THE POTENTIAL HEALTH IMPACT OF GLOBAL CLIMATE CHANGE

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ABSTRACT

It is well known that air pollution can affect human health directly and indirectly. The direct effects as a result of inhalation or dermal contact are widely studied and reasonably well characterized. However, great uncertainty still exists about the magnitude and rate of global climate change. The potential adverse impact on man warrants attention even in these early stages of change. This paper summarises information on the potential health impacts of climate change, published in international literature since 1986 with special reference to the South African situation.

1. INTRODUCTION

There is still much uncertainty about the magnitude and rate of global climate change and the effect it might have on human health[1-5]. However, the potential impacts of a continued rise in surface temperature and larger amounts of shorter wavelength ultraviolet (UV) radiation reaching the earth's surface as a result of stratospheric ozone depletion can be determined from our current knowledge of causes of disease in man. Because global warming and ozone depletion develop over many decades, ensuing adverse impacts on human health could be irreversible[3]. From a public health perspective therefore it is imperative that potential risks be minimized or managed. The adverse impacts of global climate change on human health can be direct or indirect[6,7]. The spectrum of potential adverse effects is discussed distinguishing between direct and indirect effects.

2. POTENTIAL EFFECTS OF CLIMATE CHANGE ON HUMAN HEALTH

21. Direct effects

Currently the potential direct effects of global climate change pertain to the change in disease patterns, with a general trend to increasing incidences of these diseases associated with the changes in climate rather than generating new diseases - the latter will only be known in years to come.

(a) Temperature

One of the key adverse effects likely to occur as a result of global warming is associated with increased surface temperatures[6-8]. These include:

(i) Mortalities:

We know that people, especially the elderly, the very young and the sick cannot deal easily with extremes in temperature[1,6-8]. Heat places stress on the thermoregulatory system which is closely tied to the circulatory system[7,8]. Research to date illustrates that at temperature latitudes in industrialised countries, crude mortality rates are inversely correlated with ambient temperature; death rates are lowest in July and August up to a threshold of about 32°C. Elevated mortality rates after increases in ambient temperatures have been reported in a number of studies[1,7,8], the elderly being the most vulnerable[1]. It is estimated that heart-related mortalities in 15 US cities could increase from a current estimated 1 200 deaths to 7 500 deaths annually with a doubling in CO_2[8] concentrations. Other studies predict that a similar increase in CO_2 concentrations could cause temperature-related mortalities to rise sevenfold[6].

Studies conducted by the US Environmental Protection Agency (EPA) on the other hand, found that mortality is highly dependent on degree of acclimatization. With complete acclimatization, little or no effect is predicted but moderate acclimatization could result in a net increase in mortality rate even though the number of cold-related deaths could drop[7].

(ii) Developmental effects:

Impacts of elevated body temperature on fertility and neonatal development are well described[7]. However, it is not clear whether elevated environmental temperatures have the same effect. Although seasonal (summertime) increases in perinatal mortalities and/or preterm births have been reported, further research is necessary to establish whether a link exists between the two[7]. If so, the impact on infant mortalities in developing countries in particular, could be vast.

(iii) Infectious diseases:

Climate change raises the potential for a change in the occurrence of epidemic infectious illnesses as a result of both changes in the distribution of disease vectors, reservoirs and agents and reduced cellular immunity in humans as a result of UV exposure[8]. The latter effect is discussed in Section 2.1. (c). Communicable diseases are sensitive to climate as a result of environmental needs and life-cycle related factors[8].

The effects of climate change on communicable diseases will not be limited to the Third World or the tropics[1]. After a change in climate, mosquito-borne diseases such as malaria and yellow fever could be introduced to northern hemisphere countries (such as the USA)[1,9]. Generally, it is predicted that as global temperatures increase, diseases hitherto confined to the tropics could spread to higher latitudes and vectorborne diseases could become more widespread[2]. An example of the potential impact is malaria - temperature increases would lengthen the breeding season and survival rates for *Anopheles*, flooding provides areas of

stagnant water ideal for breeding, with the result that malaria could become a greater problem in Africa and may even become prevalent in Europe[2].

(iv) Respiratory diseases:

Individuals with pre-existing respiratory diseases are likely to be adversely affected by increased temperatures as mortalities due to respiratory diseases increase with higher temperatures. However, morbidity and mortality from respiratory illnesses are related to both temperature changes and air pollution[8], which are discussed below.

