

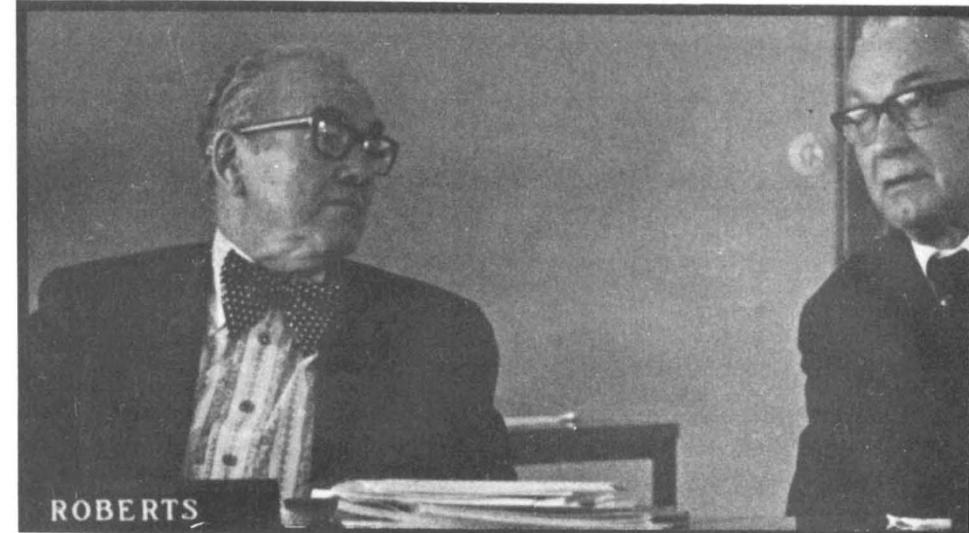
Weather watchers

As fewer and fewer agricultural regions have supplied increasing amounts of the food consumed by the countries where population growth is greatest, there has been growing concern about how the climate of the next few decades may affect world agricultural productivity. Henry Lansford, of the National Center for Atmospheric Research, Boulder, Colorado, reports.

SOME atmospheric scientists, projecting trends of the past 30 years or so, foresee steadily decreasing temperatures accompanied by greater climatic variability—more droughts, floods, unseasonable cold spells, and other extreme events that certainly would reduce agricultural productivity, at least in the regions where they occurred. Professor Hubert Lamb, of the University of East Anglia, and Professor Hermann Flohn, of the University of Bonn have warned that this sort of climatic change seems to be in progress, together with Dr Reid Bryson, of the University of Wisconsin, and Dr Walter Orr Roberts, who formerly headed the National Center for Atmospheric Research (NCAR) and is now with the Aspen Institute for Humanistic Studies.

Other climatologists maintain that the climatic trend of recent years does not necessarily represent a long term change, but should be viewed as a fluctuation that may halt or reverse itself at any time. These climatological conservatives maintain that our understanding of the mechanisms of climatic change is so rudimentary that no sound basis exists for assuming that a downward trend in temperature will continue in the future. Among these conservatives are Dr B. J. Mason, who heads the British Meteorological Office, and people like Dr J. Murray Mitchell of the National Oceanic and Atmospheric Administration (NOAA), and Professor Helmut Landsberg, of the University of Maryland.

But even these conservatives are worried about the impact of climatic variability on world food supplies. The potential consequences of droughts and other climatic anomalies are greater than ever before because of present low levels of grain reserves, increasing use of semi-arid and other marginal lands for farming, and expectations of continuing high yields



from the new "Green Revolution" crops that are highly responsive to generous supplies of water and fertiliser.

During the past year and a half, atmospheric and agricultural scientists, as well as specialists in fields such as economics, international development, law and political science, have gathered for a succession of international conferences designed to identify some of the major problems of climate-food-social interactions and to try to develop new research strategies for attacking those problems effectively. The meetings have included:

- A conference on "Weather and Climate Change, Food Production and Interstate Conflict" held in New York City by the Rockefeller Foundation in January 1974
- A workshop on "The Impact on Man of Climate Change" held at the University of Bonn by the International Federation of Institutes for Advanced Study (IFIAS) in May 1974
- A conference on "World Food Supply in Changing Climate" held at Sterling Forest, New York, in December 1974 under the joint sponsorship of the American Society of Agronomy and the Aspen Institute for Humanistic Studies
- A pair of workshops, one on the policy implications of food and climate interactions and the other on the design of a study of the social, political, economic and ethical impacts of drought, held in West Berlin by IFIAS and the Aspen Institute in February 1975
- A conference on "Climate Change, Food Production and Interstate Conflict" held by the Rockefeller Foundation at Bellagio, Italy, in June 1975.

