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Alan V. Morgan

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THE CHANGING ATMOSPHERE
Implications for Global Security

The Changing Atmosphere Conference

Alan V. Morgan
Department of Earth Sciences
University of Waterloo
Waterloo, Ontario N2L 3G1

Introduction

The objectives of *The Changing Atmosphere Conference (Implications for Global Security)* was to bring together scientists, policy makers and members of industry and environmental groups from around the world to address some disturbing observations of recent changes in the natural environment. The changes are well known to all of us in some general way. Everyone reading this is aware of terms such as "the greenhouse effect", "ozone depletion", "transboundary air pollution", and equally certainly of some of the real and potential end effects (atmospheric warming, sea level rise, skin cancers and acid rain). However, few of us are aware of the postulated rapidity of change, the real effects on the total planetary system, or the ways in which we must devise methods of coping with the socio-economic upheaval which will inevitably accompany such change.

The Conference

The conference, held in the Toronto Convention Centre on 27-30 June 1988, was attended by about 600 people. Somewhat over 200 were members of different news media, the remainder were delegates and observers. Members were recorded from 46 countries and represented 15 international organizations. There were 136 participants from Canada, 62 from the United States, 48 from different West European countries and 6 from Eastern Europe. Other parts of the world were covered by delegates from Asia (24), Africa (17), Central and South America (16) and Australia and New Zealand (5). Little expense seems to have been spared in the organization, and the world and national press were out in force.

The conference was chaired by Stephen Lewis (former Canadian Ambassador to the United Nations), and attended by Prime Minister Brundtland of Norway and Prime Minister Mulroney of Canada as well as numerous policy makers from all levels of government from different parts of the world.

The first speaker was Prime Minister Mulroney who commented on environmental proposals and tasks facing the Canadian government. He reported that on the subject of acid rain, the Federal government has reached a series of agreements with seven provinces east of Saskatchewan to reduce acid rain emissions by 50% by 1994. By 1990 lead emissions in gasoline will be reduced by 60% (from a 1986 base), and "virtually eliminated" by 1992. The Canadian Environmental Protection Act (passed about the time of the Conference) would control toxics from production to disposal, and the government now has mechanisms in place to ensure that economic decisions take environmental impact into account. Federal policies have been agreed with the provinces for the control, transport and use of PCBs, and an improved Great Lakes Water Quality Agreement was signed with the United States to "reduce pollution in the Niagara River". He went on to point out that in June a major cleanup had commenced in the St. Lawrence River, and a new marine park had been created in the Saguenay region (Québec).

On the subject of National Parks, four new ones have been created (Ellesmere Island, South Moresby, Pacific Rim, and the Bruce Peninsula) while Gros Morne National Park in Newfoundland has been designated as a World Heritage Site. (Mulroney didn't mention it, but there was considerable input from GAC members in the creation of the latter). The remaining remarks were general observations on the dangers of acid rain, ozone depletion, toxic wastes, and the "greenhouse effect".

Mulroney said that Canada would host "Stockholm II" (a World Conference on sustainable development) in 1992. The Canadian government would soon be signing the Montreal Protocol to ban all non-essential uses of CFCs (chlorofluorocarbons) and halons. A protocol for control of nitrous oxides between Europeans and North Americans would likely be signed next fall and there would be a follow-up meeting to the Changing Atmosphere Conference in early 1989.

He concluded by stating that the Canadian government is working toward sustainable development to energy futures; that items which conserved energy, which are re-cycled or recyclable, biodegradable, or free from ozone-depleting substances will be identified with a distinctive logo. He pointed out that last year Canada forgave a debt load of $670 million to African nations, and that more debt-forgiveness could lead to some slowdown of rainforest clearance in the tropics.

Mulroney was followed by Prime Minister Gro Harlem Brundtland of Norway. Brundtland chaired the United Nation's World Commission on Environment and Development, and was responsible for organizing the book entitled *Our Common Future* (informally known as the Brundtland Report). The book (Oxford Press) emphasizes the urgent need for international action on threats to the atmosphere by largely man-made chemical changes.