(b) Air Pollution

An increase in ambient temperatures is likely to have an adverse impact on the degree of air pollution in urban areas worldwide[7]. One example is a possible increase in ozone levels overall with longer lasting peaks occurring early in the day[7,10]. This can have a major impact on respiratory disease rates overall[9,10]. In the whole global climate change issue, air pollution is the key player with both direct (toxic pollutants such as sulphur dioxide causing respiratory illnesses) and indirect (non-toxic pollutants such as carbon dioxide and CFCs which threaten life-support systems) impacts on health. However, the effects of non-toxic pollutants are predicted to be much more devastating than toxic pollutants have been to date.

(c) Ultra-violet radiation

Depletion of stratospheric ozone will result in more UV-B, particularly the shorter wavelengths, reaching the earth. UV-B is biologically active because there are molecules in the skin and the eyes which can absorb its energy; these organs are therefore the main targets for adverse effects from exposures to UV.

(i) Eye diseases:

The most common form of lenticular damage associated with UV radiation exposure is cataracts[7,8]. A cataract is an opacity of the lens which can vary in degree of density[12]. The association between cortreal cataracts and UV radiation has been illustrated in epidemiological studies[8]. Other eye diseases which are caused by UV radiation are damage to the cornea ("snow blindness", commonly found in skiers), lens and retina[7].

Damage to the eyes can be prevented by protecting the eye against exposures to UV by wearing effective sunglasses.

(ii) Cancer:

Exposure to sunlight has been associated with three forms of skin cancer: basal cell and squamous cell carcinoma (also known as non-melanoma skin cancers) and cutaneous melanoma[7,12,13]. Individuals with fair complexions (20% of the world population) and those with the most outdoor exposure e.g. farmers are at greatest risk[7,8]. In the case of the non-melanoma skin cancers, exposure to sunlight is the single most important risk factor whereas other factors are also important in the case of melanoma[12].

Over the past 4 decades the incidence of both non-melanoma skin cancers and melanoma have been on the increase while the mean age of diagnosis is falling[13]. This, however, cannot be linked with certainty to depletion of the ozone layer but rather with changes in human behaviour[14].

The EPA estimates that for every 1% decrease in stratospheric ozone, there will be an increase of between 2% and 3% in non-melanoma skin cancers. Assuming no control, and growth rates of 1,2% - 5,0% in CFC production, it is estimated that there will be between about 11 and 260 million additional cases of non-melanoma skin cancer in individuals alive in 1985 and born through 2074[7,8,12]. In the case of melanomas the EPA suggests that for a 1% reduction in stratospheric ozone the incidence will increase by 0,6% - 1,5%.

(iii) Immunosuppression:

It is known from animal studies that UV radiation causes immune suppression[7,8,12]. The evidence in humans is still incomplete[12]. However, increased exposures to UV light could predispose vulnerable populations to infectious illness, particularly if compounded by poor sanitation, crowding and malnutrition[8]. In the presence of immune-suppression even mild illness could become serious and serious illnesses fatal, as demonstrated by the lethality of opportunistic infections in patients with AIDS[8].

2.2 Indirect Effects

Global climate change can affect human health indirectly through its impact on sea level, biodiversity, ecosystems and the availability of agricultural land and water for irrigation[6,7,8,14].

(a) Crowding

As global temperatures rise, so will the sea level, eventually placing thousands of hectares of land under water. Much of the world's population live along coastlines and will be forced to move inland. A rise of the sea level by 1 metre could create 50 million environmental refugees[6]. The health consequences of crowding vary from increases in communicable diseases to diseases of poverty.

(b) Malnutrition and starvation

In many areas of the world, regionally grown food is already insufficient to sustain populations. In 1980 340 million inhabitants of 87 developing countries were not consuming enough calories to prevent stunted growth and serious health risks[8]. The impact of global climate change on availability of agricultural land as well as

climatic conditions conducive to food production will exacerbate the situation. Without huge planned resettlements and new agricultural and water systems, it is likely that millions will starve[8].

Populations that depend on fish and other seafood are also at risk. Phytoplankton, a major early link in the ocean food chain may be vulnerable to increases in UV radiation at the ocean's surface as well as to rising ocean temperatures[8].

One of the ironies of global climate change is that 60% of the world population depend on rice as a staple food, but rice paddies in themselves are a source of methane, a potent greenhouse gas. Rice is also extremely vulnerable to changes in rainfall[11].

