



# Impacts of Climate Change and Adaptation Strategies in Tanzania

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This report will examine the impacts of climate change in Tanzania, and will outline the consequences, adaptation strategies, responsible parties, relevant stakeholders and likelihood of implementation of adaptation strategies for three impacts.

## Tanzania

Tanzania is a developing country on the East coast of Africa with a population of 43 million and many environmental extremes, ranging from vast salt lakes and mountain ranges to coral reef coasts (Eyakuze 2004). It is a developing country that has, and will continue to, suffer from climate change impacts that affect the 'environment, production systems, and livelihoods' (Mertz et al. 2009, p. 744).

## Climate Change Impacts

Climate change has been observed in Tanzania and across Africa and projections have been made for future change (Hulme et al. 2001). Across Africa a warming of 0.05°C per decade was observed throughout the 20<sup>th</sup> century and a warming of 0.2-0.5°C per decade is projected for the 21<sup>st</sup> century (Hulme et al. 2001; IPCC 2001). Precipitation has increased across East Africa and is projected to increase in wet months and decrease in dry months (Hulme et al. 2001; IPCC 2001). Changes vary across regions and extremes will magnify (IPCC 2001). These changes will impact Tanzania over the next century (table 1).

*Table 1: Impacts and consequences of climate change in Tanzania*

Impacts	
<b>Water Availability</b>	Warmer, drier and more variable conditions are likely to inhibit water availability (IPCC 2001) (detailed in following section).
<b>Food Security</b>	Decreased food security in terms of crops and fisheries are expected across Tanzania (Rowhanian et al. 2011) (detailed in following section).
<b>Human Health</b>	The effects of diseases, water-borne and vector-borne, are likely to be amplified due to climate change (IPCC 2001) and diseases are expected to colonize new regions as migrations occur (IPCC 2001) (detailed in following section).
<b>Extreme Weather Events</b>	Warmer temperatures are expected to increase the frequency and severity of events such as storms, floods, fires, hurricanes and El Nino events which will impact human health, the economy and the environment (IPCC 2001).
<b>Sea-Level Rise</b>	Warmer atmospheric temperatures are expected to cause a sea-level rise through melting of ice sheets and thermal expansion (IPCC 2001). This rise, along with extreme weather events and warmer sea surface temperatures will degrade coral reefs, leading to lessened coastal protection (IPCC 2001).
<b>Biodiversity</b>	Biodiversity across Africa is expected to decrease as species attempt to adapt to changing environments (Lovett et al. 2005). This will lead to decreased species diversity (Sykes & Prentice 1996; Solomon & Kirilenko 1997; Kirilenko & Solomon 1998). One example of this occurring is in the noted decrease in cloud forests (Hemp 2011), resulting in extinctions of amphibian species (Pounds et al. 2006).
<b>Coral Reef Degradation</b>	In the Indian Ocean, rapid warming killed 45% of living coral in 1998 (Muhando 2001; McClanahan et al. 2011). Rising sea surface temperatures are expected to worsen impacts on this vulnerable ecosystem (Graham et al. 2008). This will result in negative impacts on marine fisheries, which provides employment and food for Tanzanians (Cinner et al. 2012).
<b>Tourism</b>	Decreases in coral reefs will impact the tourism industry, which provides employment (Cinner et al. 2012; Khatib 1998). Also, decreased glaciers on Kilimanjaro will result

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tourism declines (Thompson et al. 2009).

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## Specific Impacts and Consequences

One of the greater concerns for Tanzania is the unavailability of food and clean water, which is likely to lead to decreased human health in the form of diseases and malnutrition (Ebi 2008).

### 1. Water Availability

Droughts can result from warmer sea surface temperatures (Funk et al. 2005). Dry months are expected to continue to receive less precipitation, leading to drought and desertification (IPCC 2001). Reductions of up to 10% in annual flow are expected for the Pangani and Ruvu rivers (VPO-URT 2003). Mount Kilimanjaro glaciers are retreating and snow cover has, and will continue to, decrease and is expected to disappear by 2020 (Thompson et al. 2009). Decreased cloud forests also resulted in a 25% annual reduction in fog water, which provides drinking water for 1 million Tanzanians (Agrawala 2005, Hemp 2011). Limited availability to fresh water then impacts food security and human health through impeding agriculture and encouraging outbreaks of diarrheal diseases (IPCC 2001).

### 2. Food Security

There exists a heavy reliance on rain for agriculture that is important for consumption and income (Arndt et al. 2012). Increased climatic variability is likely to threaten food security in regions of Tanzania (Rowhania et al. 2011). From March to May rainfall is expected to decrease, leading to decline in long-cycle crops (Funk et al. 2005; Schlenker & Lobell 2010). Extremely high precipitation associated with El Niño events can also decrease crop yields and cause flooding (IPCC 2001). Higher temperatures and associated deoxygenation of water bodies can affect fisheries (Roessig et al. 2004; Fick et al. 2005). In some regions, people who rely on agriculture have been forced to extend cultivation, diversify their livelihoods and migrate in response to climate change (Paavola 2008).

