

Impacts of Climate Change on Agriculture: Collapsing of Dry Land Potato Farming in North East South Africa

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ABSTRACT The impact of anthropogenic climate change on potato production in north east South Africa (Limpopo Province) is studied. Decreasing trend in the area rainfall due to altered dynamics and thermodynamics of rainfall forcing caused by climate change, resulted in rivers and streams to dry. Analysing rainfall time series of the past 50 years (1960-2009), shows that north east South Africa has experienced 60 percent less rainfall than normal and high frequency of drought recurrence. Consequently, farm units declined from 1200 units to 300 units as from 1960 to 2006 affecting dry land potato farming and food security in the area. In this study, afforestation and agroforestry are shown as the cheapest mitigation measure that can increase rainfall and has the potential of reducing greenhouse gas emissions. While suggested adaptation measures include; new potato varieties that require less water and fast maturing or breeding short-season varieties are recommended to contain fast water loss.

INTRODUCTION

This study is focusing on the impact of anthropogenic climate change on potato production in north east South Africa (Fig. 1), where the altered area rainfall has resulted in rivers and streams to dry; since water supply to these systems is sensitive to precipitation patterns. Such that, when the area experience below normal rainfall, rivers in the area dries up and vice versa. Dry-land potato farming depends exclusively on rainfall not on irrigation. Therefore, any change in rainfall affects dry-land potato production. In potato

production, rainfall variability/extremes can result in major delays in harvesting, malformation, high sugars, and size problems. Another severe effect on potato production due to adverse climatic conditions is black frost which results in prolonged problems with potatoes that are not fully matured. Also, in some instances the adverse climate variability/change can render a place unsuitable for producing a certain type or variety of potatoes. In north east South Africa dry-land potato farming ceased due to the changes in the area climate and water stress; which was exacerbated by land use and land cover changes (Munyati and Kabanda 2009) in the area.

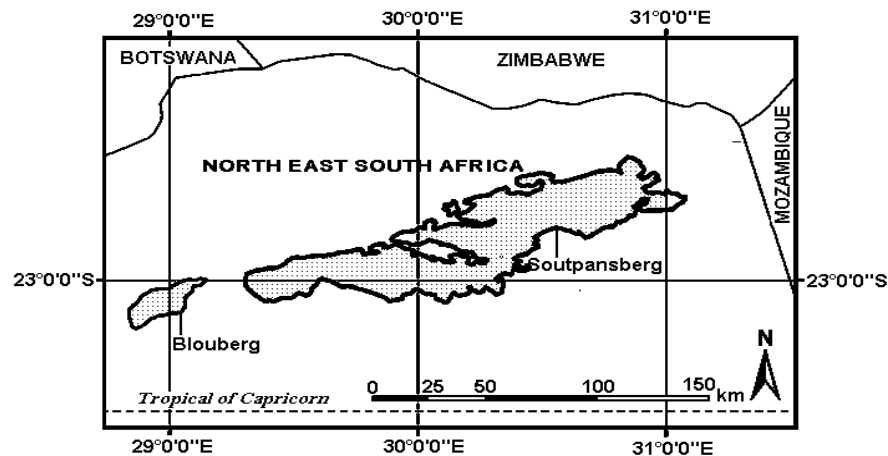


Fig. 1. The map of South Africa showing the study area (The North East South Africa)

Many land use patterns are observed in north east South Africa (Fig. 2), and depends on local environmental factors such as climate and topography. Land use patterns which are largely practiced in the area include: Commercial Forestry (4 percent), Dry land Agriculture (10 percent), Commercial Irrigation (3 percent), Conservation Areas (30 percent) and Urban Areas (3 percent). However, a large portion of the land (50 percent) is barren or covered with intrusive igneous and metamorphosed rocks which are fairly resistant to weathering. The inhabited area is not confined to the arable land only, but even the rocky outcrop is settled in some part of the region. This is due to the scarcity of land and population pressure on the cultivatable land.

