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CLIMATE AND SOCIETY: LESSONS FROM RECENT EVENTS*

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MANY of the papers presented at the World Climate Conference considered climatic impacts on society by sectors of economic and social activity and also by world regions. This paper views the subject from a different perspective, one that first emphasises extreme weather events: blizzards, droughts, floods, tropical cyclones, tornadoes and storms. Then it considers the long-term human response to their recurrence. Thus, we do not study them as isolated weather events but as prevailing features of climate.

The research drawn upon has been a collaborative effort of many scientists, particularly from the geographical community. Among those who have participated in this work are I. P. Gerasimov and T. V. Zvonkova (1974), A. C. Mascarenhas (1973) and G. F. White (White 1974, White and Haas 1975, Burton, Kates and White 1978). Specifically, studies were conducted in some 20 countries and at 40 sites, and more than 5000 people who lived and worked in areas of recurrent climatic hazard were interviewed. Additional observations have been made since 1972 in Australia, the African Sahel, India, and the western United States (Kates, Johnson and Haring (1977)). From these studies we have tried to assess the hazardous aspects of extreme natural events, their broad impacts upon society and the ways in which vulnerability can be reduced.

Our studies have been further informed by the efforts of the Scientific Committee on Problems of the Environment (SCOPE), specifically its work on environmental impact assessment (Munn 1975) and on risk assessment (Kates 1978) and also its report on the Climate/Society Interface (Canadian Climate Centre *et al.* 1978).

KNOWLEDGE OF HAZARD

Impacts on society

The burden of natural hazard is primarily climatic in origin and it is increasing. In the advanced industrial countries of the world property damage is rising and great loss of life persists or increases in the developing nations of the world. These trends are expected to continue and perhaps to intensify.

At least three-quarters of the estimated $40 billion a year of global natural hazard costs originates from three major kinds of hazard of climatic

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origin: floods (40 per cent), tropical cyclones (20 per cent) and drought (15 per cent). This estimate includes losses of about $25 billion, and the remainder from costs of prevention and mitigation.

Each year, on the average, natural hazard claims the lives of the equivalent of a small city, some 250 000 people per year, 95 per cent of whom are citizens of poorer nations. This great inequity in distribution of deaths is reversed for property losses, 75 per cent of which occurs in wealthy countries. But proportionally the burden is still heaviest in developing countries, as shown in the comparative costs for the three great hazards (Table 1). This can be understood by noting that the absolute cost of drought in a wealthy nation such as Australia exceeds that of Tanzania thirty-fold, yet the impact on the national economy in terms of the proportion of GNP is reversed, with annual drought costs in Tanzania equivalent to 1·8 per cent of GNP and 0·10 per cent in Australia. Similar comparisons can be made between the costs of floods in the United States and Sri Lanka and for tropical cyclones between the United States and Bangladesh. In proportional terms, expressed as a per cent of GNP, climatic hazards have impacts on poor countries 20 to 30 times heavier than on rich countries.

TABLE 1. Selected estimates of natural hazard losses

					Losses and costs *per capita* at risk			
Hazard	Country	Total population (millions)	Population at risk (millions)	Annual death rate/million at risk	Damages losses ($)	Costs of loss reduction ($)	Total costs ($)	Total costs as per cent of GNP ($)
Drought	Tanzania	13	12	40	·70	·80	1·50	1·84
	Australia	13	1	0	24·00	19·00	43·00	0·10
Floods	Sri Lanka	13	3	5	13·40	1·60	15·00	2·13
	United States	207	25	2	40·00	8·00	48·00	0·11
Tropical cyclones	Bangladesh	72	10	3000	3·00	·40	3·40	0·73
	United States	207	30	2	13·30	1·20	14·50	0·04

Source: Burton, Kates and White 1978

The same inequality of suffering persists within countries. Landless labourers, old people, women and children were the major victims of the Bangladesh cyclone of 1970, debt-ridden farmers in the Nigerian drought of 1972, marginal people in the Kenya drought of 1970–71 and American Indians in a flood in the USA in 1972.

Basic processes

We think we understand the basic underlying process by which human society encounters hazard in its search for useful and purposeful utilisation of the resources of land and sea. The hazardous events are simply the extremes of the distribution of events that make possible our growing of food. There is only a fine line between the flood that washes a crop away and the rainfall that permits it to grow.

