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CLIMATE CHANGE AND SOCIO-ECONOMIC DEVELOPMENT IN BOTSWANA

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ABSTRACT

Climate change is a major physical factor that impedes sustainable socio-economic development in Botswana. Trends in the climate within the country points to extreme type of variation. Consequences of climate change include: increasing incidence of droughts, desertification, decline in agricultural and natural resources productivity, water shortages for plants, animals and man and vector/water-borne diseases. The paper highlights major environmental problems which impede socio-economic development in Botswana. It identifies climate data acquisition/analysis for practical purposes and environmental education as ways of enhancing sustainable socioeconomic development in the country.

KEY WORDS: Climate change; Drought; Adaptation measures.

INTRODUCTION

Climate change is a term now used both in popular and scientific writing to refer to the dynamic nature of climate; the fact that climate is never static but varies over time and at different spatial and temporal scales. Climate change and its possible impacts on the environmental and socio-economic systems now constitute the most important environmental problem facing mankind at the threshold of the 21st century (Ayoade, 2003:1 and Ekpoh, 2002:146). Over the past few years, climate change has emerged a topical issue at national and international fora on sustainable development, the environment and the future of our planet. The simple reason is that all countries share a common planet and lack a viable alternative living space should we destroy the atmosphere of this planet. Climate is a major physical factor that determines the wealth or otherwise of any nation.

The climate of Botswana can be described as continental semi-arid. The country is located in the sub-tropical high pressure belt of southern hemisphere in the interior of Southern Africa far away from oceanic influences. As a result, rainfall is low and seasonal and diurnal ranges of temperature are high. The mean annual rainfall in Botswana varies from less than 250 mm in the extreme southwestern part of the country to over 650 mm in Kasane in the extreme north. The rains fall mostly in summer months between November and March. Very little, if any, rain falls in the winter period from May to September. Inter-annual variability in rainfall is high and drought is a recurrent element of Botswana's climate. The effectiveness of rainfall is reduced by the fact that most of the rains fall in summer when evaporation rates are high. Water which is one of the major keys to socio-economic development in the country and a basic need for human beings is scarce and determines to a large extent the density and spatial distribution of the population.

Trends in the climate of the world in general and Botswana in particular these days points to extreme type of variation that appears to be unidirectional. Botswana is highly vulnerable to various manifestations of climate change. The negative effects of climate change on socio-economic development is internationally recognized. One of the commitments of Kyoto Protocol is for all the parties to cooperate in preparing for adaptation to impacts of climate change, develop and elaborate, appropriate and integrated plans for coastal zone management, water resources and agriculture and for the protection and rehabilitation of areas, particularly in Africa, affected by drought and desertification as well as flood" (Kyoto Protocol, 1997; Article 4(e)). Botswana climate system is prone to drought and extreme weather events and displays an inherent degree of seasonal and inter-annual variability. Compounding the vagaries of climate is the high degree of dependence by society on climate system. This vulnerability poses a significant impediment to socio-economic development and in recent years has caused huge financial losses totaling billions of pula, severely impacting on the society at all levels from rural individual to the national government.

Sustainable socio-economic development implies economic growth, environmental/physical infrastructural development, investment and enrollment in education, government's commitment to and the state of health infrastructure, reduced civil strive, low level unemployment, equitable distribution of acquired benefits and their sustainability. Socio-economic development aims at improving the living standard of all people and can be considered as the prime objective of the society. The environment sets constraints to developments by the availability of renewable resources and by severe weather hazards resulting mainly from internal environmental process. Apart from development constraints set by the environment, all environmental development linkages emerge from human activities. The most relevant activities are economic ones, by they productive or consumptive. In Botswana's socio-economic structure and resources use, seven group of activities have been identified namely: livestock production; crop production; mining activities; wildlife and veld product utilization; wood utilization; other productive activities and consumptive activities by people.

