



## Climate Change Impact on Indigenous Food Resources

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<http://dx.doi.org/10.47814/ijssrr.v5i10.713>

### **Abstract**

Change in climate conditions is real and obvious to people who depend on the natural resources to meet livelihood needs. Climate manifestations such as rising temperatures and scarce rainfall negatively affect the natural resource-based livelihoods of most rural communities. The present study describes a local community members' perceptions on climate change and how it impacts on the indigenous food resources. Materials and methods: Data derived from semi-structured interviews with a sample of 120 community members selected from a rural community in Limpopo Province, South Africa, show that community members have a reasonable understanding of climate change. Results, Discussion and Conclusion: The members' explanations of climate change are centered disparities in temperature and rainfall patterns. Also, community members are aware of the devastating impacts of extreme heat and unpredictable rainfall on the indigenous resources such as subsistence crop and livestock production, and gathering of vegetables and fruits. The study suggests the use of innovative measures to conserve and sustain the indigenous food resources reported in this study to address the challenge of poverty and malnutrition in South Africa's local communities where the resources are available and used as sources of food.

**Keywords:** *Climate Change; Indigenous Knowledge; Indigenous Food Resources; Subsistence Production; Limpopo Province*

### **1. Introduction**

Local community members are aware that the climate is changing. The change is manifested in rising temperature and unpredictable rainfall (Maharjan et al., 2012). Climate manifestations are negatively affecting the natural resource-based livelihoods of most rural communities. The impacts of rising temperature and unpredictable rainfall can be divided into two areas: direct physical impacts (primary effects) and indirect effects (secondary and higher-order effects) (Mimura, 2010). The direct impacts cause changes in the physical environment, such as droughts due to less rainfall. The indirect impacts propagate into the socio-economic system and the natural environment as a result of the direct impacts. For example, migration of inhabitants occurs as a result of flooding. Developing countries are highly susceptible to these indirect effects (Mimura, 2010), especially the local communities whose livelihoods are climate-related. The most noticeable direct impacts of climate change are warming temperatures, changes in precipitation. This suggests that temperature levels in South Africa could increase by 1.2 °C, 2.4 °C, and 4.2 °C in the years 2020, 2050, and 2080, respectively, while rainfall has also been projected to decline by 5.4%, 6.3%, and 9.5% in the same window period (Popoola et al., 2020). These are expected to threaten human health and well-being by affecting local food resources (Popoola et al., 2020). The

International Panel on Climate Change (IPCC, 2013) attests that climate change will continue to alter the natural environment in ways that threaten rights to food.

Human health and well-being are among areas of human life negatively affected by the impacts of climate change. Ziervogel et al. (2014) justifies that the increase in changing weather and precipitation patterns responsible for changes in land use and ecological variations that compromise local food provision. Malnutrition, poverty and hunger are the most common health impacts of climate change encountered across human society (Food and Agriculture Organisation [FAO], 2007). Unpredictable and scarcity rainfall and warmer winter, are compromising the provision of food. Poverty, hunger and malnutrition for example, remain daunting challenges as changing temperature and rainfall impact negatively on household food production (Madzwamuse, 2010). Ziervogel et al. (2014) add that the determinants of health most likely to be impacted by climate change are food and water. Zhao (2021) corroborate that climate change is negatively impacting on fundamental requirements for health namely; household food production systems. The most noticeable direct impacts of climate change in Limpopo Province, South Africa are warming temperatures, changes in precipitation. Therefore, the present study describes the impacts of warming temperatures and rainfall scarcity on indigenous food resources. The food resources most likely to be negatively impacted by unpredictable rainfall are subsistence crop and livestock production, and gathering of wild vegetables and fruits to satisfy the food requirements.

## **2. Materials and Methods**

### *Study Area*

The study is based on fieldwork conducted in Mogalakwena community in Mogalakwena Local Municipality in Limpopo Province, South Africa. The community falls within Rebone area which has a total area of 20 km<sup>2</sup> with a population of 10579 (991.83 per km<sup>2</sup>). The households are distributed in the area between the N11 and R518 Roads. The area is mostly populated by the Northern Sotho ethnic group (62.70%) followed by Batswana (30.32%) (Statistics South Africa [Statssa], 2014). The community falls within the summer rainfall region of Limpopo Province, with the rainy season lasting from November to March. The average rainfall is 600-650 mm with the highest measurements in January and December. Thunderstorms are recorded fairly often. The climate is renowned for its hot but pleasant summers and mild sunny winters. Summer temperatures range between 27°C and 30°C. Topography of the area is characterized by irregular undulating lowlands with hills and low-lying mountains. Observable environmental challenges are inadequate sanitation systems, reliance on boreholes and bulk storage for water provision. Mines and industrial activities negatively affected the ground water quality. The local municipality is the largest contributor to domestic fuel burning emissions in the district, contributing to approximately 52% of emissions (Mogalakwena Local Municipality Integrated Development Plan [IDP], 2014-2015).

