SCOPE 27 - Climate Impact Assessment

Kates, R. W., J. H. Ausubel, and M. Berberian (eds.), 1985. Climate Impact Assessment: Studies of the Interaction of Climate and Society, ICSU/SCOPE Report No. 27, John Wiley.

10 Health, Nutrition, and Human Development

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10.1 INTRODUCTION

The climate that we know, which has slowly developed over millions of years, is in general terms optimal for human life. It ought to be, as life (one of whose end products is human life) has developed, again over millions of years, within the constraints set by climate upon it.

Dialectically, life has also changed climate, as exemplified by the appearance of free oxygen in the biosphere through the action of photosynthesis. The subsequent appearance of that peculiar life form, man, has provided many more examples: changes in albedo, in vegetation and in water distribution, and industrial and other pollution—all of which modify climate.

Humans are an efficient and complex life form, but these very qualities produce in them great vulnerability to factors which alter their habitat beyond a very narrow range within which their demands are optimally satisfied. The fact that the human body is kept within a very narrow temperature range, for example, greatly increases its energy demands, but provides the background for a highly developed physiology, and offers a much more efficient use of energy through an oxidization process of high complexity. These high energy demands are a handicap for individual and group survival, and so is the outside temperature range within which humans must live, although this latter factor has probably been overestimated, as Darwin reflected when he observed the Fuegian Indians in the Beagle Channel.

When it comes to a discussion of climatic impacts, few, if any, societal effects can surpass in value, measured in whatever form, the chance to live and be healthy. Death is generally acknowledged to be the worst fate that an individual can suffer, and that one can inflict upon others; and the sensations of illness are among the most salient that an individual can feel.

This paper seeks to explore the most profound ways in which climate affects human life—by ending it in individual cases and by reducing it in aggregate below what can be expected from genetic potential —and human health, by increasing illness episodes beyond an acceptable minimum, and by making the outcome of some illnesses death, rather than recovery.

There are three general, related categories in which climatic factors manifest themselves in human health and wellbeing: through direct effects on individual health, through population movements and behavior, and through effects on diet and nutritional level.

With respect to the first category, consequences of climate can be such phenomena as sunburn, heat stroke, heat cramps, changes in sleep patterns, frostbite, drowning, and a host of other conditions, all of which can produce incapacitation, and some of which can eventually result in death. The literature on health impacts of climate (biometeorology) has usually focused on these immediate effects. Weihe (1979) has published a thorough review (see also Landsberg,1984). It is clear from these reviews that climatic factors, defined this way, produce relatively few deaths and illnesses. For example, 1181 and 618 deaths were attributed to the severe summer heat waves of 1966 in New York and St Louis, respectively (Schuman,1972). The method used to make calculations probably overestimates the role of climatic factors, as it assigns to climate all the deaths that exceeded a historical baseline. The populations at risk were about 8 million in New York and about 700,000 in St Louis, and most of the victims were elderly.

Climatic impact, of course, can be measured through human effects other than death or illness, for example, by indicators of migration or social disruption. Political upheaval, riots, and increases or decreases in crime rates may be associated with climatic extremes, although we have to leave aside the extremely value-laden question of whether these consequences are `good' or `bad'. Substantial movements of population may also be triggered as people abandon their homes and seek new locations, value judgments again being suspended here. These climate-induced political, behavioral and migratory outcomes have been explored as part of research on CO_2-induced climatic change (Meade, 1981) and under the heading of climate and human history (Rotberg and Raab, 1981).

This paper will not deal with these two categories of climatic impacts on human health. This is partly because the questions have been heavily examined, at least in the first case. More so, it is based on the judgment of relative importance of impacts. The climate-related mechanism which affects mortality and morbidity most is the drought-induced shortage of foodstuffs, which leads to malnutrition and a host of malnutrition-related conditions. Storms, floods, snow, lightning, and frost can be spectacular, but the human loss and illness that they cause is typically small* compared with that caused by chronic malnutrition and acute starvation. The critical links to explore are not the direct ones between climate and health, but the chain extending from lack of water for growth of food to inadequate diet, which produces in humans a vulnerability that makes them prey to infections and parasitic diseases of various sorts and stunts body growth. Compare the losses from a heat wave with the certainly more than 100,000 deaths—we will never know the exact figure—mostly of children, associated with the drought during 1973 in Chad, Mali, Mauritania, Niger, Senegal and Upper Volta, where the total population at risk was only about 15 million. Demographers can easily calculate the number of `life years' lost when an infantile or an elderly population is struck, and the mechanism that we are stressing is selective in striking the former group.

Drought can be seen as a long-term phenomenon or a seasonal one. The repetitive pattern of seasonality would assign to it a label of `normality', which makes its effects appear less salient than `abnormal' droughts. Seasonality has been studied as a generator of death, illness and human suffering in various places (Chen *et al.*, 1979; Chambers, 1981; Wisner, 1980–81) and it also produces hazards other than those due to drought—those of the `wet season' being caused by increased energy demands for agricultural production, less care of children and increased morbidity (Chambers, 1982). In any case, as we shall see later, the development of productive forces would enable humans to do away with the consequences of either seasonality or long-term drought.

