(2)

Prime Minister

Here are the additional Scientific contributions to your UN speech. Here are some interesting points — it's enough to read the summary.

The domestic initiatives exercise is going much less well & is strictly sparse.

CDP
27/X.

2 MARSHAM STREET
LONDON SW1P 3EB
01-276 3000

My ref:

Your ref:

Charles Powell
Private Secretary to
The Prime Minister
10 Downing Street
LONDON
SW1A 2AA

27 October 1989

Dear Charles

PRIME MINISTER'S SPEECH TO THE UNITED NATIONS GENERAL ASSEMBLY

You mentioned to me that the Prime Minister would like more detail on science to be included in her speech to the United Nations General Assembly. We have now received replies from Sir John Mason, John Knill and Peter Wadhams of the Scott Polar Institute whom we consulted at the Prime Minister's request. Copies of their letters are attached in full although we have also distilled the most interesting and relevant elements into a form which might be included in the Prime Minister's speech. This summary is attached below.

The Prime Minister was also concerned that her speech needed to be more positive about domestic initiatives. We have worked up some extra ideas which are enclosed with this letter. We have since received your letter of 26 October and we are already pursuing the suggestions it contains with other departments. On the specific point on which you requested information for the weekend - the new Shell process - I attach a separate note which sets out what the Department of Energy know about this scheme.

You will wish to know that my Secretary of State intends to work on the text himself and to produce a revised draft next Tuesday evening or Wednesday.

I am copying this to the private secretaries to the Chancellor of the Exchequer; the Foreign Secretary; the Secretaries of State for Trade and Industry, Energy and Transport; the Minister of Agriculture and the Minister of State (Overseas Development).

R BRIGHT
Private Secretary

SUMMARY OF SCIENTIFIC CONTRIBUTION

PRIME MINISTER'S SPEECH TO THE UN GENERAL ASSEMBLY

SCIENTIFIC CONTRIBUTION

Ozone Depletion

(end para 7)

British scientists continue to take a leading role in the vital task of understanding how the polar regions influence the climate of our planet. The latest data from British researchers in the Antarctic shows that we were right to take the warnings seriously. As I speak we are entering a spring ozone depletion which is as deep as, if not deeper than, the worst depletion to date. It completely reverses the recovery observed last year and urges on us the need to strengthen measures to protect the ozone layer.

Climate Change

(insert in para 8)

Much remains uncertain about the causes and effects of climate change. Further work helps our understanding by revealing the complexity of the systems which influence our climate. Latest work by British scientists is finding new factors which contribute to climate change. We now have evidence that the plankton which forms one of the basic elements of the food chain in the ocean may also play a role in modifying the concentration of greenhouse gases. There must be a real risk that global warming could enduce mechanisms in the oceans which would further increase the concentrations of carbon dioxide.

Recent thinning of the sea ice over a large part of the Arctic provides evidence of a radical change in the pattern of surface currents. Although there is as yet no proof of thinning in the Antarctic ice the latest data shows that the first-year ice which forms the bulk of the Antarctic sea ice cover is remarkably thin and would probably be unable to sustain significant atmospheric warming without melting. The consequences of this do not stop at a rise in sea level, devastating enough in itself. Sea ice separates the ocean from the atmosphere over an area of more than 30 million sq km. It reflects most of the solar radiation falling on it, so helping to cool the Earth's surface. If its area were reduced the warming of the Earth would be accelerated due to the extra absorption of radiation by the ocean. The lesson to be learnt from these phenomena is that global environmental change resulting from man's activities may have the possibility of self-acceleration A further example of this is to be found in the tropical forests. A recent study by our Meteorological Office in which the whole Amazonian rainforest was removed in their climate model showed that rainfall over the whole area was reduced by about 10% and smaller climatic changes were perceptible much farther afield. This suggests that large-scale deforestation may affect climate directly, as well as causing an increase in carbon dioxide. We must as a matter of urgency improve our understanding of the many factors which influence our climate and our ability to predict future changes.

