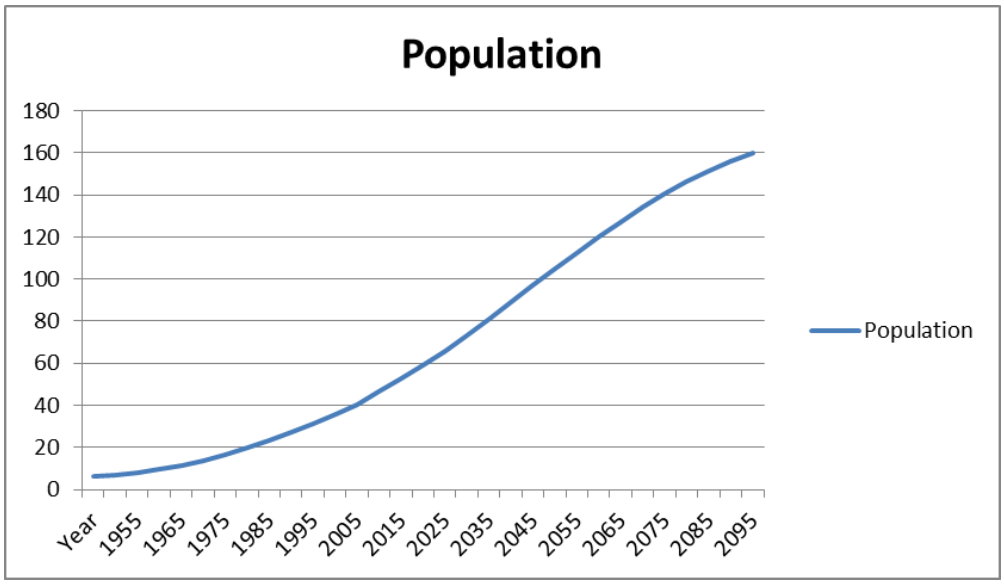

Figure 24 Kenya population growth in millions, KNBS 2008/2009

The reason for tremendously increasing population though decreasing population growth rate is inter alia the fact that Kenya has a rather adolescent population. With 43% of Kenyans are not older than 15 years, where as the biggest percentage with 15,3% of Kenyan inhabitants are represented by children up to 5 years of age. Further according to the Kenyan Bureau of Statistics about 60% of Kenyans are below 25 years of age. Due to it's very youthful population Kenya is and will encounter a challenge of securing a stable future to it's population. In order to counteract this fast growing population the government had passed an Adolescent Reproductive Health and Development Policy, which is supposed to deal with adolescent reproductive health issues such as early marriages and female genital cutting violence. According to the statistics of the UNICEF 1,5 million Kenyans suffer from HIV which are incorporated into the health plan by supporting HIV mother to child prevention as well as emergency obstetric care. (KNBS, 2008)

Another crucial factor is that Kenya as most developing countries is experiencing a sharp rise in urbanization. Presently 22% of Kenyans are living cities such as Mombasa and Nairobi. The forecasted urbanization growth rate is forecasted to reach 4,2% until 2015 which will increase the population of the presently modest cities. (KNBS, 2008)

In conclusion it can be said that the population of Kenya will be steeply rising in the upcoming decades. Therefore certain challenges have to be coped with; the economy, health and security aspects as well as the water supply for agriculture and households have to be taken into account and responsibly and anticipatory managed in order to satisfy its population essential needs.

3.2.2. Ethnic Groups

Kenya is one of the African states that is entailing the biggest variety of tribes and ethnicities. More than 50 tribes and ethnic groups are counted in Kenya, underlined by the fact that Kenyans have their origin form diverse communities that have passed today's territory and migrated to the latter during the past 4000 years, explaining why not only Kenya but also other African countries are not homogenized when it comes to their population. (M.O. Maoloo, 2005)

The biggest ethnic group in Kenya counting nearly 4,5 million people, settled in the center of Kenya (figure 16), are the Kikuyu making up for more than 20% of Kenyan

population. As a sub group of the already mentioned Bantu Gĩkũyũ is spoken though many of Kikuyus speak Swahili as well which is in Kenya and in general in East Africa the lingua franca, besides English. During colonial times the Kikuyu's land was taken away by the British displacing them from their original area, the high lands and where placed in the Rift valley which was at that time Massai territory. Ever since independence the Kikuyu have been deemed as the dominant group in Kenya. Their involvement in the resistance against the British was organized by Waiyaki Wa Hinga, a Kikuyu leader and military strategic.

