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Climate Change and Agriculture in Babati Awareness Strategies Constrains



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Abstract

Climate change caused by green house gas emissions, mainly carbon dioxide, is today's most debated environmental issue. The United Nations Framework Convention on Climate Change, with the legally binding Kyoto protocol, is the emission regulatory framework. Tanzania has ratified both the conventions supporting carbon reductions.

Tanzania has a very varied climate with two rainfall regimes dominating the country, bimodal and unimodal. Scientific literature predicts a 2,2-4°C average increase in temperature for Tanzania, all studies also predict a higher increase in the cooler period and lower in the warm period. Rainfall predictions are less certain but in general a 10 % average increase is expected but the distribution uneven, both between rain periods and geographically. Tanzanian reports estimate a 5-45 % increase in rainfall in bimodal regions and a 5-15 % decrease in unimodal regions. The distribution of increase in bimodal regions will be uneven, with an increase in the long rain period and a decrease in the short rain period.

Agriculture is indisputably the most important source of income in Tanzania standing for 80% of employment and 50% of GNP. Climate change will therefore inevitably affect the economy and livelihood of people. Developing countries are also more vulnerable due to lower adaptation capacity. Effects on Tanzania are predicted to be both positive and negative. Maize production, the major staple, is predicted an average 33% decline while cash crops like coffee and cotton are predicted to increase. To be able to adapt there first has to be a perception of need to adapt, adaption strategies then have to be developed and barriers worked through. The purpose of this thesis is to investigate the level of awareness, strategies and barriers existing for adaption to climate change on national, regional and local level, Tanzania nationally and Babati regionally and locally. The research questions are; How do people perceive climate change? What are the strategies for adapting to climate change? What are the barriers for adaption to climate change? At national level policy framework and strategies were used to answer the research questions. At regional and local level a field study was conducted in Babati to answer the research questions at these levels.

The study showed that Tanzania nationally has declared their conviction in climate change and state that the issue has to be addressed. Agriculture is identified as one of the most vulnerable areas however climate change is not mainstreamed into agricultural and environmental policy framework. In Babati district no policy was found on climate change and official perception varied. Concerns were related to timing and amount of rainfall, the results were the same for farmers. Global climate change was also known for both studied groups and existed as a parallel truth with the local reason for changes. A number of adaption strategies are also identified nationally, both used and potential, where small scale irrigation is the primary adaptive step. Switching to draught resistant crops is also prioritized in the North eastern region. In Babati adaption strategies were promoted, even though there was not a general policy or perception, by officials to switch to short-term crops and planting of trees. Switching cops was also the most commonly used strategy by farmers along with traditional diversification. Nationally a large number of barriers are also identified including, lack of funding, poverty, HIV, lack of infrastructure and analytic capacity. Officials in Babati also mentioned the lack of money, deforestation, lack of clouds, education, irrigation and seeds. The farmers in Babati were not so clear about what they needed to adapt, irrigation, livestock backup, diversification and switching crops were mentioned, not differing much from used strategies.

Key Words: Climate change, agriculture, Tanzania, perception, adaption, barriers

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List of Acronyms

ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
ASLMs	Agricultural Lead Ministries
BAWASA	Babati Urban Water Supply and Sewerage Authority
BEDA	Babati Environmental Development Association
CAB	Congo Air Boundary
CBO	Community Based Organisation
CCC	Canadian climate Centre
CCM	Chama Cha Mapinduzi
CEEST	The centre for Energy, Environment, Science and Technology
CFC	Chlorofluorocarbons
CO ₂	Carbon Dioxide
DADPs	District Agricultural Development Plans
DAC	District Agricultural Council
EMA	Environmental Management Act
FARM	Food and Agricultural Research Management
GCM	General Circulation Models
GHG	Green House Gas
GNP	Gross National Product
INC	Initial National Communication
IPCC	Intergovernmental panel on climate change
ITCZ	Intertropical Convergence Zone
LAMP	Land Management Programme
NIDP	National Irrigation and Development Plan
MAFS	Ministry of Agriculture and Food Security
MCM	Ministry of Cooperatives and Marketing
MWLD	Ministry of Water and Livestock Development
N ₂ O	Nitrous Oxide
NAPA	National Adaption Programme of Action
NCCC	National Climate Change Committee
NEP	National Environmental Policy
NEMC	National Environment Management Council
NGO	Non Governmental Organization
OECD	Organisation for Economy Co-operation and Development
PCM	Parallel Circulation Model
PO-RALG	President's Office-Regional Administration and Local Government
PPM	Parts per million
SEI	Stockholm Environmental Institute
TMA	Tanzania Meteorological Agency
UNFCCC	United Nation Framework Convention on Climate Change
VEO	Village Extension Officer
WFP	World Food Programme

1. Introduction

Climate change caused by greenhouse gas (GHG) emissions is today's most debated global environmental issue. It is a unique issue because it can affect all parts of society and the livelihood of people. Global average temperature has risen by 0,74 °C from 1906 to 2005 due to human induced emissions of GHG:s. Carbon dioxide (CO₂) having the greatest impact because of the large emissions (80 %) and the long decomposition time (1000 years). Since the middle of the 19th century CO₂ levels have increased by 35 %, creating an increase from 280ppm to 379ppm in the atmosphere.¹ Natural variation the last 650 000 years have ranged between 180 and 300 ppm. CO₂ emissions are mainly generated from fossil fuels. Methane stand for about 15 % of GHG emissions, nitrous oxide (N₂O) 7.9 % and CFC:s 1,1 %. Methane is 20 times more powerful than CO₂ but only has a 20 year decomposition time, emissions come mainly from agriculture and fossil fuels and N₂O emissions mainly from agriculture.² Developing countries, have contributed very little to GHG emissions because of the low level of economic activity. The amount of CO₂ per GDP unit produced is actually among the highest in the world, (1,65 kg CO₂ per US dollar of GNP).³ Developing countries also enhance the problem through extensive deforestation, decreasing carbon sinks by 45 %.⁴

The United Nation Framework Convention on Climate Change (UNFCCC) was submitted at the Earth Summit in Rio de Janeiro 1992 and entered into force 1994. The main objective of the treaty is to stabilize greenhouse gas concentrations *"at a level that would prevent dangerous anthropogenic (human induced) interference with the climate system."* Industrialized countries should carry the heaviest burden fighting climate change and transfer economic and technical recourses to developing countries.⁵ The UNFCCC only encourage industrialised countries to stabilize GHG emissions, and therefore the legally binding Kyoto protocol was adopted in 1997 and entered into force in 2005. The main objective of the Kyoto protocol is for industrialized countries to reduce their collective emissions of greenhouse gases by 5.2% compared to the 1990 emission levels during the period 2008- 2012.⁶

IPCC (Intergovernmental panel on climate change) is the leading organ in providing climate change reports. The IPCC climate scenarios have been used worldwide to analyse effects of climate change.⁷ The IPCC definition of climate change is a change in climate that can be identified and persists for a decade or longer, the cause can be both natural and due to human activity. UNFCCC on the other hand refers to a change in the climate that is additional to natural variations and directly or indirectly can be connected to human activities and observed over a longer time period. These are the two widely used definitions.⁸ IPCC's forth assessment report describes a trend of warming for Africa that is faster than the global average, showing that climate change is already a reality.⁹ Temperature in Africa has risen by 0,7°C during the 20th century and a 0,2-0,5°C temperature increase per decade is predicted while precipitation patterns vary considerably. Changes in frequency, intensity and predictability of rain are some of the most severe consequences of climate change for East Africa. IPCC predicts that by 2020 crop yields depending on rain will decrease by up to 50%.¹⁰ Poor countries are extremely vulnerable

¹ IPCC, 2007, p.5

² Ibid., p. 12-14

³ Ziervogel, G., et.al., 2008, p.11

⁴ IPCC, 2007, p.46

⁵ www.unfccc.int (2009-05-11)

⁶ www.kyotoprotocol.com (2009-05-11)

⁷ IPCC, 2000, p.3

⁸ IPCC, 2007, p.30

⁹ Boko, M., 2007, p. 435

¹⁰ IPCC, 2007, p.50

to climate change and people in East Africa are dependent on marginalized natural resources for their survival, yields are already amidst the lowest in the world.¹¹ Therefore Africa cannot afford to lose yields to climate change.¹²

Mwandosya at the Tanzanian Vice President's Office summarizes the situation like this; *"Developing countries and especially the poorest among us, Tanzania included, contributed the least to the phenomena of climate change yet the impact of climate change falls disproportionately on us, and we are least capable of coping"*.¹³

1.1 Background

Tanzania has a very varied climate, ranging from tropical to temperate. Average temperature ranges between 17-27°C. Average precipitation is 1042mm/year but rainfall is not high in general, only half of the country receives more than 762mm/year. Rainfall patterns also vary considerably mainly because of differences in altitude, where high elevations receive greater amounts of rain. Two different rainfall regimes exist in the country bimodal- and unimodal rainfall. Regions with bimodal rainfall receive two rain periods, the long *Masika* rains from March to May and the short *Vuli* rains from October to December. This rainfall pattern dominates in the northern parts. Regions with unimodal rainfall receive the majority of the precipitation in one rain period from December to April. Unimodal rainfall is dominating in the southern, particularly in the central and western parts of the country.¹⁴ The variations in climatic conditions and varied topography make it hard to see variations at a regional level when looking at national trends.¹⁵

Agriculture is indisputably the most important Tanzanian source of income and stands for about 50 % of GNP and 60 % of the export earnings.¹⁶ Farming is thus the foundation of the economy as well as dominating employment, about 80 % of the population. Food production is dominating and stands for 85 % of the total land use. Major staples are maize, sorghum, millet, rice, wheat, beans, cassava, potatoes and bananas. Major export crops are; coffee, cotton, cashew nuts, tobacco, sisal, pyrethrum, tea, cloves, horticultural crops, oil seeds, spices and flowers.¹⁷ Small scale farmers are dominating¹⁸ and average size of land is about 0, 9- 3ha/farmer. There is a low level of technology involved in agricultural practices and the major part of cultivation is still done by hand, 70 % of the land is cultivated by hand hoe, 20 % by ox plough and 10 % by tractor. Farms are mainly rain fed which makes the farms vulnerable to changing weather conditions.¹⁹ In 1999 only 3,3 % of the farms were irrigated, but agricultural GNP has grown with 3,3 % per year since 1985.²⁰ IPCC defines vulnerability as a function of the sensitivity of agriculture to changes in the climate, the adaptive capacity of the system and the degree of exposure to climate hazards.²¹

¹¹ Ziervogel, G., et.al., 2008, p.11

¹² Challinor et.al, 2007, p.387

¹³ Mwandosya, M., 2007, p.1

¹⁴ Agrawala et.al., 2003, p. 11-12

¹⁵ Ehrhart, C., Twena, M., 2006, p.5

¹⁶ Shayo, C.M., 2006, p.2

¹⁷ www.tanzania.go.tz a (2008-04-02)

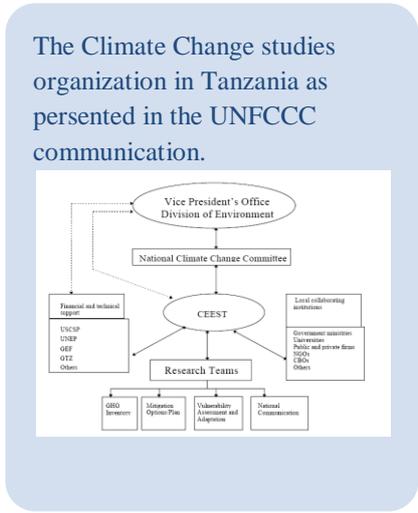
¹⁸ The Vice president's office, 2003, p.51

¹⁹ www.tanzania.go.tz b (2008-04-02)

²⁰ www.tanzania.go.tz a (2008-04-02)

²¹ IPCC, 2001, p.89

There is no environmental ministry in Tanzania,²² environmental issues and policy work is handled by the Division of Environment under the Vice President's Office.²³ Under the division there is the National Environment Management Council (NEMC) that advises the government in environmental matters.²⁴ The centre for Energy, Environment, Science and Technology (CEEST) also plays a big role and has done a number of studies relating to climate change.²⁵ There is also a National Climate Change Committee (NCCC) that have members from different ministries, institutions, NGO:s, academic and research institutions. The main function of the committee is to give advice concerning climate change to the Division of Environment.²⁶ Agricultural issues are handled by the ministry of agriculture, food security.²⁷ There is also something called the four Agricultural Lead Ministries (ASLMs) involved in policy development, namely; the Ministry of Agriculture and Food Security (MAFS), the Ministry of cooperatives and Marketing (MCM), the Ministry of Water and Livestock Development (MWLD) and the President's Office-Regional Administration and Local Government (PO-RALG). The Tanzania Meteorological Agency (TMA) is responsible for providing meteorological information to planners and other officials, by weather forecast and distributed of bulletins to governmental officials and agricultural institutions. Climate and GHG observation equipment is generally very expensive and much of the data thus comes from other countries.²⁸ Tanzania has 24 full meteorological stations, 8 atmospheric chemistry, 13 agro-meteorological, 110 climate stations and about 1400 rainfall stations. All of these apart from the climate and rainfall stations are operated by TMA.²⁹



1.2 Problem Formulation

Agriculture is indisputably the most important source of income in Tanzania that employs about 80 % of the Tanzanian population. Climate change will therefore inevitably affect the economy and livelihood of people. Poor countries are also more vulnerable to climate change because of the lack of adaptation capacity and general awareness is estimated to be very low. The importance of perception is that to adapt we first have to perceive something to adapt to, then appropriate adaptation strategies can be developed and implemented and furthermore barrier worked through. Tanzania has signed the UNFCC and Kyoto protocol and nationally declaring their belief in climate change. This does however not mean that regional and local perceptions of climate change and effects on agriculture are corresponding with this view. Research on adaption strategies is also ongoing at a national and international level, an inquiry is if people that are actually suppose to adapt are aware of how they best should adapt and what their choices are based on. National research might also identify problems for agriculture to adapt but these might not be handled in policy and might not reflect local constrains. To be able to adapt to climate change a joint action is needed and research, policy and adaption has to move in the same direction giving the farmers the best possibilities to adapt.