Consequences of climate change in Botswana include: increasing incidence of droughts, desertification and aridity resulting from changes in rainfall and intensified land use; food security at risk from decline in agricultural production and uncertain climate; water shortage for plants, animals and man; natural resources productivity at risk and biodiversity that might be irreversible lost, vector-and water-born disease, especially in areas with inadequate health infrastructure. The above named indices of climate change are the major physical events and phenomena that impinge on socio-economic development of the country.

There is problem of lack of reliable data on climate change and its derived parameters. Existing data, even at the national level, are not based on quantitative measures, but are best-guess estimates at a high level of generality, which means that they cannot be used as a baseline against which to

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measure change. The data base is poor, despite attempts in the 1980's to improve climatological information; the development of drought warning systems and the increasing use of remote sensing techniques. Climate change exacerbates many environmental problems resulting in impoverishment of any nation thus retarding rapid socio-economic development. The paper highlights these environmental problems resulting from climate change and variability. It identifies climate data acquisition/analysis for practical purposes and environmental education as ways of enhancing socio-economic development. To be able to cope with or reduce adverse effects of severe weather events which cause socio-economic woes and hamper sustainable development in the country, the paper proffers some recommendations.

Overview of Regional Climate change

The earth's climate reflects, in part, the presence of so-called greenhouse gases in the atmosphere. These gases, carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (NO_2), chlorofluorocarbons (CFCs), hydrolofluorocarbons (HFCs), and other chlorine compounds, serve to trap energy reflected by the earth's surface and cause the planet to be much warmer than it would otherwise by. The magnitude of greenhouse effect is driven by the atmosphere concentrations of these greenhouse gases. In future, the ongoing increase in greenhouse gas concentrations is expected to increase the global average temperature and cause other changes in the global climate. The global average temperature increased between 0.4°C and 0.8°C over the past century, with most of the warming occurring prior to 1940 and over the past 25 years (Aldy et al., 2001:4).

The historical record for Africa shows warming of approximately 0.7°C over the continent during the 20th century (Desanker and Magadza, 2001:489). Climate change scenarios for Africa, based on results from several general circulation models using data collated by the Intergovernmental Panel on Climate Change (IPCC) Data Distribution Centre (DDC), indicate future warming across Africa ranging from 0.2C per decade to more than 0.5°C per decade. The warming is greatest over the interior of semi-arid margins of the Sahara and central southern Africa.

Climate of southern Africa is influenced strongly by the position of the sub-continent in relation to the major circulation features of the southern hemisphere. Rainfall is highly seasonal. More than 80 per cent of annual rainfall in the region occurs between October and March (Tyson, 1987). A remarkable regular series alternating wet and dry spells has been observed over the years in the region. Years of increased rainfall were 1922, 1941, 1959, 1988, 1995 and 2000. Periods of marked decrease were observed for 1911 – 1914; 1932 – 1934; 1945 – 1946, 1951 – 1953; 1965 – 1969; 1982 – 1987 and 1992. Long term fluctuation in climate have occurred in the past in the region.

The study in Southern Africa (Shulze, 1997) emphasized variability not just from year to year but also from decade to decade, although patterns of variability vary considerably from region to region. In general, runoff tends to increase where precipitation has increased and decrease where it has declined over the past years. A study of north-central Botswana (Arntzen et al., 1994) indicated that although general geological chronology points to an aridification trend, the long term trend is not reflected by short-term data. Normalized average departures from mean rainfall for both Rakops and Manu (Botswana) do not indicate a declining trend instead, the analysis confirms the existence of periodic cycles of below average rainfall in line with the observations of Tyson et al., (1975). More recently, the pattern has been one of increased aridity throughout the country. From 1931 till date mean rainfall has decreased by more than 15%. A great lake once existed in the basin now occupied by Makgadikgadi pans in northern Botswana, fed by a number of large rivers from the south and the west whose valleys are now totally dry.

