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Climate Change and Future of Animals

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Abstract: ***Climate change is the prominent challenge that the world is facing now. Pollution, Population explosion, deforestation, rapid urbanization, industrialization, vehicular emissions are responsible for the gradual warming of our globe day by day. Global warming is affecting the seasonal cycle and causing climate change which is felt by us as early unset of summer, late winter & irregularity in rain, cyclone, storm etc. Climate change is degrading the nature and natural harmony in various ways. The most affected regions are the polar glaciers, sea ice corridors, coral beds. The arctic is being warmed up more rapidly than any other region on the planet and the result is fastest temperature and melting of the glaciers. Rain on snow or winter rain is another phenomena which blocks the access to food for the arctic herbivores. Sea ice corridors are the breeding & feeding ground for many species such as polar bear, seals, penguins, arctic fox, snow hare etc, but due to increasing temperature & decreasing the snow the species are facing various problems in their feeding, breeding & haunting activity. So their number is being decreased day by day. In order to escape from this, some species are getting shifted towards pole but that is not a permanent solution to the problem. Ocean warming putting severe impact on the coral reefs causing degradation and a 70-90% decline in the growth rate of corals. Coral reefs are the shelter and dwelling place for a number of species of fishes, molluscs, arthropods & annelids also, so the reef destruction will lead to the extinction of those animals also. Increase an atmospheric temperature alters the sex ratio and shifts it towards female sex in turtles which is a threat to the population. Another impact of global warming is the melting of glaciers increasing the sea level and constricting the beach sand beds. In near future those beds are going to vanish, which is severely affecting the turtles which need sand to lay eggs. So there is a possibility of shrinking in their number up to a threatening level. Ocean acidification, cyclone more precipitation & ocean current alteration have also impact upon turtles. Many migratory bird species have advanced their spring arrival during the latest decades, most probably due to climate change. Although there is a larger change in the migratory behavior of short distance migrants in comparison to long distance migrants, both are suffering from the rising temperature. Not only animals, but also humans get affected from climate change. Some primary health concerns are cold and heat related illness, respiratory & cardiovascular illness, increased occupational health risks, stress due to disasters, allergy, Asthma, water & food borne contaminations, skin damage & cancer due to UV exposure etc. Above effects of global warming strongly indicating towards a mass extinction of about a quarter of species in near future. Some changes also could be seen in animals to adapt the climate like darkening of skin/ fur, thinning of fur coat, decrease in fat content (subcutaneous) of body, shifting of habitat & breeding grounds, irregularities in migratory behavior of birds, decrease in number of animals etc.***

Keywords: Global Warming: The long-term increase in Earth's average surface temperature, primarily due to human activities like burning fossil fuels. Arctic Degradation: The decline in the health and integrity of the Arctic region, often associated with the melting of ice, loss of habitat, and changes in ecosystems. Coral Reef Decline: The deterioration of coral reefs, often caused by factors such as rising sea temperatures, pollution, and ocean acidification, leading to the loss of biodiversity in these ecosystems. Wildlife Impact: The effect of human activities on various species of wild animals, including habitat destruction, pollution, and climate change, resulting in population declines or extinctions. Migratory Birds Shift: Changes in the patterns of bird migration, which can be influenced by factors like climate change, altering the timing and routes of bird movements between breeding and non-breeding areas. Sea ice corridors: Sea ice corridors are navigable pathways through ice-covered regions, vital for maritime transport in polar areas. Rain on ice: Rain on ice can create hazardous conditions, as it forms a layer of slippery and potentially dangerous ice on surfaces. It's a weather phenomenon that can increase the risk of accidents and makes walking or driving more challenging.