Ultimately, the underlying question that has to be answered in looking at the link between climate and human health is `Is it climate, or is it society, or what combination of both that we are seeing?' The way to explore this question is through historical and cross-cultural comparison. Specific climatic perturbations of identifiable magnitude can be studied in their impacts on societies at different stages of development of their productive forces, and on societies which use different criteria in the allocation of their collective surpluses.

* The two great twentieth-century exceptions to this statement are Indian and Bangladeshi experiences with typhoons, and Chinese experiences with floods. A 1970 typhoon caused perhaps as many as a quarter of a million deaths in Bangladesh and India (Wisner, 1978); one in 1977 in India caused 100,000 deaths (Whittow, 1980). The 1931 Hwang Ho floods in China may have caused as many as 3,500,000 deaths (Whittow, 1980).

The general argument or hypothesis is that climatic damages to life and health decrease as the world's productive forces increase, as man's mastery over his environment improves. At the broadest level, the evidence for this line of argument is the increase in the world's human population, from 2 to 10 million around 10,000 BC, to about 750 million in 1750, about 1200 million in 1850, about 2500 million in 1950, and about 4500 million in 1980. Corresponding to this general increase in population is an increase in life span, to 60 years in the most advanced countries of the world by the turn of the twentieth century, and over 75 years today in the best circumstances.

The spatial diffusion of the human population is further evidence. Our ability to colonize almost the whole of the planet and to visit other celestial bodies is due to the ability to carry with us that particular range of environment in which we can survive and develop capabilities. Compared with most other mammals, humans have a low fertility, their offspring are helpless for a long period, and they reach sexual maturity relatively late. Thus, reproduction is a weak link in the process of maintenance of the human species. Yet, humans, through their mastery of nature, have derived an enormous strength beyond their biological capabilities. Control over the temperature affecting the species through the use of clothing, shelter, heating, cooling, ventilation, and a host of other measures allows humans to experience thermal variation under conditions which are usually quite favorable. Certainly air temperature, once an important determinant of our habitat and probably second only to the need for finding nutritional energy, now plays a minor role in constraining human activity.

Thus, the overall picture for human society appears to be one of strengthened human hold on the planet and decreased vulnerability to environmental factors, other than those we ourselves create or intensify. Why then is there the continuing spectacle of massive mortality and morbidity `due' to droughts and other climatic anomalies? Why is the development of productive forces an uneven bulwark against climatic variability and change?

This paper seeks to establish tentative answers to these questions and to lay the basis for more careful argument in the future. The presentation is divided into four parts. The first section addresses the question of what exactly is the number of people who die or are taken ill `due' to drought or other climatic phenomena. The second section sketches a case study, of comparative impacts of climate on health in Cuba and Haiti, which could shed light on the larger issues. The third section evaluates the capacity of the world food system to counter climatic aggression. The fourth section offers proposals for improvements in the measurement of climatic impact on life and health.

10.2 MEASURING MORTALITY, MORBIDITY, BODY GROWTH, AND PSYCHOMOTOR DEVELOPMENT

To estimate the impact of climatic phenomena, it is necessary to have a certain `baseline' of data against which specific climatic impacts can be compared. With respect to health, the fundamental indicators are mortality and morbidity, along with measurement of body growth (a fairly specific and quite simple indicator of what must be the most widespread health consequence of climatic anomalies: drought-induced malnutrition) and psychomotor development. Reliable historical trends for these phenomena are very scarce, cover a very small percentage of the world's population, and should in any case be treated with much caution.

The phenomenon of mortality, which is the most `exact' of the four indicators (death being a one-time, easily definable and highly salient circumstance), has fairly reliable quantitative series for some countries of northern and western Europe since about 1800. The description of cause of death, which is very important, as it should help to separate climate-related deaths from the rest, depends heavily on the state of medical knowledge and the bias of medical culture, both subject to variation over time. With advances in the structuring of modern states, reliable series have appeared for an increasing number of countries. For example, the US series are reliable since about 1900. The following review of the current status of registration of deaths worldwide thus also gives an idea of what was happening even in the most advanced countries of the world some generations ago.

Morbidity is much more difficult to assess, due partly to the potentially repetitive and much more ambiguous and culturally defined nature of the phenomenon. A good registration would imply a high medical coverage of the population, which does not exist now for most of the countries of the world. As an example, one-third of the population of Brazil today has no access whatever to medical care. In the area of morbidity, medical bias will also play a role.

Body growth is quite problematic, and psychomotor development even more so. It is not complicated to measure body parameters such as height, weight, and head, arm, leg circumference, and various psychomotor indices. Some physiological indicators of nutrition (onset of menstruation in women, for example) are easily measured or inquired about, and the results plotted against the chronological age of the subjects. Small size and degrees of psychological retardation can be taken as indicators of malnutrition. Unfortunately, measurements have to be undertaken on some sort of probabilistic population sample, for which techniques of evaluation are fairly recent, or in conjunction with a population census which, if it exists, is rarely up-to-date in a drought-stricken country, and which does not usually gather this type of information. There is also a theoretical question with regard to psychomotor development which compounds the problem: what constitutes a ›normal' development, against which deviance can be plotted?