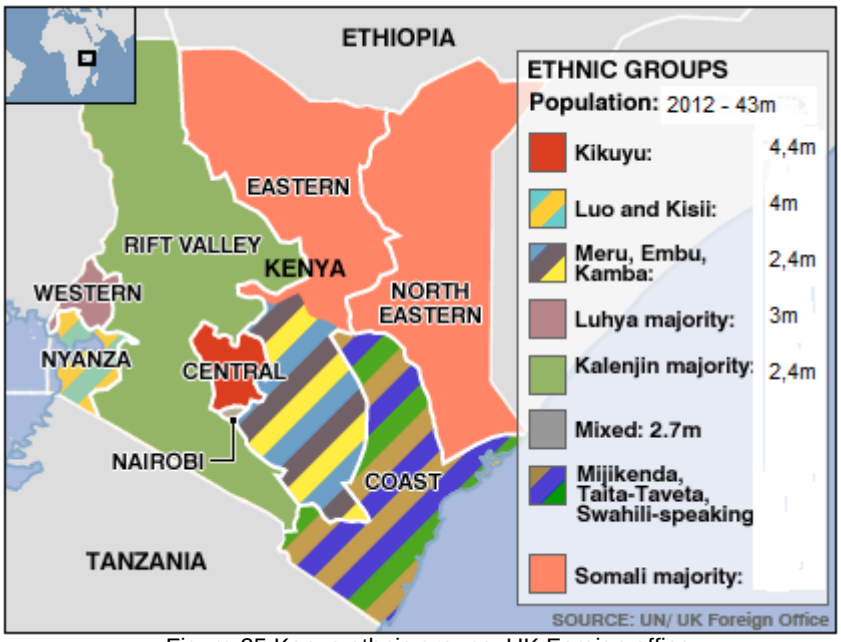

Figure 25 Kenya ethnic groups, UK Foreign office

Since 2002 Kenya's president, Mwai Kibaki is in power. During elections in 2007-2008 riots broke out due to dissatisfaction by Kenyan population due to alleged election fraud by Kibaki. Therefore attacks against Kikuyus in all over Kenya were reported due to retaliation by civilians. As international observers were allowed to enter Kenya and evaluate the situation, wrong figures provided by the Kibaki front led to even more riots and attacks. After some time Kofi Annan arrived in Kenya seeking for a mutually acceptable agreement between the allegedly Kibakia nd the opposition leader Odinga. A coalition agreement was signed which stipulates power sharing between Kibaki and the newly established prime minister position filled by Radinga and a evenly distributed cabinet among Radinga's and Kibaki's party was agreed upon. 800 people were killed during the election riots and more than 600,000 where displaced. (M.O. Maoloo, 2005)

The second largest ethnic group in Kenya are the Luhya, being a subgroup of the Bantu though again subdivided into several different tribes. Represented by a bit

more than 3 million people they constitute 14 % of the Kenyan population, settled in the West of Kenya. As the second largest group in Kenya the Luhya are have been represented in elections mostly by the position of the vice president. Three times since decolonization there has been a Luhya vice president in power. Further looking at election outcomes of the past years, it can be said that the weight of Luhyas votes are crucial in election times. This is due to the fact that mostly all Luhyas vote for the same candidate. (Horowitz J., 2009)

The Luo people, ranking the third place, with more than 2,5 million people are represented, as already mentioned, by Kenya's Prime minister Raila Odinga. The language spoken is of Niotic origin, called Dholuo and this ethnic group is not only present in Kenya but as well in Tanzania and Uganda. Most of Luos are living in the southeast of Kenya bordering Tanzania and neighboring the Kikuyu dominated center. As many Kenyan ethnic groups and tribe the Luo highly depend on farming, herding and fishing for their lively hood. (Horowitz J., 2009)

The Kalenjin population with nearly 2,5 million people is settled in the Rift Valley in the West of Kenya. As other ethnic groups, the Kaenjin are formed out of several different tribes and clans distinguished by their settlement and dialect, originating from Sudan and Unganda. Due to the variety of clans amongst the Kalenjin conflicts amongst the latter was recorded during colonization as well as after. (Horowitz J., 2009)

The last big ethnic group presented by the author is the Kambas. Making up for almost 12% of the population, the Kamabs as mostly situated in the Southeast of Kenya are as others belonging to the Bantu group. They are known to be Ivory traders in former times: (Horowitz J., 2009)

There are several other different and interesting tribes and groups in Kenya worth mentioning in this paper, though the author has decided to mentioned a few of the most interesting and for this paper relevant tribes.

