Expected Impacts of Climate Change Vulnerability and Adaptation Assessments in Zimbabwe

Source: Zimbabwe's Initial National Communication under the United Nations Framework Convention on Climate Change – 1998.

5.1 Introduction

For those economic sectors that were considered, General Circulation Models were used to simulate likely changes in temperature and precipitation as a result of doubling of CO2. The potential impacts under this scenario were then assessed for the following sectors: forestry, water resources, agriculture and health. In the near future, it is intended to conduct similar vulnerability and adaptation studies for the following vital sectors:- energy, ecosystems and human settlements. The above sectors could not be included in this Initial National Communication due to time and resource constraints. Adaptation measures can be seen against the Business-As-Usual scenario where it is assumed that the doubling of CO2 will be reached by 2075. The corresponding population projections are based on the figures produced by the Central Statistics Office of Zimbabwe.

5.2 Water resources

Of the three Global Climate Models (GISS, GFDL and CCC), the CCC reasonably simulates current temperatures particularly in the Gwayi, Odzi and Sebakwe catchments. Therefore, this model was used to develop both temperature and precipitation scenarios for the doubling of CO2 case. Estimating water demand to year 2075 was based on population projections and average growth rates in water usage from 1950 to 1995. Rainfall-runoff simulation for the doubling of CO2 scenario showed that a 15%-19% decrease in rainfall and a 7.5%-13% increase in potential evapotranspiration will result in a 50% decrease in runoff. The difference in climate change impact on runoff among the three representative catchments considered was a 50% decrease. Therefore, a 50% decrease was assumed a reasonable estimate for the whole country.

5.2.1 Impacts

Water supply

A doubling of CO2 would cause the rivers in the Eastern Highlands of Zimbabwe that are today well watered and perennial to develop flow regimes similar to those currently experienced in the dry regions i.e seasonal rivers.

5.2.1.2 Water demand

The water demand is made up of water used for domestic purposes, irrigation, livestock, industry and energy generation. The impact of climate change on water consumption for some of these water uses are not yet clearly known. It is projected however, that climate change will increase irrigation water requirements due to increased potential evapotranspiration for the doubling of CO_2 scenario.

5.2.1.3 Water supply-demand relationship

The water demand in each of the three studied river basins was projected to the year 2075. This water demand was compared to the mean annual flow with and without climate change impacts (Table 5.2). The table clearly shows that although the catchments will be water scarce as a result of increase in demand due to population growth and allied uses, climatic change will make conditions twice as severe.

5.2.1.4 Impact on conservation reliability

The major form of water conservation in Zimbabwe is through the construction of dams. All urban centres and large-scale irrigation schemes depend on dams for water supply. The impact of climate change on future water supply from dams is a major indicator of the vulnerability of Zimbabwe to climate change. The amount of water that can be supplied by these dams with a reliability of 96% was estimated for the baseline and doubling of CO_2 scenarios. The costs of constructing reservoirs with such storage capacities were estimated using current construction costs of about Z$500 per 1 000 cubic metres of water stored (Table 5.3). The analysis further shows that the yield of dams will decrease by about 30%-40%. If the same level of supply and reliability is desired, then there will be a need to either increase the storage of these dams or construct new ones. Increase in storage is not possible since all major dams are designed for their maximum yield.

5.2.2 Adaptation measures

The amount of water stored as groundwater is still unknown in Zimbabwe. Improvement in the knowledge of groundwater storage may indicate that groundwater is a feasible source of water that can be developed to cushion the impact of climate change. It is estimated that agriculture currently uses about 80% of the surface water resources. Irrigation efficiencies vary from 40-60%. The improvement in water-use efficiency is one form of adaptation that has minimal costs.

5.3 Agriculture

Studies have been carried out to investigate the effects of climate change on agriculture in Zimbabwe. Matarira et. al., (1995) used the CERES-MODEL (IBSNAT 1989) to simulate maize responses to climate change at four sites in four of the country's five natural regions. Maize was considered for the simulation because it constitutes the staple food crop of over 95% of the country's population.

Simulations were discrete, with the default initial soil water moisture set at the field capacity of the soils. Nitrogen stress and pests were not simulated. The cultivar simulated was R201, a short-season maize cultivar common in communal farming regions in the country. Various planting dates were tested. Two equilibrium climate scenarios were used, representing much larger changes in climate than are presumed to occur after 2050. This model was validated by means of local experiment crop data. Experimental data included types of cultivars, planting date, growth analysis, fertiliser application, harvesting date and final yield. Using Global Climate Models, the observed climate data were modified to create climate change scenarios. The CCCM in (Houghton, 1990) and the GFDL (Boer et. al., 1992) were used to establish the climate change scenarios for the vulnerability assessment. Subsequent sections of this chapter describe the impacts as shown by the models.

5.3.1 Impacts

Maize production at all sites shows a considerable amount of variation under climate change conditions. Maize planted late will not give good yields, thus making maize production a less viable activity under climate change conditions.

The simulated changes in crop yields are driven by two factors: CO2 enrichment and changes in climate. In the low-lying areas of southern Zimbabwe, for example, it is probable that climate change will turn the region into a non-maize-producing area, as exemplified by reduced maize production in Masvingo. If climate change becomes a reality, this area, which represents 42% of the communal area, will become even more marginal for maize production. Based on site results, seasons could be 25% shorter than now.

