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CLIMATE CHANGE, ECOSYSTEM AND HUMAN HEALTH: AN OVERVIEW

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Abstract
An overview of the impact of climate change on the ecosystem and on human health is hereby reported. The debate over the effects of ozone depletion and airborne particulate and indeed the greenhouse gases has produced a number of scientific materials on the subject matter. It therefore becomes necessary that a better understanding is established between the biosphere and climate as this will enable better planning for adapting to the changes that occur though it seems unlikely that climate management will become a reality within the foreseeable future.

Introduction

The most complex manifestation of human- induced global change is that of the earthôs climate. The debate over the effects of ozone depletion and airborne particulate (Producing a cooling influence) and greenhouse gases (Producing a warming influence) has produced a plethora of scientific material on the subject (Houghton et al, 1990). In an attempt to deal with the uncertainty in the prediction of the effect of climate change, Intergovernmental Panel on Climate Change (IPCC) has brought together a group of scientists on various climate change issues and the degree of consensus on these issues (Figure 1). Many climatologists believe that the ñenhanced greenhouse effectò, caused by the observed accumulation of carbon dioxide, methane, nitrous oxide, and chloro-fluorocarbons in the atmosphere is likely to raise mean world temperatures by about 2^0C by 2030 and mean sea level by about 30-50 cm on a comparable time scale (Warrick et al, 1988).

Rising sea levels, encroaching desert, increasing untillable land, and shifting of world nutritional resources, radical changes in rural economies could be some of the major impacts of the climate upheaval that may have been set in motion. The magnitude and extent of the change that could occur defy our imagination. The scientific community has now predicted that these will be some of the unavoidable consequences of alteration in the chemical composition of the atmosphere, owing to the progress and action of mankind. At the same time , a real threat weighs upon the ozone layer of the stratosphere, which protects life on earth from receiving an excess of ultraviolet rays from the sun.

A warming of the earth by several degrees Celsius may seem insignificant, but its not. The average temperature of the globe is currently four degrees higher than it used to be in the prehistoric glacial age. At that time, northern Europe and America were covered with ice, the sea level was more than 100 meters lower and no one can mistake Britain for an Island. Men hunted reindeer, the Mediterranean, at least to the north, was boarded by a forest of fir trees comparable to those found at present in Scandinavia and in the Alps.

These modifications of the atmosphere are likely to have amplified the variations in the quantity of solar energy reaching our planet. Be that as it may, several facts may be considered to be certain at present:

Fig 1: Degree of Consensus on various Climate Change Issues (IPCC, 2006)

Issue	Statement	Consensus
Basic characteristics	Fundamental Physics of the greenhouse Effect	Virtually certain Virtually certain
	Added greenhouse gases add beat	Virtually certain
	Greenhouse gases increasing because of human activity	Virtually certain
	Significant reduction of uncertainty will require a decade or more	
	Full recovery will require many centuries	
Projected effects by mid ï 25 Century	Large stratospheric cooling	Virtually certain
	Global-mean surface precipitation increase	Virtually certain
	Reduction of sea ice	Very probable
	Arctic winter surface warning	Very probable
	Rise in global sea level	Very Probable
	Local details of climate chance	Very probable
	Tropical storm increases	Uncertain
	Details of next 25 years	Uncertain

Virtually certain: Very probable uncertain:	Nearly unanimous agreement among scientists and no credible alternative view Roughly a nine out of ten chance of occurring Hypothesized effect for which evidence is lacking	
Climate change and global warming	The climate is changing, the earth is warming up, and there is now overwhelming scientific consensus that it is happening, and human induced	Virtually certain
Link between biodiversity and climate change q	Rapid global warming can affect an ecosystem chances to adopt naturally	Virtually certain
Flexibility mechanisms	Defined in the Kyoto protocol as different ways to achieve emissions reduction as part of the effort to address climate change issues	Virtually certain

* During the last century, the amount of carbon dioxide in the atmosphere has increased by 25% after remaining virtually constant for some 150,000 years.