The Massai counting 300,000 people in Kenya are one of the most known African tribes located around the capital. Known for their height and nomadic lifestyle, the Massai have a rather authoritive reputation amongst their neighboring people. The living conditions supported by farming in arid lands, the need of steady survival has made them to be feared by neighboring tribes since those have been victims of livestock plundering. Further the Massai are living in reservoirs that used to be the

tenfold of the present area. In contrast to other ethnic groups the Massai are holders of their land and are thereby allowed to sell the latter, based on the Indigenous and tribal People's Convention adopted in 1989. This is nowadays common due to the fact that climatic conditions have created harsher living conditions for the nomadic lifestyle of the Massai. (Horowitz J., 2009)

Another interesting rather small group of Kenyans are the Turkana. They possess the largest district in Kenya, though only counting 280,000 people situated in northwest Kenya. Due to the border to Sudan Turkana is a hotspot for war refugee, causing riots by locals. Problems due to sparse population are visible by low or non-existing political representation. As the Massai the Turkana are holding trust land, meaning that they are a self-commanded region. (M.O. Maoloo, 2005)

As can be seen Kenya is full of different ethnic groups and tribes. Huge differences in living conditions as well in security are dispersed throughout Kenya's territory. The conflict on leadership in the country is spread over several high numbered represented groups. As reported the presidential election in 2007-2008 was just a glimpse at, how easy violence can erupt due to the dissatisfaction of the population. The importance of prevalence of one group is a problem that can't be avoided on the long term, though managed properly by Kofi Annan's mediation, splitting the power between the leading parties. However as will be seen in the upcoming section, Kenyans are highly dependent on agriculture and livestock feed, sufficient water supply being essential for both. And if becoming low, this potential reason for conflict is what needs to be analyzed further.

3.2.3. Water stressed regions& availability

About 40% of the surface on the Earth is covered by so called ASAL (arid and semi-arid land) where 1 billion people are housing. 12 million Kenyans live in the ASAL zone, which is mostly located in the North of the country covering in total 80% of territory. Those parts of Kenya are said to be water scarce regions, meaning that there is less than 1000m^3 per year of water available per person. Further this area is home to Kenya's poorest, whereas 65% of people living below a certain standard in Kenya are to be found in this part. Moreover most of those people are pastoralists, being not only dependent on water for themselves and their families but as well for their livestock. Due to more frequently occurring droughts, rising temperatures and deforestation these undertakings are getting harder and harder. It is to be noted that the half of Kenya's cattle are held in this part of the country and 100% of the camels

to be found in Kenya, implying that water availability is of high importance in order to be able to supply the latter. (B. M. Mati, J.M. Muchiri, K. Njenga, F. de Vries and D. J. Merrey, 2006)

However when looking at Kenya as a whole country the water availability does not really ameliorate. In allover Kenya the water demand is higher than the actual supply. Even though there have been several attempts to better the situation, such as by introducing the National Water Master Plan in 1992 and the Water Act in 2002, the supply did not improve for most Kenyans.(Aquastat, 2006)

Huge inequalities are observed in big cities especially. Where the poorest have to pay 3-30 cents per 20 liters of water, those who are living in the pricy neighborhoods only pay 1,7$ per 10,000 liters, or less than 1 cent per 20 liters.(Omungo R., 2007)

Even though a lot of money was invested internally as well by foreign donors into the water supply systems no enhanced results where shown. Besides the fact that developed countries should not be starting to privatize public goods such as water due to the possibility of unfair pricing, Kenya has partly privatized the water supply. About 60 companies are present providing water to the population, though rural areas such as the North are left out of the supply or poorly supplied. The bad connection to the rural areas is explained by insufficient financing due to a moneyless government, such as in Mombasa where the water pipes are 250km long reaching to the next water point for supply. (WASREB, 2012)

Nevertheless it must be said that water supply as all other undertakings are not a fast process of learning. One must keep in mind that for a developing country like Kenya, the efforts made to supply its population are remarkable. The past decade of trying to establish steady supply of water to its population is only the beginning, where mistakes can happen. Further according to surveys, done in urban regions where water supply is supposed to be good, more than 75% of the people deem the water to be drinkable non-smelly and clear. However rural regions and the poorest are fighting for survival, being dependent on street sellers and weather conditions.

3.2.4. Agriculture

Agriculture is the biggest income source of the Kenyan economy contributing to 27% of the Gross Domestic Product employing more than 70% of the population. Kept in mind that approximately 80% of the Kenyans live in rural areas, the latter are responsible for a big part of the economic turnover. Moreover only 8% of total Kenyan territory is fertile due to the arid and semi-arid climate. Nevertheless the country's export, which amounts to 1/3 of the production, of coffee, tea, onions, cabbages and flowers makes it competitive on the world market.

