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Climatic Changes and Maternal and Child Health

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INTRODUCTION

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The anticipated climatic changes over the coming decades are expected to have a major impact on the health of mothers and developing humans, including fetuses, children, adolescents and young adults. Our predictive powers over exactly what will happen are limited and the ancient Greek dictum "Gods know what will come, men know what is, wise men know what is coming " is as pertinent today as it was in bygone times. We will have to enlist our wisdom if we are to correctly predict and, hence, devise rational ways to prevent and mitigate the negative effects of the changing climate on our young and the rest of us.

In this brief manuscript, I provide an overview of the predicted effects of the on-going climatic changes on the health of mothers and children by first reviewing briefly the history of earlier climatic effects on life on Earth, then the expected effects of climatic change on health and finally the prevention and mitigation measures that should be taken.

Key words: *climatic changes, health*

THE HISTORY OF CLIMATIC EFFECTS ON LIFE ON EARTH, MAN AND THE EARTH BIOSPHERE AS COMPLEX SYSTEMS

Humans and their societies are complex systems consisting of and living within other complex systems: We consist of atoms, molecules, cells, and organ systems, and, we, both as individuals and societies, are part of the Earth biosphere, the planetary system, the galaxy, and the Universe.

Complex systems consist of multiple interactants, are self-organizing, adapt through auto-regulatory feedback loops, are resilient to perturbations, and have emergent properties. The latter are not the sum of parts but something transcendent, unpredictable by knowing the parts. Thus, life itself, the human intellect, soul, and civilization are

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all emergent properties of complex systems.

Complex systems have a steady state (homeostasis), which is perturbed by disturbing forces (stressors) and re-established by adaptive forces. The Earth biosphere follows these principles of complexity. The homeostasis of the biosphere is reminiscent of "harmony turning back on itself (palin-tropos; feed-back) like that of a bow and a lyre", as astutely observed by Heraclitus (circa 500 BCE). The biosphere can maintain homeostasis when assaulted by stressors, but its adaptive capacity is limited.

Hooke's law of elasticity provides an excellent example of homeostasis and stress that can be extrapolated to the biosphere. Thus, the degree of load applied on a material (stressor severity) is correlated linearly with the degree of deformation (adaptation). However, this linearity is not infinite. There is a point, the so-called "yield or tipping point", beyond which the material properties are adversely affected, i.e. the system is in stress. And if the stressor exceeds the capacity of the system to remain intact, then we have the "fracture point" or the point of collapse. This, in a living system equates to death.

HISTORY OF THE EARTH CLIMATE AND THE EVOLUTION OF LIFE

Earth climate has changed remarkably over the 4.5 billion years of the existence of the planet. Life began about 2.7 billion years ago starting with very simple organisms, whose presence was crucial for the genesis of oxygen, the atmosphere and biosphere and the evolution to living organisms of increasing complexity. Oxygen concentrations in the atmosphere rose gradually, reaching the 18% point 2.2 billion years ago. Prokaryotic unicellular organisms developed into the more complex eukaryotic ones through incorporation of and symbiosis with simple prokaryotic organisms that became the mitochondria and chloroplasts, key organelles in the formation of living multicellular organisms, the animals and plants.

During the Cambrian period, 540 to 490 million years ago, simple unicellular protozoa developed into the multicellular metazoa and during the Devonian period, 420 to 350 million years ago, two major animal groups colonized the land. The first tetrapods, or land-living vertebrates, appeared, as did the first terrestrial arthropods, including wingless insects and the earliest arachnids. At the Devonian, there were three major continental masses: North America and Europe that sat together near the equator, much of their current land underneath seas. To the north lay a portion of modern Siberia, while a composite continent of South America, Africa, Antarctica, India, and Australia dominated the southern hemisphere. About 80 million years ago, the American and African continents separated from each other, and about 40 million years ago animals and plants on Earth followed different evolutionary paths on each continent. Thus, the primate species separated into two major classes, the Old World primates that include the human, chimpanzee, gorilla and macaque species and the New World primates, which include the marmosets and squirrel monkeys.

RECENT CLIMATE CHANGES

The modern human species has a life of about 150,000 years, a tiny time fraction of the duration of life on Earth, during which the biosphere has attained a relatively limited range of homeostasis that has allowed our growth and prosperity. However, a progressive elevation in mean temperature by about 1°C or 1.8 F has taken place on the planet over the last 100 years. Greenhouse gases are building up, ozone is being gradually depleted and noxious chemicals are being released to and accumulating in the environment. These upward trends continue in this century at a faster pace, with evidence pointing toward an anthropogenic etiology. With these trends, the projected temperature increase varies from 2-6°C over the next 100 years.