²² www.tanzania.go.tz c (2009-04-03)

²³ Vice President's office, 2003, p. xx

²⁴ www.nemctan.org a (2009-04-27)

²⁵ The Vice President's office, 2003, p.59

²⁶ Ibid., p.64

²⁷ Ministry of Agriculture and cooperatives, 1997, p.6

²⁸ The Vice president's office, 2003, p.58&63

²⁹ Ibid., p.63

1.3 Purpose and research questions

The purpose of this thesis is to investigate the level of awareness, strategies and constraints concerning agriculture in relation to climate change. The aim is to look at these three components at national, regional and local level in Tanzania. This includes the policy framework at all levels, the perception of the government, officials and local farmers in Babati. Furthermore national and regional promoted adaptation strategies are aimed to be compared with strategies used by the farmers. The perceived barriers and the need for adaptation to climate change are also compared at these three levels.

- How do people, at national, regional and local level, perceive climate change?
- What are the strategies for adapting to climate change?
- What are the barriers for agriculture to adapt to climate change?

1.4 Delimitations

Climate change is in this study seen as true and reliability of climate change studies is therefore not discussed further. The climate change scenarios described in the literature review are the ones discussed in relations to literature and results. Further this study is a compilatory empirical study pertaining to disclose the relationship between the different level of governance in climatic policy and common practices. This is done by looking at perception, adaptation and constraints of climate change in relation to agriculture, comparing national policy and strategies with regional and local perceptions and strategies obtained through a field study. The study will substantiate the relations in a comparative manner, as well as an individualistic approach. Furthermore it will maintain a broad scientific approach throughout the study analyzing the research questions. Since the thesis is interdisciplinary it aims to combine scientific research in the field of climate change and agricultural research models in relation to climate change with theoretical aspects of perception, adaptation and barriers, also exemplified by earlier studies. No specific theoretical standpoint is taken in this thesis due to the complex nature of climate change and agriculture and different disciplinary areas used. The uncertainties in predictions and numerous theoretical standpoints further illuminate the complexity and give a foundation for determining these standpoints at different levels in Tanzania and Babati, the relevance being large since it creates enormous differences in results.

It the thesis answers from the field work in Babati are compared with other studies in Africa however the thesis does not aim to identify the reason for differences. The study also focuses on climate change effects on rainfall, both amount and timing of rain, since the farmers in Babati were only concerned about this. Extreme events are excluded since it involves a different kind of strategies for emergency response. Further the thesis does not aim to identify if there is a long term human induced climate change in Tanzania or Babati effecting Babati at the moment. Neither does it aim to identify appropriate adaptation strategies nor how these should be implemented. Agriculture is recognized to have a large impact on climate change however this issue is not further investigated.

2. Literature Review

2.1 Climate Change

Climate change is predicted to affect Tanzania in various ways, including rising temperature, changes in amount and timing of rainfall as well as an increase of extreme events, sea level rise and water supply depletion.

2.1.1 Temperature

Results of General Circulation Models (GCM) used by OECD indicated that the temperature will rise by 2, 2⁰C by 2100. The highest increase in temperature will be during the cooler period, June-August, and lower in the warmer period, Dec-Feb, seen in the table below. In the Initial National Communication under the UNFCCC (INC) the government predicts a rise in mean temperature by 3,5⁰C. The government report also believes that temperature increase will be the highest during the cooler months, 3-3,9⁰C and lower in the warmer months about 2,5-3,0 resulting in an average difference of about 1⁰C. The governmental report also points at differences in the country in case of doubled CO₂ levels ranging from a projected 2,1⁰C increase in the north-eastern parts to 4⁰C in the central and western parts.³⁰ Tanzania Adaption Team estimates an increase in daily mean temperature by 3-5⁰C throughout the country and an average annual mean increase by 2-4⁰C.³¹

Estimated temperature changes in Tanzania based on GCM³²

Year	Temperature change				
	Annual	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May
2030	0,9	1,0	0,8	0,8	0,9
2050	1,3	1,5	1,2	1,1	1,3
2100	2,2	2,6	2,1	1,9	2,3

2.1.2 Rainfall

Predictions of changes in rainfall are less certain and there are quite large differences between models, but rainfall increases around 10 % is the most common number. According to OECD this will have happened by 2100. The distribution will also be uneven, with a 6 % predicted decrease in Jun-Aug and a 17% increase in Dec-Feb. Changes will not be distributed accordingly over the whole country however, some parts will receive an increase and other parts a decrease. Changes will not occur in the same time and timing and intensity of rains will be less predictable. The National Vulnerability and Adaption Assessment of Tanzania estimates that the northern and southern part of the country will receive a 5-45% increased in precipitation if CO₂ levels doubled, while other regions will suffer from a decrease. Changes in rain season patterns could also be significant, in the northern parts the amount of rain during the short rain period could increase by 25-60 % and the amount in the long rain period by 20-45 %.³³ The INC also estimates an increase in some regions and a decrease in others, the government and Tanzania Adaption Team predicts an increase in regions with bimodal rainfall by 5-45% annually while unimodal regions will experience a 5-15% decrease. The distribution of increased rain in bimodal regions will also be uneven with an increase during the long rain period and a decrease of the short rains.³⁴

Estimated precipitation changes in Tanzania

Year	Precipitation Change ³⁵				
	Annual	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May
2030	4,1	-2,4	3,9	6,6	2,2
2050	5,9	-3,5	5,6	9,6	3,1
2100	10,2	-6,0	9,7	16,7	5,4

³⁰ Vice President's office, 2003, p. 28

³¹ Tanzania Adaption Team, 2006, p.4

³² Agrawala et. Al., 2003, p. 13

³³ Agrawara et.al., 2003, p. 12-14

³⁴ Vice President's office, 2003, s. 29 & Tanzania Adaption Team, 2006, p.4

³⁵ Agrawara et.al., 2003, p.13

2.1.3 Other impacts of climatic change

Tanzania already suffers from natural hazards on a regular basis and extreme events like draughts, floods and storms are likely to become more unpredictable, frequent and intense having a severe impact on the country.³⁶ Even if the country is able to cope with extreme events at a low level it is not likely that they are able to cope with them more frequently.³⁷ Climate change is predicted to effect water resources both positively and negatively largely affecting the three major river basins; Ruvy, Pangani and Ruffji with a 6-10 % predicted run-off decrease.³⁸ The sea level is predicted to rise by 0,5-1m, severely affecting the 800km coast line where 16 % of the population lives. Land loss is estimated to 247km³ for a 0, 5 m sea-level rise and 494km³ for a 1,0m sea-level rise.³⁹ Climate change is also predicted to change the forest to drier regimes as well as the location of the forest and transform living conditions for a number of animal species.⁴⁰ It is also predicted to impact distribution of disease, for example intrusion of malaria to cool areas.⁴¹ Kilimanjaro glaciers are predicted to disappear completely by 2015-2020.⁴²

2.2 Climate Change and Agriculture

In socioeconomic literature farming households are said to face three major sources of vulnerability; shocks, seasonal variations and long term trends. Climate change is estimated to increase all these problems, especially for farmers living from rainfed agriculture.⁴³

2.2.1 Research models

Kurukulasurya & Mendelsohn argues that there are four different branches in research on economic impact of climate change on agriculture; the agronomic, panel data, agro-economic and Ricardian. Maddison recognizes three of these branches, excluding the panel data.⁴⁴ The agronomic branch predicts loss of yields in many parts of Africa. The Panel data studies are not as disastrous even if they predict the impacts to be harmful with increased weather anomalies. The agro-economic branch take the loss in yields as inevitable but assume the loss to be smaller through crop switching. The Ricardian model measures final net impacts by looking at actual adaption made by the farmers. Kurukulasurya & Mendelsohn argues that the problem with the agronomic and panel data model is that it overestimates negative impacts of climate change by neglecting future adaption. In the agro-economic model one of the problems is that the researcher has to determine what adaption could be made. The advantage with the Ricardian model is according to Maddison that it can calculate with almost indefinite adaption but the need to control many variables in relation to climate change is a weakness and the model is not able to incorporate the CO₂ fertilization effect.⁴⁵ Another problem that is not accounted for is that the model has an equilibrium in the long-run, but it is not certain that the farmers know what strategy is the best at first and it might take a long time before farmers perceive changes in climate as permanent.⁴⁶ Maddison also means that this is a problem and say that most analysis of the impact of climate change on agriculture compares equilibrium outcomes to a baseline and a climate change scenario, disclosing no facts regarding transitory losses.⁴⁷ A new model called

³⁶ Ehrhart, C. & Twena, M., 2006, p. 6

³⁷ Boko, M., 2007, p.447

³⁸ Ehrhart, C. & Twena, M., 2006, p. 16

³⁹ The Vice president's office, 2003, p.36-38

⁴⁰ Ibid, p.38-39

⁴¹ Ehrhart, C. & Twena, M., 2006, p. 17

⁴² Case, M., 2006, p.4

⁴³ Challinor et.al., 2007, p.388

⁴⁴ Maddison, D., 2007, p.5

⁴⁵ Kurukulasurya P. & Mendelsohn R.,2008, p.105-106 & Maddison, D., 2007, p.5

⁴⁶ Ibid. p. 105-106 & p.5

⁴⁷ Maddison, D., 2007, p.8

the Structural-Ricardian model was created by Kurukulasurya & Mendelsohn where a simple model of the farm is created. The farmers choose what crops are grown, one or several and a certain income is set to every crop. Using this model existing adaption is shown and the sensitivity to climate change for existing crop varieties and for shifting crops can be quantified.

Challinor et.al calls for increased realism and relevance in predictions of crop in correlation to climate change. This according to them is achieved through including adaption strategies. The assessments made therefore must seek to combine the predictions of crop yield with socioeconomic scenarios to be able to see the real impacts of climate change. Both the market and change in GNP affects the impact; this makes it even more difficult to draw definite conclusions. Some factors are easier than others to include in models, change in planting date for example can be incorporated relatively easy in impacts assessments but effects of irrigation and the role of new crop land can be more difficult.⁴⁸

2.2.2 Measuring methods

Sensitivity of agriculture to climate change can be measured in different ways. Crop sensitivity can be investigated through plant experiments that quantify the effects of increased concentrations of CO₂ and ozone directly. According to Challinor et al. a doubling of CO₂ levels would increase many crop yields by one third in Africa. The main reason for this is the higher rate of photosynthesis. Photorespiration decreases when CO₂ levels increase and since higher temperatures increases photorespiration any increase in photosynthesis due to increased CO₂ levels should be greater in warmer countries. This information is then used for modelling the crop response to climate variations and climate change. The reaction of the crops is not only depending on genotype but also the surrounding environment and farming practices making it very difficult to project crop future yields.⁴⁹

Many models on crop response to climate change have been made on major food crops. This means that there are crops and combinations of crops that are commonly used in Africa that are not modelled in a satisfying way, like sorghum, millet, banana and yams. Intercropping models are not sufficient either, which is very common in Africa. Another problem is that climate change models are often made at a very large scale while crop modelling is made on a small scale. Climate models then have to be downscaled in order to fit the crop models. It is also important to incorporate natural climate variations as well as extreme events, especially in Africa since they are predicted to have a large impact on the food production.⁵⁰

2.2.3 Predicted effects of climate change on crop production in Tanzania

Climate change is predicted to affect agriculture in Tanzania both positively and negatively. Maize production is predicted to decline due to higher temperature that shortens the growing season and decreased rainfall in some regions. Cash crop yields, like coffee and cotton, on the other hand are predicted to increase.⁵¹ Average maize production decline is predicted to 33%, with largest decreases in the central regions of Dodoma and Tabora, up to 84 %. Yields in the north-eastern highland are predicted to decrease by 22 % and in areas around Lake Victoria by 17 %. This means that the major staple, that Tanzania largely depends on, will be reduced to a base level. Maize therefore needs special attention in the adaption process and crop switching from maize is likely.⁵² In areas where rainfall increases there will be problems with leaching of nutrients, wash away of top soil and water logging. Climate change is also predicted to increase

⁴⁸ Challinor et.al, 2007, p.387

⁴⁹ Challinor et.al, 2007, p.383-384

⁵⁰ Ibid p.385

⁵¹ Agrawala, S., et.al., 2003, p. 15

⁵² The Vice president's office, 2003, p.34

diseases, pests and insects, especially if both temperature and rainfall increases. To cope with these changes farmers might have to use more chemicals and resistant crops which will increase costs. Areas that experience less rainfall will need irrigation systems or draught resistant crops to cope with changes in moisture levels due to increased evapotranspiration, increasing costs. Irrigation is also predicted to be even more expensive to develop because of reduced river runoff and the need for deeper wells. Changes in climate will also shift the agroecological zones.⁵³ The majority of the predictions for African agriculture are thus negative but vary considerably. Many studies are difficult to compare since they look at different crops and different regions, variability in yield in different places, unreliable climate information and different methods used in also affect the reliability. According to Challinor et.al there is a kind of consensus that crop yields in many parts of Africa will decrease. But predictions for maize vary from -98% to +16% in different studies and millet yield vary between -79% and +14%.⁵⁴

