GREENHOUSE GASES: A THREAT TO GOOD HEALTH AND CHALLENGE TO SUSTAINABLE DEVELOPMENT

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Abstract

The recent data of several international consortia show that global warming is accelerating at a rate far greater than that predicted a century ago and is due in large part to combustion of fossil fuels. An early investigation of this "greenhouse effect" began ever since the industrial revolution wed civilization to fossil fuels. A role for health care professional in global environmental policy is a natural extension of a growing ethos of preventive medicine. This paper reviews the now almost –universally held opinion in the scientific community that global climate change is occurring and is inescapably linked with anthropogenic activities highlighted in this paper, a the review of health records of malaria cases at General Hospital Owerri, Imo State, Nigeria shows. The potential implications to human health are considerable and very diverse, and are extensively discussed in this paper in particular, those associated with blood-sucking arthropods. The role environmental monitoring will play in the management of the problem in fostering sustainable development has also been discussed.

Introduction

The universally held opinion in the scientific community is that global climate change is occurring and is inescapably linked with anthropogenic activity. The potential implications to human health are considerable and diverse. These include, the increased direct impacts of heat and rises in sea level, exacerbated air and water-borne harmful agents and the emergence of environmental refugees. Vector-borne diseases, in particular those associated with blood-sucking arthropods such as mosquitoes, may be significantly impacted, including redistribution of some of those diseases to areas not previously affected.

The issue of global climate change, the role of human activity in such change, and the potential impact of climate change on the health of human populations are prime examples of the effect of the greenhouse gases, and are of great public interest.

This paper reviews the threat that the green house gases are posing on the health of human beings. A study of malaria cases that is increasing as the year rolls on shows that it is high time we watched this trend. A survey on the malaria cases at the General Hospital Owerri in Imo State was conducted from year 2000 to 2004 with a remarkable increase in the malaria cases. Environmental monitoring is central, including not only the measurement of the levels of atmospheric gases and physical properties that has long constituted traditional environmental monitoring but also the determination of indices that reflect the effects of relevant atmospheric changes, many of which lie outside the natural sciences (Vincent, 2003).

The Climatic Change and the Driving Politics

Five Development priorities were identified at the World Summit on Sustainable Development in Johannesburg, South Africa in August 2002: widely known by the acronym WEHAB representing pressing environmental and developmental challenges; namely:

(a) Water (b) energy (c) health (d) agriculture and
(b) biodiversity, (WEHAB 2002).

The reality of climate change and the associated role of anthropogenic activity have been debated at length in many scientific forums, and the scientific community has now established beyond doubt that a number of key indicators have changed markedly since the pre-industrial era. The first indicator is the rate of carbon dioxide emission to the atmosphere, which is yearly on the increase for over 1000 years. The results show a sharp increase in carbon dioxide emissions during the period since the industrial revolution, with as much as 80% associated with the combustion of fossil fuels and the rest with changes in land use (WHO, 2004). The second indicator is the concentration of atmospheric carbon dioxide. Analyses of air samples taken from Antarctic ice cores reflecting atmospheric conditions back as far as 420 000 years reveal sharp increases during the past 150 years in the atmospheric concentrations of carbon dioxide as well as methane and other gases (Petit et al, 1999). The third indicator is the temperature of the atmosphere. Here, Mann 1999, used pale climatic records to reconstruct annual-average Northern Hemisphere surface temperatures, and showed an increase of about 1 °C over the past 150 years.

It is a scientific fact that such temperature changes can be driven by changes in atmospheric level of carbon dioxide through the ‘greenhouse effect’. This depends critically on the balance between the rates of emission of carbon dioxide and the rates of uptake by plants, soil and large bodies of water, as described by the ‘global carbon cycle’. However, the vast majority of informed scientific opinion now leans towards the conclusion that global warming is indeed extremely serious—indeed, potentially catastrophic—and that the association with human activity is unavoidable.

In specific terms the WEHAB framework model simulations project that:

(W) water availability and quality will decrease in many arid and semi-arid regions with increased risk of floods and droughts;
(E) the reliability of hydropower and biomass production will decrease in many regions;
(H) the incidence of some vector-borne diseases and water-borne diseases will increase in some regions.
(A) agricultural productivity will decrease in the tropics and subtropics for almost any amount of warming but will increase in temperate regions, and there will be an adverse effect on fisheries; and many ecological systems will be damaged; and
(B) biodiversity adversely impacted.