POLAR RESEARCH INSTITUTE

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TO: D J FISK, DEPT OF ENVIRONMENT. FAX NO. 01-276-8355.
FROM: DR P WADHAMS, AT SEA "POLARSTERN". FAX NO 00871-1120543.
URGENT - PLEASE DELIVER TO DR FISK TODAY. 2 pages.

Dear Dr Fisk,

Thank you for your letter of 16 October, transmitting the Prime Minister's request for ideas relevant to her forthcoming speech on global environmental issues to the UN General Assembly. I received the letter by fax today aboard this ship, and I enclose a reply as follows.

FS "Polarstern". At sea, Antarctic Ocean. 23 October.
Dear Prime Minister,

Thank you very much for your invitation to submit ideas relevant to your forthcoming speech to the United Nations General Assembly. My office faxed the letter to me today aboard ship, so please excuse the haste of my reply.

In the polar regions today we are seeing what may be early signs of man-induced climatic change. Data now coming in from Halley Bay and from instruments carried aboard the ship on which I am sailing show that we are entering a spring ozone depletion which is as deep as, if not deeper than, the depletion in the worst year to date (1987). It completely reverses the recovery observed in 1988. The lowest recording aboard this ship is 150 Dobson units for ozone total content during September, compared with 300 for the same season in a "normal" year.

In the Arctic we found that in 1987 the sea ice over a large region north of Greenland was significantly thinner than in an earlier survey in 1976, amounting to a 15% loss in average thickness over an area of 300,000 sq km (twice the area of Great Britain). If not a sign of warming this is at least a sign of a radical change in the pattern of surface currents, which normally drive the ice towards the coast of Greenland and pile it into pressure ridges. In the Antarctic we have not found evidence of thinning during our present expedition, but our data confirm that the first-year ice which forms the bulk of the Antarctic sea ice cover is remarkably thin (only 50-80 cm thick) and so is probably unable to sustain a significant atmospheric warming without melting.

Sea ice is a thin and delicate skin separating the ocean from the atmosphere over an area of more than 30 million sq km. It reflects most of the solar radiation falling on it, so helping to cool the planet's surface. If its area were reduced the warming of the Earth would be accelerated due to the extra absorption of radiation by the ocean. Sea ice also takes part in a complex set of interactions with the ocean, including the production of "bottom water" by the sinking of surface water which has been made more dense by the addition of salt from freezing. This sinking carries CO2 into the deep ocean. If this process were to cease the world would lose one of its major oceanic CO2 sinks, again accelerating greenhouse warming.

While the stability of the great continental ice sheets which cover Antarctica and Greenland is not seriously doubted, there have certainly been unusual events recently. Both in 1986 and 1987 there were break-outs of giant icebergs (up to 80 miles long) from the ice shelves in the Ross and Weddell Seas, carrying away a volume of ice many times that normally calved in a year from the entire coastline of Antarctica.

The lesson of these polar processes is that an environmental or climatic changed produced by Man may take on a self-sustaining or "runaway" quality because of positive feedbacks which are not weakened by

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countervailing restraints. The effects may therefore be greater than one would expect from the magnitude of the original cause. The change may also be irreversible: an ice cover once removed may be difficult to re-establish, just as the creation of new desert by the expansion of the Sahara may be a process that cannot be reversed.

The polar regions are only one of the "indicator areas" of the world in which the climatic effects of our interference with the environment may be detected. But they are especially important because the magnitude of the warming is expected to be greatest at high latitudes, so that the polar regions may provide the earliest evidence of significant change taking place.

I would like to suggest an idea here. A valuable role which we as a nation could play, in collaboration with the other great scientific nations of the developed world, would be to undertake the monitoring of the climate-related processes and changes which are occurring in the polar regions, in order to take advantage of the opportunity which this early warning offers. The job of monitoring would be a major one, including work on the atmospheric and oceanic circulations, sea ice extent and thickness, changes in ice sheets, and associated biological changes. The whole project could be called a "World Polar Watch", and it would provide unique opportunities for fruitful international collaboration, including an important role for the developing countries of the South. In the Arctic the work of the World Polar Watch would necessarily be carried out by developed nations with scientific interests there, perhaps through the newly-established International Arctic Sciences Committee which would offer new scope for collaborations involving the USSR. In the Antarctic the work could be carried out through SCAR (the Scientific Committee for Antarctic Research) and could involve those developing nations which have joined the Antarctic Treaty system and SCAR but which at present lack an inspiring scientific role. Here the World Polar Watch offers a wonderful opportunity for a genuine unification of effort and partnership between North and South, with a goal which is important to both.