Brundtland began by a blunt statement. "Will we devote our abilities, our energy, and our efforts to further short-term material well-being, or will we commit ourselves to enhancing life on planet Earth?" She went on to praise Canada's role in the work of the Commission, and pointed out that many of the threats to the environment are global in scale and raise questions of planetary survival. She took the attitude that the problems were largely those of the North *versus* the South. The North has used the atmosphere, soils and water as the ultimate sink for industrial excesses; that the warning signal of atmosphere heating has been ignored; that we have disregarded the widespread use of pesticides, herbicides, and acidification, and that we have exported our environmental problems to the Third World. The emphasis of much of the first part of her talk was on the need for an holistic approach to the global problem, with more public awareness of the scientific concerns.

Brundtland went on to mention that the Third World finds itself in a crisis situation trying to service crushing debt loads with abnormally high real interest rates. These developing countries have no alternative but to tax their natural resources, often beyond the point of recovery, while they still find themselves (as in the case of Africa) transferring more to the industrialized countries than they receive. (The figure of $100 billion over "the past few years" was mentioned).

Different atmospheric protocols (Sulphur reduction in 1985, CFCs in 1987, and the future ECE NOx protocol to be signed in late 1988) were mentioned, together with concerns for ozone depletion in both Antarctica and the northern hemisphere. The 1.5 to 4.5°C estimated world climate increase over the next 50 years was commented on, with all of the potential for associated disasters in terms of sea level rise, and agricultural and climatic disturbances.

Brundtland concluded with 5 goals for an international action plan.

1. Immediate international discussions on the feasibility of adopting regional strategies for stabilizing and reducing energy consumption and use, before the turn of the century.
2. The development of a comprehensive international research and information programme on renewable energy.
3. The establishment of an extensive technology transfer programme with particular emphasis on the needs of developing countries.
4. Increased scientific research.
5. A global convention on the protection of climate to coordinate scientific activity, technology research and transfer, information

exchange, and concrete measures to reduce emissions of harmful substances.

Her concluding remarks established a theme which was to run throughout the Conference, and one which must be remembered by all readers. I quote; **"We have come to a point in the history of nations when we can no longer act primarily as citizens of any single nation state. We are irreversibly entangled in the same destiny, but together we also have enormous possibilities."**

The statements of concern expressed by both Prime Ministers coupled with remarks by other platform speakers were followed by lectures from scientists and officers of various environmental agencies. These were presented in a series of illustrated talks over the next two days.

Ken Hare (Chancellor of Trent University, and Chairman of the Climatic Planning Board of Canada) spoke on "The Global Greenhouse Effect". He pointed out that the effect is being created from certain gases which are being added to the atmosphere by human economic activity. CO_2 is being added, largely as a result of the burning of fossil fuels, at a rate of 4%/decade; methane at 1.5%/annum, and nitrous oxide and CFCs at lesser rates. The overall effect of such increases will likely lead to a doubling of these gases in atmospheric concentration between 2000 and 2050. This will mean an equilibrium temperature rise of 1.5 to 4°C over the Earth's surface with the greatest effects in high northern latitudes.

Such changes will have "ripple effects" in terms of accelerated rising sea level, changes in soil moisture availability, and hence, agriculture, impacts on energy consumption, and on northern navigation.

Hare was followed by R.T. Watson, Chief of the Upper Atmosphere Research Program in the Division of Earth Sciences and Applications, NASA. Watson's comments backed up the remarks made by Hare. CO_2, CH_4, N_2O, halons and CFCs are increasing at rates of 0.2 to 5.0% per year, and are due in part to biosphere metabolism, national energy use, agriculture, and other industrial policies. Controls will require nationally and internationally co-ordinated programmes of interdisciplinary research. Remote sensing tools (primarily satellites) have been used to establish that the Antarctic ozone hole is caused by man-made chemicals, and that the springtime Antarctic ozone has decreased significantly since 1975. Such decreases now extend north to about 45°S. The impact of ozone removal or thinning (especially with the newly observed northern hemisphere hole) will be seen in terms of human health, the marine and terrestrial ecosystems, and climate.

Göran Persson (Assistant Director General, National Environmental Protection Board, Sweden) addressed the problem of long range transport of airborne pollutants. In an excellent summary, statistics were presented to illustrate European recognition and concerns on sulphur transport and water acidification. He pointed out the relationship between sulphur dioxide, water laden with varying concentrations of sulphuric acid, heavy metal uptake, especially mercury and cadmium, and human birth defects. Cesium, liberated from the Chernobyl accident, crossed international boundaries and eventually girdled the globe with deleterious effects to agriculture and farming practises in many parts of Europe, but particularly in the mountainous western and northern fringes of the continent. Although sulphur compounds have been at the centre of past concerns it seems likely that transportation and deposition of nitrous substances may become more important. These, coupled with bioaccumulating and toxic chlorinated hydrocarbons (DDT, PCBs Dioxin and others), will become major concerns in the near future.