Although the participants at these meetings disagreed about a great many things, there seems to be fairly general agreement that the vagaries of climate do indeed represent a serious threat to world food supplies in

these precarious times of rapidly growing demand for food, low world grain reserves and increasing dependence of many heavily populated nations on a few regions of high agricultural productivity, usually halfway around the world from the regions of high consumption, for their food supplies.

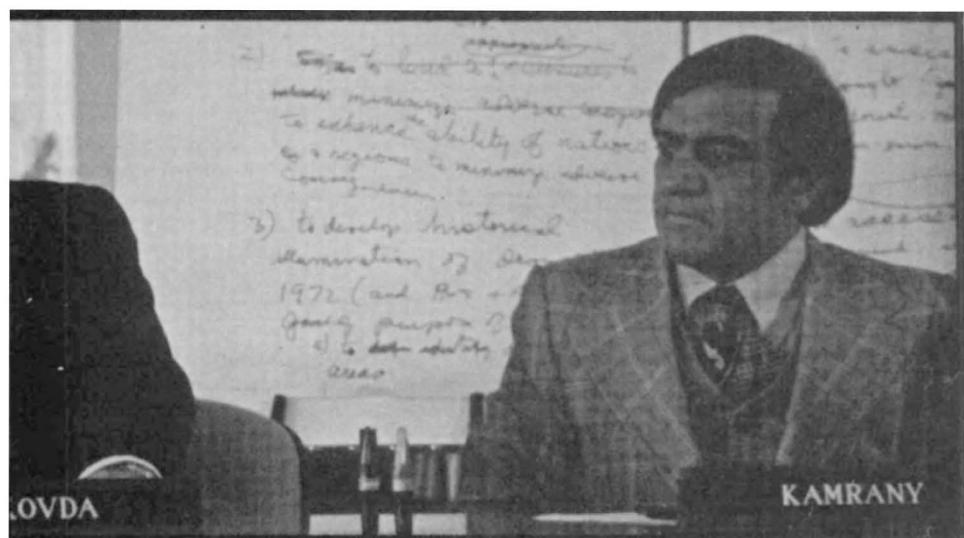
The conclusions, recommendations, and resolutions that have come out of these conferences have ranged from the strident to the cautious. The IFIAS statement that emerged from the Bonn meeting, for example, said that:

"The nature of climatic change is such that even the most optimistic experts assign a substantial probability of major crop failures within a decade. If national and international policies do not take such failures into account, they may result in mass deaths by starvation and perhaps in anarchy and violence that could exact a still more terrible toll."

With more reserve and less rhetoric, the participants in the recent Bellagio Conference came to much the same conclusion. They agreed that:

"...there is some cause to believe—although it is far from certain—that climatic variability in the remaining years of this century may be even greater than during the 1940–70 period", and concluded that "greater climatic variability than that of the last two decades could cause major crop failures quite beyond the current capability of agricultural science and technology to control or mitigate."

Although these climate-food meetings have not resulted in any solid consensus among atmospheric and agricultural scientists about just what the climate is going to do and how it will affect food supplies, much less about what international policies and mechanisms will be needed to cope effectively with conflicts that may develop among nations as a result, a few common conclusions seem to be



Walter Roberts, Nake Kamrany and Viktor Korda in Berlin.

emerging from all the discussion and debate.

As far as the climate itself is concerned, there is fairly general agreement on two points:

- The climate of the first half of the twentieth century was considerably warmer than the average of the past 1,000 years, which suggests the possibility that cooler weather can be expected to follow.
- The average global temperature, which gradually increased during the first half of the century, has been decreasing during the past quarter of a century, at least at latitudes above 55 °N. This cooling was between 2 and 3 °C for some northern locations such as Iceland. Lamb points out, however, that the length of the growing season in England increased by two to three weeks during the first half of the century and has dropped back by about two weeks since 1945.

There is considerable disagreement about whether or not the cooling trend is likely to continue. One school of opinion, which includes Bryson, Flohn, Lamb and Roberts, sees a strong probability that the downturn in temperature that has occurred since 1950 will continue for at least another two or three decades. Other climatologists such as Mitchell and Landsberg maintain that the causes and mechanisms of climatic change are not understood well enough for anyone to make such a prediction with any assurance of success.

