CLIMATE CHANGE, BIODIVERSITY, CONSERVATION, DISEASE BURDEN AND ENVIRONMENTAL MANAGEMENT EMERGING ISSUES

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Abstract

Climate change is an environmental challenge facing the world today and has emerged as a global issue facing most developing countries. This is one of the most serious threats to biodiversity, conservation and the environment. The Intergovernmental Panel on Climate Change (IPCC, 2001), refers climate change to any change in climate over time, whether due to natural variability or as a result of human activity. Climate change is already having an impact on the dynamics of African biomes and its rich biodiversity (Erasmus, Van Jaarsveld, Chown, Kshatriya, & Wessels, 2002). At the same time, the wider social and public health importance of biodiversity is not always understood. Furthermore, climate variability has had far-reaching effects and includes, but is not limited to, the following: heat stress, air pollution, slowing conservation efforts, vector-borne diseases such as malaria, water-borne and food-borne diseases. Also, pervasive landscape changes include deforestation, extension and intensification of agriculture, and livestock management, the construction of dams, irrigation projects, and roads, and rapidly spreading urbanization pose serious health implications including the emergence of new infectious diseases and altered distribution of recognized diseases. Such diseases affect over half the human population, particularly the poor (Myers, 2009). Further, the recent (re)emergence of infectious diseases however appears to be driven by globalization and ecological disruption, habitat destruction and biodiversity loss associated with biotic homogenization can increase the incidence and distribution of infectious diseases affecting humans (Montira et al., 2009). There is a global recognition that many environmental problems including conservation efforts cannot be solved or minimized with strategies that have been tried in the past, moreover, the need to effectively manage natural resources for the benefit of its population has long been recognized by many countries. However, population growth, development of new technologies, creation of hazardous substances, requirements of international convention and treaty obligations and wanton and careless exploitation of the resources among others are emerging environmental management issues that need to be currently addressed (Miller, 2000).

Key words: Climate Change, Biodiversity, Conservation, Diseases, Globalization, Environment

Introduction

The present 21st century is characterized by industrial revolution and globalization including climate change that has emerged as one of the most serious challenge to biodiversity, conservation, humanity and the environment. Industrialization releases green house gases (GHGs) in the atmosphere resulting to increased temperatures and changes in the climate system. According to (IPCC, 2001) global temperatures are expected to rise between 1.4-5.8 °C subsequently causing changes in temperature, distribution of rainfall, the frequency and intensity of extreme weather events, and sea-level rise. Many human systems will be affected by these changes, particularly agriculture, water resources, industry and human health. Further, the Inter-governmental Panel on Climate Change (IPCC, 2007) concludes that if global mean temperature increases exceed 2–3 °C above pre-industrial levels, 20–30% of plant and animal species assessed are likely to be at increasingly high risk of extinction. This paper examines global climate change impacts on biodiversity, conservation, disease burden and environmental management issues.

Since the Industrial Revolution, human activities have led to increased concentrations of green house gases (CO_2, CH_4, N_2O) in the atmosphere, causing changes to the climate system. There may be short-term local and regional benefits from these changes as a result of low to moderate levels of increased atmospheric CO_2 and climate change (IPCC 2007b), for example increased water availability, ecological and crop productivity, and human health. However, as climate change continues, greater impacts are projected (IPCC, 2007). The effects on terrestrial ecosystems may lead to a weakening or even reversal of terrestrial carbon sinks by 2100, potentially amplifying climate change (IPCC, 2007).

Climate Change

Climate change refers to a shift in climate, occurring as a result of human activities (Wigley, 1999). Furthermore, climate change is expressed as deviations from a regional climatology determined by analysis of long-term measurements, usually over a period of at least 30 years or the normally experienced climate conditions and a different, but recurrent, set of climate conditions over a given region of the world (IPCC, 1998).

Although climate change is affecting all countries of the world, a major impact of climate change in sub-Saharan Africa is its adverse effects upon the natural resource base (Kurukulasuriya & Mendelson, 2006) and countries in this region of Africa are expected to be hit earliest and hardest (IPCC, 2007) because their environments are closely linked with climate, and the livelihoods of its inhabitants are largely dependent on the utilization of land-based resources (soils and forests) as well as on freshwater, lacustrine and riverine systems as sources of potable water, fish and transport (Chidumayo, Okali, Kowero, & Larwanou, 2011).

Climate change scenarios for Africa include higher temperatures across the continent estimated to be increasing by 0.2°C per decade (Elagib and Mansell, 2000) and more erratic precipitation with slight increase in ecozones of eastern Africa and moist forest ecozones of West Africa and sustainable declines in the productivity in the Sahel and the ecozones of southern, Central and North Africa (Stige, Stave, & Chan, 2006).

