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CONSEQUENCES OF CLIMATE CHANGE ON VARIOUS ECOSYSTEMS AND THEIR IMPACT ON WILDLIFE

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ABSTRACT:

Wildlife management among the multiple other concerns resulting from climate change will be challenging. Therefore, developing and communicating information on the value of wild species and ecosystems to the human community will be an important strategy for conservation of wildlife from extinction due to the impact of climate change. Developing, managing and retaining an effective system of protected areas network (PAN) is a form of success. Changes in temperature and precipitation will affect individuals, species, ecosystems and whole regions. Individual variation and topographic differences will mean that, within any species, an individual plant or animal may be genetically predisposed to survive the stresses of dehydration, high winds or inundation for longer than another. Thus, at the micro-habitat level, each tiny location may see changes in species composition; these changes will have up and down the trophic levels and throughout the food-web, ultimately changing ecological communities at the landscape level. Predicting the consequences for humans and other species is essential if measures are to be taken in time, either to prevent these changes or adapt to them. Further research and careful monitoring are needed to ensure that adaptive management and creation of new other approaches for existing and newly emerging concepts to overcome climate change pressures on wildlife.

KEYWORDS: *Climate change, Protected areas, Ecosystems.*

INTRODUCTION:

The world is undergoing an extinction crisis the most rapid loss of biodiversity in the planet's history – and this loss is likely to accelerate as the climate changes. Impacts include changes in physical conditions, weather patterns and ecosystem functioning. As a consequence, terrestrial, freshwater and marine wildlife will be severely affected unless we manage to cope with climate changes through decisive planning and action. The direct impact on species that humans make use of which we compete, affects human communities in a very immediate way the loss of biodiversity is a loss for us. We also have an ethical responsibility to address the rapid increase in the rate of global species extinction that has been caused by climate change due to our actions. The main focus is on tropical terrestrial wildlife and its habitats, which includes other faunal ecosystems and geographical regions.

As average global temperatures rise, the impacts on habitats and species will depend on many factors, including local topography, changes in ocean currents, wind and rainfall patterns and changing albedo. In addition to variations in the rate and extent of temperature increases at different latitudes, there may be changes in the length and severity of seasons, including decreases in temperature in some areas. Rainfall patterns may likewise be affected in terms of overall annual quantity, seasonal distribution of precipitation and year-by-year regularity. Extreme weather events, such as droughts and floods, are expected to occur more often. In particular, droughts are projected to become more frequent and intense in subtropical and southern temperate forests; this will increase the prevalence of fire and predisposition to pests and pathogens

Climate change is expected to become one of the major drivers of extinction in this century as a result of changes in the breeding times of species and shifts in distributions caused by the variation in temperatures and precipitation regimes. It has been estimated that 20–30 per cent of plant and animal species will be at higher risk of extinction due to global warming and that a significant proportion of endemic species may become extinct by 2050 as a consequence. Some taxa are more susceptible than others. For example, 566 of 799 warm-water reef-forming coral species are at risk of becoming endangered because of the increasing climate change, as are about 35 per cent of birds and 52 per cent of amphibians. Moreover, the impact will likely be more severe on species that are already at risk of extinction 70–80 per cent of red-listed birds, amphibians and corals are considered susceptible to the effects of climate change (Vié, Hilton-Taylor and Stuart, 2008).

Average annual temperatures have risen steadily over recent decades and an even higher increase is predicted for the years ahead. This is most pronounced in Africa where current climate models project a mean temperature rise of 3–4 °C across the continent by the end of this century, approximately 1.5 times the global average increase (Kleine, Buck and Eastaugh, 2010; Seppälä, Buck and Katila, 2009). According to the Intergovernmental Panel on Climate Change, roughly 20–30 per cent of vascular plants and higher animals on the globe are estimated to be at an increasingly high risk of extinction as temperatures increase by 2–3 °C above pre-industrial levels. The estimates for tropical forests exceed these global averages. It is very likely that even modest losses in biodiversity would cause consequential changes in ecosystem services (Parry et al., 2007; Seppäla, Buck and Katila, 2009).