Climate Change and its Impacts

Environmental monitoring over the past century or more for a wide range of climate-related indices confirms that climate change is a reality. We now know that the land and oceans have warmed up during the past 150 years, by as much as 1 °C on the average in large parts of the northern hemisphere. There are, however, just a few relatively small pockets, in certain ocean regions in the southern hemisphere, where temperatures have fallen slightly. At the same time, precipitation patterns have changed significantly with increases over some landmasses in both the northern and southern hemispheres and decreases over the arid regions in the subtropics (Fig. 1). The latter is most worrying in parts of Africa, compounding the already difficult situation embodied in the WEHAB framework.

Fig.1: High Temperatures Causing Scorching Effect Over Arid Regions © Photo disc 2005.

Meanwhile, records going back 300 years show that sea levels have risen by more than 200 mm since 1700, most of that since 1900(Woodworth, 1999) (Fig. 2).

Fig. 2 Melting of Polar ice cap due to High Temperatures © Photodisc 2005.

Climate models can be used to simulate past changes in climate, current conditions and projected changes in climate, incorporating chemical, physical, biological and meteorological processes embodied in the Earth's system, as well as the effects of anthropogenic emissions of greenhouse gases and aerosol precursors (Intergovernmental Panel, 2001). Projected changes in climate are based on the following changes between 1990 and 2100, namely;

(a) the world's population will rise from about 5.3 billion to between 7 and 15 billion;
(b) the world's gross national product (GDP) will rise from 21 to between 235 and 550 × 10^{12} (1990 US$);
(c) the *per capita* income ratio (developed/developing countries) will fall from 16.1 to between 1.5 and 4.2;
(d) final energy intensity will fall from 16.7 to between 1.4 and 5.9 × 10^6 J US$$^{-1}$;
(e) primary energy will rise from 351 to between 514 and 2226 × 10^6 J US$$^{-1}$;
(f) the share of coal in primary energy will change from 24% to between 1 and 53%; and
(g) the share of zero carbon in primary energy will rise from 18% to between 28 and 35%.

Based on these assumptions, ranges of greenhouse gas emissions and associated changes in climate are projected.
In particular, if emissions continue unabated, with continuing increase in carbon dioxide emission. Carbon dioxide atmospheric concentrations will increase from current levels (about 370 ppm) to between 540 and 970 ppm during the next 100 years, with a corresponding global average surface temperature increasing between 1.4 and 5.8 °C. Land areas will warm more than the oceans, with the greatest warming at higher latitudes. In terms of precipitation, some areas will continue to be progressively wetter and others drier. There will be increases in severe weather, including more severe heat waves, less cold spells, more intense precipitation events in some areas and less in others, and increases in peak tropical cyclone wind and precipitation intensity. In turn, there will be intensified flooding in some areas and serious drought conditions in others. The inevitable consequences will be damage to property, loss of life and other impacts to human populations.

Climate Change and Health

Climate change has the potential to significantly influence the health of people around the world. The initial specific driving forces are temperature, hydrologic extremes and sea level rise. These in turn, may lead directly to adverse impacts on public health effects in a range of aspects: extremes in heat, exacerbated air pollution, changes in vector-borne and water-borne diseases, water and food resources, and—ultimately—environmental refugees (Patz et al,2000). These changes have had their fair share in a country like Nigeria with a population of 140 million; the threat of these climatic changes is mainly on the health of its populace.

Heat and Cold

The more than 20000 deaths in Europe associated with the unprecedented heat wave of Summer 2003 provides a stark example of the direct role of temperature on the public health aspect of climate change. Even as far north as England, temperatures exceeded the 'magic' 100 °F day after day for the first time since records began, and even healthy people were adversely affected. Heat disorders encountered during such episodes included heat exhaustion, and heat stroke. (Patz et al, 2000)

Air Pollution

Certain aspects of air pollution are exacerbated by higher temperatures, notably the formation of photochemical smog and ozone. Ozone is of special climate-related public health interest. Ozone is associated with a wide range of adverse respiratory conditions, including non-specific respiratory effects. One factor in ozone production is the availability of volatile organic compounds (VOCs), one significant source of which is biogenic and the release of VOCs from such sources is highly temperature sensitive.