According to the Strategic Agriculture Report, the Kenyan sector of agriculture has risen by 5,2% in the past 5 years. Further agriculture has been identified to be one of the 6 main sectors that are supposed to rise 10% annually for the upcoming 2 decades, by that counteracting poverty and hunger by 50%, achieving one of the millennium development goals by the year 2015. The Strategic Plan foresees to reform institutions, increase productivity, transform land use in order to be easier to farm, support ASAL for pastoralists and increase market access. (Strategic plan, 2009)

However Agriculture demands 80% of Kenyan water consumption currently. Keeping that in mind and combining this figure with the steeply rising population the problem of sufficient water supply for agriculture; hence the supply with food and water for the population rises. (Strategic plan, 2009)

At the moment the development of more efficient irrigation is managed by private companies, for those crops that are used for efficient and mass productive cultivation. Close to the urban areas of Kenya, commodities for the export are bred. Though this bears discrepancies since farmers for local supply are complaining about the extension of water pipes for irrigation throughout Kenya. Since most of those companies are now in private hands, the supply with water for irrigation in ASAL zones has to be funded by external support. Therefore new approaches are approached by the pastoralists in the ASAL zones, such as rainwater harvesting. However in order to utilize the water in a consequent way storage mediums are needed, which are in most cases absent. (Strategic plan, 2009)

The governmental participation in the sense of how to irrigate properly has been done by the Ministry of Agriculture and Water, where guidelines were established on

how to operate, develop and properly manage irrigation for a small held farm. Even though such guidelines are present there is no existing legality except the irrigation act of colonial times stipulating the tenant based irrigation mechanisms. Further the water needed for irrigation has to be permitted by the government and paid by the farmer, which are depending on the duration and type of use.

So as can be seen agriculture is one of the key economic activities in Kenya. It's well-being is not only important to the domestic economy but also can play a role of reducing poverty in the sense that if agricultural conditions are improved more jobs can be created, more food can be produced and by that more people can be nourished, especially those in ASAL zones that are prone to malnourishment and poor living conditions. However one must bear in mind that there is only a restricted availability of fertile land which might not be sufficient for supplying whole population. Therefore not only the 8% first class land has to be used but as well the low value crops in order to be able to provide equitable distribution amongst Kenyans. Another factor that is supporting this idea is that due to the growing population expansion in the sector of agriculture has to be undertaken by any means. As already mentioned 50% of total Kenyan cattle are held in those regions that are arid or semi-arid, needing water supply. (Strategic plan, 2009)

An example is the Isolo district, situated in the center of Kenya, having a arid climate. It was calculated that only this district would need 2,2 million m^3 per year in order to supply livestock and population. Water pipes and taps are not present in this area, 60% of the people rely on groundwater though only 1/5 has access to groundwater.

Problems like that are meant to be tackled by the strategic plan of the Ministry of Water and Agriculture, though the question remains whether the financial burden can be overcome and if the rainy seasons are going to be supportive.

3.3. Conflicts

As water sources are dwindling on a yearly basis in all of Africa, but severely in the East of the continent, conflicts are arising due to the high dependence for agro-pastoralists on steady water supply for their daily survival. One of the most prominent examples of water conflicts in Africa is the one of the Nile. About 9 states are on the steady struggle to legally share the waster masses of the Nile. The only country always trying to disrupt negotiations is Egypt, understandably due to its location as the downstream country, though as well threatening upstream countries with the state of war if dams or any other undertakings occur that might change the water flow towards Egypt.

However those circumstances are not only found amongst states but as well within. Therefore two examples of conflicts occurring in Kenya are provided; one that is internal, hence amongst Kenyan ethnic/regional groups, the other one will represent an example of a transboundary conflict.

3.3.1. Ewaso Ng'iro River basin

The Ewaso Ng'iro River is situated in the center of Kenya on the west side of Mount Kenya. It is of 15,200 km² size, from Kenya it is passing though Somalia and is home to about 600,000 people, whereas the region itself is said to be water scarce, due to the fact that 72% of the basins area is in arid climate. The river has 15 tributaries that are contributing into the flow which starts at Mount Kenya and ends in a swamp.

The people living in the upstream are the Kikuyu and Meru. This area is said to be semi-arid and therefore successful harvests are not possible on a yearly basis. In order still to be able to cultivate crops where food can be cultivated on regular basis irrigation by sprinklers and floods are used in order to raise the crops. For gaining sufficient water for their irrigation undertakings, the Kikuyu and Meru, have already constructed more than 200 little intakes in order to stop and collect water from the river and by that feeding their crops. Even though they are claiming that their water outtake of the tributaries of the Ewaso River is sporadically, the people living downstream can observe the decline. (Netsquared, 2011)

Those being dependent on the Ewaso water on the downstream side are agro pastoralists, like the Massai, the Somali and the Pokot. Mostly small-organized communities that are surviving in arid land by possessing livestock are using the

