International Scholars Journals

African Journal of Geography and Regional Planning ISSN 3627-8945 Vol. 7 (4), pp. 001-006, April, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

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Review

Impacts of climate change on Namibia, adaption strategies and future recommendations: A review

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Accepted 16 September, 2019

In spite of the fact that Africa has the lowest greenhouse gases (GHG) emissions, studies have shown that it is hit hardest by climate change. Furthermore, poorest people are most likely to be the most affected by climate change. Studies have shown that temperatures in Namibia have been increasing at a rate higher than the mean global rate. Namibia should continue working at the international and the national levels to improve the environment for investment, diversify sources of income, creating new job opportunities, reduce deforestation, assess the environmental impact of new developmental projects and to improve access of local communities to climate-related information and to the knowledge of best coping strategies.

Key words: Climate change, impact, Namibia.

INTRODUCTION

Our ability to predict future ecological impacts of climate change comes largely from what we know about the past. Rocks, ice cores, cave formations, tree rings, sediments, and other natural “climate recorders” have offered clues about how ecosystems respond to major climate shifts. Earth has experienced a series of ice ages over the past million years. These ice ages ended as changes in the Earth’s orbit slowly warmed the globe. These periods of cooling and warming caused widespread ecological changes; some ecosystems shifted to locations with more favorable conditions, others vanished, and new types of ecosystems emerged (National Academy of Sciences, 2009).

Climate change in the coming decades could be much more rapid on a sustained global basis than the transitions into and out of many past ice ages. In past ice ages, the change was slow enough, over many thousands of years, allowing ecosystems to adapt. Ecosystems can be particularly vulnerable when major climate change shappen over a relatively shorter period of time. One of the major concerns about the future is that climate changes may happen too fast to allow many organisms to respond. Some individuals and species can adapt or move faster or farther than others. For example, a long-lived tree species may take decades to shift to a new range, while an insect species could shift its range much more quickly (National Academy of Sciences, 2009).

The global warming predicted by climate models for the 21[st] century is a threat to most natural systems at every region. A global mean temperature change of 2°C is considered to be a critical level beyond which dangerous climate change occurs (Smith and Schellnhuber, 2001: UNFCCC, 2007).

A relatively rapid increase in temperature has been documented during the past century, both at Earth’s surface and in the oceans. The average surface temperature for Earth as a whole has risen by some 1.3°F since 1850, the starting point for a global network of thermometers. If emission rates for greenhouse gases continue on their current track, models indicate that the globe will be 4.3 to 11.5°F warmer by 2100 than it was in 1990.Sea levels are also predicted to rise (Frumkin et al., 2008). Carbon dioxide has grown by about 35% since 1850 (Figure 1).

Two other greenhouse gases, methane and nitrous oxide, are present in the atmosphere at much lower concentrations than carbon dioxide but have increased rapidly. Methane has increased by 150% (Figure 2), in addition, it is 25 times more effective per molecule at trapping heat than carbon dioxide.

Nitrous oxide, nearly 300 times more effective, has increased by more than 20% (Figure 3). Climate change in the current era is expected to be exceedingly rapid, likely at least 10 times faster than the global warming that

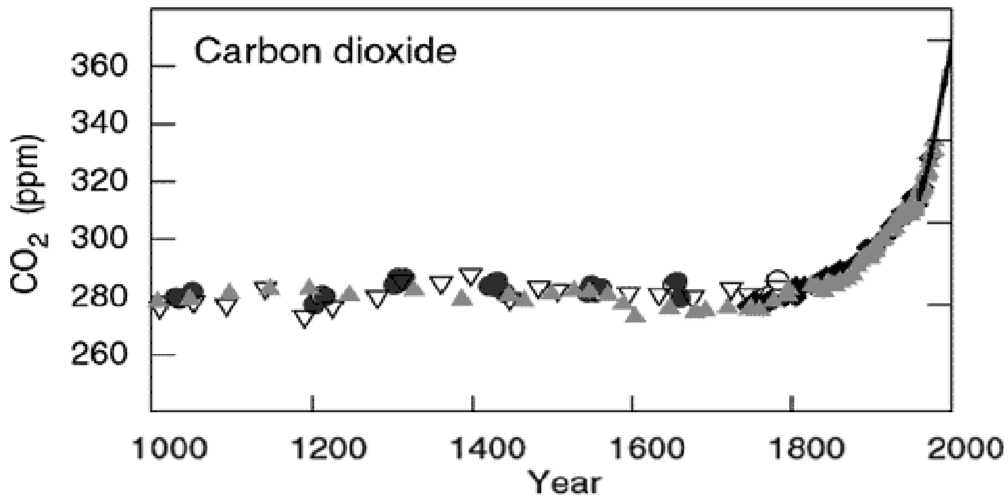

Figure 1. Atmospheric concentrations of CO_2 gas over the past 1000 years (Farquhar et al., 2001).