2.3 Perception of Climate Change

There are different factors influencing the perception of climate change. Some ways of updating perception are slow and other faster. Farmers can for example use Bayesian updating, relating the probability of certain events to occur to the probability of events that has occurred. Using this method information update is likely to be slow since generations of knowledge are not likely to be thrown away easily. There is however evidence showing that farmers use more recent information.⁵⁵ The importance of perception is according to Maddison that to adapt we first have to perceive something to adapt to then useful adaptation methods can to be identified and implemented.⁵⁶ According to the Initial Communication to the UNFCCC the general awareness of climate change in Tanzania is very low. They argue that the variability goes unnoticed since people do not see the difference between normal variations and abnormal change, thus climate change is not a prioritized issue. The reason for the lack of attention is then due to lack of awareness about the impacts of climate variability and climate change on socioeconomic development. Public awareness of the relation between daily life and climate change and the difference between natural climate variations would ease the implementation of climate change in policy, plans and programs.⁵⁷

James means that climate information have played a large role in the evolvement of existing farming practiced but is very seldom used by farmers when making decisions about the existing farming system. He further argues that if farmers are asked to rank major problems weather is usually on the list, but seldom at the top, and climate change is almost never on the list. Off course farmers face a list of other insecurities that need attention, climate change is something happening over decades and does not crave immediate decision response. Decision making probably is further hindered by the great uncertainties in climate predictions and the complexity of agricultural systems.⁵⁸ James believes that climate change will never be met with much interest if it is taken up alone; it has to be incorporated in the debate of climate variability. To be able to prepare the agricultural sector of changes that occur today and potentially in the future we have to learn more about climate variability and how this information could be used in agricultural decision making.⁵⁹

⁵³ Ibid., 2003, p.33

⁵⁴ Challinor et.al, 2007, p.386

⁵⁵ Maddison, D., 2007, p.6

⁵⁶ Ibid., p.6

⁵⁷ The Vice president's office, 2003, p.66-67

⁵⁸ Jones, J., 2003, p. 2-3

⁵⁹ Ibid. p. 7

5.3.1 African Farmers

In a study carried out by the University of Pretoria 8000 farmers in 11 countries in Africa were asked about their perception and adaption to climate change. The study showed that half of the African farmers perceived a long term change of increasing temperature and declining precipitation. One third of the farmers perceived a change in the timing of the rains and one sixth perceived draughts as more frequent.⁶⁰

African farmers perception of long term changes in precipitation and temperature⁶¹

Precipitation	Temperature
Decreased precipitation 50 %	Increased temperature 51 %
Changed timing of rains 32 %	No change 14 %
Frequency of droughts 16 %	Altered climatic range 9 %
No change 13 %	Other changes 7 %
Increased precipitation 5 %	Don't know 6 %
Other changes 5 %	Decreased temperature 5 %
Don't know 4 %	

In a study by the World Bank 9500 farmers were interviewed in 10 countries in Africa showing that a significant number of the farmers believed that the temperature had increased. In six of the ten countries the majority if the farmers believed that precipitation had decreased. A large part also believed that timing of rains had altered.⁶² The study further compared farmers' perception of climate change with weather data. Africa though having few weather stations not making the comparison reliable, data used was also average country data neglecting local variations. Temperature data is also only available for the recent time period. Weather records showed that there were real changes in many parts; however many farmers stated that the climate was getting hotter even though there was no evidence. A large number of the farmers also said that there was less rain even though there was no evidence for it.⁶³

In Ethiopia the Food Policy Research Institute studied farmers' perceptions and strategies before constructing policies aimed to reduce vulnerability to climate change. 1000 households in five different regions, covering the traditional agro ecological zones were asked if they had observed any changes in rainfall and temperature during the last 20 years. The study indicated that most of the farmers were aware of climate change and the answers were in line with the National Meteorological Services Agency report. Even though the majority of the farmers perceived changes in the climate, a large part of them did not respond.⁶⁴ A similar study was carried out in Nigeria, including 200 farmers showing that 86 % perceived a climate change. Reasons given were; farming, overgrazing, bush burning, urbanization, industrialization and deforestation. 84 % of the respondents also thought that climate change was a critical environmental issue that needs to be addressed immediately. 73 % of the respondents believed that temperature had been rising during the past decades and 83 % perceived decreasing rainfall every year and increasing anomalies. This study also showed that the more experienced and older farmers were more likely to perceive changes in the climate. The farmers were also asked about their perceived awareness among farmers about climate change. 13 % of the respondents believed that there was a high level of awareness about climate change, 33 % answered that they do not know and 54 % said that the awareness of climate change is very poor.⁶⁵

⁶⁰ Hassan, R. & Nhemachena, C., 2008, p. 85

⁶¹ Ibid., p.85

⁶² Maddison, D., 2007, p.24-25

⁶³ Maddison, D., 2007, p.26

⁶⁴ Deressa, T., et.al, 2008, p. 1-5

⁶⁵ Ishaya, S., Abaje, I.B., 2008, p. 140-141

2.4 Adaption to Climate Change

Climate change adaption aims to mitigate and develop strategies that can address negative impacts of climate change on agriculture. Most agricultural systems have autonomous (built in) adaption but human induced changes are much faster making it uncertain if farmers and ecosystems can recover without appropriate adaption strategies. According to Maddison there are four main areas affecting adaption of new technologies in agriculture; resource scarcity, price changes, learning costs and reluctance of risk taking. All affected by climate change.⁶⁶ IPCC and SEI promotes planned adaption that aims to create the capacity needed. The building of resilience in the systems is also important so that it can withstand shocks and rebuild if it is necessary.⁶⁷ Challinor et.al argues that to create effective adaption strategies public institutions and professionals have work at national, regional and local level. Institutional capacity in Africa for managing climate change and creating agro-meteorological strategies is very low. At a national level institutions need to produce long term strategies and management plans. At regional level more specific and detailed programmes have to be created to manage implementation and monitoring locally and field services are needed in different sectors. Multi-disciplinary work is also needed as well as access to an up to date database at all levels containing information about climate, natural resources and land use.⁶⁸ Challinor et.al also calls for a new test on policy where the key question should then be “*are you increasing or decreasing people’s vulnerability to climate?*”⁶⁹.

There are some differences in the view on today’s adaption to climate change. Some mean that since agriculture is sensitive to climate variability’s they also usually explicitly or implicitly take the associated risks in account. Other argues that this is not the case in the majority of the African countries.⁷⁰ Further some argue that the adaption made might not be enough because of the severe negative effects.⁷¹ Kurukulasurya & Mendelsohn mean that African farmers are already adapting to local climate variations and selecting crops that are suitable. Farmers also diversify which makes the farm more flexible and increases the likelihood that the family survives in harsh conditions. These practices therefore just have to be extended to the future making the impacts of climate change on agriculture small. Challinor et.al takes the fact that almost all staples in sub-Sahara Africa originate from other continents as a sign of the farmers adaptability. They mean that this shows that the farming systems already respond to opportunities that information and movements of genetic materials create, another possibility is that new crops will be developed in the future.⁷² Research in this area would benefit poor African farmers both today and in the future.⁷³ Ishaya & Abaje points at the neglect of indigenous knowledge in adaption strategies. Since the farmers are so dependent on the agriculture they adjust to the climate variability’s and changes in very creative ways using both traditional knowledge and new technology. Farmers living in sensitive ecosystems could actually help to increase the resilience. How indigenous people perceive climate change and adjust to it is very important since they are the ones addressing climate change to a great extent. This study further argues that indigenous people rarely are incorporated in the academic debate, policy-or public discussions concerning climate change. Climate models are also seldom adjusted to be understood at a local level making it even harder for indigenous people to become a part of the

⁶⁶ Maddison, D., 2007, p. 10

⁶⁷ Ziervogel, G., et.al., 2008, p.20

⁶⁸ Challinor et.al., 2007, p.391-392

⁶⁹ Ibid., p.394

⁷⁰ Jones, J., 2003, p.4

⁷¹ Challinor et.al, 2007, p.381-382

⁷² Ibid., p.389

⁷³ Kurukulasurya P. & Mendelsohn R.,2008, p.122-123

debate.⁷⁴ Jones finally argues that since climate change is threatening whole societies there should be a much greater activity and resources put on the development of adaption strategies at all levels, from farmers to local institutions, governments and international organisations.⁷⁵

2.4.1 The impact of adaption

To determine the sensitivity of African agriculture to climate change both with and without crops switching Kurukulasurya & Mendelsohn accounted the impacts.⁷⁶ The most popular crop choice in Africa was maize secondly maize/groundnut followed by cowpea/sorghum and millet/groundnut. This research concludes that the marginal impact of a 1°C temperature rise will reduce income from maize/beans by \$10/ha, cowpea/sorghum will be reduced by \$14/ha and sorghum by \$19/ha. Increasing net values are predicted in a warmer climate for maize/groundnut by \$32/ha and fruits and vegetables are incomes are projected to increase by \$86/ha. These results are all based on the choice the farmers in the study made. A 1mm increase in precipitation would have a significantly positive impact on millet/groundnut and maize/bean production, with a plus per hectare with \$38 and \$14 respectively.⁷⁷ The results show that switching crops is an important strategy for farmers to adapt to climate change. By using this strategy yields could increase in some parts of Africa and devastating negative effects could be reduced in other parts. If farmers are not able to switch crops the losses will be enormous, almost 70 %, but with different crop varieties the losses almost disappear.⁷⁸

2.4.2 African Farmers

Adaptive capacity varies greatly between regions, countries and socioeconomic groups when ability to adapt is seen as a function of governance, national strategy, wealth, economic development, technology, information, skills, infrastructure, institutions and equity.⁷⁹ Africa studies show that farmers have developed many innovative responses to changes even in marginal areas.⁸⁰ The most common ones include; new crop and livestock varieties that are more draught resistant, irrigation, changing dates for planting, systems mixing crop and livestock, crop diversification, diversification to other practices than farming, soil and water conservation, planting of trees for shelter and shade, agroforestry, changed use of labour and money. In the study by the University of Pretoria farmers were asked both about perceived appropriate adaption and actual adaption. The results are seen in the table below.⁸¹ Actual adaption differed from perceived appropriate strategies but many are components of actual strategies or combinations. Actual adaption was dominated by mixed multiple crops and livestock under dryland, standing for 52 %. The authors mean that the study indicates a larger influence of rising temperature than changes in rainfall for adapting. For example the results showed that a warming promoted use of irrigation and multiple crop and livestock systems and reduces mono-cropping practices.⁸²

African Farmers perceived and actual adaption to Climate Change⁸³

Perceived adaptation measures used by farmers	Farmers' actual adaptations
No adaptation 37%	Mixed multiple crops/livestock under dryland 52%
Other adaptations 22%	Mixed multiple crops/livestock under irrigation 14%

⁷⁴ Ishaya, S., Abaje, I.B., 2008, p.138-139

⁷⁵ Jones, J., 2003, p. 1-2

⁷⁶ Kurukulasurya P. & Mendelsohn R.,2008, p.108-109

⁷⁷ Ibid., p.119-120

⁷⁸ Kurukulasurya P. & Mendelsohn R.,2008, p.122

⁷⁹ Challionor et.al., 2007, p.390

⁸⁰ Ibid., p.389

⁸¹ Hassan, R. & Nhemachena, C., 2008, p.85

⁸² Ibid., p.98

⁸³ Ibid., p.86-87

Shading and shelter 21%	Multiple crops under dryland 14%
Increase water conservation 18%	Mixed mono-crop/livestock under dryland 9%
Different varieties 17%	Multiple crops under irrigation 4%
Different planting dates 16%	Mixed mono-crop/livestock under irrigation 4%
Soil conservation 15%	Specialized crop under dryland 2%
Shorten length of growing period 13%	Specialized crop under irrigation 1%
Different crops 11%	Specialized livestock under dryland 0%
Increase irrigation 10%	Specialized livestock under irrigation 0%
Farming to non-farming 9%	
Crop diversification 8%	
Use insurance 7%	
Change use of chemicals, fertilizers and pesticides 5%	
Prayer 5%	
Move to different site 4%	
Change amount of land 3%	
Crops to livestock 2%	
Livestock to crops 1%	
Adjust livestock management practices 1%	
Non-farming to farming 1%	

A study by the World Bank of 9500 farmers' perception and adaption in 10 African countries shows that there are large differences in adaption between countries, due to profound variations in custom, institution and policy. The results showed that in all studied countries apart from Cameroon and South Africa planting different crop varieties was the most used adaption strategy. Different planting dates were also important in Egypt, Kenya and Senegal and adaption through the shortening of growing season was only common in Senegal; non-farming activities, water conservation techniques, shading and soil conservation was also widely used along with prayer and ritual offerings in Senegal and Niger. In Burkina Faso, Cameroon, South Africa and Zambia almost one third of the farmers reported that they have not adapted in any way in contrast to Egypt and Ethiopia where all of the respondents said that they used at least one adaption strategy.⁸⁴ Generally farmers overall perceived changes can be said to respond through planting of different crop primary followed by different planting dates and shortening of the growing season. There are also many farmers that do not respond but very few that perceive a change that do not respond.⁸⁵

In the Ethiopian study five adaption methods were identified. The largest percentage of the farmers did not respond to climate change and the most commonly used strategy was using different crop varieties, followed by planting trees while irrigation was the least common strategy, results seen in the table below.⁸⁶