Hulme (1996) enumerated potential climate change impacts in southern Africa over the next 60 years to include:

(i) temperature rise of 1.5°C;
(ii) modest drying over large parts of the region;
(iii) decline in grasslands, which are replaced by thorn scrub savannah, expansion of dry forest biomes; expansion of desert areas;
(iv) 15 to 20 per cent of large nature reserves and national parks experiencing a change in biome, which has consequences for biological diversity.
(v) Variations in runoff and greater annual variation in the same;
(vi) Crop yield increasing generally, though with some adverse impacts in semi-arid regions;
(vii) Changes in the distribution of disease-bearing insects;
(viii) Decline in the distribution of species richness;
(ix) Other impacts- for example , sea-level rises

The above have serious socio-economic implications on Botswana as a country in the sub-region, as it is believed that climate effects would be largely negative for Africa. For example, a report by the IPCC conclude that:

> *'The African continent is particularly vulnerable to the impacts of climate change because of the factors such as widespread poverty recurrent droughts, inequitable land distribution and over dependence on rain-fed agriculture. Although adaptation options, including traditional coping strategies, theoretically are available, in practice the human, infrastructural and economic response capacity to effect timely response actions may well be beyond the economic means of some countries'* (Watson et al., 1997:6).

Climate change related impediment to socio-economic development in Botswana

The sensitivity of socio-economic development to climate change is a function of several physical features and societal characteristics. Physical features that are associated with maximum sensitivity include: climatic regime that is marginal for agriculture and livestock, highly seasonal precipitation, topography and land-use patterns that promote desert encroachment, soil erosion, flash flooding conditions and lack of variety in climatic conditions across the country, leading to inability to relocate activities in response to climate change. Societal characteristics that have maximum susceptibility to climate change include poverty and low income levels, which prevent long-term planning and provisioning at the household level; lack of human capital skills for system planning and management; lack of appropriate, empowered institutions; absence of appropriate land-use planning; high population densities and other factors that inhibit population mobility and conservative attitude toward risk.

Climate change resulting from declining rainfall and global warming gives rise to drought and desertification. These environmental problems which degrade the environment are the major physical environmental indicators of low socio-economic development in Botswana.

The phenomenon of drought

Drought is a periodic reduction in moisture availability below average conditions. Or simply defined as the non-availability of adequate amount of water for man, animals and plants. Three types of drought are recognized namely-meteorological, agricultural and hydrological. This classification is based on the different uses made of precipitation water by man. Droughts result in the depletion or exhaustion of soil and shallow groundwater and administers shocks to ecological system. Botswana experience considerable distress during drought occurrence. Mass starvation, famine and cessation of socio-economic activities

are some of droughts adverse impacts. Disasters caused by drought are also strongly affected by such diverse factors as poor agricultural practice, increase in population density and the country's inability to provide alternative supplies of food water and employment.

Major droughts in Botswana in the 20th century occurred in 1913 – 15, 1940 – 14, 1948 – 49, 1967 – 69, 1972 – 73, 1983 – 1987 and 1992 – 94 (Cooke, 1978; Tyson, 1987; Umoh, 2003). The causes of these climatic phenomena and the impact of such events on socio-economic development have been documented in the literature (e.g. Tyson, 1987; Abrams et al., 1992; AFRA, 1993; Darkoh, 1998; Vogel, 1998, 2000).

The early 1980s drought has been identified as one of the most severe on record (Dent et al., 1987). The annual total of rainfall falls short of the long-term mean by as much as 61% during the 1983/84 drought. A look at the mean total annual rainfall and mean annual temperature figures for different years in different parts of the country, the data set show a trend towards decreasing amounts of rainfall at all stations. Yet the annual mean temperature has shown no decline. Indeed, the mean annual temperature values tend to be highest in years of lowest rainfall. Table 1 shown the chronological order of drought disaster between 1965 and 2002 in Botswana. It is observed that there was high frequency of droughts in the 1980's. Annual drought frequency probability for three stations in Botswana has been calculated by Pike (1971) as follows: Kasane, 1 year in 20; Gaborone, 1 year in 15 and Ghanzi 1 year in 7