10.2.1 Current Worldwide Measurement

The current worldwide measurement of the parameters of mortality, morbidity, body growth, and psychomotor development is not encouraging. There are standard demographic and epidemiological reference books published by various international agencies in which mortality and morbidity data are collected,* but these bulky and impressive tomes, with table upon table filled with rows and columns of numbers, must not be taken at face value. Much of the information presented in them is inaccurate, and it is more inaccurate in those parts of the world where climate would seem to impact most upon human populations. This relationship, which is a causal one, will be developed later on.

This sorry situation is not the fault of the international agencies which present the data. They are at the mercy of national governments which collect the data and transmit them to the agencies. For mortality the sources of these data are usually the country's records of vital statistics, and for morbidity, the country's health care systems. Little systematic data for body growth is currently being published.† The existing data are, furthermore, flawed by a selective underregistration of deaths (births are much more accurately registered) and by a massive underregistration of prevalent illnesses on the part of health care systems which have a very low coverage of population. Prompt improvement in this situation seems unlikely, and indeed the opposite phenomenon seems to be taking place: the current and deepening crisis of the world's economy is `underdeveloping' many countries, with direct consequences in their data collection systems (Escudero, 1980).

Quality of statistics is related to a country's overall social fabric, which cannot change rapidly even in the best of circumstances. There are also sometimes political implications from an improvement in the quality of health care figures; for example, the infant mortality rate in Nicaragua in 1966-67 was not 43 per thousand but approximately 126 per thousand; El Salvador's infant mortality rate at the same time was not 63 per thousand but approximately 118 per thousand. The former figures were gathered from Vital Statistics, reported by the countries' governments and transcribed in the relevant United Nations Demographic Yearbooks; the latter were calculated using alternative demographic methods for mortality data collection and analysis (Behm *et al.*, 1976,1977)—the `indirect methods'.*

* These are: the *Demographic Yearbook*, United Nations, New York; and three World Health Organization (Geneva) publications: the *World Health Statistics Annual*, the *World Health Statistics Quarterly* (until 1976 the *World Health Statistics Report)*, and the *Weekly Epidemiological Record.*

† Cuba appears to be the only Third World country that systematically publishes body growth data with nationwide coverage (see Jordán, 1979).

Table 10.1 Comparison of infant mortality rates in various Latin American countries provided by official statistics and by alternative methods

Country	Period	Official infant mortality rate (per thousand live births)	Infant mortality rate by other methods* (per thousand live births)
Argentina	1966	54	54
Bolivia	1971–72	–	161
Chile	1970	79	79
Colombia	1968–69	70	100
Costa Rica	1968–69	65	70
Cuba	1970	36	38
Dominican Republic	1969	62	110
Ecuador	1969–70	81	104

El Salvador	1966–67	63	118
Guatemala	1968–69	92	110
Honduras	1970–71	36	115
Nicaragua	1966–67	43	126
Paraguay	1967–68	44	64
Peru	1965	74	153

* From various `indirect methods'. See Behm *et al.* (1976, 1977).

Source: Escudero, 1980, 423.

Fortunately, the last decade has produced great advances in the study of mortality and fertility. The already mentioned `indirect methods' have produced estimates of mortality, especially infant mortality, which for many countries revise upward drastically the figures published in the international reference books. Examples of this revision for Latin American countries, which are by no means those with the worst statistics, are shown in Table 10.1. For the countries whose data are published in the reference books, one must take into account a substantial underregistration of impacts, climatic or otherwise. In the case of malnutrition the situation is especially serious, and those population groups which suffer most (infants, young children, the rural population) are those for whom the quality of data is worst. Overall, a significant proviso has to be made: if the structural factors which cause the poor quality of the data are more or less stable, the data can still show trends and can indicate, qualitatively if not quantitatively, the character of a given impact.

* For examples of the use of these, see Brass *et al.*, 1968; Sullivan, 1972; and Brass and Hill, 1973.

In terms of knowledge of mortality, Latin America is generally better off than Asia or Africa, where climatic impacts may be presumed to be more severe and where data usually range from very poor to nonexistent. An attempt to appraise the impact of the Sahel-Ethiopian drought of 1972 in terms of morbidity and mortality showed that the area of uncertainty was enormous. The dictum that the bigger the problem the worse the data, and that the worst problem might not produce any data whatever, was exemplified by the way the Ministries of Health of the countries concerned viewed the famine in their midst. The 1972 `Rapport sur l'activité des services de santé' of the Ministeré de la Santé Publique et des Affaires Sociales of the Republic of Niger made no reference whatever to malnutrition. The Republic of Mali's health report for 1974 did not mention malnutrition (Imperato, 1976). The morbidity statistics of the Republic of Chad in 1974 quoted malnutrition as being 1 percent of the pathology observed, as reported in the *Annuaire du Tchad*, Vol. 1, Chapter 4, `La Santé'. For a further discussion of this, see García and Escudero (1982).