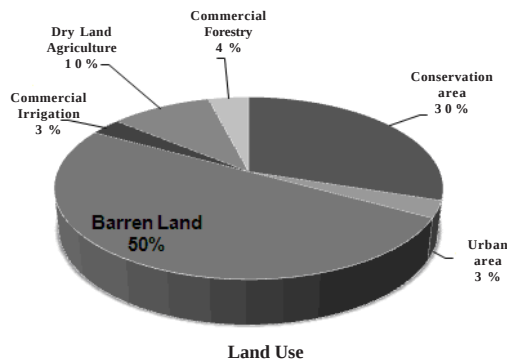


Fig. 2. Land Use in North east South Africa

Soutpansberg Mountain ecosystem has not been spared of these sporadic settlements in search of land for farming (Mphaphuli 1999); in fact in some areas most of the indigenous forests have disappeared completely. Deforestation in South Africa is a big problem which comes with negative ecological and socioeconomic consequences on the livelihoods of some already impoverished people (Smith 1991; Du Plessis 2000; Binns et al. 2001). Clearing of vegetation from high elevated areas like mountains, changes the surface albedo and affect the cloud cover and depth and therefore, the distribution of rainfall.

Using remote sensed data, it was observed that the area under natural forest declined by about 20 percent (18,296.5 ha) from 91,476.3 ha in 1990 to 73,179.8 ha in 2006 in the Soutpansberg area (Munyati and Kabanda 2009). The location of this loss in natural forest cover is in the vicinity of human settlements and has a potential to influence rainfall reduction.

METHODOLOGY

The present study encompasses the Limpopo Province portion of the North East South Africa, roughly between 29° E and 31° E, and 22° S and 23° S. The main physical feature of the study area is the Soutpansberg Mountain that features the East-West direction. The mountain shows a gradual rise in altitude with some areas depicting complex terrain. The general terrain of mean ridge height approximately 800-1200m is common while in some places, there are peaks reaching 1500 m above the surrounding. The mountain plays a vital role in rainfall distribution and temperature moderation; for example, to cause rain to increase as a result of the influence of topography (Oliver and Van Heerden 1999).

However, if the topographic influence is altered by any means that can result into environmental change or climate change this will in turn affect the rainfall and temperature of the surrounding areas thus affecting agricultural productivity. According to Munyati and Kabanda (2009), Kabanda and Munyati (2010) and Mphaphuli (1999), the land cover of the Soutpansberg Mountains has been tempered with by human developments in the area; thus affecting the orographic influence of the mountain on the area rainfall.

RAINFALL TREND IN NORTHEAST SOUTH AFRICA

Rainfall variations along the Soutpansberg Mountain are presented in Figure 3. The stations were selected based on different section and characteristics of the Soutpansberg Mountain from east to west. Punda Maria is the easternmost point of the mountain where moisture from the Indian Ocean begins to ascend the Soutpansberg. Tshakhuma and Klein Australie are found in the middle of the Soutpansberg; while Tolwe station is the westernmost point on the Soutpansberg or, in this case, the exit point of the easterly flow.

From Figure 3, Punda Maria on the moisture entrance to the east, maintained rainfall closer to the long-term average, while Tolwe and Tshakhuma reports a negative trend. However, Klein Australie shows a positive trend although it is situated about 30 km east of Tshakhuma which maintained a reduction in rainfall with time. It should be noted that the rainfall increase during 1999/2000 is due to the floods that occurred in southern Africa that was associated with Tropical Cyclone *Eline*

(Reason and Keibel 2004) If you ignore this amount of rain from the data, the trend line will show an accelerated dip illustrating a strong reduction in rainfall with time for Tolwe and Tshakhuma.

The superimposed 5-year running mean (Fig. 3) indicate that; without the influence of El-Niño Southern Oscillation (ENSO), a quasi-sinusoidal oscillation is observed in the area rainfall pattern from east to west. However, rainfall continued to decrease toward the west of the Soutpansberg

affecting biodiversity conservation and groundwater recharge in the west. According to Mucina and Rutherford 2006, the area changes from rainfall gradient distribution of dense deciduous woodlands and evergreen montane forests to a poorly developed grassy layer, and relatively open savannah westward. It is the area to the west that used to grow dry-land potatoes and which is now getting dryer and dryer.