In order to reap the useful we adjust our society and economy to cope with recurrent extreme events by a combination of individual and collective action. When these adjustments are inadequate, or the extremes too great, loss of life and property occurs. In the most extreme cases we have disaster. Thus, the impacts of these natural events are joint outcomes of the state of nature and the nature of society. In this perspective a flood and a drought are relative phenomena.

There is some evidence that the long-term trend is for successful adjustment, that is a reduction in the damage from recurrent events whose frequency occurs on the average of about a human generation, but at the same time there is an increase in the catastrophic effects of those events of still greater rarity.

Reduction of vulnerability

We are substantially reducing the toll of climatic hazard. We do know how to make things better, how to reduce unwanted impacts in many kinds of situations. There are three basic strategies open to us: to reduce or prevent the climatic events, to limit the vulnerability and to prevent or mitigate the impacts. In general the broader the range of measures employed to reduce vulnerability the more effective they are. For example, comprehensive programmes employing a spectrum of adjustments limit the impacts of floods in the United States, water shortage in Israel and avalanches in Switzerland.

However, 'more' is not always 'better'. There are situations in which a society may actually be better off to suffer a rare or unexpected loss than to divert its scarce and needed resources to prevent such an occurrence. And there are common situations in which attempting to make things better may make things worse in the long run, a classic example being the use of levees for flood control. Such limited flood control frequently encourages an expansion in flood plain occupancy, thereby exposing more people and property to flood in the rare instances when the levee is overtopped. The water then trapped on the wrong side of the levee causes far greater damage than would have been the case in an unprotected flood plain. Such was the case in 40 per cent of the 'protected' flood plains inundated in the United States by Hurricane *Agnes* in 1972.

Inadequacy of knowledge

As in all scientific study, as these findings and insights accumulated we also began to learn where our knowledge was inadequate. Here are three examples of our ignorance that will surely relate to the entire range of climatic impacts we will study in the future.

(*a*) Reducing vulnerability in the face of inequality

We do not know how to reduce the harmful impacts of climatic events in the face of great inequality within and between social systems. Consider the conflicting interpretations of what happened during the Sahelian drought of 1968–1972.

According to the first and seemingly dominant view among scholars (Dalby *et al.* 1977), the Sahelian drought found the affected population more vulnerable to its impacts than in the past. It has thus been claimed that the Sahelian people are the victims of a colonial and neocolonial international, economic and technical order, one which increases their dependency and reduces their self-sufficiency by decreasing the area devoted to food crops, by draining off the agriculturally important labour supply by migration, by creating technical conditions for a rapid increase in population and livestock numbers and by adopting policies that favour the small urban elite. Proponents of this position of increasing vulnerability may emphasise one or another element: neocolonialism, population, land-use, technology and so on.

The competing view holds that the recent Sahelian drought with all its attendant difficulties saw a reduced vulnerability to drought than in past periods (Caldwell 1975). This occurred because the Sahelian nations could call upon the conscience of the world for assistance, upon extended families which were not entirely dependent on vulnerable crops or herds, upon modern medical care which controls the childhood disease epidemics that often accompanied famines in the past and even upon a rudimentary infrastructure and national organisation which were available, together with international aid to assist great numbers of people. Only where governments failed to act (as in Ethopia (Hussein 1976)) or in especially remote areas was there great loss of life.

Depending on which view summarises the actual Sahelian experience, strongly contrasting policy implications follow. The latter view, essentially the 'modernisation' thesis, appears still to dominate the development policies of the Sahelian countries themselves. Despite some effort to acquire self-sufficiency of food much, if not most, of the development effort is oriented towards improving accessibility of rural areas and towards land and water development – at a cost that makes a significant effort in export crops a necessity. At the same time the structural dependency of the nations involved has, if anything, increased over time and supplemental labour incomes have become increasingly important. However, if the former view, the 'underdevelopment' thesis, is correct many of the current and future programmes, well-intended as they may be, will only increase vulnerability to the next climatic fluctuation. Similar contrasting issues can be found elsewhere in Africa and also in Asia and Latin America.

(*b*) The role of perturbation in complex social systems

We social scientists share with the geographical scientists ignorance of the effects of perturbations on complex systems – in our case, social systems. Consider an example that contrasts with the Sahelian drought, the severe drought that occurred in California in 1976–1977. This seriously affected both urban and agricultural systems, but there were surprisingly modest overall repercussions. The trend toward self-sufficiency in underground water accelerated, urban areas succrssfully cut water use by upwards of 50 per cent, and, with some minor exceptions in certain crops and water using activities, a major disaster was averted.