Natural ecosystems are not only threatened by climate change. Loss and degradation due to human encroachment, the agricultural expansion for crop and rangelands, invasive species, over-harvesting and trade in natural resources (including wildlife), epidemic diseases, fires, and pollution still exceed the current impacts of climate change. It is widely recognized that measures to limit such non-climatic human-induced pressures can help reduce the overall vulnerability of ecosystems to climate change. The impacts of climate change will include permanent changes in physical conditions, such as snow cover, permafrost and sea level along with increases in both the irregularity and severity of extreme weather events like droughts, floods and storms, which will lead to changes in ecosystems and ecosystem functioning. Degraded ecosystems are expected to be less resistant to climate change than intact ones.

Disturbance and extreme weather conditions

The frequency and severity of extreme weather events is widely reported to be on the rise, making it more difficult to plan for such events. Past records have previously been used to predict the likelihood of future droughts, floods, hurricanes and storm surges, but this approach is becoming less reliable as precipitation patterns change on local, regional and global scales. This unpredictability makes planning for climate change extremely challenging. It is clear that extreme weather events not only impact wildlife and human communities directly, they also hamper people's very capacity to survive, let alone to protect threatened and endangered species and habitats (Dilley et.al. 2005).

Climate change is of global warming, the phenomenon might be more accurately termed "global water problems". Managing water for human activities frequently impacts wildlife and natural habitats, whether by flooding dammed river valleys or lowering river levels and water tables when water is extracted to supply cities or to irrigate large-scale agriculture(GWP; 2010). Reduced precipitation not only places animals and plants under stress but increases the risk of forest fires. Globally, more than 350 million ha are estimated to be affected by vegetation fires each year, of which some 150 to 250 million ha are tropical forests (Appiah, 2007; UNEP, FAO and UNFF, 2009). Drought also dramatically increases rates of the breakdown in arid land and desert vegetation, leading to further desertification, soil erosion, dust storms and impacts on wildlife that live in these ecosystems(Omar and Roy, 2010). Extreme precipitation events also affect wildlife.

Consequences of climate change on various ecosystem and their impact on wildlife:

Ecosystem and landscape changes

Changes in temperature and precipitation will affect individuals, species, ecosystems and whole regions. Individual variation and topographic differences will mean that, within any species, an individual plant or animal may be genetically predisposed to survive the stresses of dehydration, high winds or inundation for longer than another. Thus, at the micro-habitat level, each tiny location may see changes in species composition; these changes will have up and down the trophic levels and throughout the food-web, ultimately changing ecological communities at the landscape level. Predicting the consequences for humans and other species is essential if measures are to be taken in time, either to prevent these changes or adapt to them.

Coastal regions changes:

Coastal wetlands are among the most productive of all-natural ecosystems (Day et al., 1989) and so the impacts of climate change will be extremely important in coastal. In addition to the effects of rising temperatures and changes in rainfall, animals and plants in coastal habitats face another threat from climate change

Rising sea level

This is due to a combination of melting polar ice caps, ice sheets and montane glaciers coupled with thermal expansion, wherein warm water occupies a greater volume than cold water. The IPCC predicts that in the next century, average sea level will rise by 0.18–0.59 m compared to the 1980–1999 levels (Parry et al., 2007). Other climate models go even further, with estimates of 0.5–1.4 m a rise that would inundate many low-lying areas. Human population and development pressure is in many cases likely to prevent coastal habitats from moving inland, thus leading to net habitat loss.

Such changes will have immediate impacts on many wildlife species (Michener et al., 1997). Sea turtle populations are likely to be hit as their nesting beaches are inundated. It is predicted that a rise in sea level of 0.5 m will result in the loss of 32 per cent of sea turtle nesting grounds (Fischlin et al., 2007). Tidal mudflats, low-lying coastal and intertidal areas may cease to be exposed, affecting the feeding grounds of many species of birds, such as ducks, geese, swans and waders. If their feeding success is reduced, migratory birds may be prevented from building up sufficient stores of energy to allow their annual migration to breeding grounds. (Galbraith et al., 2002).