Airborne allergens may also be significantly influenced by climate change. It has been shown that pollen counts rise with increasing temperatures (Tamura et al,*1997*, Ahlholm et al,*1998*). In addition, increased atmospheric carbon dioxide provides enhanced 'fertilization' of pollens such as ragweed (Ziska and Caulfield, 2000).

Extreme climate-related occurrences can also contribute to air pollution. The forest fires in Malaysia and Indonesia in 1998 are now known to have been linked with the El Niño episode—and associated lack of monsoon rains—that year. As much as 7500 km^2 of forests were destroyed and 300 million people were affected. (Sastry,1997).

Water-Borne Diseases

Water-borne diseases have long been considered to be a major public health problem throughout the world, especially in developing countries. These include such serious diseases as cholera, cyclospora, cryptosporidiosis, campylobacter and leptospirosis. One of the effects of climate change is the increased incidence of local extreme weather episodes including extreme precipitation events. For these, observations in the United States over the last 100 years indicate that precipitation events with more than 5 cm of rain in 24 hours have increased by about 20% (Karl and Knight,1998). Studies of precipitation in the 18 hydrological regions in the United States show a strong correlation between the incidence of the outbreak of water-borne disease and the occurrence of extreme levels of precipitation (Curriero , *2001*). One notorious such episode was the *cryptosporidium* outbreak in the city of Milwaukee, Wisconsin, in 1993

(Fox and Lytle,1996), with more than 400 000 cases reported, contributing to more than 100 fatalities (Graczyk et al, 2000).

Environmental Refugees

Climate change is already leading to significant rise in sea levels. Coastal populations are inevitably at the greatest risk, especially among poorer, developing countries that cannot provide the preemptive resources to handle such challenges. In Bangladesh, nearly 20% of the land area would be lost from a 1 m rise in sea level, affecting over 10% of the population, while in Egypt, the corresponding figures are 13% and 10% respectively (Myers,2000).

The Role of Climate Change in the 20th Century Resurgence of Vector-Borne Diseases

Vector-borne diseases involve the transmission of infectious agents, by hematophagous arthropods such as mosquitoes (Fig. 4 a). The survey of malaria cases carried out at Owerri Genaral Hospital show that there are growing cases of malaria related illness as shown in fig. (4 b and 4 c) Major epidemics of vector-borne viral diseases during the same period included dengue fever. West Nile virus, eastern equine encephalitis, Japanese encephalitis, yellow fever, Chikungunya , Rift Valley Fever, and many other lesser known viral diseases.

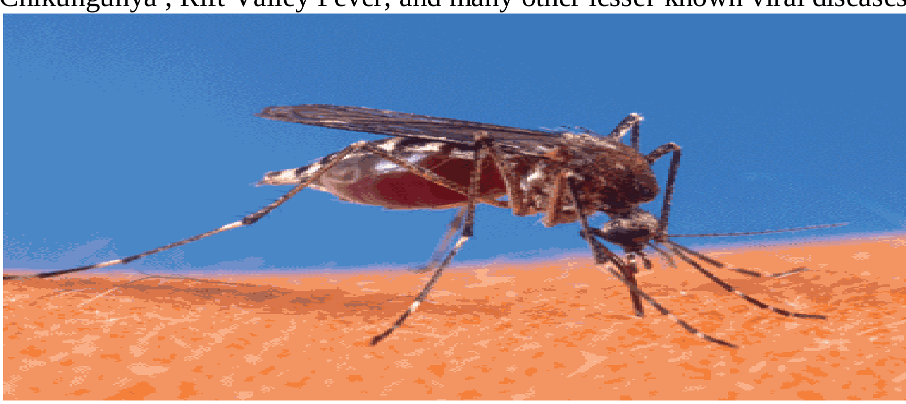

Fig.4a. ***Mosquito a Vector for Malaria Fever © USDA-ARS 2005.***

There are now concerns about the emergence of new vector-borne diseases, along with the resurgence of some that were previously controlled along with expanded geographical distribution and increased epidemic activity. Certainly, major demographic and societal changes in the past 50 years are known to be the main contributing factors to this resurgence of infectious diseases. These include Lyme disease, Dengue and the more serious Dengue hemorrhagic fever, Yellow fever, Japanese encephalitis fever, Waste Nile virus, Alkhurma virus, Venezuelan equine ancephalitis, epidemic poly arthritis, Barmah forest, Rift valley fever, Oropouche, Cliffonia encephalitis, and Crimean-Congo hemorrhagic fever(Kovats et al, 2001).