While working down here for the past six weeks I have been conscious that even the Antarctic Ocean is not a dead sea of ice, but is itself full of life - penguins, seals, whales and petrels. The rest of our planet, and the precious life that it contains, may be able to benefit from the vital information that these regions have to offer,

Yours sincerely,

Peter Wadhams

Dr Peter Wadhams.

(2)

The Royal Society

The Norwegian Academy of Science and Letters

The Royal Swedish Academy of Sciences

SURFACE WATER ACIDIFICATION PROGRAMME

Programme Director:
SIR JOHN MASON, C.B., D.Sc., F.R.S.,
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London, SW7 1LU

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18 October, 1989

Dr. D. J. Fisk
Chief Scientist
Department of the Environment
Romney House
43 Marsham Street
London SW1P 3PY

Dear David,

In reply to your letter of 16 October, this is the best I can do in 48 hours.

I have just written a more comprehensive review of the Greenhouse Effect which will be published during the next 3 months. I can send you a typescript if you wish, but you may find this summary adequate.

I sent the Prime Minister a personal copy of the Royal Society booklet on the subject, which she has read. It contained the written evidence we submitted to the House of Lords Select Committee.

Yours sincerely,

John

JOHN MASON

NOTES FOR PRIME MINISTER'S SPEECH TO UNITED NATIONS

SIR JOHN MASON

The attached note on The Greenhouse Effect summarizes the status of current knowledge and understanding of the climatic changes that may result from continuing increases in the atmospheric concentrations of the greenhouse-gases.

The large uncertainties in the predictions of the magnitude and timing of these effects can be reduced only by improvements in the climate models which, in turn, require a major international effort to acquire adequate observations from the atmosphere and the oceans.

The Prime Minister may care to emphasize:

(i) the leading role which the U.K. plays in climate modelling and its readiness to receive scientists from abroad to work in the new Climate Centre of the Meteorological Office;

(ii) the U.K. contribution to international observing programmes such as the World Climate Programme, the World Ocean Circulation Experiment and the Joint Global Ocean Fluxes Study and to encourage other nations to participate as fully as possible.

These scientific programmes should proceed in parallel by studies of the likely economic and social impact of possible climate changes on different sectors of the economy, e.g., energy

agriculture, forestry, coastal defence, etc., with a view to devising adaptive measures such as energy conservation and substitution, introduction of new crops, breeding of more suitable cultivars, changes in land use, better management of soils and identification of natural and semi-natural plant communities that may be subject to new pressures.

Attempts should be made to develop adaptive strategies and contingency plans designed to minimize the impacts of the climatic changes with a reasonable balance between risk and cost.

For example:

(i) Coastal defences could be planned and designed to be implemented in incremental fashion, enhanced construction being matched to the perceived threat as this develops, but phased over several decades.

(ii) The impact on agriculture could be reduced by the introduction of a wider variety of crops and the breeding of new varieties and strains with greater resistance to drought, frost, disease, etc.

As regards large-scale deforestation, this may affect climate directly, apart from causing an increase in carbon dioxide. The Prime Minister may like to refer to the recent Meteorological Office study in which the whole Amazonian rainforest was removed in their climate model with the result that the rainfall over the whole area was reduced by about 10 per cent whilst smaller climatic changes were perceptible much farther afield.