1. Introduction

Climate change is not a new topic in biology. The study of biological impacts of climate change has a rich history in the scientific literature, since long before there were political ramifications. Grinnell (1917) first elucidated the role of climatic thresholds in constraining the geographic boundaries of many species, followed by major works by Andrewartha & Birch (1954) & Mac Arthur (1972). There is ample evidence that climate change has caused phenological shifts that eventually can result in change in distribution or abundance of species (Walther et al.2002; Parmesan 2006; Willis et al.2008; Lehikoinen and Sparks 2010). With the changing climate of earth the atmosphere and ocean have also warmed, sea level has risen, the amount of snow and ice has declined globally and the arctic is a global hot-spot that is warming more quickly than any other region on the planet. (Intergovernmental Panel on Climate change, 2013).

Severe degradation of coral reefs in recent decades has been driven by a range of threatening processes including climate change. Ocean warming is expected to have further serve impacts on reefs unless global warming is restrained well below 2ºC (the goals of Paris Agreement).

Developing countries are the most vulnerable to climate change impacts because they have fewer resources to adapt: socially, technologically & financially. Over next decades, it is predicted that billions of people, particularly those in developing countries, face shortages of water and food and greater risk to health and life as a result of climate change. (2007 UNFCCC).

Climate Change impacts on wildlife in high Arctic region:

One of the most visible and dramatic impacts of climate change in the Arctic has been the reduction of sea ice, which has declined markedly in recent decades in terms of overall extent, thickness, proportion of multilayer ice and seasonal duration. Although the physical models that predict sea ice extent still contain a lot of variability, continued sea ice declines are expected and a seasonally ice-free Arctic is predicted to occur well before the end of this century (Kowk et al., 2009, Overland & Wang, 2010, Wnag & Overland, 2009, see also Tietsche et al., 2011). This would be a first for Arctic marine systems during the last 5+ million years (see Polyak et al., 2010 for historical sea ice patterns). A summer-time ice-free Arctic ocean will have implications for ocean circulation and our global climate system (Kern et al., 2010, White et al., 2008, Mueter et al., 2009, Mueter & Litzow, 2008, Pipenburg, 2005, Post et al., 2013).

Arctic terrestrial ecosystems are also being impacted heavily by climate change, with the major changes in earth-surface phenomena being declines in a glacier ice & snow, melting of permafrost, increase in vegetation, productivity and climate feedbacks induced by shrub encroachment, which are all expected to mediate changes in trophic interactions. (Cooper, 2014, Ims & Ehrich, 2013, Sturm et al., 2001). The strong warming predicted for the coming decades in the Arctic will result in average mid-winter temperatures approaching 0ºC (Hansen et al., 2014), which will likely have far-reaching implications for terrestrial ecosystems in the region. Winters are getting warmer (forland et al., 2012, Hansen et al., 2014, Nordii et al., 2014), which is having significant impacts on the biodeversity, structure and functioning of Arctic terrestrial ecosystems (Cooper, 2014, Hansen et al., 2013, Ims & Fuglei, 2005).

Rain on Snow (ROS) events occur due to strong oceanic influence on the weather systems (Svendsen et al., 2002), but such events increasing in frequency due to winter warming (Forlang et al., 2012). ROS have a significant impact on the entire terrestrial ecosystem by changing snow pack properties and sub-snow pack soil temperatures (Putkonen & Roe, 2003, Rennert et al., 2009). Winter rain results in encapsulation of vegetation in ice, which blocks access to food resources for herbivores (Hansen et al., 2013). ROS events have synchronized the population dynamics of reindeer Rangifer tarandusplatyrhynchus, the rock Ptarmigan Lagopusmutahyperborean, the sibling vole Microtus levis and their principal predator/ scavenger, the Arctic fox Vulpeslagopus (Hansen et al., 2013, Stien et al., 2012). So ROS events likely represent one of the most important facets of ongoing climate change for Arctic terrestrial ecosystems (Thompson et al., 2013).

