

# PILOT DEVELOPMENT RESEARCH PROJECT FINAL REPORT

## CLIMATE OF MOUNT KILIMANJARO REGION P10-08-Tan

### POLICY BRIEF

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## 1.0 Introduction:

The administrative Kilimanjaro region implies the area encompassing seven districts: Moshi urban, Moshi rural, Mwanga, Same, Rombo, Hai and Siha. The Kilimanjaro reserve is divided between Moshi rural, Hai, Siha and Rombo Districts where most of conservation and protection activities are being undertaken and generally the reserved areas are on the mountainous part, an areas experiencing high rainfall, relatively low temperature and considered important for the ecology of the mountain which includes biodiversity and various catchments. The conservation activities have been mainly on Wildlife and forest reserves. At 5895 metres (~19341 ft) above mean sea level height Kilimanjaro is the highest mountain in Africa. Above 2700 meters is the Kilimanjaro National Park (which also comprises of the forest reserve). The Park is inhabited by numerous animals and plants, some of them indigenous only to this mountain. The ecosystem services from the mountain play a major role for every life aspect of the region population i.e. the National economy through tourism and for the community's livelihood, from water source and availability, energy to agricultural benefits, tourism industry, etc. Generally the conservation strategies intend to maintain the environment of the region which may maintain the natural processes undisturbed.

Mount Kilimanjaro is a World Heritage site, It is a volcanic tropical mountain with a well-known snow cap which has been a centre for admiration among mountain hikers. Mount Kilimanjaro has been on the limelight as an icon representing the impacts of climate change, specifically global warming. These impacts have been illustrated by the reduction of the mountain ice cap and reported glacier vertical recession. Several findings have been presented on the reason giving rise to glacier recession on the Kilimanjaro (and other mountains in the tropics), which include increased temperatures, solar radiation intensity changes, precipitation variability, albedo decrease due to various reasons including black carbon deposition and ice sublimation<sup>1 2</sup>

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<sup>1</sup> Meyer H. 1900. *Der Kilimandscharo*. Reimer–Vohsen: Berlin

<sup>2</sup> Klute F. 1920. *Ergebnisse der Forschungen am Kilimandscharo 1912*. Reimer–Vohsen: Berlin.

<sup>3 4 5 6 7 8</sup>. So far there has been no definitive conclusion on the causes of this change, although it has persistently been indicated to be a result of global climate (but not necessarily temperature) changes. Varying magnitudes of the extent and rate of the impact of changing climate have been reported. Some alarming predictions were made by the same Thompson<sup>3</sup> projecting total disappearance of snow between 2015 and 2020. Thereafter, several observations have indicated varying and contradicting interpretations and predictions on the dynamics of the top glacier and snow cap.

The climate of the Kilimanjaro region need to be ascertained through continuous investigation and analyses of the outcomes since local environmental conservation strategies emphasises on local measures whereas globally, the changes are considered to be a response to global climatic changes. Through various literatures it is observed that more facts emerges as one extends research time. With current mixed understanding and responses of various actors, the Kilimanjaro region is in great need for integrated research.

## 2.0 Nature and Extent of the Problem

The Universal climate problem in the region is exemplified by the glacier recession. The nature of glacier loss is such that there is bottom melting which is followed by vertical collapse and ice frakes formation. This process seems to be the factor accelerating the vertical retreat of the glacier since the formation of ice frakes accelerates melting. Significant retreat was always

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<sup>3</sup> Thompson L. G., Mosley-Thompson E., Davis M. E., Henderson K. A., Brecher H. H., Zagorodnov V. S., Mashiotta T. A., Lin P. N., Mikhalenko V. N., Hardy D. R., Beer J. 2002. Kilimanjaro ice core records: evidence of Holocene climate change in tropical Africa. *Science* 298: 589–593.

<sup>4</sup> Kaser, G., Douglas R. Hardy, D. R., Mölg, T. M., Bradley, R. S. and Hyera, T. M. 2004 Modern glacier retreat on Kilimanjaro as evidence of climate change: observations and facts. *Int. J. Climatol.* 24: 329–339. DOI: 10.1002/joc.1008

<sup>5</sup> Mölg T, Hardy DR. 2004. Ablation and associated energy balance of a horizontal glacier surface on Kilimanjaro. *Journal of Geophysical Research*. Submitted for publication.

<sup>6</sup> Hansen, J., Nazarenko, L. 2004. Soot climate forcing via snow and ice albedos. *Proc. Natl. Acad. Sci. USA* 101, 423–428,.