THE GREENHOUSE EFFECT

SIR JOHN MASON

The greenhouse gases, especially water vapour and carbon dioxide, play a crucial role in regulating the temperature of the Earth and its atmosphere. In the absence of these gases, the average surface temperature would be -19°C instead of the present value of +15°C, and the Earth would be a frozen, lifeless planet. There is now concern that atmospheric temperatures will rise further, due to the steadily increasing concentration of CO_2 resulting largely from the burning of fossil fuels. The concentration is now 27% higher than that which prevailed before the industrial revolution, and is increasing at 0.5% p.a. It is expected to reach double the 1860 value during the second half of the next century. Recently we have become aware that other strongly absorbing gases, notably methane, nitrous oxide, ozone and chlorofluorocarbons (CFCs) are adding to the greenhouse warming and may, by the middle of the next century, contribute about half as much again as the doubling of CO_2.

Higher temperatures will be accompanied by changes in other climate parameters such as precipitation, cloudiness, soil moisture, snow cover and may, eventually, result in significant melting of the ice sheets and hence a rise in sea level. Just when the atmospheric concentration of carbon-dioxide will reach double the pre-industrial

about half of the CO_2 that man emits into the atmosphere, as it has done for the last 100 years, and if emissions continue to increase at the current rate of 2 per cent a year, the atmospheric concentration will double by about the year 2060.

The warming of the atmosphere by CO_2 and the other greenhouse gases will, however, be delayed by the oceans absorbing some of the additional heat and releasing this again to the atmosphere only slowly, probably on a time scale of 20-30 years. By the same token, the greenhouse warming will be prolonged by the oceans continuing to release heat long after any reductions in the emissions of greenhouse gases have taken place.

The delay caused by the oceans is probably the main reason why there is, as yet, no direct observational evidence of greenhouse warming, although the 27% enhancement of CO_2 since 1860 should have produced an increase in the average global air temperature of about 0.5°C. Indeed, there is good evidence that temperatures have risen by about 0.5°C since 1900 but most of this rise occurred between 1900 and 1940 when CO_2 was increasing at only one-fifth the current rate, and there was actually a slight cooling between 1940 and 1970. It is true that the last 4 years have been abnormally warm but all these changes are most probably due to natural fluctuations and not due to the greenhouse effect.

In the absence of direct evidence of a steady rise of temperature due to the greenhouse gases, we have to rely on the predictions of enormously complex computer models of the global climate. Such models have been developed only at three centres in the U.S.A. and in the U.K. Meteorological Office. They have been remarkably successful in simulating the present world climate and its seasonal and geographical variations but, unfortunately, the differences between the various

model predictions of the relatively small changes that will be caused by the greenhouse effect are too large to provide firm guidance for major policy decisions. This is largely because the model predictions are very sensitive to how clouds and their interaction with the incoming radiation from the sun and the outgoing radiation from the earth are represented in the models.

Thus, until very recently, the Meteorological Office model predicted rather larger increases in average global temperature and rainfall than the U.S. models. For a doubling of carbon dioxide, the Met. Office model predicted a temperature rise of 5.2°C and an increase in rainfall of 15 per cent, whereas the 3 U.S. models averaged 4.1°C and 12 per cent. However, the Met. Office has just published the results of introducing into its model a much more realistic method of computing the clouds and their radiative properties. This has reduced the predicted greenhouse warming due to doubling of carbon dioxide from 5.2 to only 1.9°C.

Since both sets of computations were made with a model which couples the atmosphere to only a very crude model of the ocean, one cannot have much confidence in the actual numerical value of either prediction. However, continued improvement in model resolution and model physics should cause the predictions of the different models to converge and thereby narrow the range of uncertainty.

This will require several years of further model development, especially in respect of the oceans, and much faster computers. Above all, we shall need an adequate supply of global observations from both the atmosphere and the oceans to feed and validate the models and to monitor the actual changes in climate that may eventually manifest themselves.