The worst case with regard to mortality data would be no data at all, although it might be argued that complete absence of data at least does not mislead the investigator. The latest *World Health Statistics Annual* (1980) has no data on causes of death and no rates for such countries as China, India, Pakistan, Indonesia, the Philippines, Brazil, Bolivia, Haiti, Nigeria, Egypt, Sudan; in total for about two-thirds of mankind. In a review of most Asian countries, it was estimated that only five have `reliable' vital registration statistics, including determination of cause of death: Hong Kong, Japan, Singapore, the Philippines and Thailand (Arriaga, 1979). Even in these five, the Philippines and Thailand have a high degree of underregistration of deaths, and a low quality of determination of cause, as shown by the fact that 50 percent of Thai deaths (themselves underregistered) are coded of `ill defined' cause.

Records of morbidity are similarly troubling. The vital and health statistics of a country with good records by Third World standards, Mexico, showed that from 1967 to 1972, 14,725 deaths were reported from tetanus, while morbidity records showed only 5522 notifications of the same disease (Briceño *et al.*, 1979). The omission percentage of notification of measles, an easily diagnosable disease, ranged from 64 percent in 1971, through 63 percent and 50 percent in 1972 and 1973, to 64 percent in 1974 (Crevenna, 1978). The situation of most countries whose data are published in the reference books is even worse than this. As is the case for mortality, most of the countries of the world do not publish and basically do not know their prevalent morbidity.

Body growth, which is a simple and fairly reliable indicator of both chronic malnutrition and acute starvation, especially in children, is the least complete of the three indicators for which some bulk data are available. No data of this type are systematically published.* Nutritional assessments can serve as a proxy in certain cases, but these are carried out on an extremely unsystematic basis, with methodological discrepancies.

In summary, we know a great deal about the two thousand-odd lives lost in the Netherlands floods in 1953, or the few dozen deaths in the US heat wave of 1979; we know much less about the several tens of thousand lives, give or take a few thousand, lost every decade in typhoons in Bengal. Of the 1976 drought in Europe we can say with certainty that no lives were lost; we have a hazy notion that a few hundred thousand deaths took place during the Sahel and Ethiopian drought of the early 1970s.

10.2.2 The Problem of Recording Causes of Death

For countries that publish records including cause of death, a significant bias in registration appears. Some climatic phenomena, such as floods and heat waves, produce straightforward causes of death —drownings and heat strokes, respectively. Drought, in contrast, is mediated by malnutrition, which leads to subtle forms of bias. These pertain to the routine for selection of cause of death and to the view of malnutrition which is dominant among the medical profession. It is important to keep in mind that the medical profession is charged with the responsibility for recording death and has a large hand in designing the methodology regarding it.

Deaths worldwide are assigned a `basic cause' through the use of the `Rules for Selection of Basic Cause', which are stated in the Ninth Revision of the *International Classification of Diseases* (ICD). These selection rules are applied when more than one cause of death appears on the death certificate, a fairly common circumstance. Malnutrition hardly ever acts alone; it usually coexists with an infectious process or with a parasitic disease, and in any case is not easily perceived by physicians. When malnutrition and an infectious-parasitic disease both appear on a certificate, the relevant rule for ›selection of basic cause' of the Ninth Revision of the ICD (currently in use, with a preliminary revision scheduled for 1984 and no implementation of changes scheduled) states that only the infectious-parasitic disease and not malnutrition should be coded. Thus, malnutrition enters the limbo of non-events. The causes for this curious bias of the ICD, which goes against current knowledge of the malnutrition –infection interaction, lie partly in the convenience of simple explanation and partly in the training of medical professionals, who prefer to explain the world in terms of anatomy and microbes than in terms of food or of sociopolitical systems.

* Cuba would appear to be an exception to this. For a compilation of body growth data, see Eveleth and Tanner, 1976.

Another subtle form of bias affects both physicians and laymen and makes for further underestimation of both mortality and morbidity caused by malnutrition. Perception of illness implies some sort of deviance from the normal. For example, we would not be so complacent with depression among the elderly if this condition were not so prevalent. Similarly, the spectacle of children with stunted growth and bloated bellies, or of emaciated adults, is ›normal', i.e., usual, with the massive chronic malnutrition which usually accompanies prolonged droughts, and is therefore not remarkable. So, it is rarely noted on death certificates. For an expansion of the above arguments, see Kotliar and Escudero (1974), Escudero and Kotliar (1975), Escudero (1978), Escudero (1980), Sabelli (1981), García and Escudero (1982), and Escudero (1984).

The magnitude of this underestimation of malnutrition as a cause of death by 'official' health statistics systems can be considerable. For Mexico, circa 1975, it was estimated that malnutrition caused approximately 70,000 deaths annually, whereas that country's vital statistics (as reported in the *World Health Statistics Annual 1973-1976)* gave a figure of 6498 deaths for 1973 (Escudero, 1984).

10.3 BOTH SHORES OF THE WINDWARD PASSAGE: A CASE COMPARISON

The Windward Passage is a narrow strip of ocean which separates Cuba from Haiti. At its narrowest point it is 90 km wide. Climate on the two sides of the Passage is fairly similar; droughts, floods, hurricanes, and other climatic disturbances occur on both shores of the Passage with more or less the same frequency and intensity. Yet the Windward Passage separates the greatest mortality and morbidity differential in the Western Hemisphere. Proving this point, nonetheless, involves certain difficulties. As mentioned above, where health is bad indeed, there are few or no statistics to prove the fact.