In fact, a review of a series of disaster impact studies reveals that this pattern of successfully coping with perturbations is the typical pattern in an industrialised country such as the United States. Nevertheless, in recent years we have had the greatest flood in our history in terms of property loss, and we do not really understand the detailed factors that have separated successful dampening from amplification.

(*c*) Slow, pervasive, cumulative change

Finally, we do not understand how to deal with slow, pervasive, cumulative change such as might occur with future climatic change and currently does occur with erosion and desertification and persistent downturns in moisture availability. In all of the excellent documentation for the United Nations Conference on Desertification (1977) we could find only one study in which people subject to desertification were asked to comment on their own perceptions of its cause and manifestation (Malhotra 1977). This contrasts with our good understanding of people's response to more acute extreme events.

LESSONS TO BE DRAWN

There are three central lessons to be drawn from the experience with extreme events and from the discussions at this Conference. The first is the need to act upon what we already know, the second is to recognise fully the challenge of climatic impact analysis and the third is to understand the basic value judgements involved in responding to climatic information under conditions of uncertainty.

Acting upon what we know

Despite the great scientific uncertainties reflected in this Conference we already know much of value with which to enhance human security and make better use of climatic resources. We do not need to decide on the question of increasing, decreasing, or continuing variability. It is sufficient to note that much, if not most, economic planning in the world has been carried out with the current central tendency (averages or means) of climate together within an assumption of little or no variability. Nor is there need to estimate the probability of a melting of the Antarctic ice sheet and subsequent sea-level rise to observe the peril of the continued and rapid growth of settlement along the shore at less than three metres above sea-level. In the

United States, for example, there is a population the size of Boston occupying the three-metre zone in the stretch of coast between Boston and Washington and in the Bay of Bengal perhaps 15 per cent of the 90 million people of Bangladesh live in such an area. And we do not need to determine the regional impacts of a hypothesized one-degree change in temperature to observe that in many countries commercial non-food crops often pre-empt the best land and the best climate, relegating critical food production to marginal areas, and that access to technologies such as high-yielding, drought-resistant seed is often limited to the largest and wealthiest farmers.

Thus, a world climate programme needs to include from its earliest inception a major component, namely the distillation and synthesis of what we already know about climatic variability, extreme events, climatic resource areas and the range of potential human adjustment. If this were done just for the extreme climatic events, and if we acted upon what we already know, as is being done in some places, we estimate that the world death toll from flood, drought and tropical cyclones could be reduced by 85 per cent and the property damage by 50 per cent.

We must emphasise, however, that this is no small or unchallenging task. It is not a task to be relegated to an 'information applications office' or to the production of a set of accurate but sterile handbooks, such as can be found in the synthesis of agrometeorological data. Rather, it involves basic research into such varied processes as the perception of threat, the dissemination of warnings, the use of environmental data in the planning and the design of human settlements.

The challenge of climatic impact analysis

This Conference has many remarkable qualities, not the least of which is the initiative of the WMO and the organisers to extend the welcoming hand of collegiality to those of us in the human sciences and to propose a partnership for the joint solution of one of the potentially great questions of the human environment. Such initiatives are unfortunately rare in the house of science, and the atmospheric science community is again providing leadership for scientific co-operation between disciplines as it earlier provided leadership for international co-operation within its discipline.

It is easier, however, to invite a guest than to make him or her welcome, and easier yet than to share one's home. Considerable patience will be required to consummate this partnership, and such patience might be encouraged by recognising one great similarity and one great difference between the geophysical and human sciences.

First the similarity. It is common, though somewhat insulting, to use such terms as 'hard' and 'soft' science to describe differences between physical and social science, and one is struck by how difficult it would be to apply such terms generically in the context of our common subject – climate.

Indeed, in a very real sense there is a convergence of our common scientific problems.

Earlier I singled out three scientific problems that we scientists of society face in understanding climatic impacts: the absence of an accepted theory of social development; the failure to understand the effect of perturbations on complex social systems and our limited knowledge of human perception and behaviour in the face of slow, pervasive, but cumulative change. However, after a week of listening to the disarray of the atmospheric theory of forcing mechanisms, to the debate over the so-called 'robustness' of the atmospheric system and to the confusion of how to recognise the signals of slow, pervasive cumulative climate change, I do not feel 'soft' at all. Some of our understanding seems to be considerably harder than that of the physical scientists. For example, we understand the human causes of desertification better than the atmospheric causes and we have clearly identified a number of positive feedback loops that make things worse when one tries to make them better.