Ethiopian Farmers adaption strategies to Climate Change⁸⁷	
No Adaption 42 %	
Planting Trees 21 %	
Soil Conservation 15 %	
Different Crop Varieties 13 %	
Changing Planting Dates 5 %	
Irrigation 4 %	

In the Nigerian study 60 % said that they planted different crop varieties to adapt to climate change. 15 % said that they changed planting dates and shortened the growing season as a response, this was mainly practiced when there was less rain than normal, changes in timing of rainfall or more frequent draughts. 30 % of the farmers said that they adapted through

⁸⁴ Maddison, D., 2007. p.28

⁸⁵ Ibid., p.29

⁸⁶ Deressa, T., et.al., 2008, p.9

⁸⁷ Ibid, p.9

maximizing water practices. The rising temperature also leads to losses of moisture in the soil which makes people use mulching and sheltering techniques, 2,5 % of the respondents said that they mulch the land to deal with this problem. Extreme changes in rainfall made people to move from agriculture to non farming activities, see table below.⁸⁸

Nigerian Farmers adaption strategies to climate change⁸⁹

Different Crop Varieties	60 %
Maximizing Water Practices	30 %
Shortening of growing season	15 %
Use of fertilizer	12 %
Extension of farming land	4 %
Mulching	2, 5 %

Shayo from the Vice president's office mentions a number of local adaption strategies used in Tanzania; use of local varieties and seed selection, since they in many cases are more draught resistant and have longer shelf life; inter-cropping and diversification, to lower the risks when the climate is changing; draught resistant varieties, either through a total switch or adaption of some; disease control and grain storage. He also believes that when realizing the effects of climate change local methods for predicting short, medium and long term changes will be used more and more.⁹⁰ A study made in the Morogoro region in Tanzania looked at people's vulnerability and adaption to climate change concluding that it difficult seeing specific strategies since farmers often suffer from multiple stresses. But since draught is a frequent and reoccurring phenomena in East Africa this stress has to be handles also over long time periods. The study however showed that the majority of the farmers used some kind of strategy to adapt. Strategies used was; extension of agricultural land, diversifications of crops and other practises, growing of certain crops for the market, crop switching, altering of grown crops and changed planting dates based on weather forecasts or climate the previous year. In Morogoro maize and rice yields have decreased in dry years, by up to 75 % in 1996-1997 and 50 % 1999-2000. Sorghum and cassava yields though have varied much less and sweet potato yields have even increased on dry years, giving a kind of insurance against food shortage. Farmers had also stopped to cultivate during the short rain period in some areas due to uncertainty of rain and low yields.⁹¹ Many households also use natural resources to cope with variations in the climate, some reports saying that up to 68 % of family incomes in Morogoro and Dodoma regions can be obtained from the forest. Non-farming activities and moving temporarily to areas with better conditions and good market access are also used strategies.⁹² Paavola concludes that the necessity for adaption today can affect the environment in such a way that it can preclude the use of common adaption strategies in the future. Paavola mean that the three important parts of the work with adaption to climate change are; effective management, increased marked participation and investments in human capital.⁹³

Challinor et.al also point out that extreme events can affect the availability of seeds. Therefore an important adaption strategy is the strengthening of formal and informal seed systems. They mean that the seed system in Africa generally is malfunctioning and that the majority of the farmers save seeds for planting or get them from farmers in the area which obstruct distribution. To be able to build resilience in the seed system the government should to be responsible since the seeds are not commercially produced, the system also has to be decentralised, new seed laws are

⁸⁸ Ishaya, S. & Abaje, I.B., 2008, p. 141

⁸⁹ Ibid., p. 141

⁹⁰ Shayo, C.M., 2006, p.11

⁹¹ Paavola, J., 2004, p. 9-10

⁹² Ibid, p. 11-12

⁹³ Ibid., p. 14-15

needed, seed stocks need to be maintained locally and regionally and seeds has to be distributed following disasters.⁹⁴

2.5 Barriers for Adaption

There are a lot of barriers affecting the level and speed of adaption. Research has mainly looked at what makes people adapt while local studies focus at barriers. Many studies show a positive relationship between information and education in adaption. Education gives access to information, new technology and production methods and therefore increases the probability of adaption.⁹⁵ Information from outside the local system can come through for example extension service or Farmer Field Schools⁹⁶, where extension service is believed to increase adaption.⁹⁷ The large uncertainties in climate information might however make farmers adapt through more robust farming practises rather than following information and predictions. Experience also affects adaption, where older and thus more experienced farmers more frequently notice decreases in precipitation, timing of rain and frequency of draughts, floods and crop yields.⁹⁸ But there are studies showing that old farmers are less likely to adopt because of their shorter planning horizon.⁹⁹ Farmers that noticed changes the most were according to the World Bank experienced farmers that have contact with extension service informing about climate change. But even if a farmer perceives a change and adapts it is not certain that the chosen method is the most appropriate.¹⁰⁰ According to some theories male-headed households are more likely to access information about new technologies and more willing to take risks, but there are also studies showing the opposite. Access to credit, social capital and cooperation also increases the likelihood of adaption. Farm size has both positive and negative effects however farm size is often associated with wealth which is assumed to increase adaption possibilities. Larger households also have larger labour forces and might also adapt more frequently because of fixed costs of adaption. Further there are buildings and machines that are suitable for certain crops and hinder farmer to adapt as planned. Land tenure also plays in where people that borrow land are less willing to adapt.¹⁰¹

There are also environmental impacts on adaption; farmers in different agroecological settings adapted in different ways because the variations in conditions like climate and soil influence perception and thus decisions for adaption.¹⁰² Decreasing precipitation significantly increases the likelihood of adaption while high perception might have a counteracting affect, relaxing constrains. There is also a strong link between current climate and adaption, where farmers already stressed by climate are forced to adapt.¹⁰³

Two of the main reasons for not adapting are according to Ishaya & Abaje poverty and ignorance. There is generally a large gap between existing information about climate and knowledge among the farmers. The overarching need in the adaption process is to create an environmental ethic among people which only can be achieved through education and support. The government here has a great role in implementation, promotion, encouragement and facilitating the process and guard the adaption. Indigenous people should also be involved in the

⁹⁴ Challinor et.al., 2007, p.388-389

⁹⁵ Deressa, T., et.al., 2008, p.16 & 19-20

⁹⁶ Challinor et.al., 2007, p.391

⁹⁷ Maddison, D., 2007, p.34-35

⁹⁸ Ishaya, S., Abaje, I.B., 2008, p.140-141

⁹⁹ Maddison, D., 2007, p.18

¹⁰⁰ Ibid., p.34-35

¹⁰¹ Deressa, T., et.al.,2008, p.11-12

¹⁰² Ibid., p.11-12

¹⁰³ Deressa, T., et.al., 2008, p.16 & 19-20

development of new sustainable agricultural forms.¹⁰⁴ Learning by doing however takes time, experimentation can be costly, learning by copying requires that there is someone to copy and learning from instruction requires an instructor. Maddison argues that looking at technology adaption in Africa during the green revolution shows that the rate of adapting was very slow and there is no reason that new climate change technologies should do any better, especially because of the spatial characteristics.¹⁰⁵

2.5.1 African Farmers

In a study of farmers in 10 African countries a number of barriers were identified; few farmers perceived lack of information about the weather and climate change to be a barrier for adaption. There were also few farmers that perceived that the lack of knowledge as a barrier however in Ethiopia a quarter felt that they lacked information about climate change. A large number felt that lack of finances was a barrier for adaption; this was given as a reason by more than half of the respondents in Niger. Lack of access to water was also seen as a major problem in many countries but seen as a barrier of adaption only in Ethiopia, Kenya and Senegal. Lack of the right seeds and lack of property rights and marked access were mentioned in all countries except for Ethiopia. A large number of the farmers did not see any barriers of adaption.¹⁰⁶

In Ethiopia five major obstacles were identified; lack of information, lack of money, shortage of labour, shortage of land, and low potential of irrigation. Most of these obstacles are associated with poverty. Lack of money hinders famers to get technology and other things that are necessary for adapting, for example even if there is water in the area farmers might not have the resources to invest in irrigation that would be needed for sustaining the families livelihood. In adaption there is also a demand for labour and if farmers are unable to get the work force needed from the family members and cannot afford to hire labour they cannot adapt. High pressure on the cultivated land also makes it difficult to change the farming practices, for example tree planting might require more land.¹⁰⁷ In Nigeria there were also several factor hindering farmers from adapting to climate change. 24 % of the farmers said that the major obstacle for adapting is the lack of improved seeds. Other obstacles were the high price of the quality seeds needed, lack of accessible water for irrigation, lack of information about adaption methods, lack of information about the weather and lack of finances for buying available technique. The Nigerian study concludes that in general the strategies for adapting to climate change are very weak.

4. Method

4.1 Description of the study area

The United Republic of Tanzania is divided into 26 regions. Babati district, where the field work was conducted is situated in Manyara region. Babati is the largest district in the region with a population of about 300 000 and is administratively divided into 21 wards. Babati Town is also capital of the Manyara Region and has a population of around 31 000.

Babati is situated at about 1300m and average day temperature is 30°C and night 20°C. The region has bimodal rain periods and an unpredictable climate with large natural variations, effected both by the Intertropical Convergence Zone (ITCZ) and the Congo air boundary (CAB). The ITCZ is a belt of low pressure surrounding the earth's equator. It is formed by vertical ascent of moist warm air from northern and southern latitudes. The ITCZ moves back and forth

¹⁰⁴ Ishaya, S. & Abaje, I.B., 2008, p. 141-142

¹⁰⁵ Maddiosn, D., 2007, p.8-9

¹⁰⁶ Ibid., p.30-31

¹⁰⁷ Deressa, T., et.al., 2008, p. 9-10

across the equator following the earth's zenith point greatly effecting rainfall in equatorial countries.¹⁰⁸ The CAB is a boundary where many different climate systems converge creating for example draught, rain and cyclones when shifting over the area. The climate in Babati varies not only from year to year but also cyclicly making it harder to see general trends in a shorter perspective. The shifting weather and need for natural recourses have generated a large amount of agricultural adaption strategies, the main strategy being diversification. By diversifying farmers secure their livelihood when increasing the probability of specific plants survive.¹⁰⁹ There is also a great variety of agro-ecological zones in Babati. Zones are semi-humid to semi-arid highlands and uplands to lowlands diversifying climate and agricultural practises even more.

4.2 Qualitative research methods

Qualitative research methods are concerned with understanding why people behave as they do; their knowledge, perception and beliefs for example in comparison to quantitative methods. Qualitative methods also give much richer answers to research questions that might be missed using other methods; they can even help the understanding of quantitative data. On the other hand qualitative research is time consuming and labour intensive making studied groups smaller. The method is often criticized for being partial, hard to analyze and then impossible to reproduce and generalize.¹¹⁰ Interviews are one form of obtaining qualitative research, chosen in this thesis.

4.2.1 Semi-structured interviews

The interview form chosen for this thesis was semi-structured open ended interviews. In semi-structured interviews the same questions are asked at all the interviews but it is possible to add follow up questions during the interview. Since the questions are open ended the informant is allowed to speak more freely making it possible to go more in to depth on issues that the informant knows a lot about.

4.3 Primary data

The empirical material used in this thesis was collected during a three week field trip in Babati district, Tanzania. The field work was conducted between the 16th of February and 8th of March 2009. The first week was dedicated to learn about the area and broader situation. The following two weeks were committed to interviews. The field work was carried out in Babati town and in the villages Mamire, Ayayae and Singe in Babati rural. To be able answer the research questions respondents from different areas were interviewed, totally two agricultural officers, two NGO:s, one CCM (Chama Cha Mapinduzi) politician, one meteorologist and five elderly farmers.

Officials were interviewed to get a picture of the district policy framework, perception and what work that was carried out in the area. The idea was to follow the work from national level, to district level and then to local farmers. This however turned out to be difficult since it was hard to get hold of officers in Babati and even harder to get hold of documentation. There was no policy on climate change but remarkably a lot of work was still carried out regardless. The study therefore focuses more on the perception of officials and the work actually carried out by them according to the interviewees. Samuel John from CCM was interviewed to represent the ruling party's standpoint. Mr Majid at the Ministry of Agriculture and the Extension Agricultural Officer in Mamire Mr Mshana were interviewed for the agricultural view. Mr Kasindei at FARM-Africa, formerly DAC employee, was also interviewed and Mr Edam Coordinator at BEDA to broaden the picture and see if the NGO:s were ahead of the government with climate change policy and adaption. The meteorologist in Babati, Mr Alphonse, was also interviewed to get an experts point of view at climate change in the district. TMA also have a central role in

¹⁰⁸ www.skybrary.aero (2009-05-11)

¹⁰⁹ Lindberg, C., 1996, p. 9

¹¹⁰ RDSU, p. 2-3

distribution of climate information to agricultural institutions. The intention was also to get local data of rainfall and temperature to compare the perception with reality unfortunately this information was not available due to red tape.

To be able to get a long time perspective at the perceived climate change and a bigger chance that the respondents could distinguish climate change from climate variability's elderly farmers were chosen, the youngest was 52 and the oldest 86. The farmers were found with help from my field assistant, Ruth Mtatuu, and the agricultural officers. Elderly farmers have also been interviewed in previous studies in the area of climate change and agriculture since they were found to more frequently see decreases in precipitation, changes in timing of rain and frequency of draughts, floods and crop yields.¹¹¹ The farmers were interviewed in three different villages to see if there was any difference in information from agricultural officers. To be able to see the potential effects on agriculture in relation to the IPCC scenario the farmers were asked about effects of this specific scenario as well even if it was not a scenario that they themselves believed in, this however was a bit hard since there was a confusion with more rain and flooding probably since increased rain in more normal amount was not a part of their conception.