Climate change drives an increase in tiger attacks in the Sundarbans

The Sundarbans in the Ganges delta, World Heritage Site at the border between India and Bangladesh, is one of the largest remaining areas of mangrove habitat in the world. The area hosts the most substantial population of Bengal tiger (*Panthera tigris persica*), estimated at more than 500 tigers in the 1960s. The population decreased to about 350 in the whole Greater Mekong region at the beginning of the 21st century and is currently estimated at some 150–200 tigers in the area, with their decline mainly due to poaching and habitat loss (New Scientist, 2008).

The Sundarbans is the largest natural low-lying mangrove ecosystem in the world, distributed over 10000 sq.km. The sea-level rise recorded over the past 40 years is responsible for the loss of 28 per cent of the mangrove ecosystem. Modelling suggests that up to 96 per cent of suitable tiger habitat in the Sundarbans could be lost in the next 50–90 years (Loucks et al., 2010). The decreasing size of the mangrove habitat has caused wildlife, particularly small and medium-sized mammals, which the tigers prey upon, to move to other areas. The wildlife populations inhabiting the mangrove ecosystem have thus decreased dramatically. Tigers have followed the move of the most mobile species and are approaching villages more frequently, causing conflicts often fatal with inhabitants. At the same time, the loss of wildlife leaves the local fishing communities short of a primary source of income. The local people, who live off fisheries and NTFP's, such as honey, need to enter restricted areas more often, thus increasing dangerous contact with tigers (New Scientist, 2008).

The Sundarban area is protected and human access too many islands is restricted. Cases of humans killed by tigers are often associated with unlawful behaviour – for example, people entering the restricted area – and thus the fatal event is not reported to the authorities. Between 2003 and 2005, it was estimated that only 10% of tiger attacks resulting in injury or death were reported, with 90% of the victims have entered illegally into the Sundarbans of Bangladesh.

The number of humans killed by tigers is on the rise as the area of the natural habitat of the tiger's decreases. As a result, tigers are exposed not only to higher pressure from poachers but also to being killed in retaliation for the threat they pose to human life. Thus, the population of Sundarbans tigers is predicted to continue to decrease steadily in the future (Neumann-Denzau and Denzau, 2010).

Mountains regions changes:

Mountain ecosystems cover close to 24 per cent of the earth's land surface and, with their steep and varied topography and distinct altitudinal zones, they support a high variety of species and habitats and a high degree of endemism, particularly sensitive to changes in temperature and precipitation because of their geographical and orographic nature. Climate change is exposing alpine and subalpine areas to increasing temperatures, with the projected result of a slow migration of ecosystems towards higher elevations. The expected migrations will cause a disintegration of current Mountain ecosystems are often located in small and isolated areas. As a result, species will be forced to try to adapt to changing conditions within the ecosystem. Migrating upwards, plants and animals will be faced with reduced areas of habitat and, in some cases, no suitable habitat will remain. Extinctions are predicted to occur at higher rates in mountainous areas than in other ecosystems. Among the species reported to be at highest risk are the mountain pygmy possum (*Burramys parvus*) in Australia, the ptarmigan (*Lagopus muta*) and snow bunting (*Plectrophenax nivalis*) in the United Kingdom of Great Britain and Northern Ireland, the marmot (*Marmota spp*.) and pika (*Ochotonaspp*.) in the United States of America, the gelada baboon (Theropithecus gelada) in Ethiopia and the monarch butterfly (Danaus plexippus) in Mexico (Malcolm and Markham, 2000).

Mountain gorillas in the Virunga Mountains face new threats as their habitat changes

The Virunga Volcanoes Conservation Area of Central Africa contains the habitat for the largest population of mountain gorillas (*Gorilla beringei beringei*) as well as many other endemic species of animals and plants. The long-standing threats of poaching and habitat degradation have mostly seen in this region. From a low of 242 in 1981(Harcourt et al.,1983), the population of mountain gorillas has now doubled to 480 and for the past seven years, has been rising at 3.7 per cent per annum(International Gorilla Conservation Programme, 2010). This is good news for the thousands of people employed in gorilla tourism.

