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THE WHITE HOUSE
WASHINGTON

May 2, 1990

MEMORANDUM FOR JOHN H. SUNUNU

FROM: D. ALLAN BROMLEY 
SUBJECT: CARBON PROBLEM

I am sorry that it has taken as long as it has to get back to you on this carbon question, but it has turned out to be more complicated than I had previously anticipated. With very substantial help from Bob Watson of NASA, Bob Corell of NSF, Berrian Moore of the University of New Hampshire, and Nancy Maynard of my office, I now believe that I have a reasonably detailed understanding of what is going on and how the various numbers fit together.

I would propose to lay out in this memorandum my understanding of how the numbers are being put together in current publications up to and including the IPCC Working Group Reports. As a reference that ties the rough numbers together, I would suggest that you use the enclosed figure. One that I supplied to you previously.

First of all, a general comment may be in order. As you will see in the following notes, there is a fair degree of definitional confusion that is being used to the advantage of activists in the field. I shall try to be as specific as possible concerning these matters of definition.

- o It has become traditional in the field when discussing doubling to use the preindustrial situation as the base but this is rather infrequently mentioned. The preindustrial burden of carbon in the atmosphere was with reasonable certainty, 600 Gt.

- o In all discussions of doubling, one must understand that there is a missing word. What is being discussed is in fact effective doubling, i.e., one includes all other greenhouse gases, such as methane, nitrous oxide, and ozone, with carbon dioxide and then asks when the total radiative forcing brought about by this mixture of greenhouse gases, will be twice that caused by the pre-industrial atmospheric loading.

- o The increase of carbon dioxide in the atmosphere is perhaps the best known single datum in the whole discussion resulting from the pioneering measurements of Keeling of the Scripps Oceanographic Institution beginning in 1957 in Hawaii as part of the U.S. participation in the International Geophysical Year. These data show that in 1990 the best figure for the atmospheric burden of carbon is 750 Gt (this is larger than the 740 Gt shown in the figure but is a more correct number for the present day situation). Given this number, it is then clear that the carbon content of the atmosphere has increased by 25% with respect to the pre-industrial base.

o However, at the present time, the other greenhouse gases, i.e., methane, nitrous oxide, and ozone together have almost precisely the same radiative forcing impact as does the anthropogenic carbon dioxide which then raises the total radiative forcing by another 25% and leaves us with a radiative forcing term in the atmosphere that is 50% above the preindustrial value.

There is an obvious weakness in this whole argument in that we know relatively less about the methane and nitrous oxide situation in the preindustrial period so that our base is perhaps a little weak but the argument is that the uncertainties that reflect these other gases in the preindustrial period are relatively small.

Despite such questions it is very clear that these numbers represent, by far, the hardest data in the whole carbon cycle.

o In order to do its work the Working Group #1 of IPCC required information on the future emission profile for greenhouse gases and requested such information from Working Group #3. As nearly as I can determine, the three scenarios that are being studied in the IPCC are the result of a rather arbitrary selection of the dates 2025, 2050, and 2090 as representing high emission, medium emission, and low emission scenarios and then working backwards from those arbitrarily selected numbers. There has simply been no very credible, complete attempt to build these effective doubling dates from the bottom up.

Perhaps the most effective study is the one that has been done by EPA and Dutch workers at the request of the IPCC Working Group #3, but in this study only the carbon dioxide emissions have been considered (omitting methane, nitrous oxide, and the like) and the preliminary results of these studies, although not yet released, would seem to suggest that an effective doubling would occur perhaps by 2020, although there is very substantial uncertainty associated with this estimate.

Unfortunately, the IPCC groups in at least the first revision of their working group documents have chosen, instead of presenting analyses based on all three of their scenarios, simply to pick the high emission one with an effective doubling date of 2025 and have also agreed to refer to this as the "business as usual" scenario.

Let me now turn to the question of how the numbers get put together.

o In all the IPCC work, it is assumed that carbon dioxide contributes between 50 and 60% of the total radiative forcing.

o The dominant source of anthropogenic carbon is that resulting from the combustion of fossil fuel shown in the figure as 6 Gt per year. Evidence over the past few years indicates that after more than a decade of relatively constant emissions, our fossil fuel combustion rate has begun to grow again and the assumption is that by the 2020 to 2035 period fossil fuel combustion will correspond to between 7 and 8 Gt a year.

All this being assumed, we are then defining an effective doubling as corresponding to the situation where we have 900 Gt of carbon in the atmosphere—carbon up by 50% over the preindustrial value with the other greenhouse gases contributing an additional 50%. This is obviously a misleading situation because in fact the carbon is only increasing by 50% and yet everyone is talking about doubling without making it at all clear that other greenhouse gases are involved.

- o Given that we are now at 750 Gt in the atmosphere, we then require only another 150 Gt.

- o It is always assumed, however, that 50% of the anthropogenic carbon is removed from the atmosphere so that we would then require an emission of 300 Gt and at an emission rate of 6 Gt per year from fossil fuel combustion, we come up by simple arithmetic with effective doubling in 50 years, i.e., by 2040. Obviously if we agree with the IPCC that the emission rate from fossil fuel combustion will rise between now and that time, the date at which effective doubling occurs will be earlier. If it were to average say 7.5 Gt per annum, we would be talking reaching the effective doubling point in 2030.

Contrary to what I mentioned to you earlier, the carbon release from the manufacture of Portland Cement through dehydration of calcium carbonate, contributed only a few percent of that due to fossil fuel combustion and is not considered in most of these discussions. It had been raised in earlier papers as being potentially a much more serious contributor but the more quantitative estimates of the last few years have reduced its importance.

There is obviously another source of carbon release from the earth's surface through deforestation. In the figure this is indicated at 2 Gt per year, but a very detailed estimate carried out in 1980 could only put the number at somewhere between 0.6 and 2.5 Gt per annum. The number is very poorly known and in most current calculations it is taken as 1.6 Gt per year, or frequently rounded as here to 2 Gt per year.

- o The above mentioned Hawaiian data allow us to say with considerable certainty that we are adding between 3 and 3.5 Gt of carbon to the atmosphere each year at the present time.

- o We are then faced with a open question. If we add up the deforestation and fossil fuel contributions and set them equal to 7.5 Gt per year, and if 3.5 Gt, let us say, stays in the atmosphere, where does the remaining 4 Gt per year go?

- o Classically, it has always been assumed in recent calculations that the ocean uptake is 2.5 Gt per year, but this number could be anywhere between 1 and 3 Gt per year and the IPCC has chosen to use a value of 2 Gt per year in its calculations. The measurements of carbon dioxide partial pressure in the oceanic surface waters has been extremely spotty and limited to only some parts of the ocean so that our knowledge of its present value is relatively uncertain.

o However, when we add up these numbers, we come up with something like 2 Gt per year carbon that is missing. Some assume that it must be taken up by the terrestrial biosphere in mid-latitudes and others assume that for unspecified reasons, the deforestation contribution must be very close to zero rather than the usually assumed 2 Gt per year. It is quite clear that there is no good scientific basis for either of these suggestions and it is also clear that those in the field are simply working backwards and trying to explain this missing carbon in some plausible fashion.

o The question of the possible sequestering in mid-latitude terrestrial biota raises the question of one of the many feedback loops that have not been adequately considered. We know that over the past 50 years there has been a regrowth of forests in the mid-latitudes largely because of a migration from rural to urban societies, and it is entirely possible that the nitrous oxide, and to a lesser extent, sulphur dioxide, released from industrial processes could have acted as fertilizer and thus stimulated biomass carbon sequestration. Indeed, the mere presence of more CO_2 could itself have acted as a fertilizer and increased growth rates.

o It has become quite clear in the recent past that the controlling factor in ocean sequestration of carbon is not in the atmosphere ocean interface but rather in the effectiveness of the translation mechanism which carries carbon from the surface to the much deeper water. However, these transport mechanisms are very poorly understood.

o Given all of the above, you have some feeling for some of the uncertainties involved and, I hope, a better feeling for the basic thrust of the IPCC calculations as to effective doubling times.

o Having established a doubling time, one then turns to the global circulation models to try to establish what impact the increase in radiative forcing would have on global temperatures and the like. The best IPCC estimate at the moment lies in the range of 1.4 to 2.9 degrees centigrade relative to the preindustrial situation.

o These models would also predict that today's global temperature should have increased between 0.5 and 1.1 degrees centigrade relative to that in say, 1750. There is general agreement in the scientific community that on average there has been something like a 0.5 degree centigrade in the mean global temperature over this period. And this would, therefore, fall at the low end of the model predictions if all of the warming could be attributed to anthropogenic carbon. Obviously it cannot.

o There are several possibilities. The observed warming could be attributed to purely natural fluctuations and there is clear evidence in the paleoecological ice core data of such fluctuations in the past, although these data are not sufficiently accurate to really pin this down with satisfactory precision. Alternatively, the observed increase could result from the superposition of an anthropogenic signal and a natural one and, since we have no way of knowing apriori what the natural signal is, we are left with substantial uncertainty. It is quite clear, however, that we are not talking about the 5 degrees centigrade predictions that have gained substantial publicity.

o As something of a footnote, and simply to illustrate some of the difficulties here, it should be noted that in the IPCC calculations it is assumed that we retain 50% of our current CFC emissions in the industrialized world plus some estimate of growing use in the developing world. Whereas, given present indications it is entirely possible that a very large fraction of the most potent CFCs will be removed from the atmosphere by about 2000. If this is the case, of course, the IPCC calculations overestimate the future radiative forcing but the effect is not all that large. If one were to assume that the CFCs were removed effectively by the year 2000, then we move the effective doubling time back by between 10 and 15 years.

This is typical of the uncertainties that lurk throughout this entire question, not to mention the whole series of feedback loops that are only beginning to be examined.

I am enclosing herewith the third draft of a section of the first IPCC Working Group Report that deals with greenhouse gases and aerosols and, as you will note, considers in section 1.2.7 a number of the possible oceanic and terrestrial feedback mechanisms. This at least represents a start in the right direction. This particular chapter has, like all the others, not been scrubbed by any of the IPCC participating governments but it has been prepared by a group led by Bob Watson and I think is a workman-like job in general.

I hope that this is helpful. I've concluded that relatively few people who have been engaged in the global warming discussions really understand what is going on with the numbers and I have attempted to spell out my best understanding here.

Enclosures

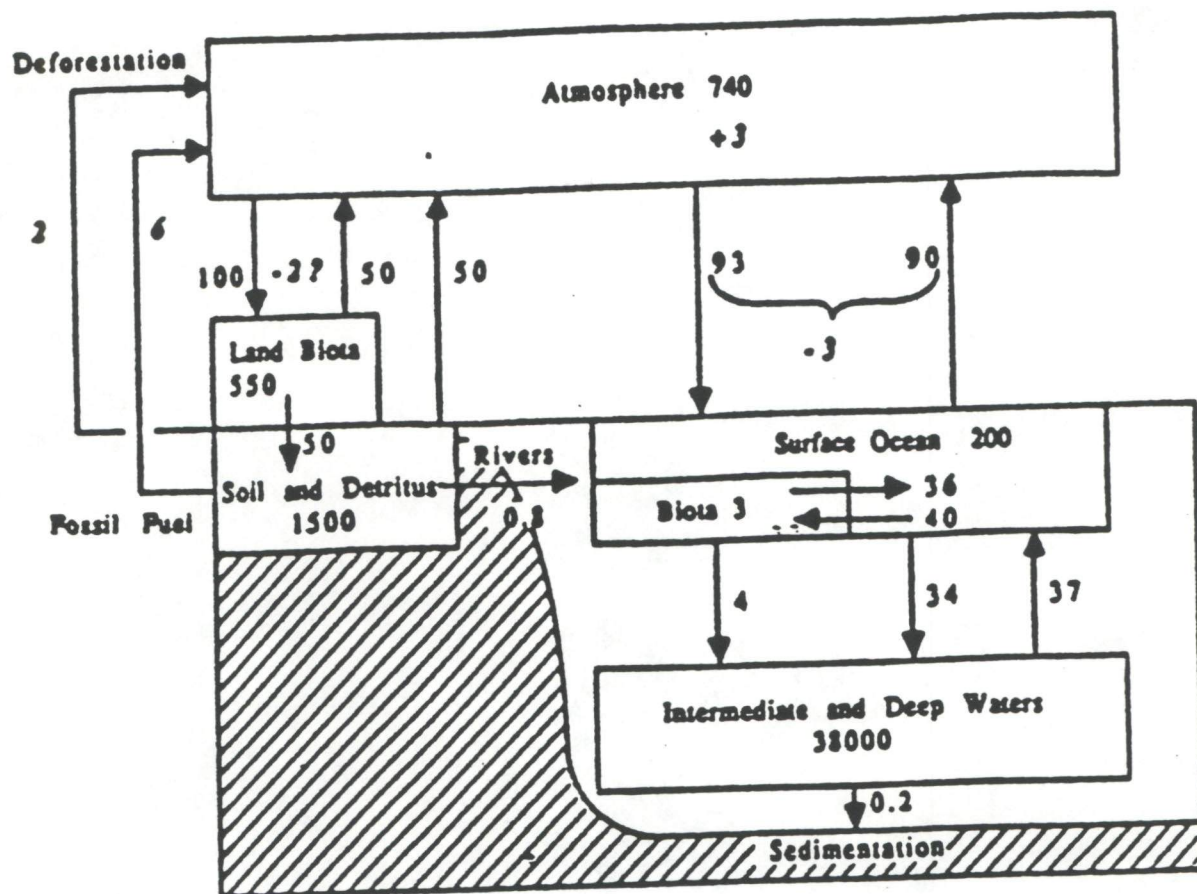


Figure 1: Global carbon reservoirs and fluxes. The numbers apply for the present-day situation and represent typical literature values. Fluxes, e.g. between atmosphere and surface ocean, are gross annual exchanges. Numbers in bold-face italics indicate net annual perturbation fluxes to the atmosphere and annual atmospheric CO_2 increase due to human action. Units are gigatons of carbon (GtC; $1\text{Gt} = 10^9$ metric tons = 10^{12}kg) for reservoir sizes and GtC yr^{-1} for fluxes. More details and discussions are found in several reviews (Sundquist, 1985; Trabalka, 1985; Bolin, 1986; Siegenthaler, 1986).

NOTES FROM
PCC-GLOBAL CLIMATE WORKING GROUP
JANUARY 16, 1991
STATE DEPARTMENT

Ken,
Fy1
Vickie

Vickie V. Sutton

Dan Evans did his presentation a second time for the PCC group, after he left Bromley's presentation this morning.

His presentation was fairly consistent with the Bromley presentation, except he did not cite a specific miles per gallon quotation, instead saying they did not have specific figures on it yet. One of his associates asked me to relay to Dr. Bromley that the 40 MPG figure was a bit exaggerated.

In the discussion about reductions of 10-40% of greenhouse gas emissions, he said that it could be "accomplished by the nation at a fairly low cost." The 40% end of the spectrum assumed total penetration.

Buff Bohlen and Zeigler were being briefed at 10:45a.

Negotiating Session in February:

The first reception will be on February 6, Wednesday, from 7-9pm in the Air and Space Museum, hosted by Buff Bohlen. Everyone is invited to attend from the PCC group. Invitations will not be sent out because they are "trying to save money" since they are footing the whole bill for the negotiating session.

Brussels Meeting, January 28-29, 1990:

The Brussels meeting delegation includes: Howard Gruenspecht, Chris Dawson, Dan Esty, Jonathan Weiner, JR Spradley, Bob Reinstein, Dick Morgenstern, and ???

They will have a meeting in Room 7835 on Tuesday, January 22, 1991 at 10am.

Briefing Book:

The briefing papers passed out at the meeting today, need to be commented on by Friday COB to Jonathan PERshing at 647-4069.

Science and Economics paper: DOE has drafted targets and timetables, but it is being held up for consistency with the Bromley group paper; and the NES. [The primary concern; however, is that Watkins does not want the NES figures released!]

Also, Bob Watson, NASA (I think) said that CEES needed until Tuesday noon to go through the paper and sign off on it.

OMB Circular 175: Reported that it was distributed by the Bromley group and "once it is finished, it will be on its way"

Gohal planning
file

M. Thatcher's talk
March 26, 1990

Document Originally
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* * * * *

TO: NANCY MAYNARD USA (202) 395-3719

COMPANY: OFFICE OF SCIEN. TECHNOL. POLICY.....

FROM: BOB WATSON & DAN ALBRITTON

DEPARTMENT: IPCC WG 1, WINDSOR, UK

DATE: 25 MAY 90 TOTAL PAGES: Cover and 9 pages
to followOUR FAX NUMBER: 0784 - 430596
OUR TEL NUMBER: 0784 - 434355

MESSAGE:

This is the printed text of Mrs. Thatcher's speech. We do not know what she actually said (only a small group was present). We add a few comments to the attached text.

Dan & Bob

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PRIME MINISTER'S SPEECH

AT THE

OPENING

OF THE

HADLEY CENTRE FOR CLIMATE

PREDICTION AND RESEARCH

ON

FRIDAY 25 MAY

24 MAY '90 09:39

P.3

- 2 -

Many of us have been worried for some time now about the accumulating evidence of damage to the global environment and the consequences for life on earth and for future generations. I spoke about this to the Royal Society in 1988 and to the United Nations General Assembly in November last year.

Today, with the publication of the Report of the Inter-Governmental Panel on Climate Change, we have an authoritative early warning system: an agreed assessment from some three hundred of the world's leading scientists of what is happening to the world's climate. They confirm that global warming is taking place as a result of man's activities; and that it will continue, with consequences which are capable of prediction. We want to predict these more accurately. That's why we are opening this centre today.

We have, therefore, a Report of historic significance. It's not something arcane or remote from everyday concerns: what it predicts will affect our daily lives. Governments and international organisations in every part of the world are going to have to sit up and take notice and

this is not correct. the report does not assert that the current warming trend is due to man's activities. Rather, it only the summary has actually been made available thus far

24 MAY '90 09:40

P.1

- 3 -

respond.

Of course there is a lot more that we still need to find out. But if the Panel's predictions are broadly right, then the world could become hotter than at any time in the last 100,000 years [and can I remind you that Abraham was around only 5,000 years ago]. We know that there have been major changes in the world's climate and environment in the past. For instance, in this country you could grow vines as far north as Edinburgh in Roman times, and fossils of serpents have been found from even more ancient times. But the changes which we are talking about now will occur at a faster rate than anything our natural world has known in the past. One of the effects could be a great migration of animal and plant life, and possibly the loss of some of them altogether. The calculation has been made that a one degree rise in temperature would over time lead forests to move 100 kilometres further north and some ordinary farming crops may move 200-300 kilometres further north. Just imagine the effects on farming, on the CAP, and on the sort of crops you can grow in particular areas - and on nature reserves. They might find themselves in the wrong places, if the flora and fauna which

they are meant to protect migrate.

Changes in the sea level as the sea expands could also affect our lives considerably. At a Commonwealth Heads of Government Meeting a year or two ago, the President of the Maldives reminded us that none of his country was more than six feet above sea-level, and the consequences of a significant overall rise in the sea-level could be one less member of the Commonwealth. Other low-lying countries like Bangladesh would be badly affected, and there would surely be a great migration of population away from areas of the world liable to flooding, and from areas of declining rainfall and therefore of spreading desert. Those people will be crying out not for oil wells but for water.

Of course every detail, every particular, may not be quite right. It very rarely is when you are trying to predict the future. There is still a great deal of work for the scientists to do, particularly in trying to estimate the detailed distribution of the effects of global climate change which I have described. As the Panel's report itself will make clear, we should have a better understanding of many of these things in ten or

out of the air and storing it. It stands to common sense that these figures are going to go up as the world's population increases, with greater intensity of agriculture, more destruction of forests and woodlands, and more use of fossil fuels. When I was born, the world's population was some 2 billion people. My grandson is going to grow up in a world of more than 6 billion people, and the predictions are that we shall have 10 billion people by the middle of the next century. Whichever way you look at it, problems are bound to arise as a result of going from 2 billion to 10 billion in such a short time. Putting them right will be all the harder until we succeed in curbing that rate of population growth.

The second conclusion that can already be drawn is that more than ever we are one world. The fact is that you cannot divide up the atmosphere into segments and say: all right, we'll look after our bit and you look after yours. We shall only be able to deal with the problems by a giant international effort, in which we all co-operate.

And that leads on to the third conclusion: we would be taking a

establish a realistic international programme of action and an equally

realistic time-table. Discharges of carbon dioxide and CFCs, if unabated, will go on accumulating in the atmosphere and cannot be reversed. Even the most urgent measures now cannot fully repair the damage of the past. But action now will prevent the problem from becoming acute and give us time to improve our predictions and enlarge our understanding. The Panel's report will present us with a very full agenda for the next fifteen years up to 2005 and we should start on it without delay.

May I wish this Hadley Centre and all who work here every success.

Your task is no less a one than to help us safeguard the future of our planet. May we all be equal to that task.

25 May 1990

MEMORANDUM FOR: Alan Bromley

FROM: Bob Watson *Bob.*
Dan Albritton *Dan*

SUBJECT: IPCC WG 1 Executive Summary

We attach the final version of the Executive Summary of the IPCC Working Group 1. It is a 3-page condensation of the approximately 35-page Policymaker's Summary. The final version of the latter will be available sometime next week, and we will send you a copy as soon as we obtain it. We may be able to get a marked-up next-to-final version to you somewhat sooner.

The attached Executive Summary will be made available to the public. The Chairman of Working Group 1 will give a press conference here today and the Executive Summary will be available. It will also be the basis of Mrs. Thatcher's speech this morning at the opening of the Climate Center.

That speech portends to be quite pro-active regarding global warming and actions to limit it. We hope to have a copy of that speech later today and will fax it to you also.

We add a few comments here with regard to the attached Executive Summary. It incorporates many (but not all) of the U. S. suggestions. We think that the Summary is an adequate representation on the Policymaker's Summary. Compared to the earlier version (Third Draft, 2 May 1990), the most significant changes are the following:

- o First statement ("We are certain of ..."). first bullet: This version clarifies what is "real", i.e., the natural greenhouse effect. Hence, misinterpretation is less likely than with the earlier version.
- o First statement, second bullet: There are still a lot of "wills", but it now has a few balancing words like "on average". The statement on the water vapor feedback is stronger here than in the previous version.
- o Third statement, first two bullets: All four of the IPCC Scenarios are mentioned, and they are explicitly identified as "scenarios" (in contrast to the implication that they are

"predictions"). The predicted temperature increases are referenced to today's temperature, rather than the pre-industrial temperature.

- o Third statement, first bullet: The fact that this prediction has uncertainty is now better reflected, to some extent, in the use of the word "likely" in the next-to-the-last sentence.
- o Fourth statement: The topics for which there is the most uncertainty now appear in the title.
- o Fifth statement: The comparability of the observed temperature change to natural variation has been moved forward to the first sentence.
- o Sixth statement: The first three bullets are now consistent with the U. S. Global Change Research Program's three goals of "observe, understand, and predict". The needs for expanding research to address the uncertainties and better international data exchange now appear explicitly.

We would be pleased to give you a short summary of the process next week, if you wish.

cc: Nancy Maynard

Intergovernmental Panel on Climate Change Working Group I

SCIENTIFIC ASSESSMENT OF CLIMATE CHANGE

Report to IPCC, 25 May 1990

Executive Summary

We are certain of the following:

- there is a natural greenhouse effect which already keeps the Earth warmer than it would otherwise be.
- emissions resulting from human activities are substantially increasing the atmospheric concentrations of the greenhouse gases: carbon dioxide, methane, the chlorofluorocarbons and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface. The main greenhouse gas, water vapour, will increase in response to global warming and further enhance it.

We calculate with confidence that:

- some gases are potentially more effective than others at changing climate, and their relative effectiveness can be estimated. Carbon dioxide has been responsible for over half the enhanced greenhouse effect in the past, and is likely to remain so in the future.
- atmospheric concentrations of the long-lived gases (carbon dioxide, nitrous oxide and the CFCs) adjust only slowly to changes in emissions. Continued emissions of these gases at present rates would commit us to increased concentrations for decades to centuries. The longer emissions continue to increase at present day rates, the greater reductions would have to be for concentrations to stabilise at a given level.
- the long-lived gases would require immediate reductions in emissions from human activities of over 60% to stabilise their concentrations at today's levels; methane would require a 15-20% reduction.

Based on current model results, we predict:

- under the IPCC Business-as-Usual (Scenario A) emissions of greenhouse gases, a rate of increase of global mean temperature during the next century of about 0.3°C per decade (with an uncertainty range of 0.2°C to 0.5°C per decade); this is greater than that seen over the past 10,000 years. This will result in a likely increase in global mean temperature of about 1°C above the present value by 2025 and 3°C before the end of the next century. The rise will not be steady because of the influence of other factors.
- under the other IPCC emission scenarios which assume progressively increasing levels of controls, rates of increase in global mean temperature of about 0.2°C per decade (scenario B), just above 0.1°C per decade (scenario C) and about 0.1°C per decade (scenario D).
- that land surfaces warm more rapidly than the ocean, and high northern latitudes warm more than the global mean in winter.
- regional climate changes different from the global mean, although our confidence in the prediction of the detail of regional changes is low. For example, temperature increases in Southern Europe and central North America are predicted to be higher than the global mean, accompanied on average by reduced summer precipitation and soil moisture. There are less consistent predictions for the tropics and the southern hemisphere.
- under the IPCC Business as Usual emissions scenario, an average rate of global mean sea level rise of about 6cm per decade over the next century (with an uncertainty range of 3 - 10 cm per decade), mainly due to thermal expansion of the oceans and the melting of some land ice. This amounts to a rise of about 20cm in global mean sea level by 2030, and 65cm by the end of the century. There will be significant regional variations.

There are many uncertainties in our predictions particularly with regard to the timing, magnitude and regional patterns of climate change:

- sources and sinks of greenhouse gases, which affect predictions of future concentrations
- clouds, which strongly influence the magnitude of climate change
- oceans, which influence the timing and patterns of climate change
- polar ice sheets which affect predictions of sea level rise

These processes are already partially understood, and we are confident that the uncertainties can be reduced by further research. However, the complexity of the system means that we cannot rule out surprises.

Our judgement is that:

- Global - mean surface air temperature has increased by 0.3°C to 0.6°C over the last 100 years, with the five global-average warmest years being in the 1980s. Over the same period global sea level has increased by 10-20cm. These increases have not been smooth with time, nor uniform over the globe.
- The size of this warming is broadly consistent with predictions of climate models, but it is also of the same magnitude as natural climate variability. Thus the observed increase could be largely due to this natural variability; alternatively this variability and other human factors could have offset a still larger human-induced greenhouse warming. The unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more.
- There is no firm evidence that climate has become more variable over the last few decades. However, with an increase in the mean temperature, episodes of high temperatures will most likely become more frequent in the future, and cold episodes less frequent.
- Ecosystems affect climate, and will be affected by a changing climate and by increasing carbon dioxide concentrations. Rapid changes in climate will change the composition of ecosystems; some systems will benefit while others will be unable to migrate or adapt fast enough and may become extinct. Enhanced levels of carbon dioxide may increase productivity and efficiency of water use of vegetation. The effect of warming on biological processes, although poorly understood, may increase the atmospheric concentrations of natural greenhouse gases.

To improve our predictive capability, we need:

- to **understand** better the various climate-related processes, particularly those associated with clouds, oceans and the carbon cycle
- to improve the systematic **observation** of climate-related variables on a global basis, and further investigate changes which took place in the past
- to **develop** improved models of the earth's climate system.
- to **increase** support for national and international research activities, especially in developing countries
- to **facilitate** international exchange of climate data

1. We applaud Mrs. Thatcher's commitment to furthering understanding of global climate issues by increasing Britain's research budget by 5.5 million pounds. This will complement the United States' 1 billion dollar global research effort.

2. Current Bush Administration policy responses to potential climate warming will result in a reduction of "greenhouse gases" on par with what PM Thatcher announced today. The steps we are taking now, pending a more certain scientific understanding of the global climate, will result in a reduction of these gases by some/over 25% from presently projected levels in the year 2000. Thatcher's suggestion today of targeting a 30% reduction by 2005 is "in the same ballpark" as current U.S. policy will achieve.

[ONLY IF ASKED ABOUT THATCHER'S COMMENTS ON THE SCIENCE...]

3. The reporting on Thatcher's speech today has tended to oversimplify the actual findings of the IPCC working groups by not reflecting the degree of uncertainty that has yet to be resolved. We agree that our predictive capabilities of climate systems need to be strengthened and in fact this is an important part of our research program.

Global Change
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IPCC 4TH PLENARY SESSION

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1. SUMMARY, THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) APPROVED ITS FIRST ASSESSMENT REPORT ON CLIMATE CHANGE AT ITS FOURTH PLENARY SESSION IN SUNDSVALL, SWEDEN, AUGUST 27-31. DESPITE EFFORTS BY SOME DEVELOPING COUNTRIES SEEMINGLY DESIGNED TO PREVENT COMPLETION OF A REPORT AT SUNDSVALL, AGREEMENT WAS REACHED AT 3:00 A.M. ON AUGUST 31 AFTER A VERY DIFFICULT MEETING. THE IPCC REPORT WILL NOW BE TRANSMITTED TO THE PARENT UN BODIES (WMO AND UNEP), THE SECOND WORLD CLIMATE CONFERENCE, AND THE U.N. GENERAL ASSEMBLY AS ORIGINALLY SCHEDULED, THUS PAVING THE WAY FOR THE START OF FORMAL NEGOTIATIONS ON A FRAMEWORK CONVENTION ON CLIMATE CHANGE. END SUMMARY.

2. THE IPCC FOURTH PLENARY SESSION WAS HELD IN SUNDSVALL, SWEDEN FROM AUGUST 27-30 UNDER THE CHAIRMANSHIP OF DR. BERT BOLIN OF SWEDEN. 72 COUNTRIES PARTICIPATED, INCLUDING 42 DEVELOPING COUNTRIES (UP FROM A TOTAL OF 33 LDCS AT THE FEBRUARY PLENARY SESSION IN WASHINGTON). THE U.S. DELEGATION WAS HEADED BY DR. FRED BERNTHAL, DEPUTY DIRECTOR, NATIONAL SCIENCE FOUNDATION;

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THE ALTERNATE U.S. REPRESENTATIVE WAS ROBERT REINSTEIN, DEPUTY ASSISTANT SECRETARY FOR ENVIRONMENT, HEALTH AND NATURAL RESOURCES, DEPARTMENT OF STATE.