* Since it was first measured in 1958, this increases has consistently been of the order of 0.5% per year, clearly showing that the natural regulatory mechanism ï plants, ocean-are over loaded. No longer can they absorb the billions of tons of carbon dioxide emitted by the combustion of oil, coal, gas and wood.

* Concentrations of other gases in the atmosphere are increasing even more dramatically. This could contribute, if it has, not already, to accentuating the greenhouse effectô of carbon dioxide.

* Combined together, these developments are likely to produce world-wide climate changes within the next several decades, resulting in a global warming in the order of 1 - 5^{o}C.

IMPACT OF CLIMATE CHANGE ON THE ECOSYSTEM

All ecosystems and socio-economic systems vital to human development and well-being, including human health, are sensitive to both the rate and magnitude of climate change. Climate change could inflict severe additional stress on already over-burdened ecosystems.

Already, major ice shelves are breaking off Antarctica and for the first time it is possible to sail around the James Ross Island. Formerly connected ice to the mainland of Antarctica. According to a study by the British Antarctic survey, continued increase in temperature could result in the disintegration of the large Ronne and Ross ice shelves, which are each roughly the size of Spain. Collapse of these ice shelves could result in land-based ice falling into the sea and cause a rise in the sea levels of as much as 5 meters, flooding many coastal cities and causing massive population disruptions. (Frolich, 1989)

Although the magnitude and some effects of the greenhouse effect remain hotly contested, the scale and complexity of potential changes has led to a desperate scrabble to foresee the future. Large-scale extinction have occurred as a result of past major climate changes, cataclysmic disturbances, and human activities (Crowley et al, 1988) Although little scientific consensus has emerged on the impacts of apparent current changes, it appears highly likely that global warming and associated disturbance events, particularly when coupled with human population growth and accelerating rates of resource use, will bring further losses in biological diversity.

A growing body of research has examined the possible effects of climate changes on individual species and biotic communities. This research suggests that biological communities will change and shift in complex and unpredictable ways as the geographical distribution of species are altered individual rather than in community units. Further, because species are interrelated, any advantage falling to a given species in a closed system will affect other species in ways that are not always predictable. The rate of species invasion and extinctions in likely to accelerate further, bringing about complex changes in species com-positions and interactions (Lodge, 1993). Thus rather than causing a simple pole ward or uphill shifting of ecosystem with all of their inhabitants intact, climate changes will serve to reorganize biological communities.

For example, small changes in temperature alone may differentially alter the spatial distribution predator and prey species in marine ecosystems (Murawski, 1993). The 1982/1983) EI Nino (a periodic climate event characterized by inter-annual climate variation in the Pacific Basin and beyond, elevated sea surface temperatures, replacement of upwelling cold water in the Humboldt current by warn water, and changing barometric pressure as far as west of Southeast Asia) increased Galapagos rainfall by a factor of ten, with a resultant increase in seed production and caterpillar abundance. Ground finches responded to the increase in food supply by producing up to 10 egg clutches instead of the usual one to five, increasing population size by a factor of four (Gibbs et al, 1987). On the other hand, oceanic productivity was low, so that many seabirds did not breed. The Galapagos penguin and the flightless cormorant population were reduced by 46 and 77 percent, respectively (Valle et al, 1987).

In forest ecosystems, rain seasonality as well as temperature may be influential, particularly if they cause major changes in fruit or seed production. Further, the response of forests to climate change may depend as much on the indirect effects of climate and vegetation on soil properties (Pastor et al, 1988). The ability of animal and plant species to shift their ranges in response to climate changes also depends on dispersal mechanisms. Significant changes in temperature could occur during the lifetime of some long-lived tree species; trees that disperse light, wind-blown seeds or drop seeds carried by animals may be able to disperse more easily than others (Peter et al, 1992). On the other hand, tree species dependent on animal pollination or seed dispersal may be affected by changing ranges of animal species.