Lyme disease, involving the infection of humans, following an infected deer tick bite has become significant public health problem in the United States (Steere et al, 2004).

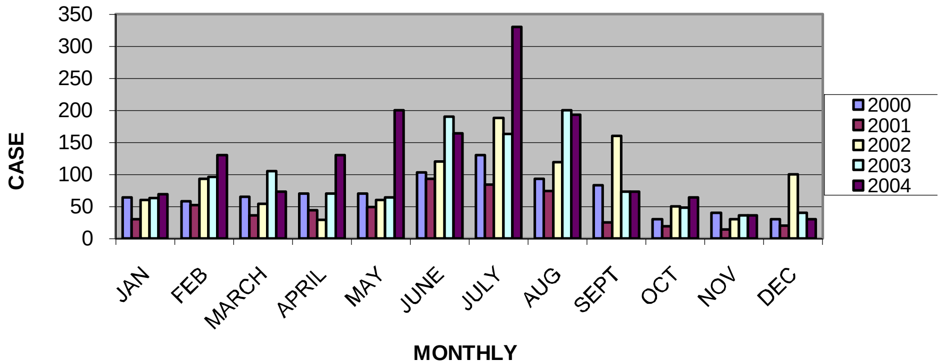

FIG. 4b: Histogram of Malaria Cases 2000-2004 At General Hospital Owerri, Imo State

The mosquito-borne West Nile virus first isolated in Uganda until recently was distributed in Africa, Europe, West and Central Asia, etc. The incidence of this illness rose sharply in the following years as reported by the Center for Disease Control (CDC) in 2003 with 233 deaths. Nigeria is not left out in these statistics.

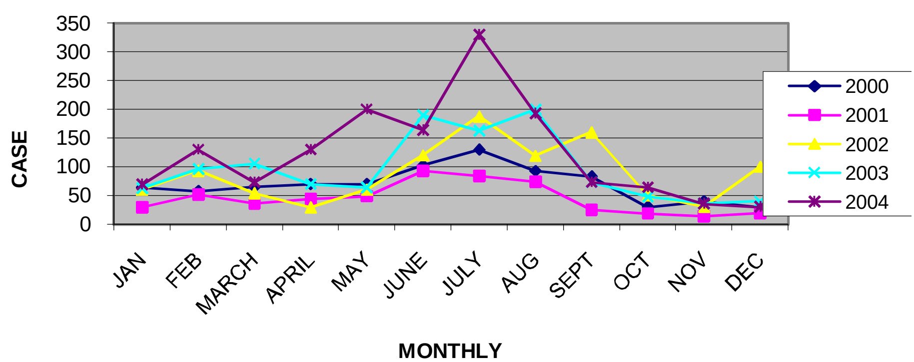

Fig. 4c : Line Graph of Malaria Cases 2000-2004 At General Hospital Owerri, Imo State

The figure below (fig.5a) shows the graph of CO_2 emission since 1915 to 2003. This increase has lead to the rise in temperature from 32^{o}C to the prevailing 35^{o}C as at present (The CDC West Nile, www.cdc.gov).

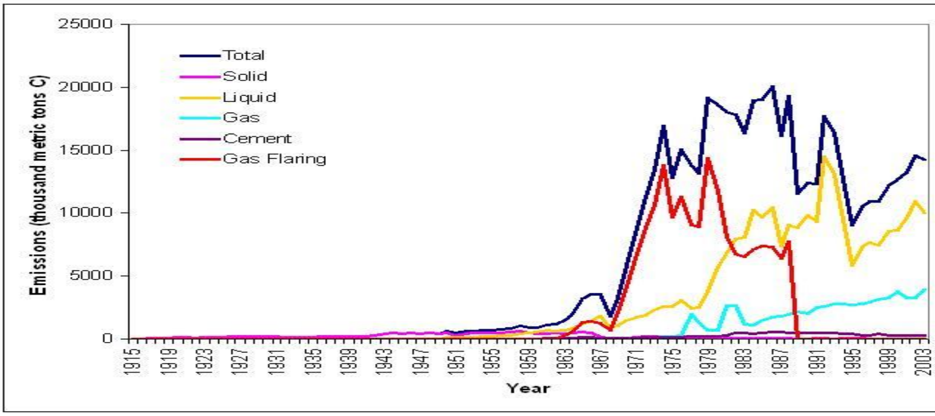

Fig. 5a CO_2 Emission in Nigeria form 1915- 2003. (http://cdiac.esd.ornl.gov:80/cdial/)