3. THE PRIMARY PURPOSE OF THE FOURTH PLENARY SESSION WAS TO APPROVE THE IPCC'S FIRST ASSESSMENT REPORT ON CLIMATE CHANGE SCIENCE, IMPACTS, AND RESPONSE STRATEGIES. IPCC CHAIRMAN BOLIN BEGAN BY INVITING COMMENTS FROM THE PARTICIPATING COUNTRIES ON THE DRAFT EXECUTIVE SUMMARY AND OVERVIEW AND CONCLUSIONS PAPER, WHICH HE HAD PREPARED IN CONSULTATION WITH THE WORKING GROUP CHAIRMEN. SOME DELEGATIONS, INCLUDING THE U.S. AND JAPAN, DIRECTED THEIR COMMENTS PRIMARILY AT THOSE SECTIONS OF THE DRAFT PAPER WHICH THEY FELT DID NOT FULLY REFLECT THE CAREFUL BALANCE STRUCK IN THE UNDERLYING WORKING GROUP REPORTS. THESE INCLUDED AN OVERSTATEMENT OF WHAT IS KNOWN ABOUT THE SCIENCE OF CLIMATE CHANGE AND A LACK OF RECOGNITION OF THE FACT THAT THE IPCC WAS UNABLE TO UNDERTAKE A FULL ANALYSIS OF VITAL ECONOMIC ISSUES. FOR THESE AREAS, THE U.S. AND OTHER DELEGATIONS PROPOSED ADDING SPECIFIC QUOTES FROM THE UNDERLYING DOCUMENTS IN ORDER TO MAINTAIN A MORE BALANCED PRESENTATION.

4. OTHER DELEGATIONS, LED BY BRAZIL, EXPRESSED DISSATISFACTION WITH THE ENTIRE IPCC PROCESS, IN PARTICULAR THE LACK OF PARTICIPATION BY DEVELOPING COUNTRIES IN IPCC WORKING GROUP ACTIVITIES. THESE DELEGATIONS SOUGHT TO BLOCK A CONSENSUS ON A FINAL TEXT, ARGUING THAT THE REPORT SHOULD EMPHASIZE SUCH ISSUES AS THE PROVISION OF NEW AND ADDITIONAL FINANCIAL RESOURCES TO LDCS, THE PREFERENTIAL TRANSFER OF ENVIRONMENTALLY SOUND TECHNOLOGIES, AND THE ROLE OF THE UNGA IN PREPARATIONS FOR NEGOTIATIONS ON A FRAMEWORK CONVENTION. AT ONE POINT, WHEN CONSENSUS SEEMED IMPOSSIBLE, IT WAS SERIOUSLY CONSIDERED THAT THE IPCC MEET AGAIN IN SEPTEMBER IN GENEVA TO COMPLETE ITS CHARGE.

5. THE NORTHERN EUROPEAN COUNTRIES, WHICH HAVE ACTIVELY CALLED FOR SPECIFIC AGREEMENT ON GREENHOUSE GAS TARGETS AND TIMETABLES, WERE NOT SO OUTSPOKEN AT THE SUNDSVALL MEETING. PERHAPS RECOGNIZING THE IMPORTANCE OF HAVING THE IPCC COMPLETE A REPORT AS AN PREREQUISITE FOR THE FRAMEWORK CLIMATE CONVENTION NEGOTIATIONS, THEY PLAYED A MODERATING ROLE IN SEEKING AGREEMENT ON MAJOR AREAS OF CONTENTION.

6. IT SOON BECAME EVIDENT THAT CONSENSUS COULD NOT BE REACHED ON THE 40 PAGES OF THE OVERVIEW AND CONCLUSIONS PAPER AS DEVELOPING COUNTRIES CONTINUED TO RAISE

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OBJECTIONS WHICH COULD NOT BE RESOLVED IN SMALL WORKING GROUPS. BY THE AFTERNOON OF AUGUST 30, AGREEMENT IN PRINCIPLE HAD BEEN REACHED ONLY ON PORTIONS OF THE EXECUTIVE SUMMARY OF THE FINAL IPCC REPORT AND FRAGMENTS OF THE "OVERVIEW AND CONCLUSIONS" PAPER.

7. AS A RESULT OF THE IMPASSE, IPCC CHAIRMAN BOLIN PROPOSED TO PROCEED BY RADICALLY CHANGING THE STRUCTURE OF THE FINAL IPCC REPORT. IT WAS AGREED TO ELIMINATE THE 35-PAGE OVERVIEW AND CONCLUSIONS PAPER AND COMPLETE INSTEAD AN ENLARGED EXECUTIVE SUMMARY, TO BE CALLED SIMPLY "OVERVIEW", BASED ON WORK DONE AT SUNDSVALL. THE FINAL IPCC REPORT WOULD THUS CONSIST OF THIS "OVERVIEW" TOGETHER WITH THE ALREADY COMPLETED POLICYMAKERS SUMMARIES OF THE THREE IPCC WORKING GROUPS, AND THE FULL REPORT OF THE SPECIAL COMMITTEE ON DEVELOPING COUNTRY PARTICIPATION. BASED ON THIS AGREEMENT, WORK ON COMPLETING THE IPCC EXECUTIVE SUMMARY RESUMED AND A FINAL TEXT WAS SUMMARILY APPROVED AT 3:00 A.M. ON AUGUST 31.

8. FROM THE U.S. PERSPECTIVE, THE FINAL IPCC TEXT IS HIGHLY DESIRABLE BECAUSE IT IS DRAWN LARGELY VERBATIM FROM THE UNDERLYING DOCUMENTS AND THUS MAINTAINS THE CAREFUL BALANCE REACHED BY THE IPCC WORKING GROUPS. THE FINAL IPCC REPORT REFLECTS THE FULL RANGE OF VIEWS EXPRESSED ON CLIMATE CHANGE AND PROVIDES A SOUND BASE FROM WHICH TO INITIATE NEGOTIATIONS ON A FRAMEWORK CONVENTION. THE IPCC REPORT WILL NOW BE TRANSLATED, PUBLISHED, AND FORMALLY PRESENTED TO THE SECOND WORLD CLIMATE CONFERENCE. WITH THE REPORT APPROVED, THE WMO/UNEP ORGANIZATIONAL MEETING IN GENEVA FROM SEPTEMBER 24-26 CAN NOW PROCEED AS SCHEDULED AND MAKE THE NECESSARY PREPARATIONS FOR THE START OF FORMAL NEGOTIATIONS TOWARD A FRAMEWORK CONVENTION ON CLIMATE CHANGE IN EARLY FEBRUARY. 44

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DPC GCWG - Rump Session

February 15, 1990

1. Attendees:

D. A. Bromley
M. Boskin
M. Deland
F. Bernthal
D. Reifsneider (with FB)
R. Grady
S. Danzansky
R. Corell
F. Keel
N. Maynard
K. Yale
B. McBee

2. Corell will have the revised version of the issues paper for review by the group.
3. Corell and Keel are prepared to discuss the status of preparations for the Conference, such as:
 - . Budget (must have resolution - can not move forward without)
 - . Location
 - . Logistics
 - . Agenda (with speakers, special events, etc)
 - . Working group activities
4. Any other issues you wish to have the GCWG address tomorrow?

90-08-30 20:38 FROM:

ID:

SID 1

Fax Message to Dr. John Knauss, Undersecretary of Commerce for
Oceans and Atmosphere

Fax: 202-377-8203

Also, please pass to Dr. E.W. Friday, Jr., Assistant
Administrator for

Weather Services

Fax: 301-587-4524

*Global
Change
file*

By Thursday at 6 PM, the IPCC-IV had only completed work on the scientific part of the Executive Summary of the Overview and Conclusions document as well as about 20 pages of the main text. The impacts part of the Executive Summary was available in draft but had not yet been discussed in plenary while the response strategies part was being hotly debated word for word in plenary. A working group meeting was unable to produce a draft of the response strategies part of the document after three hours discussions the evening before.

Most delegates still feel that an executive summary can be finished by 11 PM despite the departure at 6 PM of the interpreters and a few of the delegates who had originally expected the session to conclude by noon. The First Assessment Report may consist of the agreed Executive Summary plus five annexes: the three Policymakers Summaries, the report of the developing countries, and the legal measures paper.

Some delegations (notably USSR, Brazil, and Saudi Arabia) proposed a 3-day meeting in September in Geneva before the preparatory meeting for the framework convention to finish the main text of the Overview and Conclusions with the idea that the Executive Summary would be issued as a report of this meeting only. The Western Europeans, the U.S. and others were not in favor of this additional meeting. Most felt that it would look bad to leave this meeting without an IPCC Report of some form.

The conduct of the meeting left much to be desired. Perhaps entertaining written comments before the meeting and coming in with new text with comments would have made things go more smoothly. Because of the many U.S. interventions, we are being perceived as obstructionists to the production of a report by other delegations and the press. By Thursday, the number of U.S. interventions had been greatly reduced leaving most comments to be made by others first, but the obstructionist perception persisted and whatever intervention was made by the U.S. was usually debated strongly by others.

A lot of hallway discussion took place regarding the preparations for the framework convention including the chairman and secretariat, and the drafting session for the SWCC ministerial declaration and its chairman. The U.S. passed out its own draft for the SWCC ministerial declaration and found much sympathy for our approach especially among the several WMO Perm Reps at this meeting.

- 2 -

While the exact handling of the secretariat for the framework convention was unresolved, Tolba had suggested that it be split between WMO and UNEP while Obasi wanted it to be at WMO headquarters for economy of effort, making use of the vacated offices of the SWCC Coordinating Office after December 1990.

The likely chairman for the framework convention preparatory meeting will be Topkov (Bulgaria) who is the current UNEP Governing Council Chairman. The likely co-chairman for the drafting session for the SWCC ministerial declaration will be Zou (China), WMO President and Topkov.

J. R. Spradley
Martin C. Yerg, Jr.

Ken Y

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

August 28, 1990

MEMORANDUM TO STEPHEN FARRAR
SPECIAL ASSISTANT TO THE PRESIDENT FOR
POLICY DEVELOPMENT AND ASSOCIATE DIRECTOR FOR
INTERNATIONAL ECONOMIC POLICY

FROM: NANCY MAYNARD *NM*
OFFICE OF SCIENCE AND TECHNOLOGY POLICY

ROBERT W. CORELL *RWC*
NATIONAL SCIENCE FOUNDATION

SUBJECT: REFERENCE MATERIAL ON GLOBAL CHANGE FOR MEETING
WITH PRIME MINISTER THATCHER

In preparation for the upcoming meeting with Prime Minister Thatcher, we have put together some reference materials for Drs. Sununu and Porter. Included is a set of background notes on major upcoming events or meetings on global change as well as some information from recent conversations with representatives of the UK government to provide clues to their current thinking. If you have any questions, please do not hesitate to call.

Update - The UK, Global Change, and the US

1. Representatives from the British government have recently approached several of us (OSTP, NSF, NASA) to urge that the US and UK work much more closely on the issue of global change because they feel that we are not very far apart on the substance of the issue and that we can make alot more progress on essentially common interests if we work together. Specifically, they feel quite strongly that we should join together in our preparations for the Framework Convention in order to negotiate an agreement which is most acceptable to both countries.

*** Last week, in fact, Sir Terrance Heiser (Permanent Secretary, Dept. Environment) was in Washington and made a point to meet with EOP and agency people on the need for the 2 countries to work together as we approach the Framework Convention negotiations and the Second World Climate Conference. (He was very interested in both President Bush's and Dr. Sununu's views on various aspects of global change.)

Specifically, he noted that they feel quite strongly that we should join together in our perparations for the Framework Convention in order to negotiate an agreement which is most acceptable to both countries.

- . They assume that we, like they, want to negotiate a Vienna-type Convention with protocols. (If we do not plan to follow this model, we may want to consider working with them to plan a joint strategy.)
- . They think we should be working on the Protocols within the near future (e.g., a Science Protocol)
- . Sir Heiser is just completing a government white paper on "UK Policy on Global Change"; however, we haven't been able to get a copy or any hint of its substance.

**Background Notes
on
Science and Policy Issues Related to Global Change
(August, 1990)**

MAJOR EVENTS OR MEETINGS:

IPCC - The Intergovernmental Panel on Climate Change (IPCC)

The IPCC is holding its fourth Plenary Session in Sundsvall, Sweden, August 27-30, 1990. The IPCC functions under the auspices of the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP), both UN organizations. The principle agenda items of the meeting are:

1. Approve the Final IPCC Report, in particular the Policymakers Summary. The U.S. position on the Policymakers Summary, also known as the July 1990 Draft "IPCC Overview and Conclusion Summary" was articulated to the IPCC Chairman, Dr. Bert Bolin, in a letter from Dr. Fred Bernthal dated August 20, which stated that the U.S. position on the Overview and Conclusions Summary is "that the careful balance which was struck in the Working Groups and conveyed in their Reports has not been maintained in this draft." The U.S. suggested to Bolin that "you may wish to consider a significantly shorter Overview and Conclusions document, drawing heavily on the three executive summaries (taken from the three IPCC Working Group Reports on Science, Impacts, and Response Strategies) to which the underlying summaries for Policymakers would be attached." A telephone report from Dr. Robert Watson who is the lead scientist on the U.S. delegation in Sundsvall indicates:
 - o As of Monday night, only broad delegation statements and general talks (Obasai and Tolba) had been made.
 - o Watson had gone over US comments with Bolin and thought there was a good chance our points will be incorporated but cautioned that it was early in the meeting to predict outcome. He will try to call in each day for update.
2. Consider the future workplan and structure of the IPCC.

There are several other items that may be considered at the Sundsvall IPCC meeting, including the fact that the Noordwijk ministerial meeting on climate change approved a "remand" that specifically requested the IPCC to provide inputs to the Second World Climate Conference (

October 29, November 7, 1990) concerning greenhouse gas emissions targets. The other issue that is likely to be addressed is the Framework Convention on Climate Change that is proposed for February 1991, and which the President Bush has indicated the U.S. will host.

WMO - UNEP MEETINGS

The WMO and UNEP have scheduled several important meetings in September.

Ad Hoc Working Group of Government Representatives to Prepare for Negotiations on a Framework Convention on Climate Change

Secretary-General Obassi of the WMO and Executive Director Tolba of the UNEP have invited governments to send "legal and technical experts" to an "open-ended" ad hoc meeting on 24-26 September 1990 in Geneva to assist Messrs. Obasi and Tolba "begin preparations for negotiations on a framework convention on climate change . . . taking into account (the recent) work of the IPCC". The United States has not yet received an agenda and other documentation for this meeting.

Nevertheless, the present U.S. understanding is that this meeting will define the process through which such a convention should be developed. It is expected that the U.S. offer to host the initial session of the negotiations, probably in February 1991 in Washington. The U.S. position is that such a convention should remain focussed on "climate change" and should not be broadened to address the much wider range of issues associated with "global change".

It may be important to note that Prime Minister Thatcher has proposed that the United Kingdom stabilize carbon dioxide emissions by the year 2005 at 1990 levels, if other countries are willing to do so as well.

International Coordination of Global Change Research

The international global change research effort has concentrated to date on physical and natural sciences research. Research on the "human dimensions" and economics of global change is being slowly but effectively fed into this effort. The physical and natural sciences components are well-coordinated at the international level, primarily by the WMO and ICSU through the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP).

ICSU has convened a series of major meetings on the IGBP on 3-7 September 1990 in Paris. The scientific communities of both the U.K.

and the U.S. will be solidly represented at these meetings. ICSU has also recently established a new advisory committee to assist ICSU to identify and fill any gaps which might exist between the WCRP and the IGBP in addressing the full range of global research needs.

Governmental agencies which fund global change research in a number of countries have begun meeting twice a year on a relatively informal basis to review the status of such funding on a truly international level. This Group is called the International Group of Funding Agencies for Global Change Research (IGFA), the UK member of which is Dr. Elleen Buttle, Head of NERC, and the U.S. member is Dr. Robert Corell, Chairman of the US/Global Change Research Program Working Group of CES. A key objective of this Group is to identify any important needs for research and/or supporting technology which are not being met and to assure that these needs are met through appropriate existing national funding mechanisms. The U.S. CEES initiated this effort in response to advice from ICSU. The CEES hosted the first meeting in January of 1990; the FRG hosted the second in July of 1990; and the U.K. will host the third in February of 1991.

The U.K. and its scientific community have been and are expected to continue to be strong supporters of global change research, including human dimensions and economic research. The Prime Minister is considered to be a strong advocate of basic research, including research on global change.

SECOND WORLD CLIMATE CONFERENCE (October 29 - November 7, 1990)

The Second World Climate Conference will be held in Geneva, Switzerland, October 29 - November 7, 1990. The First World Climate Conference was held in Geneva, in 1979, and resulted in the establishment of the World Climate Program, and the World Climate Research Program, one of the key components in the global change research programs in the U.S. and in other countries. The Second World Climate Conference is divided into two parts, a scientific meeting of experts and a ministerial meeting. The major purposes of the two meetings are:

Scientific Meeting (Attended by Experts, no delegation):

- o "To create an awareness through specific case studies or examples drawn from experience in the World Climate Programme or the economic of climate and benefits from climate applications"

o "To assess the current state of knowledge on the global issues of climate change and greenhouse gases, and requirements for future scientific activity and implications for public policy"

U.S. attendees include scientists and representatives of government offices and agencies, including the CES, and scientists and experts from the non-governmental science community.

Ministerial Meeting (There will be country delegations):

o The Ministerial part of the SWCC will be held in Geneva November 6-7, 1990. It is expected to culminate in the adoption of a declaration, a draft of which was sent to governments on July 14, 1990 by WMO Secretary General Obasi. The draft declaration has been made available to all interested US agencies and discussed at two interagency meetings in early August. US comments should have been returned to Obasi as well as specific amendments by August 24th so another version of the declaration can be prepared for the preparatory meeting scheduled to take place in Geneva September 27-29, 1990.

o US concerns about the declaration have been transmitted in a letter to Obasi from Under Secretary McCormack. Essentially they are:

- * the primary thrust of the declaration should be closely connected with needs and commitments for monitoring, detecting and studying climate change,

- * SWCC is an appropriate forum for launching international cooperation in understanding climate change and related issues such as - global radiation balance, cloud amounts and types, the role of oceans, chemical reactions in the atmosphere, and economic aspects,

- * significant uncertainties regarding timing, magnitude, and regional aspects of climate change are not made clear,

- * many statements regarding policy actions are premature and prejudice the outcome of the future negotiations on a framework convention on climate

change,

- * there should be a focus on widespread implementation of measures that are beneficial in their own right as well as beneficial from a climate change viewpoint,

- * areas where further scientific and economic work is needed should be identified.

There have been indications that as many as ten Heads of State may address or attend the Ministerial portion of the SWCC, including Prime Minister Thatcher. The level of participation and specific individuals for a U.S. delegation have not been decided.

ENVIRONMENT 1992 - A Meeting of Major Importance in Brazil in 1992

The meeting will be held in Rio in June of 1992. U.S. preparation are being coordinated through a Policy Coordinating Committee (PCC), chaired by the DOS.

The first meeting of this kind was held in Stockholm in 1972, known as Environment '72. The U.S. participation was lead by a team of Russell Train, as Head of CEQ, and Howard Baker, who at that time was a Congressman. We understand that neither Baker nor Train held the title of Ambassador, though we are still checking these facts. One of the most important results of this meeting was the formation of the United Nation Environment Program (UNEP).

It has been proposed that the U.S. appoint a "Special Ambassador to oversee the complex U.S. efforts required to be successful at the meeting" and to serve as head of the U.S. delegation. OMB has the lead to consider this proposal.

SCIENCE ISSUES

The major new developments in the science of global change were discussed at a recent briefing, lead by Drs. D. Allan Bromley and Robert W. Corell. The Talking Points for this briefing are appended.

Drafted by Robert W. Corell
August 28, 1990

Talking Points for Science Briefing on Global Change

KEY SCIENCE ISSUES (AUGUST 1990)

- o **GREENHOUSE GASES--SOURCES AND SINKS**
 - **CARBON SEQUESTRATION (CARBON DIOXIDE)**
 - * **OCEAN VS TERRESTRIAL BIOSPHERE**
 - **METHANE**
- o **ROLE OF OCEAN IN CLIMATE**
 - **EL NINO/SOUTHERN OSCILLATION--INTERANNUAL TIMESCALES**
 - **AIR-SEA COUPLING--DECADAL TIMESCALES**
 - * **NORTH ATLANTIC--THERMOHALINE FORCING**
 - * **ANTARCTIC HEAT UPTAKE**

o EARTH SYSTEM MODELLING

- **CLOUDS/RADIATION BALANCE/LIQUID WATER**
- **VALIDATION OF QUANTITATIVE OCEAN MODELS**
- **REGIONAL MODELS/PREDICTION-ENSO READY TO GO**
- **ROLE OF LAND SURFACE IN TRACE GASES, ENERGY
AND WATER EXCHANGE**
- **SNOWMASS INSTITUTE-FULLY-COUPLED SIMPLE MODELS
AVAILABLE IN 4-5 YEARS**

o **TRENDS**

- **LONG-TERM VARIABILITY IN TEMPERATURE WELL-DOCUMENTED**
- **OBSERVED INCREASE IN TEMPERATURE OVER LAST ONE HUNDRED YEARS; CAUSE AND EFFECT NOT ESTABLISHED**
- **DETECTION OF PREDICTED ANTHROPOGENIC WARMING WILL TAKE 10 TO 50 YEARS**
- **SEA LEVEL RISE--ROLE OF POLAR ICE SHEETS UNCERTAIN**
- **RESPECTIVE CONTRIBUTIONS OF DEFORESTATION--TROPICAL AND MID-LATITUDE UNCERTAIN**

o RESEARCH PRIORITIES

- CARBON CYCLE**
- GLOBAL WATER AND ENERGY CYCLES**
- GLOBAL MODELS WITH REGIONAL RESOLUTION**
- ECOSYSTEMS AND POPULATION DYNAMICS**

A Proposed Structure for an International Convention on Climate Change

WILLIAM A. NITZE

Formal negotiations toward an international convention on climate change will begin shortly after completion of the interim report of the Intergovernmental Panel on Climate Change (IPCC); presentation of the report to the Second World Climate Conference will be this fall. The United Nations (UN) and its member governments will be under pressure to have a final text ready for signature at the 1992 UN Conference on Environment and Development, if not before. In a 25 May speech responding to greenhouse warming predictions made by the IPCC science working group, Margaret Thatcher said that Britain would reduce the proposed growth of its CO₂ emissions enough to stabilize them at 1990 levels by 2005 if other countries did their part.

Yet the United States, Japan, and other countries that emit substantial quantities of greenhouse gases continue to resist potentially expensive emission-reduction targets or control measures, citing continuing uncertainties about the extent, timing, and distribution of future climate change and its economic consequences. Similarly, developing countries are unlikely to agree to emissions targets or control measures that they perceive as impeding their economic development and will almost certainly condition their participation on a commitment by the Organization for Economic Cooperation and Development (OECD) countries to provide additional development assistance.

When confronted with these political realities, must we settle for a "bare-bones" framework convention similar to the Vienna Convention on Protection of the Ozone Layer, or can we devise a more substantive convention that would stimulate policy changes by the parties without requiring costly emission reductions in the short-term? I believe we should take the latter course and pursue a more substantive convention along the lines described below.

A central task for a climate convention will be to provide the international community with a permanent mechanism for coordinating its efforts to deal with climate change. At present, the IPCC is serving this function reasonably well, but it remains an ad hoc working group with no permanent status. The "conference of the parties" to the convention would replace the IPCC and would establish subsidiary bodies similar to those established by the IPCC. Those bodies would include the following.

1) *A bureau.* The bureau, or group of officers in charge of managing meetings of the parties, would consist of a chair, one or more vice-chairs, and one or more rapporteurs elected for fixed

terms of several years.

2) *An executive council.* The executive council would consist of representatives of the parties, including the bureau, which would meet more frequently than the conference of the parties and would oversee implementation of whatever program was approved by the conference.

3) *Permanent committees.* The convention should establish permanent committees on science, environment, and socioeconomic impact, and policy responses similar to IPCC Working Groups I, II, and III.

4) *A strong secretariat.* The breadth and complexity of the climate change issue make it essential that the work carried out under the convention be supported by a strong secretariat of at least 20 professionals, including experts on atmospheric science, economic analysis, financial mechanisms, international law, and public education.

The convention should go beyond organizational structure to establish a process for updating the parties' understanding of the science and potential impacts of climate change and for building consensus on policy responses. It is crucial that the science and impacts committees produce peer-reviewed annual updates of their respective assessments to provide a basis for evolving policy responses.

To support this ongoing assessment process, the convention should explicitly provide for (i) building up the international network of climate monitoring stations as part of the World Climate Program coordinated by the World Meteorological Organization; (ii) international collaboration in developing and funding a space-based monitoring system along the lines of Mission to Planet Earth; (iii) international cooperation in developing and funding the hardware and software for the next several generations of general circulation climate models; and (iv) maximum participation of developing country scientists and technicians in all these activities.

Whereas an international convention is in many respects a top-down undertaking, a more bottom-up process is preferable for developing policy responses. Only policies formulated at the national level will overcome widespread concern about economic costs and reflect the different circumstances of different countries. The convention should drive this process by requiring each party to prepare and distribute its own national plan for reducing greenhouse gas emissions and for adapting to future change while achieving its development objectives. The convention would contain general guidelines for preparing national plans, including the sectors and general issues to be covered. Each party would be free, however, to determine its own emissions reduction strategy consistent with any

The author is a Visiting Scholar at the Environmental Law Institute, Washington, DC. Before joining the Institute, the author was Deputy Assistant Secretary of State for Environment, Health and Natural Resources.

overall targets and timetables established by the convention.

The point is to require each party to make an initial determination of the national measures it is prepared to commit to and then to share that determination with other parties for analysis and discussion. From such analysis and discussion should emerge (i) an initial baseline emissions scenario based on implementation of the national plans, (ii) a more complete inventory of possible policy responses, and (iii) an initial indication of the additional financial and technical resources that might be required to implement the plans, particularly in developing countries.

As national plans are revised and updated, one would hope that various parties could be induced to make their plans more ambitious and effective in response to the information and feedback they receive from other parties and outside sources. Potential opportunities for asymmetrical reductions or emissions trades should become more apparent. The convention should require each party to prepare an initial plan within 1 year of its becoming subject to the convention and to update that plan every 2 years thereafter.

To obtain the participation of key developing countries such as China, India, and Brazil, the convention will have to contain strong provisions with respect to technology transfer and financial assistance. Despite the popularity of the sustainable development concept, developing country governments still perceive a direct conflict between their goals for economic development and measures to reduce greenhouse gas emissions in their countries. This perception is exaggerated. Developing countries collectively will be investing hundreds of billions of dollars for economic development over the next few decades. If this money is invested in systems that are energy and materials efficient, the environmental impact of a given level of economic development can be substantially reduced. For example, China's ratio of CO₂ emissions to gross national product (GNP) is roughly five times that of Japan (1). If China were to achieve even 60% of Japanese efficiency and carbon intensity levels in its new energy-producing and energy-consuming infrastructure, it could improve this ratio substantially in a relatively short time. The one major hurdle is obtaining the technical information, management assistance, and capital required to promote more efficient and less polluting supply and use of energy and other natural resources.

A climate convention could make an important contribution to overcoming this hurdle. First, the convention could establish a fund to meet all or part of the hard currency costs of preparing and updating the developing countries' national plans referred to above. The fund would cover the costs of sending public and private sector experts from OECD countries and multilateral institutions to work with counterparts in developing countries in preparing the national plans and more detailed studies of energy, transport, agriculture, and other key sectors. The money required for such a fund might be in the order of a hundred million dollars per year, which could be contributed by the OECD countries proportionate to greenhouse gas emissions. Only developing countries that were parties to the convention could have access to the fund, which should provide a major incentive for developing countries to become parties.

The national plans and sectoral studies would have to identify capital requirements sector-by-sector and possible sources of capital, domestic and foreign. To help meet those requirements, the convention should contain provisions that encourage the private sector to furnish the capital required. The OECD countries would be obligated to arrange for soft loans from multilateral development banks, provide expanded political risk insurance, and even offer credit guarantees for projects meeting certain criteria. The developing countries would be obligated to provide a favorable investment climate for foreign investors making climate-related investments, including effective protection of intellectual property rights and patents, no prohibition on operating control, taxation of profits at a

national rate or better, and foreign exchange priority for dividend and capital remittances within certain limits.

Finally, we come to the issue of targets and timetables for greenhouse gas emission reduction and their appropriate role. The purpose of short-term targets and timetables is not to set final goals. There is simply too much uncertainty about the science, regional impacts, and socioeconomic consequences of climate change for the United States and other key countries to commit to ambitious short-term emissions reduction goals within the next few years. Rather, the purpose of short-term targets and timetables is to catalyze a process—to induce governments and the private sector to take certain initial steps needed to set the stage for more far-reaching changes later on. Once this process has begun we will be able to achieve much greater emissions reductions than we can imagine today, irrespective of what is written into international agreements.

The following is a set of targets and timetables for greenhouse gas emissions reductions that might be politically acceptable and yet sufficiently ambitious to begin to bring about results.

1) A short-term stabilization target placing an overall ceiling on the parties' emissions of all greenhouse gases (expressed in equivalent units) at their levels for the year the convention entered into force effective 10 years thereafter.

2) An OECD CO₂ stabilization subtarget that would require each OECD country to hold its emissions at their average level for the year the convention enters into effect and the previous 4 years effective 10 years after the convention enters into effect. The combination of a chlorofluorocarbon phase-out and stabilization of CO₂ emissions from industrialized countries would provide leeway for short-term emissions increases from developing countries.

3) An energy efficiency subtarget, whereby all parties would be obligated to improve the ratio of their carbon emissions to GNP by 2% per year over the same 10-year period. This rate of improvement, which was achieved by Japan and the United States during the 1973 to 1986 period (2), would allow individual parties to seek the combination of energy efficiency improvements and reductions in the carbon intensity of their overall fuel mix that best suits their particular circumstances. It would also allow parties with high GNP growth rates correspondingly high emissions.

4) A deforestation subtarget, whereby all parties agree to eliminate net loss of forests by the end of the 10-year period in question. Achieving this goal would help preserve biodiversity and promote other environmental goals as well as reduce net carbon emissions.

To supplement and reinforce the targets and timetables proposed above, the convention should impose a general obligation on the parties to use the best available technology that is economically achievable to reduce emissions of greenhouse gases. This general obligation is particularly important for greenhouse gases such as methane and nitrous oxide, for which it is difficult to set targets because their sources and sinks are not yet well understood. An annex to the convention could describe specific technologies currently available for reducing emissions and their respective unit costs.

The international community has an unprecedented opportunity to pursue a "no regrets" strategy that will put us on a development path that simultaneously achieves an acceptable degree of economic development and minimizes the possibility of environmental disruption. A properly structured climate convention could be an important step toward grasping this opportunity.

REFERENCES

1. W. U. Chandler, *Clim. Change* 13, 245 (1988).
2. *The Global Environmental Challenge: Japanese Initiative for Technological Breakthrough*, Report of the Japanese Ministry of International Trade and Industry (March 1990), p. 6.