4.4 Secondary data

To supplement the field work a secondary data review was carried out using articles from scientific journals concerning climate change and agriculture. Secondary data was obtained mainly from Science Direct, Springer Link and Google Scholar. Reports from IPCC were used as a base for climate scenarios. The official Tanzanian homepage was used to find governmental policies and documents, through the homepage reviewed policies concerning agriculture and environment were found.

4.5 Limitations and Source Criticism

One of the limitations in the field work was the language barrier. The use of a translator makes it more difficult to get detailed answers, it takes longer time and the risk of misinterpretations is greater. During most of the interviews the same translator was used which eased the issue since she was familiar with the subject. Another language issue was the resistance from respondents to use translator even if needed creating misunderstandings. Another problem was to actually get the interview, even though meetings were arranged, making interviews especially with officials, was very time consuming taking valuable time from other interviews that would have been interesting. Some respondents were also tense and nervous during the interview giving the impression that they tried to please me with their answers making answers more unreliable. Another problem was the lack of documented facts and the difficulties to get information from the offices, files were not allowed to leave the office or be photo copied and one time money was asked for, leaving me without concrete data from Babati. Further, off course lack of time was a limitation, both for conducting the number of interviews wanted as well as time with the translator. When arriving at a new place in an unfamiliar country it is also hard to find the right people to interview at once as well as cultural barriers might affect the interview situation. To be able to create a picture of the situation interviews have to be cross-checked or triangulated. This was done by comparable questions at local and district level as well as triangulation through comparison of answers from respondents at the same position. However the small amount of interviews and lack of existing local research on the subject makes triangulation more difficult.

The secondary data review was limited by the lack of up to date information on official Tanzania homepages, not working homepages, language and the lack of similar studies in the area, probably because the area is quite new. The study in Babati therefore is compared with studies in other African countries instead of Tanzanian studies. Many essential documents were not to be

¹¹¹ Ishaya, S., Abaje, I.B., 2008, p.140-141

found on official homepages wherefore it was difficult to get a picture of the policy framework and information was scattered at different places. Local homepages are also in Kiswahili. Further there was a lack of downscaled climate information since IPCC reports are very general they might not be right for Babati and also a lack of obtained regional literature making it hard to cross check the information from certain interviews with literature. A large part of the literature looking at national policy and work carried was written by the government making it more likely that documents are partial. Studies made in relation with the UNFCCC might also be overestimating how highly Tanzania prioritised issues. There are however numerous studies made by other organizations and researchers having an independent point of view. Studies made of certain organizations might also be partial in the opposite direction trying to make reports look more alarming than they actually are because of the need of funding and reactions from the reader. There is also a great uncertainty in all studies concerning climate change; the reality might be a completely different to the standpoint used here. There is also a great uncertainty in calculations of crop production and studies are hard to compare due to use of different methods and research in different areas. There are also endless factors effecting decision making and hindering people both physical and mental wherefore this thesis only is able to bring up the ones most commonly referred to in literature in the area.

5. Results

The results are divided in three parts; perception, adaption and barriers. These three areas are in turn presented at the three different levels; national, regional and local. National level is a summary of policy documents and statements, regional level from interviews with officials in Babati and local level of both interviews with farmers in Babati and results from other African studies.

5.1 Perception of climate change

5.1.1 National level

According to the Vice president's office there has been a general increase in temperature the last 40 years. During this period rainfall has decreased in large parts of the country and the frequency and intensity of draughts and floods has increased.¹¹² According to Shayo there has already been land loss because of climate change followed by land use conflicts. The frequency of extreme weather like the El Niño in 1997-1998 is one of the evidence¹¹³ created a 1,7m surface rise of Lake Victoria.¹¹⁴ Tanzania Adaption Team also gives the draughts in 2004-2005 as an example having large impact on both nature and economy.¹¹⁵ Two of the big rivers in Tanzania have also suffered from reduced flows creating water shortage, low yields and decreased biodiversity.¹¹⁶ Shayo at the Vice President's Office argues that in the last years the agricultural sector has shown increasing vulnerability and decreases in the production of certain crops because of climate variability, unpredictable seasons, erosion and environmental degradation.¹¹⁷

There are a number of policy documents concerning climate change as well as documents not mentioning it when expected. The National Development Vision 2025 is the latest national development program but despite the long time horizon climate change is not mentioned.¹¹⁸ In

¹¹² Mwandosya, M., 2007, p.1

¹¹³ Shayo, C.M., 2006, p.2-3

¹¹⁴ Case, M., 2006, p.6

¹¹⁵ Tanzania Adaption Team, 2006, p. 4-5

¹¹⁶ Case, M., 2006, p.4

¹¹⁷ Shayo, C.M., 2006, p.2

¹¹⁸ www.tanzania.go.tz d (2009-04-12)

communications to national convention climate change is only considered to the INC to the UNFCCC.¹¹⁹ In Tanzania's National Report to World Summit on Sustainable Development (2002) a number of agricultural adaptation methods are discussed concerning current climate variations; mentioning irrigation, draught resistant and high yield crops.¹²⁰ There is also a strategy for Urgent Actions to combat degradation of land and water catchments adopted in order to control environmental degradation, GHG emissions and climate change.¹²¹ The government has also implemented Famine Early Warning System and Livestock Early Warning System as adaptation methods. The government has also tried to mainstream the environment into local and regional plans; in 2006 this had been implemented in 38 of the 123 districts. A number of policies were constructed in concerning environment, climate variations and climate change during the 1990s. These are discussed in more detail below along with the Agriculture and Livestock Policy.

5.1.1.1 National environmental policy

1997 Tanzania adopted the National Environmental Policy (NEP) providing the framework for incorporating environmental questions into mainstream decision making. The environmental policy main objectives concern degradation control, preservation of biodiversity and ecosystems. The policy also points at the importance of raising awareness, the vital linkages between environment and development, participation in environmental and global work. For agriculture the main objective is food security and poverty eradication in rural areas through improving the agricultural system.¹²² According to Maro this policy has not had a big impact on environmental work concluding the urgent Tanzanian need of an assessment and updated policy as well as education. The National Environmental Policy is extensive in the area of conservation and management but lacking important issues like globalization and climate change. Climate change is only mentioned once expressing the need for climate studies.¹²³

5.1.1.2 Environmental Management Act

In 2004 the Environmental Management Act (EMA) was created to implement the National Environmental Policy. The EMA 2004 replaced the EMA from 1983 and re-established the NEMC. EMA provides the legal base and institutional framework for sustainable management of the environment, pollution prevention and control, waste management, environmental quality standards, public participation, environmental compliance and enforcement. EMA seeks to provide for and promote the management, enhancement, protection, conservation and management of the environment. Climate change is not included in this document.¹²⁴

5.1.1.3 National Action Plan on Climate Change

In 1997 Tanzania developed its first National Action Plan on Climate Change, the plan contains information of emissions sources and possible CO₂ sinks. The plan has three different objectives for three different time frames, a short term for 1-2 years, a medium term for 2-5 years and a long term for 10-20 years. The short term objectives are to raise awareness of the possible impacts of climate change and investigate how the different sectors can help climate change mitigation. The medium term programme aims to support projects incorporating climate change issues also climate change should during this period be included in secondary education, the government should also introduce environmental economic instruments such as taxes. The long term programme aims to carry out large energy and transport projects and adaptation strategies for rising sea level should be implemented.¹²⁵

¹¹⁹ Agrawala, S., 2003, p.26-27

¹²⁰ Ibid., p.26-27

¹²¹ Shayo, C.M., 2006, p.7-8 & 10

¹²² www.tanzania.go.tz e (2009-04-03)

¹²³ Maro, P., 2008, p.153-154

¹²⁴ www.nemctan.org b(2009-04-27)

¹²⁵ Agrawala, S., 2003, p.27

5.1.1.4 National Adaption Programme of Action

The NAPA document is formed after the visions in the National Development Vision 2025 as well as international conventions. In NAPA Tanzania recognizes the importance of problems related to climate change and the need to deal with the effects, the vision is to;

*“Identify immediate and urgent Climate Change Adaptation Actions that are robust enough to lead to long-term sustainable development in a changing climate. It will also identify climate change adaptation activities that most effectively reduce the risks that a changing climate poses to sustainable development”*¹²⁶

The effects of climate change on key sectors have been identified and actions within these prioritized. Agriculture and food security is ranked as number one followed by water, energy, forestry and health; vulnerabilities in the agricultural sector are also identified. The sector is highly important because of the significant role in the economy and for development. Global warming could also accelerate growth, reducing the length of the season leading to production decreases of certain crops. It is also concluded that the average food production in Tanzania is sufficient but shortage of food has existed in almost one third of the countries districts during 2001-2005 and self-sufficient levels have varied from 88-103%. Districts with scarcity of food have varied between 13 and 62 during the same time period. Agroecological zones might also shift changing the crop calendar and production and thus the economy on household level.¹²⁷

5.1.1.5 National communication to the UNFCCC

In the initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC) from 2003 both mitigation and adaptation are central issues. Tanzania here recognizes climate change and state that they believe in global warming and that the issue has to be addressed to ensure sustainable existents for present and future generations. Tanzania fully supports the objectives of the UNFCCC, *“to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.”*¹²⁸ According to Tanzania Adaption Team the country has carried out a number of measures to meet the obligation connected to the UNFCCC. They have implemented several projects and activities and written series of reports that provide up-to-date scientific information on impacts and adaption. Of reports from the Division of Environment some have been published for policy makers, academics and the private sector. Tanzania has also put together a number of sectoral policies and plans that include climate change.¹²⁹

5.1.1.6 Agriculture and livestock policy

In the Agriculture and livestock policy the government concludes that agriculture will, also in the long term, have a central role in the economy. Agriculture is in this policy document defined as *“the area of human activity involving all aspects of crops and livestock”*.¹³⁰ The government here points out the importance of adapting policy according to environmental changes.¹³¹ The ultimate goal for Tanzania in the field of agriculture is to improve the well being of people whose principal occupation and is based on agriculture. The policy focuses on commercializing agriculture to increase income levels and surpluses. The general goal is specified into nine objectives; assuring basic food security and improve nutrition, improved living standard in rural areas, increase foreign exchange earnings, produce and supply raw materials, develop and introduce new technology, promote sustainable use of natural recourses, develop human

¹²⁶ Division of environment, 2007, p.1

¹²⁷ Ibid., p.33

¹²⁸ Vice President´s office, 2003, p. xiv

¹²⁹ Tanzania Adaption Team, 2006, p.9

¹³⁰ Ministry of Agriculture and cooperatives, 1997, p.10

¹³¹ Ibid., p.2

recourses within the sector, provide support sectors and promote access for women and youth to land, credit, information and education¹³²

5.1.1.7 Agricultural Sector Development Strategy

The Agricultural Sector Development Strategy (ASDS) from 2001 objective is to create an environment for improving profits in the sector, improving income and reducing poverty. The ASDS sees virtually unlimited natural recourses in the country however some weaknesses are identified including poor coordination and low productivity.¹³³ Costs for implementing the programme amounts around 255m USD.¹³⁴

5.1.1.8 Agricultural Sector Development Programme

The Agricultural Sector Development Programme (ASDP) is a tool for implementing the ASDS that origins from the policy from 1997. It was developed by the four Agricultural Lead Ministries. The ASDP has two main objectives; to enable better access of knowledge, technology, marketing and infrastructure, all contributing to higher productivity and to promote private investments. Both aim to ASDS and ASDP aim to create a 5% growth rate for agriculture through commercialisation, trough private and public partnerships and implementation of District Agricultural Development Plans (DADPs). Central regions research will focus at maize, sorghum, sunflower, pearl millet and ground nuts. Funding will come from the growing season 2008/2009.¹³⁵

5.1.2 Regional Level

Samuel John represented the CCM standpoint on agriculture and climate change in Babati. The policy applicable on climate change was according to John the CCM slogan “*better life for every citizen*”, that the president used. He believed that the climate started to change in 1995 when rain patterns and amount of rain started to differ. Previously maize and beans were planted in Oct-Dec and harvested in February then started to be planted again, but it is not possible anymore. Since many people are depending on the rain the changes can lead to draught and famine. John believes cutting of trees is the reason as well as a global issue. He has heard about climate change from the mass media and that the industries are the reason and point out that CCM is working with it.¹³⁶

Mr Majid at the Ministry of Agriculture believes that the climate is different every year; the changes are then temporary and natural. He listed several effects that changes in climate have on agriculture and that the government should work with; shortage of food, high prices on commodities (one bag of maize might go up from 20 000 shillings to 45 000 shillings), shortage of water, lack of water for animals, malnutrition especially of young children, lack of pasture, lack of vitamins because of malnutrition and other diseases.¹³⁷ Farm Africa (Food and Agricultural Research Management) assists the District Agricultural Council (DAC) and helps them with the work that they cannot handle. Mr Kasindei that was interviewed has worked at DAC prior to his work at FARM-Africa, and they are both situated in the same building. He told me that FARM – Africa has not got a policy on climate change and he does not know if the DAC has one either. He believes that the rain has changed and since the rains have changed “*there must be something wrong*”. He also talks about the difference in rain periods and said that usually there are two rain seasons one long and one short, the short one is normally tree months,