Because climate change is expected to be greatest at high latitudes, Arctic communities are also expected to undergo particularly rapid changes. Many of Europeȇs most productive wildlife habitats are in the far north, where algae, bacteria and other microscopic organisms grow on the underside of sea ice during spring. As the ice brakes up with the approach of summer, the organisms are released into the water, where they support a series of food webs that include large species such as whales, polar bears and seals. An increase of 5^{o}C over the next 50 years could melt even the permanent Arctic, (Pain, 1988) bringing changes to polar ecosystems. Alexander (1992) notes that the melting of sea ice would also affect marine mammals that use ice floes for rest, travel and reproduction. If an ozone hole becomes established over the North Pole, those impacts could be greatly magnified. Natural ecosystems provide many goods and services that are important to sustainable development, including the following; food, fiber, medicines and energy; processing and storing carbon and other nutrients; assimilating wastes, purifying water, regulating run off, and controlling floods, soil degradation and beach erosion; and recreation and tourism. Climate change may alter the composition of many ecosystems and reduce biodiversity and the services that ecosystem provide (Watson, 1995). Some forest and mountain ecosystems may disappear altogether and desertification is likely to become more severe and less reversible. Aquatic and marine ecosystems important to tourism, freshwater supplies, fisheries and biodiversity, such as coastal wetlands, coral reefs and river deltas will be at particular risk from climate change and sea level rise.

Impact of Climate Change on Human Health

Human societies over the ages have depleted natural resources and degraded their local environments. Populations have also modified their local climates by cutting down trees or building dams. In consequence, many of these local populations have been more vulnerable to disease and ill health. Today, the aggregated human impact has attained an unprecedented global scale, which reflects rapid increase in population size and energy intensive consumerism. (World Meteorological Organisation 1999)

As the science of human-induced climate change becomes clearer, the importance of addressing its potential impacts increases. Initial concerns tend to focus on material and ecological systems important to society; human settlements; coastal zones, agriculture, forests and fisheries. Recognition has now grown that climate change is also likely to affect health of human population directly. Global warming could lead to spread of diseases. An insect vector transmits many important infectious diseases. For example species of mosquito transmit malaria, yellow fever and Rift valley fever and species of tsetse fly African trypanosomiasis or ósleeping sicknessô such vector- borne diseases are major burden of ill health in developing countries especially for children. Insect such as mosquito are cold blooded and are therefore particularly sensitive to climate and meteorological factor. Mosquitoes breed in standing water and, therefore, their population densities are often related to rainfall events. It is underestimated, that currently more than one million children die from malaria each year. Anopheles mosquitoes which carry malaria are limited to areas with average temperature of 16^{o}c, but with global warnings, the range of these mosquitoes could be dramatically extended northward (Martin, 1995). Further, warmer temperature accelerate the lifecycles of disease-carrying insects, encouraging them to feed more often and therefore infecting significantly more people in warmer weather. One study in Rwanda found that a 1^{o}C temperature rise caused malaria infection to increase by337 percent. Because climate can play a dominant role in determining the distribution and abundance of insect vectors, either directly or indirectly through its effects on host plants and animals, climate change is likely to have a significant effect on the geographical range of many vector species, and potentially on the distribution of the disease themselves.

Extremes in climate help to create conditions that can lead to outbreaks in infectious diseases. For example, the epidemic of pneumonic plague in India in 1994 was at least partly due to hot, dry conditions, which enabled disease carrying fleas to thrive. And the 1993 outbreak of hantavirus in the southwestern United States appear to have been caused at least partly by extreme climate event of over the previous six years which produced an abundance of the food that disease-carrying rodent prefer; but the draught, accompanied by federally-funded predator-control programmes, had killed off many of the normal but slow-breeding predators of the rodent. This shows again, how unbalanced ecosystems can have profound and unpredictable effect.

Stratospheric ozone depletion and greenhouse gas accumulation both induce changes in global climate the 'global commons'. That is, although the gaseous emissions arise from diverse localized sources, in all continents, their environmental impact is of a diffuse globalize kind, Local emissions thus contribute to an integrated global change that has serious consequences for human health.