One must now have a strong awareness of the similarity of our problems, of the real challenge we share in understanding and acting upon climatic impacts. In the past this convergence has not been clearly recognised. Geophysical scientists expected and received from social and behavioural scientists highly simplified and relatively uninteresting attempts at impact analysis based on simple stimulus-response, deterministic, one-impact-parameter models drawing on weak correlations. No basic research effort to encourage and support impact assessment was developed, there were no observational networks put in place and there was no mobilisation of resources. In many instances 'impact assessors' were either viewed as helpful technicians or entertaining lunch partners but not as serious scientific collaborators. The impact assessment phase of the World Climate Programme will fail unless it is acknowledged that the problems are of wide scope and that numerous disciplines including the human and physical sciences must converge and collaborate for their solution.

Let us recognise that the differences between our disciplines may raise difficulties over collaboration even in matters of common interest and responsibility. There is no straightforward disciplinary and institutional development of economists, political scientists, psychologists, and sociologists interested in questions of climate. Only 'human geographers' have some basic disciplinary encouragement in that direction – that is why we are so well represented at this Conference. Indeed, the disciplinary structures of most of the social and behavioural sciences serve to draw them away from an involvement in climate impact studies. Thus a special effort will have to be made to create new incentives for attracting and holding the interest of bright social and behavioural scientists. For many of us here, whose lives revolve around understanding the oceans of air and water, it is difficult to imagine a partnership with those for whom the interest is at best peripheral.

We will have to move towards the creation of a human-oriented atmospheric science if our programme is to succeed.

Climate choice as evaluative judgment

Finally, I wish to dispose of a certain fallacy before we enshrine it as a myth. Implicitly, and occasionally explicitly, the suggestion has been made here that the end result of a world climate programme would be to have such scientific understanding of climatic change, variation, and impact that rational, objective decisions can be made. We actually know a great deal about decision-making and what we know does not suggest that this simple view, often labelled as the 'economic' or 'expected utility' model, will prevail. The great choices that our emerging climatic understanding will pose will always be made under conditions of uncertainty. They will be made in the face of conflicting information by nations and individuals with conflicting goals. In the face of such uncertainty choices that depend on climate will be evaluative rather than cognitive and we would be well-advised to consider such value judgements directly.

For a long time to come our understanding of the benefits and costs of various choices will, of necessity, be clouded and limited. Are there any transcendent, overriding values that should not be determined by standards of *efficiency*? Let me suggest one for discussion.

In a world where we can fashion Concordes and Tupolevs, spray cans and military weapons, minimum security from disaster should be a *human right*. The last great subsistence crisis in the Western World took place in 1816 (Post 1977); no one dies of drought today in dry Australia and upwards of a million people are now routinely evacuated in the coastal plains of the United States. There is much in nature beyond our control, but the death rate from climatic disaster can be drastically lowered. There is no rational calculus that will demonstrate the value of the 150 000 Bangladeshis that might have been saved in 1970, or of the tens of thousands in Ethopia in 1972. There is only a powerful moral value that declares that if such deaths are unnecessary and preventable then they are unacceptable.

Currently we have no completely rational or objective way to foresee the future, yet for a week we have discussed the climatic impacts of the year 2000, 2050, or even 2400. Proper economic analysis always discounts the future against the present and even at the smallest reasonable discount rate the future quickly becomes valueless. But unfortunately we do not behave as if we believed in such analysis. The concern for future generations (as well as for ancestors) is a part of our common human heritage. How to assert this value, how to recognise it in a rational calculus that denies it, is a troubling and vexing issue.

Finally, perhaps the most troubling of all to incorporate into our analysis is our ambivalence towards nature, to love it and reject it, to know it and control it. If it will be shown that our burning of fossil fuel will, in the course of a handful of generations, create a climate unknown for the last two million years of existence, can we change that climate with moral impunity? Whether nature is 'robust' or not, are there no constraints other than practical considerations to our right thus to perturb our environment?

There is a healthy dialectic between *fact* and *value*. It is to be hoped that fact will inform our values and narrow the dilemma of our choices. But in the years ahead, of trying and difficult research, of confusing international and interdisciplinary collaboration, of fluctuations in the support and attention our programme will receive, it will be our *values*, our common outrage at needless death and destruction, our common concern for the future and for future generations and our common love for the nature we struggle to understand, that will bring us together, that will keep us together and that will carry forward this programme.

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