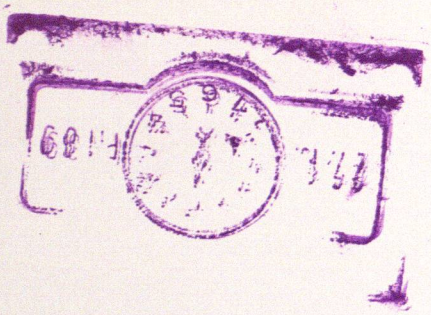
Estimates of effects of greenhouse warming on the rise in sea-level are also subject to a good deal of uncertainty. Changes in the Antarctic and Greenland ice sheets are likely to be rather small and to largely cancel each other. The largest contributions over the next 50 years are likely to be made by the melting of glaciers at small ice caps and, especially, by thermal expansion of the ocean waters. If greenhouse warming of the air reaches 2.2°C by the year 2050, the best current estimate is that sea level will rise by 33 cm. If the temperature continues to increase and reach 4.2° by the end of the next century, the sea level rise may double to 66 cm - substantial and serious, but a great deal less than some greatly exaggerated claims.

RECOVERY OF CO2 FROM FLUE GAS

The Department of Energy have consulted Shell about the suggestion in No.10's letter that Shell are developing technology for liquefying carbon dioxide.

Shell have won the contract to build a 350MWe gasifier combined cycle plant for a utility in the Netherlands (at Buggenum). It is due on stream in 1993 but there are no plans to remove the CO2 by a shift reaction after the gasifier stage. Shell and others have in the past sponsored paper studies to look at the possibilities of such a technology but have not gone beyond that.

There is a pilot project in California, being run by an American energy research organisation, which converts CO2 into liquid form, but this is at present very small.



DOMESTIC INITIATIVES

PRIME MINISTER'S SPEECH TO THE UN GENERAL ASSEMBLY

ADDITIONAL DOMESTIC INITIATIVES

Green Bill

We do not have to wait for international negotiations to tackle all our environmental problems. Many issues require action at the national, local and individual level. To meet this challenge we in the UK will shortly introduce a major piece of new legislation to strengthen environmental protection. This will establish a new approach to environmental protection called integrated pollution control. It considers all types of industrial emissions, whether to air, water or land, as part of the same process and determines the best practicable environmental option in each case. Integrated pollution control is a pioneering but practical approach and we will be happy to advise others who wish to follow our example. We will also introduce tighter regulations on waste disposal and controls over the release of genetically manipulated organisms to ensure that fear of the latest scientific discoveries is replaced by trust in their potential benefit. We will also give each citizen the power to demand anenvironment free from litter. Some of these problems are by no means global in their impact but they are of very great concern to people and unless every one of us is willing and able to put our own house, and its immediate environment, in order we cannot hope to tackle the more serious challenges which face us.

Recycling

We aim to recycle at least 50% of our household waste by the end of the century. To meet this ambitious target we need more efficient waste management and better design of products to minimise the waste produced. We must bring an end to the throw-away society if we are to avoid reducing our planet to a giant rubbish tip.

Energy Efficiency

Energy efficiency saves money and saves our environment. In the UK we aim to stimulate savings of over £0.5 billion a year. So that everyone can contribute to this effort and save money we are supporting insulation of housing for people on low incomes and providing advice to industry. We will also introduce better standards for insulation in new buildings which should result in a 20% improvement in energy savings.

Air Pollution

The UK fully recognises its responsibilities to its neighbours. ike them we produce some pollution which travels beyond our own national frontiers. To reduce acid rain we will be carrying out a £2 billion programme of improvements to reduce emissions of sulphur dioxide and nitrogen oxides from our power stations.
We have agreed in Europe tough standards to reduce the emissions of polluting gases from cars. But we are also urging our European Community partners to go further and develop measures to reduce vehicle emissions of carbon dioxide, the major greenhouse gas.

Water Pollution

Over the past ten years my government has developed the principle that the regulation of industry must be separate from its commercial operation. This is a necessity if we are to adequately protect our environment. In England and Wales we have set up a new body to control water pollution called the National Rivers Authority. Safe drinking water and proper disposal of sewage are basic concerns for all of us. In the UK our water industry will spend £18 billion over the next 10 years to improve the service to the consumer as well as the quality of the environment.