Table 1 Drought disaster in Botswana (1965 – 2000)

Year	Drought disaster	Population Affected
1965	Drought	60,000
1968	Drought	60,000
1969	Drought	87,600
1982	Drought	409,770
1983	Drought	409,770
1984	Drought	1,037,300
1985	Drought and Locust Infestation	880,000
1986	Drought	648,000
1987	Drought	671,000
1992	Drought	100,000

Source: The OFDA (Office of U.S. Foreign Disaster Assistance) International Disaster Database

Table 2: Summary of calculations of probability/frequency of drought in various regions of Botswana

Region	Probability/frequency/severity of drought			
		Moderate	Severe	Disastrous
Gaborone	P	≤ 0.50	≤ 0.22	≤ 0.02
	F	1 in > 2 years	1 in > 5 years	1 in > 50 years
Mahalapye	P	≤ 0.50	≤ 0.23	≤ 0.02
	F	1 in > 2 years	1 in > 5 years	1 in > 50 years
Francistown	P	≤ 0.50	≤ 0.23	≤ 0.02
	F	1 in > 2 years	1 in > 4 years	1 in > 50 years
Maun	P	≤ 0.07	≤ 0.03	Negligible
	F	1 in > 16 years	1 in > 33 years	
Ghanzi	P	≤ 0.09	≤ 0.04	Negligible
	F	1 in > 11 years	1 in > 25 years	
Tshabong	P	≤ 0.16	≤ 0.09	≤ 0.02
	F	1 in > 6 years	1 in > 11 years	1 in > 50 years

Symbols: P = Probability; F = Frequency (ie, once in every x years); < means at most; > means at least

A computation of probability/frequency of droughts of given degree of severity occurring in different regions of Botswana is shown in Table 2. For example there is a 22% chance of severe drought in the Gaborone region and 50% chance of moderate drought in the Francistown area. Annual frequency of moderate, severe and disastrous droughts are also shown on Table 2. For instance, severe drought will occur 1 year in 5 in Gaborone; 1 year in 33 in Maun and 1 year in 11 in Tshabong. One feature of the results in Table 2 is that the probability of drought is not, once determined for a region, constant and unchanging over time. This is not solely because of possible long-term secular or cyclical changes in rainfall. Drought probability is also determined by the productivity of the environment, by government investments that make grazing more accessible, or by changes in livestock numbers and, hence, in feed requirements. All these factors change with the passage of time.

Drought index analysis shows persistence of negative indices for virtually all stations from 1965 to 2000. The annual mean temperature shows no decline. The product moment coefficient of correlation (r) calculated for the data set is – 0.91 with student t-test of 8.3816 that is significant at the 0.001 probability level given a degree of freedom of 11. This implies that potential evapo-transpiration would be increasing. Implications of increased occurrence of drought spells and expanding desert-like terrain on water resources are the coincidence of low discharge, low recharge and low runoff. Under such conditions, there is very little water available on the surface and much less is available as groundwater. Compounding the effects of drought are increasing pressure of

human and livestock population and the explosive urban growth.

Desertification

Desertification is a general name given to the processes whereby ecosystems loose the capacity to revive or to repair themselves. The process of desertification is defined as 'the impoverishment of arid, semi-arid and some humid ecosystems by the combined impact of man's activities and drought' (Dregne, 1977). Climatic variability might exacerbate desertification through alternation of spatial and temporal patterns in temperature, rainfall, solar insolation and wind. Botswana experiences declines in rainfall, resulting in decreased in soil fertility and agricultural, livestock, forest, and rangeland production. Ultimately, these adverse impacts lead to socio-economic instability.