### *Study Design*

An exploratory study was conducted to describe the impacts of climate change on the indigenous food resources in a rural community.

### *Participants*

The study sample was made up of 120 members of the community. The participants were purposely selected on the basis of age and period of stay in the community. They lived in the community for more than 40 years, which is evidence of a long period of resident in the area and a vast ecological knowledge. Of the 120 participants, 93 participants were born in the community and 27 originated from other communities but have lived in Mogalakwena community for more than 40 years. The age of participants ranged between 50 and 89 years. The gender ratio of the participants was 50 % female and 50% male.

### *Collection of Data*

Participatory research was used to collect data. This method was chosen because awareness of changing climatic conditions and their effects on health conditions concern the entire community. It was therefore important to design a participatory study to have community members together sharing experiences about the observed changing climatic conditions and how these affect their livelihoods. The researcher conducted discussions with six groups of seven members each and one group of eight members. The discussions were conducted in Sepedi, the local language spoken and understood by the study participants. Two Master's students were appointed as research assistants to assist with data collection through a tape-recorder and taking field-notes. Discussions were centred on observable changing climatic conditions and how they affect the indigenous food resources.

### *Data Analysis*

Data from tapes were transcribed and analysed through culturally infused descriptions, opinions, impressions and interpretations of change in environmental conditions and how the changes affect community members' health conditions. Data were translated from Sepedi to English and edited by experts in the Department of Translation Studies at the host institution.

### *Trustworthiness*

Trustworthiness of the study results was ensured through constitution of the study sample by elderly members of the community as custodians of the cultural values and their vast knowledge of climatic conditions. Reliability of data was ensured through repeated discussions with participants after the initial data collection process to ensure consistency of the study results. Objectivity was ensured through avoidance of bias. The study results are based on analysis of the responses provided during the discussions other than the researchers' own views about climate change and its impact on health.

### *Ethical considerations*

The participants consented to participate in the study by signing the consent form. Ethical approval was obtained from the host university. The local authorities of Mogalakwena community granted the research team permission to conduct the study. The real names and identities of the participants were not used to protect their identities and the information contributed during the discussions. Data collected during the discussions were treated confidentially and were never shared with participants in other groups.

## **3. Results**

### 3.1 Participants' perception of climate change impacts on indigenous food resources

Participants identified extreme heat and less and unpredictable rainfall as remarkable manifestations of climate change responsible for depletion of indigenous food resources.

#### *Extreme Heat*

Participants reported increased temperature as a deadliest weather-related hazard. It was cited as compromising the community livelihood. Fifty participant described how extreme heat had caused decrease in crop production. Extreme weather events like storms and floods, and their increasing unpredictability, pose direct and indirect threats to the health of the community as the crops wither, biodiversity depletes leading to death of livestock as a result of lack of fodder.

Forty-five participants reported:

*'In present times, summer is hotter than it was 30 years ago. There are increased hotter days because winter has become shorter. Winter is warm instead of cold, and has little precipitation. The seasons are beginning to be shorter because of short winter, longer warm days and short rainfall season.'*

#### *Unpredictable Rainfall*

Drought was reported as the most common climate-related disaster. It presents a risk to human health by increasing exposure to reduced water quality and quantity, and diminished food resources. Drought has devastating consequences on the community indigenous food resources such as subsistence production of crops and livestock, and collection of vegetables in the wild.

Responses from all participants were that:

*'There is a decrease in rainfall. Rainfall is no longer satisfactory.'*

Responses from 52 participants were that:

*'We started experiencing change in rainfall and temperatures around the year 1990. Rainfall is scarce. Rainfall has become unpredictable. There is a noticeable change in the timing of rainfall. Recently it comes late and makes the rainy season shorter. The delays in rainfall makes it intermittent.'*

Thirty elderly participants reported:

*'We noticed a decrease in rainfall about 30 years ago, and that was the last time we had good rainfall. Since that time rain has become unpredictable. Recently we experience rainfall in winter. We have started experiencing a recurrent drought.'*