Withdrawal/Redaction Sheet

(George Bush Library)

Document No. and Type	Subject/Title of Document	Date	Restriction	Class.
01. Memorandum	To: Allan Bromley From: M. Bernthal Re: Future of the IPCC and the US Role (3 pp.)	7/3/90	(b)(1)	

Collection:

Record Group: Bush Presidential Records
Office: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: Global Climate Change Files
WHORM Cat.:
File Location: Intergovernmental Panel on Climate Change (IPCC): General [1 of 2] [1990]

Date Closed: 4/7/2010	OA/ID Number: 62053-006
FOIA/SYS Case #: 2005-0336-F	Appeal Case #:
Re-review Case #:	Appeal Disposition:
P-2/P-5 Review Case #:	Disposition Date:
AR Case #:	MR Case #:
AR Disposition:	MR Disposition:
AR Disposition Date:	MR Disposition Date:

RESTRICTION CODES

Presidential Records Act - [44 U.S.C. 2204(a)]

P-1 National Security Classified Information [(a)(1) of the PRA]
P-2 Relating to the appointment to Federal office [(a)(2) of the PRA]
P-3 Release would violate a Federal statute [(a)(3) of the PRA]
P-4 Release would disclose trade secrets or confidential commercial or financial information [(a)(4) of the PRA]
P-5 Release would disclose confidential advice between the President and his advisors, or between such advisors [(a)(5) of the PRA]
P-6 Release would constitute a clearly unwarranted invasion of personal privacy [(a)(6) of the PRA]

C. Closed in accordance with restrictions contained in donor's deed of gift.

PRM. Removed as a personal record misfile.

Freedom of Information Act - [5 U.S.C. 552(b)]

(b)(1) National security classified information [(b)(1) of the FOIA]
(b)(2) Release would disclose internal personnel rules and practices of an agency [(b)(2) of the FOIA]
(b)(3) Release would violate a Federal statute [(b)(3) of the FOIA]
(b)(4) Release would disclose trade secrets or confidential or financial information [(b)(4) of the FOIA]
(b)(6) Release would constitute a clearly unwarranted invasion of personal privacy [(b)(6) of the FOIA]
(b)(7) Release would disclose information compiled for law enforcement purposes [(b)(7) of the FOIA]
(b)(8) Release would disclose information concerning the regulation of financial institutions [(b)(8) of the FOIA]
(b)(9) Release would disclose geological or geophysical information

LIST OF IPCC MEETINGS AND OTHER RELATED INTERNATIONAL ACTIVITIES

<u>Date</u>	<u>Venue</u>	<u>Meeting/activity</u>	<u>Organization</u>
AUGUST			
8	Toronto	Ecosystems sub-groups	IPCC WGI/WGII
SEPTEMBER			
11-13	Tokyo	World Conference on Global and Human Responses to Sustainable Development	Japan: Environment Protection Agency
11-13 21-22?	The Hague	International Steering Committee: Ministerial Conference	The Netherlands
11-15	The Hague	World Clean Air Congress	IUAPPA
11-15	Helsinki	Climate Change and Water Conference	WMO
11-15	Berne	Workshop: Greenhouse Gases Sub-group	IPCC WGI
18-20	Geneva	Hydrology and Water Resources Sub-group	IPCC WGII
18-20	Toronto	Meeting of Sub-group on Cryosphere and Permafrost	IPCC WG II
21-22	Paris	Agriculture and Forestry Sub-group (AFOS)	IPCC WGII/OECD*
25-26	Reading, UK	Workshop: Sea level rise Sub-group	IPCC WGI/Univ. of East Anglia
28-29	Paris	IPCC Special Committee on Developing Countries	IPCC
28-29	Geneva	Energy and Industry Sub-group	IPCC WGIII *
-	Washington	Agricultural Data and Practices: Sub-group on Agriculture and Forestry (AFOS)	IPCC WGIII *
-	Helsinki	Workshop on Boreal Forests: (AFOS)	IPCC WGIII *

* WG III

OCTOBER

2-6	Geneva	Second session	IPCC WGIII *
2-6	Moscow	Climate Change and World Fisheries: Sub-group on World Oceans and Cryosphere	IPCC WGII
12-13	Bonn	Preparatory meeting for Workshop on Energy and Environment	FRG: Ministry of Environment
30-31	Bonn	Workshop on Temperate Forests (AFOS)	IPCC WGIII *
30-1 Nov.	Geneva	Resource Use & Management Sub-group	IPCC WGIII *
31-3 Nov.	Geneva	Second session	IPCC WGII
-	Oslo	Preparatory meeting: Conference on "Action for a Common Future"	Govt. of Norway
-	Brazil	Workshop: Tropical Forests, WGIII (AFOS)	Govts. of USA/ Brazil

NOVEMBER

2-3	Geneva	Agriculture & Forestry Sub-group	IPCC WGIII *
2-3	Noordwijk	Pre-conference: Senior Officials	The Netherlands
6-7	Noordwijk	Ministerial Conference on Atmospheric Pollution and Climate Change	The Netherlands
14-15	Maldives	Meeting of Senior Officials on "Small States Conference on Sea Level Rise"	Govt. of Maldives
16-18	Maldives	Ministerial Meeting on "Small States Conference on Sea Level Rise"	Govt. of Maldives
21-24	Geneva	Executive Body/LRTAP Convention	ECE*/UN
27-1 Dec.	Miami	Coastal Zone Management Sub-group	IPCC WGIII *
29-1 Dec.	Bracknell, UK	Climate Trends Sub-group	IPCC WGI

* ECE - Economic Commission for Europe

DECEMBER

11-14	Bonn	Workshop: Energy and Environment	FRG: Ministry of Environment
18-21	Cairo	Preparing for Climate Change	Climate Institute
-	Brisbane	Sub-group on Model Predictions and Validation	IPCC WGI

SECTION B: 1990

FEBRUARY

-	Washington	IPCC 3rd session/IPCC Bureau 2nd session	Govt. of USA/IPCC
-	Australia	Coastal Zone Management Sub-group	IPCC WGIII *

APRIL

-	-	2nd Conference of the Contracting Parties to the Montreal Protocol	UNEP/Parties
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MAY

8-16	Bergen	Conference on "Action for our Future"	Govt. of Norway
22-24	UK	Second session of WGI	UK Govt./IPCC

AUGUST

-	Stockholm	4th session of IPCC	Govt. Sweden/IPCC
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NOVEMBER

12-23	Geneva	Second World Climate Conference	WMO/UNEP/UNESCO/ICSU
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July 5, 1990

Professor Bert Bolin
Department of Meteorology
Arrhenius Laboratory
University of Stockholm
S10691 Stockholm
Sweden

global
change
file

Dear Bert:

My congratulations on the careful and thoughtful effort you have put into drafting both the IPCC executive summary and the overview and conclusions. I suspect that the meeting in Geneva was a useful preview for what to expect in Sundsvall! The draft documents that we recently received from the Secretariat incorporate many of the comments that the Drafting Committee raised in our meeting. We hope that careful consideration of the comments made in this additional iteration on the draft will save time and expedite consensus.

We have reviewed the draft documents as thoroughly as the tight deadline permits and offer both a reworked executive summary and detailed comments on the overview and conclusions. Some of the items in the enclosures reflect concerns about tone or policy implications and will require that substantive revisions be made, while others address typographical or stylistic problems which, if corrected, will improve readability and make for more lucid discussions in Sundsvall.

Because these documents will be used by ministers and heads of state to establish global policy on climate change, they must be clear and convincing and flow logically for the lay reader. Improving the readability in English will also simplify the task of the translators. Ideally, the drafts should undergo a thorough English-language editing. Recognizing that the time constraint precludes this step, we have offered extensive suggested revisions in the enclosures.

The purpose of this letter is to highlight our key concerns and suggestions which warrant your attention. It is essential that the plenary documents clearly distinguish between what is known and what is projected or hypothesized. This was the task mandated to IPCC. The three Working Groups have labored to strike a balance; that balance must be reflected in the plenary reports.

EXECUTIVE SUMMARY

The executive summary currently lacks, but must contain, a careful statement acknowledging the significant uncertainties inherent in the underlying science. The proposed redraft must contain the following statement regarding uncertainties taken from page 2 of the WG I policymakers summary:

There are many uncertainties in our predictions particularly with regard to the timing, magnitude and regional patterns of climate change, due to our incomplete understanding of the sources and sinks of greenhouse gases, clouds, oceans, and polar ice sheets.

The executive summary must strike a balance in its treatment of observed warming over the past 100 years and predicted warming. This can be accomplished by including the statement contained in the WG I policymakers summary (p. 30, last paragraph), as follows:

The size of the warming over the last century is broadly consistent with the predictions of climate models, but is also the same magnitude as natural climate variability. If the sole cause of the observed warming were the human-made greenhouse effect, then the implied climate sensitivity would be near the lower end of the range inferred from the models. The observed increase could be largely due to natural variability; alternatively this variability and other man-made factors could have offset a still larger man-made greenhouse warming.

There must be a more balanced presentation in the science summary of natural versus anthropogenic fluxes of greenhouse gases, notable CO₂. As I noted in Geneva, we should not be afraid to place the entire story before the reader, especially since it may become essential to consider what steps might be taken to modify the "natural" CO₂ cycle, should the situation turn out to be more serious even than we now expect. This can be done by including the following short paragraph:

While the annual anthropogenic emissions of carbon dioxide are only about 4 percent of the total annual exchange of carbon dioxide by natural processes, they have been large enough to modify significantly the natural balance since pre-industrial times. Stabilization of atmospheric carbon dioxide concentrations can be achieved by either a 60-80% reduction in anthropogenic emissions, or an increase in natural sinks by 2-3%.

OVERVIEW AND CONCLUSIONS

Scenarios

The Emission Scenarios A-D should be defined in a separate section at the beginning of the document. The explanation of how they were formulated should be taken from the WG 3 report, Section 3.1. For example, for Scenario A:

Scenario A assumes that few or no steps are taken to limit greenhouse gas emissions. Energy use and clearing of tropical forest and the amount of biomass per hectare are low and fossil fuels, in particular coal, remain the world's primary energy source. The Montreal Protocol comes into effect but without strengthening and with less than 100 percent compliance. Under this scenario, the equivalent of a doubling of pre-industrial CO₂ levels occurs, according to WG I, by around 2025.

We strongly suggest that the Business-as-Usual Scenario should be called Scenario A. At a minimum the designation should be "Scenario A (Business as Usual)."

Similarly, the Reference Scenario should be explained with regard to its purpose, with clarification that it is a scenario and not a plan, and the data on which it is based. The language should be drawn from WG III report, section 3.2.

Greenhouse Gases

This draft continues to focus on CO₂ to the virtual exclusion of other greenhouse gases, notably methane, so that the reader is left with the impression that CO₂ reduction on the anthropogenic side, and reforestation on the natural side, are the only real options to consider. This does not reflect the conclusions of the AFOS report of WG III. To balance the presentation, lines 21 through 34 on page 17 need to be replaced with the following:

Because the sources of other greenhouse gases, most notably methane, but also including nitrous oxides and ozone, are diverse and the quantitative importance of each of their sources not well known at present, emissions reductions may prove difficult to achieve and the effectiveness of different control strategies hard to evaluate.

Methane emissions arise primarily from agricultural, energy and waste management activities. Control strategies may include improved agricultural practices; use of low-emitting rice strains; and prevention, or recapture for energy recovery, of emissions from mine shafts, pipelines, and landfills.

Natural Sources and Sinks of Greenhouse Gases

As stated earlier, the document must more explicitly discuss the natural sources and sinks of carbon dioxide, and uncertainties associated with the anthropogenic fluxes. The section (page 4, lines 22 to 30) needs to be expanded. This can most easily be accomplished by using Figure 1 (carbon cycle) on page 8 from Section 1 on the IPCC WG I scientific assessment, and the following text:

The anthropogenic flux of carbon dioxide is about $6+0.6$ Gt C per year from the combustion of fossil fuels, plus an additional $0.6 - 2.5$ Gt C per year associated with tropical deforestation and changing land-use. These fluxes are much smaller than the natural exchange fluxes (about 200 Gt C per year) which occur between the atmosphere and the terrestrial biota and between the atmosphere and the oceans (Figure I). However, while the anthropogenic fluxes are much smaller than the natural fluxes, they have been large enough to modify significantly the natural balance since pre-industrial times as evidence by: (i) a 25% increase in atmospheric carbon dioxide during the last 200 years; (ii) an increase in the interhemispheric gradient of atmospheric carbon dioxide; (iii) trends in the atmospheric isotopic composition of carbon dioxide. Stabilization of atmospheric carbon dioxide can be achieved by a 60-80% decrease in the anthropogenic emissions of carbon dioxide or by an increase of about 2-3% in the natural sinks of carbon dioxide.

Comprehensive Approach

There must be further mention of the comprehensive approach to any possible solutions to the greenhouse gas problem. The document must state that all greenhouse gases whose atmospheric concentrations are increasing must be considered together and that this can be done through the concept of greenhouse warming potentials (GWPs). A short section, such as the following, needs to be inserted on page 15 line 35:

All greenhouse gases whose atmospheric concentrations are increasing because of human activities contribute to the enhanced greenhouse effect. Therefore, in view of the interrelationship among all greenhouse gases, their sources and sinks, when considering approaches to limit anthropogenic increases in radiative forcing it is essential to take a comprehensive approach to reductions in greenhouse gas emissions, i.e., all gases should be treated collectively (carbon dioxide, methane, nitrous oxide, CFCs, HCFCs, HFC, and ozone and its precursors). To evaluate possible policy options, it is useful to know the relative radiative effect (and, hence potential climate effect) of equal emissions of each of the greenhouse gases. Working

Group I developed the concept of relative global warming potentials (GWPs) which take into account the differing times that gases remain in the atmosphere. Table x lists the GWPs for several key greenhouse gases, together with their 1990 emissions. (Table at the bottom of page 18 of WG I Policymakers Summary should be added here.)

I cannot overemphasize the fact that a considered response to these matters is most essential if we are to have any hope of reaching consensus in Sundsvall. Please call if there is anything further that I can do to help in reaching this most important consensus.

Best regards,

Frederick M. Bernthal

enclosures:

- 1) reworked executive summary
- 2) specific comments on overview and conclusions
(to follow on July 6, 1990)

EXECUTIVE SUMMARY

Science

* There is a natural greenhouse effect (from water vapour, carbon dioxide and other naturally occurring gases) which keeps the Earth warmer and more habitable than it would otherwise be.

* In assessing the scientific basis for concern regarding possible global climate change, it is important to distinguish: (a) what we know with certainty, (b) what we calculate with confidence, (c) what is predicted by current models, and (d) what our best judgment is on matters that are more uncertain.

* Over many thousands of years there have been significant changes in atmospheric greenhouse gas concentrations and global climate, such as the Ice Ages, and the mechanisms causing these changes are not yet well understood.

* Emissions resulting from human activities are substantially increasing the atmospheric concentrations of certain greenhouse gases -- carbon dioxide, methane, chlorofluorocarbons (CFCs), and nitrous oxide. These increases will enhance the greenhouse effect, resulting on average in an additional warming of the Earth's surface.

* The total increase of greenhouse gas concentrations attributable to human activities is at present equivalent to an increase of carbon dioxide since pre-industrial times of about 50 percent.

* The human-caused emissions of carbon dioxide can be measured against the background of much larger natural sources and sinks. Annual human-caused net carbon dioxide emissions are about 4 percent of the total annual exchange of carbon dioxide by natural processes. However, while the human-caused fluxes are much smaller than the natural fluxes, they have been large enough to modify significantly the natural balance since pre-industrial times. Stabilization of atmospheric carbon dioxide concentrations can be achieved by either a 60-80 percent reduction in anthropogenic emissions, or an increase in natural sinks by 2-3 percent.

* There are many uncertainties in our predictions, particularly with regard to the timing, magnitude and regional patterns of climate change, due to our incomplete understanding of sources and sinks of greenhouse gases: clouds, oceans, and polar ice sheets.

* Based on current model results, we predict, under the IPCC Scenario A (Business as Usual) emissions of greenhouse gases, a rate of increase of global mean temperature during the next century of about 0.3 degrees C per decade (with an uncertainty range of 0.2-0.5 degrees C per decade); this is greater than that

seen over the past 10,000 years. This will result in a likely increase in global mean temperature of about 1 degree C above the present value by 2025 (about 2° C above that in the pre-industrial period) and 3 degrees C before the end of the next century (about 4° C above that in the pre-industrial period).

* The oceans act as a heat sink and thus delay the full effect of greenhouse warming; the realized (actual) temperature change is at any given time estimated by the computer models to be between 50 and 80% of the eventual committed temperature change when the climate system has reached equilibrium.

* Because of the long atmospheric lifetimes of some greenhouse gases, if the human-caused emissions were stopped, the greenhouse gas concentrations are expected to decrease only slowly, i.e., over a period of decades to centuries..

* The size of the warming over the last century is broadly consistent with the predictions of climate models, but is also of the same magnitude as natural climate variability. If the sole cause of the observed warming were the human-made greenhouse effect, then the implied climate sensitivity would be near the lower end of the range inferred from the models. The observed increase could be largely due to natural variability; alternatively, this variability and other human-caused factors could have offset a still larger human-caused greenhouse warming.

* The confidence in regional estimates of climate change as a result of a global average warming is low, especially for the changes of precipitation and seasonal variation.

Impacts

* Because of the lack of accurate estimates of the expected regional changes of climate, precise predictions of the regional impacts of climate change cannot yet be made; however, certain general conclusions may be drawn.

* If no preventive measures are taken to limit the further increase of human-caused emissions of greenhouse gases (Scenario A), an average rate of global mean sea level rise of about 6 cm per decade is projected by computer models over the next century, with an uncertainty range of 3-10 cm per decade.

* Although studies have not yet conclusively determined whether on average global agricultural potential would increase or decrease, changes of climate would have important effects regionally:

- o Some current forests will mature and decline in a

climate to which they are increasingly poorly adapted, while others may eventually develop elsewhere.

- o Natural terrestrial ecosystems could be markedly influenced because the rates of climate change are likely to be faster than the ability of some species to adjust.

- o Enhanced carbon dioxide concentrations in the atmosphere might enhance growth of certain plants.

- * Comparatively small changes of climate can cause large water resources changes. The availability of water and biomass might be significantly affected, either positively or negatively, and both are major energy resources in many developing countries.

Response Strategies

- * A major dilemma of the issue of climate change due to the increasing emissions of greenhouse gases into the atmosphere is that some actions may be required well before many of the specific issues that are raised can be resolved by further research.

- * The long-lived greenhouse gases -- carbon dioxide, CFCs and nitrous oxide -- would require reductions in emissions from human activities by more than 60% in order to stabilize concentrations at today's levels. Methane would require a 15-20 percent reduction.

- * The CFCs are already being eliminated to prevent their continued destruction of the stratospheric ozone layer. This action is also a most effective measure to slow down the rate of predicted global warming. The CFCs will probably be partially replaced by HCFCs and HFCs, which are weaker greenhouse gases, but every effort should be made to find other replacements which have little or no greenhouse warming potential or ozone depletion potential.

- * Assuming a projected increase of the world population to about 8 billion by 2030, the present global average emissions of carbon dioxide of about 1.45 ton of carbon per capita would have to be reduced to about 0.35 ton of carbon per capita in order to stabilize carbon dioxide concentrations in the atmosphere.

- * If the present rate of deforestation were reduced to about half of the present rate, this could reduce the rate of increase of carbon dioxide in the atmosphere by 5-15%; reforestation of 12 million hectares per year during the next forty years would slow down the rate of increase of carbon dioxide in the atmosphere during this period by an additional approximately 10% compared with the present rate.

Roles of Industrialized and Developing Countries

* Industrialized and developing countries have a common responsibility in dealing with the issue of potential climate change. The former should take lead in two ways:

- 1) to limit climate change by adapting their own economies in accordance with future agreements to limit emissions,
- 2) to cooperate with developing countries in international action, without standing in the way of the latter's development.

* Sustainable development requires the proper concern for environmental protection as the necessary basis for continued economic growth. It will increasingly have to take into account the issue of climate change. It is imperative that the right balance be struck between economic growth and environmental objectives.

* The developing countries are rapidly increasing their emissions of greenhouse gases in striving to improve their living standards. Recognizing the poverty that prevails among the populations of developing countries, it is natural that achieving economic growth is given priority by them. A full partnership of all nations of the world, taking into account their different financial and technical resources, is essential to the development of a strategy to deal with the climate change issue.

Options

* The potentially serious consequences of climate change give sufficient reasons to begin by adopting response strategies that can be justified immediately in their own right, even in the face of significant uncertainties. These include:

- elimination of CFC emissions, and careful assessment of the greenhouse gas potential of any proposed substitutes
- use of cleaner, more efficient energy sources, with resulting lower emissions of greenhouse gases
- improved energy end use efficiency
- improved forest management
- review of agricultural practices

* There is no single quick-fix technological option for limiting net greenhouse gas emissions. A comprehensive strategy addressing all aspects of the problem and reflecting economic, social and environmental costs and benefits is necessary.

* Consistent with this strategy, consideration of measures for adapting to global climate change should be begun as soon as possible, particularly with regard to disaster preparedness

policies, coastal zone management and control measures for desertification, since many of these responses may be justified in their own right.

* Individual nations, or groups of nations, should consider and evaluate appropriate actions to limit as much as possible net emissions and thus assist in the prevention of an acceleration of greenhouse gas concentrations in the atmosphere.

* In the long term perspective, work should begin on evaluating the impacts of climate change and its costs on the one hand, and economic and social costs and benefits and practicalities of reductions in emissions on the other. This evaluation should take into account what might be an acceptable level of climate change and reflect the changes of scientific and economic understanding and technological capabilities.

* It is important that any potential measures to adapt to or limit global climate change be as economically efficient and cost-effective as possible, while taking into account important social implications. In addition, adaptation and limitation strategies must be considered as an integrated package.

* In general, environmental objectives can be achieved either through regulations requiring the use of a specific technology or attainment of specified goals, or through economic instruments such as emissions fees, subsidies, sanctions, tradeable permits, or a comprehensive system that might address all greenhouse gas sources and sinks. Market based economic instruments encourage limitations in emissions by those who can achieve them at least cost. Careful and substantive analysis of the implications of such instruments is needed.

* Economic instruments, through their encouragement of flexible selection of abatement measures, frequently offer the possibility of achieving environmental improvements at lower cost than regulatory mechanisms. Unlike many regulations, they tend to encourage innovation and the development of improved technologies and practices for reducing emissions. Economic mechanisms also have the potential to provide the signals necessary for more environmentally sensitive operation of markets. It is unlikely, however, that economic instruments will be applicable to all circumstances.

Future Work

* The measures that may be necessary require a high degree of international cooperation, with due respect for national sovereignty of states. To assist in that process, international negotiations on a framework convention on climate change should start as quickly as possible.

* The IPCC recommends that research regarding the climate change issue in general, and the international economic implications in particular, be intensified.

* Because climate change would affect, either directly or indirectly, almost every sector of society, and because important policy response options will have to be developed against the background of uncertainty, broad global understanding of the issue will facilitate the adoption and the implementation of such response options as deemed necessary and appropriate. Further efforts to achieve such global understanding are urgently needed.

* The IPCC appeals to multilateral and bilateral funding organizations to assist developing nations in their efforts to take part in the international cooperation with regard to the climate change issue and to do so without awaiting the outcome of future negotiations on a climate convention. It further appeals urgently to governments for continuing and increased contributions to the IPCC Trust Fund so that the work of the IPCC can continue.

DRAFT

2-15-90

The Honorable Richard B. Cheney
Secretary of Defense
The Pentagon
Washington, D.C. 20301

Dear Secretary Cheney:

As you are probably aware, President Bush, on February 5, 1990, announced at the United Nations Intergovernmental Panel on Climate Change that he will host a White House Conference on Science and Economic Research Related to Global Change.

The Conference is scheduled for April 17-18, 1990, in Washington, D.C. It will convene ministerial level officials from seventeen nations including the U.S., and bring together the essential disciplines of science, economics, and the environment.

The President has appointed me, Michael Boskin (Chairman of the Council of Economic Advisers), and Michael Deland (Chairman of the Council on Environmental Quality) as co-chairmen of this Conference. The task he has given us is to structure an international conference that will be "an important further step in a joint international approach to the problems and opportunities with which our global environment confronts us."

I have asked Dr. Robert Corell to act as Conference Director and Dr. Franmarie Keel to act as Conference Coordinator. They have identified key requirements and I would ask your help in meeting these specific needs:

Most critical is the need for an executive officer to pull this effort together. I am aware of your Defense and the Environment Initiative, and the work Tom Harvey has done in organizing the effort. This and his experience on the Hill and in the White House are the skills we need to make the President's initiative a success. I believe there is a direct linkage between what the President wants to do and what your initiative is all about. If it is at all possible, I would ask that LTC Harvey be made available to help with this Conference.

In addition, I request that DOD provide a company grade action officer, data management capability (operators and equipment), two vehicles and operators (one van and one sedan), and use of the Old Guard for escort duties during the Conference. Dr. Keel will provide additional details concerning these items. The effective dates of this project requirement will be 19 February to 30 April 1990.

To accomplish what needs to be done in the timeframe available will require a significant cooperative effort. I hope I can count on your support to make the President's initiative one that will have a lasting positive impact across the globe and keep our Nation at the forefront of these vital issues.

Thank you for your consideration.

Yours sincerely,

D. Allan Bromley
Assistant to the President

DRAFT

2-15-90

The Honorable James Baker
Secretary of State
2201 C Street, N.W.
Washington, D.C. 20520

Dear Secretary Baker:

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I have asked Dr. Robert Corell to act as Conference Director and Dr. Franmarie Keel to act as Conference Coordinator. They have identified key requirements and I would ask your help in meeting these specific needs.

Accurate communication is crucial for the success of this meeting and this means excellent translation support. I would ask that the State Department provide translation and transcription capability during the pre-conference, conference, and immediate post-conference phases.

I would be most appreciative if you would agree to be the opening speaker on the morning of April 17th.

In addition, I request that the State Department provide a liaison officer, two secretaries/word processors, a protocol officer, and transportation resources to support the conference planning and execution process.

The effective dates of this project requirement will be from 19 February 1990 to 30 April 1990. Dr. Keel will provide additional details concerning these items and she can be reached through my office.

To accomplish what needs to be done in the timeframe available will require a significant cooperative effort. I hope I can count on your support to make the President's initiative one that will have a lasting positive impact across the globe and keep our Nation at the forefront of these vital issues.

Thank you for your consideration.

Yours sincerely,

D. Allan Bromley
Assistant to the President

DRAFT BUDGET

WHITE HOUSE CONFERENCE ON SCIENCE AND ECONOMICS RESEARCH RELATING TO GLOBAL CHANGE

At Marriott's Georgetown Leavey Conference Center and Guest House

Washington, DC
April 17-18, 1990

LABOR - DIRECT COST TO PROJECT

Conference Coordinator (Keel; 2.75 mo. at \$6,958)	\$19,135
Conference Director (Corell, with NSF bearing one-half salary; 3.5 mo. at \$3,479)	12,177
Executive Assistant (3 mo. at \$3,333)	10,000
Facilitation Team	51,000

LABOR - COST TO BE BORNE BY AGENCIES

Two Secretaries/Word Processors (fulltime, 3 mos.) [State]
Two Data Processing Personnel (fulltime, 3 mos.) [Defense]
Ten Translators (in six languages -- English, French, Spanish, Russian, Chinese, and Japanese -- for 2.5 days each) [State]
One Executive Officer (parttime) [Defense]
One Protocol Officer (parttime) [State]
One Liaison Officer (parttime) [State]
One Action Officer (fulltime) [Defense]
Four Action Officers (parttime) [Economic Policy Council, CEQ, EPA, and NSF]
Two Drivers (fulltime; with one sedan and one van) [Defense]

CONFERENCE PREPARATION

Letterhead and Envelope Art/Printing	1,900
Planning Meetings (twice a week)	9,500
Conference Invitation and Brochure Art/Printing	15,000
Initial Mailing	20,000
Interim Mailings	9,000
blic and Media Outreach Program	35,000
Information Support (including data base management; preparation of fact sheets; etc.)	23,500

HOTEL COSTS

Two continental breakfasts at \$10 each times 250 people	5,000
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Two lunches at \$30 each times 250 people	15,000
Four coffee breaks at \$5 each times 250 people	5,000
200 hotel rooms at \$100 for two nights	40,000
Meeting rooms and hospitality suite, at \$1,450 for two da.	2,900
Hospitality suite service, two days	5,000
Media support rooms	1,000

CONFERENCE OPERATIONS

Conference Protocol (meeting, escorting, etc.)	21,000
Conference Management/Logistics (on-site)	24,000
Audiovisual (videotaping, remote screens)	21,500
Audio Taping/Transcription of Proceedings	5,800
Duplication (including of materials prepared for and brought by participants)	60,000
Speaker Support	20,000
Dinner at State Department	26,000
Transportation Support	10,000

1870

POST-CONFERENCE COSTS

Conference Report Writing/Editing	15,000
Conference Report Art/Printing	30,000
White House Briefings/Materials on Conference Results	32,000
Follow-Up Mailings (including of conference report, going to a larger audience than conference participants)	50,000
Labor for Post-Conference Activities	20,000

MISCELLANEOUS SUPPORT COSTS

Office Space (fully serviced including rent, phone system, and furnishings -- but excluding computers and other office equipment)	16,500
Office Equipment Rental/Support/Service (including computers, printers, typewriters, copier, facsimile machine, and answering machine), at \$2,000 per month	6,000
Deliveries/Couriers	5,000
Mailing, Miscellaneous	3,000
Office Supplies (including computer supplies)	10,000
Publications and Maps	8,000
Desk Top Publishing	15,000
Telephone/Telex/Fax (including for international)	30,000
Travel (for conference organizers)	21,000
Consultants, Miscellaneous	22,000
Miscellaneous	25,000

Process Rels
475
\$3060

TOTAL

\$776,912



THE INTERPARLIAMENTARY CONFERENCE ON THE GLOBAL ENVIRONMENT

April 29–May 2, 1990
Washington, DC

Legislative Strategy Papers

Final

*For my friend Alan Bromley
with great respect,*

Printed on recycled paper

Al Gore

TABLE OF CONTENTS

Working Group Co-Chairs	page 1
Legislative Strategies - A Preamble	page 3
Global Climate Change	
- Resolution	page 11
- Legislative Strategies	page 13
Ozone Depletion	
- Resolution	page 22
- Legislative Strategies	page 24
Sustainable Development	
- Resolution	page 29
- Legislative Strategies	page 34
Population	
- Resolution	page 39
- Legislative Strategies	page 42
Deforestation and Desertification	
- Resolution	page 47
- Legislative Strategies	page 51
Safeguarding Oceans and Water Resources	
- Resolution	page 56
- Legislative Strategies	page 60
Preservation of Biological Diversity	
- Resolution	page 76
- Legislative Strategies	page 78
Delegates to the ICGE	page 82

Working Group Co-Chairs

Global Climate Change

Al Gore
United States Senate
USA

James Miruka Owuor
National Assembly
Kenya

Ozone Depletion

John Chafee
United States Senate
USA

Monika Ganseforth
Mitglied des Deutschen Bundestages
Federal Republic of Germany

Sustainable Development

John Heinz
United States Senate
USA

Fabio Feldmann
Camara Dos Deputados
Brazil

Population

Timothy Wirth
United States Senate
USA

Attiya Inayatullah
Member of Parliament
Pakistan

Deforestation and Desertification

Rudy Boschwitz
United States Senate
USA

Felicito C. Payumo
House of Representatives
Republic of the Philippines

Safeguarding Oceans and Water Resources

John Kerry
United States Senate
USA

Richard Northey
Member of Parliament
New Zealand

Preservation of Biological Diversity

Max Baucus
United States Senate
USA

Alexey V. Yablokov,
Deputy Chairman, Committee on Environment and Rational Use of
Natural Resources, Supreme Soviet
USSR

LEGISLATIVE STRATEGIES—A PREAMBLE

This document represents a general consensus of the conference; it is understood, however, that signatories to the Declaration of Environmental of Interdependence do not necessarily endorse every resolution and strategy incorporated herein.