Increasing aridity and increasing pressure of population on the drought-prone environment easily lead to desertification. This is so because the land is not allowed to recover from the stress imposed by drought before cattle are sent in for grazing or people begin to cultivate it. In the study of desertification in north-central Botswana (Artnzen et al., 1994), it was found that below average flow have persisted in the Boteti river since mid 1980's drought period. This has turn denied recharge to aquifers in the area while at the same time increasing dependence on groundwater source. This has led to a drop in the water table both locally and regionally. This had necessitated the deepening of hand-dug wells in the Boteti river channel many times in the past few years. Over exploitation of groundwater resources often leads to deterioration in quality due to higher levels of salinity which occurs as fresh water is pumped out and is replaced by saline water.

Desertification and the attendant problems of declining biological productivity, deterioration of the physical environment and increasing hazards for human settlement and life affect Botswana. The whole of Botswana is rated as potential desert. About two-thirds of Botswana is covered by sandy soils which are infertile. These are the red and cover much of the country. Shrub savanna prevails in the arid southwest. This gives way in sequence to the Bush savanna, the Tree and Bush and Tree savanna with mopane as rainfall increases towards the north. Grass savanna prevails over much of Makgadikgadi pans.

Climate change impacts on socio-economic development

Scientists believe that significant climate change will take place gradually over a period of many decades. If the change is gradual, the overall socio-economic impact on wealthy countries such as United States and United Kingdom will be modest. Whether it is fast or slow, climatic variability has greater impact on Botswana (a developing country) than on the rich countries. Two factors lead to this conclusion. First, Botswana is forced to live 'closer to the edge' and have less capacity to adapt to climatic changes. The second reason is that people in Botswana live traditional lives in cultures that depend much more directly on a specific climate. Their agricultural practices, their housing and many aspects of their way of life, are adapted to local climate conditions. These traditional ways have been passed down for countless generations. Because of low education levels and strong cultural traditions, changing these ways in response to climate changes may be very difficult.

Climate change usually impacts negatively at both national and at local or household level. At the national level it can affect several sectors of the economy particularly those relating to agriculture or those making heavy use of water as well as on national food security. At household level, it affects food security, particularly for the rural poor who commonly have few reserves to cope with food shortage. Economic and social conditions among Botswana during drought years deteriorated, and real regional output was estimated to have fallen by 1.3 per cent in 1981, stagnating further in 1983 and 1984 (Vogel, 2000). National cattle herds, a source of wealth and draught power in Botswana, Lesotho, Mozambique, Zambia and Zimbabwe, declined to 30 per cent of the norm, with estimate of one million cattle dying in the region (Vogel, 1998).

Climate change exerts remarkable effects on river flows, groundwater recharge and other biophysical components of the water resource base, and demands for that resource. Changes in water resources and demand will impact on water supply, flood risk, power generation, navigation, pollution control, recreation, habitats and ecosystems services. Surface water resources in the Botswana consist of rivers, most of which are ephemeral and wetlands notable the Okavango Delta and the various salt pans. Most of the rivers have low flows that are highly variable and erratic. High rates of evaporation accounts for significant reduction in sustainable yields from reservoirs as indicated in Table 3. The extractable volume of groundwater in Botswana is estimated to be about 100000 million m^3 (Khupe, 1994). But only 1% of this amount is rechargeable by rainfall as a result of the semi-arid climate characterized by low rainfall and high rates of evaporation as well as the nature of the geology and the aquifers.

Table 3. Yields of existing and potential reservoirs in Botswana

River	Storage site	Catchments Area (Km^3)	Storage volume (10^6m^3)	Mean annual inflow ($106m^3$)	Annual yield (10^6m^3)
Notwane	Gaborone	3982	144	29.7	9.4
Shashe	Shashe	3650	88	87.3	25.3
Boteti	Mopii	-	95	-	-
Nywane	Nywane	238	2.3	1.7	-
Metsemolthaba	Bokaa	3570	35	12.2	4.9
Mahalapswe	Mahalapye	754	13	10.4	2.7
Motlouse	Letsibogo	5480	125	64.9	30.8
Shashe	LowerShashe	7800	408	146	73
Limpopo	Cumberland	42000	1000	179	50
Limpopo	Martins Drift	97000	1000	471	120
Limpopo	Point Drift	158000	1000	620	175