Cuban health statistics were poor prior to the 1959 revolution. For the period 1955-60 it has been estimated that underregistration of deaths was approximately 45 percent (Alvarez Leiva, 1964). Coverage of health services was very spotty and was centered on the cities of Havana and Santiago de Cuba. Beginning about 1963, great improvements started to appear in the vital and health statistics of Cuba, illustrating again that demographic and health statistics are rarely healthier than the social fabric that produces them. A very significant reduction of illiteracy and unemployment, and a great expansion in the country's health services, produced as a byproduct great improvement in Cuba's vital and health data. A health care system was developed with total coverage of the population: 98.3 percent of births took place in hospitals in 1979 and the number of prenatal consultations per birth was 11; there were 4.5 annual medical and 0.9 dental consultations per inhabitant in 1979 (Ministerio de Salud Pública, República de Cuba, 1974, 1980; Puffer, 1974; Rojas Ochoa and Sánchez Teixidó, 1977; Ríos Massabot, 1981). These standards are comparable with those in the richest countries of the world.

What the Cuban data show now is a demographic and morbidity profile that is no different from that of European countries, Canada, Australia, or the United States: for 1980 a crude birth rate of 14.1 per thousand, an infant mortality rate of 19.6 per thousand (Ministerio de Salud Pública, República de Cuba, 1981); a life expectancy at birth of 73.5 years *(World Health Statistics Annual, 1980);* the virtual eradication of mortality due to diphtheria, measles, whooping cough, tetanus, malnutrition, and meningitic tuberculosis; and the eradication of malaria, polio, neonatal tetanus and human rabies. The so-called diseases of civilization—cardiovascular, cancer and suicide—have come to the fore. Cuban mortality is the lowest in the Western Hemisphere excepting the United States and Canada.

Haitian vital and health statistics are virtually nonexistent, but from various disparate sources a picture can be built of a 'constant catastrophe'. The Haitian birth rate is estimated at 37 per thousand. Haitian mortality appears to be the highest in the Western Hemisphere. The infant mortality rate has variously been estimated at 98–300 per thousand; life expectancy is estimated to be 50 or 51 years (King, 1978). As to nutrition, a survey undertaken by the US Agency for International Development with the Bureau de Nutrition d'Haiti in June–September 1978 showed that 73 percent of children were malnourished, of which Grade 3 (a very serious condition) accounted for 3 percent (Graitcer *et al.*, 1980). It has been estimated that 400,000 children under age 5 may be in the second or third degrees of malnutrition (Titus, n.d.).

Compare the situation in the Nord region of Haiti with that of Guantanamo Province, Cuba, 90 km away. The Haitian region comprises the provinces of Nord-Quest and Cap-Haitien. No separate mortality or mobidity statistics for this region exist, but different malnutrition surveys have shown a high prevalence of malnutrition among children: Grades 2 and 3 malnutrition accounted for 17.5–35.2 percent and 5.6–16.3 percent, respectively (Titus, n.d.).

Taking Haiti as a whole, 60 percent of all deaths appear to occur among children of less than 5 years of age (King, 1978). A comparable percentage for the province of Guatanamo, Cuba, is 14 percent, where the infant mortality rate (well recorded) is of 24.1 per thousand (Ministerio de Salud Pública, República de Cuba, 1981).

These two settings, geographically close and socially distinct, provide a laboratory for the study of climate's relation to human health. How would climatic phenomena of the same magnitude affect life and health in Cuba and Haiti? It would be interesting to compare, for example, the impact of an `average' hurricane on both sides of the Passage, to examine the relative quality of the emergency response apparatus, the possibility of evacuating population and livestock, the preparedness of the health care system in an emergency situation, durability of housing, capacity for delivery of relief to the affected population, provision of food and shelter, and so forth. Such a study, which would constitute a particular instance of methodology to study climatic impact, would be likely to show damages in Haiti much higher than those in Cuba, and societal response much weaker. It might remove from `climate' much of the blame that it usually gets in naive approaches to climatic damage assessment. A study of comparative malnutrition associated with drought would likely lead in a similar direction.

Just as cross-cultural studies can shed light on the mechanisms which connect climate to human health and wellbeing, so can historical studies within a culture. Warrick (1980) has examined a hypothesis of gradual `lessening' of the impacts of drought in the Great Plains of the United States. Additional interesting cases might include Ireland, where the subsistence crisis of the 1840s led to massive starvation and migration (Willigan, 1977), and Russia, where the great famine of 1891–92 was set off by climatic conditions comparable to those experienced more recently (Robbins, 1975).

An outcome of these studies should be a better vocabulary for describing the connections between climate and health. Even tentative exploration provides a strong argument against saying that a drought or a hurricane in Haiti `caused' so many deaths, so many illness episodes, and so much malnutrition. If climate is not the cause, or is just the eventual trigger of a series of linked causes, should not analysis be directed at other causes which, unlike the proverbial weather, can be modified? A rapid view of the world food system and its capacity to counter damages attributable to climate is thus in order.