Ewaso water. Therefore if water declines and there is no possibility of watering their livestock, anger against upstream people are easily evolved. Moreover by the occurrence of droughts livestock dies due to the lack of water. Therefore those pastoralists are then forced by the natural circumstance to move towards the upstream tributaries where they encounter those that are partially responsible for their water shortage. Cases were recoded were downstream groups have wandered northwards and when encountering intakes destroying them, leading to conflicts where the presence of the police was necessary in order to halt a fight. Further as observed in 2004, pastoralists due to heavy droughts, invaded white owned farms , where mediation team Seanet International had to intervene to hinder a total take over, supported by food relief programs of the state and NGOs. (Netsquared, 2011)

3.3.2. Lake Turkana

The Lake Turkana, is situated in the Northwest of Kenya. It is home to about 300,000 people from several different tribes. Since the lake is located in the North, aridness is prevailing the climatological conditions, though at the same time being the biggest desert lake in the world.

This lake is one of the biggest soda water lakes in the world, it's water level is steadily shrinking. The lake used to be situated In the North of Kenya and South of Ethiopia, though due to decreasing water the lake shrunk and is nowadays mostly to be found on Kenyan territory. This gave a reason to the Ethiopian tribe, Daasanach to move according to their traditional water source. The neighboring tribe, the Turkana did not welcome this approach. The latter is represented by a tenfold higher number then the Ethiopian Daasanach who are highly dependent on the water of the lake. In former times the border between those two tribes was the Omo River delta that flows into Lake Turkana from Ethiopia. However as already mentioned these borders have been moving south due to shrinking of the Lake causing the Dasaanach to move along. Due to the change in water availability and the appearing of Ethiopian agro pastoralists on Kenyan territory about 70 Kenyans and Ethiopians have died, due to retaliatory violent actions. (International rivers , 2009)

Not enough that the lake was anyways shrinking due to high temperatures and therefore higher evaporation rates as can be seen in Figure 26, it was later on also decided by the Ethiopian government to construct a dam, called the Gibe III, which would halt water that usually was going from the Omo River into the Lake Turkana. This would in turn cause the main source of the Lake to more or less to be

completely shut down. Though the goal of the Ethiopian government is to construct the dam, gain energy by hydro plants and then sell it to neighboring countries such as Kenya, hence taking again away from the poorest and selling it to the richest. A energy purchase contract was agreed upon between Kenya and Ethiopia in 2006, though no specifications on the effects on the Lake Turkana were discussed. That means that the people living in this region were not informed nor advised on how they can protect themselves against certain changes in the river level. In an area like the Lake Turkana where several dozens of different ethnic groups collide, a conflict due to low water availability, claiming a high number of casualties, is of big concern. (International rivers, 2009)

Figure 26 Lake Turkana 1975& 2010 Comparison, Yale 2010

This dam would cause the Lake to loose seven to ten meters in depth in the first couple of years due to the fact that the dam is in a upstream position reducing water in downstream territory. Additionally five to eight meters are already lost due to climate change. Further when looking at the financial aspect of this project, one has to consider that the Ethiopian government cannot bear the costs by itself. Therefore foreign investors are of uppermost importance. Those might be the African

Development Bank, European Investment Bank, JP Morgan Chase and the Italian Government. However those financers are always asking for an Environmental Impact Assessment, which shall show that the environment is not affected by the undertakings. The one that the Ethiopian government issued, was including information such as, that the dam construction will help increase the water level of Lake Turkana. Therefore most of the investors backed off, despite the African Development Banks which his still considering to lend money for the project. (Circle of blue, 2011)

The construction of this dam will most likely lead to water depletion, resulting in less water available to those living in ASAL zones in North Kenya and the South of Ethiopia, though the Turkanas would be much more effected, since they outnumber the Dasaanachs. Further the mixture of the several dozens of ethnic groups and the increasingly worse weather, hence water conditions can easily disrupt into armed conflicts, as already experienced in this region.

So as can be seen conflicts are occurring as well in Kenya amongst different groups. It is ironic that those that are the wealthiest in the country. The Kikuyu and Meru, have the upper hand on the water supply for most pastoralists in this region. Also indicated by the presidential election riots in 2008 it is visible that people are in general dissatisfied and ready to fight and stand against inequalities, if that is against each other or different nationals.

4. Conclusion

In this section of the paper it is reflected upon the research question, which is solely treating the topic of whether or not the decrease of water availability due to changes in climatological conditions, anthropogenic influences and population growth might cause major conflicts amongst Kenyans as well as trigger conflicts of transboundary nature.