All this is threatened by climate change. If the predicted changes in temperature and precipitation occur in Central Africa, the Virunga endemics will face new threats. An increase in average temperatures would cause the vegetation zones to move upwards, reducing their extent and changing the distribution of many species. The volcanoes form an archipelago of ecological islands and are just as vulnerable to climate change as species on oceanic islands that are facing rising sea levels. If they are unable to adapt to warmer conditions, they will become. Paradoxically, the upward movement of vegetation zones could benefit mountain gorillas by slightly increasing the distribution of their major food plants. The bitterly cold weather at high altitudes limits the time that gorillas spend there. Unfortunately, any gains from a temperature increase are likely to be countered by the likely decrease in precipitation and the extent of relevant vegetation zones. If the montane forest dries out, it remains to be seen whether sufficient food plants can survive and whether the gorillas will be able to adapt. The drier forest will be more susceptible to fire, which, along with the risk of the peat bogs drying out, would make the Virunga Volcanoes a significant carbon source rather than a sink. Agricultural productivity would decline with less rain and this would likely increase pressure on resources in the Virunga conservation area.

Forests regions changes:

The impact of climate change on forests will vary from region to region according to the extent of change in local conditions. Among the effects already being reported, increased atmospheric carbon dioxide (CO2) levels are thought to be stimulating growth and increasing the sequestration rate of forest carbon in areas with sufficient rainfall (DeLucia et al., 1999). However, any potential growth increases are being countered by the negative effects of rising temperatures, higher evaporation rates and lower rainfall, with longer and more frequent droughts. This is leading to higher tree mortality, greater risk of forest fires, increases in insect attacks and a change in species composition (Eliasch, 2008).

Reduction in rainfall will not simply turn a tropical moist forest into a tropical dry forest. Drastic changes in forest ecosystem structure and functioning will likewise have major impacts on associated wildlife, with specialized species likely to become extinct as the conditions for particular ecosystems disappear or shift to geographically distant places. The predicted effects of climate change on primates, for example, are highly negative. This is in addition to other anthropogenic threats that have put 48 per cent of primate taxa on the IUCN Red List of Threatened Species. Endemic species with strict ecological constraints are likely to be most affected (IUCN/SSC Primate Specialist Group, 2008).

Savannahs, grasslands and steppes regions changes:

Grasslands cover huge areas of the temperate, tropical and sub-tropical zones. Due to their high productivity, many have been converted to croplands over the centuries or used as pasture for domestic livestock. Savannahs and steppes are mainly grassland ecosystems found in semi-arid climates. They are usually transition zones between other types of ecosystems and, if they were to receive less rain otherwise they would change into deserts. With increased precipitation, they would develop into tallgrass prairies, shrubland or forests. Savannahs and steppes are generally rich in grazing and browsing ungulates and other fauna (small mammals, reptiles, birds and insects), and are usually controlled by fire and grazing regimes.

As global average temperatures rise, savannah, grassland and steppe habitats are predicted to shift their distribution polewards, where forest areas may be transformed into grassland- and steppe-like environments, potentially because more frequent and hotter fires may suppress tree growth(Briggs, Knapp and Brock, 2002). Grasslands are predicted to undergo significant scrub invasion(van Auken, 2000). An ecosystem can remain grassland rather than developing into the forest.

Rainfall is an important factor in determining the dynamics of migratory species, such as in African savannahs, where the reproduction, survival and movements of ungulates strongly respond to rainfall fluctuations(Ogutu et al., 2008). Droughts thus have an important effect on herbivores in these savannahs the species residing in the Mara-Serengeti ecosystem have declined by 58 per cent in the last 20 years due to drought-related effects on vegetation (Ottichilo et al., 2000) and the 2009 drought in the Amboseli ecosystem reduced the wildebeest (*Connochaetes taurinus*) and zebra (*Equus quagga*) populations by 70–95 per cent (Kenya Wildlife Service et al., 2010).