Although a number of the scientists who anticipate a global downturn in temperature participated in the Bellagio Conference, the group as a whole took a cautious view of the question of global cooling. The conference participants concluded that:

"It is not certain that the decline in Northern Hemisphere temperature will continue; it may halt or reverse itself. Even if the global average temperature were to decrease steadily over the next

20 years, it is unlikely that it would drop as much as one degree Celsius."

But they went on to point out that: "temperature change *per se* is not the most serious climatic threat to food production. The possibility of increased climatic variability, particularly in distribution of precipitation, is of greater concern."

The question of variability is another subject of controversy. Bryson and others believe that the cooling trend in the high latitudes of the Northern Hemisphere has changed large scale atmospheric circulation patterns by increasing the temperature contrast between tropical and polar regions. They believe that this has produced increased climatic variability—a higher incidence of droughts, floods, unseasonable cold weather and other extreme events that have characterised recent bad crop years such as 1972 and 1974.

Whether or not the climate is growing more variable, even the climatological conservatives such as Landsberg agree that climatic variability represents a continuing threat to uniform crop yields in many agricultural regions. Although the Bellagio Conference participants did not conclude that the climate is becoming increasingly variable, they agreed that "climatic variability—region by region and from year to year in particular regions—is and will continue to be large."

In discussing problems of climate and food, atmospheric scientists have frequently referred to the climate of the first half of this century as "benign," implying, perhaps unintentionally, that it provided the best possible growing conditions for crops everywhere. But at Bellagio the agricultural scientists pointed out that this is not so. The frequency of droughts in the Soviet Union increased sharply during that period. In parts of the mid-western United States, summer temperatures have often been too hot for

optimum yields from some crops that are grown there. A general cooling trend, while shortening the growing season in some northern regions, might result in a compensating increase in crop yields in regions further south. Professor Lamb has suggested that, in discussions of climate change, it would be wise to avoid using the words "benign" and "normal," as they both imply value judgments that are subject to considerable argument.

After listing some of the impacts that a cooling trend might have on agriculture—changes in distribution of precipitation, shorter growing seasons in high latitudes, and cooler growing temperatures in some regions—the Bellagio participants admitted that:

"Some effects of such climatic changes would be beneficial to agriculture and others would be detrimental, but the net effect, for the whole world or for any particular region, is not known."

To remedy this lack of knowledge of the agricultural impact of future climatic developments, it was recommended that a set of 'scenarios' specifying plausible future climatic sequences be developed and that the impact of each possible climatic future on agricultural production, the world food situation and international relations be assessed as precisely and quantitatively as possible.

Regardless of the changing casts of characters, different approaches, and specific conclusions that have characterised the recent climate-food meetings, one grim theme emerges from all of them. Whether or not any long term change to cooler temperatures or increasing climatic variability is in progress, there is a high probability that major regional and world food emergencies will occur during the next decade or two as a result of serious reductions in crop yields or major crop failures caused by climatic anomalies.

A number of possible research and policy strategies have emerged that could contribute to effective national and international responses to such emergencies.

It seems that the atmospheric scientists should accelerate their efforts to determine whether or not it is possible to predict climatic conditions a season or more in advance, as well as examining ways in which existing climatic information can be made more useful in coping with agricultural problems. An improved understanding of the workings and interactions of the five physical elements of the total climatic system—atmosphere, hydro-sphere, cryosphere, lithosphere and biosphere—is badly needed. Both theoretical and empirical approaches to problems of climate change should be pursued. Agricultural scientists should

assess the potential impact of various climatic anomalies on various crops, particularly the new high yield varieties, and should consider plant breeding strategies, as well as techniques of crop, soil and water management, that can reduce the impact of climatic stresses on agricultural productivity. Special attention should be given to the role of soils in mitigating the impacts of drought, and to the improvement of dryland-farming practices, as more and more semi-arid lands are brought under cultivation.

Application of new and existing agricultural technology to improvement of crop yields in regions that supply food for their own consumption seems to be at least as valuable in the long run as striving to continue to increase yields in exporting regions such as the United States and Canada.

Policy makers must assess national and international policies on agriculture and food in the light of the probability that major food shortages,

affecting large regions if not the entire world, can be expected to result from climatic stresses over the next few decades. Although years of bad climate such as 1972 may not necessarily reduce total world food production, they clearly have the potential for disrupting world food trade patterns and raising prices to the extent that people in some regions will go hungry not because there is no food, but because it costs so much that they cannot afford to eat properly. The potential is great for conflict among nations as well as for human suffering in the regions that are affected directly by climatic anomalies.