10.4 THE WORLD FOOD SYSTEM—ITS CAPACITY TO ABSORB CLIMATIC PERTURBATION

If assessed globally, the productive forces that the world has developed today to feed its population are ample. Indeed, there is `slack' of such magnitude as to minimize—in some cases out of existence—the result of any climatic anomaly that is likely to appear in the near future. In 1960, calculations were made that by the year 2000 a world population of 6.5 billion (a 50 percent increase over current population) could easily be fed. The premises behind this calculation were that the area cultivated in 1950 could be doubled or even tripled, and that with `know how' available in 1960, yields of 3–5 tons of grain per hectare could be achieved (Buringh, 1977). An advisory group to the US President calculated in 1967 that 19 percent of the planet's surface was under cultivation, but that the potentially cultivable areas were 24 percent *(The World Food Problem*, 1967).

More recent studies have estimated that a maximum use of photosynthesis for the production of grain would yield about 50 billion tons of grain per year (Buringh *et al.*, 1975; Buringh and Van Heemst, 1977). This is about 43 times what is currently produced, and would satisfy—using standards which have been shown to be adequate for the population of China—a human population in the planet which is 55 times larger than the current one (Escudero, 1983). It has further been calculated that global eradication of malnutrition—that is, the compensation of a daily deficit of about 350,000 kilocalories —would mean redistribution of 3.8 percent of the world's available cereals. In economic terms, this amount is equivalent to 2.4 percent of the gross national product (GNP) of `developing' countries and 0.3

percent of the world's GNP, used to purchase grain (Reutlinger and Selowsky, 1976).

At the national and regional level, the question of potential food self-sufficiency is more difficult to assess. However, case studies of countries such as Bangladesh, whose name is synonymous with malnutrition, show that the country produces food in excess of basic nutritional needs, and that the prevalent malnutrition can be explained only in terms of its social and economic structure (Hartmann and Boyce, 1979).

Thus, for the globe and for most regions the leeway in food production to compensate for climatic damage is enormous. The facts that food production is not geared primarily to satisfy the needs of all the world's people and that abundant production coexists with massive malnutrition, due to climate or not, can be exemplified by the production of animal protein by the world's food industry, especially its most `modern' segment.

10.4.1 The Animal Protein Diversion

The amount of food that is diverted into production of animal proteins with no nutritional justification is an example of how our productive forces are not geared to supplying human needs, among them the needs created by climatic perturbations.* US consumption of animal protein increased from 55 pounds per person in 1940 to 117 pounds in 1972 (García and Escudero, 1982). This hyperproteinization of diets may in itself be harmful to health; the fats which accompany animal proteins have a causal role in the production of atherosclerosis. More important is the fact that from five to ten units of vegetable energy are needed to produce one unit of animal protein energy. A study of diets in the People's Republic of China suggests that the Chinese population is adequately fed with 450 pounds of grain per person annually, of which 350 are consumed directly and 100 are given to animals as fodder (Mayer, 1976). Currently, an enormous quantity of grain, about 490 million metric tons annually or about 43 percent of the world's production, is given to animals as fodder (FAO, 1977). These animals, or their produce, are going to be eaten by those who can pay for such foods as animal proteins and fats—the rich countries of the world, or the rich minorities in poor countries. The amount of grain used as fodder, using Chinese standards of human consumption, could provide food for 2000 million people, or 40 percent of the world's current population (García and Escudero, 1982).

* For criticisms of the organization of the world food market and its irrelevance to human needs, see George, 1977; Lappé and Collins, 1977; Groupe d'Information Tiers Monde, 1978; Tudge, 1979; Escudero, 1981.

Two additional points should be considered. The first is that by far the prevalent human malnutrition in the world is not due to a specific deficiency of proteins or animal proteins, but to a general deficiency of energy, that is, calories. To illustrate, a nutritional survey in 7000 Indian homes showed that 50 percent of those who had energy deficiencies also had protein deficiencies, whereas only 5 percent of those who had no calorie deficit showed a protein deficit (Sukhatme, 1970). Thus, while there have been frequent recommendations to cover protein needs, it seems unlikely that a food intake that is sufficient to cover energy needs might be insufficient to cover protein needs (UN World Food Conference, 1974). Moreover, if protein above a minimum is given to a malnourished person, it is not utilized as such, and is instead burnt as energy. This relationship between protein and calories leads to a re-evaluation of the nutritional advantages of traditional diets, such as the Mexican maize and bean combination, which provides at much lower cost an overall balance of essential amino acids from vegetable sources.*

The second point is that the emphasis on proteins, especially animal ones, stems from outdated sources. The historical origins of the emphasis on protein were some thorough epidemiological studies on human malnutrition, undertaken in West Africa in the 1930s. From a dietary point of view, West Africa is an exceptional region: the staple foods are roots, cassava, plantain, and breadfruit, with an exceptionally low protein content. The malnourished population exhibited a specific protein deficiency which the researchers baptized `kwashiorkor'. This deficiency is rarely seen elsewhere in the world to such a degree. Indeed, it can now be said categorically that specific protein deficiencies are a rarity in the epidemiology of malnutrition. Nevertheless, the Protein Advisory Group of the United Nations took up the emphasis on protein as the nutrition problem of the world, and it has taken many years to reverse this trend (McLaren, 1974).