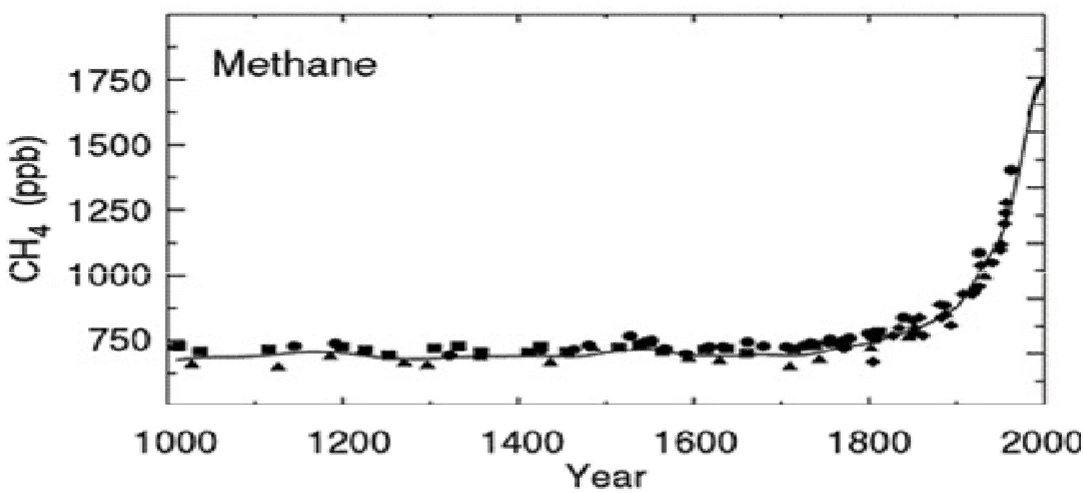

Figure 2. Atmospheric concentrations of CH_4 gas over the past 1000 years (Farquhar et al., 2001).

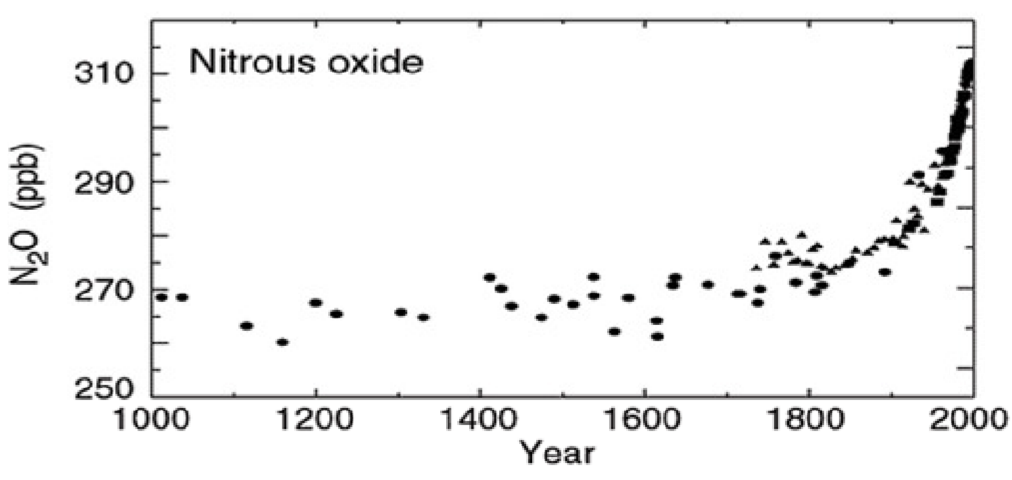

Figure 3. Atmospheric concentrations of N_2O gas over the past 1000 years (Farquhar et al., 2001).

occurred after the last ice age. Changes that are both large and rapid place greater stress on ecosystems. Under a "business-as-usual" emissions scenario, CO_2 concentrations are expected to increase rapidly as estimated by some models (Forster et al., 2007).