Stratospheric ozone shields the Earth's surface from incoming solar ultraviolet radiation (UVR), which is harmful to all animals and plants. Significant stratospheric ozone losses have occurred mainly at middle and high latitudes due to human activities. Increases in ground level UVR are presumed to have occurred, particularly at higher latitudes. However, such trend are difficult to ascertain because wavelength specific UVR measurements have only recently begun. In addition local factors such as clouds, aerosols and ozone pollution can absorb or reflect UVR before it reaches the ground.

Many epidemiological studies have implicated solar radiation as a cause of skin cancer in fair-skinned humans. Thus, skin cancer rates are very likely to increase due to stratospheric ozone depletion, and may already be doing so. The Ozone Secretariat of the United Nations Environment Programme estimates for a "European" population living at around latitude 45 degrees North there will be an excess incidence of skin cancer, peaking at around a 5 percent increase during 2070s. this corresponds to an extra 100 cases of skin cancer per million populations per year. The current ground rate of skin cancer is approximately 2,000 cases of skin cancer per million populations per year.

Ultraviolet radiation is known to affect human health in other ways. UVR can cause damage to the eye, such as snow blindness, and apparently causes certain types of cataract. There is now good evidence that UVR cause the immune system to be suppressed in human and animal. The wider significance of this for patterns of disease (especially infectious disease) in populations, however, is difficult to asses (World Meteorological Organisation, 1999).

FIG. 2 Possible major types of impact of climate change and stratospheric ozone depletion on human health (WHO/WMO/UNEP)

	Mediating Process		Health outcome
	Direct		
TEMPEATURE AND WEATHER CHANGES	Expose to thermal extremes	→	Altered rates of heat-and cold-related illness and death
	Altered frequency and/or intensity of other extreme weather events	→	Deaths, injuries, psychological disorders: damage to public health infrastructure
	Indirect		
	DISTURBANCES OF ECOLOGICAL SYSTEMS Effects of range and activity of vectors and infective parasites	→	Changes in geographic ranges and incidence of vector-born diseases
	Altered local ecology of waterborne and foodborne infective agents.	→	Changed incidence of diarrhoea and other infectious diseases
	Altered food (especially crop) Productivity, due to changes in climate, weather events, and associated pests and diseases	→	Malnutrition and hunger, and consequent impairment of child growth and development
	Sea-level rise, with population displacement and damage to infrastructure		Increased risk of infectious disease, psychological disorders
	Levels and biological impacts of air pollution, including pollens and spores	→	Asthma and allergic disorders; Other acute and chronic Respiratory disorders and deaths
	Social, economical and demographic dislocations due to effects on economy, infrastructure and resource supply	→	Wide range of public health consequences; mental health and nutritional impairment, Infectious diseases, civil strife.
	STRATOPHERIC OZONE DEPLETION	→	Skin cancers, certain types of cataract and immune system suppression; indirect impacts via impaired productivity of agricultural and aquatic systems

SOURCE: WORLD METEOROLOGICAL ORGANISATION (1999) No. 892

Long-term changes in world climate would affect the foundation of public health: sufficient food and safe and adequate drinking water. Climate change will have an impact on freshwater resources ï both the availability of fresh water (for domestic, Agricultural or industrial consumption) and water quality. Timing and intensity of rainfall is a major determinant of runoff, flooding, groundwater recharge and also soil erosion. Flooding can lead to the contamination of water with human and animal waste and agricultural chemical. Reduced water level can concentrate pollution and pathogens in surface water. As well as affecting food supply, reduced water availability has health implications because it has been shown that in times of water shortage cooking takes precedence over hygiene. The contamination of drinking water with waste and/or salt water already occurs in many countries under current climate conditions. Such problems will be exacerbated with sea-level rise.

CHANGES IN CLIMATE:

Predictions

Interactions between the biosphere and climate will become much better understood as increasingly sophisticated technical means are developed to measure the chemical composition of the atmosphere, and changes to it as a result of human actions. This increased understanding will enable better planning for adopting to the changes, though it seems unlikely that climate management will become a reality within the foreseeable future.