Changes in species distribution, composition:

Species distribution is determined by temperature, rainfall, geographical barriers and other ecological factors that will be largely unaffected by climate change. Where temperature and rainfall are the main limiting factors to species distribution. The temperature increase due to climate change is responsible for the poleward and upward range expansion of several insect species and changes in the seasonal phenology, leading to faster development and higher feeding rates. Two-thirds of 35 butterfly species assessed in Europe shifted their ranges northwards by 35–240 km(Parmesan et al., 1999).In the Mediterranean region, this shift has led to outbreaks of insect pests, such as the pine processionary moth (*Thaumetopoea pityocampa*) in previously unaffected areas(Battisti,2008). The insects show high performance and low mortality due to the absence of the main natural enemies in their new distribution areas and the presence of many usual or potential host species. In the Atlas Mountains, large attacks by pine processionary caterpillars were observed in cedar forest stands. The changing food supply of wildlife species will also change species distributions, stimulating some populations while depressing others. A decline in caribou and reindeer (*Rangifer tarandus*) in parts of the boreal region of the north is consistent with predicted climate change impacts on their food supplies (Vors and Boyce, 2009).

Conflicts at the human-wildlife–livestock:

The resolution of conflicts between wildlife and humans sharing the same areas is a key issue in the management of wildlife and natural resources. Increasing human population densities and the encroachment of human settlements and activities into wildlife habitats have made conflict situations more frequent in the last few decades (FAO, 2004; Lamarque et al., 2009). Conflicts are common in all areas where wildlife and human populations coexist and share limited resources. Climate changes affect the intensity and frequency of such conflicts indirectly, by modifying environments and their productivity, favouring, some species that cause problems for humans. Together with increased human population densities, this is exacerbating existing conflict situations around the world.

Conflicts become more intense where livestock and agriculture are important to rural livelihoods. In rural communities of developing countries, competition with wild animals over natural resources is intense and the people are vulnerable to high economic losses. Severe droughts cause a decrease in natural resource productivity and are associated with a considerable increase in human-wildlife conflicts (Lamarqueet al., 2009).

In Africa, most traditional dispersal and migration areas for wildlife are now occupied by humans as populations have increased exponentially. Under changing climatic conditions, wild animals move to these areas and human-wildlife conflict escalates. The consequence is that the animals are usually killed. Humans also invade wildlife reserves in search of natural resources – often fodder for their livestock – increasing the conflicts between wild and domestic animals. Warmer temperatures reduce plant and vegetation productivity in semi-arid environments, and wildlife in those areas usually enter into competition with domestic livestock for both food and water. In northern Kenya, longer and more frequent droughts have ravaged pastoralist populations in recent decades, increasing the pressure on the limited resources available, which have to be shared with wildlife (Conservation Development Centre, International Institute for Sustainable Development and Safe world, 2009). This situation has led to lower tolerance for damages caused by wildlife, result in man-animal conflict.

Measures for adaptation to climate change

Climate change is already occurring, and as global average temperatures continue to rise, it will be important to develop strategies to conserve the species and habitats that are unable to adapt to change.

The response to wildlife challenges due to climate change fall into four main categories:

1. Maintaining current ecosystems
2. Adapting management
3. Restoring damaged
4. Adopting landscape.

1. **Maintaining current ecosystems:**

This is crucial, particularly where ecosystems are reasonably intact and therefore likely to withstand climate change. A strong and effective network of protected areas is a critical element in this strategy.

2. **Adaptive management:**

Protection alone will not be enough, as ecosystems change around us. Wildlife biologists are now considering new approaches and more radical steps, including the relocation of protected areas, perhaps on a temporary basis, to allow migration to suitable conditions; translocation of species that have lost optimal ecological conditions; artificial feeding of wildlife in times of emergency; and modification of habitats. All of these approaches are accompanied by risks and costs and will require that strong safeguards are in place to be successful.

3. **Restoring ecosystems:**

Restoration will also be needed, particularly in ecosystems that are important for climate change resilience but are already badly degraded. These include mangroves, inland waters, forests, savannahs and grasslands.

4. **Landscape approaches:**

Actions taken in isolation are likely to fail, making integrated approaches vital. Examples of fire, invasive species and disease and pest management are included.

SUMMARY AND CONCLUSION:

Wildlife management among the multiple other concerns resulting from climate change will be challenging. Therefore, Developing and communicating information on the value of wild species and ecosystems on the human community will be an important strategy for conservation of wildlife from extinction due to the impact of climate change. Developing, managing and retaining an effective system of protected areas network (PAN) is a form of success. Further research and careful monitoring are needed to ensure that adaptive management and creation of new other approaches for existing and newly emerging concepts to overcome climate change pressures on wildlife.

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