I. State of the World Environment

The earth today is in the early stages of a global ecological crisis of historic and unprecedented proportions. Citizens and governments in every nation confront environmental problems that test political leadership at all levels—grassroots, local, national and international. The survival of basic life support systems of our planet is at risk if humanity cannot muster the will and harness the effort to meet these challenges.

The environmental problems facing the world encompass every economic and social sector—business, industry, agriculture, health, education—and every discipline, from economics to biology, from ecology to engineering. Many of these problems will require the nations of the world to agree on comprehensive multilateral treaties and conventions.

However, it must be accepted that these kinds of problems result from cumulative effects of actions taken *within* national boundaries. While working urgently to formulate the needed international agreements, the world's nations must at the same time, individually and collectively, accept responsibility for the environmentally degrading activities within their own borders, and begin to take action on their own initiative. This process will be greatly facilitated by communication among nations, sharing knowledge about possible options, and mutual assistance. This process can and should begin today, even before major international agreements are in place.

One thing is transcendently clear: the world's environment is under threat from many quarters, and the need to take action to reduce these threats is urgent. The appropriate responses will be in large part the product of deliberations in these nations' legislative bodies, and will be embodied in the laws that these bodies adopt. Parliamentarians around the world, representing citizens who are deeply concerned about these problems, are increasingly called upon to take leadership in response to these challenges.

II. Purpose of the Conference

The Interparliamentary Conference on the Global Environment provides an opportunity for parliamentarians from nations around the world to begin this process of deliberation, seeking shared concerns and common solutions.

Actions that can be taken at both the national and international levels have been discussed, with the purpose of developing as comprehensive a list as possible of environmental policy options that are appropriate for action by parliaments around the world. Steps have been taken to ensure effective continuing communications and relationships among the world's legislative bodies to encourage prompt and appropriate actions to be taken.

III. Conference Issues

Many of today's pressing global environmental problems have long been recognized by scientists and environmental professionals; the warnings were sounded 20 years ago in a landmark declaration from the 1972 United Nations Conference on the Human Environment in Stockholm, Sweden. What has changed in recent years is the increased public awareness of these problems and the increased sense of cascading crises resulting from the exponential growth of population, pollution, and resource degradation.

The Conference is organized to consider seven issue areas, chosen for their signal importance and the fact that they are global in scope, possessing enormous inertia and momentum. Although many environmental issues are international in character, these seven issues have particular significance beyond geographic and temporal immediacy: global climate change, stratospheric ozone depletion, deforestation and desertification, loss of biological diversity, degradation of oceans and water resources, population growth, and sustainable development.

Some of these issues represent the impacts or results of human activities that are proving to be unsustainable in the long-, or even in some cases, in the immediate-term. Global climate change, resulting from increasing "greenhouse gas" emissions, and depletion of stratospheric ozone, attributable to industrial and commercial chemicals, both reflect the unsustainable "affluent/overload" effects of developed economies and advanced economic activity. Many developed countries have already experienced extreme deforestation, desertification and losses of biological diversity, and many developing countries are following the same dangerous path. Oceans and losses of water resources through pollution and overuse result from overloads from human activities in both developed and developing areas. As noted, population growth, underlying the constant expansion of the human activities that cause these environmental stresses, contributes to all of these problems.

As a result of the interrelated nature of ecological systems, these problems that have been considered separately and on a fragmented basis can now be addressed through the diffuse and interconnected causes and effects of potential climate change. Consequently, policymakers who seek measures to protect the earth's atmosphere can and must deal with some of these long-standing international environmental issues in a new and urgent context.

It is important and desirable that action on these environmental problems begin without delay, and that we immediately begin discussion of measures appropriate for individual nations. Because ozone depletion, deforestation and desertification, loss of biological diversity, and degradation of oceans and water resources have largely resulted from the pressures of overpopulation and unsustainable development, and are cumulatively leading to global climate change, actions dealing with climate change can best be reviewed in the context of the population and sustainable development policies of each country. These issues must be addressed together and not in isolation. Population control and sustainable development will provide the foundation for a response to these problems, and will pose new directions for human activities that will enable economic activities with fewer unwelcome or unsustainable side-effects.

There are two faces to unsustainable development: one is the unsustainability of industrial and energy-use activity, concentrated for the most part in affluent or developed economies, in which ecological systems are overloaded by rapid consumption and waste products. The other is the unsustainability of poverty, in which rapidly growing populations put ever-increasing pressure on meager resources, overexploiting and eventually exhausting land, water, forest and other resources.

The first of these requires strategies focusing on retrofitting, replacing, and eliminating existing infrastructure and means of doing business. The second calls for the incorporation of sustainable concepts into new activities and methods.

Both are costly and difficult, and will require significant planning and forecasting. Both require a greater awareness of the ways that human activities are affecting the earth's life support systems and critical natural resources, and finding new methods of economic production that protect both the environmental and economic sustainability of human activities. Both will also provide many benefits and improvements in the quality of life on earth, beyond those directed at environmental improvement alone.

Global Climate Change

Citizens around the world have become increasingly aware that human activities have changed the earth's atmosphere in ways that may threaten human well-being and even the earth's basic life support systems. The U.N. General Assembly has recognized climate change as a common concern of mankind. Climate is an essential condition which sustains life on earth. The fact that emissions from industrial, transportation, residential and consumer activities have already resulted in measurable changes in the concentration of carbon dioxide and other greenhouse gases in the atmosphere—and could result in long-term global climate change—has produced urgent calls for international action to reduce human impacts on the earth's atmosphere. Even more frightening is the realization that climate change involves massive inertia, and that even drastic reductions in emissions today may not diminish climate change for some time.

Many nations will want to ask their citizens to change habitual and accepted ways of living and conducting business only after international agreements have been achieved on the needed actions. At the same time, however, many of the changes necessary to prevent and deal with global climate change are beneficial in their right and would be desirable in any case. For example, actions to reduce emissions through enhanced energy efficiency may also reduce dependence on foreign sources of fuel, reduce acid rain problems, improve health conditions in urban centers, protect infrastructures, and save money in the long run.

Stratospheric Ozone Depletion

Earlier warnings that a number of industrial chemicals might result in depletion of the stratospheric ozone layer were substantiated in the mid-1980s by scientific findings that a large "hole" had developed in the ozone layer above Antarctica. Later research revealed that the causes of the creation of that hole were directly linked to a group of chlorofluorocarbons (CFCs) used as refrigerants, foam agents, and aerosols. In addition, thinning of stratospheric ozone has been observed at all

latitudes. Reductions in ozone levels have now been found in the stratosphere above the North Pole.

Urgent international negotiations have already produced the Vienna Convention on Protection of the Ozone Layer (1985), and the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. However, parties to these agreements have since agreed that a more rapid phase-out of harmful ozone-depleting chemicals is called for, and additional negotiations will soon be underway. Developed countries must work toward the most rapid development and deployment of CFC substitutes, while assuring the environmental safety of the substitutes, and developing countries must seek out methods of achieving development goals within the constraints posed by threats to the atmosphere from CFCs, and similar ozone-destroying compounds such as the halons, methyl chloroform, carbon tetrachloride, and hydrochlorofluorocarbons (HCFCs).

Deforestation and Desertification

Loss of the world's forests and productive agricultural land has been accelerating over the past several decades. These losses have occurred all over the world. Many developed countries have experienced drastic deforestation through the creation of agricultural lands and urban high-density communities. Large sections of the land has since been allowed to convert back into second-growth immature forests, lacking in biodiversity and resources.

Deforestation pressures are especially severe in tropical areas because of the pressures created by expanding populations and unsustainable methods of land-use. Tropical forests are of special concern for several reasons: they occur in extensive systems that are thought to play a key role in climate and regional weather patterns; they contain a rich store of biological diversity on earth; the cleared land cannot sustain agricultural activity; and in many areas they are under heavy pressure from incoming settlers who clear huge forest areas by burning, making substantial contributions to the greenhouse gases that cause global climate change.

Because of the contributions such burning makes to total human-caused emissions of greenhouse gases, because of the loss of biological diversity when large habitat areas are burned or cut, and because the resulting alternative uses of the land are usually not sustainable (soils are usually poor and do not support either long-term agriculture or grazing), global attention has been focused on stemming the loss of tropical forests and on the need for reforestation and sustainable management of timber cutting operations.

In many countries, loss of vegetative cover leads to desertification or loss of productive capacity in large areas. In savannah and agricultural land, overuse, overgrazing and poor agricultural and irrigation practices also contribute to desertification. These problems are occurring in both developed and developing countries. The cumulative effect of the loss of natural resources in many countries has an impact on the global economy as well as the global environment.

Biological Diversity

As wilderness areas around the earth are subjected to encroachment by human settlements and agriculture, native species of plants and animals in these habitats are rapidly being extinguished. Larger animals have become the victims of direct overexploitation through hunting or poaching, and are threatened with extinction. Genetic erosion in agricultural fields and in husbandry is also a major threat to the global biodiversity.

No firm figures exist on the number of species on earth today, but it is estimated that there are some 30 million species of plants, insects, animals and other life forms, of which about 1.5 million have been identified. Some experts state that within the next ten years, if tropical forests continue to be destroyed at current rates, some 15 percent of all plant species will be eliminated by the year 2000. Many species also face extinction in developed countries through the loss of habitat, exposure to toxins, and over-exploitation.

Such losses are important to humanity for many reasons. In the complex interaction of ecological systems that support life, loss of even small links in the biological chain can doom the entire system. Because of which have symbiotic interrelationships, continuation of the system depends on the presence of most of the organisms in the system. Moreover, medicines and pharmaceuticals are heavily dependent on specialized chemistry found in living organisms. Loss of these wild organisms could destroy the possibility of potential pharmaceuticals to cure human disease or form the basis of ecologically benign chemicals.

The domesticated plants that form the basis for the world's agriculture must be replenished by infusions of stock from wild plants from time to time. Some of the "raw material" of biotechnology is to be found in the genetic riches of living organisms that are being eliminated in the current wave of extinctions, described as the most rapid loss of species since the mass extinctions of eras before human life on the Earth.

Oceans and Water Resources

Pollution from human sources threatens future use and productivity of both oceans and freshwater sources. Sources of this pollution span the entire spectrum of economic activity, from agricultural runoff that silts up and pollutes rivers and marine estuaries to industrial and urban sources that produce toxic pollutants that foul not only shorelines but water resources used for human consumption, groundwater and surface waters.

Many of these oceans and water resources problems cross national boundaries or are global in scope. Pollution threatens ocean waters, as does overharvesting of marine resources that provide an essential and irreplaceable food source for many nations. Marine fisheries produced 84.5 million tons in 1987, a fourfold increase since 1951. The upper limit of fisheries yields may be around 100 million tons, according to some estimates, but pollution and loss of habitat may mean that goal will never be achieved.

Water resource scarcity afflicts growing regions of the world and threatens to increase political tensions in water-short areas. Population pressures and agricultural activities are increasing fresh-water demands, causing water tables to

be drawn down and aquifers to be depleted. Nations whose rivers receive heavy pollutant loads from upstream neighbors also feel the need for cooperative mechanisms to alleviate their water quality problems.

As pollution from oil spills and land-based sources continues to increase, concern around the globe is rising about these abuses of the global oceans "commons." Mechanisms are being sought to increase international cooperation in stemming ocean pollution.

Population Growth

Human population growth has been a leading cause of increased pressure on the global environment. Over the past 50 years, the world's population has been increasing at unprecedented speed. Current estimates project an eventual levelling off of the population in the next century at between 8 and 14 billion people. Current trends are moving towards the upper estimate.

Many of the world's environmental problems arise from practices that are insignificant if done in limited areas by modest numbers of people. However, it is the cumulative effects of these practices, increasing exponentially with the human population growth, that causes the acute ecological impacts the world is now seeing. In this way, demographic trends, together with the production and consumption patterns chosen by individuals and societies, are a critical underlying cause of many environmental dilemmas facing the world.

A necessary pre-condition for addressing the global population issue is the universal availability of education about family planning methods, education about why family planning information, counselling and services are important, and access to reproductive health care and services. Assuming that this precondition exists, efforts to address population planning should focus on two necessary factors.

First, childhood survival rates should be increased to levels which cross the threshold necessary for the demographic transition to low birth rates and low death rates. Most countries with high rates of population growth also have low childhood survival rates and this basic condition must be changed.

Secondly, the status and education level of women must be increased. Until women have some control over their destinies and the knowledge to make responsible choices for their future, family planning efforts will be ineffective.

Both of these activities must take place in the context of national economic development and the concept of environmental sustainability. Long-term economic and political stability is likely to be achieved in countries where human resource development and equitable sharing of wealth goes along with concern about the conservation and protection of natural resources. Such policies also create conditions under which family planning programs are more likely to succeed.

Sustainable Development

A common thread emerges in the search for environmentally sustainable economic activity and development. This might be defined as activity that does not involve degradation of the basic resource base on which future economic activity, health, or well-being depend; i.e., financing today's activities with tomorrow's resources. A new approach is required in which all nations aim at a type of development that integrates production with resource conservation and enhancement. An adequate basis for livelihood and equitable access to resources are essential. Because economic and social systems and ecological conditions

differ widely among countries, each nation must work out its own policy implications.

The discussion of sustainable development involves crosscutting issues, such as national economic, development, and population policies, international cooperation on global funding options, development of mechanisms for technology transfer, and other related concerns. Each of these topics should incorporate criteria of sustainability, and each nation should reexamine its own policies and activities to ensure that this is the case. It is important that this philosophy be reflected in each nation's approach to planning.

Although the idea of sustainable development involves unique concepts, all the other issues contain sustainable development concepts, as well. As specific options are developed for addressing the issues, each should also be based on sustainability concepts.

IV. Products of Conference

What follows are lists of legislative goals and strategy options developed for each of the seven issues of this Conference, along with short background papers attached as appendices. The items identified could be enacted by an individual parliament, and are categorized into goals directed at national activities and goals directed at international activities and relations with other nations.

Not all strategies will be appropriate for all nations; not all delegates will even agree with each option. What remains is the need to develop specific mechanisms, model laws, and examples for implementing these goals: the tools to fill these tool boxes.

One means for doing this is through the International Network for Environmental Policy (INEP). INEP is a computer network for individuals and organizations interested and involved in environmental policy issues. Initially developed for this Conference, INEP will continue to provide policy makers from around the world a means for communicating and sharing ideas on means of dealing with environmental issues.

Initial legislative participants of INEP will be found in the countries attending the ICGE. Additional participants in the network will include parliamentarians from other nations, managers, policymakers, scientists, and others. INEP will enable its participants to discuss approaches, strategies, and philosophies of legislative environmental actions and to develop consistent, effective environmental legislation.

Global Climate Change

GLOBAL CLIMATE CHANGE

Whereas:

- Global climate change, which disrupts basic agricultural cycles, imposes heavy economic costs, disturbs the ecological balance, and causes the oceans to encroach upon coastal regions, threatens the well-being of peoples in all nations;
- More severe forms of global climate change threaten the survival of nations and the entire international order, both directly as a consequence of environmental effects, and indirectly as a consequence of political conflict and war induced by desperate social stress;
- The weight of scientific evidence supports the conclusion that greenhouse gas emissions caused by the radical increase in human economic activity during this century will, if they continue, cause serious global climatic disruption;
- The Intergovernmental Panel on Climate Change, under the auspices of the United Nations Environment Programme and the World Meteorological Organization, will present reports on the science, impacts, and response strategies regarding global climate change at the November 1990 Second World Climate Conference in Geneva;
- The emissions of gases responsible for global climate change are projected to increase sharply during the remainder of this century and in the early decades of the next, absent concerted effort to reverse existing patterns;
- The choices made now about strategies to deal with greenhouse gases will determine whether the globe will experience climate change in its lesser dimensions, which will impose serious but more controllable stress upon nations and the international system, or be committed to change on a scale which could threaten calamity;

NOW, therefore, be it resolved that:

- The time to act is now; delay exposes us, our children and their children to calamities which we will have made irrevocable by inaction in the present;
- Nations should commit themselves to negotiating a global agreement on climate change, whose basic feature will be a specific overall global target for reducing greenhouse gas emissions by 50% from 1990 levels by the year 2010, with the responsibility of individual nations proportionately related to factors such as per capita emissions and levels of economic development; and that the 50% goal be reached with, for example, a combination of a complete phase-out of CFCs and related compounds, reductions of at least 50% in levels of annual deforestation as well as increases in reforestation, reductions of approximately 10% in methane emissions and 20% in carbon dioxide emissions from the burning of fossil fuels, and other actions;
- The developed nations should together initiate a global Marshall Plan for sustainable development and the environment to share the burdens in proportion to their abilities and actively assist the developing nations so that all nations may reach this goal;
- The developed nations should launch a Strategic Environment Initiative to stimulate the development of industrial technologies, agricultural techniques and renewable energy sources with the potential for radically diminishing greenhouse gas emissions, including the establishment of an international agency to promote the development and application of all forms of solar energy on an urgent basis;
- The level of greenhouse gas emissions established as a global target should be

lowered regularly in light of new developments in such technologies, and national plans and international arrangements for sharing the costs of rapidly applying such technologies should also be adjusted as appropriate. All nations of the world should unite in global goals of immediately stabilizing and reversing current declining trends in worldwide forest coverage; and, by 2000, to increase worldwide forest coverage at a rate of 30 million acres annually;

- Nations should begin now to identify, plan for, and make preparations to deal with the most likely early consequences of global climate change;
- As we act to prevent global climate change, national and international programs of global climate research must be pursued as top priorities to sharpen our ability to understand these processes, to measure them, and to gauge the implications of our policies for them.
- Industrialized nations should ensure that trade or export development or development aid programs do not subsidize the export or sale to developing nations of technologies, products or substances that add to the problem of global climate change and redirect resources to the transfer of safer technologies.
- Development aid support the production of manufactured products in the developing country where the raw resources originate to help reverse capital flow out of developing countries and to reduce transportation requirements.

GLOBAL CLIMATE CHANGE

Legislative Strategies

A number of gases produced by human activity have been measured at increasing concentrations, adding to the greenhouse effect in which the atmosphere traps heat from the sun. An increased greenhouse effect is expected to warm the planet and alter climate systems. Increases in the level of man-made emissions of carbon dioxide, methane, chlorofluorocarbons (CFCs), and nitrous oxide, all greenhouse gases, are a direct result of increases in population and economic activity.

Different economic sectors produce different levels of greenhouse gas emissions. In the industrialized nations, energy-related emissions predominate, while in developing nations, land-use and energy-related emissions both comprise significant portions of total emissions.

National Actions

Listed below are legislative goals that could potentially contribute to the reducing emissions of greenhouse gases. Not all of these goals will be appropriate, effective, or efficient in all countries and regions of the world. Economic conditions and political culture, as well as the level of emissions from each economic sector, will be important considerations in choosing a package of goals.

General Emissions-Reduction

Goal: Accelerate development and dissemination of new technologies to promote sustainable growth while minimizing degradation of the environment.

Strategy: In industrialized nations, establish the national government as a model and thereby a stable market for technologies that minimize or eliminate greenhouse gas emissions.

Strategy: Fund necessary research and development of alternative sources of energy and fuel, with mechanisms to provide for demonstration and commercialization.

Goal: Set national standards, guidelines, or goals to limit emissions of carbon dioxide, CFCs, methane, and nitrous oxide.

Goal: Identify and eliminate existing national policies that work against reductions in greenhouse gases.

Strategy: Reexamine national economic, development, tax, and research policies in order to minimize or remove incentives for increased use of fossil fuels.

Strategy: Redefine long-term energy strategies to achieve higher efficiency and limit future requirements for carbon-emitting technologies.

Goal: Establish training centers at the national level to acquaint the nation's professionals with the technologies and strategies available to reduce greenhouse gas emissions from all sectors of the economy.

Manufacturing Sector

The manufacturing sector contributes substantially to greenhouse gas emissions, particularly carbon dioxide and CFCs. The principal relevant manufacturing activities are energy-intensive, heavy-industrial processes which consume fossil fuels for process heat, electricity for process heat, and electricity for motive force. In addition, some of these industries generate greenhouse gases in non-combustion processes, either directly or as a by-product of their manufacturing processes. The sector's potential for assisting with prevention and mitigation of the greenhouse effect is relatively large.

Goal: Encourage industrial research and development with the aim of redesigning manufacturing processes or equipment to improve energy efficiency and/or reduce fossil fuel use.

Goal: Promote use of energy-efficient equipment and processes in manufacturing.

Strategy: Establish subsidies, tax credits, and other incentives to encourage industry to replace low-efficiency equipment with high-efficiency equipment and appliances.

Goal: Promote building operation and maintenance improvements to reduce emissions of greenhouse gases.

Goal: Promote switching industrial energy inputs to fossil fuels with less greenhouse gas impact, such as natural gas.

Goal: Reduce demand for fossil fuel-intensive manufactured goods by encouraging development, production, and marketing of alternative goods.

Goal: Encourage process changes in industries that are energy-intensive and release carbon dioxide.

Goal: Encourage co-generation by manufacturers.

Goal: Encourage recovery and recycling of fossil fuel-intensive manufactured materials, particularly scrap steel, aluminum, plastics, paper, and glass; and encourage incorporation of recycled materials in manufactured products.

Goal: Encourage manufacturers to produce products which are more durable or repairable, or which generate fewer residuals when discarded.

Goal: Promote the use of sustainably harvested wood for products made from petroleum resources, where appropriate.

Goal: Promote the use of natural products as fillers and/or substitutes for petroleum-based products, where appropriate.

Goal: Discourage incorporation of CFCs in manufactured products.

Goal: Encourage substitution and process changes to minimize CFC use in manufacturing, and/or encourage or require the use of closed processes and recovery technologies to eliminate the release of CFCs to the atmosphere.

Goal: Restrict or discourage the release of CFCs to the atmosphere from products which incorporate CFCs.

Strategy: Ban the improper disposal of products containing CFCs, or use a deposit-refund system on those products to encourage proper disposal and CFC reclamation.

Strategy: Use advertising, labeling, or government statements and signals to communicate the hazards of CFC release, and promote consumer demand for substitute products.

Agricultural and Forestry Sectors

In no other sector is climate a more determining factor than in agriculture and forestry. The use of energy, production of agricultural inputs, processing of food, and not least the metabolism of all living things, release a variety of greenhouse gases. The sector includes important sources of methane, carbon dioxide, and nitrous oxide.

Goal: Promote sustainable agricultural and land-use practices that require less land, conserve energy, and reduce greenhouse gas emissions.

Strategy: Encourage more efficient use of agrochemicals, fossil fuels, and irrigation water, including the development of new crop varieties that require less water and fewer chemical inputs.

Strategy: Encourage the conversion of unneeded cropland to woodland vegetation.

Strategy: Develop and promote alternatives to burning for land management and clearing, and control burning practices.

Strategy: Promote research in rice production to minimize methane emissions.

Strategy: Encourage more efficient manufacture of commercial fertilizers.

Goal: Promote activities in agronomy, agriculture, and biology which will allow plant and animal species to be better suited to changing climate conditions.

Goal: Minimize food losses and wastes in the food distribution system.

Goal: Promote investment in sustainable forests and their harvest.

Strategy: Encourage the use of non-wood forest products, such as nuts, fruits, and medicines.

Goal: Encourage accelerated and sustained tree-growing in the public and private sectors.

Strategy: Promote research into fast-growing tree species.

Strategy: Encourage utilities to offset carbon dioxide emissions through urban tree planting and rural afforestation.

Electric Power Sector

The electric power sector is a significant source of carbon dioxide and nitrous oxide emissions, and emissions sources are highly concentrated relative to other economic sectors. In addition to attempts to reduce its share of greenhouse gas emissions, the electric power sector may need to adapt to any future climate change due, for example, to changes in weather-sensitive demand, changes in streamflow.

Goal: Accelerate research, development, and demonstration of non-fossil electricity supply technologies, such as wind power, geothermal power, solar thermal power, solar electric power, ocean energy, and biomass energy.

Strategy: Fund necessary research and development of renewable sources of energy and fuel, with mechanisms to provide for demonstration and commercialization.

Goal: Increase public and commercial awareness of high-efficiency and renewable-fuel appliances and equipment.

Strategy: Fund locally-developed education programs for individuals on how to evaluate and maximize efficient use of energy consumption in their everyday lives.

Goal: Eliminate fiscal incentives that encourage use of fossil fuels.

Goal: Promote high-efficiency co-generation.

Goal: Encourage anticipation of possible effects of climate change on fuel supply and infrastructure for electricity generation.

Goal: Promote efficiency through utility operating and maintenance procedures.

Goal: Promote the use of generating technologies and fuel combinations that minimize greenhouse gas emissions and environmental damage overall, when investments are made to increase or replace generating capacity.

Strategy: Impose greenhouse gas emission fees, or carbon-based fuel user fees, on utilities using fossil fuels.

Strategy: Establish tax credits for investments in selected, low- or non-emitting technologies.

Strategy: Set technology standards or emission limits for new investments in generating capacity.

Goal: Increase capital turnover rates to accelerate retirement of polluting or inefficient equipment.

Goal: Promote consideration of end-use efficiency improvements and co-generation, as low-cost alternatives to generating capacity expansion.

Goal: Encourage investment in new, more efficient transmission and distribution technologies.

Strategy: Support research and development of superconducting technology and power system automation.

Strategy: Establish standards for replacing transmission and distribution equipment.

Goal: Promote efforts to offset new sources of carbon emissions, with measures such as tree planting or investments in energy efficiency.

Goal: Promote development and implementation of technologies with low or no greenhouse gas emissions.

Strategy: Establish design standards requiring the use of the best available or best practical technology for efficient use of fuel in new generating capacity.

Strategy: Research, develop, demonstrate, and introduce technologies that utilize clean fuels, such as hydrogen.

Goal: Improve the end-use efficiency with which electricity is used by all consumers.

Strategy: Establish efficiency standards.

Strategy: Develop subsidies and incentives to encourage use of efficient technologies, materials, and procedures.

Goal: Encourage least-cost utility planning, which analyzes all demand-side conservation and efficiency measures in the same framework as supply-side measures, for providing electrical services.

Goal: Reduce methane emissions from hydro facilities and other water impoundments.

Strategy: Require full environmental impact assessments prior to developing water containments, in order to determine potential methane emissions levels from such facilities prior to project approval.

Transportation Sector

Vehicle operations are the most obvious source of greenhouse gases from transportation, but the sector also emits greenhouse gases from the construction of infrastructure, the manufacture of operating equipment, and the production of fuels. The greenhouse gases emitted by the sector are carbon dioxide, CFCs, and methane. The sector also emits oxides of nitrogen (a possible precursor of nitrous oxide), as well as other pollutants that contribute to urban air quality problems.

Goal: Promote research and development aimed at improving vehicle fuel economy, and developing vehicles that can use alternative fuels with low or no greenhouse gas emissions.

Goal: Promote design, production, marketing, and purchase of fuel-efficient vehicles, and vehicles that operate on fuels with low carbon dioxide emissions.

Goal: Promote vehicle operation and maintenance improvements to reduce emissions of greenhouse gases.

Goal: Slow the growth in the number of vehicle-kilometers travelled, and increase vehicle occupancy.

Goal: Promote efficiency in urban, suburban, and rural transportation infrastructure designs, including location of residences, businesses, and services, as well as layout of roads and highways, that minimizes the need for private vehicle use and otherwise minimizes overall energy demand for personal transport.

Strategy: Promote and facilitate use of relatively fuel-efficient modes of travel, such as walking, bicycling, urban mass transit, or high-speed rail, where appropriate.

Goal: Promote development and utilization of telecommunications to reduce the need for travel to exchange information or obtain services.

Goal: Promote transportation infrastructure designs, and strategies for extending their useful life, that reduce requirements for materials whose production releases large amounts of greenhouse gases.

Goal: Promote maximal use of the least energy-intensive modes of freight transport.

Residential and Commercial Sectors

The residential and commercial sectors consume energy for applications in areas such as cooking, space heating, lighting, and air conditioning. The most obvious opportunities for reducing greenhouse gas emissions are in improving the efficiency with which these services are provided. Community design and weatherproofing of structures also play a role in determining how much energy is consumed to regulate the indoor environment. In addition to their direct and indirect contribution to carbon dioxide emissions, the commercial and residential sectors account for a substantial portion of CFC emissions.

Goal: Encourage energy efficiency and conservation, and overall resource efficiency, in new and existing buildings, through building design, siting and landscaping, construction, energy-use management, and retrofitting older buildings.

Strategy: Encourage urban tree planting for shade, as a means to reduce building cooling loads.

Goal: Demonstrate and promote increased efficiency of fuelwood use; provide incentives for substitution of more efficient fuels.

Goal: Promote efficiency in urban transportation infrastructure designs, including location of residences and services, street layout, and landscaping, that minimizes the need for private vehicle use and otherwise minimizes overall energy demand from communities.

Strategy: Promote use of relatively fuel-efficient modes of travel, such as walking, bicycling, urban mass transit, or high-speed rail, where appropriate.

Goal: Encourage the adoption of updated building codes that require highly efficient equipment and practices.

Goal: Promote the use of non-fossil energy, such as passive and active solar, wind,

and biomass, for space heating, water heating, and other applications.

Goal: Promote research and development aimed at improving energy efficiency and developing alternative fuels for residential and commercial applications.

Goal: Encourage proper operation and maintenance of building equipment, to ensure optimal efficiency.

Goal: Promote the manufacture and purchase of high-efficiency equipment and appliances.

Goal: Encourage methane recovery from landfills.

Goal: Stimulate research, development, and marketing of chemical and/or technological substitutes for CFCs, in appliances, building materials, and commercial equipment.

Goal: Promote retrieval of CFCs from appliances prior to disposal.

Goal: Control use of CFCs in construction materials and appliances for residences and businesses.

Goal: Encourage co-generation in commercial and institutional settings.

International Strategies

Climate change is an international problem, whose solution will require international cooperation. The following list offers some strategies that may help to promote the common overall goal of protecting the global environment.

Goal: Promote, support, and become involved in international cooperative activities aimed at mitigating greenhouse gas emissions.

Strategy: Participate in negotiations for a global climate convention.