It has been observed that everyone is affected by climate change but not every country contributes equally to emissions of greenhouse gases (Venevsky, 2006).

It is becoming widely acknowledged that poor nations will suffer most from the effects of climate change. This is partly due to their geographic location in drought or flood areas (UNFCCC, 2007; Bowen and Famkhauser, 2011). Their capacity to cope with climate change is also lower than that of wealthier nations because of limited financial resources, skills, technologies and high levels of poverty. In addition, they are heavily reliant on climate-sensitive sectors such as agriculture and fishing. Namibia is very dependent on natural resources, some estimate that up to 30% of its GDP is reliant on the environment (Lange, 2003).

Ironically, it is also these poor nations who have contributed least to the problem of climate change. Data covering 1950 to 2000 from the Climate Analysis Indicators Tool, developed by the Washington DC-based World Resources Institute, indicates that African countries contributed 4.6% of cumulative global carbon emissions during that period (World Resources Institution, 2006). Later it was found that their share of emissions is even lower, amounting to just 3.5% of the total carbon emission (MacGregor, 2006). Namibia was in fact estimated to be a net sink for carbon dioxide in 1994 due to the large uptake of CO_2 by trees. Namibia contributed less than 0.05% to global CO_2 equivalent emissions in 1994, even when this carbon sink is excluded from calculations (Midgley et al., 2005).

SOME FACTS ON CLIMATE CHANGE

1. CO_2 emission has grown up about 80% between 1970 and 2003; almost all other greenhouse gases have also shown significant increase in the same time periods.
2. 11 of the 12 years (1995 to 2006) rank among the 12 warmest years of surface temperature since 1850.
3. Global average sea-level rose at an average rate of 1.8 mm per year between 1961 and 1993 and the rate for 1993 to 2003 was 3.1 mm.
4. Globally, about 20 to 30% of plant and animal species are highly vulnerable (risk of extinction) to a change of temperature of 1.5 to 2.5°C.
5. Glaciers and ice caps have experienced widespread mass losses and have contributed tosea-level rise during the 20th century (Khatun and Islam, 2009).

The physical processes that cause climate change are scientifically well documented; both human activities and natural variability are contributing to global and regional warming.

According to the Intergovernmental Panel on Climate Change, it is very likely that most of the observed warming over the past 50 years is the result of increased greenhouse gases generated by human activities (Smith and Schellnhuber, 2001; Forster et al., 2007).

Namibia has experienced increased warming during summer in the past few years, draughts and livestock losses. Early this year, 2011, regions in the northern part of Namibia have experienced severe floods which resulted in crop damage and communities relocations to higher grounds.

THE EFFECTS OF CLIMATE CHANGES

Living things are intimately connected to their physical surroundings. Even small changes in the temperature of the air, the moisture in the soil, or the salinity of the water can have significant effects. Each species is affected by such changes individually, but those individual impacts can have a joined serious effect on an ecosystem. In particular, two important types of ecological impacts of climate change have been observed in different places, shifts in species' ranges (the locations in which they can survive and reproduce), and shifts in phenology (the timing of biological activities that take place seasonally). Examples of these types of impacts have been observed in many species, in many regions, and over long periods of time. It is important to note that individual species may move and adapt, that is, not the entire ecosystems (Johnson and Moghori, 2008).

As Earth warms, many species are shifting their ranges to areas with more tolerable climate conditions, in terms of temperature, precipitation, and other factors. About 40% of wild plants and animals that have been studied over decades are relocating to stay within tolerable climate ranges. Some organisms that cannot move fast enough or those whose ranges are actually shrinking, are being left with no place to go. For example, as arctic sea ice shrinks, so too shrink the habitats of animals that call this ice home, such as polar bears and seals. As these habitats contract toward the North and South poles, the animals that depend on them will reach the end of the Earth as they know it. Climate change is also driving changes in the timing of seasonal biological activities. Studies have found that the seasonal behaviors of many species now happen 15 to 20 days earlier than several decades ago. Migrant birds are arriving earlier, butterflies are emerging sooner, and plants are budding and blooming earlier. If all of the species in an ecosystem shifted their seasonal behavior in exactly the same way, these shifts might not create problems. But when a species depends upon another for survival and only one changes its timing, these shifts can disrupt important ecological interactions. For example, a small black-and-white bird called the European flycatcher has not changed the time it arrives on its breeding grounds even though the caterpillars it feeds its young are emerging earlier. Missing the peak of food availability means fewer chicks are surviving, in turn causing the flycatcher's population to decline. In addition to shifting ranges and seasonal behaviors, other ecological impacts of climate change include changes in growth rates, in the relative abundance of species, in processes like water and nutrient cycling, and in the risk of disturbance from fire, insects, and invasive species (Johnson and Moghori, 2008).