<sup>7</sup> Jacobson, M. Z. 2004. Climate response of fossil fuel and biofuel soot, accounting for soot's feedback to snow and sea ice albedo and emissivity, *J. Geophys. Res.*, 109, D21201, doi:10.1029/2004JD004945

<sup>8</sup> Pierrehumbert 2005. Tropical Glacier Retreat Online: <http://www.realclimate.org> accessed on 1 December 2007

observed between June – September and therefore, between September and October is the period when minimum glacier level is experienced. The seasonality of ice formation follows precipitation rates in the region which is bimodal and the end of precipitation season is followed by glacier and ice melting consequently determining the magnitude of water flow. The observed flow indicates that although the forest zone plays an important role in maintain river flow, many rivers originate outside the forest zone as well, implying that the commonly overemphasized importance of forest cover on the water flow is supported by this other source in this region i.e. at higher altitude above the forest zone glacier have significant contribution to the low altitude water flow.

The glacier is considered to be an important source, together with the forest zone, of water flow in the low altitude of the mountain. Since climate effects continue to affect the region at a global scale the local effect observations indicate that Kilimanjaro glacier recession is continuing and will continue to take place. The major local effect will be on the hydrology of the region i.e. the water flow of the region will continue to be affected by climatic changes.

The land relief of the mountain shows that we are currently experiencing seasonal flow of water within and beyond the forest zone as can also be observed up the mountain. This may be signifying that as the ice cap and the large glacier are lost, some annual river flow has been reduced to seasonal rivers. The native of this region were used to annual river flow which was supporting small household irrigation schemes. It is now apparent that water availability is becoming a problem and no longer available for the yearly crop production and there is a tendency to commercialize water supply as opposed to traditional domestic water sources. This is contested by communities in some areas of the mountain.

The Kilimanjaro region is an important catchment for the Pangani basin which is supporting two major hydro-power stations for generation of electricity in the country. This downstream national importance of water usage is protected by government regulations set in order to maintain priorities to National need for Electricity generation in the country. Because the

downstream water flow is maintained, communities upstream water needs are affected and suffer from such limitations which interferes with their daily livelihood activities.

### **3.0 Affected Ecosystems and Populations:**

The region has no uniform weather dynamics at different altitudes and mountain side. The observations do not provide weather element stability. These provide varying influences on the hydrological parameters. Major affected ecosystems which can seasonally be visible is the mountain hydrology which is influenced by two parameters; the summit glacier melting and the forest catchment area. It is always noted that melting of the larger glacier starts from the bottom leading to large horizontal fragmentation. This problem affects all glacier reserve on the mountain summit, i.e. the Northern ice field and the southern glacier reserve, the largest of the current available reserves.

Most communities in the region are rural inhabitants dependent on the mountain ecosystem for their livelihood. According to the national 2012 census, Kilimanjaro region has a population of 1,640,087 people. Over 64% of the population live along the slop of the Kilimanjaro, dependent on the mountain resources mainly water (surface and ground water) and forest or forest product. Since climate highly and directly influences the two major livelihood supporting ecosystem benefits of the mountain (Forest and water availability) the major affecting factor is weather. The weather effect to the two has direct impact on the majority of the community's livelihood. The Kilimanjaro forest has been affected by fire outbreaks, wood fuel collection and illegal lumbering. The three activities are being carried as a way seen to be part of coping strategies caused by diminishing ecosystem support. Since weather changes have affected availability of water, there is a general failure of agricultural productivity which has been caused by low water supply to traditional irrigation schemes. And since agriculture is a universal livelihood activity, almost every household has been affected and suffers food shortage.

The food shortage has been magnified by the emergency of new diseases especially the regional delicacy, banana. This has aggravating food shortage as one of the major problems in

the region. Food as a principal life supporting need, its shortage caused by poor land productivity to support the growing population and uncontrollable new banana disease must have triggered mass movement of the regional population to other regions of the country as was testified by village communities in the area that for them to adapt, families need to be supported by family members outside the Kilimanjaro region.

#### **4.0 Climate and Conservation Risks**

The lack of involvement of communities in the implementation of environmental conservation measures may lead to difficulties in successful ecological restoration or conservation of the mountain. The current observed ecological conservation is not based on awareness creation but on regulation and national park law. Although communities are considered to be conservation stakeholders, they don't consider themselves to be that but the reserve nuisance. This result from the way they are handled by the authority. The mountain forest is generally vulnerable as a source of fuelwood and other non-timber forest products. Unless access to these products can be assured, destruction and sabotages of the mountain environment cannot be avoided, this include fire outbreak. Community access to the forest resources in the region cannot be avoided since observations indicate that to be the easiest area for coping strategy resources.

The mountain glacier retreat is historical and longtime event which need to be monitored over extended time. Many research results indicate different interpretations which imply the need for more observation and further research initiatives in order to have long-term certainty of the mountain environment. There is a risk of misinterpretation of the observed problem as has been in the past (Thompson *et al.*, 2002), which is understandable due the fact that climate change factors are dynamic and not stationery.