Irving Mintzer, Senior Associate Director of the Energy and Climate Project of the World Resources Institute, Washington commented on Energy Policies, Air Pollution and Global Warming. After summarizing the background of global warming and documenting the increase in the greenhouse gases he commented on some of the social aspects of change, and what effects such as sea level rise would mean to population densities and agriculture. This was followed by a series of scenarios which predicted what would happen if energy use was encouraged, left "as is", with modest reductions in energy, and with a slow build-up of energy use. The year when mankind will be irrevocably committed to temperatures elevated in the range of 1.5 to 4.5°C above pre-industrial global temperatures varies from 2015 (in the high emission case) to 2030 (in the "as is" case), to 2075 (in the modest to slow build-up case). The net warning was that something should be initiated immediately to reduce the (inevitable) impacts of warming.

Professor G. Obasi, Secretary General of the World Meteorological Organization, Geneva, addressed International Co-operation in Atmospheric Sciences and the Changing Atmosphere. He pointed out that world-wide data from instrumental records shows an overall, continuously increasing trend, with 1987 as the warmest year on record. At the same time, atmospheric greenhouse gases have also increased, and most alarmingly, the warming trend is entirely consistent with the computer-predicted GCMs (general circulation models). Despite strongly suggestive correlations he cautioned against a straight cause and effect relationship. He then outlined various factors which could influence the predictive models. These included the type and extent of cloud cover, natural changes in the recent geological past, geo-biochemical cycles (analysed by means of bubbles trapped in glacial ice), and possible variations in oceanic deep-water circulation. Professor Obasi concluded with a synopsis of the work of the World Meteorological Organization, explaining about their activities in monitoring destruction of the ozone layer, the Air Pollution Monitoring Network, and with the tracking of ocean pollution and events such as the radioactive cloud released from the 1986 Chernobyl reactor accident.

In Session 4, five discussants dealt with the topics of food security, forest lands, water resources, the human cost of natural disasters in Latin America, and health effects associated with global air circulation and pollution.

Professor S.K. Sinha asked that scientists address the concerns of food security in a world where precipitation patterns, temperature, and atmospheric gas content are likely to undergo rapid change. Only 5% of the world food supply comes from the oceans, and the agricultural areas for land-based food supplies are undergoing serious competition from different directions. He suggested that food imports to developing countries are not the answer, but on the other hand there is little extra arable land to be brought into production. The only method is by increased crop yields, and some expansion of arable land. Increased crop yields require additional energy input (from manual and draught labour to machines) while it also faces the problems of decreasing fertilizer response, limits on higher yields from genetic strains, and the degradation of the resource base. Although these problems are bad enough under the present climatic regime they could be exacerbated if the climate changes. Elevated sea levels and the movement of moisture belts, coupled with rising temperatures and drought could be some of the adverse factors. Elevated mean annual temperatures, by as little as 2°C could see the demise of up to 25% of the rice crop because of increased sterility in the crop. Similarly, increases in insect pests could counter any increases in real production.

J.S. Maini, Assistant Deputy Minister, Forest Policy, of the Canadian Forestry Service commented on the importance of forests and the socio-economic implications of climatic shifts to the forest regions of the world. Natural factors affecting forests under a changing climatic regime would be temperature (increasing), soil moisture (decreasing), forest fires (increasing), forest insects and diseases (increasing), possible new species (increasing), reproduction (increased vegetative reproduction), competing vegetation (decreased commercial yields), harvesting (adversely affected), hydrology and wildlife habitats (variable). Several interesting points were made, not the least of which was that lead times for equipment modification are short, and that seedlings planted today will be only halfway through their rotation time by 2030, but may well be growing in an altered climatic regime.