We know now that because of this temperature rise, the Earth biosphere has over 15 areas that are stressed and close to their tipping point. These include the Amazon rain forest, the Golf stream, and the Arctic and Antarctic ice sheets. With the anticipated further rise of temperature, extreme weather phenomena are expected to increase. Heat waves, massive forest fires, floods, torrential rains, and hurricanes and tornados are expected to occur with increased aggressiveness and at higher frequency.

A hotter climate is expected to reduce the yield of crops. Agricultural scientists anticipate that for every rise of 1°C (1.8 F) above the norm, wheat, rice and corn yields will drop by 10%. With a continuous rise of the Earth population, especially in developing countries, projected in the ensuing years up to 2050, the absolute numbers regarding

hunger and the consequences of malnutrition are expected to rise.

As the temperature increases in temperate zones, vectors from the tropics will move into them and carry with them diseases. For instance, the mosquito Anopheles, which is a vector for the malaria parasite, is expected to move to erstwhile temperate zones bringing with it malaria.

EXPECTED EFFECTS OF CLIMATIC CHANGE ON HEALTH

Recently, a whole issue of the Lancet was dedicated on the effects of climatic changes on human health. It was entitled "Climate change is the biggest global health threat of the 21st century". The articles emphasize how North America, Europe and China produce the highest amount of carbon, contributing to the greenhouse effect, while Africa, which produces the least emissions, is suffering the consequences of global warming with ever increasing morbidity and mortality.

A good index of health in the population of a region is the number of disability–adjusted life years (DALY) per million of population. At this time, the world average is 930, developed countries are 89, Africa 3071, Southeast Asia 1703. These indices are expected to worsen disproportionately in the developing world as the climate changes.

The Earth population is about 7 billion people and increasing. The massive urbanization of the population that is occurring so rapidly is a contributor to environmental and health problems. Now over 50% of the Earth population is urban, with 170 cities having over 1 million citizens. At the present time, 13 out of the 20 largest cities in the World are at sea level and bound to suffer floods and inundation as the temperature rises. If trends continue, in 2100 over 80% of the Earth population will be urban.

If we consider the ensuing 100 years into the future i.e., 4 human generations, and 4 different scenarios according to which the temperature is going to increase by +2, +3, +4, or +6^{o}C, one can project the proportional devastation that will be caused. This theme has been discussed in documentary movies by the National Geographic, such as the 2007 "Six Degrees Could Change the World ", and books, such as the 2008 "Six Degrees: Our Future in a Hotter Planet", and the effects predicted on health are frightening.

What are the expected changes from temperature elevations? Several, and, and probably not all, have been predicted: First, rise of sea levels; second, extreme weather conditions with heat waves, draughts, forest fires and floods; third, increases in land aridity, with a major effect on food production; fourth, exposure to UV radiation; and fifth, pollution of the environment with noxious chemicals.

What are the expected health effects? They follow the changes from the temperature elevations, as outlined in the preceding paragraph, one by one. First, we will have direct adverse effects of the extreme elements, such as drownings and heat strokes; second, we expect famines and the resultant malnutrition and increased susceptibility to infectious and other diseases; third, we expect exhaustion and/or pollution of water supplies; fourth, we anticipate expansion of waterborne and vector borne infectious diseases and re-emergence of "forgotten" diseases, as well as the emergence of new diseases; and, finally, we predict that the exposure to UV radiation and pollution with noxious chemicals, will undoubtedly lead to allergies, hypofertility and increased incidence of cancers.

Who are the most vulnerable populations to the adverse of effects of climate change? Obviously, the children, the women, especially pregnant ones, the old persons, the patients suffering from chronic diseases and the poorest members of a society. We have many recent examples, where the vulnerability of children with the misfortune of living in failed states became apparent for the world to see. These include: The hunger and malnutrition in Biafra in 1968, the Thai border in 1979, Ethiopia in 1985, Somalia in 1992, Sudan in 1998, Angola in 2002, and Niger in 2005. These examples have given us a bitter taste of what to expect if the Earth temperature continues to rise. In such conditions, the four horsemen of the Apocalypse, - famine, pestilence, war, and death-, will visit our world as some eschatological ancestors had imagined. Famine, pestilence, fire and flood (λιμός, λοιμός, πυρ και καταποντισμός), the four natural human misfortunes of the ancient Greeks, will be visiting us with increasing frequency.

Today, 150 million children are underweight in the developing world and more than half are in South Asia. These numbers are expected to rise if the climate continues to change unabated. It is ironic that malnutrition and its direct opposite, obesity, now both plague the developed and developing world.

The effects of the physical evils that may befall

the world on the human psyche are not to be ignored. Enormous psychological pain is expected at all ages, however, the suffering of children and its long-term effects on the young survivors for the rest of their lives will have even worse consequences on human societies.