Agriculture

Biological diversity is not just a matter for countries with tropical rainforests. It has been estimated that old hedgerows in Britain can contain as many as 300 species. To ensure that these are not lost we are providing grants to encourage farmers to adopt agricultural practices which will protect the landscape and conserve valuable natural habitats.

Environmental Impact Assessments (raised by Prof Knill)

We have introduced regulations to ensure that all information about the environmental impact of major new development projects is collected and published and that those affected have an opportunity to comment.

NERC

From the Secretary
Dr Eileen Buttle

Natural Environment Research Council

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United Kingdom

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Your ref

Our ref

20 October 1989

Dr D J Fisk
Chief Scientist
Department of the Environment
2 Marsham Street
London
SW1P 3EB

Dear David,

IDEAS FOR INCLUSION IN THE PRIME MINISTER'S SPEECH TO THE UNITED NATIONS - AUTUMN 1989

As requested in your letter of 16 October, I attach ideas from NERC for inclusion in this speech. After a general introduction, they are ordered under the themes you suggested. Specific examples have been provided where it is thought they would be helpful. They are set out in italics, while the main text is conventionally printed. I have co-ordinated this response in Professor Knill's absence on business. Should he wish to make any further comment, this will be passed to you as soon as possible on Monday.

We are, of course, happy to help should you need further information on any point.

Yours sincerely

Eileen Buttle

NERC CAU

SUBMISSION FROM THE NATURAL ENVIRONMENT RESEARCH COUNCIL FOR POSSIB. IN THE PRIME MINISTER'S SPEECH TO THE UNITED NATIONS GENERAL ASSEMBLY AUTUMN 1989

GENERAL INTRODUCTION

There is a growing concern that mankind may, as a consequence of the Earth's enlarging population and its demand for resources, be changing the balance of t global system, possibly irreversibly. Whilst much is known already to give good grounds for this concern, further research is undeniably needed to give sufficient confidence to predictions of the timescale and impact of global changes to enable governments to adopt further mitigating policies.

To be successful a comprehensive approach is needed. This covers a wide spectrum of activities from basic research on the fundamental processes at work in the atmosphere, oceans, biological systems and solid earth, through studies of the impacts of global change to the more targeted applied research necessary to form national and international policies and produce action.

International collaboration for Global Environmental Research (GER) is essential - both because the phenomena studied are intrinsically international and because the scale of the research effort needed requires resources and scientific expertise beyond that available in a single country. The UK is making a significant contribution already to the necessary international effort. There are particularly strong research groups in the fields of atmospheric and oceanic systems, land surface hydrology, in the development of space-borne and ground-based instrumentation, and in plant molecular biology and development. There is also a strong tradition of research on sea-ice and ice-sheets in both polar regions, and of palaeo-environment research involving analysis and interpretation of past climatic data from sediment and ice cores.

SPECIFIC THEMES

1 Permanent global environmental damage.

The accent here is on 'permanent'. Many of the environmental issues causing complaint are temporary and reversible, although damaging - eg straw burning, biological effluents etc. Global attention should be focused on the almost irreversible changes: eg large-scale soil erosion, heavy-metal pollution, major changes in atmospheric or oceanic composition.

EL NINO

The climate of Earth is governed by changes occurring inside the ocean. Predicting climate requires an understanding of how the ocean and atmosphere interact. The interaction is strongest in tropical oceans, which every few years foster the El Nino - one of the greatest causes of short-term climate disruption extending all round the globe. Predicting the El Nino is one of the highest priorities in climate research. Last year Britain's Natural Environment Research Council despatched the flagship of its oceanographic research fleet RRS "Charles Darwin" to study the phenomenon in the tropical Pacific Ocean. The scientists on the "Charles Darwin" made important measurements on how the intense rainfall from the tropical showers affects the interaction between ocean and atmosphere. These

measurements are now being incorporated into the computer model of the El Nino being developed at the British Meteorological Office. Such collaboration between oceanographers and meteorologists is an essential component of our strategy for improving predictions of climate change.

As well as these highly visible changes, the initially invisible change of the loss of genetic diversity, as species become extinct, must be considered. This is a wholly irreversible process with, perhaps, the most severe implications of all for the future.