Warming of Arctic has strong impact on herbivores. It explains part of the rapid increase in the population of Pink-footed geese Anserbrachyrhynchus (Jensen et al., 2014, Kery et al., 2006, Madsen et al., 2007)

Climate change and Marine ecosystem in Arctic:-

Change in sea temperature and the changing nature of sea ice (i. e. less multilayer ice, less seasonal coverage) have already affected the marine food web. For ex. blue mussels Mytilusedulis have reappeared in svalbard after an absence of 1, 000 years (Berge et al, 2005), Atlantic cod Gadus morhua, Atlantic snake pipefish Entulerusaequoreus and heddockMelanogrammusaeglefinus have shifted their distributions pole-ward into Svalbard waters (Fleischer et al., 2007, Renaud et al., 2012), Temperate Birds like great skuaStercorariusskua and northern gannet Morusbassanus are likely to benefit from warming of the sea and their population numbers have been gorwing rapidly (strom, 2006, strom, unpubl. data)

Changes in sea ice and consequences on bird and mammal breeding ecology:-

Warming of the Arctic seas and associated declines in sea ice will affect some Arctic wildlife through more direct mechanisms which could be observed through observation of effects of sea ice loss on reproduction of marine species like polar bears, walrus, seals, Arctic fox etc. (Lydersen & Kovacs, 1999). lairs are used for protection against harsh winter weather and also protection from the many predators that prey on ringed seal young, including polar bears, Ursusmaritimus, Arcticfoxes and even avian predators such as glaucous gulls Larushyperboreus (Gjertz & Lydersen, 1986, Lydersen & Smith, 1989). In most recent years sea ice formed early enough to accumulate sufficient snow for construction of lairs which is negatively affecting their breeding (Lydersen, 1998, Lydersen & Gjertz, 1986). Due to lack of sufficient snow & sea ice there have been unnaturally high densities of ringed seals in the small areas that have land-fast ice during the pupping period and females have given birth directly on ice without protection of snow lairs. Pup mortality rates are extraordinarily high under such conditions (Lydersen & Smith, 1989, Smith & Lydersen 1991, Kovacs and Lydersen peers, Obs)

For polar bears, sea ice provides a corridor that allows for movement between hunting, mating & denning areas (Derocher et al., 2011, Hansen et al., 2010). But in recent years lack of sea ice have a negative impact on that.

Glacier fronts also represent important hunting areas for Arctic foxes in the spring (Lydersen et al., 2014). Tidewater glaciers are the key foraging areas for various predators such as seabirds, seals and Arctic whales (Arimitsu et al., 2012, Hamilton et al., 2016, Lydersen et al., 2014). Glacier pieces drifting at the surface near glacier fronts are used as resting platforms for many seabirds and seals (Lydersen et al., 2014); This habitat is also important as hunting place of polar bears. So the loss and permanent melting of glaciers may cause a negative consequence to those species.

Rising temperatures can favour the emergence of new diseases or parasites (Ipstein 2001, Harvell et al., 2002), and also exacerbate the impacts of contaminants (e. g. Kallenborn et al., 2011, Armitage & Wania 2013, Nikinman 2013, Braune et al., 2015), with potentially important consequences on wildlife population dynamics. For example the prevalence of ticks Ixodesuriae on the Brunnich's guillemot is strongly linked to the average winter temperature (Descamps, 2013) and an increase of 1ºC in the average winter temperature was associated with a 5% increase in the number of birds infected by these actoparasites.

Effect of climate change on Coral reefs

Coral reefs provide habitat to over a million species as well as essential ecosystem services (e. g., food, coastal protection) to hundreds of millions of people throughout the tropics and subtropics (Cinner et al., 2012 and Pendleton et al., 2016). Despite their importance, coral reefs are in rapid decline, with the rate accelerating for many coral reefs over the past decade (e. g., great Barrier Reef, Hughes, et al., 2017). Human impacts such as fishing pressure, coastal development and pollution are combining with rising ocean temperatures to push reefs increasingly in to states typified by low coral abundance, reduced biodiversity and degraded ecosystem services (Cinner, et al., 2012 & Pendleton, et al.2016). While all treats facing coral reefs need addressing, those associated with global ocean warming are the most serious, with the near total loss of coral reefs across the planet expected by midcentury under current green house gas emission projections (Hughes et al., 2017 and Hoegh-Guldberg, O., 1999). Within this context, reducing the impact of local threats has the potential to build much needed resilience for coral reefs as they face escalating threats from global climate change.