¹³² Ibid., p.12-14

¹³³ United Republic of Tanzania, 2001, p.1&4

¹³⁴ Ibid., p.7

¹³⁵ United Republic o Tanzania, 2008, p.1-2

¹³⁶ Interview, John, 2009

¹³⁷ Interview, Majid, 2009

Oct-Dec, but these days the short rain has changed sometimes generating nothing or just a few drops in Oct- Nov or only in December. Even amount of rain in the long rain period has decreased. The distribution of the rain is also different, the rain can come during a short period causing great run-off and erosion since the soil cannot absorb the water demanding water capture. He believes that the changes started 15 years ago seen as a proof for climatic change. He believes that the changes are caused by human interactions mainly through cutting of trees. Mr Kasindei believes that since everyone is a farmer *“it is very obvious that climate change has affected them”*. Visible effects are lack of food security, lack of income and changes in crops from maize that needs more rain to cassava, sorghum and millet. His predictions for the future were uncertain concluding that we have to be careful since the situation will get worse, it is a semi-arid area that can become desert. The work should be global but locally connected.¹³⁸ Mr Mshana is an extension agricultural officer in Mamire and he believes that there is a climate change seen in shorter rains and rising temperature. He also focuses the solutions on tree planting both at national and ward level. When we came to talk to him and farmers in Mamire a rainmaker had just died. Two days before the visit to Mamire there was meeting because of the problems with rain. According to Mr Mshana there are few people today that believe in rain makers, very few he point out and explains that most people believe in natural causes for rain.¹³⁹

BEDA (Babati Environmental Development Association) did not have a policy on climate change either and according to the coordinator Mr Edam and no work is done in the area and no support given by the government however BEDA is planning to start an cooperation with other NGO:s during this year to create a policy on climate change. The changes in climate are large from year to year but Edam also believes that there is a more long term change and that Tanzania is affected by the global climate change, according to him the reasons local and global well as natural and not natural. Changes are less rain and different timing as well as hotter climate one reason being deforestation and fire. He also believes that rain is the main problem the temperature is not so important and if rainfall and temperature increased it would be positive for the farmers. Edam believes that the government should work with climate change issues and they should provide education.¹⁴⁰

There is a meteorological station in Babati that has been running for four years placed under BAWASA. It is still under development and a new station is being built in Komoto (mars-09) that should be finished at the end of the year. The new station will be placed in a better location and have more advanced equipment since there are a lot of trees around the station at the current location holding up the wind. When the new station is finished there will be six people working there, at the moment Mr Alphonse works alone there. There are more than 20 rainfall stations around Babati district; they are all manual except for the one next to the office that is automatic. This is the only big station where more than rain is measured; like air temperature, humidity, pressure, wind direction, wind speed and solarimeter. All the data is collected and sent to Dar Es Salaam where weather forecasts are made for the country. Alphonse does not have a scenario for the future since the station has only been in place for four years saying he needs at least 30 years in Babati before he can give any predictions. He however believes that the ITCZ has a bigger effect on Babati than the global warming. Even though this year has been very dry he believes that it is due to natural variations and *“the coming years there will not be a problem”* and proclaims that *“the Congo air bus did not bring so much water this year”*. The climate has changed but only temporary and according to Mr Alphonse climate change is the same in the eastern highlands. Babati, Arusha and Kilimanjaro will then be affected in the same way so it is

¹³⁸ Interview, Kasindei, 2009

¹³⁹ Interview, Mshana, 2009

¹⁴⁰ Interview, Edam, 2009

possible to combine Babati with these two to make a prediction because *“the data from the Manyara region is not so available”*.¹⁴¹

5.1.3 Local Level

Elderly farmers in Babati were asked if they had perceived any changes in the climate during their life. The farmers were only concerned about the timing and the amount of rainfall, temperature was not seen as an issue. One interviewed farmer said that there has been a very big climate change and rainfall has decreased every year. He also believed that there had been large changes in rain periods. The changes in rain periods concerned more of the farmers, especially the short rain period, Oct-Dec; either said to be missing completely or less than before leading to changes in planting dates. One farmer said that since there is no rain in Nov-Dec the maize is planted in January instead. Another farmer also commented the differences in planting dates and remember the difference very clearly since they used to have beans for Christmas before. The occurring changes were both referred to as temporary and permanent, the ones that believed in a permanent change said that it started in 1980 and another one 1999 another farmer answered that rains are different from year to year *“sometimes the rain comes and sometimes not”*.

The farmers were also asked about what they thought was the reason for the changes, the answers were mainly concerning human activities. Increasing population and livestock was given as an important reason as well as charcoal, extended farming, soil erosion, building of houses and building roads. People without other employment also use the forest for their survival and the increased amount of animals has led to overgrazing. The trees and the forest was the recurrent issue that was related to all the mentioned activities. A man that was involved in the tsetse clearings said that before the clearing of the trees there was enough rainfall but now the rain is a problem, however now trees are planted. Another reason for the changes was also given; *“when the wind blows from the north the rain comes but when the wind changes direction there is no rain”*.

Another area concerned if they had heard about something called climate change and where they had learned about it. One old farmer simply answered *“I am too old to think about it”*. The other ones said that they had heard about climate change from the mass media and one also mentioned that the president has announced it. From the media they had learned that industrial pollution causes climate change and that the lack of rain is due to air pollution that disturbs the ozone layer. They also said that they believed in these facts even though they did not mention them in relation to changes in the climate.

The impact of the changing climate was also discussed concluding that changes in the climate have enormous effects on the family. The main income for the farmers comes from agriculture, and production stands both for food and income to the family. Thus the weather affects both income and food security. The money is needed for family matters and expenses seem to rise, like school fees, hospital visits and clothes. Famine is a direct effect of quick weather changes, one farmer said that many students have left school because of famine in the family and the situation is getting worse. Another farmer also said that the food production has been affected this year (2009) and that this month (February) many people are hungry. The decreased production is because of the shorter rain period this year, three months instead of six. Even if the government is trying to help people are still dying in some villages. The farmers were also asked about what they thought would happen if temperature and rainfall increased. And again the effects of a rising temperature was not seen as a large problem, summarized as *“the effect of rain is bigger than the effect of sunshine so it would be good”*. The increase of rain also worried the

¹⁴¹ Interview, Alphonse, 2009

farmers that said that the maize and millet would not survive if it was raining all the time and compared this with the El Niño in 1995 when they could not harvest anything.

5.2 Adaption to climate change

5.2.1 National Level

There are a number of national adaption strategies, mainly presented in the NAPA and the INC. One prioritized strategy in NAPA is improving food security in dry areas by promoting draught resistant crops, mainly sorghum and millet, believed to make a significant contribution to food security; seeds are also handed out for free as an introduction.¹⁴² The regions mentioned as most affected are; Shinyanga, Dodoma and Singida region where rain shortage has caused food shortages, other affected regions are Arusha, Tabora, Kilimanjaro and northern Iringa. Awareness at a local level of the negative impacts of climate change on maize production is also promoted. Other strategies are relocation of agroecological zones and investigate availability of water and fertilizers. There is a project under the leadership of the Ministry of agriculture and food security together with the local governmental authority, Tanzania Meteorology Authority, the local community, NGO:s and CBO:s promoting these strategies with a total three year 8 500 000 USD budget.¹⁴³

Ranked vulnerabilities and adaption activities for the agricultural sector in Tanzania¹⁴⁴

<i>Vulnerability</i>	<i>Existing Adaption Activity</i>	<i>Potential Adaption Activity</i>
<ul style="list-style-type: none"> • Unpredictable rainfall • Shifting in agro-ecological zones • Prolonged dry spells • Increased weed competition • Changes in pests and disease • Decline of maize yields (33%) • Decline of cotton yields (10-20%) 	<ol style="list-style-type: none"> 1. Small scale irrigation • Research and development of drought tolerant seeds • Agriculture extension activities • Diversification of agriculture • Water harvesting 	<ol style="list-style-type: none"> 1. Increase irrigation to boost maize production in selected areas 2. Alternative farming systems 3. Make better use of climate and weather data, weather forecasts, and other management tools 4. Create awareness on the negative effects of climate change 5. Increase the use of manure and fertilizer 6. Range management for livestock production 7. Change land use patterns 8. Drip irrigation for specific regions 9. Integrated crop and pest management 10. Biological control of tsetse fly 11. Promote indigenous knowledge • Change planting dates in some agro ecological zones • Reduce reliance on maize as staple food by growing short-season and drought tolerant crops such as sorghum and millet • Shift crop farming to more appropriate agro ecological zones • Change crop rotation practices • Sustainable water management to boost food crop production • Strengthen early warning system • Follow standard agronomic practices • Promotion of annual and short term crops

In the INC a vulnerability assessment was made were potential agricultural adaption strategies were identified.¹⁴⁵ Proposed adoptions mainly concern land use and management. Changes in land use include changes in farmed land, changes in type of crops and changes in crop location. Changes in management include introduction of irrigation systems, improved fertilizer use, better control of pests, weeds and diseases, changes in planting dates and better use of climate and weather data. Further strategies include the shifting of agricultural areas where cotton is grown if rainfall decreases in favour of draught resistant crops and crops that mature at different times. To reduce the effects of leaching nutrients and top soil run-off where rainfall increases,

¹⁴² Ministry of Agriculture and cooperatives, 1997, p. 100-106

¹⁴³ Division of environment, 2007, p. 38-40

¹⁴⁴ Ibid., p.21& 34

¹⁴⁵ The Vice president's office, 2003, p.28

tillage technologies have to be introduced combined with planting of cover crops and green manure crops, mulching is also important for reduction evaporation. Current irrigation systems have to be improved to reduce water losses. There will also be a need for food programmes and other social security programmes in case of crop failure.¹⁴⁶ Tanzania has according to the Tanzania Adaption Team made efforts creating public awareness of climate change and tried to mainstream climate change in all governmental sectors.¹⁴⁷ The Tanzania Adaption Team however say that very few of the existing development plans take climate change in account but believe that INC and NAPA both came with possible suggestions for this.¹⁴⁸ The government also believe that convenient adaption strategies can be created through an upgrading of old techniques mentioning the importance that Tanzania initiates an awareness program targeting especially agro-pastoralists, pastoralists, industrialists, government agencies, organizations, professional associations and communities. The programmes should be carried out by different methods like TV programs, newsletters and pamphlets in both English and Kiswahili.¹⁴⁹ Irrigation could also stabilize agricultural production and enable production of high value commodities. There is a potential for expanding the irrigation through rivers and lakes from the 1997 years level of 150 000 hectares to 1 million hectares wherefore the national irrigation development plan (NIDP) has been developed and irrigation promoted.¹⁵⁰

The Agriculture and Livestock Policy have a number of services used for reaching policy goals including; agricultural extension service, agricultural research, training, regulatory service and technical services with numerous services included in these categories. Through the agricultural extension service new agricultural technology should be transferred through the research – extension- farmer linkage. Trough this channel technology should also be simplified if needed and farmers’ problems transfer to research level. The extension service uses a visitor and training methodology carried out by one extension agent. At ward level there is a village extension officer (VEO) who should serve around 700 people.¹⁵¹

5.2.2 Regional Level

The work of adapting agriculture to climate change carried out by the CCM is primary conducted trough leaders meeting followed by village meetings. In these meetings CCM informs about climate change and how to cope with it. They talk to the farmers and try to encourage them to plant short term crops and not to cut trees. They give out 10kg short term maize seeds/family for free and 10 tree plants because *“if the place has a lot of trees, it starts to rain”*. According to John 3880 people in 8 villages in Babati rural have already been given this information and 2700 also got short term maize seeds. The government also gives food to families affected by famine. He is also confident that by using these strategies promoted farmers can cope with climate change. Everyone should be encouraged to plant short term crops like maize and plant trees *“we are planning on meeting everyone in the district, we are working on it”*.¹⁵²

Mr Majid working with crops at the ministry of agriculture said that they work through the extension officers that are present in every village; they gather the leaders and encourage them to plant short term crops and to sell animals if there is a draught. They are also working to prevent famine and he informs me that this week the WFP (World Food Programme) will hand out food. 11 villages suffered from shortage of food at the moment and 4 of these were chosen for food

¹⁴⁶ Ibid., p.44

¹⁴⁷ Tanzania Adaption Team, 2006, p.2

¹⁴⁸ Ibid., p.5

¹⁴⁹ The Vice president’s office, 2003, p.66-67

¹⁵⁰ www.tanzania.go.tz a (2008-04-02)

¹⁵¹ Ministry of Agriculture and cooperatives, 1997 p.15-16

¹⁵² Interview, John, 2009

support.¹⁵³ According to Mr Kasindei at FARM-Africa they and the ministry are already doing a lot of work and *“we are on our way and we have already achieved about 20% of our work, but still we need a lot of effort”*. The work that is done concerns; soil conservation, agro-forestry and tree planting, a lot of the effort is put on the forest because *“the forest trap the clouds, if you have clouds coming the forest traps them and if you have no forest they go away”*¹⁵⁴

In Mamire the agricultural officer Mr Mshana inform people of the situation in the world to make sure that the villagers produce enough food, inform about draught tolerant crops like millet, sweet potatoes and bulrush millet and give away ½ acre of millet to every household for food security. They also inform about conservation that includes crop rotation, minimum tillage/ cultivation and maximum soil cover. There are also groups in Mamire that talk about food security and have something called food security cards that indicate the required amount of food per person per year.¹⁵⁵ According to Mr Edam education is the solution to prevent negative effects and conserve the environment. Through education the famers can cultivate the land sustainable and prevent for example tree cutting.¹⁵⁶

5.2.3 Local Level

The interviewed elderly farmers in Babati used a number of strategies for adapting to climate variations and climate change. However switching crops was the strategy that was mentioned in all the interviews in the different villages. This strategy was also promoted strongly by the agricultural officers. One farmer from Singe said that the only possible adaption is planting when the rain comes, even if is just a few acres. Another farmer from the same village believed that livestock helps the farmers in dry periods as well as mixing of different crops while diversifying was the main strategy. Another strategy mentioned by a third farmer from Singe was the change of crops to the ones that could be sold at the market in the Babati region such as; onions, tomatoes, vegetables and sunflowers. The three farmers in Singe all mentioned switching of crops as a strategy; one said that because the rains have changed they now plant short term crops like millet, short term maize (2,5 months), cassava and sweet potatoes. Governmental information has also reached Singe; one farmer said that the government created a policy in 1974 that encourage farmers to plant crops that are less sensitive to draught than maize like cassava and millet. I was also told that the government is working with this issue now and in every ward there is an agricultural officer that talks to the farmers about climate change, so everyone is aware of the issue. The government advices them to plant short term crops. The short term crop seeds are also distributed to the farmers for free as well as fertilizer (urea). He also said that *“this is the first time since the freedom in 1961 that the farmers get something back from the government”*.