Source: Botswana National water Master Plan 1991

Studies of the impact of drought on environment and people have indicated that rainfall in Botswana reduces in quantity and reliability as one goes from north to south. Drought has serious impact on water resources. Major rivers such as Limpopo and Shashe have very low flow. Smaller streams, small dams and wetland areas in the valleys dried up early, reducing water for human consumption, livestock use and vegetable production. On a global scale, the number of people living in water stressed countries (i.e. countries with more than 600 people per flow unit) was estimated as 300 million in 1990. This be in Africa and South Asia. By 2025, most countries in the Nile, Zambezi and Limpopo River basins will be water stressed or will even suffer chronic water scarcity.

Environmental hazards resulting from climate change reduce the productivity of land and deprive people of biological resources that are important for human sustenance. The impacts in turn lower the incomes and subsistence of millions of already poor, peasants, herdsmen and urbanities who form

part of the same economy. Prolonged dry periods lead to hunger, malnutrition and starvation, high infant mortality and accelerated rural migration. Loss of biodiversity in cultivated plants and domesticated animals, and in wild foods which are so important when agriculture fails in times of drought, is a direct threat to food security (IPED, 1994). Drought has accelerated the migration of farmers from the countryside to the cities, putting addition pressure on basic city services such as water and sanitation. During the 19987 drought for instance, water-dependent factories and mines shut down, throwing thousands out of work. Many schools and hospitals in Nywane, Bokaa and Mahalapye also had to close, unable to operate without water (Khupe, 1994).

Climate has big influence on plants and animals in the natural environment, on oceans, and on human activities such as agriculture, water supplies and heating and cooling. The agro-economic effects of climate change include lower and variable per hectare yields, reduction in acreage of cropped lands, less high-yield food cropping, diminished rangeland productivity, changes in pastures and in composition and size of herds, and lower prices as herdsmen flood the market with sickly cattle seeking to sell them before they die.

The effects of climate depend upon how much change there is, how fast it occurs and how easily the community can adapt to the new conditions. These effects on people would change from place to place. Economically developed societies, like those in North America, Europe and Japan, could use technology to reduce direct impacts. For example, they might develop new crop varieties, construct new waters systems, and limit coastal development. In contrasts, economically less developed societies, like Botswana and other sub-saharan African countries depend much more directly on climate and could be hit much harder by sudden or large changes. Peasant farmers may have difficulty adopting new agricultural practices. The resulting social tensions could lead to more political unrest, large scale migration and serious international problem such as terrorism and wars.

The role of climate information and environmental education

Botswana is a country with limited resources it takes for development because of climatic and environmental limitations. The politicians jockey for the few resources. The cumulative effective is fragrant corruption, deprivation, wastage and impoverishment which intensify underdevelopment. Poverty is a great challenge facing the administration of the country. Since the Rio conference of 1992, efforts have been stepped up to understand causes of climatic variations and change in an attempt to know and assess the vulnerability of developing countries in different sectors so as to recommend effective mitigation and adaptive strategies to be adopted.

It has been argued that environmental problems resulting from climate change contribute to a great extent to low socio-economic development and high poverty levels experienced in sub-Saharan African countries. Climate change factors include global warming, carbon dioxide (CO_2) concentration in the atmosphere, green house gas (GHG) emissions, increase in atmospheric methane (NH_4) and chlorofluorocarbons (CFCs) and ozone (O_3) economic losses resulting from climatic variations is unquantifiable.

Very regrettably, comprehensive climatic data is lacking in Botswana and where available are of poor quality, very scanty and limited in areal coverage. Based on the enormous problem poised by climatic variability to the environment, there is great need for collation, analysis and interpretation of climatic and environmental hazard data for planning and forecasting purposes. These data should be transformed to their derived parameters at different scales of analysis for practical applications to various environmental problems. An important development has been the advent of climatic modeling enabling climatologists to make predictions about future changes. Global climate modeling and forecasting, together with an improved understanding of the variability of landscapes and people are useful tools for understanding the environment for sustainable development.