Strategy: Promote the establishment of international financial mechanisms to assist developing countries in their compliance with a possible climate protection treaty, and existing treaties for protecting the stratospheric ozone layer.

Strategy: Sign and ratify the Montreal Protocol.

Strategy: Support negotiations to strengthen the Montreal Protocol.

Goal: Promote information dissemination on technologies and techniques available to reduce greenhouse gas emissions.

Goal: Promote technology-transfer and joint technology development programs, particularly for energy-intensive activities such as manufacturing and electricity generation, and for CFC-replacement technologies.

Goal: Facilitate financing for implementing projects to reduce greenhouse gas

emissions, including energy efficiency, alternatives to fossil fuels, and reforestation.

Goal: Establish environmental criteria for economic assistance programs and institutions; for example, such criteria might promote development of more effective environmental guidelines, and financing of environmentally sound projects.

Ozone Depletion

OZONE DEPLETION

Whereas:

- The best available scientific evidence shows that certain manufactured substances, including chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), methyl chloroform, carbon tetrachloride, and halons, are causing destruction of the stratospheric ozone layer;
- Destruction of the stratospheric ozone layer will lead to increased rates of disease in humans, including skin cancers and cataracts, threaten food crops and marine resources, and otherwise damage the natural environment;
- No level of stratospheric ozone depletion caused by human activities can be deemed safe;
- The Montreal Protocol on Substances that Deplete the Ozone Layer provides a framework for all nations of the world to protect the Earth's ozone shield;
- The control measures that are currently set forth in the Montreal Protocol are far too weak to protect the stratospheric ozone layer;
- Ozone-destroying CFCs and related compounds are also powerful greenhouse gases projected to be responsible for 20 to 25 percent of global warming;
- Stratospheric ozone depletion from continued emissions of CFCs and other ozone-destroying compounds imperil human health and the environment worldwide;
- In order to protect adequately the stratospheric ozone layer, avoidable emissions of all ozone-destroying compounds should be terminated rapidly;
- Industrialized nations should encourage industries to develop and convert to safe, alternative products and technologies that do not rely on ozone-destroying compounds;
- There will be substantial development and transition costs which will be more difficult to bear in developing than in developed economies;
- The effort to protect the Earth's stratospheric ozone layer by phasing out ozone-destroying compounds cannot succeed if it is not universal;

NOW, therefore, be it resolved that:

- National laws, regulations, agreements and similar enforceable standards must be reviewed and improved to minimize the release of all ozone-destroying compounds to the atmosphere, through use of improved emissions controls, recapturing and recycling, and safe disposal systems;
- National laws, regulations, agreements and similar enforceable mechanisms should encourage the transition from all ozone-destroying compounds to environmentally benign substitutes, through the application of measures such as taxes or fees, incentives, and the implementation of national safety and licensing standards;
- National laws, regulations, agreements and similar enforceable standards should be used to encourage the rapid development of new technologies, processes and/or manufactured compounds so that the costs of transition will be minimized;
- National laws, regulations, agreements and similar enforceable standards must be applied to prevent the transfer or exchange of ozone destructive technologies among nations;
- The Montreal Protocol must be strengthened at the June, 1990 Second Meeting of the Parties in London by
 - (1) expanding coverage to include all ozone destroying compounds, such as methyl chloroform, hydrochlorofluorocarbons (HCFCs), and carbon tetrachloride;
 - (2) accelerating the reduction schedule for production and use of all ozone

- destroying compounds;
- (3) limiting growth in production and use of HCFCs, with more stringent limits applicable to compounds that either have an atmospheric lifetime greater than two years or that contribute significantly to other environmental threats, including but not limited to global climate change;
 - (4) providing for elimination of the production of CFCs, the halons, carbon tetrachloride, and methyl chloroform as early as possible, but in no event later than January 1, 2000, with special consideration to the needs of developing countries; and
 - (5) providing for elimination of the production of HCFCs as early as possible, but in no event later than January 1, 2030, with earlier elimination dates applicable to compounds that either have an atmospheric lifetime greater than two years or that contribute significantly to other environmental threats, including but not limited to global climate change.
- To encourage global participation in and compliance with the Montreal Protocol, equitable mechanisms must be developed to share the responsibilities and the costs of transition to ozone-safe processes, technologies, and/or manufactured compounds, including but not limited to bilateral and multilateral funding assistance from industrialized nations to developing countries and creation of an international fund to assist developing countries seeking to comply with the Montreal Protocol.
 - Those countries capable of reducing and eliminating production or use of ozone-destroying compounds faster than required by the Protocol, especially compounds with atmospheric lifetimes greater than two years, should do so.

DEPLETION OF THE STRATOSPHERIC OZONE LAYER

Legislative Strategies

National Actions

Goal: Establish disincentives to discourage the use of ozone-destroying chemicals. Increasing the cost of production, sale and use of ozone-destroying chemicals through taxes or fees provides disincentives for the use of those chemicals and increases demand for substitutes, technologies and processes that do not rely on ozone-destroying chemicals. Fees could be imposed through the requirement for licenses to produce these chemicals. Taxes could be imposed on both their sale and on equipment, appliances or processes which use them.

Strategy: Impose excise taxes on ozone-destroying compounds, both domestic and imported, to discourage their use. However, exemptions should be allowed for exports to developing countries.

Strategy: Impose excise taxes on appliances, processes, and equipment, both domestic and imported, based on their potential to contribute to ozone destruction, to discourage their use.

Strategy: License production of all ozone-destroying compounds and attach fees to obtaining the licenses.

Goal: Encourage the use of safe substitute technologies, processes and/or manufactured compounds. Prior to the eventual abolition of ozone-destroying compounds, systems can be developed to encourage switching to safe substitutes earlier than required. Incentives can also be provided to industry and researchers to develop effective and efficient substitutes. Incentives for the recycling and reuse of ozone-destroying compounds should be developed as well. These programs will be expensive, and should be supported in developing countries through assistance from developed countries.

Strategy: Production and purchase of safe substitutes is subsidized and supported so as to encourage broad use.

Strategy: Subsidies and supports are provided for the manufacture and purchase of equipment, processes, and appliances which do not rely on ozone-destroying compounds.

Strategy: Manufacturers and research firms receive tax deductions, credits, and other subsidies for the research and development of substitute technologies, processes, and/or manufactured compounds.

Goal: Regulate the production, use, and disposition of ozone-destroying compounds. National regulations should be developed to control production and use of ozone-destroying compounds and to lead to reductions which are consistent with or more stringent than international agreements such as the Montreal Protocol.

Strategy: Develop accelerated reduction schedules for allowable production prior to elimination of ozone-destroying compounds, including CFCs, halons,

methyl chloroform, hydrochlorofluorocarbons, and carbon tetrachloride.

Strategy: Mandate elimination of all ozone-depleting compounds. Selection of a date for elimination for HCFCs should consider the degree of environmental threat presented by the specific HCFC compound, the effect of early dates on the willingness of producers to make necessary investments and the ability of developing countries to avoid a growing dependence on CFCs.

Strategy: Develop strictly controlled venting practices and emissions control programs.

Strategy: Require and enforce appropriate recycling and disposal methods.

Strategy: Ban equipment, processes, and appliances which use ozone-destroying compounds.

Strategy: Prohibit non-essential consumer items which use ozone-destroying compounds.

Goal: Develop funding mechanisms for ozone-protection programs. Initially, the revenues gained from taxes and fees, together with fines imposed through enforcement activities and tariffs imposed on importation of ozone-destroying chemicals and appliances which use them, will provide some funding for research, enforcement, and other activities. However, these resources are limited and short-lived. Long-term funding mechanisms must be developed.

Strategy: Support the development of international trust funds or other sources.

Goal: Develop and fund research programs designed to reduce and ultimately eliminate production and use of all ozone-destroying chemicals and to retrieve, recycle, and safely dispose of them. It is not necessary for all countries to conduct research on all aspects of ozone protection, but programs should be established to obtain and apply the results of research from those countries that are conducting research activities.

Strategy: For those countries which have the resources, research programs, both national, private, and local, should be funded on ozone issues. Research efforts should focus on:

- a. Atmospheric effects
- b. Substitutes for CFCs, halons, carbon tetrachloride, methyl chloroform, and HCFCs and the energy efficiencies of each
- c. Emission controls for those uses that cannot be eliminated quickly
- d. Recycling, containment and disposal methods
- e. Economic effects
- f. Policy impact research

Strategy: Establish national clearinghouse to disseminate information on ozone-destroying substitutes, the disposal and handling of undesirable chemicals, and ozone depletion to industry, businesses, and citizens.

International Actions

Goal: Strengthen the Montreal Protocol.

Strategy: Expand coverage of Protocol to include methyl chloroform, carbon tetrachloride, and hydrochlorofluorocarbons; accelerate reduction schedules in the current protocol; add provisions providing for elimination of all ozone-destroying compounds as rapidly as possible.

Goal: Broaden worldwide participation in and compliance with the Montreal Protocol.

Strategy: Use bilateral and multilateral assistance to promote participation and compliance with Protocol.

Strategy: Prompt development and demonstrated availability of safe, substitute technologies and processes that do not rely on ozone-destroying compounds will promote willingness of all nations to comply with terms of the Protocol.

Goal: Explore and support international cooperative activities. It is important that countries establish mechanisms for sharing of information and means for reducing use of ozone-destroying compounds. One way of doing this is through UNEP and WHO clearinghouses of information.

Strategy: Develop programs for sharing appropriate technologies which reduce use of ozone-destroying compounds.

Strategy: Support cooperative research programs to develop safe substitute technologies and processes that do not rely on ozone-destroying compounds.

Strategy: Ratify international treaties like the Montreal Protocol and the Vienna Convention.

Goal: Encourage use of environmental criteria by economic assistance programs and institutions.

Strategy: Increase pressure on national overseas development agencies and multilateral development banks to develop more effective environmental guidelines and to support ecologically sound projects, and, conversely, to end those projects which directly or indirectly promote the use of ozone-destroying substances.

Strategy: Provide effective technical assistance and other bilateral assistance to research and other programs which encourage the use of safe substitute technologies and processes that do not rely on ozone-destroying compounds.

Strategy: Negotiate provision and acceptance of bilateral assistance to include

environmental criteria.

Goal: Develop economic pressures and sanctions.

Strategy: Develop mechanisms to encourage countries that are not reducing or limiting production and use of ozone-destroying compounds to do so. These mechanisms should at least be consistent with the Montreal Protocol.

Strategy: Plan for prohibiting importation of all ozone-destroying compounds.

Strategy: Develop financial aid to needy countries for substituting, recycling, capturing, and disposing of all ozone-destroying compounds.

Strategy: Prohibit importation of equipment and appliances that require the use of ozone-destroying compounds.

Strategy: Prohibit exportation of specified products to countries that are not signatories to and in compliance with the Montreal Protocol and the Vienna Convention or successors.

Strategy: Enforce economic sanctions against countries that produce ozone-destroying compounds beyond the limits of the Montreal Protocol or successors.

Strategy: Prohibit export of technologies to produce or expand use of any ozone-destroying compounds to countries that are not signatories to and in compliance with the Montreal Protocol.

Sustainable Development

SUSTAINABLE DEVELOPMENT

The goal of sustainable development is nothing less than the permanent preservation of life on earth.

Whereas:

- The basic needs of our growing populations, and the aspirations of all peoples for themselves and their children require continued economic progress especially in developing regions of the world;
- Each nation has the right to choose the pattern of development most compatible with its history, tradition, culture and the concerns of its people;
- Implementation of sustainable development policies must include a full recognition that poverty and illiteracy, as human conditions, must be eliminated. Such conditions are critical impediments to national and global achievement of sustainable development;
- Current approaches to development are rapidly consuming the natural endowments of all nations, in terms of land, water, minerals and fuels, at rates which cannot be sustained over an extended period of time;
- Current approaches to development are destroying increasing numbers of living species of animals and plants, the loss of which impoverishes us and our descendants economically, intellectually and morally;
- The effluents which are a byproduct of economic growth have reached levels that severely compromise local and regional environments, to the extent that the economic and social costs arising from these practices already have begun to outweigh economic gains;
- Some of these effluents, such as the greenhouse gases, have reached levels that will increasingly disturb the basic natural cycles and systems upon which the global environment depends for stability;
- Local and regional environmental and resource degradation will render existing strategies for development increasingly ineffective, threatening our ability to advance;
- Natural systems imbalances at the global level will threaten the fabric of organized international life, with risks and costs escalating rapidly with every delay in addressing the sources of this threat;
- Major improvements in the technologies now used for economic growth as well as new measurement indices will be needed to respond to these profound challenges;
- Even revolutionary advances will be of little use, unless matched by similarly deep changes in attitude, policy, and institutions in every nation;
- The uncontrolled pursuit of biotechnology experimentation and genetic manipulation imposes unusual dangers on the global environment and is inconsistent with the principles of sustainable development and more time is required for international dialogue on the ethical and moral dimensions of genetic manipulation;
- It is necessary to distinguish between the terms "economic growth" and "development." "Economic growth" only takes into consideration numerical measures such as GNP, and does not take into account social and environmental costs; and
- "Development" must be understood as a qualitative measure of well-being. "Sustainable development" is a necessary balance between the interests of present and future generations. It includes both social justice and a healthy environment.

NOW, therefore, be it resolved, that

- The parliaments of each nation are urged to provide the leadership to change and refocus national priorities on conservation and ecological protection as primary national responsibilities.

NATIONAL CHARTER FOR SUSTAINABLE DEVELOPMENT

Be it further resolved, that

- each nation is urged to undertake the establishment of a National Sustainable Development Charter to include self-binding rules and obligations, including economic incentives or disincentives, to respect and concretely recognize the principles of responsible and sustainable development, including:
- measures to control and stabilize population growth;
- practices to conserve and adequately reduce reliance on fossil fuels and non-renewable resources generally;
- revisions of national accounting systems to recognize and incorporate environmental values such as the depletion of non-renewable resources;
- regulations for preservation of habitat, endangered species, and biodiversity;
- policies to prevent the unsustainable use of wetlands, farmlands and forests;
- limitations and controls on the generation and disposal of toxics;
- elimination of subsidies that result in loss of habitat, species, or biodiversity, or the excessive consumption of non-renewable resources;
- practices, especially for industry, to reduce energy demand and minimize waste; and
- adherence to internationally agreed upon standards of ecological conduct applicable to both domestic and international entities, incorporating a principle of global fairness.

GREEN COMMON MARKET

Be it further resolved, that

- the membership of GATT is urged to take the necessary steps to establish a Green Common Market for Trade and Technology in which participants agree to assume an appropriate and comprehensive range of sustainable development strategies and practices while gaining complete and open market access, free of duties, tariffs, quantitative restrictions and other direct and indirect market barriers.
- such Green Common Market shall be established by (1) improving and utilizing the mechanisms of Article XX, or (2) concluding a Sustainable Development Code conferring enforceable obligations upon signatories.

BANK FOR SUSTAINABLE DEVELOPMENT

Be it further resolved, that

- the industrialized world recognize its responsibilities and self-interest in assisting developing countries in achieving sustainable development by establishing a Bank for Sustainable Development with the special purpose of supporting the transition of developing countries addressing and implementing sustainable development practices. Eligibility shall be extended to:

- (1) Those countries with low levels of development and percapita income and for which comprehensive application of sustainable development principles is currently infeasible and which undertake an effective and sustained program to achieve "demographic transition".
 - (2) Those developing countries adopting practices and policies consistent with a national charter for sustainable development;
- capitalization for the Sustainable Development Bank shall be drawn, insofar as possible, from the military and defense budgets of the major industrialized countries; and
 - as an interim measure while arrangements for this new institution are being completed, a "Green Window" for ecologically-related loans be inaugurated at the World Bank.

POPULATION

Be it further resolved, that

- the growth of population must be limited to sustainable levels by each nation, and
- any nation yet to achieve "demographic transition" shall be granted benefits under the Sustainable Development Code upon demonstration that such nation has undertaken a comprehensive program to achieve demographic transition, which program includes but is not limited to:
 - recognition of basic human rights, including the education, employment, and empowerment of women;
 - provision of educational and market-driven employment opportunities, to enable people to earn an adequate minimum standard of living; and
 - successful implementation of effective family planning programs to achieve and maintain replacement-level birth rates.
- all major sustainable development planning should incorporate women's development, education, and family planning policies which take the human factor into careful account.

INTERNATIONAL BORROWING AND LENDING

Be it further resolved, that

- no multilateral lending institution, nor any government agency or government chartered financial institution, shall extend credit:
- for any activity that is inconsistent with sustainable development; or
- to any nation that has not systematically begun to incorporate the principles of sustainable development in its policy practices.
- the determination by any one multilateral lending institution shall be binding on all others.
- all decisions by international lending institutions shall be based on the submission of a thorough evaluation of environmental and social impacts of any activity proposed to be financed.
- policies of all multilateral lending institutions shall respect the perspectives and needs of borrowers as well as lenders.
- all multilateral lending institutions and creditor governments shall adopt policies to strongly encourage and facilitate the reduction and conversion of existing debt, according urgent and highest priority to debt for nature swaps.

TECHNOLOGY TRANSFER

Be it further resolved, that

- the transfer of technologies essential to achieving sustainable development be given high priority for support by all multilateral financial institutions.
- special rules and concessionary terms for the transfer of technologies and access to intellectual property be established to speed and facilitate access by those nations subscribing to the principles of sustainable development.
- pending the completion of international dialogue on biotechnology and genetic manipulation and the establishment of uniform guidelines and protections, no patents be issued that would result in the release of genetically-engineered organisms to the natural environment.

TOXICS

Be it further resolved, that

- each nation shall commit to the urgent implementation of measures to reduce and control toxic emissions into the environment and pledges:
 - (1) to reduce all toxic and mutagenic elements in production activities to the greatest extent feasible by the year 2000.
 - (2) to routinely and accurately monitor the composition and volume of such effluents that are necessary and unavoidable to production activities (after the application of best control technologies); and
 - (3) to dispose of such residual effluents in the most environmentally responsible and protective manner, consistent with the principles of sustainable development, in the country or region where the materials are produced,and shall adopt such national requirements and regulations and dedicate such resources as are necessary to achieve these objectives.

ENVIRONMENTAL COSTS

Be it further resolved, that

- each nation shall develop and apply revised accounting systems and practices that shall fully recognize, in national product and income accounting, all costs associated with:
- the depletion of non-renewable resources, including energy, ecological systems, and species diversity, and
- damage to the environment.
- each national government shall use economic and fiscal measures to require such costs to be imposed on, and returned by, the public or private entity engaging in such activity; and
- each nation shall support and encourage similar revision in accounting systems maintained by the United Nations and other regional and international organizations.

PEACE

Be it further resolved, that

- the sovereign nations of the earth recognize that the material and spiritual sustenance of humankind requires the full commitment of each nation to

- achieving and maintaining global peace. To this end, the nations undertake:
- to resolve conflicts and disputes peacefully through negotiation, diplomacy, and reliance on international law and institutions, including the establishment of an Environmental Court and an Environmental Security Council within the U.N. structure;
 - to reallocate insofar as possible investments in military weapons and defense systems to meet human needs, and particularly the protection of the global environment, education and the eradication of poverty; and
 - to establish policies and norms of behavior that are conducive to the harmonious and sustainable conduct of relations with other countries and peoples.

SUSTAINABLE DEVELOPMENT

Legislative Strategies

The goal of sustainable development is to balance environmental and ecological requirements with economic development. It is a concept which has great tensions. Affluence can cause global warming and ozone depletion as its unintended by-products. Poverty can accelerate the loss of tropical forests and inhibit biodiversity. Population shifts and growth are an critical factor to the ability of a nation or culture to sustain itself over long periods of time.

National Actions

Goal: Develop a national definition of "sustainable development" incorporating economic and ecological sustainability with an eye towards enhancing and preserving our future.

A new approach is required in which all nations aim at a type of development that integrates production with resource conservation and enhancement. An adequate basis for livelihood and equitable access to resources are essential. Because economic and social systems and ecological conditions differ widely among countries, each nation must work out its own goals.

Strategy: Develop criteria for sustainability for industry and agriculture using national definition.

Strategy: Apply national definitions and criteria to national economic and development policies.

Strategy: Establish a national governmental focal point on environmental foresight and policy,

Strategy: Require a review of environmental assessments of major national products and development activities.

Goal: Refine economic and development polices to reflect sustainable development criteria.

Environmental considerations must be integrated into economic, technological, energy, transport, trade, industrial, foreign, and defense policies in order to meet criteria for sustainable development.

Strategy: Develop and implement a national income accounting system that takes appropriate account of the destruction or degradation of natural resources.

Strategy: Support the development of tax incentives that encourage development of criteria for environmental sustainability.

Goal: Establish and fund research programs into methods of conducting sustainable development.

To develop effective methods of sustainable development, we need to know much more about what kinds of development are, and what kinds are not, sustainable.

Goal: Develop best environmental sustainability practices with regard to industrial production, agriculture, and energy goals. Establish regulatory mechanisms to apply and enforce national criteria for evaluating success.

Strategy: Promote national sustainable development discussions with local government, industry, and community leaders.

Goal: Establish National Foresight Capability. In order to fulfill the responsibilities of each generation as a trustee of the environment for succeeding generations, every country should establish a national foresight capability to develop a process for understanding the long-term consequences of major actions and their international implications. Likely areas of potential concern might include: balance of payments/trade; economic well-being; environmental quality; information transfer and communications; national security; population structure, mobility and growth; public health; resource conservation and use; social equity; and technological productivity.

Industrial Practices:

Strategy: Develop industrial standards to provide identifiable criteria for preventing the use of materials that cause waste, recycling those that can be recycled, and disposing of the end products in the most responsible fashion.

Strategy: Develop standards for transport, handling, and disposal of hazardous wastes and emissions.

Strategy: Establish notification procedures for hazardous waste accidents and releases.

Strategy: Develop regulations limiting emissions from industry. Require appropriate use of pollution prevention and control technologies.

Strategy: Establish reasonable and responsible enforcement programs.

Strategy: Encourage community participation in evaluating and advising on hazardous materials affecting them.

Land Use and Agriculture Practices

Goal: Broad land conservation categories should be established to provide for the enhancement of already developed areas; to prevent the development of reserve areas; and to require restoration when necessary. These categories should reflect the national sustainability criteria.

Strategy: Subsidies that overstimulate food production and create inappropriate pressures on land resources at the expense of wetlands, parks and fragile lands should be eliminated or modified.

Strategy: Broad agricultural and forestry categories should be established, indicating proper levels of cropping, grazing, and lumbering for each type of ecosystem represented. These categories should reflect the national sustainability criteria.

Goal: Environmentally sustainable agriculture established as a national goal.

Strategy: Research on optimal mix of chemical and pesticide inputs to lower costs of production and preserve the resource base with minimum damage.

Strategy: Establish active extension services to disseminate new techniques using optimal/minimal effective inputs and maximizing effective organic alternatives.

Goal: Develop programs to improve use of natural resources and crops through use of local seed banks to store and propagate genetic material to prevent the loss of biodiversity and restore the natural functions of biological communities and ecosystems.

Strategy: Establish and fund seed banks and research efforts to utilize the resources available there.

International Actions

Goal: Promote economic assistance programs that incorporate sustainable development criteria which include appropriate technology transfer

Aid agencies should adopt a longer term perspective directed at the protection and rehabilitation of the natural resource base. Intermediary institutions, either non-governmental or linked to local government, that can administer aid more cheaply and involve local people should be established. Aid agencies should adopt stringent requirements for environmental impact assessment, examination of decentralized alternatives, and involvement of affected people.

Strategy: Increase pressure on international lending organizations and other nations to adopt national income accounting practices which incorporate degradation of natural resource factors in calculating GNP.

Strategy: Lender nations should expand the economic criteria by which they provide loans to include environmental and sustainable development criteria.

Strategy: Increase pressure to relevant international organizations, such as UN agencies, the World Bank and regional groups, to develop model contracts and guidelines incorporating a range of sustainable development principles(e.g., principles that encourage exploitation of renewable resources within limits defining sustainable yields).

Strategy: Increase pressure to relevant international organizations such as the OECD to develop codes of conduct for transnational corporations which deal explicitly with environmental matters, embracing the objectives of sustainable development.

Strategy: Require development assistance to be targeted at Least Cost Energy Technologies. (These involve a method of reviewing the full range of options available—for increasing supply and for reducing demand—before making a commitment to follow a particular strategy for energy enhancement.)

Goal: Become signatory to and support international environmental treaties and conventions

Strategy: Sign and support international conservation treaties and conventions, such as World Heritage, and Endangered Species.

Strategy: Encourage a strong and effective international convention for the handling and disposal of hazardous wastes.

Strategy: Promote international codes of practice covering technical, economic, and social (including health and environment) aspects of energy production and consumption.

Goal: Areas already set aside under Debt-for-Nature swaps should develop mechanisms for addressing the needs of adjacent human populations for sustainable development.

Goal: Establish international cooperative compacts reflecting sustainable development with environmental criteria.

Because of potential transboundary effects, it is essential that governments cooperate to develop internationally agreed upon codes of practice. In order to streamline programs and lead to the sharing of expenses for regional initiatives, processes to strengthen co-operation are essential. This requires the identification, analysis and coordination of solutions to international environmental problems.

Strategy: Establish national process for evaluating multilateral treaties, including trade, in order to look at their environmental impacts.

Population

POPULATION

Whereas:

- Annual global population increases are greater, in real terms, than at any time in human history;
- At current rates, in the 30 years it takes for one generation to succeed another, the world's total population will grow by close to 3 billion people;
- Yearly increments over the next 10 years will approach 97 million human beings world-wide, 94 per cent of which will be born in the developing world;
- The implications of such developments are staggering. Nearly everywhere, increasing demands are damaging the natural resource base – land, water and air – upon which all life depends;
- Urban overcrowding and the lack of economic opportunity in many parts of the world exists. Moreover, poverty is widespread and growing: For some 1.2 billion people, poverty is a way of life;
- Pressures on resources reflect the growth of population, equally relevant is the pursuit of lifestyles by industrialized countries which threaten ecosystems and sustainable development. Efforts should be taken by the industrialized countries to show bolder leadership on population and the environment.
- The projected growth of the global population could be as high as 14 billion or approximately 10 billion before it stabilizes sometime late in the next century;
- There is a marked difference between the social, economic and environmental implications of a global population that grows to 14 billion versus one that grows to 10 billion;
- Recognize the importance of economic choices and increased equality at the local, national and international levels, to the success of family planning programs.
- The working group on Population believes that the 1990s are a critical decade for developing population programs that will reduce the future size of the global population;
- Clearly, it is time for concerted action. The triad of population growth and distribution, environmental degradation and pervasive poverty threatens us and our planet as never before. Future generations must be given basic human rights and have equal access to all the benefits society has to offer.

NOW, therefore, be it resolved that Parliamentarians in all nations should:

- Endorse the "Amsterdam Declaration" developed by the participants of the International Forum on Population in the Twenty-first Century, held in Amsterdam, the Netherlands, from 6 to 9 November 1989, whereby population goals and objectives for the coming decade and beyond should include:
 - 1) a reduction in the average number of children born per woman commensurate with achieving, at a minimum, the medium variant population projections of the United Nations;
 - 2) a major reduction in the proportion of women and men who are not currently using reliable methods of family planning, but who want to postpone, delay or limit childbearing;
 - 3) a substantial reduction in very early marriage and teenage pregnancy;
 - 4) an increase in contraceptive prevalence in developing countries so as to reach the objectives of the medium variant population projection of the United Nations.
- Strengthen their political commitment to family planning programs, particularly by giving visibility through Administrative priority;
- Promote citizen participation in national population programs at all levels, in particular at the local and community level;
- Recognize and promote the importance of the rural family. In particular, programs should be encouraged to strengthen the delivery of reproductive health services,

infant and child health care, maternal health care and the education of women in rural areas. Further, it is recommended that effective programs be demonstrated which protect the welfare of rural inhabitants and provide economic choices which enhance equality;

- Develop programs that improve the organization of all planning programs, with particular emphasis given to addressing the rapid urbanization of the global population;
- Improve educational programs at all levels, both within and independent of school systems. Every individual has the right to education. Particular attention should be given to improving the education of, and to reduce illiteracy among, women around the world. In addition, population and environmental education should be developed and promoted at every level;
- Develop programs to improve reproductive health care for women. Programs should be designed to ensure safer motherhood by assisting women to avoid unwanted pregnancies and to procreate during the biologically safe reproductive years. Special attention should be paid to the prevention of pregnancies which carry extra health risks;
- Develop programs that will improve the delivery of family planning services. Particular attention should be paid to improve the logistics and supply of family planning programs so the unmet need for family planning is addressed.
- Promote programs that raise the priority given to population in international diplomacy. In particular, increased international funding for population programs is critical. Increased funding for population programs by multilateral institutions and for non-governmental population programs both nationally and through multinational non-governmental organizations is imperative. Recognizing the recommendations of the Amsterdam Declaration, population programs designed to attain the United Nations median variant estimate of population growth (10.3 billion) must be funded at a level of US \$9 billion, distributed in accordance with the specific needs of individual countries. To reach this goal, all governments, and the United States in particular, must increase financial support for population programs. The United States is encouraged to renew its historical position as the world's leader in international programs.
- Promote the development of integrated population, environmental and economic planning, recognizing that policies affecting one of these areas affects the others as well;
- Encourage policies that promote responsible parenthood -- particularly with respect to male responsibility and participation in the child-rearing process;
- Promote the development of policies that improve the health of children and recognize the effects of environmental degradation on the young. In particular, efforts should be directed at creating educational programs to promote breast-feeding and ensure low-cost, effective, child survival measures. Pursuant to the Amsterdam Declaration, support is given to reducing the 1980 rate of infant mortality to rates of at most 50 per 1000 live births by the year 2000 in all countries and major sub-groups within countries. The health and nutrition of children must be improved so that the decline in infant mortality is a recognized reality by parents;
- Promote policies that take into account the cultural relevancy of population programs -- by taking into consideration social, political, religious and cultural traditions.
- Recognize that poverty is both a determinant of and dependent upon population growth. The development of economic development programs is a critical determinant of fertility and should be encouraged nationally and internationally. Parliamentarians are particularly urged to promote more egalitarian systems and increase equity in national agriculture and rural policies. Recognizing the woman's role as a subsistence farmer, it is desirable to seek a restructuring of social, economic

and political controls over agriculture and land so that women can participate in the management and decisions related to these resources.

- Initiate a review of existing legal mechanisms that can be implemented to further population programs. All nations are urged to develop national population policies. Parliamentarians are encouraged to help educate political colleagues about the nature and urgency of the population issue and to work with colleagues to develop legislative agendas that promote population programs. It is recognized that family planning is a human right. It is the right of individual couples to voluntarily determine family size. We respect human rights for all families and individuals, and family planning must be consistent with acceptable doctrines of human rights.
- Promote family planning research, in particular, these efforts should: (1) encourage the improvement of existing and the development of new methods of family planning; (2) study the causes and the consequences of rural-urban population migration; and (3) generate a data base on the relationship between demographic characteristics and the outcome of development programs. Increasing funding for this research is essential.