This paper presented in firstly East Africa as a whole. The climatic conditions were described, including precipitation evaporation and runoff. It was shown that rain will increase in the short rainy season, which is at the moment responsible for only 24% of the total rain, though this excessive amount of rain will be missed in the long rainy season where people are dependent on rain the most. Evaporation is also increasing, as shown at hand of the big water bodies of East Africa, such as the Lake Victoria, that has lost already one meter of its water level. Further it was looked at the demographics of East Africa, where population growth is averaging with 2,6% per year, resulting according to the UNFPA report 2011 in 710 million people by the year of 2050, being the third biggest population block in the world. Moreover 75% of the East Africans are dependent on agriculture as a labor force, which makes the latter the most important source of income for most of the people. However agriculture in East Africa is dependent on rain availability, since most fields are rain fed and as well on the irrigation, since without the latter a harvest would be possible only every 5 years in arid regions of East Africa. The water consumption by sector as well as the effects of urbanization on water availability was described in order to show how the poorest in the peri-urban areas are facing high prices for drinking water.

The major part of this paper focused on Kenya. It was taken as an example for the reasons of diverse climate conditions and multifaceted ethnic groups within the country. As Kenya's North is an ASAL zone it is highly dependent on precipitation for its agriculture. It was looked at precipitation values of seven different stations and it was found, according to the studies of Butterfield that rain will increase in Kenya by 7%-9% by 2030. Nevertheless this rain might not be of benefit since temperatures will increase as well and thereby causing high evaporation in northern cities such as Lodwar and Wajir where the latter is already ten times as high as the rain. Further Kenyan ethnic groups were shown as well as their problems amongst each other such as the presidential riots in 2008, indicating on the propensity to

violence. As in the previous chapter, the importance of agriculture was shown with 80% of the Kenyans being employed in this sector as well as the plan by the government to boost agricultural undertakings and support tits nation in the latter. Already occurring conflicts were presented as well to underline those conflicts such as at the Ewaso Ng'iro basin where disputes amongst Kenyans are common. Additionally a trans boundary water conflict was presented displaying disputes amongst Ethiopians and Kenyans on a water body that used to be on both country's territory though due to receding of the water is now only found in Kenya. Therefore conflicts occur when the Ethiopians are following the water into Kenyan territory.

Taking, for East Africa firstly, into account that most countries are found in rather arid climate zones with rapidly growing population growth rates as well as a high dependence on rain fed agriculture those factors might make the East African population vulnerable to changes in climate patterns. If that might lead to a conflict is rather hard to predict. Though it can be said that due to rising population, receding water sources and changes in precipitation and temperature, water shortages are likely to increase. Especially when taking into consideration that agriculture is demanding the biggest part of water used in total by an East African country. When looking at the current situation of East African countries 10 out of the 19 presented are listed under the Least developed Countries (LDC) worldwide, characterized by low income, economic vulnerability and strong deficits in nutrition, health and education. (UN-OHRLLS, 2005) Therefore if those that are already struggling with poor living conditions are said to be hit the hardest by effects of climate change, such as the variability of rain and increase in temperature, combined with a fast growing population, even lower than present food availability caused by water shortage is of a high chance in this part of Africa providing a basis for internal as well as tans boundary conflicts. According to the international organization Oxfam, 12 million people lack proper access to food, clean water and basic nutrition in East Africa. Refugee waves from the horn of Africa into Kenya and Ethiopia are high as never before, according to Isaiah Esipisu, a journalist for the Somali International Press Service, due to the worst droughts in the last 60 years. The Somali refugees mostly stay in the North of Kenya and East of Ethiopia where they encounter the similar hard living conditions. Those migration patterns, where people that are trying to leave drought areas are moving into other countries where resources are short as well, is also providing a basis for disputes amongst the domestics and refuges which might end up in a resource or food conflict, again caused by water shortage.

Therefore the chance on conflicts caused by large populations lacking proper access to water and adequate water availability in East Africa is of a high chance in the upcoming decades.

80% of Kenya's land is covered in arid and semi-arid climate. Predominantly in the North, rain is of upmost importance for the agro pastoralists in order to be able to feed their livestock and families. However, as shown, rain is varying and predicted to rise as well as the temperature, meaning that even though there is more rain the rise in temperature will cause even higher evaporation with less water left for the inhabitants to use to feed their livestock. Thus if one considers that Kenya's population is supposed to rise to almost 100 million by 2050, given the worsened climatological circumstances, the population will face harsher living conditions than it does now. Droughts causing mass starvation, leaving 5 million Kenyans in the need of external food aid are present scenarios, though if the population doubles in the upcoming decades the water availability will not be sufficient according to the large number of inhabitants. As Kenya is holding a large variety of ethnic groups, discrepancies between the largest ethnic group, the Kikuyu and other ethnic groups that felt betrayed due to election fraud by the Kikuyu president, such as the riots at the presidential elections during 2008 showed that violence is easy to erupt due to dissatisfaction of the mass. Examples of conflicts due to decreasing water availability, as described in the chapter on conflicts in Kenya serves as evidence of already occurring tension due to low water availability in Kenya. It showed that amongst Kenyans, as in the case of the Ewaso Ng'iro river basin, where intakes by upstream groups were constructed to hold back water for personal irrigation led to the movement of pastoralists, who have been affected by the water shortening due to the intakes, towards the water body. In this case they encountered on their way, those that have constructed the latter and there by the issue could have only been resolved by the police. The other example, of the Lake Turkana, where Ethiopian groups are moving onto Kenyan territory to use water of the lake is showing how conflicts of trans boundary nature are established, causing armed surveillance of the water and the surrounding territory by Kenyan pastoralist and 70 dead people. Therefore if currently there are armed conflicts due to the utilization of water by different groups, caused by the lack of water availability, there is a high chance of a far bigger number of victims due to the lack of water, if one takes into account that it is forecasted that temperature increase is going to cause higher evaporation and therefore less water accessible to the population in combination with the prognosis