Dietary requirements for protein have been revised downward in recent decades. The US Food and Nutrition Bureau suggested 70 grams of protein daily per adult in 1942. By 1968 these requirements had been reduced to 65 grams, and by 1974 to 56. British standards asked from 66 to 146 grams in 1950 and from 68 to 90 grams in 1969. By 1975, Canadian standards asked for 56 grams and West German ones for 63 grams.* A joint FAO/WHO ad hoc committee recommended 44 grams in 1973 (FAO/WHO, 1973).

10.5 PROPOSALS FOR IMPROVEMENT OF MEASUREMENTS OF CLIMATIC IMPACT ON LIFE AND HEALTH

This section presents proposals for improving the measurement of climatic impacts with respect to mortality, morbidity and body growth. A previously cited work (García and Escudero, 1982) recommends grading such proposals according to feasibility, that is, the human, material, temporal and political inputs needed to implement them. This approach is repeated here to some extent. We start with approaches which demand a low input of resources.

10.5.1 Mortality

For acute climatic impacts, causing a sudden loss of life in countries with a weak information infrastructure, a `journalistic' approach, combined with longitudinal and retrospective case studies, would initially be useful. The margin of uncertainty surrounding estimations of loss of life, illness, migration and human suffering is going to be large.

For `chronic' or long-term climatic phenomena, the initial effort must be to arrive at a more or less reliable baseline of data on mortality and morbidity. It is useless to suggest for the many countries with imperfect to nonexistent vital and health statistics the immediate development of a statistical network of the type which developed countries have evolved after many years and much expenditure of money. Indeed, spending large amounts of money on white elephants such as a statistical bureaucracy or a `modern' computer data processing system may be counterproductive in this context, as the resources employed are likely to be diverted from more pressing societal needs, including direct action against climatic aggression. For the former elephant the excuse may be made that it at least provides employment; the latter elephant has no excuse whatever.

For a more or less correct measurement of mortality and fertility, the new `indirect' methods referred to earlier are both very cheap and fairly reliable. These methods consist of a few questions put to respondents with regard to the fertility and mortality experienced over a fixed recollection period by the respondents themselves and their families, together with questions on family composition, birth order of siblings, and so forth. Analysis of the responses generates a Life Table for the population under study, and this in turn generates statistics on age-specific mortality risks, together with a fertility table. These analyses can create a baseline, which was lacking, for example, when efforts were made to measure the impact of the Sahel-Ethiopian drought. If an infrastructure for the probabilistic collection of data exists in the countries (and the methodological problems in using this tool have been solved, by and large), the operational ones that remain need not be insurmountable. The method can also be employed in conjunction with a population census with fairly complete coverage. Given greater resources, it is also possible to perform in-depth mortality studies through sampling, like the one undertaken by Puffer and Serrano (1973), which threw so much light on the underregistration of deaths and the prevalence of malnutrition in Latin America. In general, for countries in very unfavorable data situations, it is advantageous to carry out population censuses at more frequent intervals than the 10-year one suggested by the United Nations. The census is a fundamental and comparatively cheap tool for the quantification of a society.

* For Mexico, see Chavez, 1980; and Ramirez *et al.*, 1971. For a general re-evaluation of traditional foods, see Béhar, 1976 (reprinted in García and Escudero, 1982).

* For US, British, Canadian and West German standards, see Munro, 1977.

10.5.2 Morbidity

Morbidity is a more difficult proposition than mortality. Those countries that have good population coverage for their social services and an institutional health care system—for example the European ones, Canada, or Cuba—obtain good morbidity statistics as a byproduct. Those with good population coverage and with no institutionalized health sector, like the United States, know their morbidity basically from probabilistic sample surveys, which are expensive and, for exactness, must rely on complicated measurement methods. For the great majority of the poor countries, perhaps a simple monitoring system can be tried by using interrogation of population exclusively, and accepting an inevitable margin of error.

10.5.3 Malnutrition

Malnutrition, that most common biological manifestation of climatic aggression, can be assessed by using such simple measures as weight and height for age;* several body circumferences, such as that of the arm (Jelliffe and Jelliffe, 1969), or rapidity of growth (Martell *et al.*, 1979); age of onset of menstruation in girls; and prevalence of anemia or edema.† Probabilistic methods for these indicators can, again, be applied to groups at risk, to population samples, or to censuses. The depth of use must depend on resources available and time constraints facing investigators, who need to bear in mind that prompt diagnosis of malnutrition can produce the decision to give food to malnutrition victims. Food is a cheap therapeutic product with hardly any side effects, especially when compared to the products of the drug industry, or to the subsequent alternatives.

* Several methodologies exist for this, and also several tables of `normality' against which results can be plotted. For a discussion of what `normal' constitutes, see Martorell *et al.*, 1975.

† There is a good brief review of these methods in Bourbour, 1981. For a methodological discussion of body measurements, see Jordán, 1979; and Eveleth and Tanner, 1976.

With respect to data on malnutrition, compromises can be put forward. Death certificates, if they exist, can be coded separately where mention is made of malnutrition (Escudero and Kotliar, 1975), disregarding the rules put forth by the International Classification of Diseases. Deaths `due to' measles, diarrhea, bronchopneumonia, and parasites can be monitored, as they give an idea of the underlying malnutrition which plays a role in their occurrence. Paramedical personnel can be quickly trained to recognize malnutrition. All of this would also provide, with approximations, the baseline that is needed to know the prevalence and trends of mortality and morbidity phenomena.