POPULATION

Legislative Strategies

National Actions

Goal: To make family planning information and services widely available for any who want it. This should be carried out in a manner that takes account of the diversity of cultures. On average, an annual expenditure of \$15-20 per couple per year could provide adequate family planning information and services in most nations, as well as the training and research need to expand and improve services.

Strategy: Increase funding for national population programs.

Strategy: Increase funding for international family planning programs

Strategy: Dedicate a higher percentage of foreign assistance funding to international family planning.

Strategy: Encourage increased funding for population programs by multilateral development banks.

Strategy: Encourage increased funding for government and non-government population programs both nationally and through multinational non-governmental organizations.

Goal: Develop national population strategies to stabilize population size.

Strategy: Create mechanisms/surveys to determine population targets that can be sustained with domestic natural resources and that can benefit from economic growth and an enhanced quality of life.

Strategy: Encourage balanced distribution of the population in relation to the long-term carrying capacity of the country.

Goal: Develop integrated national population plans.

Strategy: Encourage the development of national plans that coordinate and set environmental, economic, social and overall development goals in conjunction with a comprehensive population plan.

Strategy: Include population considerations in all environmental assessment processes.

Goal: Encourage reductions in fertility rates.

Strategy: Encourage birth spacing—the period of time between births—which promotes infant health, reduces maternal-related illness and reduces family size.

Strategy: Encourage generational spacing—delaying average age at which women first give birth.

Strategy: Create incentives for delaying the birth of the first child.

Strategy: Develop mechanisms to reduce teenage pregnancy through adequate sex education and appropriate services.

Strategy: Raise minimum ages for marriage.

Strategy: Assist women to avoid unwanted pregnancy and to procreate during the biologically safe reproductive years.

Strategy: Expand and reorient primary health care services to increase their impact on women's reproductive health.

Goal: Reduce infant and child mortality

Strategy: Create educational programs to promote breast feeding and ensure sustained low cost effective child survival measures.

Strategy: Develop child nutrition programs.

Strategy: Provide safe drinking water and hygienic conditions through sanitation facilities..

Goal: Reduce maternal mortality

Strategy: Encourage birth spacing.

Strategy: Expand health care services (neo-natal/post natal care).

Strategy: Expand health education programs.

Strategy: Special attention should be applied to the prevention of pregnancies which carry extra health risks.

Goal: Improve the status of women. (Fertility rates are related closely to the status of women in society.)

Strategy: Expand educational opportunities for girls and women.

Strategy: Reduce female illiteracy.

Strategy: Draft and enact laws that promote equal rights for women in marriage, land ownership, and employment.

Strategy: Encourage pay equity

Strategy: Encourage women's participation in the public and the private sector, and in the political and economic spheres of influence.

Goal: Promote policies that reduce rural/urban migration.

Strategy: Land distributive changes through land reform and transmigration of rural population from land-short to surplus areas.

Strategy: Improve communication facilities and electrification which breaks rural isolation and backwardness.

Strategy: Develop services for secondary towns.

Goal: Improve the cultural relevancy in the delivery of population programs. The success of population programs is closely related to delivery that recognizes: (1) local customs and prevailing social mores; (2) community based family planning programs carried out through voluntary non-governmental organizations.

Strategy: Initiate a national inventory of demographic/cultural patterns for assessing the delivery of population services.

Strategy: Expand population programs in the community, especially at the grassroots level through religious leaders. The attention of parliamentarians in Muslim countries or communities is directed to the ACFH Declaration of the International Congress on Islam and Population Policy held in Indonesia in February, 1990.

Goal: Encourage private sector involvement in population programs.

Strategy: Create incentives and encourage the provision of family planning information and contraceptives in the workplace.

Strategy: Establish/mandate promotion of contraceptives in commercial enterprises.

Strategy: Create incentives for private sector research to advance the development of new forms of contraception.

Strategy: Provide quality counseling to allay fears and misconceptions using community leaders, non-governmental organizations and government public health workers.

Goal: Encourage widest possible availability of contraceptive services, including social marketing.

Strategy: Develop national media programs to promote family planning.

Strategy: Establish national programs to distribute family planning information and contraceptive devices.

Goal: Promote family life and sex education for young people.

Strategy: Promote out of school programs for young people to provide sex education and, where appropriate, contraceptive services.

Strategy: Establish national education programs that include course requirements in sex education and family planning.

Goal: Target high-priority groups in national demography.

Strategy: Encourage programs to reduce teenage marriage and pregnancy rates.

Goal: Share information with non-parliamentarians.

Strategy: Organize local conferences on population.

Strategy: Meet/write executive branch officials to encourage family planning programs.

Strategy: Work with religious leaders.

International

Goal: Reinforce the Global Mexico City Population Policy.

Strategy: Create greater awareness of global population goals and policies among parliamentarians everywhere and encourage greater support for these.

Strategy: Network information about program successes and needs with other international parliamentarians.

Strategy: Increase international funding to assist in the production and distribution of contraceptive commodities.

Strategy: Increase funding for international research to improve existing and develop new methods for family planning and contraception.

Strategy: Establish sub-regional, regional and international information networks to collect and disseminate information on family planning programs.

Strategy: Encourage existing organizations to establish cooperative international family planning programs.

Strategy: Fund and support international family planning information and services to make family planning information and services widely available in a manner which is sensitive to diverse cultural beliefs.

Strategy: In order to lower family size (number of births per family) deemed desirable for survival, support programs which promote human well-being, development of human resources, and sustainable economic development combined with environmental and ecological protection. (See Sustainable Development Goals and Options.)

Deforestation and Desertification

DEFORESTATION AND DESERTIFICATION

Whereas:

- Forests are disappearing in every part of the world as the result of human activity driven by economic concerns;
- Other regions are desertified by many factors, including drought and subsistence agriculture. Desertification, as a result of physical, geographic, and man-made developments, leads to the destruction of ecosystems, and to deterioration of all forms of organic life;
- The forests of the world, especially rainforests, are often complex ecosystems, the loss of which is often irreversible. The short-term gain from their destruction is frequently followed by permanent reduction of any other economic potential;
- Our advancing knowledge of the rainforests already shows that they can most often produce more wealth if left intact for sustainable uses, than if they are cut down, or burned, for short-term gain;
- Land cleared through deforestation is in many regions unsuitable for ongoing agriculture and exhausted within a few years, so that the deforestation leads to no permanent gain, but rather could and often does lead, to a cycle of growing economic costs, including flooding, disruption of hydrological cycles, and, ultimately, in the some instances, desertification;
- Sharply declining global acreages of forest, particularly through burning, contribute to large numbers of environmental problems, including the increase of greenhouse gases in the atmosphere, reduced food production due to erosion of soil, flooding, etc;
- The destruction of forests and other habitats forever denies to humankind the benefits derived from species of animals and plants that disappear in this process, including especially plant species which may be essential for improved crops for cultivation and those which may form the basis for biotechnological application, medicine, and other scientific uses;
- Deforestation, especially from burning, also results in significant release of carbon dioxide into the atmosphere and a contribution to the greenhouse effect that causes global warming;
- Protection of existing forests from clearcutting and burning is more cost-effective than reforestation; in addition to avoiding the expense of reforestation, this performs important watershed protection functions, preserves biological diversity, and reduces atmospheric carbon dioxide emissions more effectively;
- The economic impetus behind the destruction of rainforests often stems from economic pressures caused by poverty and population growth, which leads to land clearing and pressure on land resources for marginal agriculture;
- Debt pressures in many developing countries are creating destructive pressures on both forest and land resources;
- International trade practices often play an important role in over-exploitation of forest and land resources;
- International lending institutions have contributed, often inadvertently, to deforestation;
- In many cases, excessive use of pesticides and other chemical substances has reached a critical level, leading to depletion of soil fertility and soil degradation that contributes to desertification;
- Loss of tree cover in arid and drought-prone areas causes soil erosion and desertification, and creates fuelwood shortages that leads to further deforestation;

- The world's temperate forests are suffering extensive degradation from air pollutants, often trans-boundary in origin. Large areas in many forests subjected to such pollutants, as well as wood cutting and burning, have died or suffered severe ill effects;
- The role of women in rural societies has often been ignored by development efforts, despite the fact that in many societies women are the main farmers and fuelwood gatherers, acting through desperate poverty as the agents of deforestation and desertification; and
- The processes of deforestation and desertification occur locally but the consequences are often global.

NOW, therefore, be it resolved that:

- Governments seeking to protect the fundamental, long-term interests of their people should seek to arrest deforestation and desertification and the reverse their effects where possible;
- This interest involves not only the direct responsibility of each government to sustain forests and lands under its legal authority, but also a responsibility for all governments to cooperate and to assist in this task as part of a global effort;
- An international convention for the protection of all the world's forests, along the lines of the International Whaling Convention, should be urgently pursued. The importance of protecting both temperate and tropical forests should be stressed, together with the specific responsibilities of both developed and developing countries. Such a convention should recognize the unique value of the remaining old growth, primary forests of the world, and establish mechanisms and incentives for their protection. Specific targets for reducing deforestation and goals for achieving reforestation should be established;
- Reversing deforestation in all nations is essential. In tropical areas this is especially important in view of the contributions to greenhouse gas emissions made by burning of forests, and in view of the unsustainability of the agriculture and livestock practices in these areas of poor soils. The nations of the world should work together to develop the incentives that will encourage forest protection while assuring economic development of the people in countries where these large tropical forest are located;
- The important role of paper recycling in protecting forests -- by reducing demand for tree cutting -- should be recognized, and nations should encourage such recycling to the maximum extent possible.
- Increased scientific knowledge will be needed to enable forests to survive the impact of human activities, and to retard the spread of deserts. Major efforts should be made to discover forest products, both timber and non-timber, that can be harvested on a sustainable basis. New strains of crops suitable for arid agriculture and marginal lands must be developed and disseminated. Governments should provide resources for the accumulation of this knowledge as a priority;
- A strong emphasis on technical and financial assistance targeted to women is essential, particularly in small-scale efforts and agricultural extension, in order to provide them with alternatives to practices that exacerbate deforestation and desertification;
- Governments should also act to change the economic incentives which now promote deforestation and desertification. At the national level, this will require a mixture of tax incentives, new laws and regulation bearing on land use, and in many cases land reform;

- International trade agreements should take into account and attempt to reduce their environmental impacts, especially those on forests and other natural resources. Implementation of trade agreements should be monitored to determine any negative effects on deforestation or land use practices that they have;
- In order to relieve the pressures on environment and natural resources, especially in marginal lands, such as steep slopes, forests, and arid lands, debt reduction measures should be pursued more vigorously, both through bilateral and multilateral channels. This may include greater use of debt-for-sustainable development designed to assure forest protection, especially providing better economic alternatives. However, such transactions should occur only when initiated by the debtor country, in order to avoid any concerns about infringements on sovereignty;
- Governments should adopt national accounting methods that reflect the loss of forests and land resources as reductions in national wealth to be balanced against monetary gains from their exploitation;
- Sustainable methods of forest management must be developed and implemented. In particular, the negative impacts on all types of forests of destructive logging practices should be recognized and avoided.
- The Tropical Forestry Action Plan should be supported, to achieve sustainable management of forests and to improve forest protection and preservation of nature reserves. It should be carefully monitored to assure that it is a mechanism for developing better forest protection options;
- Internationally, the role of many air pollutants, including acid precipitation, as causes of trans-boundary forest deterioration should be recognized by governments, and measures to reduce them should be pursued;
- Development and dissemination of sustainable agricultural methods should be a high priority in order to reduce causes of desertification, including soil erosion, over-exploitation of fragile lands, over-grazing on rangelands, and over-use of chemical inputs that can reduce long-term productivity of the land;
- Irrigation should be carefully designed to prevent the salinization and waterlogging of the soil that results in desertification;
- Fuelwood alternatives should be developed, especially through application of renewable energy technologies that will facilitate development while relieving pressures on tree cover that causes desertification;
- Deforestation caused by fires--intentionally set for agricultural clearing or otherwise--that go out of control has been extensive; forestry aid to countries and communities should take into account the need for fire control equipment and training;
- Reforestation should be carried out using ecologically appropriate species and methods, choosing those that are appropriate to site-specific conditions;
- Combatting desertification outside the forest zones requires introduction of new systems of agriculture, reduced use of chemical herbicides and pesticides, protection of soil from erosion and secondary salinization, and sound rangeland management;
- Desertification control through better water management and water research should be a goal of government policies and international assistance;
- Technical and financial resources specifically targeted at forest and rangeland preservation, rehabilitation, and reforestation must be provided. The developed nations have a particular responsibility to provide assistance, both bilaterally and through multilateral lending institutions, for such purposes. This should include greater use of "debt-for-nature" swaps;

- All financial assistance, both bilateral and multilateral, should avoid negative impacts on forest and other natural resources;
- In order to facilitate increased private sector involvement in reforestation, lending practices should recognize the very long-term nature of such investments, and should be designed to provide a moratorium on payments for the first ten years, or until reforested areas are able to produce income; and
- Public environmental education, that includes the important role of forest and rangeland protection in a healthy environment, should be established in every country.

DEFORESTATION AND DESERTIFICATION

Legislative Strategies

National Actions

Establish a national forest protection goal with research, education, and operational programs. In order to develop effective policies concerning deforestation and desertification, many of the gaps currently existing in our knowledge of the subjects will have to be filled. Research and programs aimed at preservation and restoration of forests, rangelands, and croplands are needed. Programs to educate citizens about reasons for not deforesting and about alternatives to current practices are necessary, along with citizen participation in developing the best methods of implementing the goals.

Goal: Preserve existing forest cover.

Strategy: Develop natural forest management techniques.

Strategy: Establish protected areas, including intact biosystem reserves.

Strategy: Develop selective timber harvesting techniques.

Strategy: Establish and implement economically viable, non-timber-producing options, including tourism.

Strategy: Pursue reductions in ozone depletion and air pollution, both of which adversely affect forest cover.

Strategy: Link forest protection values to watershed management programs.

Goal: Restore forest cover in deforested areas.

Strategy: Reforest tropical and other wooded areas.

Strategy: Develop tree planting programs.

Goal: Develop explicit sustained-yield timber harvest management policies.

Strategy: Improve timber valuation, utilization and marketing to capture real values of timber and to reduce waste.

Strategy: Regulate timber sale practices, including foreign concession contract terms.

Goal: Ensure that national economic policies promote sustained-yield management of forests and land resources as well as long-term preservation of forests.

Strategy: Include evaluations of social and biological costs of deforestation/reforestation in economic analyses of development projects and policies.

Strategy: Review financial and economic incentives to deforest, including tax breaks, subsidized interest rates, and guaranteed loans, and, where possible, eliminate them.

Strategy: Provide incentives, such as tax credits and other financing mechanisms, for restoration and for sustainable uses of forests and semi-arid areas.

Strategy: Develop alternative sources of employment and income outside forests, to relieve pressure on existing forests and marginal lands.

Strategy: Work with farmers, peasants, small landowners, and indigenous people through community participation in local strategies for economic development, sustainable land use management, and environmental protection. This might include measures such improved credit, guaranteed loans, land grants, and market incentives.

Goal: Include the use of agroforestry in basic agricultural goal.

Strategy: Develop a research program on agroforestry.

Strategy: Establish optional combined production recommendations for crops and trees, in a non-destructive sustainable manner, while meeting basic needs for food, fuel, and timber

Strategy: Develop improved cropland management practices, which include agroforestry, and require their use.

Goal: Establish and strengthen educational and research programs.

Strategy: Establish and fund forest resource inventories.

Strategy: Develop research on alternative/renewable fuels, to substitute for wood now used for cooking and heat. Research increased cooking stove efficiency, wind and other renewable energy sources.

Strategy: Develop education programs to illustrate suggested alternatives to current practices and illustrate current practices which are successful.

Strategy: Develop land use planning standards which incorporate environmental incentives for preserving, restoring and improving land productivity for forests. These should be consistent with sustainable development and biological diversity.

Strategy: Promote the recycling of wood products, e.g. newsprint.

Goal: Restore degraded land.

Strategy: Restore and rehabilitate current desert areas and other degraded drylands.

Strategy: Develop improved rangeland management practices, e.g., prohibition of agriculture and grazing in certain areas, reseedling, low-input agriculture, sustainable annual cropping, improved cultivation practices, and

planting of shelterbelts.

Goal: Promote effective conservation financing techniques.

Strategy: Support the development of Conservation Trust Funds, to finance protection, enforcement, training, education programs, land swaps, park establishment, relocation, etc.

Strategy: Pursue debt-for-nature swaps.

International Actions

Goal: Promote, support, and become involved in international cooperative activities.

Strategy: Support Debt-For-Nature swaps, which can dramatically increase the impact of conservation expenditures.

Strategy: Explore other debt-reduction measures for countries with endangered forests.

Strategy: Review objectives of FAO-initiated Tropical Forestry Action Plan to ensure that action plans can be shown to decrease deforestation. Monitor the extent the activities can be shown to promote reduction of deforestation and the sustainable use of the world's forests.

Strategy: Support work of International Tropical Timber Organization, which involves sustained yield forest management and forest conservation.

Strategy: Revitalize the U.N.'s 1977 Plan of Action to Combat Desertification, dealing with ecologically appropriate land uses and recovery measures.

Strategy: Cooperate in the use of satellites and other modern technology to monitor the world's forests and dry rangelands, and trends towards further desertification.

Strategy: Create global conservation or environment funding mechanisms through the World Bank, UN organizations, or an independent mechanism.

Strategy: Support activities of non-governmental organizations (NGOs) involved in forestry activities in both industrialized countries and the developing world.

Goal: Become signatory to and support international environmental treaties and conventions.

Strategy: Sign and support international conservation treaties and conventions, such as World Heritage, Convention on Trade in Endangered Species and World Flora and Fauna (CITES), Ramsar Convention, etc.

Strategy: Encourage timber conservation components of international commodity groups.

Goal: Establish environmental criteria for economic assistance programs and institutions.

Strategy: Increase pressure on national overseas development agencies and multilateral development banks to develop more effective environmental guidelines and to support ecologically sound projects, and, conversely, to end those projects which directly or indirectly promote deforestation or damage critical areas of high biological richness.

Strategy: Provide effective technical assistance and other bilateral assistance to research and other programs assisting forestry and drylands activities in developing countries.

Goal: Explore other economic pressures and sanctions.

Strategy: Explore transfer taxes or tariffs imposed on underpriced commodities imported from another country.

Strategy: Require country-of-origin labelling provisions for such underpriced commodities.

Safeguarding Oceans and Water Resources

SAFEGUARDING OCEANS AND WATER RESOURCES

Whereas:

- The global water cycle is essential to life on earth;
- The scale of human activity has caused changes at every level of this cycle: polluting the earth's water and oceans; endangering human health; shifting the distribution of water by large-scale development; and reducing aquatic life due to pollution, over-harvesting, destruction of habitats, and alteration of ecosystems on local, regional, and global scales;
- The best way to protect water resources is to keep pollution from entering waters;
- High-seas driftnet fishing and other destructive activities disrupt marine life throughout the world's oceans;

and

- Short-term economic benefits from exploitation of ocean and water resources deprive future generations, diminish the quality of life, disrupt international stability and global security, and even threaten life itself.

NOW, therefore, be it resolved that:

- It is in our interest and that of future generations to address the exploitation of ocean and water resources to prevent further irrevocable damage;
- Ocean and water resources are so important to life that a precautionary approach should be used in allowing discharge of potentially harmful pollutants and wastes. Where there is reason to believe that adverse effects of discharges are likely, even in the face of scientific uncertainty, such discharges should be prohibited;
- Policies must be adopted to stop pollution at its source, with highest priority placed on measures that prevent the creation and dispersal of environmental contaminants;
- Changing our practices requires strengthening and enforcing environmental laws on all levels, based on equity within and between communities, regions and nations and on the requirement that these resources be managed in such a way that they may be bequeathed in a healthy condition.
- Policies must be adopted that ensure future land development in a manner sustainable to the global water cycle;

- Worldwide efforts should be made to develop and share new practices and technologies that minimize pollutants resulting from industrial, agricultural, and other human activities;
- Polluters should pay for the control of pollution and the damages they cause. But this principle is not sufficient to protect oceans and freshwater. It must be accompanied by incentives or fee systems to prevent overuse and exploitation of water resources;
- Expand international programs of research and technology development to protect, manage and restore our marine and freshwater resources. These programs should be internationally funded and should ensure the active participation by developing countries. The need for further research should not be used as an excuse to delay protective actions;

and

- Establish strong international systems for monitoring and enforcement of international conventions, treaties, and laws and for the protection of ocean and water resources.

AND in furtherance of these goals, be it resolved that nations join together in international convention and by individual action in an effort to:

- Properly treat and disinfect sewage and sludge before discharge to the water or land or use for agriculture or other purposes;
- Establish policies and programs to:
 - minimize the use of toxic substances and the generation of toxic wastes, including bans on certain chemicals that are highly toxic;
 - clean up abandoned hazardous waste sites to prevent contamination of surface and ground waters; and
 - implement the Basel Convention regarding the international transportation and management of hazardous waste;
- Prohibit ocean dumping of harmful or potentially harmful wastes;
- Limit urban and agricultural runoff containing harmful substances through land use controls and agricultural practices that minimize the use of fertilizers and pesticides and control soil erosion;
- Establish policies to avert and respond to oil spills and regulate offshore drilling discharges by:
 - increasing penalties and liability for spills at the national and international levels;
 - requiring double hulls and bottoms for oil tankers and improving navigation and licensing requirements;

- establishing an international fund for emergency response and clean up of oil spills and compensation for damages that result from spills to be paid for by a fee on oil from exporting and consuming countries.
 - Reduce the use of plastics and properly dispose of plastics and other debris to prevent pollution to beaches, oceans and coastal waters and reduce the threat to marine life.
 - Prevent acid rain by promoting energy efficiency and conservation and requiring pollution control technologies on power plants, industry and automobiles;
 - Require multilateral development banks to fully assess environmental impacts and to fund projects that are environmentally sustainable;
 - Develop and implement comprehensive national and international plans to manage activities in the coastal zone with particular emphasis on the relationship of land use practices to coastal degradation;
 - Seek unilateral and cooperative measures to;
 - minimize sea level rise;
 - mitigate impacts on low lying countries of increases in sea level that may occur from environmental changes already in motion; and
 - direct development away from areas susceptible to sea level rise;
 - Protect marine biodiversity and productivity by developing mechanisms to preserve sensitive coastal areas such as wetlands, barrier islands, estuaries, coral reefs, and other critical wildlife habitats;
 - Establish regional regimes for effective sustainable management of international fishery resources, and in particular, ban high-seas driftnet fishing;
 - Strongly limit the taking of marine mammals by banning commercial whaling and reducing whaling under scientific permit;
 - Use freshwater more efficiently through conservation and recycling;
 - Establish international agreements for the extraction, use, and protection of freshwaters shared between nations;
- and
- Protect groundwater resources by limiting withdrawals to sustainable levels and controlling major activities, such as land development and discharges that may contaminate important aquifers.

Be it also resolved that:

- As Antarctica plays a significant role in the global climate system and the aquatic food chain, provide comprehensive and effective protection of the Antarctic ecosystem by:
 - granting Antarctica special protective status as a Land of Science, treaty park, and international wilderness area;
 - extending the current moratorium on mineral exploration and negotiating a total ban on exploration and exploitation of mineral and energy resources in Antarctica;
 - adopting specific environmental protection measures until a comprehensive environmental protection regime can be negotiated to control tourism, waste disposal, oil spills, research activities, and to extend protected areas;
- and
- We encourage parliamentarians to return to their respective nations and propose domestic legislation that would prohibit all exploitation of Antarctica until a new convention is signed.

SAFEGUARDING OCEANS AND WATER RESOURCES

Legislative Strategies

National Actions

I. Water Quality

Pollution threatens future use and productivity of waters. Contaminants include toxic chemicals, microorganisms, nutrients, oil and grease, plastics, and litter. Pollutants enter aquatic environments predominantly from land-based municipal, agricultural and industrial sources and are primarily a result of human activities involving use of the land and waste disposal. Pollution is best controlled by preventing contaminants from entering surface waters, groundwater, estuaries or oceans. Treatment of contaminated waters is often difficult, particularly in the case of groundwater.

Pollution has serious adverse effects on human health. Water-borne pathogens (bacteria and viruses) cause human illness when ingested in contaminated shellfish, drinking or bathing water and lead to diseases such as cholera, typhoid, dysentery, gastroenteritis, and hepatitis. Nitrate-contaminated drinking water, from fertilizers and sewage disposal, is responsible for serious illness in humans. Toxic chemicals in drinking water can cause acute illness and increase the risk of chronic disease, such as cancer.

In addition pollution is harmful to fish and wildlife. Excessive nutrients (phosphorous and nitrogen) lead to eutrophication, or aging of lakes, streams, and estuaries, in which excessive algal growth depletes oxygen, kills fish and degrades drinking water supplies. Toxics contaminate aquatic organisms causing acute (short-term) impacts including death and chronic impacts (disease). Toxic chemicals are often harmful at low levels, and may persist in the environment for many years.

Ocean and water resources are so important to life that a precautionary approach should be used in allowing discharge of potentially harmful pollutants and wastes. Where there is reason to believe that adverse effects of discharges are likely, even in the face of scientific uncertainty, such discharges should be prohibited.

Polluters should pay for the control of pollution and the damages they cause. But this principle is not sufficient to protect oceans and freshwater. It must be accompanied by incentives such as a fee system to prevent overuse and exploitation of water resources.

There is continuing need for international programs of research and technology development and transfer to protect, manage and restore our marine and freshwater resources. The program should be internationally funded and should ensure the active participation by developing countries. However, the need for further research should not be used as an excuse to delay protective actions.

There must be a strong international program for monitoring and enforcement of international conventions, treaties, and laws for the protection of ocean and water resources.

Goal: Improve sewage treatment. Sewage discharges may release pathogens,

nutrients, and, in many cases, toxics to waters. Control will require proper treatment and disposal of sewage along with monitoring and closing contaminated waters to drinking, bathing, and fishing.

Strategy: Eliminate discharges of raw sewage.

Strategy: Upgrade all sewage plants to at least secondary treatment.

Strategy: Require proper operation and maintenance of sewage treatment plants.

Strategy: Promote low technology methods to cycle sewage nutrients especially in conjunction with aquaculture and/or irrigated agriculture. It is important that the sewage not be contaminated with toxic substances.

Strategy: Disinfect sewage effluent to kill pathogens. Assess technologies and make information available to all nations.

Strategy: Ensure proper disposal of sewage sludge. Evaluate methods including incineration, ocean disposal and landfill.

Strategy: Establish water quality and discharge standards to restrict pollutant discharges from sewage treatment plants.

Strategy: Limit growth where sewage treatment capabilities are at or near capacity.

Strategy: Monitor waters to assure that standards are met.

Strategy: Prohibit new or increased discharges of pollution from sewage plants that would cause a violation of water quality standards.

Strategy: Eliminate combined sewage overflows and separate stormwater treatment from sewage treatment so that raw sewage is not allowed to bypass treatment plants.

Strategy: Strengthen industrial waste pretreatment programs to prevent toxic wastes from harming or interfering with proper functioning of sewage treatment plants or contributing to violation of water quality standards.

Goal: Eliminate toxic pollution. Toxic chemicals enter waters in effluent discharges from industrial and household sources, nonpoint source runoff, and from improper disposal of hazardous wastes. Prolonged exposure even to small doses of heavy metals, organic compounds, pesticides and other toxic chemicals can cause a variety of health and welfare problems for humans and aquatic organisms. Toxic chemicals build up in the tissues of humans and animals, working their way up the food chain from tiny plankton to humans as larger organisms consume smaller ones. Toxics also have a high affinity for sediments and tend to accumulate there over time. Toxic muds can reach high concentrations, are deadly to the benthic biota, and can act as a long term source of toxins in the water column.

Strategy: Set as the highest priority, to establish preventive measures to reduce formation and use of toxics.

Strategy: Establish and enforce water quality and effluent standards to prevent discharge of toxic chemicals from industrial sources.

Strategy: Issue and enforce permits that limit toxic discharges with firm goals of zero discharge.

Strategy: Monitor waters and discharges to assure that standards are met.

Strategy: Require proper disposal of hazardous wastes.

Strategy: Establish fiscal and tax incentives for reduction, recovery and reuse of waste toxics.

Strategy: Strive for worldwide bans on certain chemicals that are highly toxic.

Strategy: Set international standards and establish international monitoring networks.

Strategy: Impose and enforce economic and criminal penalties for violation of effluent limits.

Strategy: Clean up old or abandoned hazardous waste sites that may be leaking toxic chemicals into surface and ground waters.

Strategy: Clean up leaking underground storage tanks that hold petroleum and other products and initiate regulations to ensure that such products are properly stored.

Strategy: Control runoff from factories, storage areas, etc.

Goal: Protect oceans from harmful or potentially harmful wastes. One important and relatively easy way to manage sources of ocean pollution is to prohibit deliberate at-sea disposal of wastes that degrade the marine environment. Included among these are toxic industrial wastes, radioactive waste, sewage sludge, toxic incinerator ash, and contaminated dredged materials. At-sea incineration of hazardous wastes may pollute the sea through deposition of airborne toxics, ash disposal, or spills in transportation.

Strategy: Ratify and enforce the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and Their Disposal.

Strategy: Eliminate ocean disposal of sewage sludge and municipal, hazardous, and radioactive wastes.

Strategy: Eliminate at-sea incineration of hazardous wastes.

Strategy: Phase out disposal of contaminated dredge spoils and establish water and sediment quality programs to prevent further toxification of sediments during phase out.

Goal: Control urban runoff. Rainfall runoff from urban areas contributes vast amounts of sediment, nutrients, bacteria, and toxic chemicals (organics, heavy metals, oil and grease) that pollute waterways. Necessary control programs range from simple maintenance efforts such as street sweeping to construction of projects

that will prevent polluted runoff from entering nearby streams.

Strategy: Implement land use controls, including zoning and comprehensive planning; site planning; building codes; special area and resource protection zones; acquisition and conservation easements; and coastal zone management programs.

Strategy: Create riparian buffer zones; control overdevelopment; protect sensitive aquifers, wetlands, and other critical areas; and evaluate and mitigate cumulative impacts of existing and proposed developments in a watershed.

Strategy: Establish effective urban stormwater management programs that address both existing and future development; include design standards and performance standards to ensure compliance with water quality standards; and prevent runoff through site designs that use proper drainage patterns and open space, retention and detention basins.

Strategy: Establish erosion and sediment controls that require diversion structures to channel runoff away from disturbed surfaces; retention or treatment of any contaminated runoff; rapid and permanent stabilization of disturbed surfaces; and best management practices to prevent contamination of runoff by construction chemicals or other materials.

Strategy: Adopt erosion and sediment control regulations that ensure that a control plan is developed before construction begins; inspections are carried out at construction sites; and administrative penalties, stop work orders, and enforcement actions may be pursued.

Strategy: Educate the public to minimize the use of polluting chemicals around the house and yard.