of nearly 100 million Kenyan inhabitants by 2050. This means that if there are already conflicts of this nature, the potential that these conflicts reach far more victims due to a bigger population, is foreseeable. Another factor that might play a role in this scenario is the construction of the Gibe III dam which is meant to generate energy by hydro plants by the Ethiopian government. This energy is supposed to be sold to neighboring countries like Kenya, which might let the Kenyan government feel betrayed since it would cause not only less water for the domestic Turkana tribe but as well the migration of a lot of Ethiopian Daasanach to Kenya. This might also serve as a basis for international conflicts due to water scarcity in this region.

The question therefore arises *How can water scarcity and the resulting possible conflicts be avoided?*

There are several countries in Africa having difficulties managing their water resources properly when looking at their population growth or position on the river flow. One of the most prominent examples is the Nile River Basin case. This region around the Nile River is inhabited by 160 million people, from 9 countries, whereas the population is foreseen to double in the next decade. Further countries like Egypt and Sudan, bearing the highest population within the group of these 9 states, are highly dependent on the water of the Nile River. That is due to the fact that firstly they are downstream countries, therefore dependent on the action of the upstream countries, if agreeing to the equitable distribution of the rivers water. When looking at the other 7 countries more water sources exist on their territory and more water per person can be allocated as in Sudan and Egypt. Additionally the Nile Agreement of 1929, renewed in 1959, allocates the right to 55bnm³ out of a total 84bn m³ to the Egyptian control, including the Nile water outside the Egyptian territory. Therefore Egypt is claiming that any irrigation or dam projects that is desired to be undertaken by the other 7 states and is affecting the amount of water flowing towards Egypt is ought to be allowed by the Egyptian government. Even though the 9 member states of the Nile Basin Initiative (NBI) are seeking cooperation for the last 12 years through the initiative the upstream countries were opting for independence from Egyptian claimed control over their water undertakings. (Lumumba P. 2007)

Though after the Arab spring, hence the substitution of former president Mubarak by a new government the relations to the other Nile Basin countries have bettered. Sharaf, the new Prime Minister has agreed upon with the Ethiopian Prime Minister,

Zenawi, that a new era concerning the Nile Basin relations has started, promising to be part of a win-win situation for all participatory parties to the Nile Basin Initiative, which is a intergovernmental organization amongst Nile Riparian states, aiming at equitable and sustainable management of the river.(NBI news, 2012)

A commission, consisting out of representatives of all member states is governing all decisions and undertakings supported by a Secretariat. The NBI has also integrated a Shared Vision Program that is based on the establishment of interactive and coordinated undertaking amongst the member states, constituting a facilitated network. Projects like providing training in water resource management by supporting the development of resources and institution building should be of aid for farmers and abutters of the Nile river, resulting in schooling for more efficient and increased production use of water.(NBI mission 2011)

Similarities are shown in the case of the Okavango River case. The river is situated in the South of Africa and is claimed to be one of the still unindustrialized rivers in the world. This river system is the fourth longest in whole Africa reaching 1,100 km in length from central Angola through Namibia towards Botswana. Further this river delivers a foundation aquatic life as well as its landscape that provides a water source for several species. It is of supportive nature to the riparian population with their livelihood from fisheries to agriculture and for Botswana this river system also bears a steady income by its attraction for tourists. In general this river basin, meaning the Okavango river tis self and its tributaries, is populated by 921,890 people satisfying the basic needs of the latter and is as well forecasted to grow to 1,28 million people by 2025, consisting out of 13 different main ethnic groups.(OKACOM, 2012a)