Dengue/dengue hemorrhagic fever occurs throughout tropical regions of the world. Epidemic dengue was first recorded in the late 1700s in Asia, Africa and North America. Although there were repeated epidemics, typically at intervals of from 10 to 40 years, the current global pandemic began in Southeast Asia during and after World War II, and has sharply intensified during the past two decades. The marked increase in the number of cases there during the past three decades correlates strongly with the widening regional distribution of the mosquito species *Aedes aegypti*, the primary mosquito vector for this disease. By 2004, dengue has now become the most important mosquito-borne viral disease affecting humans. Its global distribution is comparable to that of malaria, and an estimated 2.5 billion people live in areas at risk for epidemic transmission (The CDC dengue www.cdc.gov).

Influence of Climate Change on Vector-Borne Diseases

Vector-borne infectious diseases are maintained in complex transmission cycles that are influenced by many extrinsic and intrinsic factors. Local and global climate considerations are likely to be important. The specific climatic variables that can influence the distribution and incidence of vector-borne diseases include temperature, rainfall patterns and extreme weather events. In turn, changes in these variables in the directions consistent with global warming trends may be expected to influence—more likely exacerbate—the emergence or resurgence of many vector-borne diseases like those described. For example, in one study carried out in Zimbabwe, a strong relationship between malaria and altitude was shown where altitude was taken as a good surrogate for temperature (where the average temperature decrease with height was approximately 6 °C per 1000 m) (Taylor and Mutambu,1986).

The Challenge and Responses to The Environmental Health Impacts Of Climate Change

The magnitude of the emerging climate change-related environmental problem requires discussion of how countries can respond, both now and in the future. Possible responses fall into four classes:

(a) dealing with the effects of climate change,
(b) identifying and dealing with the causes,
(c) establishing processes to sustain and adapt both these types of efforts over the long periods required for managing climate change, and
(d) trying to learn more.

What Does It Mean to Deal With The Effects of Climate Change?

The projected impacts of climate change are diverse in character and severity, and specific to particular places, people, and activities (Parson et al,2003). As reflected in the title of this paper, human health is one important domain of climate change-related environmental impacts. But there are other significant ones, including large-scale changes in the climatic conditions for agriculture, damages to coastal zones through loss of land to gradual sea-level rise, all exacerbated by storm surge and a potential increase in the intensity of tropical storms. In addition there will be shifts in the total quantity, regional distribution (and timing) of freshwater availability, with a particular risk of acute summer shortages in regions that depend on snow-fed rivers. Overall, there will be major disruption of natural ecosystems.

There are other measures that may be taken to reduce vulnerability of people specifically to climate-change impact, including reduction of poverty and promotion of economic development and the degree of dependence of poor communities on subsistence agriculture and to strengthen emergency preparedness and response systems.

On the whole, any coherent response to the climate change issue must involve major efforts directed towards addressing both effects and causes.

Reduction of Emissions

Stabilizing the global climate will require a large reduction in future emissions through the deployment of low-emitting and (preferably) non-emitting energy technologies. One approach to the problem would be to set long-term targets. It is generally believed that energy production using technologies of today, with some evolution, can put us on the right track until about the year 2050. A broad portfolio of energy production technologies including fuel switching (coal/oil to gas), increased power plant efficiency, carbon dioxide capture and storage, increased use of renewable energy technologies and nuclear power, complemented by more efficient use of energy in the transportation, buildings and industrial sectors, which are currently available to reduce greenhouse gas emissions. Stabilization of carbon dioxide equivalent concentration at or near 450 ppm requires emission cuts to begin immediately using today's technologies, but must be supported by investments in new technology and the development of policy-based incentives to support climate-friendly technologies.