Strategy: Develop technologies to recycle waste oils and grease.

Goal: Control runoff from agricultural and range lands. Runoff from croplands treated with fertilizers and pesticides and from lands used to raise domestic animals is a major contributor of nutrients (nitrates and phosphates), sediment, toxins, and microorganisms to the aquatic environment. Effective control programs restrict the amount of pollutants available to transport and reduce the exposure of these pollutants to waters.

Strategy: Establish programs which include design standards that require or prohibit certain practices and performance standards that prohibit any significant off-site transfer of pollutants.

Strategy: Restrict the amount or timing of fertilizer and manure applied.

Strategy: Educate farmers on agricultural practices that minimize the use of fertilizers and pesticides, and control soil erosion.

Strategy: Expand research on low-input methods of agricultural production.

Strategy: Require vegetated buffer strips along surface waters.

Strategy: Develop programs that address livestock pollution by controlling livestock densities and locations and preventing livestock access to riparian areas.

Strategy: Establish programs to address pesticide pollution by controlling the amount, timing, and type of pesticide used.

Strategy: Create funds through multilateral development banks and other development organizations to promote transfer of agricultural technologies to developing countries.

Strategy: Control pesticide pollution by taxes on pesticide sale and manufacture, and through pesticide registration and reporting requirements.

Strategy: Examine current practices to try to discourage overuse of fertilizers or pesticides.

Strategy: Develop new technologies to reduce dependence on fertilizers and pesticides.

Strategy: Eliminate or reduce subsidies that promote overproduction and farming on erodible or marginal lands.

Goal: Avert oil spills and regulate offshore drilling discharges. Oil spills have devastating effects on aquatic ecosystems: polluting beaches, destroying habitats, killing fish, waterfowl, benthic organisms, and marine mammals, and inhibiting spawning and growth of fish. Offshore drilling operations generate large quantities of waste materials that are discharged to surrounding waters.

Strategy: Close sensitive areas to oil and gas development and insist on strict tanker traffic control patterns within designated areas.

Strategy: Increase penalties and liability at the national and international levels.

Strategy: Improve tanker design, construction, navigation and licensing requirements.

Strategy: Require double hulls/bottoms for vessels carrying oil and refined products.

Strategy: Develop regional or international contingency plans to address potential oil spills.

Strategy: Promote energy efficiency to reduce the demand for oil.

Strategy: Institute operating and licensing requirements for offshore drilling and terminals.

Strategy: Prohibit discharge of drilling and production waste in sensitive offshore areas.

Strategy: Reduce the number of processing, storing, and transfer facilities by encouraging common use.

Strategy: Guarantee that ships, sailing in environmentally vulnerable coastal areas, with hazardous cargo, are guided by persons with knowledge of local conditions.

Strategy: Develop an international marking system for transported oil that would identify the source of a spill.

Strategy: Create an international treaty and funding mechanism to pay for the preparation for, response to, and cleanup of oil spills.

Goal: Prevent plastics and debris pollution of beaches and ocean and coastal waters. The haphazard disposal of plastic material on land and from ships results in littering of beaches and seriously damages marine life, particularly sea mammals, diving birds, and reptiles. These may be injured by the ingestion of plastic fragments, or entrapped in plastic packing and fishing gear. Enforcement of existing regulations on land and at sea, and increased public education, should reduce considerably the amount of plastic refuse, while better design and more frugal utilization of plastics for packing and fishing purposes would reduce the risk to aquatic organisms.

Strategy: Prohibit disposal of plastics from vessels and sewers.

Strategy: Reduce usage of disposable plastics (e.g. 6-pack holders) through recycling programs or substitution of more environmentally compatible material.

Strategy: Adhere to MARPOL Annex V Protocol and ensure that adequate terminal facilities and receptacles are provided for proper disposal of vessel generated garbage.

Strategy: Enforce littering fines on beaches.

Strategy: Regularly remove debris that is floating or has washed up on shore.

Strategy: Regulate disposal of medical waste and enforce laws against illegal disposal.

Strategy: Initiate further consideration of and research into the development of biodegradable products.

Goal: Prevent acid rain. Acid deposition, caused by the atmospheric transformation and long-range transport of emissions from fossil fuel power plants and other sources, causes widespread damage to lakes, streams and aquatic organisms, as well as crops, forests, statues and buildings. Nitrogenous components of acid rain are a major source of eutrophication in coastal waters.

Strategy: Promote energy efficiency and conservation and develop least cost energy plans.

Strategy: Reduce emissions of sulfur dioxide and oxides of nitrogen by switching to low sulfur fuels or using scrubbers or other technologies to clean emissions.

Strategy: Develop international goals and timetables to reduce emissions of pollutants that contribute to acid rain.

Strategy: Promote and coordinate research and development into new technologies and share technologies internationally.

Strategy: Tighten auto emissions, promote alternative fuels, and encourage car pooling and mass transportation.

Goal: Consider environmental effects of projects. Massive development or public works projects often create adverse effects on nearby lakes and streams, through runoff and physical alteration of the aquatic, stream and wildlife habitat, while planning for such projects – whether by government or private citizens – frequently fails to take into account unintended environmental impacts.

Strategy: Establish criterion of sustainable development for approval of large-scale development and public works.

Strategy: Require environmental impact assessments during the planning of large-scale development and public works projects to identify and prevent harmful environmental effects.

Strategy: Allow for full and adequate public participation in planning projects and allow for citizen suits to challenge the adequacy of planning and environmental assessments.

Strategy: Consider the effects of all development in the watershed.

Strategy: Continue to pressure multilateral development banks, such as the IMF and World Bank, to include environmental assessments in the loan decision-making process and to fund environment and conservation projects..

Strategy: Encourage developers to incorporate measures to mitigate harmful environmental effects of their projects.

II. OCEANS AND COASTAL WATERS

While large disasters such as the Exxon Valdez oil spill in Alaska attract world attention, it is the routine assaults to the marine environment that are the most damaging. In addition to pollution and waste disposal discussed in the previous section, the assaults to oceans and estuaries come from coastal population and development, destruction of important habitat, overharvesting of living marine resources, and sea level rise.

Goal: Implement coastal zone management. The coastal zone is a unique region with resources that require special attention. About half of the world's population lives along the coast, creating enormous pressures from activities such as development and waste disposal. Many countries have instituted comprehensive management programs for the coasts that consider a variety of land- and water-based activities and their relationship to coastal resources.

Strategy: Develop economic or broad scope plans for sustainable fisheries, ports and shipping, transportation, agriculture, tourism, and industry in the coastal zone that take into account the need to protect important coastal

resources.

Strategy: Participate in UNEP's Regional Seas Program to improve a nation's institutional capability, data base, and financial support for management and research in transboundary issues such as marine pollution, fisheries protection and storm forecasting.

Strategy: Develop national, state or local land use plans, including maps, policies, guidelines, legally binding zoning ordinances, and special restrictions or setback requirements.

Strategy: Develop integrated resource management plans that consider combined effects of cross sectoral projects on coastal environments and any cascading effects from one ecosystem into another.

Strategy: Eliminate subsidies that encourage coastal development. Assess environmental impacts of coastal development projects.

Strategy: Establish mechanisms to protect critical coastal areas such as wetlands, barrier islands, coral reefs, and endangered species habitats.

Strategy: Establish evacuation plans for severe storms.

Strategy: Establish monitoring programs to identify sources, fates, and effects of pollutants, and to assess the effectiveness of management efforts.

Strategy: Establish coastal special area acquisition programs.

Strategy: Develop coastal atlases or data banks.

Goal: Minimize and protect against sea level rise. Global warming may cause sea levels to rise as a result of thermal expansion and melting of polar ice caps. If current estimates are correct, sea level rise could displace millions of people, destroy large acreages of arable lands, and completely eliminate some low-lying countries. Rising seas could also destroy beaches, mangroves, and wetlands; inundate valuable shoreline property; and cause saltwater intrusion into coastal freshwater aquifers. Severe storms and droughts would occur more frequently. Engineers and managers will have to choose between fortifying the shoreline through expensive construction projects or abandoning inundated areas. Either option carries great social and economic costs.

Strategy: Research, develop, and implement effective cooperative measures to minimize or eliminate the impact of any sea level rise in low lying island countries and areas.

Strategy: Identify areas susceptible to sea level rise.

Strategy: Develop national and regional strategies to prevent development that would be seriously affected by anticipated sea level rise.

Strategy: Direct new development away from areas threatened by storm surges.

Strategy: Discourage rebuilding in coastal areas that are susceptible to sea

level rise and have been severely damaged by storms.

Goal: Protect Antarctica. While the continent of Antarctica and the surrounding Southern Ocean remains among the earth's last unspoiled ecosystems, this status is threatened by a number of current and future activities. Improper waste disposal practices, overfishing and the potential for minerals development all could undermine the viability and integrity of the Antarctic ecosystem. These problems, though diverse in nature, can only be adequately addressed through a unified and comprehensive approach. The uniquely international nature of Antarctic policy presents numerous obstacles to effective environmental protection, but at the same time offers unparalleled opportunity for creative solutions. If adopted together, the options listed below could provide a framework for lasting protection of Antarctica.

Strategy: Support the negotiation of a Comprehensive Environmental Protection regime within the Antarctic Treaty System to provide an effective integrated approach to environmental protection in the Antarctic while continuing to negotiate and implement specific environmental protection measures that are necessary in the immediate future.

Strategy: Adopt a Conservation Strategy within the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) to ensure the health of the marine ecosystem.

Strategy: Grant Antarctica special protective status as a Land of Science, Antarctic Treaty park, and international wilderness reserve.

Strategy: Urgently negotiate a ban on prospecting, exploration and development of mineral and energy resources within the Antarctic Treaty Area. Oppose international agreements that would open the door to mineral prospecting and likely future exploitation in Antarctica.

Strategy: Call for the extension of the current voluntary moratorium on all Antarctic minerals activities until a Comprehensive Environmental Protection regime is in place which must include a permanent ban on mineral and energy exploration and extraction activities.

Strategy: Allow activities only if not harmful to the ecosystem based on best available scientific data and through comprehensive environmental impact assessment and monitoring procedures which should be applied to all human activities in Antarctica.

Strategy: Ensure that environmental protection measures adopted under the Antarctic Treaty are implemented and enforced by national research programs.

Strategy: Limit the amount and type of materials brought to Antarctica, increase recycling, and removal of waste from the Treaty area. Phase out incineration, open burning, landfilling, and dumping of untreated sewage and other waste and hazardous materials into the Antarctic environment from land or from ships, with strict controls on navigation and discharge from vessels.

Strategy: Extend national environmental policies to national facilities and activities in Antarctica.

Strategy: Encourage sharing of Antarctic research facilities to avoid overcrowding of stations and unnecessary environmental impacts.

Strategy: Institute strict guidelines for tourist activities to reduce hazards to wildlife and habitat. Oppose land-based tourist operations as being inherently too damaging to the environment.

Strategy: Combat overfishing and allow depleted finfish stocks to recover. Impose a moratorium on all finfishing in the Southern Ocean until a Conservation Strategy is adopted. Cap krill harvesting at current levels and contain this fishery to areas monitored under CCAMLR.

Strategy: Expand the Antarctic Treaty's system of protected areas with appropriate involvement of nongovernmental organizations and see that areas are well marked and that management plans are followed.

Strategy: Require long-term environmental monitoring efforts to identify and anticipate environmental problems

Goal: Manage fisheries. The global yield of marine fisheries reached a record level of 84.5 million tons in 1987, up from 21 million tons in 1951. Scientists estimate the oceans can sustain a 100 million ton commercial fishery, but pollution, waste, and habitat loss may reduce this yield. Meanwhile, world demand is expected to double by the year 2000. The increasing sophistication of fisheries technology and the expanding scope of fishing activities are exerting enormous pressures on the world's living marine resources. Overfishing has depleted a number of valuable fishery resources, while sewage pollution has made some shellfish unfit for human consumption. Highly productive estuaries and coastal waters are increasingly degraded, and marine resources could eventually be damaged on a global scale. In addition, the expansion of mariculture and aquaculture must minimize local pollution, preserve ecological balance, and protect against introduction of exotic species and diseases.

Strategy: Assess stocks using catch-per-unit effort data or independent assessments to evaluate stock status. Establish vessel onboard and shoreside observer programs to provide data on harvested stocks. Include observer programs as an important element of international living marine resource conventions and agreements.

Strategy: Set a goal of sustainable development for all fisheries and develop regulations and economic incentives to achieve that goal. Develop management plans that separate stock conservation determinations from allocation decisions. Work towards regional or international management of all transboundary and highly migratory stocks.

Strategy: Strengthen conservation efforts through international fisheries agreements and conventions.

Strategy: Stop overfishing by evaluating the effectiveness of alternative forms of limited entry, limited access, and individually transferrable quotas. Institute gear, area, time, or harvestable size restriction to control stock exploitation whenever necessary. Prevent overcapitalization by eliminating subsidies for fishing vessel construction.

Strategy: Identify and protect critical habitat, especially breeding areas. Create marine reserves in areas where there are problems of overexploitation.

Strategy: Develop international standards for aquaculture operations.

Strategy: Provide for enforcement of restrictions, guidelines, and standards including sanctions and penalties sufficient to deter continued undesirable activities. Increase cooperative monitoring and enforcement agreements between nations.

Strategy: Ban the use of large-scale driftnets and other inefficient and wasteful techniques on the high-seas of the world's oceans. Work to secure bans on driftnet fishing through existing regional and international management regimes, such as the United Nations resolution "Large-scale driftnet fishing and its impacts on the living marine resources of the world's oceans and seas", the International North Pacific Fisheries Commission, Convention to Prevent Driftnet Fishing in the South Pacific, The International Convention for the Conservation of Atlantic Tunas, etc. Press for statistically valid observer programs on the high seas driftnet fleets to provide complete data for moratoria decisions scheduled for 1991.

Strategy: Develop and enforce effective sustainable management regimes for highly migratory fish stocks, such as albacore tuna, on a regional basis.

Strategy: Minimize by-catch of non-target species by technological advances in gear engineering, more efficient harvesting methods, and economic incentives.

Strategy: Invest in research and development of ecologically sound fishing technology.

Strategy: Clean up sources that pollute shellfish beds.

Strategy: Support full funding for national and international fisheries research.

Goal: Protect marine biodiversity. The ocean is home to the broadest variety of organisms on earth. Coastal marine ecosystems are rapidly becoming biologically impoverished due to the widespread effects of pollution and overharvesting. New fishing technologies threaten the variety of life in numerous marine ecosystems. Coral reefs are perhaps the most acutely endangered of all marine systems – due to pollution, runoff from deforestation, overfishing, and rises in sea temperatures. Coastal wetlands are also critically threatened, often due to development activities in the coastal zone.

Strategy: Protect critical habitat by establishing protected areas and marine sanctuaries.

Strategy: Give protected area status to important coral reefs.

Strategy: Establish national programs to preserve, protect, and enhance wetlands, estuaries, and other important habitat.

Strategy: Establish economic incentives for protection of critical habitat and

disincentives for its destruction. Remove economic incentives that promote unwise coastal development.

Strategy: Encourage direct acquisition of important habitat and consider use of conservation easements.

Strategy: Establish international recovery programs for endangered marine species.

Strategy: Eliminate trade in endangered species by establishing effective international sanction provisions capable of enforcement against offending nations, corporation, or individuals.

Strategy: Identify and protect critical habitat for endangered species.

Strategy: Increase international attention to the aggressive and timely listing of marine species in need of added protection.

Strategy: Support efforts of international organizations such as the International Whaling Commission (IWC) to limit taking of marine mammals . Participate in international observer programs. Strengthen the IWC's current moratorium on whaling into a ban, and reduce whaling activities outside the ban, in particular, reduce whaling under scientific permit.

Strategy: Support research on biological diversity in ocean ecosystems.

Strategy: Consider biological diversity as a component of environmental impact assessments.

III. FRESHWATER SCARCITY

Freshwater is an increasingly scarce resource due to the growing demands generated by population growth, urbanization, industrialization, and irrigation. Competition between domestic and agricultural uses and conflicts between countries are likely outcomes of this scarcity. Areas including northern China, northern Africa, parts of India, Mexico, the Middle East, and parts of the Western United States may experience severe water shortages as early as this decade. Traditional engineering solutions, including building dams, drilling wells, and conducting interbasin transfers of water are often costly and environmentally damaging, and therefore, these concerns must be balanced against the need for the project. Faced with increasing shortages, nations must work toward better management of existing supplies, recognizing that each country has unique problems. Conservation and recycling can provide water at lower cost and with less environmental damage than developing new sources even for nations that have abundant supplies.

Goal: Use water more efficiently. By increasing water productivity -- the benefit gained from each liter used -- food production, industrial output, and cities can expand without a parallel increase in waters demands. Investments in water efficiency, recycling, and conservation can increasingly yield more usable water per dollar than can conventional water supply projects. But their potential is severely undermined by pricing policies and water laws that encourage inefficiency and

waste. Removing these institutional barriers is crucial to expand the many new water-conserving methods now in limited use. Only by managing water demand, rather than ceaselessly striving to meet it, is there hope for a truly secure and sustainable water future.

Strategy: In developed countries, use water pricing to manage demand. Remove, where possible, public subsidies of water. Set price at the marginal cost – the cost of delivering additional water from the best available source.

Strategy: Establish water markets that allow water or water rights to be transferred between willing buyers and sellers.

Strategy: Where appropriate, establish regional water programs where one user can "loan" water to others in years when they do not need the water.

Strategy: Require management plans that evaluate efficiency measures as an alternative to developing new supplies.

Strategy: Conserve irrigation water by leveling fields, upgrading sprinklers, recycling used irrigation water, installing drip or trickle irrigation systems, irrigating according to need, and educating about the appropriate quantities and precise scheduling requirements of different crops.

Strategy: Abate water leakages by, for example, lining canals.

Strategy: Conserve industrial water by recycling cooling water, using water efficient technologies, recycling rather than manufacturing materials, and applying strict pollution control requirements for wastewater.

Strategy: Conserve domestic water by encouraging use of water efficient appliances and requiring their use for new construction, and by instituting regular leak detection programs for distribution systems and in homes, factories, and offices.

Strategy: Use brackish water, treated wastewater or stormwater for irrigation, industrial cooling water or other demands that do not require potable water.

Strategy: Support research on water efficient technologies.

Strategy: Expand research on cost-effective, low-energy methods of desalting water.

Strategy: Use rainwater collection systems in urban areas, where appropriate.

Goal: Consider environmental consequences of water projects. Large water projects have harmful social, health, and environmental impacts, and this is often ignored in evaluating the cost-benefit of the project. Excessive water withdrawals from the world's rivers threaten the fish and other wildlife dependent on a minimum flow, and effect the lakes, estuaries and inland seas that rely on inputs of freshwater. Dams and reservoirs in developing countries have displaced hundreds of thousands of people and spread serious diseases like malaria and schistosomiasis.

Strategy: Discourage large environmentally damaging water projects.

Strategy: Encourage development of agroforestry and erosion control measures, and improve efficiency of water use as alternatives to large water projects.

Strategy: Protect instream requirements, including the fish and wildlife that depend on the stream, by setting minimum streamflow requirements.

Strategy: Provide tax and land use incentives and controls to retain streamside vegetation and wetlands that help regulate stream flows.

Strategy: Practice riverbasin or watershed management and upland reforestation.

Strategy: Coordinate management of land and water resources. For example, discourage growth and development in water short areas.

Goal: Prevent groundwater mining. In much of the world, groundwater withdrawals exceed the rate of replenishment, threatening future water supplies and leading to subsidence and saltwater intrusion.

Strategy: Limit water withdrawals to "safe yield" -- water is only taken out at the same rate that it is recharged to maintain water equilibrium.

Strategy: Use fees or financial incentives to discourage groundwater withdrawals and encourage conservation.

Strategy: Limit development above overburdened aquifers and protect key aquifer recharge areas.

Strategy: Recharge aquifers with fresh water where cost-effective and practical. Help restore aquifers through reforestation and improved land use management.

Goal: Protect groundwater quality. Groundwater programs should coordinate the related issues of allocation and quality. Excessive groundwater pumping can spread a contamination plume through an aquifer or draw in low-quality water from, for instance, a coastal or salt-water aquifer.

Strategy: Map aquifer systems and their associated recharge and discharge areas.

Strategy: Classify aquifers to identify critical drinking water supplies and other particularly sensitive aquifers for priority protection.

Strategy: Adopt a policy of non-degradation.

Strategy: Minimize excessive groundwater withdrawals in coastal areas to prevent saltwater intrusion.

Strategy: Establish ambient water quality standards. Use these standards to trigger controls on sources of contamination and to gauge the effectiveness of limits on discharges that cannot be measured, such as those from nonpoint pollution sources.

Strategy: Control sources of contamination through comprehensive source reduction and waste minimization techniques, discharge controls, or surface-use restrictions (e.g. zoning, controls over facility siting, and public acquisition of land to protect aquifer recharge areas). Implement "best management" controls on nonpoint sources.

Strategy: Establish groundwater monitoring programs to assure that standards are met.

Strategy: Establish compliance and enforcement mechanisms and take action against violators. Allow citizens suits and citizen rewards for providing evidence against polluters.

Strategy: Coordinate all environmental and natural resource programs that affect groundwater resources, especially those that control the allocation and use of groundwater and those that integrate surface water and groundwater management.

Preservation of Biological Diversity

PRESERVATION OF BIOLOGICAL DIVERSITY

Whereas:

- The diversity of life on our planet is part of the common inheritance not only of nations but also of humankind, and is a trust for each generation to hold safe for the next;
- The impact of human intervention has accelerated far beyond natural levels the loss of species of all life forms;
- The weakening and ultimate disappearance of certain animal and plant species damages land and water based food chains in ways that increase the cost and reduce the availability of food for hundreds of millions of people;
- The destruction of untold other species, which are perishing wholesale because of the loss of their habitats, cuts off forever scientific discoveries of potentially great benefit in medicine and plant genetics for agriculture;
- The processes by which humankind destroys the habitats of other species are inseparable from the processes by which humankind is destroying its own habitat;
- The uncontrolled extinction of other species is a clear signal of dangers already menacing human life;
- Humankind cannot survive unless it develops a relationship to the natural environment sustainable over generations;
- We cannot hope to successfully defend our own habitat if we do not also act to defend other species and preserve their habitats; and
- National laws to protect species and their habitats must often contend with economic forces that are international in scope, including the consumption demands of other nations and the behavior of international institutions including major lenders and multinational corporations;

NOW, therefore, be it resolved that:

- In order to curtail the loss of species worldwide, nations should commit themselves to the negotiation of a Convention on the Preservation of Biological Diversity, with the objective of opening the Convention for signature by 1992;
- In order to preserve the world's most concentrated areas of species diversity, the nations of the world should commit themselves to the shared responsibility of ensuring no further loss of primary forest by the year 2000;
- Laws and regulations are needed not only to prevent the extermination of specific species, but also to assure the preservation of habitats, and to subordinate human interaction with these habitats to that purpose;
- National law should require accountability by all institutions whose actions affect the survival of species and of habitats, including the effect of legislation itself upon the environment;
- Major international lending institutions and trans-national corporations, including private banks, should be required by law and by international agreement where needed, to publicly submit to procedures which honestly and publicly estimate the impact that the ongoing projected activities of these institutions will likely have upon the survival of species and of habitats;
- Nations must strive to mitigate economic and cultural activities which threaten the survival of species and ecosystems by extending legal and fundamental principles of protection to all life forms and natural communities and by finding methods of mediating and adjudicating conflicts between economic, cultural and protection goals;
- Natural area inventories should be undertaken to locate and determine the

- status of the earth's various life forms and their habitats and natural communities; the knowledge of which must establish protection goals and guide the development policies and decisions of nations and investors;
- Because wetlands are critical and especially threatened ecosystems, all nations should develop immediately policies designed to comply with the Ramsaar Convention.
 - As global climate change occurs affecting and possibly disrupting food production cycles, there is a special need for national and international legal instruments to protect the habitats of critical plant species, essential to devise new strains of crops able to survive in stressed environments;
 - Knowledge generated by these activities should belong to the scientific community at large, to the maximum extent possible. However, commercial benefits derived from such knowledge must be shared equitably by those who discover and market new products, with the nation from whose natural endowment the original samples and genetic information came.
 - All nations should ban commerce in endangered species and their products; and
 - Biotechnologies and genetic manipulation of plants and animals in agriculture and husbandry should be restricted and even forbidden insofar and when genetic erosion, genetic uniformity or instability of the ecosystem and loss of biodiversity are implied or involved.

PRESERVATION OF BIOLOGICAL DIVERSITY

Legislative Strategies

National Actions

Goal: Develop a full inventory of national biological resources through monitoring, research programs and data management. If we are to develop effective policies to prevent loss of biological diversity, we need to know more about existing ecosystems and use that information for protection and management decisions.

Strategy: Accelerate inventories of biological, species, subspecies, communities and ecosystems.

Strategy: Intensify and expand monitoring of key populations, subspecies, species, communities, ecosystems and biological processes, particularly those threatened with extinction or likely to be declining, to assess biological diversity and impacts from development activities.

Strategy: Develop, promote and fund additional research relating to biological diversity, particularly with regard to species that are likely to be declining.

Strategy: Establish conservation data centers to collect and distribute information on the location and status of all elements of biological diversity.

Goal: Promote protection and management of lands and waters that serve as critical habitat for maintaining biological diversity. A coherent and consistent approach must be taken with respect to protection and management of lands and waters at the national and local levels, with the explicit goal of preserving biological diversity.

Strategy: Coordinate management of national lands at national, regional and local levels so as to preserve biological diversity.

Strategy: Provide incentives, and eliminate disincentives, to local community protection of natural resources in protected areas.

Strategy: Orient national land and water protection decisions toward establishing a system of protected reserves and sanctuaries that preserve biological diversity.

Strategy: Establish protected areas of sufficient size and appropriate design to maintain ecological processes.

Strategy: Place greater investment in restoration/rehabilitation of degraded critical ecosystems, e.g. wetlands, estuaries, lakes, rivers, tropical forests, coral reefs, coastal bottom communities, climate zones, and oceanic islands. Preserve entire, intact ecosystems, ecological corridors, altitude gradients, etc.

Goal: Promote development of planning processes that include protection of biological resources. Improved national and local planning is needed to ensure that development occurs in a manner compatible with the maintenance of biological

diversity.

Strategy: Develop land and water resource management plans that promote sustainable use of living resources.

Strategy: Develop integrated coastal zone management plans to guide coastal development in a manner that is consistent with the protection of critical ecosystems and their inherent biological diversity.

Strategy: Encourage integrated planning and coordination among industrial, transportation, agriculture, forestry, fisheries, parks and education sectors.

Strategy: Promote integrated planning in areas of special value to biological diversity as identified by inventories and monitoring.

Strategy: Limit and control the impact of all national defense activities that threaten biological diversity.

Goal: Establish captive propagation and reintroduction programs. Protection, storage, propagation and reintroduction of genetic material is a valuable supplement in preventing loss of biological diversity and to restoring the natural structure and function of biological communities and ecosystems. This approach should not be considered a cure, but only a crutch where needed.

Strategy: Increase research on storage, propagation and reintroduction of species.

Strategy: Support and establish zoos, botanical gardens, seed and gene banks to preserve and propagate organisms, especially for endangered species.

Strategy: Encourage reintroduction of organisms into former native habitats.

Goal: Develop more effective regulatory approaches aimed at protection of biological diversity. National regulations should be developed and enforced to prevent the loss of biological diversity through destruction of ecosystems, communities and individual organisms.

Strategy: Enact explicit requirements to consider impact on biological diversity as part of the environmental assessment of national regulatory and economic development decisions.

Strategy: Enforce regulations of the use and consumption of biological resources.

Strategy: Enact and enforce laws to protect endangered species.

Strategy: Focus regulatory programs in areas having special value to biological diversity as identified by inventories and monitoring.

Strategy: Regulate the use of advanced biotechnology, such as gene technology.

Strategy: Each nation must take ultimate responsibility for the preservation of species endemic to that nation.

International Actions

Goal: Raise priority of biological diversity in economic assistance programs and institutions, and promote supportive policies. Ensure that decisions by economic assistant programs and institutions are consistent with the maintenance of biological diversity.

Strategy: Environmental guidelines and criteria on grants of foreign economic assistance should be developed to prevent loss of biological diversity.

Strategy: Encourage coordination among donors of bilateral and multilateral economic assistance to adopt consistent environmental assessment requirements that include impact on biological resources and habitat.

Strategy: Modify development programs to assist local efforts to protect forests, wetlands, waters, and other critical ecosystems.

Strategy: Increase pressure on national overseas development agencies and multilateral development banks to develop more effective environmental guidelines and to finance ecologically sound projects, and, conversely, to end those projects which directly or indirectly promote deforestation or damage critical areas of high biological richness as well as displace indigenous peoples.

Strategy: Provide effective technical assistance and other bilateral assistance to research and other programs assisting forestry and drylands activities, as well as wetlands, and activities in other critical ecosystems in developing countries.

Goal: Pursue international cooperative activities to ensure protection of biological diversity. Improved international cooperation is essential to maintain biological diversity because organisms, communities and ecosystems are not organized according to political boundaries.

Strategy: Use Debt-for-Nature swaps to provide financial resources for management of protection areas.

Strategy: Develop a genetic treasure map of the world based on Vavilov's "Centers of Biodiversity."

Strategy: Establish a protection plan for Centers of Biodiversity.

Strategy: Respect the unique knowledge of ecosystems and species which indigenous peoples have.

Strategy: Preservation activities should respect the habitats, customs and cultures of indigenous peoples.

Goal: Nations and companies which benefit from the utilization of biological resources in other countries should participate appropriately in the preservation of the affected communities from which the resources are taken.

Goal: Those nations whose biological resources are utilized by other countries should share equitably in the earnings derived from their development.

Goal: Establish an international cooperative program in the U.N. system or independently to identify and preserve genetic material that is needed to reinforce and restore productivity of commercial food crops.

Strategy: Encourage establishment of conservation trust funds, through allocation of national funds and contributions from international conservation organizations and other nations, to support projects to conserve biological diversity.

Strategy: Support and endorse both an international convention for the conservation of biological diversity and for the establishment of a fund for that purpose.

Strategy: Participate in Regional Seas programs, as coordinated by UNEP.

Strategy: Establish international marine reserves in critical ecosystems that encompass international waters.

Strategy: Provide economic incentives for those countries which act boldly in matters of biodiversity protection.

Strategy: Sponsor the transfer of technology devoted to increase the production and protection of the species, including the results of genetic engineering research, referring to food.

Strategy: Support international agreements to control air and water pollution and toxic chemicals that threaten critical species.

Strategy: Develop river basin compact on river management, water use, etc.

Goal: Encourage all nations to protect endangered ecosystems and species.

Strategy: Ban commerce on importation and exportation of endangered species and their products. Support Convention on Trade in Endangered Species and World Flora and Fauna (CITES).

Goal: Raise priority of international cooperation concerning possible adverse consequences of advanced biotechnology.