All three countries are struggling with water scarcity. 70% of Namibians, mostly living in rural areas, climatological changes that result in extreme droughts, will be affected by water scarcity, according to a South African newspaper article. (iol, 2012) Angola is said, according to USAID, the biggest rate in diarrheal diseases worldwide with 114 out of 100 people dying due to the latter sicknesses.(Webgovernment, 2011) As for Botswana, its North is as well affected by water scarcity, due to rainfall variability, upstream abstractions and tectonic instability. (Ringrose S., T. Bakaya, L.Cassidy, W.Matheson, M.Masie, 2010)

In 1994 the three countries have decided to create an agreement that is responsible to handle coordination and issues regarding Okavango waters in Namibia’s capital

Windhoek. The Agreement stipulates that members cooperate in a coordinated and environmental friendly way when it comes to the water development in the Okavango region. At the same time the signatory parties agreed upon respecting economic needs of each member state when it comes to undertakings around the river system as well as recognizing the effects that projects in upstream countries can have on downstream ones. (OKACOM, 2012b)

In order to being able to regulate the cooperation within those countries an organ was created, namely the Okavango River Basin water Commission (OKACOM), whose task it is to give technical advice to the governments of the three countries. This task includes consulting in the development, conservation and utilization issues. Further OKACOM may also be assigned to solve assignments given by the member states to the latter. However the most important task of the OKACOM is to pre empt any uncoordinated allocation of the river's water, meaning to coordinate projects in a manner where no member is affected negatively. (OKACOM, 2012b)

OKACOM is made up out of three representatives from each member state, whereas it receives technical support by the Steering committee which consists too out of three representatives from each country and as well out of task forces. The latter is overlooking effective policies that are supposed to lead to an efficient governance of the Okavango delta. Other organs like the Hydrological task force, which oversees the rightful interpretation of water data and the Biodiversity Task force which controls the implementation of the animal and plant life, are crucial in order to keep up sustainable development in this area. (OKACOM, 2012b)

The Protocol on Shared Watercourse Systems by the South African Development cooperation (SADC) is a treaty that constitutes the main objectives for river basin institutions established in this region such as the OKACOM, emphasizing on monitoring the execution of development plans in shared watercourse systems and the equitable utilization of shared watercourses. Moreover the functions of such are described in the protocol as well as the definition on the settlement of disputes which occurs in case two parties to this agreement can't settle their disputes out of court, the case is ought to be brought in front of the Tribunal of the SADC. (SADC protocol)

The two examples of the NBI and the OKACOM are showing that African countries which are as well experiencing water scarcity and being forecasted to have low

water availability in the future, managed by international agreements and the establishment of supra governmental organs to steer the utilization of common water sources in a productive and mutually beneficial way. It is proposed that, in the case of Kenyan Lake Turkana, the utilization of the latter is stipulated in a formal agreement, where as in the example of the OKACOM and the NBI, countries agree to cooperate in a coordinated and environmental friendly way when it comes to the water development in the region. Shared vision programs as in the NBI, boosting cooperation amongst member states, such as training in water resource management as well as schooling people in order to achieve more efficient use of water, would be a crucial step forward for the people in the Lake Turkana basin. This might also result in a friendly approach amongst former belligerent ethnic groups such as the Daasanach and the Turkana, if they would be schooled together, as it is done in the Confidence Building and Stakeholder Investment project which is supposed to increase the interconnection of existing stakeholders, ranging from the farmers to the decisions makers in policy. This project would also be of advantage to all stakeholders since it is responsible for publishing examples of accomplished projects, designing a positive example for the investors as well as for the people who are living in the proximity of the river. Further it would be beneficial, if this supra governmental organization amongst Kenya and Ethiopia would be led by equal representatives as it is in the OKACOM and NBI. Transparency in this matter would also be of upmost importance. As in the case of the dam construction by Ethiopia which might be harmful for the downstream country Egypt, where it was agreed upon that Egyptian official are allowed to have an insight in the plans of the dam construction in order to ensure their accordance with the construction of the latter. This type of transparent cooperation would leave no room for hostile thinking and could also be applied to the case of the Gibe dam III that is planned to be constructed in Ethiopia and that might cause decrease of the Lake Turkana water level. However in order to completely delete the option of having conflicts as a result of unequally used water of the Lake Turkana, a similar treaty as the Protocol on share Watercourse Systems established by the member of the SADC. Such a treaty amongst Kenya and Ethiopia might ensure that any disputes that might arise, can't be settled out of court, but is ought to be brought in front of a 3rd party's court.

The already poor Kenyan population will be facing harsher living conditions in the upcoming future, caused by climatological changes and anthropogenic influences as

well as population growth. These living conditions will be worsened by lower water availability, lower than it already is, and by that might be able to cause starvation of several thousands of Kenyans, who will be put in a position for literally fighting for their survival. Therefore it is of crucial importance that a supra governmental organization is established in order to be able to maneuver those type of conflicts into a safe and fair environment, where an impartial court can rule on the further procedure.

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