Major changes in global vegetation cover are expected to occur in response to global climate change, primarily as a result of changing temperature and precipitation. Rising temperature and precipitation will result in the expansion of boreal forest, but overall forest area is expected to shrink, with grasslands and deserts increasing in extent (Schelesinger, 1991). In North America, Europe, Asia and Southern African desert and other areas of sparse vegetation may expand at the expense of grasslands, shrub land, and prairies. On the other hand, shrubby vegetation may spread into areas of sparse vegetative cover in Southern Africa, Saudi Arabia and Autralian(Woodward, 1992).

By the end of the next century, global surface temperatures are predicted by the IPCC (1992) to increase by 2 ï 6^oC with an attendant rise of sea level of 0.5-1.5m; such a change would be 10 to 50 times faster than the natural rate of temperature change since the end of the last glaciations. These changes could bring increased frequency and destructive-ness of hurricanes; (Emmanuel, 1987), more protracted droughts, longer and hotter heat waves, and more severe rain periods; and significant changes in the area of the great ice sheets of Antaretica. (Frolic, 1989)

Summary Observations

Whether all the potential ecological and public heath implications of climate change will be realized depends on the assumptions made, the correctness of the models used and the degree of mitigation and adaptation that will be feasible, acceptable, and economically affordable. A country with falling agricultural production, but with sufficient potential for industrial growth can expect to feed its population from good import. A nonmalarious country with well-functioning public health system may contain the threat of malaria without even increasing health sector expenditure. However, for vulnerable populations in the developing world of the tropics, the effect of climate change may be cumulative: malnutrition may exacerbate disease and death from infectious disease, some of which contribute to malnutrition. Anthropogenic climate change is likely to influence both malnutrition and infection.

The 1992 United Nation Conference on Environment and Development (UNCED) recognized in Agenda 21 that the unavoidable uncertainties attached to forecasting the potentially serious impacts of global environmental change do not justify a wait-and-see inaction. Rather; in such circumstances there is a strong case for prudent, precautionary action. The "Precautionary principle" is directly relevant to global climate change and stratospheric ozone depletion because of the possible occurrence of irreversible changes in the world's environment and climate systems and because of the potentially serious nature of the health outcomes.

Both exiting and future environmental health problems share many of the same underlying causes, relating to poverty, inequality, and socio-economic values and practices. The global-scale process of climate change and environmental change and degradation will tend to exacerbate these various current health problems, such as malnutrition, and range of vector-borne infections and the consequence of weather events in many countries. Climate change may also present new and unanticipated problems for human health.

While the industrialized countries are spending billions of dollars for marginal environmental improvements especially in the field of pollution, developing countries face immediate and obvious health threats from diseases associated with poor sanitation, polluted drinking water, climate change and other environmental ills. Funds spent to address those developing country problems – following the example of carbon offsets would be far more efficient in addressing global environmental problems.

Technological solutions are also limited by their uneven availability. Not only is access to resources and skills unevenly distributed in the present, but the cost of new technology are likely to be prohibitive for many developing countries, so that future development is likely to preserve the existing international economic structure for decades to come. Many of the products of agricultural biotechnology are likely to compete with tropical export commodities, such as palm oil, rubber, and cocoa, further weakening the position of developing countries in international market.

The developed world is also much more likely to successfully absorb the economic cost associated with global climate change, and have access to the benefits of biotechnology and other technologies that will allow high standards of living to be sustained. High incomes in parts of the developed countries will facilitate mobility and adaptation in respect to global change. By contrast climate change will force small-scale agriculturists in developing countries to intensify agricultural product on their already environmentally stressed land and increase activities such as logging and mining, thus intensifying the environmental impact of current land use practices. Low-income agricultural households in the developing world will be particularly vulnerable to the increasing frequency of extreme climatic events as well as temperature change.

Conclusion: In conclusion it is evident that a society has developed where everything from human habits to politics and economics exploits the environment with callous indifference. Unless the nature of the state is harmonized with the state of nature, humanityòs greed and ignorance will eventually take the world beyond the capacity of the very ecosystem that support human existence.

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