Professor Jaromir Nèmec, Chief of the Water Resources, Development and Management Service, F.A.O., Rome discussed the implications of the changing atmosphere on water resources. Changing weather patterns will almost certainly bring modifications to traditional patterns of precipitation and evaporation. Marginal areas will be hardest hit, and these are often in the developing countries. Examples were cited to show that a 20% decrease in rainfall coupled with a 15% increase in evapotranspiration resulted in a 75% decrease in the potential area for irrigation. The Aswan High Dam in Egypt is now threatened by lack of water. (Had the dam been constructed at the end of the last century runoff would have topped the sill of the dam). Decreased flows in the Blue and White Nile Rivers now seriously threaten the power production and irrigation necessary to support Egypt's increased population. The question of improved irrigation practises was addressed but the quality of water supplies was stressed even more. Water quality is decreasing, not only from agricultural runoff, but also from heating and pollution. Sanitation needs conflict with potable water in many developing countries where water is the principal transmission agent for 80% of all diseases. These include trachome, malaria (0.8 billion cases/year), schistosomiasis, elephantiasis, typhoid, cholera, hepatitis, leprosy, yellow fever and diarrhoea. The latter kills an estimated 1,000 children each hour! Nèmec also addressed the question of air-borne pollutants, and the attempts at various protocols to restrict the release of certain pollutants. He commented on the potential rise in sea-level with the loss of deltas, coastal wetlands, and the contamination of coastal aquifers by salt-water intrusion. Probably the most important portion of his discussion was on the question of large-scale water diversion. Most of these schemes are limited because of real political, social, economic, environmental or engineering problems. Even when some or most of these concerns are removed (as in the case of the Soviet Union) there are real scientific concerns about the potential negative effects of such massive interference with a hydrologic regime. Of possible interest to Canadians was a statement which states; "In Canada there are at least six proposals for interbasin transfers of water for power purposes and *more than six proposals for schemes for redistribution of continental water resources.*" [Italics mine]. Nèmec suggested that more efficient use of water, coupled with a reduction of pollution is far more preferable than large-scale water transfers "which would likely have... irreversible, detrimental effects on the environment."

Jorge E. Hardoy, Director of the Human Settlements Programme of the International Institute for Environment and Development, Argentina, addressed the question of natural disasters and the human cost in urban areas of Latin America. Urban expansion has been rapid in many areas of South and Central America, and in most cases, the growth has been uncontrolled. Poor sections of the population have been reluctant to move far from sources of employment and have occupied areas unsuited for commercial development. These areas are usually on lands subject to flooding and landslides, but even the major commercial centres and capitals have often been situated in geologically "unsound" regions. In an exposé better suited to the theme of the International Decade for the Reduction of Natural Disasters, Hardoy's talk went on to address many of the socio-economic and political implications of earthquakes, landslides, flashflood debris flows and hurricanes (surprisingly, not volcanic hazards), with specific case studies from Central and South America. I sensed a plea for assistance from the developed countries to assist in better planning and the integration of all sectors of the populace into new urban centres.

Lester D. Grant, Director of the Environmental Criteria and Assessment Office of the US Environmental Protection Agency commented on health effects associated with regional and global air pollution. Some involved increasing tropospheric ozone levels ("urban smogs") with ozone-induced health effects (and with associated co-pollutants); others involved the effects of decreasing stratospheric ozone and the increase of UV-B radiation (cancers/cataracts/crop damage/increased "weathering" of polymers and cultural materials). Acid aerosols and their relation to respiratory diseases were discussed (with the suggestion that acid aerosols were perhaps more important than previously thought in the cause and effect relationship attributed to smoke and SO_2 production in the London "smogs" of the early fifties). Beside the almost inevitable increase in mortality by heat-stress during a greenhouse-warmed summer, there are the more disturbing implications (in North America) of northward movement of arthropods and insects carrying Lyme's Disease, Rocky Mountain spotted fever, encephalitis, malaria and, possibly, Dengue fever. Lest these comments appear too alarming, Grant pointed out (and attached a rider to the written release) that these are personal views and should not be construed as official US EPA policy.

The final speaker was W.H. Mansfield III, Deputy Executive Director of the United Nations Environment Programme who gave a short address on strategies to cope with climate change. He pointed out that it was possible to develop major international agreements (the Montreal protocol was cited), but the lead time from recognition to implementation was long. (In the quoted example 10 years, with five of these devoted to the international agreements). Since changing climate is a man-made problem, and global in scope, it will need broad international agreement. Suggested methods involved increased energy efficiency, adjustment of the energy mix to less polluting fuels, and reconsideration of solar, wind, biomass, geothermal and nuclear options. Major efforts must be made in limiting deforestation and encouraging the planting of more trees. Technology transfer is essential, particularly in terms of fuel efficiency, and the reduction of CO_2 and other greenhouse gases. A key consideration must be in financial relief to the developing countries by means of monetary assistance and debt relief.