There does not seem to be any miraculous 'technological fix' waiting in the wings to save the day. Agricultural technology probably can be applied to achieve additional increases of 100% or more in crop yields in some regions, primarily those where food consumption is highest, but such increases are not likely in most of the present major food-producing regions.

Climate forecasting will be useful only if workable alternatives are available so that the farmer can respond to the foreknowledge that a drought or a short growing season is imminent. Weather-modification technology may have the potential for improving crop yields in some regions under some conditions, but it has not been demonstrated that cloud seeding can do much, if anything, to remedy major climatic anomalies such as large scale droughts.

Science and technology certainly have appreciable contributions to make to solutions to our growing climate-food-society problems. But the evidence that has emerged from the recent conferences indicates clearly that the responsibility for establishing a framework within which scientific and technological knowledge can be applied effectively to solving the problems rests as much with the policy makers as it does with the plant breeders, the climatologists and the cloud seeders. □

A small experiment now taking place in Britain seems to be having results that warrant a little more attention from our drought-stricken sociological experts. I refer to the resistance of the Anglo-Saxon mind to metrification, a resistance which, whether inwardly sullen or sudden, is outwardly passive so long as our feet are not pushed to the wall. For the inevitably vociferous, the issue is seen in the emotive terms of an unimpeachable heritage threatened from without, and the City Editor of the *Sunday Telegraph* euphorically praises "the glorious indifference of the British people [to metrification]", himself excepted, presumably.

Because, here in the USA, metric measures are now unofficially and surreptitiously appearing in all sorts of odd corners, from the food and building industries to sports events, not to mention our completely ravished science, we are not indifferent to watching the unenthusiastic attitude of the British to losing their 2,000-year-old Roman measures. Admittedly, the decimal Roman measures became a little unmetrified after the UDI of Hengist and Horsa in a petrified British culture, but Anglo-Saxon we have staunchly remained for the 1,500 years since.

Are we now to throw over that measured tradition? Galileo learned, to his cost, the strength of tradition when, in the naive cause of truth, he tried fervently to upend it overnight. Pope Gregory's reform of the calendar was regarded by the English as even more of an occasion for cheating than the recent decimalisation of £.s.d. Tradition! Should we resist and drop

metrification, except for odd corners of science that can easily be swept clean again; should we denigrate, admire or diplomatically ignore the resolution of South Africa in enforcing it by law in one fell swoop; or do we characteristically muddle on with a facade of creeping metrification that is merely a

system of Boadicea, without the benefit of those delightfully duodecimal Roman "uncias" of length and weight. (British readers, now perhaps only able to afford their tobacco by the gram, may be interested to know that in the USA "one pound" of pipe tobacco has shrunk to 12 ounces, in precise conformity with the original definition, but not, alas, out of any respect for tradition.)

Need we go metric? Cannot measuring systems of the world co-exist as do languages? Is there a good case for Britain and the USA to drop, or stop, the whole costly and unwanted experiment and re-trench? As far as I am aware, the token metrification of Britain has barely entered everyday thought, estimation and judgment. One does not see Mr. Wilson, one of Britain's better known pragmatists, contemplating his bowl in centimetres and °C.

If metrification, an abomination of a word redolent of graduation in dietetics, really is desirable for us Anglo-Saxons, then it will not stem from the will of the people in their present mood. Either those in authority must coerce, or those favouring the change must be seen to step aside from the appointed bureaucrats of Whitehall and Washington, and start cutting ice, or, for those who disdain the methods of Sam Adams and the founders of the American Revolution, advertise the fact in the manner of the huge, state sign on the main Boston-Montreal highway: "Barre, 100 kilometers".

Maybe we can continue along the broad way, rather than take the narrow road of decision. But I fear that, in nautical parlance, we're tying ourselves in unfathomable knots.

Failing to take the point

P. A. MOHR

measure of creeping paralysis of will?

Certainly, the British Metrification Board, in urging the people of Britain to think metric for reasons of logic and utility alone, has completely misjudged the Anglo-Saxon mind. Those who oppose metrification see the ultimate argument quite clearly: metrification is alienation. Logic and possible future utility make no impact on the gloriously indifferent.

Can the Imperialists . . . (no, that won't do) . . . Can the opponents of metrification discover that the non-Anglo-Saxon world, by discarding multifarious old measuring systems, has impaired its heritage? It might make for an interesting discussion; but surely many would prefer to regard tradition as something not merely inherited, but to be fashioned for those who will inherit it, hopefully improved, from the living. Otherwise we would still be sticking to the measuring