Recently, the Lancet published a timetable with the prospective effects of graded temperature rises (1-6 ^{o}C) on the water supplies, ecosystems, food production and changes at the coasts of the planet, along with their graded effects on health. The effects on health were divided into those from the increased burden from the results of heat waves, floods, draughts and other extreme physical phenomena; those from the extension of disease vectors, including insects, such as mosquitoes and flies, rats and other disease carrying animals; those resulting from malnutrition, diarrhea and infections, and those that will not be properly dealt with even in countries with good health care systems because the capacities of these systems will be exceeded.

PREVENTION AND MITIGATION MEASURES

Aristotle had suggested that man consists of three elements: first, physis, i.e., his/her genetics, second, ethos, i.e., his/her environment and third, logos, i.e., his/her logic. The human rational response to climate change should be to limit anthropogenic climate changes in the biosphere and to devise measures capable of preventing further environmental changes and of helping cope with those that will inadvertently occur.

What is to be done?

The rational road map to correcting the factors that threaten our civilization has four main components: first, to cut carbon emissions by as much as possible, mostly by employing renewable sources of energy such as wind and sun power; second, to stabilize earth's population by offering basic health care, reproductive health care and family planning; third, to eradicate poverty; and fourth, to restore the planet's forests, soils and aquifers. Difficult? Yes, but eminently achievable.

It is noteworthy that the anthropogenic climate change as percent of global greenhouse gas emissions is 20% due to food production, primarily of meat and milk, and 15% due to transportation, with three quarters owing to road traffic. Earth's climate is burdened 10 times as much for the same amount of calories obtained by meat over that obtained from plant food. Average meat consumption by humans is 100g/day, ranging between 25 and 250g/day. Clearly, the people in developed countries eat too much for their own health, while those of developing countries eat too little. Moderation in the consumption of meat will help both the climate and our own health.

THE HEALTH CO-BENEFITS OF CLIMATE CHANGE POLICIES

There are major health co-benefits of climate change policies. For instance, eating less meat will not only decrease the generation of carbon in the biosphere, but will also help with development of less atherosclerosis; more walking and biking will decrease our dependence on transportation consuming nonrenewable fuels and will decrease cardiovascular disease, as well as traffic accidents; also, the decrease in air pollution will be associated with a lesser incidence of pollution-related illnesses, including respiratory diseases, cancer and hypofertility; finally, the decreased morbidity and mortality of healthy lifestyle will lead to diminishing health system budgets, allowing them to have better solvency and increased effectiveness at times of crises.

What are other general prevention and mitigation methods beyond stopping our environmentally stressful habits? These include four main measures: First is the education and empowerment of women, second is the eradication of poverty, third is population control and reproductive health care and fourth is preparation to face environmental crises, including global surveillance for early signs of such crises.

Regarding the health vicissitudes of the changing climate, health care professionals should follow the Hippocratic exhortation: "Give your assistance to all; for the love of Man and for the love of the Art". He meant inclusive care of the weak, the poor, the women, the children, the old, and the slaves. It will be the poor countries, and their most vulnerable citizens, i.e., the women, the children and the poor, that will bear the brunt of the climate change burden on health. Actually, it is the countries and people that have done the least to cause these changes that will suffer the most and this should be kept in mind.

MAN'S GENETIC ABILITY TO ADAPT

In 2009, humanity celebrated the 200-year anniversary from the publication of Darwin's seminal book "The Origin of the Species". Now, we have the benefit of the stupendous progress of biology and

genetics to understand the mechanisms through which the human species has evolved by adapting to and surviving through major evolutionary stressors. These selective pressures explain to a great extent the appearance of the modern chronic diseases of humanity, such as obesity, the metabolic syndrome, hypertension, allergies, autoimmune disorders, chronic pain and fatigue syndromes, anxiety and depression.

Interestingly, remarkable, accelerating positive selection of mostly regulatory DNA areas and genes appears to have been taking place in our species over the last 40,000 years, changes that show that we have the ability to adapt genetically to a rapidly changing environment. I mention this because for a long time we had thought that the species was staying behind genetically, with the spontaneous mutation rate and positive selection remaining constant, while lifestyle changes were occurring at a dramatic rate.

Recent studies comparing the human and chimpanzee genomes have demonstrated that changes of a little over 200 mostly regulatory noncoding DNA areas or genes coding for transcription factors that occurred over a period of about 6 million years account for the astounding phenotypic differences- especially brain functions- between these species. This means that even though our brains are our best ally in the battle against climate deterioration, we should not write off the spontaneous ability of our genome to adapt successfully to rapidly changing environmental conditions.

The Red Cross Spirit Speaks
By John Finley

WHEREVER war, with its red woes,
Or flood, or fire, or famine goes,
There, too, go I;
If earth in any quarter quakes
Or pestilence its ravage makes,
Thither I fly.

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