(c) Allergic diseases

Global warming is likely to have impacts on forests, farmland and wetlands to the extent that these impacts can result in changes in the degree and/or quality of vegetation. This could result in changes in the concentrations of allergens eg. moulds and pollens which in turn could impact on the prevalence of respiratory tract allergies such as asthma and hayfever[7].

(d) Medication

It is well known that the most important pharmaceutical drugs are derived from nature. Biodiversity is a valuable resource for life-giving medicines and by driving plant and animal species to extinction we may lose a key component of an essential medicine, apart form losing the beauty, mystery and variety of life about us[15].

(e) Weather extremes

Global warming will produce increases in the regional temperature gradients that drive wind and storm systems. Weather extremes are very likely to increase. This will increase the large number of eco-refugees from starvation and weather disasters[8].

2.3 The South African situation

The potential impact of climate change on the health of the South African population has not been modelled as in the case in other western countries such as the USA. However, we are likely to face the whole spectrum of impacts (direct and indirect) discussed in this paper. Currently non-melanoma skin cancers are the most common cancer in white males while in white females it shares top position with breast cancer. Melanoma which is a fatal disease is the fourth leading cancer in white females in South Africa[16]. Squamous cell cancer of the skin is the sixth most common cancer in both black South African males and females[16]. As predicted in the USA particularly, the fair complexion component of the population will be specially vulnerable to the effects of increased UV radiation.

There are currently approximately 400 000 blind people in South Africa (1,05% of the population) while the prevalence of cataracts is 0.56% making it the leading cause of blindness in this country (personal communication, Mr Pieter Lombard, Bureau for the Prevention of Blindness, Pretoria). Without intervention, the impact of UV radiation exposure in South Africa - which is known as the sunny country - could be serious.

Another major health problem which we could be forced to deal with in South Africa, as a result of climate change, is related to infectious or vector-borne diseases. Malaria is already taking its toll in various parts of the country. Temperature increases will lengthen the breeding season and survival rate of the carrier insect *Anopheles*, increasing the receptor area and the risk of exposure. Another example which has already taken place, is the extension of schistosomiasis (causing bilharzia) in Africa into the previously pristine Lake Malawi, illustrating redistribution of disease to higher latitudes as a result of favourable environmental conditions.

2.4 Human Health Protection Strategies

There are basically three ways to approach the environmental crisis: to intervene, to accommodate, or to prevent. Of the three, the most active response in prevention through energy conservation, reforestation, reduced CO_2 emissions, controlled industrial development and population control[8]. These measures are the most appropriate but also the most difficult. To argue that humans are adaptable and already live in varied environments and will be able to cope with a hotter world, is missing the point[10]. If the predictions about global warming are correct, the ecological framework supporting our currently habitable environments could disintegrate making it impossible to adapt. The key issue is also that we should remember that the most vulnerable human settlements are those especially exposed to natural hazards such as small island nations, China, Bangladesh, etc[10]. These settlements are also the least capable of managing the situation.

From a health point of view alone, the potential impacts of global climate change are so devastating that little doubt that prevention and management are the way to go. For South Africa, as with most other countries, there is a great lack of knowledge about the extent and magnitude of impacts likely to occur and particularly the factors which will determine the likelihood and magnitude of impacts - information which is crucial to manage the situation. Clearly the first priority is to prevent the occurrence of a major disaster by intervening now. These actions are already receiving much attention worldwide. The second priority is scientific research to broaden our knowledge and understanding of the processes and risks predicted. For South Africa there is a need for the following research activities with respect to human health.

- Ecological studies of a multi-disciplinary nature involving botanists, zoologists, epidemiologists, entomologists, climatologists etc. The information needed

to project what could happen with climate change in this country, can best be acquired in the field, studying survival and adaptation.

- Specialized research projects such as those studying means of controlling vectors and vector borne diseases beyond the current borders.
- Sociological studies with public educational components addressing the dangers of UV radiation among others. (The risk of developing cataracts for example can be minimized by wearing protective sunglasses.)
- Descriptive research projects compiling basic statistics on prevalence and incidences, and information on risk factors for the diseases associated with climate change. We need to know what the bottom line is to enable us to monitor any change in disease patterns. South Africa needs an atlas of the diseases likely to be associated with climate change.
- Ongoing monitoring projects, keeping records of key indicators of climate change and its impacts should be a high priority.

3. ACKNOWLEDGEMENTS

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