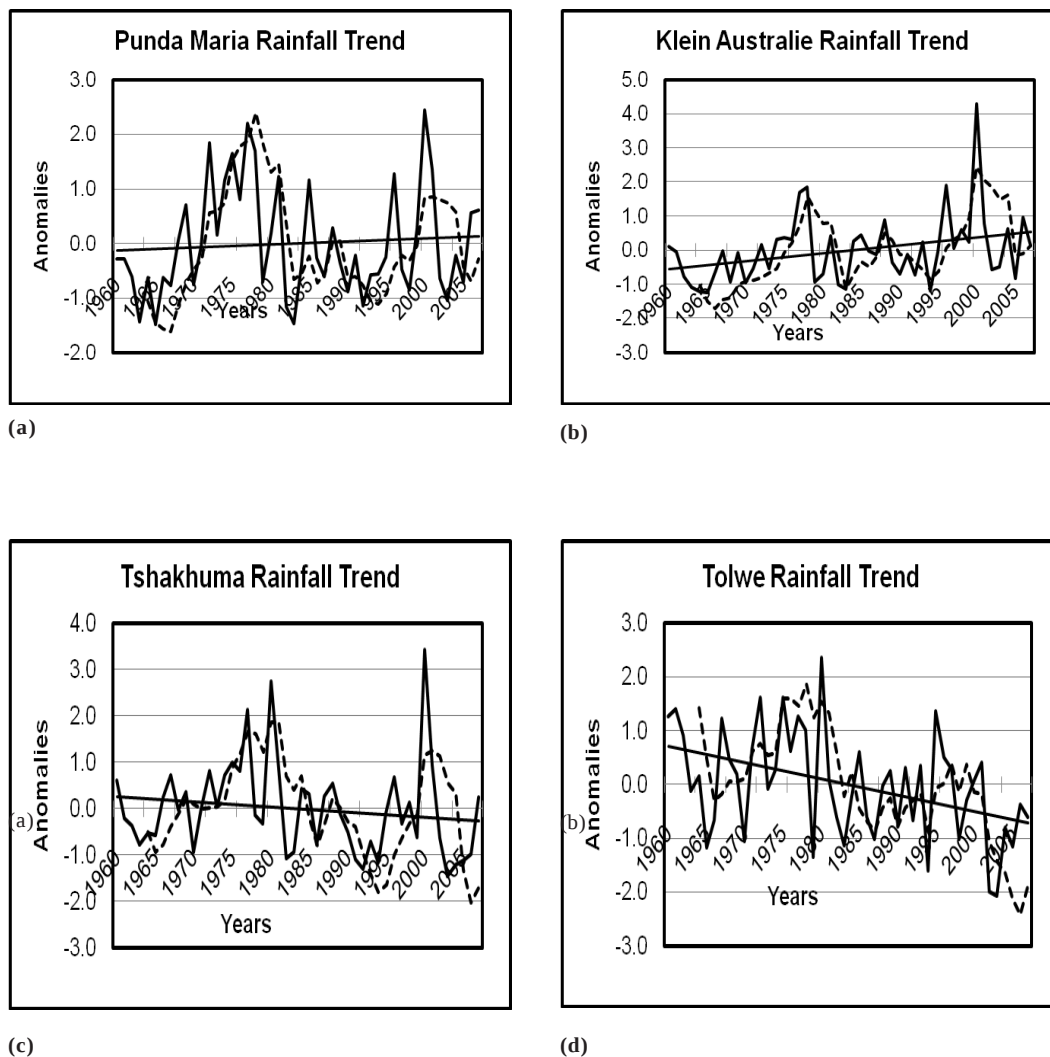


Fig. 3. Rainfall trends in the North East South Africa Rainfall. The straight line is the trend line while the superimposed 5-year running mean curve is in dashed line

Dry-Land Farming in North East South Africa

According to Aliber et al. (2008), historically, white farmers settled in what is now northern Limpopo in the late 19th century. As a group, these farmers quickly expanded, and almost as quickly embarked on plantation and orchard crops. Dry-land farm fields that included dry land potato production were open and expanded, supported by years of good rains. However, in South Africa as a whole, there were risks involved in dry land potato production due to local climate fluctuations and one of them is “over production” in good years with market prices below production costs, while, “under production” in dry years would result in very good market prices. The resultant fluctuation in quantity and price places a heavy burden on the infrastructure at fresh produce markets and impacts negatively on consumer preferences (potatoes South Africa 2002). On the other hand, the climate of the North East South Africa was changing and increases in frequency and severity of droughts from the 1960s continued to ravage the area unabated (Kabanda 2004). Although some years reported good rains and sometimes floods, generally rainfall was declining. In the west of the Soutpansberg the rivers were drying and many farms were abandoned (Steyn Koos, personal communication 2008).