For studies involving malnutrition, the selective blindness of the medical profession toward it must be overcome. During the 1972 Sahel famine, as noted, it was horrifying to observe that the publications of the Ministries of Health of the countries concerned did not mention, or hardly mentioned, the malnutrition that was striking the population. The retraining of the medical profession to recognize malnutrition is more difficult than it seems, as many of the countries where malnutrition is most prevalent use curricula copied from malnutrition-free countries (to which many of the physicians emigrate).* Change in curriculum is a good example of an apparently simple measure to improve defence against climatic aggression, which in reality implies the use of a great input of political power.

There are other indicators of human stress and suffering which should be mentioned, although they fall outside the scope of death, illness and modification of growth. These indicators of climatically induced stress are very real, even if they are not easily or commonly quantified. All of the `adjustment' techniques that humans can devise to subsist under climatic (mostly drought-induced) stress can give rise to indicators of increased wretchedness: emigration; curtailment of the purchase of items that are not essential to survival; forced sales of household utensils, tools, animals, clothes; up to the number of unclaimed corpses found in the streets of cities (Currey, 1978; Rahaman, 1978). All of these can be measured and analyzed as timely pieces of evidence of the magnitude of human suffering involved.

Some measures are not advocated here, and it is important to explain why. Monitoring of food production is cumbersome and usually has little bearing on the nutritional status of the people who are supposed to eat the food. The `animal protein diversion', already described, can produce the contradictory (or logical) situation of massive malnutrition in countries with agricultural production which, in `per capita' terms, is well in excess of the nutritional needs of the population. Situations of this type in Argentina and Brazil have been discussed elsewhere (Escudero, 1978; García and Escudero, 1982). Nutritional surveys, which try to measure food intake quantitatively, either through the weighing of food through recall, are consuming of time and resources and much subject to measurement errors. It is usually better to measure nutrition by its end result rather than by the intermediary measurement of food intake at individual or family levels. An exception would be programs in which remedial measures are directly taken to correct food deficiencies suggested by the survey.

* A publication on medical migration is, Mejía *et al.*, 1979; a description of the Bangladesh situation can be found in Hartman and Boyce, 1979. Latin American medical emigration to the United States is discussed in Escudero, 1977.

A promising new line of measurements involves intakes and losses of energy on the part of individuals. So far this has been undertaken at case study levels only, due to the laboriousness of the method (Spurr *et al.*, 1975; Brun *et al.*, 1979; Blaiberg *et al.*, 1980). A tentative finding is that the energy loss from work on the part of some agricultural workers is so large that their salaries are insufficient to compensate for it. As these workers have to be well fed in order to keep earning wages, the bulk of their families' food goes to them, thus creating malnutrition in their children who are, in effect, a captive population to any climatic misfortune that might weaken their already precarious hold on life (Gross and Underwood, 1971).

10.6 CONCLUSION

The problem of damages to human health from climatic perturbations is substantially political, that is, it pertains to the fashion in which societies allocate their collective surplus, as much as to the magnitude of the surplus itself. Ultimately, societies can be grouped by the ways in which they utilize their collective surplus to improve the quality of life: by minimizing mortality and morbidity; maximizing educational achievement, nutrition, lodging, community and political participation; or in other ways. Thus, the `climate *vs* society' dichotomy is a fundamental one, and for its resolution we must look across cultures and backward in history, to see societal suffering, which we may assign in a much too facile way to climatic causes, in a different light. Were the Honan drought-famine of 1942–43 (2 million dead), the Bengal drought-famine of 1942 (over a million dead), or the Ethiopian drought-famine of 1972 (some hundreds of thousands dead) caused by a climatic agent or by a faulty societal response—a symptom of a fundamental failure of the societies and governments themselves?

It can be expected that societies which more or less fulfill the kinds of aims mentioned above will also be relatively impervious—as impervious as the development of productive forces allows—to climatic damages to health. For evidence, look to the negligible human consequences produced by the drought in Western Europe in 1976 or the unusually hot summer season in the United States in 1979. Or, look to the road conditions at the Dutch-Belgian border after a snowstorm in 1979: the Dutch roads were snow-free, the Belgian ones were not.

The Dutch roads evidently reflected a different perception of the costs and benefits of road clearance (de Vries, 1980). In the case of most of the poorer countries, this example can be magnified a thousand-fold, and it is not a hampering of transportation or the loss of a few lives from hazardous driving conditions that is at stake in a circumstance of climatic aggression, but the sheer fact of survival for millions of humans. The Belgians could purchase and run snow clearance equipment but did not; dozens of countries of the world can act so that some climate hazards result in virtually no deaths, but do not.

In parallel, and in a development that can be seen as paradoxical or as consistent, the societies whose health appears to be little affected by climate also have good monitoring systems to measure the unfavorable impacts of climatic aggression. A recommendation of an ultimate type would be for all societies to become like these fortunate ones, but no consensus exists on the way to reach their position, and the road in any case is certain to be difficult and even violent.

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Back to Table of Contents

The electronic version of this publication has been prepared at the *M S Swaminathan Research Foundation, Chennai, India.*