Sea levels are rising

Warmer temperatures cause glaciers and land ice to melt. The global average sea level rose by just under 0.07 inches per year during the 20th century, but that number has risen to 0.12 inches per year since the early 1990s.

Under a "business-as-usual" greenhouse gas emissions scenario, models indicate that sea levels could rise 2 feet or more by 2100 compared to 1990 levels (National Academy of Sciences, 2009). Climate change has complex effects on water supply and demand. The seasonal rhythms of streams and rivers have changed as winter precipitation falls increasingly as rain instead of snow, and as earlier spring temperatures cause snow in the mountains to melt earlier and faster. Climate change may mean that some places will experience more days with very heavy rain; other places may see more frequent, intense, and long-lasting droughts. Warmer temperatures also mean higher evaporation rates and thirstier plants and people, increasing demands for water. A warmer world will experience more precipitation on a global scale, but the changes will not be the same everywhere. Projections indicate that on average dry areas will tend to get drier, and wet areas will tend to get wetter.

Climate change due to increasing concentration of green house gas is likely to affect groundwater recharge and thus affect the saltwater intrusion because of changes in precipitation and temperature (Revenga et al., 2000; Arnell, 2004). Any reduction in groundwater flow towards the sea will cause intrusion of saltwater into the aquifer as the saltwater–freshwater interface moves inland. Coastal aquifers within the zone of influence of mean sea level are threatened by accelerated rise in global sea level which accelerates salinization of coastal aquifers (Titus, 1990; Watson et al., 1998; Priyantha et al., 2009).

Much of the carbon dioxide emitted by human activity has already been taken up by the ocean, thus moderating the increase of carbondioxide in the atmosphere. However, as carbon dioxide dissolves in sea water, it forms carbonic acid, acidifying the ocean. Ocean acidification will likely cause serious harm to marine organisms (Johnson and Moghori, 2008).

Climate change is reflected in extreme weather

It is considered very likely that increasing global temperatures will lead to higher maximum temperatures, more heat waves, and fewer cold days over most land areas. More severe drought in some areas, combined with other factors, has contributed to larger and more frequent wildfires.

Wildfire is dramatically escalating in frequency and extent in western forests, among other areas. There are now four times as many wildfires exceeding 1½ square miles as there were 30 years ago, and these frequent large fires are burning six times as much forest area. In the last 20 years, the western fire season has expanded by more than ten weeks. Forest could be lost due to frequent and more intense fires (Reid et al., 2007).

THE FORECAST FOR NAMIBIA

Temperatures in Namibia have been increasing at three times the global mean temperature increases reported for the 20th century. The temperature rise predicted for 2100 ranges from 2 to 6°C. Particularly in the central regions, lower rainfall is expected, while overall rainfall is projected to become even more variable than it is now. Even if rainfall changes little from current levels, rises in temperature will boost evaporation rates, leading to severe water shortages. Poor rural and dry-land populations will be affected most. The frequency and intensity of extreme events such as droughts are likely to increase (Reid et al., 2007).

QUANTIFYING THE IMPACTS

Evidence from low-income countries around the world suggests that the people likely to be most affected by climate change are the poorest and most vulnerable. In Namibia, results show that climate change impacts will hit the poor hardest, with employment opportunities constrained and a substantial decline in wages, especially for unskilled labour (Reid et al., 2007).

Namibia's advanced Natural Resource Accounts (NRA) helps to evaluate the contribution of the environment to the national wealth by developing so-called 'satellite' accounts for natural assets such as fish, forests, wildlife, water and minerals. Data from the NRA can be fed into the conventional national economic accounts. This capability potentially allows for sound sustainable development planning that includes natural resources as well as man-made or owned assets, a clear advantage for policymakers in economies such as Namibia's, which is dependent on natural resources.