Figure 4 pieces together information from agricultural census reports for North East South Africa. The pattern is typical in that the number of farming units rose and peaked in the mid-20th century; what is distinctive however, is that the area under farming has declined from the mid-20th century at least as precipitously. Whereas for South Africa as a whole, the pattern is one of only a modest decline in the area under commercial farming; implying increasing average farm size as the number of units drop, in North East South Africa the amount of land in commercial farming has declined by about two-thirds.

Potato Production Trends

Potato production trends in the whole of South Africa since 1991 to 2003 (Potato SA 2002) show that dry land potato production was leading in 1991 when 50.8 percent of the production was from dry land farming against 49.2 percent of irrigated land. However, by 2002/3 the dry land farming has shrunk to approximately 22 percent while irrigation increased to the tune of 78 percent.

According to Potato SA 2002, the high production costs compelled the introduction of irrigation technology by farmers to manage high risks and price fluctuations characteristic of dry land potato production. From Table 1, it is shown

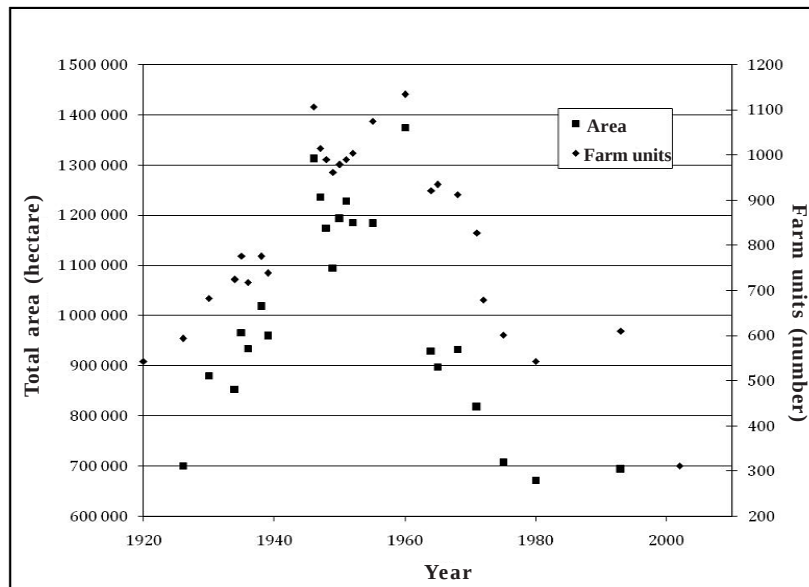


Fig. 4. Commercial farms, North East South Africa, 1920 to 2002
(Based on Aliber et al. 2008)

that dry land production decreased from 33,543 ha in 1991 to an all-time low of 12,915 ha in 2000, whereas irrigation production increased from 32,251 ha in 1991 to 38,000 ha in 2002/3. It is observed (Potato SA 2002) that in 2002/2003 there was a decline in irrigated hectares planted with potatoes as farmers shifted to maize because of the higher prices of maize at that time.

In Figure 5, Potato production trends in South Africa since 1991 is plotted together with Tolwe rainfall from the former dry land potato farming community area, the trend lines area super-imposed in each curve. It is evident that dry land potato farming was declining as the rainfall in the area was taking a plunge. On the other hand, irrigated potato production was increasing.

Production Costs for Potatoes

It might also be argued that production costs of potatoes' different farming practices are the reason for the change from dry land to irrigated farming. According to Potato SA (2004), this argument does not hold much credit when you consider that the cost vary from between R20, 915 per hector for dry land production to more than R42, 000 per hector for both seed production and the production of table potatoes under irrigation. The production costs considered were

from the summary of the average for the 2002/ 2003 season.