The obvious change in climatic conditions reported by participants in the recent years is the rising temperature and unpredictable rainfall. The increased temperature patterns and decreased incidences of rainfall observed by participants are supported by reports of increase in average global temperature and extreme and unpredictable weather as the most common manifestations of climate change (Shivanna, 2022). Community members are aware that the climate is changing through their observations of rising temperature and unreliable. The United Nations Framework Convention on Climate Change (UNFCCC, 1994) notes that humans are quick to observe any changes in their local environment because their livelihoods, culture, spirituality and social systems are connected to their local environment. The human perceptions of environmental changes are informed by experiences of how the changes influence people's livelihoods. The knowledge gained from investigating how local populations perceive changes in weather could be used to develop community specific adaptation strategies which address the most relevant effects of climate change (Razaq et al. 2021). Participants' perceptions of increasing temperatures and scarce rainfall as manifestations of changing weather patterns are validated by reports of warming trends with less rainfall over the eastern and southern parts of Limpopo Province by South African Weather Services (SAWS, 2015). The Limpopo Economic Development and Tourism (LEDET, 2013) support that temperature trends for Limpopo Province over the past 50 years have not been consistent between the seasons.

### 3.2 Climate change impacts on indigenous food resources

#### *Subsistence crop production*

Seventy-six percent of participants reported that:

*'Our local food sources are declining. Subsistence crops production used to be our reliable source of food. We used to grow crops, cereals and vegetables in the home-gardens and fields to provide household food requirements throughout the year. Production of subsistence crops is poor under the current rainfall patterns. We produce little, poor quality crops. Rainfall is scarce sometimes accompanied by intermittent drought which limits our garden production.'*

Sixty-eight percent of participants agreed that:

*'The crop yields are low due to increased temperature, lack of rain, and frequent wind and storms that destroy crops.'*

Observations from 97% of participants revealed that a drop in subsistence consumption is a result of changes in temperature and rainfall patterns, which have led to poor productivity and harvest, and a shortage of indigenous food sources.

Further observations were that:

*'The production of indigenous crops is poor as the crops die and wither before they reach maturity and are ready for consumption. Increased hotter temperature and less rainfall are responsible for poor production of subsistence crops. Rising temperature destroys the crops as they grow. Food is currently procured from the retails.'*

To the participants' observations of the impacts of rising temperature and decreased rainfall on subsistence crop production, Zhu et al. (2021) concede that climate change is driving increasing losses in crop productivity. The loss in crop production from climate-driven abiotic stresses represents a major threat to global food security (Razaq et al. 2021). The IPCC (2021) acknowledges that the poorest countries would be hardest hit with reductions in crop yields in most tropical and sub-tropical regions due to increased temperature, decreased water availability and new or changed insect pest incidence. Macchi (2011) asserts that unpredictable rainfall and excessive heat are major climate hazards and can destroy rain-fed subsistence crops. In a warmer world, there is likely to be an increased vulnerability of some crops to problems like fungal diseases and insect pests that will stick around longer during a longer growing season (IPCC, 2021). Misra (2014) shows that climate change disrupts food availability, reduce access to food as temperature increases and rainfall declines. Poverty, hunger and malnutrition, for example, remain daunting challenges as changing temperature and rainfall negatively affect household food production (Razaq et al. 2021). Ziervogel et al. (2014) show that determinants of health most likely to be impacted by climate change are availability of and accessibility to food and water. The IPCC (2021) corroborate that variations in temperature and precipitation patterns are negatively affecting subsistence crop yields as fundamental requirements for human health and well-being. A decline in the availability of healthy, nutritious food due to increased temperatures perpetuates a vicious cycle of poverty and malnutrition, and growing dependence on food imports (Kalinda, 2014). As climatic patterns and habitats change and so do the spatial distribution of agroecological zones, the distribution patterns of plant diseases and pests, may have significant impacts on small-scale agriculture and food production (FAO, 2007).

Loss of biodiversity as a result of rainfall scarcity and increased temperature negatively affected two indigenous food resources, namely livestock production and gathering of vegetable materials and fruits.

### *Livestock Production*

The study participants were asked about their perceptions of the impact of the change in temperature patterns on indigenous plant materials the stock feeds on in the wild. Participants reported that they used to raise large herds of cattle, sheep and goats collectively referred to as *leruo* (wealth). Each family raised their own stock. Livestock were slaughtered only for ceremonial purposes, or when they have died of natural causes. Economically, they were a source of meat and milk while the skins are used as mats. These herds feed on grass, leaves, shoots and leaves from the wild and ploughing fields. The stock feed solely on the available pastures, except after harvesting when they graze on the stalks in the fields. During the rainy season, the stock grazed in the veld and near the villages. During wintertime they fed on pods and stalks in the fields. Once these resources become exhausted, winter grass was sought far from the village. Participants reported that they lost these natural resources crucial to their subsistence livestock production. They experience unpredictable weather; increased temperatures that have contributed to the decline in biodiversity; destroying many plant materials browsed by livestock, affecting livestock fodder resources. A clear decline in sources of livestock fodder in the form of grass, leaves, fruits and pods is attributed to changes in rainfall patterns, drought and changing weather conditions.