In Bashnet the strategies were the same, the same short term crops were planted instead of sensitive maize and beans, new plants were however mentioned; pyrethrum and wheat, that also were said to be draught resistant. In Mamire the information about switching crops was also given by the agricultural officer, creating a laugh among the elders when I asked about this since the officer was the one translating. They all laughed, pointed at him and said that he was the one that told them. The farmers there were advised to plant millet and bulrush millet by Mr Mshana. In Mamire they also had a programme where 1kg of millet is given out for free and then 2kg are returned to motivate the farmers. Worth to note is also that all the farmers did diversify growing mixes of; maize, beans, pumpkin, millet, sweet potatoes , fruit trees, timber trees, pyrethrum,

¹⁵³ Interview, Majid, 2009

¹⁵⁴ Interview, Kasindei, 2009

¹⁵⁵ Interview, Mshana, 2009

¹⁵⁶ Interview, Edam, 2009

pigeon peas and sunflowers. Some were also using agro-forestry techniques and agro-pastoralist techniques but these were not mentioned as strategies.

5.3 Barriers for Adaption

5.3.1 National Level

The main barriers for implementing the strategies according to NAPA limited internal funding, extreme poverty in certain groups, inadequate infrastructure, small credit opportunities in rural areas, HIV/AIDS draining the economy and family situation, health issues, limited analytic capacity for analyzing impacts of climate change at local level and thus develop practical strategies.¹⁵⁷ Governmental research and projects on draught resistant crops and short term crops for the different agro-ecological zones, development of storage methods, fertilizer amounts and water methods have also faced problems. Good quality Sorghum and millet seeds have been developed but the government has problems with distribution, extensions services and marketing which slows the process. Cassava has also faced draw backs even though these crops are highly important for maintaining the food security in the country. During draught periods officials have often handed out maize, which have given the impression that maize is superior to these grains and too much resourced have been directed to maize production and maize is frown against the climatic conditions.¹⁵⁸

5.3.2 Regional Level

Mr Majid at the Ministry of Agriculture believes the district need several things to be able to adapt to climate change. Babati needs education for the farmers, assistance for building irrigation, assistance of short variety seeds, preparation of dams for animals drinking water, storage structures for crops , no cutting of trees for charcoal use, educate livestock keepers, education about fire. According to Mr Kasindei a joint effort is needed. At least three ministries have to cooperate; the Ministry of Agriculture, the Ministry of Natural resources and the Ministry of Livestock as well as NGO:s. Knowledge among famers is also needed so that they can store water to compensate for the irregular rains and are able to conserve the environment and control fires and this could be done through projects similar to the SIDA funded LAMP project. Limiting factors for adaption today are lack of training, lack of money, deforestation causing erosion, loss of clouds, large run-off, lack of roots binding soil and less fertile soil. Mr Mshana believes that participatory learning is needed since people need to be involved in the learning and change themselves. The change has to come from the grass roots so that they can manage themselves. When new techniques are introduced different groups of people also adapt in different speed. There are some that adapt straight away and then there are the laggards that never adapt. But generally people are positive to changes that generate more money. There is also a new cash crop called *dolichos lablab* being introduced.

5.3.3 Local Level

In Babati interviewed farmers were not so clear about what they would need to adapt. One farmer said that since they are depending on the rainfall they need support if the rain does not come. After some talking about what kind of things that potentially could help, irrigation systems were mentioned as a solution, livestock as a backup, planting in different places so that at least some of the fields get rain. Planting of rice and vegetables was another potential strategy. The farmers were also asked about their thought about the future in relation to climate change, giving various answers. The need for planting short term crops to survive was one thing taken up. According to one respondent “*the farmers need to change their crops but they stick to what they traditionally have grown. The reason for this is ignorance and they don’t like to change.*”

¹⁵⁷ Division of environment, 2007, p. 20

¹⁵⁸ Ministry of Agriculture and cooperatives, 1997, p. 100-106

They could get the food if they changed the crops, it would not be a problem.” Another respondent also promotes the short term crops saying that beans only take three months to grow, millet two months and short term maize three months but today the farmers don’t plant them. Another need for the future was to plant a lot of different crops so that some have a chance even if the weather changes. It is good to plant as many crops as possible *“If one dies the other survive”*. One of the respondents said that the government is taking care of the issue through tree planting and forbidding tree cutting. According to him it is important to take care of the forest since the forest attracts rain and if these methods above are used there will not be a problem but if they don’t act the situation will get worse. The last interviewed respondent however had a different view, according to him no one will survive; the economy will drop because of the lack of rain since the economy is depending on the farmers.

6. Discussion

The purpose with this thesis was to investigate the level of awareness, the strategies and constraints concerning agriculture in relation to climate change in Tanzania. The aim was to look at these three factors at national, regional and local level. The three research questions were; How do people, from national level to local farmers, perceive climate change? What are the strategies for adapting to climate change? And what are the barriers for agriculture to adapt to climate change? According to the government environmental work is carried out in the proper way from policy level to legal framework and institutions. Finding out what policies actually exist and how agriculture could be effected and adapted is however very difficult. When institutions and policy framework is looked at more closely, besides what the government presents in the ordinary information channels, other institutions and policy documents are found that actually are of higher importance for climate change. To find all relevant information it is necessary to know what you are looking for which of course makes it a lot harder. According to Tanzania Adaption team climate change should be mainstreamed into all governmental sectors but this is clearly not the case. Climate change is dealt with in the National Action Plan on Climate Change, NAPA and the INC, in these Tanzania identifies agriculture as the most vulnerable area, but it is not seen in the Agricultural Policy. However the agricultural policy shows a framework that information could easily be carried out through. The agricultural policy says that new technology should be transferred through the research-extension-farmer link; this channel should also transfer farmers’ issues to research which could be very valuable. Transference of science however demands a knowledge and ability to assimilate that kind of information. In Babati language, offices rules and lack of documents did that no written information could be obtained from official documents or homepages and no official policy was found through interviews. The only policy suggested was *“better life for every citizen”*, which could virtually be used for everything. Knowledge was varied but both local and global reasons were mainly given by both farmers and officials. Old and new knowledge seem to exist parallel but still both seem to be true, but local reasons seemed to be given higher importance maybe possible because of the lack of knowledge of the bigger picture. The officials varied in information indicating that a large extent of scientific information did not reach them making it hard to believe that scientific information was transferred through the research-extension-farmers link. However the link seemed to function well and information did reach out in other matters. The meteorologist did not seem to be involved in any spreading of climate related information as stated that TMA is responsible for. Another finding in Babati was that the NGO:s and Extension Agricultural Officer believed in climate change but not the meteorologist and the Agricultural Officer at DAC, they both believed in natural variations. Officials and farmers were mostly concerned with decreases in the short rain period and the main reason for climate change given was cutting of trees and information about global effects seems to come from mass media. This indicates that information is not only obtained through Bayesian updating but also through more modern information channels.

Tanzanian awareness is estimated to be very low due to failure to see differences in variability and long term trends. Farmers in Babati however gave detailed information about the climate from the 1940s and had a perception of what was changing. Information from farmers was in many senses more detailed than the one obtained from officials and meteorologist. Answers from Babati are also in line with African studies showing that; 86% of Nigeria farmers perceive a change; a majority in Ethiopia which also was in line with metrological reports. 50 % of African farmers experienced a decrease in precipitation consistency with rainfall data however varied. Partly explained by insufficient rainfall data to compare with, being a problem in many areas. Another theory is that farmers always believe that things are getting worse. Climate is essential for farmers wherefore their perception might be more detailed, but officers in agriculture should be able to obtain the information from other sources than self experience. If farmers are to adapt to climate change, awareness of the problems is the first step. Awareness is however a diffuse term, the level of awareness could be said to be very high in Babati since everyone had heard about climate change and had an opinion. On the other hand the accuracy of information around the issue was very varied. The trees are for example given an extremely large role in climate change issues; off course the impact of tree planting have a positive impact as both a carbon dioxide sink and for the local climate but the picture is too simplistic when believing that planting some trees around your house will capture clouds making it rain. Giving trees a too big role might hinder other information to be considered appropriately and other adaption methods to be developed. The right trees also have to be chosen when some trees actually take a lot of water from plants and can acid the ground. The dual picture of local and global is also seen here where trees might be the one way that Tanzania has effected climate change and a way that they can relieve consequences, they are still however affected by global change and even if they are not affecting it they have to adapt.

The majority of Tanzanian agricultural predictions in relation to climate change are negative, indicating large yield losses in major staple food. Predictions seem to correspond more to the agronomic and panel data theories neglecting the effectiveness of adaption. There are however many adaption possibilities developed by the Tanzanian government showing that the national level is being more positive than many studies indicate, incorporating adaption like in Ricardian models. It is not very clear though what models results in reports are based on neither was there a large amount of calculations to be found. To be able to adapt effectively work also has to be carried out at national, regional and local level. Work is today carried out at all these levels however there is a much wider range of adaption strategies proposed at national level that promoted regionally. NAPA ranked small scale irrigation as number one at the existing adaption list, followed by research; extension services, diversification and water harvesting. A strategy advocated in the north eastern regions is switching to draught resistant crops, mainly sorghum and millet. In Babati Small scale irrigation was not mentioned nor was water harvesting. Diversification is dominating already and extension service as well. In INC adaption mainly concerned; crop location, irrigation, fertilizers and better use of weather data none was mentioned as a used strategy in Babati. Effects of increased rain, like leaching of nutrients and top soil, should be handled by tillage, cover crops, mulching and irrigation. These problems were however not in line with regional and local perception and therefore not further investigated. Despite the lack of policy there was clear work being done in the area and adaption strategies being promoted and implemented in the region as a response to climate variability and climate change. No one could answers where the chosen strategy came from but directives must at least to some extent have come from the top since they were the same in all villages and offices. The two main strategies mentioned in Babati were shifting to short term crops and planting of trees. Draught resistant crops were also promoted in one village seeds were also handed out for free. Promotion off short term crops is not at the NAPA existing adaption strategy list but at the

potential adaption list, but not among the top 10 prioritized ones. Planting of trees is not a national strategy either but existing in many other areas in Africa. Officials also said that they inform about climate change as well about new draught resistant crops but only one of the interviewed farmers said that they had gotten information about climate change from agricultural officers, the other said media, they had however gotten clear information about that they should switch crops. Agricultural officers seem to have an influence on farming practices and being the main channel for information the picture given could also be more nuanced incorporating broader information.

At local level there is a wide range of strategies used showing that the farmers do incorporate risk in their farming as oppose to some researcher believe, farmers also adapt wherefore Ricardian models seem more appropriate when accounting the effects. When looking at changes in rainfall planting of different crop varieties was the most common response in Africa followed by different planting dates and shortening of the growing season. In Ethiopia planting trees was the most common strategy, in Nigeria different crop varieties followed by improved water practises and in Mogorogoro extension of land, diversification, crop switching and changed planting dates after weather forecasts. Sorghum, cassava and sweet potatoes were then planted when dry years were predicted. Using weather forecast was also a strategy mentioned in the INC but none of the farmers or officials in Babati mentioned anything about it even though crops are the same. Some farmers in Mogorogoro had also stopped cultivating during the short rain period which could happen in Babati as well if the short rain keeps decreasing. In Babati many strategies were mentioned among the farmers, however switching crops was the most common. Short term crops planted were millet, short term maize, cassava and sweet potatoes. Short term crop seeds were also distributed for free as the officials said. According to theory few farmers that perceive climate change neglect adaption, in Babati this seemed to be true but the Ethiopian study showed that there was a large part perceiving that did not adapt. At a national level adaption strategies are clearly created in connection to climate research. At district level I was not able to understand what the official based their decisions on. Local farmers seemed to be aware of global issues but adapting to local variations. Planting draught resistant crops is a national strategy for the region but not short term crops; however some of the crops were mentioned in both categories.

Climate change has a disadvantage according to research because of the long time perspective, lowering the interest for action. However long- and short term changes are both effecting farmers and interest for climate change seemed quite big. One farmer said that he was too old, which is in line with the theory of elders short time horizon however other farmers seemed concerned about the future and since many their children most probably will become farmers climate change might not be so far away after all. The largest interest during the field work for global climate change work came from the farmers furthest away with the smallest plot of land asking about how the international work was progressing to hinder the global warming. There is clearly confusion between climate variability and climate change which can be problematic if strategies have a short planning horizon taking valuable time from implementing long term strategies. However the large interest for climate variability also gives an opportunity to incorporate climate change in the discussion even if some farmers are adapting only to variability at the moment, as promoted by Jones. Local variations and climate change are off course also connected. Decrease of rain in the short rain period that is a perceived change today is what scientific literature believes for the future, scientific prediction however estimates an increase bringing another set of problems not dealt with in the current strategies. But since farmers are already feeling the impacts introduction of further strategies should be relatively easy, as science trickles it way down to the farmers. Perception inevitable effects action, definitely locally and maybe even at official level today, this perception is however changeable.