Possible variability in climate and associated environmental and human dimensions are focus of several international research teams and initiatives such as the International Geoshpere and Biosphere Programme (IGBP), the International Panel on Climate Change (IPCC), International Human Dimensions Programme on Global Environment Change (IHDP), the project on Land Use and Cover Change (LUCC) and the International Decade for Natural Disaster Reduction (IDNDR). Climate change must not be viewed within in context of physical dimensions of these systems only but be remembered that human activities also have a pronounced influence. Climatic variability and associated impacts should be extensively monitored in the country. Several research submissions at conferences, meetings on climate change such as the High Level Policy Seminar on Drought in Southern African (Botswana, 1997) and the presence of Botswana among other countries of the south African sub-region at the important meeting on global change in Kyoto, Japan (December, 1997), point to the concern with which local scientists and policy-makers view the current and future climate change and their accompanying effects on socio-economic development.

The essence of education in any part of the world is to assist people to maximize their potential for optimum self development and development of the society. There is no doubt that there is need for conceptual knowledge of the environment to be increased because of prospect for future degradation of the environment are high. Environmental education, is education aimed at developing a world population that is aware of an concerned about the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitments to work individually and collectively towards a solution of current problems and prevention of new ones (Oulton and Scott, 1995). Environmental education is a life long process of education aimed at creating healthy harmonious existence of man with the environment. It is at times referred to as "green curriculum|".

Environmental education can be utilized as an effective means of creating awareness of climate change and its accompanying evils. The awareness should be created through education of children from the early age and then continuing to adulthood. Only in this manner will these youngsters as adult feel that it is their responsibility to be committed to the improvement of the environment in their communities. However, environmental education should be introduced at all levels. Through such course, student will gain an understanding of the importance of environment in their existence, survival and quality of life as an individual and as a member of an 'endangered' race as well as ability to think critically and creatively about problems of the environment in their immediate community and how to solve them especially checking the decadence in the environment and helping it to regenerate itself.

The implication of this programme is that the individual will understand the relationship that exists between himself and his physical environment and strike a balance between environmentally unsuitable behaviour/activities and sustainable environmental conservation/protection. The public should be informed of the danger of environmental change, especially in relation to sustainable development. This could be through new media and public enlightenment agencies. There may be need to fortify the National Orientation Agency with qualified environmental scientists and educationist that will strengthen the campaign against environmental deterioration. Environmental education should be incorporated in the mass-literacy campaign programmes of the government.

CONCLUSION

Climate is a complex system, changing on several spatial and temporal scales. Botswana is prone to climate

extremes and variability contributing to low level of socio-economic development and its implications in agriculture, forestry, biodiversity, water supply, flood, erosion, drought, local air quality, and human health. Effectively coping with and responding to climate change and events to ensure sustainable socio-economic development requires a concerted, combined response that include: effective mitigation means of climatological and other early-warming systems; an understanding of vulnerable areas; well-planned strategy that can effectively manage the outcomes of environmental disasters; acquisition and analysis of relevant climate information as well as environmental education.

It is recommended that Botswana must have:

- A Ministerial Organ of Government on Climate Change Issues and Environmental Protection
- Adequate data on climate event (past and present) for early Warning System (EWS)
- Institutions committed to Research and Development in the area of Climate Modeling and Predication.
- Sound National Environmental Action Plans (NEAPs) to guide intervention strategies
- The ability to disseminate information fast and accurately through reliable networking system.
- An informed citizenry, public organs of government, corporate bodies, NGO's etc who will not only translate action plan to meaningful programme but will actively utilize available information for sustainable economic activities

Our improved understanding of relevant derived climatic parameters through climate change information, environmental education and better appreciation of our influence on the atmosphere-biosphere system, should enable us to manage the environment better thereby ensuring its sustainability for the future generation and stable socio-economic development.

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