CONCLUSION

Commercial farming decline in the North East South Africa may be strongly influenced by deforestation in the caused by increase in human activities in the name of development. These developments depleted much of the vegetations over the Soutpansberg Mountain, the mountain is responsible for influencing the area climate especially rainfall and temperature. Observations and rainfall analysis show that the formation and development of the orographic rainfall, which is a local-scale feature that feeds the summertime convection, is impacted by vegetation cover change. The vegetation cover over the area is indeed responsible for preferential formation of clouds over the study area and disappearing of vegetation contributes to the observed rainfall reduction in this region. In turn, the dry land agriculture especially potato farming which sole depended on seasonal rains, has dwindled to an extent that it is no more significant. This is tantamount to food insecurity in the area.

Generally, South Africa has moved away from dryland potato production towards irrigated potato production. Potato production from

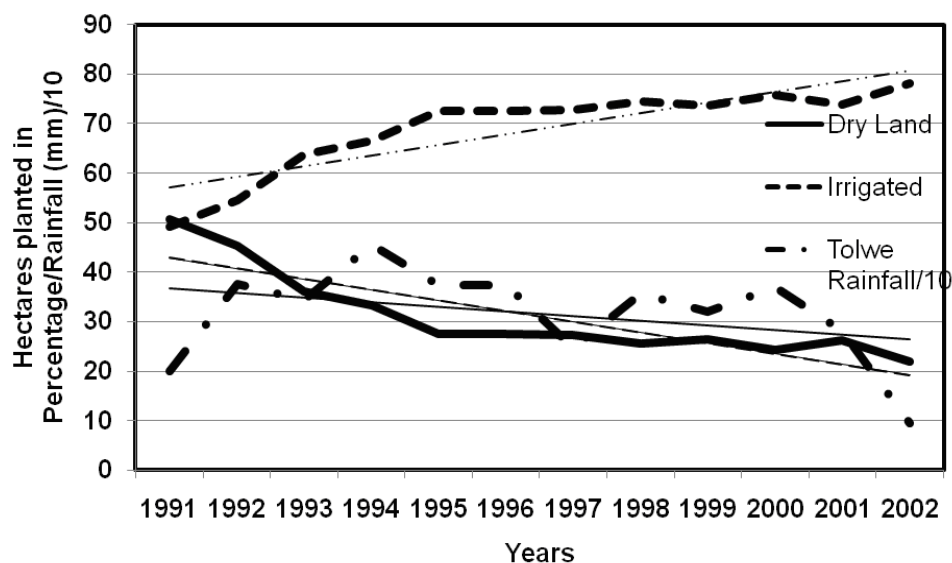


Fig. 5. Potato production trends in South Africa since 1991 plotted together with Tolwe rainfall

dryland has decreased by 62 percent while irrigated potato production has increased by 35 percent since 1991. This trend is in all likelihood pointed to the increased productivity that irrigated production offers potato producers and the reduction of risk associated with rainfall, particularly low rainfall (Potato South Africa, 2005). Although production costs of potatoes for dry land production is ~50 percent less (R 20, 915 per ha) compared to production under irrigation which is ideal for emerging small-scale farmers, who cannot afford costs associated with irrigation; on the other hand, due to climate change small-scale farmers, in particular, will be very directly affected by any yield loss. Many of these people do not have the financial means and the know-how required to adapt to changing conditions.

The long-term promotion of climate change adaptation which in the long run can restore rainfall in North East South Africa is needed. For example, planting trees on the Soutpansberg Mountain and increasing vegetation density will re-establish the altitude of the mountain hence lowering the Lifting condensation level (LCL) closer to high humidity content (Vegetation Level) to enhance the formation of cloud. Increase evapotranspiration and contribute to cloud formation over the mountains and spill over to the mountain surrounding area. Vegetations will further, reduce absorption of atmospheric radiation direct to the earth surface and therefore, maintain high humidity closer to the ground. Recovery of dry land agriculture (dry land Potato farming) will be restored in the area after the rainfall recovery and when anthropogenic climate change is contained.

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