Climate and Atmosphere

In the profile presented below we have the recent contribution of Nigeria to the CO_2 emission

Country Profile – Nigeria

Carbon Dioxide (CO_2) Emissions {a}	**Nigeria**	**Sub-Saharan Africa**	**World**
(in thousand metric tons of CO_2)			
Total Emissions, 1998	78455	515001	24215376
Percent change since 1990	-12 %	10 %	8 %
Emissions as a percent of global CO_2 production	0.3 %	2.1 %	
Emissions in 1998 from:			
solid fuels	172	292852	8654368
liquid fuels	25410	151843	10160272
gaseous fuels	11325	16330	4470080
gas flaring	40202	42110	172208
cement manufacturing	1345	11865	758448
Per capita CO_2 emissions, 1998			
(thousand metric tons of CO_2)	1	1	4
Percent change since 1990	-28 %	-12 %	-2 %
CO_2 emissions (in metric tons) per million			
dollars Gross Domestic Product {b}, 1998	2537	X	773
Percent change since 1990	-29 %	X	-10 %
Cumulative CO_2 emissions, 1900-1999			
(in billion metric tons)	2162	16887	933686
CO_2 Emissions by Sector, 1999 {c} (in million metric tons of CO_2)			
Public electricity, heat production,			
and autoproducers	6	X	8693
Other Energy Industries	6	X	1205
Manufacturing Industries and Construction	9	X	4337
Transportation	16	X	5505

Residential	3	X	1802
Other Sectors {d}	2	X	5640
Total Emissions All Sectors:	43	X	27180
CO_2 Intensity, 1999			
Emissions per total energy consumption			
(metric tons CO_2 per terajoule energy)	11	32	56
Emissions per Gross Domestic Product {e}			
(metric tons of CO_2/million $PPP)	387	X	582
Non-CO_2 Air Pollutants, thousand metric tons			
Sulfur dioxide emissions, 1995	764	5345	141875
Nitrogen oxide emissions, 1995	835	9309	99271
Carbon monoxide emissions, 1995	21424	177268	852415
Non-methane VOC emissions {f}, 1995	3424	17375	159634

In addition, many of the technologies that reduce greenhouse gas emissions yield ancillary human health benefits through the reduction of local and regional air pollutants (Fig. 5 b).

Fig. 5 b G*reen House Gas Emission into the Atmosphere © Photo disc 2005*

Continuing Need for New Knowledge

The final component of the response to climate change is the continued search for improved knowledge, in part to further narrow uncertainties and in part to expand technology research aimed at developing non-green house-emitting alternatives to the present energy systems by experts. With enough participating experts of appropriate and recognized stature, and a sufficiently clear and fair deliberative process, such assessment processes can make statements of scientific knowledge that may come to be treated as authoritative by most or all participants in policy debates.

Conclusion

It is now widely agreed that climate change, loss of biodiversity, and land and water degradation threaten poverty alleviation and sustainable economic growth. In the scenario that has been described, industrialized countries are primarily the cause of human-induced climate change, but developing countries are the most vulnerable. But it is reasonable to expect that, provided that political will and moral leadership are brought to bear, cost-effective and equitable solutions can be found. However it is important to ensure the development and implementation of more effective disease prevention strategies and public health infrastructures, involving improved community-based preventive medicine, health education, control of communicable diseases, application of sanitary measures and environmental monitoring.

There is significant evidence, some of it summarized in this paper, that changes in the health of peoples around the world, as reflected in a number of health-related indices, may be plausibly associated with climatic changes like those described. The responses to what appears to be a growing climate-related global health problem will need to include arresting the driving force. In the first instance that will require a significant reduction of anthropogenic emissions that underlie the rise in atmospheric concentrations of carbon dioxide and other greenhouse gases, in turn limiting the rise in global temperature. This will need full participation in international agreements (such as the Kyoto Protocol) to reduce emissions. In addition, for many of the health effects mentioned, individual governments can achieve much by the development and application of appropriate and responsive public health, governmental and administrative procedures. In the United Kingdom, for example, it is thought that any emergence and spread of vector-borne diseases such as malaria can be prevented by appropriate public health infrastructure (Hunter,2003).

Finally, the study of the problem of climate change and its impacts on human health and in turn the development of workable policies for corrective actions by the nations of the world will require a concerted multidisciplinary approach to environmental monitoring and surveillance. This will include monitoring in its widest sense, including not only measurement of the chemical and physical properties of the atmosphere and pollutants within it, but also the responses of biological systems to changing climatic conditions and the dynamics of the health and well-being of human populations. The latter would include the application of epidemiology to associate human health effects with changing environmental factors. This is far from what may be traditionally thought of as environmental monitoring and may include the monitoring of population-based indices such as, the rates of mortality associated with specific illnesses, hospital admissions, insurance claims, *etc.* It is also an important reflection of the widening disciplinary spectrum within environmental science—and environmental monitoring.

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