Increased temperature has negatively affected the growth of local vegetation including the livestock fodder sources. Many species which are sources of stock- feed are failing to grow to their full extent, and the recovery of overused species has been harmed by the increase in temperatures and rainfall scarcity. Many participants (72%) confirmed that indigenous plants on which community members depend for fodder are rain-fed. However, such species are rarely found in the local environment because of the recent scarcity of rainfall. These observations are corroborated by observations that the grassland biome appeared to be at most risk of significant change under all scenarios (i.e. low, medium and high risk climate scenarios until approximately the year 2050). The eastern and northern sections of the fynbos biome are most likely to be under climate stress, with the forest biome projected to be affected by frequency of fire incidence due to changing climatic conditions (IPCC, 2014). Bomuhangi et al. (2016) and Israr et al. (2016) support that increased temperatures and diminished rainfall are responsible for the death of pastures, the drying up of water resources for livestock drinking.

### *Gathering*

Participants showed a wide knowledge of the flora from which they derived their food.

Eighty-nine percent of participants reported:

*'We have knowledge of edible plants and insects. There were literally many plant species which we collected as a source of food. The plant materials were usually vegetables cooked to relish porridge. The Gathering of vegetables was largely the activity of women and children. Gathering of foodstuffs was largely limited to the nine months from August to April. This was the time when most of the edible leaves and fruits appeared.'*

Sixty-five participants reported:

*'As long as these vegetable sources were available, women were expected to provide regular supply for their households. These provided the steadiest supplies of food, since the other edible foodstuffs gathered, mostly fruit and vegetables, had relatively short seasons of availability. The vegetable leaves could be dependent upon for most of the summer season.'*

All participants reported the decline in the availability of vegetables and fruits that they collect from the wild. They reported that:

*'The plant species that bear fruits and vegetables are currently not appearing because of lack of rainfall and rising temperature.'*

The participants' observations of the negative impacts of climate change on the availability of indigenous plants gathered for food in the wild, are corroborated by reports that climate change is likely to cause increasingly adverse impacts on South Africa's ecosystems. The country's biodiversity and ecosystems are increasingly under pressure from accelerated climate change i.e. temperature increases, changes in rainfall patterns (Ziervogel et al. 2014). The increase in temperature impacts two aspects of growth and development of plants. One of them is a shift in distributional range of species and the other is the shift in phenological events (Shivanna, 2022). Climate change's induced shifts in species would threaten their sustenance even in protected areas as they hold a large number of species with small distributional range. Zhao et al. (2020) analysed detailed meteorological and phenological data from 1960 to 2016 and confirmed that climate warming has altered the phenology and compressed the climatically suitable habitat of this species. Rising temperatures and declining rainfall are responsible for shifting ecological zones, a loss of flora, and a reduction in ecological productivity (IPCC, 2021). Increased temperature, erratic rainfall patterns and ecological variability are responsible for shifts in the spatial distribution of floral species (Kruger & Sekele, 2012). The challenge with depletion of edible plant materials, Shivanna (2022) supports that the indigenous plant reproductive events such as the timing of flowering, fruiting, their intensity, and longevity are important phenological events dependent on favourable climatic conditions. These perceptions of the influence of changing weather on the indigenous resources corroborate Halder and Sharma's (2012) findings that marginalised communities depending on natural resources are vulnerable to the potential effects of climate change.

### **Conclusion**

The present study describes the local community members' perceptions on climate change and how it impacts on the indigenous food resources. The study results show that the members of the Mogalakwena community members have a fair understanding of climate change. Their explanations of climate change are centred on variations in temperature and rainfall patterns manifest as rising temperature trends and scarce rainfall. Also, community members are aware of the devastating impacts of extreme heat and unpredictable rainfall on the indigenous resources from which they derive food. For instance, subsistence crop and livestock production are practiced sparingly for fear of poor yields as a results of lack or enough rainfall and rising temperature that negatively affect the crops and livestock growth and sustenance. An additional observation is devastating malnutrition and poverty are a result of the negative impacts of climate and environmental variability on the resources upon which the community derives vegetables and fruits. The study suggests the use of innovative measures to conserve and sustain the indigenous food resources reported in this study to address the challenge of poverty and malnutrition in South Africa's local communities where the resources are available.

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