Adverse impacts arising from changes in climate are already being observed. For example, climate change may have led to the extinction of 74 species of highland cloud forest frogs (Parmesan, 2007). In Asia, rising temperatures have contributed to declines in crop yield (IPCC 2007b), and in 2003, a heat wave across Europe caused 35,000 deaths in France, Belgium, the Czech Republic, Germany, Italy, Portugal, Switzerland, the Netherlands and the UK (IPCC, 2007b). Furthermore, the oceans are becoming more acidic as a direct result of the increase in atmospheric CO_2 since 1750 (Royal Society, 2005).

Climate Change, Biodiversity, and Conservation

Biological diversity (biodiversity) is defined by the Convention of Biological Diversity (CBD) as the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part. This includes diversity within species, between species and ecosystems. The role and function of biodiversity in ecosystems is complex and therefore the services they provide, are influenced by the characteristics of the species present and their functional traits (Reich et al., 2004; Hooper, Chapin III, Ewel, Hector, & Inchausti, 2005).

In addition to the direct impacts of climate change on natural systems and society, there may be indirect effects; for example on human wellbeing as a result of political and social instability prompted by climate induced resource scarcity. Equally, the efforts of society to reduce climate change, e.g. by growing biofuel crops, will in some cases cause further biodiversity loss and reduced ecosystem functioning. It is therefore essential that these interactions are taken into account when assessing the implications of climate change and the impacts of mitigation policies (Royal Society, 2008).

Recent reviews (IPCC, 2007; Parmesan, 2007) have concluded that climate change is already disrupting species interactions and ecological relationships. With relatively small changes in recent temperatures (a rise of 0.76 °C from 1905 to 2005), half of all wild species for which there are long-term data have shown a response to local, regional or continental warming (Parmesan & Yohe, 2003). Every major biological group that has been studied (e.g. from herbs to trees, from plankton to fish, and from insects to mammals) has shown a response, and responses have been seen on all continents and in all major oceans (Parmesan & Galbraith, 2004; Parmesan, 2006). Also, rare species that live in fragile or extreme habitats are already being affected, for example species that depend on the extent of sea ice such as the polar bear, ringed seal and the Adelie Penguin are showing drastic declines (Parmesan 2007).

According to a report by the royal society titled 'Biodiversity-climate interactions: adaptation, mitigation and human livelihoods' of 2008, the report asserts that climate and biodiversity are inextricably linked and that significant political commitments and policy objectives for each now exist at national and international levels. And that our understanding of these issues, the relevant processes and their inter-relationships is far from complete keeping in mind new mechanisms are needed to galvanise work in this area, especially at the inter-governmental level. The report further states that significant impacts of climate change on biodiversity have already been identified, with up to 50% of the species studied worldwide affected.

In addition, according to co-operation on health and biodiversity (COHAB, 2010), genetic diversity in food systems provides the foundation of crop development and food security, and promotes resistance and resilience to environmental stresses including pests and diseases of crops and livestock. Biodiversity loss can also impact on community traditions and livelihoods centered on traditional medicinal practices that utilize wild animals and plants. Millions of people depend upon traditional medicines for their primary health care.

Arguably biodiversity is the foundation of human health, it not only secures the life-sustaining goods and services that biodiversity provides to us, it also provides significant benefits to our health. Most importantly, continue loss of biodiversity through climate change represents a direct threat to our health and well-being. In addition, enormous range of benefits which biodiversity provides to our health and well-being is largely underappreciated and unrecognized.

Biodiversity supports food security, dietary health and livelihood sustainability. Genetic diversity in food systems provides the foundation of crop development and food security, and promotes resistance and resilience to environmental stresses including pests and disease of crops and livestock. Diets based on a diversity of food species promote health, and can help to protect
against disease by addressing the problem of micronutrient and vitamin deficiencies. Loss of agricultural biodiversity can therefore threaten health, livelihood sustainability and our future security of food and nutrition (COHAB, 2010).

What is more, the centre of health and biodiversity, 2010 argues that biodiversity loss can impact on community traditions centered on traditional medicinal practices that utilize wild animals and plants, particularly for indigenous and local communities, keep in mind millions of people depend upon traditional medicines for their primary health. The cooperation on biodiversity and health further asserts that biodiversity loss and ecosystem change can increase the risk of emergence or spread of infectious diseases in animals, plants and humans, including economically important livestock diseases, zoonotic outbreaks and global pandemics. In addition, in recent year's outbreaks of SARS, Ebola, Marburg, Hantavirus pulmonary syndrome, avian influenza and malaria have been attributed to human impacts on biodiversity, the wildlife trade or unsustainable land use change.

Furthermore, biodiversity has social, cultural and spiritual importance within communities. Ecosystems change can result in disconnection of populations from open spaces or the wider countryside, with negative implications for physical and mental well being and loss of 'sense of place'. This has been linked to an increased prevalence of diseases affluence (diabetes, obesity, cardio-pulmonary illness) and psychological disorders in many communities.