Data from the NRA was fed into CGE (computable general equilibrium) model, which uses actual economic data to determine how economies respond to policy or other changes. This revealed that under a best-case scenario, agricultural impacts would be partly offset by improved water distribution; there would be no impact on fisheries and the overall GDP would fall by only about 1%. Under a worst-case scenario, large-scale shifts in climate zones would reduce agricultural and fishing outputs, and the overall GDP would fall by almost 6% over 20 years. However, this estimate constitutes only a fraction of possible climate change impacts because it considers only two economic sectors, agriculture and fisheries, and ignores impacts such as those on health, infrastructure and energy that relate less to natural resources (Reid et al., 2007).

Even under the best-case scenarios generated by the CGE model, subsistence farming will fall sharply. In the worst-case scenario for agriculture, labour intensive livestock farming is hit hard, and while high-value irrigated crop production could thrive, employment creation in this area would be minimal. Thus, even under the best-case scenario, a quarter of the population will need to find new livelihoods. Displaced rural populations are likely to move to cities, which could cause incomes for unskilled labour to fall by 12 to 24% in order to absorb the new workers.

Namibian natural resource experts have further worked to quantify, as much as possible, the economic impacts of climate change on Namibia's natural resource base. Estimates of how climate change will affect various sectors, and subsequent translation into economic impacts, can only be best guesses. Expert estimates suggest that over 20 years, annual loses to the Namibian economy could be between £35 million and £100 million - if no action is taken to adapt to climate change (Reid et al., 2007).

WORLDWIDE CHALLENGES

1. Food production needs to double to meet the needs of an additional 3 billion people in the next 30 years.
2. Climate change is projected to decrease agricultural productivity in the tropics and sub-tropics for almost any amount of warming (Griggs, 2001).
3. Wood fuel is the only source of fuel for one third of the world's population, Wood demand will double in the next 50 years.
4. Forest management will become more difficult due to an increase in pests and fires (Griggs, 2001).
5. One third of the world's population is now subject to water scarcity; population facing water scarcity will be more than double over the next 30 years.
6. Climate change is projected to decrease water availability in many arid- and semi-arid regions (Griggs, 2001).

Humans are challenged to find a set of policies, practices, and standards of behavior that provide long-term economic opportunities and improved quality of life around the world while maintaining a sustainable climate and viable ecosystems. The world should invest in minimizing the amount of climate change that occurs and in adapting to the changes that cannot be avoided (Johnson and Moghori, 2008).

IN THE WAY TO ADAPTION

Increasingly, countries are recognizing the need to assess the likely impact of climate change on their desired development pathways, and take steps to ensure all policies and activities are 'climate-proofed' (Reid et al., 2007). While agriculture has traditionally been the focus of attention on climate change impacts, nearly every sector is sensitive to climate change and will need to adapt to future conditions. Adaptation must be approached collectively. Involving the Ministry of Finance is crucial to reflect adaptation efforts in the budget.

Some of the issues are so big that the involvement of governments will be required. These include decisions about the best ways to reduce a country's carbon emissions and where to invest funds in research on alternative energy sources (Johnson and Moghori, 2008).

Other decisions are best addressed at the individual, family, or business level. Each time a car or a machine is purchased, a decision is made that has a small influence on climate change. But many small decisions, made by billions of people, can combine to have large effects (Johnson and Moghori, 2008).

An important way for society to help reduce the ecological impacts of climate change is by initiating conditions that make it easier for species in ecosystems to adapt, that is, by reducing other human-influenced ecosystem stresses. Encouraging investments in conservation, sustainable agricultural practices, pollution reduction, and water management can all help ecosystems withstand the impacts of a changing climate (Johnson and Moghori, 2008).

FOR NAMIBIA

Namibia should

1. Continue working with the international community to enhance progress in reducing deforestation in Africa;
2. Continue to improve the environment for investment to diversify sources of income and inject new jobs;
3. Continue to integrate climate issues into economic planning at the national level;
4. Make stronger efforts in assessing new projects and programs in their effect on the environment;
5. Continue to improve access of local communities to weather and climate-related information and to the knowledge of best coping strategies.

RECOMMENDATIONS ON MITIGATION FOR DEVELOPED COUNTRIES

1. Strong commitments to emission reductions by developed countries will effectively help minimizing the negative impact of climate change;

2. Allocating funds to support the development and implementation of clean energy;.

3. Effectively support plans to reduce deforestation in Africa.

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