Coral bleaching

Most warm-water corals exhibit a symbiotic relationship with single-celled algae (zooxanthellae) from which they derive much of their nutrition. This relationship breaks down under stress. Algal densities decline and photosynthetic pigments may be reduced. As a result, corals become pale or “bleached” and in some cases die. Mass bleaching events around the world were first noted in 1983 and have been linked to elevaled sea temperatures. These events usually last for a few weeks to few months, and are acute threats to the corals, whose presence and structure underpin the entire ecosystem. Severe seawater warming in 1998 affected most coral reef regions and caused widespread coral mortality, particularly in the Indian Ocean.

Most corals live close to their upper thermal maximum and an increasing frequency of bleaching is projected with warming background temperatures. Even coral surviving bleaching may be affected, with impaired reproduction, susceptibility to disease, and reduced calcification. Within the caribbean, increase in thermal minima have probably played a role in the spread of disease in acroporid corals (Randall et al., 2015).

Effect of Climate change on Sea Turtles:

For many species of reptiles such as crocodilians (Lang et al., 1994), some fresh water turtles (Bull 1980) and all species of sea turtles (Janzen 1994), Sex is determined by incubation temperature during embryonic development (Valenzuela, 2004). In sea turtles cooler temperature produce more male hatchlings while warmer temperature produce more females (Janzen 1994 and Valenzuela 2004). The incubation temperature that produces 50% of each sex (Mrosovsky et al., 1980) is defined as the pivotal temperature. With warming global temperatures and most sea turtle populations naturally producing offspring above the pivotal temperature (Hays et al., 2017), it is clear that climate change poses a serious threat to the persistence of these populations. Further more extreme incubation temperature not only produce female only hatchlings but also cause high mortality of developing clutches (Hays et al., 2017).

Rainfall is highly variable both temporally & spatially, but long term observed trends during the past several decades are evident over many regions linked to rising atmospheric CO_2 levels. (IPCC, 2007; Zhang et al., 2007). The intensity of cyclones has increased in some regions such as the tropical North Atlantic, the Indian Ocean and South-west Pacific Oceans (IPCC, 2007; Saunders and Lea 2008). Sea level has risen by an estimated 1.7mm/year during the twentieth century due to thermal expansion of the oceans and widespread melting in glaciers and ice caps (IPCC, 2007). Rising temperature will affect atmosphere and ocean circulation regionally in the tropics and extra tropics (IPCC, 2007)

Ocean acidification is not a direct effect of climate change but is a consequence of fossil fuel CO_2 emissions, which are the main driver of recent climate change (Denman et al., 2007).

Turtles tend to nest just above the high water mark but cyclones, storm & heavy rainfall can inundate nests or erode sand dunes resulting in significant nest and egg loss (Edminston et al., 2008; Foley et al., 2006; Pike and Stiner, 2007a; Ragotzkie, 1959; Whiting et al., 2007; Xavier et al., 2006)

Coupled with increase in storm intensity, rising sea levels may results in increased risk of tidal inundation or destruction of turtle nests on low-profile beaches, thereby reducing population reproductive success. Nesting area reduction may also result on subsequent increases in nesting density, thus increasing the risk of nest destruction during digging of neighbouring nests and the risk of predation (Mazaris et al., 2009).

Warmer ocean temperatures are likely to extend the potential global pelagic habitat of marine turtles further polewards (Mc Mahon & Hay, 2006).

Wind & currents play a number of roles in the distribution of juvenile turtles at sea. They may influence turtle movement, particularly through advection, offer a thermal refuge from colder waters and will influence to a large degree the availability of planktonic prey.

Ocean acidifications have indirect effect on turtles, particularly if coral reefs decline or ocean productivity decreases.