The need for country policy modification may be under risk of implementing measures which address microenvironment while as have been predicted by models, the region is influenced by global weather circulation. Under such circumstances, although local measures contributes to

global weather maintenance, this may have minimum impacts to the strategy to save the changing glacier status as is always locally implied.

Conservation strategies are likely to failing due to the fact that community economic and social development does not match with the current population increase of the region, which has increased to an extent that needs extra land mass and resources.

## **5.0 Social Impacts**

Mount Kilimanjaro, a tropical mountain has fascinated trekkers due to its legendary glaciers on its summit. It is the most famous mountain in Africa and the world for its easy summit accessibility, therefore a famous place for most mountain climbers. It is one of the most famous National Parks in Tanzania contributing significantly to the National foreign currency earnings (45% of all Parks). Tourism has been supporting the country's economy which for the past eleven years has contributed an average of 13.6% of the national GDP. Kilimanjaro is one of the two major youth employing Parks in the country, as porters and guides who predominantly come from local communities. Observation<sup>9</sup> has indicated that tourism in the Kilimanjaro region employs approximately 11,000 people providing about \$50 million a year into the regional economy. The impact of climate change which may lead to total loss of the top glaciers will likely affect the Kilimanjaro passion of many mountain climbers and subsequently affect most of local tourism companies employing local communities together with all the above benefits. This will be one of the notorious social impacts to the region and the whole country. There are other economic consequences of the region due to changing livelihood dependence. The region food was for many years, banana. Due to climatic changes which have affected banana availability, the region has resorted to cereals especially maize and surely maize meal is now the major meal in the region. Under these circumstances there is an increased need for labour support of almost all families in order to provide required quantities of farm produce to support household food needs.

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<sup>9</sup> Mitchell, M., Jodie K and Jenny L. 2009. ' Making success work for the poor: Package tourism in Northern Tanzania.' 16 January, 2009. SNV.

The need for mountain resources has increased tension between village communities and the park staff who are considered to be aggressors. On the other hand the park authorities have made the mountain forest reserve out of bounds to communities for all activities in fear of sabotage and destruction although this may not be necessary. This situation breeds false accusation, for example water shortage which is sometimes considered by communities as a deliberate movement by the park authority even when it is under weather influence.

## **6.0 Actions**

There is a great need for coordinating all researches conducted in the region with consideration that research should not focus on meteorological parameters which are classically used to define climate. Other physical information is needed for understanding the challenges affecting the region. Factors like seismic effects to large glaciers and volcanic effects need to be integrated in order to segregate physical parameters. This implies that focus should go beyond the administration region of the Kilimanjaro Mountain where now almost all conservation activities are concentrated. Meteorological, physical and biological responses of the region need to be integrated for interpreting the regional changes. Other surrounding regions should be considered to be part of the investigation perimeters.

In general for effective research and conservation activities the following are suggested to be included in understanding the Kilimanjaro changes and its association to Climatic Changes:

- Establish a one-stop-centre for specifically coordinating and archiving all research activities and outputs. This should be receptive and exposed to other parts of the world researches in order to harness other world experience.
- Establish a visible educational centre to accommodate different knowledge among researchers and communities in the region. Youth especially those involved and with direct benefits from the mountain tourism activities need to be educated on the wide range of knowledge about climate change.



- Include communities to be part of the conservation programme and not to be considered as environmental nuisance, not welcomed in the area.
- Major alternative livelihood activities should be initiated in the region in order to minimize dependence on the mountain resources and consequently human interaction with the mountain environment. This will avoid human induced catastrophes like bush fires, the source of which are currently disputed and not yet resolved.
- Establishment of modeling centre as a modern tool for prediction and forecasting of the regional weather. This is highly needed as part of the modern approach for understanding climate change analyses. Tanzania as a country has very limited knowledgeable people in modelling
- Continuous monitoring of the major river flow should be maintained in order to establish baseline information which will expose effects of the changing regional environment.
- There should be a regional conservation programme in order to strengthen the meaning of climate management strategy. This should be widely implemented not only to the Park conservation area but to the whole region associated to the microenvironment of the Mount Kilimanjaro. This will be part of the world mitigation contribution.
- A need for better water management in the region which will consider the diminishing resource, population increase in the region and the national need as the major source of the hydro power generators in the Country.
- The need to re-introduce a buffer forestry zone which will minimize human activities in the reserve forest and avoid frequent fire ignition.
- For the survival of the Kilimanjaro resources, specifically the forest resources, sustainable utilization with extra government support should be sought especially on energy, water and food availability for the region community.
- Research activities should continue and widened to encompass some other aspects as observed that the region weather fluctuations limits conclusion with certainty on various weather element dynamics.