To create appropriate climate change strategies local studies are needed, variations in the country are too large to national strategies and maybe even to use general large regional studies in some parts. To be able to determine effects of climate change in Babati it would be necessary to downscale climate change information as well as predict the effects locally on crop production. Adaption strategies cannot be neglected when calculating thus climate change cannot be seen as a static event affecting us indefinitely. It would be interesting calculating agricultural yields in a Structural-Ricardian model in Babati, using downscaled climate information to see if it would differ in any way from strategies used today. Without this kind of downscaled information it is hard to determine whether the decision of promoting short term crops is the right way to go however it is clearly in line with existing perceptions. The field work leaves two questions in the adaption part, what are the decisions at regional level actually based on and why is short term crops the only strategy promoted? Strategies used might be right, I am not the one to determine this, but if no water harvesting or irrigation techniques are used a shortening of the short rain period will be more severe however work done for relieving effects of floods in Babati might reduce effects of predicted increases of rain in the long rain period. In the diverse agroecological zones in Babati there further has to be differences within the region and other methods that could be combined with the promotion of short term crops. Irrigation and water harvesting could make use of short term and draught resistant crops less necessary. Promoting only one solution to climate change seems a bit too risky especially when diversification is the basic strategy for securing livelihood under normal conditions, diversification in adaption strategies would therefore also be expected to be promoted.

There are a lot of barriers affecting the adaption process; theory identifies a large number of them including characteristics of the farm, infrastructure, institutions, education, sex, information, uncertainty of information, extension service, credit, social capital, cooperation, farm size, agro-ecological zone, markets, land tenure, current climate. The Tanzanian Government identifies the barriers to be; lack of funding, extreme poverty, inadequate infrastructure, lack of credit, HIV/AIDS, health and lack of analytic capacity. Sorghum and millet seeds have been developed but faced problems with distribution, extension service and marketing. In draught periods the government often hands out maize, giving the impression that maize is superior even though it is sensitive. At district level there were also a number of barriers taken up; lack of training, money and deforestation, loss of clouds, large run-off and low soil fertility. And the need for education, irrigation, short-term seeds, storage structures, no cutting of trees and participatory learning. Generally people were also said to be positive to adaption even if there are of course differences between groups. In the African study few farmers perceives information and knowledge as a barriers. Other barriers identified were lack of water and the right seeds, property rights and marked access. A large part did not see any barriers. In Ethiopia five main barriers were identified, lack of information, money, labour, land and irrigation. In Nigeria lack of improved seeds, high price of the right seeds, lack of water for irrigation, finances, and information about adaption methods and weather were identified barriers. In Babati the interviewed farmers were not clear about what they would need to adapt. Identified needs for adapting were; assistance if there is a shortage of rain, irrigation, livestock backup, diversification, taking care of the forest, diversified planting places and switching crops. Both short term crops like beans, millet and maize were mentioned as well as rice and vegetables. Ignorance was also seen as a barrier.

It is hard to compare the theoretical aspects on barriers with national identifications and local perception since many of the barriers are not easy to see from the inside. National barriers identified also have a broader perspective than farmers probably have when thinking of barriers, which probably is just seen as normal life for farmers and hard to look away from. It is very

interesting that the government themselves realize that handing out maize is working as a promotion for maize in dry periods. At the same time it is understandable since it is the major food crop that people usually eat. It however indicates that there is a lack of information since this connection is done by the receivers. Farmers in Babati however seemed very aware of what crops are draught resistant and thus it does not seem likely that the interviewed elderly farmers would do that connection. Promotion of sorghum, millet and cassava did seem to reach many of the farmers and work was ongoing also indicating that the promoted strategy is working in Babati. The interviewed farmers in Babati should according to theory also be the ones that most easily adapt, experienced and with access to extension service maybe giving them an advantage. Officials also said that most farmers were willing to adapt, but they also wanted the farmers to be willing to do so.

That farmer themselves see information and knowledge as barrier for adaption is also interesting, since they carry a lot of knowledge about adaption to natural climate variation it is probable that old traditions also contains a lot of the knowledge needed. Knowing that you lack information also indicate that you know something about it and believe that you should know more. It might however also be convenient answers if the interviewer seems to think that you should know something about it. Lack of seeds and high prizes of the right seeds was also identified as problems by African farmers as Challinor et.al discusses as an issue. Irrigation was also taken up by many farmers in earlier studies as a barrier but only mentioned by one farmer in Babati after discussing the issue, none of the farmers thought of it spontaneously. In many studies there was also a difference in adaption strategies carried out and the ones that were perceived as appropriate, but Babati farmers mentioned mainly already used strategies as needs for the future. They were also the only ones mentioning help as an adaption strategy, thus continuing as before and get help when needed. Money was also mentioned by farmers in previous studied countries but not by the Babati farmers. Nigerian farmers also saw lack of weather information as a barrier, not mentioned by Babati farmers even though they have a relatively large weather station and soon six people working there and access to radios, interest might however grow when the system is further developed in the future. A large part of African farmers did not see any barriers, and Babati farmers did not have many ideas for future adaption. This might either be because they feel that they have what they need but it might also be because it is hard to imagine what it would be one needed if you do not have the knowledge about the possibilities. Relieving the barriers and enable adaption would help farmers to adjust and hence lessen the effects of climate change. It would help them maintain their livelihood and food security today and in the future policymakers would win a lot on raising awareness of climate change and appropriate adaption methods.

7. Conclusions

Tanzania has ratified the UNFCCC and the Kyoto protocol and has declared that they believe in global warming and that the issue has to be addressed. Climate change is however not mainstreamed into environmental and agricultural policies even though this should be the case. Agriculture is also identified as the most vulnerable area in relation to climate change. At regional level, in Babati district, there are no climate change policy or guide lines, the only suggestion was *better life for every citizen* that then should incorporate climate change as well. Perception among officials in Babati was varied. Concerns were related to amount and timing of rain and the main reason for the problem was thought to be cutting of trees. Global warming was known and information came from the media. The farmers were also only concerned about changes in timing and amount of rainfall, occurred changes were both referred to as temporary and permanent but everyone perceived a change. They gave the same reason as officials and were also aware of global warming which they believed in; somehow parallel to beliefs of local reasons. Farmers in other African countries also to a large extent perceived changes in rainfall.

At a national level adaption strategies are presented mainly in the INC and NAPA listing existing and potential adaption strategies, where most are at the potential list; small scale irrigation being number one followed by research, extension service and diversification. They also promote awareness, relocation and development of water recourses and fertilizers. One prioritized strategy in the north eastern regions is switching to draught resistant crops. I did not get any written down adaption strategies but there was clearly adaption work being carried out in Babati. The two main strategies were shifting to short-term crops and tree planting. Draught resistant crops were promoted in one visited village. Information about climate change was also said to be spread by the officials together with adaption strategies however farmers mainly said that they got the information about adaption not the causes. Adaption strategies at local level are numerous, in Africa different crop varieties is the most common response, followed by changing planting dates and shortening the growing season. In Ethiopia planting trees was the most common strategy; Morogoro in Tanzania extension of land, diversification and crop switching was used. In Babati switching crops was most common; millet, cassava, short term maize and sweet potatoes were mainly planted and some seeds were also given out for free.

There is a large difference in perspective when looking at barriers for adaption making answers at different levels differ. The Tanzanian government identifies barriers for adaption to be lack of funding, extreme poverty, inadequate infrastructure, lack of credit, HIV/AIDS, health and lack analytic capacity. Officials in Babati mention lack of training, lack of money, deforestation, loss of clouds, run-off and low soil fertility. They also expressed a need for education, irrigation, short-term seeds, storage structures and participatory learning. African farmers saw lack of water lack of the right seeds property rights and market access as barriers. A large number did not see any barriers. In Ethiopia lack of information, money, labour land and irrigation was identified and in Nigeria; lack of improved seeds, high process of the right seeds, lack of water for irrigation, finances and information. In Babati farmers were not very clear about the barriers and needs for adaption. Mentioned needs were help when there is a draught, irrigation, livestock backup, diversification, forest care, diversified planting places and switching crops.

References

Shardul Agrawala, Annett Moehner, Andreas Hemp, Maarten van Aalst, Sam Hitz, Joel Smith, Hubert Meena, Stephen M. Mwakifwamba, Tharsis Hyera & Obeth U. Mwaipopo, (2003). *Development and climate change in Tanzania: focus of mount Kilimanjaro*, OECD.

Boko, M., I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability*, Cambridge University Press, Cambridge.

Michael Case, (2006), *Climate Change Impacts on East Africa A Review of the scientific Literature*. WWF, Gland.

Andrew Challinor, Tim Wheeler, Chris Garforth, Peter Craufurd & Amir Kassam, (2007). *Assessing the vulnerability of food crop systems in Africa to climate change*, Climatic Change (2007) 83:381–399.

Ehrhart, Charles & Twena, Michelle, (2006). *Climate Change and Poverty in Tanzania*, CARE

Temesgen T. Deressa, Rashid M. Hassan, Claudia Ringler, Tekie Alemu, and Mahmud Yesuf, (2008). *Analyzing the Determinants of Farmers' Choice of Adaptation Methods and Perceptions of Climate Change in the Nile Basin of Ethiopia*, International Food Policy Research Institute.

Division of Environment, *National adaptation programme of action (NAPA)*, (2007). Vice president's office

Rashid Hassan & Charles Nhemachena, (2008). *Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis*, Centre for Environmental Economics and Policy in Africa (CEEPA), University of Pretoria

Ishaya, S., Abaje, I.B., (2008). *Indigenous people's perception on climate change and adaption strategies in Jema'a local government area of Kanduna State, Nigeria*, Journal of Geography and Regional Planning Vol. 1(8) 138-143 November 2008.

IPCC, (2007). *Climate Change 2007: Synthesis Report*, IPCC

IPCC, (2007). *FN.s klimatpanel: Den naturvetenskapliga grunden*. Naturvårdsverket, Stockholm

IPCC, (2000). *IPCC, Special report on emission scenarios*, IPCC

Jones, W. James, (2003). *Agricultural Responses to Climate Variability and Climate Change*, NOAA, Washington.

Kurukulasurya Pradeep & Mendelsohn Robert, (2008). *Crop switching as a strategy for adapting to climate change*, UNDP & Yale University

Paul S. Maro, (2008). *A review of current Tanzanian national environmental policy*, Department of Geography, University of Dar es Salaam.

David Maddison, (2007). *The Perception of and Adaption to Climate Change in Africa*. The World Bank.

Clas Lindberg, (1996). *Society and Environment Eroded A Study of Household Poverty and Natural Resource Use in Two Tanzanian Villages*, Uppsala

Ministry of Agriculture and cooperatives, (1997). *Agricultural and livestock policy 1997*, Dar es Salaam.

Mark J. Mwandosya, (2007). *Statement in the plenary on adaption during the United Nations high level meeting on climate change*, Vice presidents office, United Republic of Tanzania.

Jouni Paavola, (2004). *Livelihoods, Vulnerability and Adaption to Climate Change in the Morogoro Region, Tanzania*, University of East Anglia, Norwich, UK

RDSU, *Qualitative research methods*. Peninsula research & Development Support Unit.

Rosenzweig ,Cynthia & Nicola Tubiello Francesco, (2007). *Adaptation and mitigation strategies in agriculture: an analysis of potential synergies*, Springer Science

C.M. Shayo, (2006). *Adaption Planning and Implementation: Agriculture and Food Security*, Vice presidents office, United Republic of Tanzania.

SSN Tanzania Adaption Team, (2006). *Poverty and Climate Change a South North Collaboration, Summary of Tanzania Vulnerability and Adaption to Climate Change, Variability and Extreme Events*. The Centre for Energy, Environment, Science and Technology, Dar es Salaam.

United Republic of Tanzania, (2001). *Agricultural Sector Development Strategy*, Tanzania.

United Republic of Tanzania, (2008). *Agricultural Sector Development Programme (ASDP)*, Tanzania.

Vice President's office, (2003). *Initial National Communication Under the United Nations framework Convention on Climate Change (UNFCCC)*, United Republic of Tanzania.

Gina Ziervogel, Anton Cartwright, Adriaan Tas, James Adejuwon, Fernanda Zermoglio, Moliehi Shale and Ben Smit (2008). *Climate change and adaption in African agriculture*, Stockholm Environmental Institute, Stockholm.

Internet

www.tanzania.go.tz

<http://www.tanzania.go.tz/administrationf.html> -a (2008-04-02)

<http://www.tanzania.go.tz/lands.html> -b (2008-04-02)

<http://www.tanzania.go.tz/ministriesf.html> -c (2009-04-03)

<http://www.tanzania.go.tz/vision.htm> -d (2009-04-12)

<http://www.tanzania.go.tz/environmentf.html> -e (2009-04-03)

www.nemctan.org

<http://www.nemctan.org/m-v.htm> a (2009-04-27)

<http://www.nemctan.org/nemacts.htm> b (2009-04-27)

www.unfccc.int

http://unfccc.int/essential_background/feeling_the_heat/items/2914.php (2009-05-11)

www.skybrary.aero

<http://www.skybrary.aero/index.php/ITCZ> (2009-05-11)

www.kyotoprotocol.com

www.kyotoprotocol.com (2009-05-11)