Effect of climate change on Migratory Birds:-

In birds, and especially migrants, there is a large body of scientific evidence for the effect of climate change on phonology and population trends (Root et al., 2003; Parmesan and Yohe 2003; Moller et al., 2008; Both et al., 2010). In many areas especially in Europe and North America, spring events like budburst and caterpillar availability occur earlier during the latest decades due to warmer temperatures (Visser et al., 1998; Bauer et al., 2010) and many migratory bird species are advancing their arrival to the breeding ground (Cotton 2003; Parmesan and Yohe 2003; Janzen et al.2006; Knudsen et al., 2011).

For a number of reasons, including competition for territories and fitness cost of early egg-laying (e. g. Jonzen et al., 2007; Johansson and Jonzen 2012. Visser et al.2012), the advancement in bird arrival dates is sometimes not as large as the earlier occurrence of the food peak, but may still be an adaptive response to climate change. If the time between arrival and breeding is limited, the consequence may be a temporal mismatch between breeding time and food availability, leading to situations where chicks are record under suboptional conditions (Both & Visser 2001; Strode 2003; Both et al., 2006)

Several studies show that spring arrival in long distance migrants is less affected by temperature than in short distance migrants (Nott et al., 2002; Tryanowski et al.2002, Hubalek 2004; Miller-Rushing et al.2008b). This has been suggested to be a result of long distance migrants being more restricted by their endogenous time program (Both & Visser 2001; Coppack & Both 2002; Jenni and Kery 2003). Short distance migrants have also been shown to display a more flexible behavioral response to local weather at stopover sites (Calvert et al.2012). Larger ecological mismatches at the breeding grounds have thus been suggested to explain the observation of negative population trends in long distance migrants. (Both et al.2010; Saine et al.2011)

Effects of Climate Change on Humans:

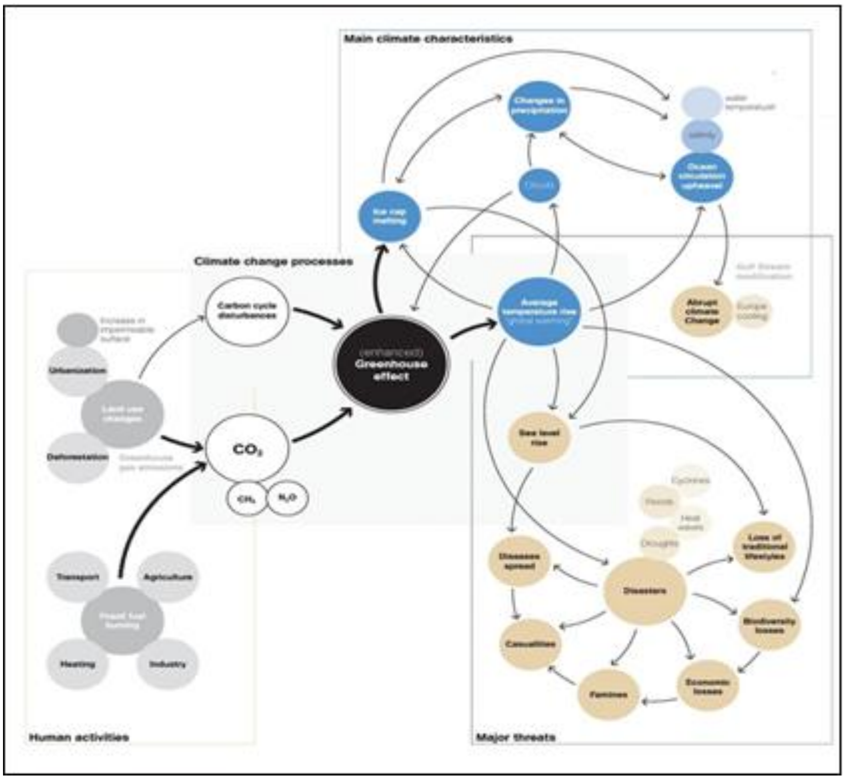
The WHO (2014a, 2014b) estimated that climate change is expected to cause approximately 250, 000 additional deaths per year between 2030 and 2050: 38, 000 due to heat exposure in elderly people; 48, 000 due to diarrheal disease; 60, 000 due to Malaria; and 95, 000 due to childhood under nutrition. Additional negative outcomes include unintentional injuries related to coastal and inland flooding, droughts, and fires, with the greatest areas impacted in resource-limited countries.