### 3. Human Health

The spread and intensity of diseases is expected to increase (IPCC 2001). Climate is a key determinant in the distribution and prominence of vector-borne diseases such as malaria and dengue fever (Mia et al. 2011). For example, malarial emergence, extinction and transmission are heavily dependant on climate (Parham & Michael 2010) and warmer, wetter conditions increases instances (Githeko & Ndegwa 2001; Zhou et al. 2004). Changes in rainfall and increased temperatures can also increase the risk of diarrheal diseases such as cholera (Trarup et al. 2011).

## Potential Adaptation Strategies

Climate change projections have a degree of uncertainty and adaptation strategies need to consider the worst-case scenario (Mahrenholz 2008). Water availability, food security and health are intertwined; therefore strategies need to have a holistic approach (Eriksen et al. 2005). 'Small-scale local associations have a potential to facilitate collective experimentation and risk management, contributing to the resilience and sustainability' (Rodima-Taylor 2012). However, a broader perspective and a national policy reform are required to provide the basics such as water, food and education (Downing et al. 1997).

Food shortages can be worsened by lack of education as individuals are unable to turn to alternate income sources and their children leave school due to hunger, resulting in limited education in the

next generation (Eriksen et al. 2005). This cycle must be broken by providing better education and a safety net for vulnerable individuals in the form of a protected natural resource base (Paavola 2008).

Adaptation strategies must involve the governance of natural resources, as they provide irreplaceable reserves for vulnerable groups (Paavola 2008). More efficient policies and regulations are required for natural resource management and environmental protection to conserve limited resources (Mustelin 2009). The major hurdle is the lack of funding for such policies to be developed and deployed (Mustelin 2009).

Institutional reforms and improving national markets are important in driving people to intensify and diversify agricultural practices, making them more productive and sustainable in the long term (Paavola 2008). Paavola (2008) argues that market participation is also important to drive innovation towards more sustainable farming methods.

National initiatives are important in ensuring water availability as communities and villages are often ill-equipped to self-source safe water. Educational programs should be used to promote sustainable irrigation practices that aren't reliant on rainfall and do not deplete natural water supplies (Rowhani et al. 2011).

The financial costs of adapting to the increased medical burdens of climate change are substantial and human and financial resources need to be injected into adaptation strategies (Ebi 2008). Therefore, uncostly, small-scale educational programs are fundamental to promote hygiene, malaria awareness and the importance of clean water (Ebi 2008).

### **Responsible Parties**

The COP-13 Bali Climate Conference identified the need for developed countries to assist developing countries such as Tanzania with adaptation to climate change by transferring available technologies (Mertz et al. 2009). Tanzania is likely to require extensive international support and parties such as the United Nations, international aid bodies and charity organisations will be required to implement local initiatives and provide funding. The Tanzanian government is also responsible for providing adequate access to fresh water, food, education and health care, which will empower individuals to help themselves and move towards using adaptive practices (Mertz et al. 2009).

### **Relevant Stakeholders**

The impacts of climate change are likely to disproportionately affect the poor and those unable to adapt (Mertz et al. 2009). This includes hotels and organisations reliant on tourism, the people they employ, coastal communities likely to be inundated, villages reliant on rainfall agriculture and individuals with limited access to fresh clean water (Mertz et al. 2009). It is unlikely that many parties will benefit from the projected climate change in Tanzania as the consequences of the above outlined impacts are vast and intertwined (Mertz et al. 2009).

### **Likelihood of Implementation**

When faced with adversity, populations are resilient and resourceful (Mortimore & Adams 2001; Thomas & Twyman 2005) but Tanzania has low adaptive capacity (Mukangara 2005; Adger & Vincent 2005). However, there has been success with implementing low-cost, effective programs at a grass-

roots level that educate and assist communities to adapt through using sustainable agricultural practices, decreasing disease by eliminating still water, using mosquito nets and sterilising drinking water (Rodima-Taylor 2012). Effective implementation of adaptation strategies is likely to require international support (Adger & Vincent 2005) and it is likely that, should adaptation strategies not be implemented efficiently, mass migration events will occur (IPCC 2001).

## **Conclusion**

Tanzania will face climate change impacts and the required adaptation strategies are most effective at a community level but must be considered with a holistic approach. Tanzania requires international support and government reforms to adapt and, although the population is resilient, it is likely that Tanzania will be disproportionately affected by climate change due to delayed implementation of adaptation strategies.

Words: ~1200

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