In the UK genetic diversity of species with conservation, recreation and game interst has been seriously damaged by agricultural intensification. NERC's studies show that old hedgerows can contain around 300 species - old meadow land over 250 species. The majority are lost when hedgerows are grubbed out, or meadows ploughed or fertilized. There is also a loss of within-species diversity with the use of carefully bred strains for agricultural crops and grasses, all on a narrow genetic base. Only 16 plant species provide 90% of the world's food, and the gene pool to allow new selections must be maintained.

In tropical forests the genetic diversity is far greater than in UK, (they contain some 50% of the 5-10 million species in the world), but many species have a limited geographical range, and are easily lost when forests are logged over - some 80 m acres per year of forest are lost. Total world losses of species are claimed to be several hundred per week. NERC has studied the regeneration of individual species for forest replanting, over the last 15 years, with great success. Now it is planning a major research programme on natural and artificial regeneration of mixed forests with a wide genetic range. This will take into account the soil degradation that often follows felling. An important question in this is how far the genetic diversity of the forest insects and animals depends upon the diversity of the trees amongst which they live. The ultimate aim must be to reproduce and manage tropical forests in a sustainable way, while maintaining a very high degree of diversity in its fauna.

Our response to environmental issues should depend on their potential for reversal rather than on their visible impact *(eg a lake turned green by a pollution induced plankton bloom can be restored by water quality management: an extinct species cannot be re-created.)*

2 Sustainable development.

In many subjects research is still needed to predict what development is truly sustainable. The possibility of global climate change makes such predictions much more difficult. 'Sustainable' agricultural investments may be found to be non-sustainable under different climates; eg acceptable levels of effluent may not be so if river flow decreases. A large margin of safety is needed.

More data is still needed to give the understanding of climatic change required for accurate prediction of sustainable development. This is clearly demonstrated by the recent British discovery of the impact of the "plankton multiplier" in global warming.

Earlier this year, analysis of past climates recorded in glacier ice and deep sea sediments led to a major change in the way global warming is viewed. The data shows that changes in ocean biology contributed to the extremely rapid warming of our planet 15,000 years ago. A new (British) theory explains how that change could be caused by subtle variation in the distribution of solar heating. The theory predicts a "plankton multiplier" which in the past provoked major global warmings every 100,000 years or so when triggered by changes in the Earth's orbit. The theory suggests that the plankton multiplier will also work in the next century as atmospheric pollution increases. The result could be a more rapid warming than has been predicted by models which do not include the effect. It is urgent for marine scientists to test the theory and, if it proves correct, to incorporate the plankton multiplier effect into climate prediction models. The international scientific community has responded imaginatively to the challenge with the JGOFS (Joint Global Ocean Flux Study). Marine scientists in Britain are playing a substantial role in that study. Indeed, it is the largest project ever mounted by the Natural Environment Research Council. Results gained from the international expedition in the North Atlantic this year have already advanced the subject substantially, and the first prototype computer model of the plankton multiplier is now running. The result of this research will be more accurate predictions of the timing and magnitude of global warming.

Even with the enhanced knowledge that these research programmes provide, it should not be forgotten that 'sustainable' development may still damage the environment. Tropical tree crops are relatively stable and protective of the soil environment. However, when a crop consisting of one or two tree types is established, the huge variety of micro-habitats found in the great diversity of plants in mature tropical rain forest is lost and with them their associated fauna and flora.

3 Partnership.

The 'North' should set proper standards as examples in its own countries, help in research and development and carefully target its aid. Nothing can remove the responsibility of the 'South' to manage their social and economic systems so as to minimise the environmental damage that is unavoidable, with their aim of rapid development.

5 UK domestic policies.

Greater availability of more detailed, authoritative information in the public arena would enable policies to be targetted more accurately for solving environmental problems, such as those which support sustainable development. This should include much greater use of Environmental Impact Assessments, all fully published, for any development of substance. At present Environmental arguments are too often conducted in newspapers and without the benefit of any authoritative statement of fact or best professional opinion.