The health impacts of climate change occur in several key areas: exposure to temperature extremes; extreme weather events and related disasters; the effects of air pollution; lack of access to food and water; vector-borne and zoonotic diseases; and ozone depletion. The resulting deleterious effects are detrimental to the social, economic and health circumstances of population worldwide.

Health concerns related to climate change are cold and heat related illness. Increased occupational health risks, Damage to public health infrastructure, Injuries and illnesses, Social and mental health stress due to disasters, Occupational health hazards, population displacement, Allergy, Asthma and Other respiratory diseases, heart attack, stroke and other cardiovascular diseases, Cancer, Diarrhea and intoxication caused by chemical and biological contaminants, Skin damage and Skin cancer cataracts, Disturbed immune function etc. (Canadian Nurses Associate 2005, 2008)

Effect of climate change on future Humans:-

The intergovernmental panel on climate change (IPCC, 2007a, 2007b, 2007c, 2007d) projected that the future burden of disease related to climate change will include increases in diarrheal diseases and malnutrition as global warning affects access to clean water and less availability of arable land. Vector-borne diseases such as malaria, dengue, and zika are sensitive to climate change and are expected to increase in tropical areas. The effects of air pollution are a major health threat in numerous countries and are directly linked to deleterious effects on cardiac and respiratory health. Extreme weather events, including floods, droughts, fires, hurricanes, typhoons, and severe storms have increased due to climate change and global warning. These disasters lead to health, related consequences for communities worldwide; namely differently in access to food and water, inability to support agriculture and livestock farming, saltwater intrusion etc.



Analysis of Data & Prediction of the future of Animals due to Climate change:-

The main characteristics of climate change are increase in average global temperature (global warning); changes in cloud cover and precipitation, particularly over land; melting of ice caps and glaciers in ocean, temperatures and acidity- due to seawater absorbing heat and CO2 from the atmosphere.

There is ample evidence that climate change has caused phenological shifts that eventually can result in change in distribution or abundance of species (Walther et at 2002; Parmesan 2006; Willis et at 2008; Lehikoinen and Sparks 2010). Over the next decades, it is predicted that billions of people, particularly those in developing countries, face shortages of water and food and greater risks to health and life as a result of climate change. Under a business as usual scenario, greenhouse gas emissions could rise by 25-90% by 2030 relative to 2000 and the earth could warn by 3C this century. Even with a temperature rise of 1-2.5C the IPCC predict serious effects including reduced risk of hunger, spread of climate sensitive diseases such as malaria and an increased risk of extinction of 20-30% of all plants and animal species (IPCC 2007).

Following the decline in sea ice and climate change the animal like, Polar bear, Arctic fox, snow hare, seals, penguins and arctic fishes are shifting more towards pole and temperate fishes, birds are shifting more towards the polar region. The shifting could be a temporary solution but could not be a permanent one.

Animals are undergoing physical, physiological and behavioral changes. Thinning and graying (Gloger rule) of fur coat to face the increasing temperature. Thinning of subcutaneous fat in animals like whale and polar bear, Increase in length of extremities (Allen’s rule). Variation in BMR and growth rate, reduced capacity for respiratory gas exchange, increased in blood viscosity, decrease in reproductive rate and fecundity, change/shifting of sex ratio. Increase in speed of ontogenic development, variation in growth rate, increase in locomotory speed, increase in feeding and food processing, variation in skeletal deposition, smaller body size (Bergman’s rule), Decrease in number of fin rays and vertebra (Jordan’s rule), variation in gene expression etc. (Perspectives in ecology, Manideep Raj).

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