5.3.2 Adaptations

5.3.3.1 Land-use changes

Studies have shown that Southern Africa is one of the most vulnerable regions to climate change. In Zimbabwe, the agriculture sector is quite vulnerable with marginally productive areas probably shifting to non-agricultural use. For areas where crop production becomes non-viable, livestock and dairy production may be developed as major agricultural activities. Some farmers could switch to different crops or change to more drought tolerant and disease resistant crops.

In areas of high temperatures and high evapotranspiration rates, introduction of irrigation systems would help to sustain agricultural production. Switching from monoculture to diversified agriculture is one of the more popular adaptive measures. This is already being encouraged through various awareness raising campaigns. However, it can only be expected that local farmers, mainly subsistence, are conservative and would gradually accept growing other crops.

Cash crops such as tobacco need much more skill, specialised equipment and capital to grow. Use of supplementary feeds and livestock breeds adaptable to drought will enable farmers to cope with some adverse climate change impacts. This again requires cash injections and the more vulnerable groups are usually uncredit worthy, sceptical of borrowing and possess no formal training on agricultural practices.

5.3.3.2 Management changes

Changes in agriculture management practices can also offset negative impacts of climate change. The timing of farming operations (for example, planting dates; application of fertilisers, insecticides, and herbicides) becomes imperative if farmers must reduce their vulnerability to climate change. Changing plant densities and application rates of fertilisers and agrochemicals would also help farmers to cope with the impacts of climate change.

5.4.3.3 Anticipatory adaptive measures

At the national level, adaptive measures are anticipatory. Through its policies on infrastructure development, research and development, education, water resources management and product pricing, the government can plan and implement anticipatory adaptive measures.

a) Infrastructure development

The Government has an ongoing investment programme to construct medium to large dams throughout the country. Increases in dam capacities and numbers will enhance the availability of water in future. Construction of these dams allows policy makers to establish irrigation projects, which facilitate a shift from subsistence agriculture to a cash-crop economy and higher rural incomes. Technology of irrigation has to improve as well in order to minimise water costs.

b) Research and development

The Government policy and support for research and development considerably influences the agricultural production sector. Strategic research planning and a well-directed research programme are needed to study crops, and livestock that are more drought tolerant and disease resistant. Sustained research on short-season, high-yield crop varieties and livestock breeds is of paramount importance to adaptation.

5.4 Human health

Both the IPCC and the World Health Organisation (WHO) have raised concern about potential adverse effects of climate change on human health. In Zimbabwe, investigations into the possible implications of climate change on human health have been rather limited. Reviews that have been conducted reveal the complex nature of the problem, where demographic changes, increase of malaria incidences, water-related health effects as well as changes in heat stress associated with temperature increases have been observed. Incidences of malaria usually reach a peak during the rainy season when temperatures are high and bodies of stagnant water are abundant. It is estimated that about one in every three people live in malaria risk areas.

In 1996, the incidence of malaria was very high after heavy rains and high temperatures throughout the country. About 1.4 million clinical cases were reported. The estimated deaths of 6 000 represented a major cause of national mortality. In general, the risk is highest during the wet season and in low lying and warmer regions of the country. These increasing malarial trends are likely to become more pronounced as the climate changes due to increase of greenhouse gases.

Other climate change associated diseases are cholera, dengue fever, yellow fever and general morbidity.

VULNERABILITY AND ADAPTATION OF MAIZE PRODUCTION TO CLIMATE CHANGE IN ZIMBABWE

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Summary

This peace of work presents results of the maize vulnerability and adaptation to climate change. Global climate change models (GCMs) and the PS123 crop growth model were used to assess the potential effects of climate change on maize production in Zimbabwe. These effects were estimated for maize, since maize is the most widely grown crop in Zimbabwe. This crop is increasingly coming under stress due to high temperature and low rainfall conditions. Projected climate change causes simulated maize yields to decrease dramatically under dryland conditions in some regions. The reduction in modelled maize yields are primarily attributed to temperature increases that shorten the crop growth period, particularly the grain-filling period, causing dramatic negative effects on yields.

There are several potential adaptation strategies that may be used to offset the negative impacts of climate change on maize yields. These include switching to drought-tolerant maize varieties, and appropriate agricultural management policies. More research is called for to generate technologies that equip farmers to adapt to the effects of climate change.

Conclusion

Climate change is slowly taking place. Because this change will result in impacts whose direction, magnitude, timing and path are neither fully understood nor accurately predictable, there is a need for sustained scientific research. This is to enable the prediction of the impacts of climate change with more confidence as well as develop and implement the most appropriate resource management strategies and technologies to combat the impacts of climate change on the agricultural sector.

The estimated effects of climate change as indicated in the simulated maize yields are indicative of the potential problems ahead of us. Zimbabwe, which is highly dependent on agricultural production sector, could see a rapid deterioration in the livelihood of the population as a result of climate change.

Without the appropriate policies or adaptive strategies in place, the smallholder farmers will find it extremely difficult to operate sustainable agricultural production systems in an environment with changed climatic conditions.

(Full publication can be requested from the climate change office).