Also, species are more likely to be present with characteristics that will enable the ecosystem to adjust to environmental change (Hooper et al., 2005; Reusch, Ehlers, Hammerli, & Worm, 2005; Tilman, Reich, & Knops, 2006). This means that ecosystems can continue to function and provide critical services such as water purification. As biodiversity declines, so too does the resilience of the system. Ecosystems with low resilience, when subject to shocks or disturbance, may reach a threshold at which abrupt change occurs (Scheffer, Carpenter, Foley, Folke, & Walker, 2001). Biodiversity is therefore important as it provides flexibility and insurance, and spreads risk across temporal and spatial scales (Yachi & Loreau, 1999).

Lastly but not least, biodiversity and healthy ecosystems can provide important natural buffers against natural disasters such as floods, drought and landslides. In addition, habitat loss is also a contributory factor in desertification and dryland salinity, impacting on livelihoods community stability. Those who are poor or sick, or who experience low levels of livelihood security, are likely to be at greatest risk from such events. Lastly, in many regions, rural communities and the poor are typically more dependent upon ecosystems for their livelihood security and well being, and they are therefore most vulnerable to the impact of disasters if these ecosystems are compromised before or by disaster impacts (COHAB, 2010).

Disease Burden and Environmental Management Emerging Issues

According to the IPCC (2001), vector-borne diseases are among the diseases that have been linked with climate change. Githeko and Ndegwa (2001) assert that malaria is probably the deadliest climate sensitive vector-borne disease. Diseases such as malaria, dengue fever, cholera, dysentery and respiratory diseases are expected to increase as a result of climate change. For example, malaria is already a serious health problem for East Africa; climate change is likely to only worsen this situation. A global mean annual temperature increase of between 1 and 3°C would enable mosquitoes to extend their range, while increased rainfall would attract vectors and increase their survival rate (Githeko & Ndegwa, 2001).

Warming of the climate is expected to lead to latitudinal and altitudinal temperature increase. Furthermore, the temporal and spatial changes in temperature, precipitation and humidity that are expected to occur under different climate change scenarios will affect the biology and ecology of vectors and intermediate hosts and consequently the risk of disease transmission. What is more, the risk increases because although arthropods can regulate their internal temperature by changing their behaviour, they cannot do so physiologically and are thus critically dependent on climate for their survival and development (Lindsay & Birley, 1996).

Further, the greatest effect of climate change on disease transmission is likely to be observed at the extremes of the range of temperatures at which transmission occurs. For instance, on one hand, many diseases lie in the range 14–18 °C at the lower end and on the other hand, 35–40 °C at the upper end. Therefore, warming in the lower range has a significant and non-linear impact on the extrinsic incubation period (Watts et al., 1987), and consequently disease transmission, while, at the upper end, transmission could cease. However, at around 30–32 °C, vectorial capacity can increase substantially owing to a reduction in the extrinsic incubation period, despite a reduction in the vector's survival rate (Githeko & Ndegwa, 2001).

In addition, climate conditions affect malaria transmission in various ways mainly due to the fact that development rate of immature mosquitoes is very much temperature dependent. For instance, below 16°C, development of Anopheles gambiae, the main malaria vector in most parts of Africa, will completely stop, and the larvae will die in water temperature below 14°C. Also, in low-temperature conditions, mosquito larval development is severely delayed and high mortality incurs. Furthermore, in the adult stage, increase in ambient temperature will accelerate the digestion of blood meals taken by mosquitoes leading to increased human biting frequency and malaria transmission as female mosquitoes obtain blood meal to develop their eggs, they pick up malaria parasites which they develop and become infectious to the next human host that is subsequently fed upon. In addition, increased biting frequency and faster blood meal digestion also means increased fecundity and better reproductive fitness. However, increased temperature also shortens the development time for the malaria parasite in the mosquito (Githeko & Ndegwa, 2001). Rise in water temperature, results in the larvae taking a shorter time to mature (Munga, Minakwa, Zhou, Githeko, & Yan, 2007) consequently a greater capacity to produce more offspring during the transmission period. Direct influence of temperature on the biology of vectors and parasites, changing precipitation patterns can also have short and long term effects on vector habitats. For instance, increased precipitation has the potential to increase the number and quality of breeding sites for mosquitoes and the density of vegetation, affecting the availability of resting sites (Githeko & Ndegwa, 2001).

Changes in the environment, such as deforestation, could increase local temperatures in the highlands resulting in accelerated vector and parasite development causing increased transmission. Deforestation is a common event in many regions of Africa. For example, in the East African highlands, 2.9 million hectares of forest were cleared between 1981 and 1990, representing an 8% reduction in forest cover in one decade (Lindblade, Walker, Onapa, Katungu, & Wilson, 2000). Elsewhere, Malava forest, a tropical rain forest in Kakamega county, has shrunk from 150 km2 in 1965 to 86 km2 in 1997 (FAO, 1993). Therefore, land use and land cover changes may modify the temperature and relative humidity of malaria vector habitats in the highlands (Lindblade et al., 2000). These changes in regional climate and microclimatic conditions of mosquito habitats causes abundant changes of the existing mosquito species, and may make some areas permissive to the proliferation of new species (Manag, Toto, & Carnevale, 1995).

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