Following the formal presentations the sessions remained closed while 13 working groups discussed policy implications. Canadians co-chaired or chaired working groups on Urbanization and settlement and on Legal dimensions. Other working groups included Energy, Food security, Water Resources, Land Resources, Coastal and Marine Resources, Forecasting and Futures, Policy and Uncertainty, Industry, Investment and Trade, Geo-political issues, Communication and Education, and Integrated Programmes. After one and one-half working days the delegates emerged for a final "Concluding Session", chaired by Stephen Lewis.

This last session involved a panel summary with M. Masse (Canada), E.H.T.M. Nijpels (Netherlands), Y. Sedenov (USSR), J. Goldenberg (Brazil), C. Cissakho (Senegal) and G.E. Brown (USA). To me, the most impressive presentation was given by Nijpels, the Dutch Minister of the Environment, who stated "Climate change is a reality, and a new ethic is needed. We need to act now, since delay can be disastrous, and we need to act together. The industrialized countries have a special responsibility to reduce our levels (of consumption and pollution) to set an example." Several other speakers echoed similar points, and stressed particularly that technology transfer is essential between the developed and the developing world. Goldenberg made the point that mankind as a whole is responsible for global change; that "The agriculturalist cutting trees in the Amazonas Valley is contributing to a rise of temperature in Chicago as much as coal burning in the Ruhr contributes to sea-level rise in Bangladesh."

The Conference ended with the release and critique of a draft Conference Statement. The final document discussed by the assembly, although being a short condensation of the contribution made by hundreds of participants, is too long to be discussed in detail. I will however cite the first two paragraphs (which may still be modified by the time the final documentation is released).

"Humanity is experiencing an enormous, unintended globally-pervasive process whose ultimate consequences could be second only to a global nuclear war. The Earth's atmosphere is being changed at an unprecedented rate by emissions resulting from

human activities, fossil fuel use and the effects of rapid human growth in many regions. These changes represent a major threat to international security and are already having harmful consequences over many parts of the globe.

"The most far-reaching impacts will be caused by global warming and sea-level rise, which are becoming increasingly evident as a result of continued growth in atmospheric concentrations of carbon dioxide and other greenhouse gases. The best predictions available indicate potentially severe economic and social dislocation for present and future generations, which are likely to worsen national and international social tensions and increase the risk of conflicts among and within nations. It is imperative to act now."

Comment

As a geologist attending this conference, I appreciate that the major thrust was on the "Changing Atmosphere", but nevertheless, I was surprised that there seemed to be little geological input. Earth scientists capable of commenting on non-renewable energy resources, the proxy data record and different geomorphological processes, all of which materially effect (or have affected) the global atmosphere, were somewhat thin on the ground. Practically every working group had recommendations which impact on the Earth Sciences. Some of these include sea-level rise, the occupation of coastal lands, and the problem of contamination of coastal aquifers; reduction of the use of traditional fossil fuels, and potential increase of radioactive elements; modification of the use of inorganic nitrogen fertilizers; modification of agricultural practises (in a geomorphological context); making use of knowledge of the past (proxy-data); technology transfer; interdisciplinary approaches to the physical environment; protection of soils, tundra and wetlands; solid waste treatment and land disposal; location of hazardous sites to prevent urban build-up in these regions; and the identification of critical regions and river basins where changes in hydrological processes and water demand will cause serious problems.

My personal feeling is that earth scientists have a great deal to contribute to the Global Change story, and not the least of this is a good understanding of all past natural change before, and up to the time that mankind really started to modify the planet. This largely unwritten story is ONLY understood by geologists. Failure to take the natural record of the most recent geologic past into consideration in any kind of future scenario reduces the study from a work of science to some glorified model where too many parameters are simply not understood. Problems of human habitation in regions which will be adversely affected by global climate change falls directly under the mandate of environmental geology. Mankind's use of the energy minerals and in particular, the problems and promises of nuclear power, must have the input of knowledgable earth scientists. The global change train has already started to pull out of the station, and I get the feeling that the coaches are fully staffed with atmospheric physicists, chemists and computer modellers. I hope that the crowd of Earth scientists sprinting along the platform will manage to get onboard before it is too late!

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