Strategy: Increase international research and development programs.

Strategy: Provide an international discussion concerning environmental ethics within biotechnology.

Goal: Establish a world system of nature preserves.

Strategy: Encourage the establishment of multinational nature preserves.

Strategy: Coordinate planning for preserves among neighboring countries.

Strategy: Coordinate preserves for critical habitats of species that migrate among nations.

Delegates to the ICGE

Australia

- Alasdair Webster
- Brian Harradine

Austria

- Ilona Graenitz
- Werner Fasslabend

Brazil

- Nelson Carneiro
- Antonio Luiz Maya
- Jarbas Passarinho
- Amaury Muller
- Aloisio Vasconcelos
- Cristina Tavares Correia
- Maurilio Ferreira Lima
- Fabio Feldmann

Cameroon

- Francois Kwengoua
- Samuel Tamfu

Canada

- Lee Clark
- Mira Spivak
- Jim Fulton
- Marlene Catterall

Czechoslovakia

- Juraj Mesik
- Zdenek Krivsky
- Pavel Sremer

Denmark

- Niels Ahlmann-Ohlsen
- Hanna Severinsen
- Helen Beim
- Margrete Auken

Egypt

- Soufy Abotalib
- Salah El Hamady

European Parliament

- Hemmo Muntingh

Finland

- Jussi Ranta
- Pekka Puska
- Martti Tiuri

France

- Laurent Fabius
- Jean-Marie Bockel
- Jean-Yves Le Deaut
- Roland Nungesser
- Hubert Martin
- Louis Perrein
- Bernard-Charles Hugo

Germany

- Hermann Scheer
- Klaus Kuebler
- Monika Ganseforth

Guatemala

- Marco Antonio Dardon
- Jorge Cordon
- Arturo Amiel
- Claudio Riedel
- Gilberto Morales
- Gilberto Barillas
- Victor Hugo Miranda

Indonesia

- H. Jailani Naro
- Theo L. Sambuaga
- R. Ng Bambang Soepangat
- Yan Mokoginta
- M. Yanis Zahiruddin
- Susilastuti Sutopo Isnomo
- Edy Wibowo
- Kemas Badaruddin

Italy

- Antonio Rastrelli
- Roland Riz
- Lorenzo Strik Lievers
- Giorgio Tornati
- Franca Falcucci
- Massimo Serafini
- Milvia Boselli
- Franco Sapio
- Francesco Rutelli

Japan

- Tamako Nakanishi
- Wakako Hironaka
- Masahisa Aoki
- Kazuo Aichi
- Takeshi Kosugi

Kenya

- Joseph Muliro
- Philip Leakey
- Kausai Francis Xavier ole Kaparo
- Bonaya Adhi Godana
- James Miruka Owuor
- Silvester Mate
- Joseph Mwenda Malebe

Madagascar

- Lucien Xavier Michel Adrianarahinjaka
- Anaclet Imbiky

Maldives

- Ahmed Zahir
- Mohamed Shihab
- Mohamed Ismail Fulu

Malta

- Stanley Zammit

- Francis Zammit Dimech
- Daniel Micallef
- Dom Mintoff
- John Dalli

Mexico

- Laura Alicia Garza
- Hector Mayagoitia
- Bulmaro Pacheco
- Cristobal Arias
- Arely Madrid
- Carmen Moreno
- Gerardo Medina
- Vicente Luis Coca

Netherlands

- Roelof Kruisinga
- Egbert Schuurman
- Arthie Schimmel

New Zealand

- Richard Northey
- W. Rob Storey

Niger

- Moutari Moussa
- Kada Labdo Abou-Bacar
- Ibrahim Labo
- Mai Manga Yacouba
- Maidoka Abou-Bacar

Norway

- Kirsti Kolle Groendahl
- Haakon Blankenborg
- Sverre Mauritzen
- Knut Hanselmann
- Per Aunet
- Svein Alsaker
- Ragnhild Queseth Haarstad

Pakistan

- Attiya Inayatullah

Philippines

- Heherson T. Alvarez
- John H. Osmena
- Edgardo Angara
- Ernesto M. Maceda
- Felicito C. Payumo

Poland

- August Chelkowski
- Andrzej Konopacki
- Stefan Kozlowski
- Jerzy Rusecki
- Franciszek Sobieski
- Jam Sroczynski
- Janusz Steinhoff

Spain

- Bernardo Bayona Aznar
- Alfonso Arenas Ferriz
- Clemente Sanz Blanco
- Vicent Beguer Oliveres
- Francisco Quetglas Rosanes
- Juan Jose Aspuru Ruiz
- Rafael Garcia Contreras
- Carlos Davila Sanchez
- Lluís Recoder Miralles
- Rafael Martinez Campillo
- Eduardo Vallejo de Olejua
- Ernesto Caballero Castillo
- Jon Larrinaga Apraiz
- Maria Teresa Estevan Bolea

Sweden

- Margareta Winberg
- Lennart Nilsson
- Ivar Virgin
- Lars Ernestam
- Karin Starrin
- Annika Ahnberg
- Roy Ottosson

UK

- Hugh Rossi
- Eric Illsley
- Mr. Flowers
- Mr. Carver

USSR

- Kakimbek Salykov

- Aleksei Yablokov
- Georgii Komarov
- Lev Kuznetsov
- Yurii Shcherbak

Venezuela

- Bernardo Orande
- Jose Guadalupe Jordon
- Alejandro Sanchez
- Pedro Escarras
- Carlos Aspurua

Zaire

- Ma Kong Maneng
- Mpagazehe Kanyankogote
- Madragule Angoyo Mandango
- A Tezo Lubaki Mpasi



World Meteorological Organization
Organisation météorologique mondiale

Case postale N° 2300
1211 - GENEVA 2
SWITZERLAND

United Nations
Environment Programme
Programme des Nations Unies
pour l'Environnement
PO Box 30552 - Nairobi Kenya



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

IPCC WORKING GROUP II (IMPACTS)

Draft Report and draft Policy-Makers' Summary



Intergovernmental Panel on Climate Change

Policymakers' Summary

of the

Potential impacts of climate change

Report to IPCC from Working Group II

First draft, April 1990

Prepared by an editorial drafting group of:

Professor Y-U. Izrael, USSR (Chairman, WGII)
Dr M. Hashimoto, Japan (Co-Vice-Chairman WGII)
Dr W.J.McG. Tegart, Australia (Co-Vice-Chairman, WGII)
Dr A. Hecht, USA
Dr A. Sinha, India

Contents

Executive summary	1
Agriculture and forestry	1
Natural terrestrial ecosystems	1
Hydrology and water resources	1
Human settlements, energy, transport, and industrial sectors, human health and air quality	1
Oceans and coastal zones	2
Terrestrial cryosphere	2
Overview	3
Summary	5
Potential impacts of climate change on agriculture, land use and forestry	5
Potential impacts on agriculture	5
Major findings	5
Principal issues	5
Magnitudes of possible dislocation	5
The most vulnerable regions and sectors	5
The effect of altered climate extremes	5
Effects on crop growth potential, land degradation, pests and diseases	6
Regional impacts	6
Rates of adaptability	7
Recommendations for action	7
Potential impacts on forestry	8
Biophysical effects	8
Socioeconomic implications	8
Adaptation	8
Recommendations for action	9
Potential impacts of climate change on natural terrestrial ecosystems and the socio- economic consequences	9
Major findings	9
Principal issues	10
Particularly sensitive species	10
Changes in the boundaries of vegetation zones	10
Changes within ecosystems	11
Recommendations for action	12
Potential impacts of climate change on hydrology and water resources	12
Major findings	12
Principal issues	13
Regional impacts	13
Recommendations for actions	14

Potential impacts of climate change on human settlement, the energy, transport and industrial sectors, human health and air quality, and likely impacts of changes in UV-B radiation	15
Major findings	15
Principal issues	15
Human settlement	16
Energy	16
Transport	17
Industry	17
Human health	18
Air pollution	18
UV-B radiation	18
Recommendations for action	19
Potential impacts of climate change on the world ocean and coastal zones	19
Major findings	19
Impacts of sea-level rise (impacts on coastal zone)	19
Threatened populations in low-lying areas and island nations	20
Alteration of the biophysical properties of estuaries and wetlands	20
Inundation and recession of barrier islands, coral atolls and other shorelines	21
Impacts on the world ocean	21
Recommendations for action	22
Impacts of climate change on the terrestrial cryosphere and socioeconomic consequences	23
Major findings	23
Principal issues	23
Seasonal snow cover	24
Ice sheets and glaciers	24
Permafrost	25
Recommendations for action	26
Outstanding issues and future actions	27
Concluding remarks	28

Executive summary

A number of scenarios has been used by the Working Group to assess the potential impacts of climate change. These have the features of:

(i) doubling of CO_2 in the atmosphere between now and 2025 to 2050 for a 'business as usual' scenario;

(ii) a consequent increase of global temperature in the range 1.5°C to 4.5°C ;

(iii) an unequal global distribution of this increase, namely a smaller increase of half the global mean in the tropical regions and a larger increase of twice the global mean in the polar regions; and

(iv) a sea-level rise of about 0.3–0.5 m by 2050 and up to 1 m by 2100.

Against these scenarios, the major conclusions of the Working Group are:

Agriculture and forestry

On balance, our assessment indicates that food production at the global level can be sustained at levels sufficient to meet world demand, but the cost of achieving this is unclear. There may be severe negative effects at the regional level, particularly in areas of present-day high vulnerability, such as some semi-arid and subtropical regions in Africa and South America, and some humid tropical and equatorial regions in Southeast Asia and Central America. Patterns of trade could be altered by decreased production in some of the currently high production areas for cereals such as southern Europe, southern USA, parts of South America and Western Australia. On the other hand, cereal production could increase in Northern Europe. Policy responses directed to breeding of new plant species designed to cope with changed climate conditions could lessen the severity of regional impacts.

In the case of forestry, major forest-type zones and species ranges could shift significantly as a result of climate change, with both northern and southern boundaries of temperature and northern forests shifting several hundred kilometres northward. Particularly sensitive are boreal forests where stands are mainly even-aged and temperature limited, and forests in arid and semi-arid regions. Changes in forest

patterns have significant socioeconomic consequences for both humans and animals.

Natural terrestrial ecosystems

The rate of projected climate changes is the major factor determining the type and degree of impacts on natural terrestrial ecosystems. These rates are likely to be faster than ecosystems can respond. Major vegetation zones could, therefore, face severe disturbances and disruptions, influencing plant and associated animal populations. Species could disappear, leading to substantial reductions in biological diversity. The socioeconomic consequences of these impacts will be significant, especially for those regions of the globe where societies and related economies are dependent on natural terrestrial ecosystems for their welfare.

Hydrology and water resources

While many areas will have increased precipitation, and thus will change patterns of agriculture and ecosystems: soil moisture will decrease in other areas, particularly those that are already in marginal situations such as in Africa. A 1°C to 2°C temperature increase, coupled with a 10% reduction in precipitation, could produce a 40–70% reduction in annual runoff. This has significant implications for agriculture, for water storage and reticulation, and for hydroelectric power generation. Future water resource engineering design will need to take possible impacts into account when considering structures with a life to the end of the next century.

Human settlements, energy, transport, and industrial sectors, human health and air quality

The impact of climate change will be largest on human settlement in vulnerable areas near coasts, such as in Bangladesh, and on small islands, such as in the Pacific and the Caribbean. Inundation due to sea-level rise and increased frequency of storm surges could lead to significant movements of people. Major impacts are possible on large urban areas due to availability of water and increased health

1 problems due to heat stress and susceptibility
2 to infections. Changes in precipitation and
3 temperature could radically alter the patterns of
4 vector-borne diseases by shifting them to higher
5 latitudes and thus put large populations at risk.

6
7 The impact on energy, transport and industrial
8 sectors will largely be determined by policy
9 responses to climate change, rather than by
10 climate change itself. Changes in patterns of
11 energy generation and usage would impact on
12 lifestyles and living patterns, especially in the
13 developed countries, while developing countries
14 with little or no indigenous energy resources will
15 need to consider their options, particularly for
16 renewable energy sources such as biomass.
17 Global warming can be expected to affect the
18 availability of water resources and biomass,
19 both major energy sources in a large number of
20 developing countries. Such changes in areas
21 which lose water may jeopardise energy supply
22 and materials essential for human habitation
23 and energy.

24
25 The impact on air quality will be largely related
26 to the policy responses on fossil-fuel
27 combustion and on transport. Improved
28 combustion technology, coupled with
29 conservation of energy, could lead to a
30 reduction in emissions of greenhouse gases
31 and also other deleterious gases such as
32 sulphur dioxide.

33 34 Oceans and coastal zones

35
36 While there has been a steady global sea-level
37 rise of about 12 cm over the past century, the
38 impact of a rise of 30-50 cm in the next 50
39 years, ie a three-fourfold increase in rate, will be
40 significant in terms of cost of protecting and
41 defending coastlines. It is important to
42 recognise that the rate of sea-level rise with
43 increase in air temperature is exponential so
44 that, if no control measures on emissions are
45 instituted, the sea-level rise could be 1 m by the
46 year 2100. The impacts will be correspondingly
47 more severe and adaptation costs far higher.

48
49 Coastal zones such as mangroves and wetlands
50 could be markedly affected with significant
51 impacts on terrestrial and ocean ecosystems.
52 While there may be regional impacts on fish
53 stocks, particularly in high-latitude regions in
54 both the northern and southern hemispheres,
55 the assessment suggests that world fish
56 supplies will not be significantly affected,
57 although there could be significant migrations of

species with consequent socioeconomic
impacts.

Terrestrial cryosphere

The real extent of snow, near-surface layers of
permafrost and some masses of ice will be
substantially reduced. This reduction may have
significant impacts for related ecosystems,
particularly where permafrost degrades.
Impacts on human settlements in permafrost
and glacial areas may also be significant and
include possible increases in terrain instability,
erosion and landslides. Water supply for
irrigation, hydroelectric generation and human
consumption will be affected in areas
dependent on snow and glacial melt for their
water resources.

Overview

The IPCC Working Groups on scientific analysis (Working Group I), impacts (Working Group II) and response strategies (Working Group III) were established in November 1988 and proceeded to work in parallel under instructions from IPCC. The responsibility of Working Group II is to describe the environmental and socioeconomic implications of possible climate changes over the next decades due to increasing concentrations of greenhouse gases.

In an ideal world, Working Group I would have had the time to produce scenarios which could have been used as a basis for the analyses of this Working Group. However, work proceeding in parallel precluded this possibility. As a result, and in order to complete its work in time, Working Group II was forced to use a number of scenarios based on existing models in the literature. It has attempted to eliminate inconsistencies where possible.

An issue of importance which has not been considered in any detail is the impact of possible response strategies (developed by Working Group III) on the scenarios used here. Thus, a major change in energy production from fossil fuel to nuclear or renewable energy sources could drastically alter our assessments. Further, changes in agricultural practice could dramatically alter yields of particular crops in certain regions. These impacts of response strategies require much additional work.

A particular issue is the use of scenarios derived from global general circulation models and from paleo-analog techniques. Paleoclimate analogs are proposed by Soviet scientists as a means by which climate changes can be assessed. The methodology assumes that past warm geologic intervals provide insight into possible future climate conditions. The general circulation models are based on mathematical representations of the physical processes in the atmosphere and the interactions of the atmosphere with the earth's surface and the oceans. There is considerable scientific debate about the merits and demerits of each of these as discussed in the report of Working Group I. We have used both techniques in attempting to construct scenarios for the assessment of impacts in different areas. A major difficulty has been the development of regional scenarios to evaluate assessments of regional impacts to assist policy makers. This

is particularly the case for rainfall where there is considerable disagreement between various model results.

As a general guide, the scenarios that have been used for temperature, based on a doubling of CO_2 , have the features of:

- (i) an increase of global temperature in the range 1.5°C to 4.5°C ;
- (ii) an unequal global distribution of this increase, namely half the global mean in the tropical regions and twice the global mean in the polar regions; and
- (iii) CO_2 doubling would occur between now and 2025 to 2050 for a 'business as usual' scenario.

The paleoclimate analogs suggest a relationship of an increase of temperature for doubling of CO_2 in the range of 2° – 4°C consistent with the predictions of climate models.

The timing for doubling of CO_2 is critical to an assessment of potential impacts, but depends on projections for energy production and usage which, in turn, are dependent on projections for population growth and per capita income. Initially, it was believed that doubling would occur by 2050 on a scenario of continued energy usage at the current rate, but Working Group III has revised this downwards to 2030. As noted above, the impact of possible response strategies is significant in determining the rate of increase of CO_2 .

Another issue has been the assessment of the impact of increased sea-level. It should be emphasised that our ability to estimate future climate change is constantly improving as new information and analyses become available. The original estimates of sea-level rise were up to 1 m by 2050 for a doubling of CO_2 and some of the subgroups have used this as their basis for assessment. However, Working Group I now considers that the rise will be about 20 cm by 2030 and this leads to smaller impacts and less urgent policy responses. It should be noted that the scenarios based on 1 m rise could be reached by 2100 if emissions continue at the present rate of growth and thus these potential impacts serve as a warning of the

1 consequences of continued uncontrolled
2 emissions.

3
4 The smaller rise does not lessen the anxiety for
5 their continued existence of the small island
6 states, particularly of the Pacific Ocean and the
7 Caribbean, or of the larger populations in low-
8 lying coastal areas such as Bangladesh. It is
9 difficult to predict the regional effects of sea-
10 level rise with any certainty. Significant
11 variations of sea-level already occur for a variety
12 of reasons, while there are considerable shifts in
13 land levels associated with tectonic plate
14 movements which can also lead to rises and
15 falls.

16
17 Despite all these uncertainties, it is possible to
18 make assessments of potential impacts of
19 climate change by considering the sensitivity of
20 natural systems to significant variations. These
21 are summarised in the following sections under:
22 agriculture and forestry; terrestrial ecosystems;
23 hydrology and water resources; human settle-
24 ment, energy, transport, industry, human health
25 and air quality; likely impacts of changes in
26 ultraviolet-B radiation; world ocean and coastal
27 zones; terrestrial cryosphere.
28

Summary

Potential impacts of climate change on agriculture, land use and forestry

Potential impacts on agriculture

Major findings

- Sufficient evidence is now available from a variety of different studies, to indicate that changes of climate would have an important effect on agriculture. Yet the fact that there are major uncertainties regarding likely effects in specific regions should be a cause for concern. Studies have not yet conclusively determined whether, on average, global agricultural potential will increase or decrease.
- On balance, the evidence is that food production at the global level can, in the face of estimated changes of climate, be sustained at levels sufficient to meet world demand, but the cost of achieving this is unclear.
- However, there may well be severe negative effects at the regional level, particularly in regions of high present-day vulnerability that are least able to adjust technically to such effects.
- Increases in productive potential at high mid and high latitudes, while being of regional importance, are not likely to open up large new areas for production.

Principal issues

Magnitudes of possible dislocation

Under the estimate of changes in productive potential for the changes of climate outlined in this report, the cost of producing some mid-latitude crops such as maize and soybean, could increase, reflecting a small net decrease in the global food production capability of these crops. Rice production could, however, increase if available moisture increased in southeast Asia. The average global increase in overall production costs could thus be small (perhaps a few per cent of world GDP).

Much depends on the how benefits of the so-called 'direct' effects of increased CO₂ on crop yield. If plant productivity is substantially enhanced and more moisture is available in some major production areas, then world production of staple cereals could increase relative to demand with food prices reduced as a result. If, on the contrary, there is little beneficial direct CO₂ effect and climate changes are negative for agricultural potential in all or most of the major food-exporting areas, then the average costs of world agricultural production could increase significantly. These increased costs could amount to over 10% of world agricultural GDP.

The most vulnerable regions and sectors

On the basis both of limited resource capacity in relation to present-day population and of possible future diminution of the agricultural resource base as a consequence of reduced crop-water availability, two broad sets of regions appear most vulnerable to climate change: (i) some semi-arid, tropical and subtropical regions (viz western Arabia, the Maghreb, western West Africa, Horn of Africa and Southern Africa, eastern Brazil), and (ii) some humid tropical and equatorial regions (viz Southeast Asia, Central America).

In addition, certain regions that are currently net exporters of cereals could also be characterised by reduced productive potential as a result of climate changes. Any decrease in production in these regions could markedly affect future global food prices and patterns of trade. These regions include: southern Europe, southern US, parts of South America, Western Australia.

The effect of altered climate extremes

Relative small changes in the mean values of rainfall and temperature can have a marked effect on the frequency of extreme levels of available warmth and moisture. For example, the number of very hot days which can cause damaging heat stress to temperate crops could increase significantly in some regions as a result of a 1°C to 2°C increase in mean annual temperatures. Similarly, reduction in average levels of soil moisture as a result of higher rates

1 of evapotranspiration could increase sub-
2 stantially the number of days with a minimum
3 threshold of water availability for given crops.
4

5 Although we know little, at present, about how
6 the frequency of extreme events may alter as a
7 result of climate change, the potential impact of
8 concurrent drought or heat stress in the major
9 food-exporting regions of the world could be
10 severe. In addition, relatively small decreases in
11 rainfall or increases in evapotranspiration could
12 markedly increase both the risk and the
13 intensity of drought in currently drought-prone
14 (and often food-deficient) regions. Change in
15 drought risk represents potentially the most
16 serious impact of climate change on agriculture
17 at both the regional and global level.
18

19 **Effects on crop growth potential,** 20 **land degradation, pests and** 21 **diseases** 22

23 Higher levels of atmospheric CO₂ are expected
24 to enhance the growth rate of some staple
25 cereal crops, such as wheat and rice, but not of
26 others such as millet, sorghum and maize. The
27 use of water by crop plants may also be more
28 efficient under higher CO₂ levels. However, it is
29 not clear how far the potentially beneficial
30 'direct' effects of enhanced atmospheric CO₂
31 will be manifested in the farmer's field rather
32 than in the experimental glasshouse.
33

34 Warming is likely to result in a poleward shift of
35 thermal limits of agriculture, which may increase
36 productive potential in high-latitude regions.
37 But soils and terrain may not enable much of
38 this potential to be realised. Moreover, shifts of
39 moisture limits in some semi-arid and sub-
40 humid regions could lead to significant
41 reductions of potential with serious implications
42 for regional food supplies in some developing
43 countries.
44

45 There are indications that precipitation in a
46 warmer world would be received in more
47 intense storms at the expense of more wide-
48 spread and less intense showers. This would
49 tend to encourage higher rates of soil erosion
50 especially if higher rates of evaporation lead to
51 greater differences in soil moisture between dry
52 and wet periods of the year.
53

54 Temperature increases may extend the geo-
55 graphic range of some insect pests and
56 diseases, allowing the expansion of these pests,
57

at present limited to tropical countries, to
current subtropical and temperate regions.

Regional impacts

Impacts on potential yields are likely to vary
greatly according to types of climate change
and types of agriculture.

Considering the most important aspects of
global warming that are critical to agriculture:
increased atmospheric CO₂ concentration,
increased temperature, increased global
precipitation and a lengthening growing season
in temperate regions, it is likely that productivity
of world agriculture will increase, provided
technological and economic factors do not limit
yields. The exceptions to the above may occur
in some regions, yet it will not change the
general trend.

At the first stage of global warming (200-2005)
some deterioration of agrometeorological
conditions in a number of major regions may
occur, in particular in the temperate zones of
the Northern Hemisphere. However, manage-
ment and technological adjustments can
prevent serious disruption of world food
production.

On the basis of global circulation models (GCM)
scenarios in the northern mid-latitude regions,
where summer drying may reduce productive
potential (eg in the south and central US and
southern Europe) yield potential is estimated to
fall by ca 10-30% under an equilibrium 2xCO₂
climate. Towards the northern edge of current
main producing regions, however, warming may
enhance productive potential in climatic terms.
When combined with direct CO₂ effects,
increased climatic potential could be substantial
- though in actuality this may be limited by soils
and terrain.

In the northern mid-latitude regions where
summer drying may reduce productive potential
(eg in the south and central US and in southern
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Towards the northern edge of current core
producing regions, however, warming may
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When combined with direct CO₂ effects,
increased climatic potential could be substantial
- though in actuality it may be limited by soils
and terrain.

1 There are indications that warming could lead to
2 an overall reduction of cereal production
3 potential in North America and to reduced
4 potential in southern Europe, but increased
5 potential in northern Europe. Warming could
6 allow increased agricultural output in regions
7 near the northern limit of current production in
8 the USSR and North America, but output in the
9 southern areas of these regions could only
10 increase if corresponding increases in soil
11 moisture were to occur, and this is at present
12 uncertain.

13
14 Reduced output in North America, particularly of
15 corn and soybean, would be likely to lead to
16 increases in world prices of these crops and
17 resultant increases in costs of livestock food
18 and livestock products. The prices of wheat,
19 rice and other staples would, however, depend
20 on changes in yield potential in other major
21 producing regions, and insufficient is known at
22 present about possible changes of climate in
23 these areas.

24
25 An alternative view on the basis of paleo-analog
26 scenarios, as a result of enhanced precipitation
27 after 2000, together with further increases in
28 temperature and the beneficial direct effects on
29 plant growth, the beneficial agricultural effect in
30 these regions will be more pronounced.

31
32 In some of the existing uncertainties of
33 assessments of regional climate change under
34 different levels of global warming, it is obvious
35 that the length of growing season in higher and
36 middle latitudes will generally benefit crop
37 production potential. Consequently, produc-
38 tivity will increase due to adaptation of later
39 maturing crop varieties with higher yields. It is
40 natural that revision of agricultural technology
41 and sowing dates, in particular, will lead to
42 growth of productivity due to fuller utilisation of
43 increased heat resources. This applies to all of
44 the agricultural regions in middle latitudes
45 except ones where precipitation deficiencies
46 would be manifested. Even with summer
47 drying, it is not necessarily the case that yields
48 would decline. To evaluate fully drying requires
49 examination of the ability of these regions to
50 adopt crop management practices to make full
51 use of existing technologies.

52
53 Little is known about likely impacts in semi-arid
54 and humid tropical regions, because production
55 potential here largely depends on crop-water
56 availability, and the regional pattern of possible
57 changes in precipitation is unclear at present.
58 It is wise, however, to assume that crop-water

availability could decrease in some regions.
Under these circumstances there could be
substantial regional dislocation of access to
food supply.

Rates of adaptability

In some parts of the world, climatic limits to
agriculture are estimated to shift by 200-300 km
per degree of warming (or 100 km per decade
under a scenario of a 3°C global warming by
2060), and 150-200 m in elevation.

There are indications that agriculture has an
ability to adjust, within given economic and
technological constraints, to a certain, limited
rate of climate change. This capability varies
greatly between regions and sectors but no
thorough analysis of adaptive capacity has yet
been conducted for the agriculture sector.

In some currently highly variable climates,
farmers may be more adaptable than those in
regions of more equable climate. But in less
developed economies, and particularly in some
marginal types of agriculture, this intrinsic
adaptive capability may be much less. It is
important to establish in more detail the nature
of this adaptability and thus help determine
critical rates of climatic change that would
exceed those that could be accommodated by
within-system adjustments.

Recommendations for action

This study has emphasised the inadequacy of
our present knowledge. It is clear that more
information on potential impacts would help us
identify the full range of potentially useful
responses and assist in determining which of
these may be most valuable.

Some priorities for future research may be
summarised as follows:

- Improved knowledge is needed of effects of
changes in climate on crop yields and live-
stock productivity in different regions and
under varying types of management. To
date, less than a dozen detailed regional
studies have been completed, and these are
insufficient as a basis for generalising about
effects on food production at the regional or
world scale.
- Improved understanding is needed of the
effects of changes in climate on other

physical processes, for example on rates of soil erosion and salinisation; on soil nutrient depletion; on pests, diseases and soil microbes, and their vectors; on hydrological conditions as they affect irrigation water availability.

- An improved ability is required to 'scale-up' our understanding of effects on crops, effects on farm production, on village production, and on national and global food supply. This is particularly important because policies must be designed to respond to impacts at the national and global levels. Further information is needed on the effects of changes in climate on social and economic conditions in rural areas (eg employment and income, equity considerations, farm infrastructure, support services etc).
- Further information is needed on the range of potentially effective technical adjustments at the farm and village level (eg irrigation, crop selection, fertilising etc) and on the economic and political constraints on such adjustments. In particular, it is recommended that national and international centres of agricultural research consider the potential value of new research programs aimed at identifying or developing cultivars appropriate for altered climates.
- Further information is needed on the range of potentially effective policy responses at regional, national and international levels (eg reallocations of land use, plant breeding, improved agricultural extension schemes, large-scale water transfers etc).

Potential impacts on forestry

Biophysical effects

Major forest-type zones and species ranges could shift significantly as a result of climate change. Results of several studies show that both northern and southern boundaries of temperate and northern forests and tree species may shift hundreds of kilometres northward.

At the stand level, the following effects of climate change on forests are likely: increased mortality due to physical stress; increased susceptibility to and infestations of insects and diseases; increased susceptibility to and incidences of fire; changed stand growth rates, both increases and decreases; more difficult

stand establishment by both natural and artificial regeneration; and changed species composition.

Two broad types of forests are likely to be very sensitive to a changing climate: (i) boreal forests, where stands are mainly even-aged and often temperature limited, and where temperature changes are expected to be large; and (ii) forests in arid and semi-arid regions where increased temperatures and stable or decreasing precipitation could render sites inhospitable to continued existence of current forest stands.

Socioeconomic implications

The socioeconomic implications of shifts in tree species ranges will be influenced by the fact that climate will probably change much faster than tree species can naturally respond (eg through migration).

Moreover, new sites may not be edaphically hospitable, having evolved over thousands of years under other climatic and vegetative regimes. Further, new range suitability, and actual forest composition and growth patterns under new climates, will have no regard for non-ecological boundaries such as woodsheds, ownerships, parks, nature reserves and recreation areas.

It is concluded that climate change could more likely exacerbate most current and near-term issues and tensions rather than relieve them. This finding is very dependent on the assumption that, during the next 30-50 years in response to climate change, forests everywhere in the world will be prone to some measure and form of decline. If, on the other hand, forests in some regions are largely unaffected by climate change, or actually experience increased growth rates, then perhaps most of the issues and tensions could be at least partly relieved.

Adaptation

Much can be done to reduce the susceptibility of socioeconomic systems to climate-induced forest declines.

Appropriate measures include the whole array of forest-management tools, to be chosen and implemented as local conditions warrant, but

1 some may be detrimental to other indicators, for
2 example, wildlife or recreation.

3
4 For wood supply, the forest-products industry
5 can move processing technology towards new
6 kinds and qualities of fibre, and plan new mills
7 in areas improving in wood-supply potential.
8 Governments can support economic-
9 diversification efforts in forest-based
10 communities, and engage in improved long-
11 range planning for future changes in land
12 potential for forestry. Regarding recreation
13 enterprises, another example of a very
14 important forest-based economic sector,
15 governments and private firms must look ahead
16 to see how forested landscapes might change,
17 and plan divestments of old facilities and
18 investments in new facilities accordingly.
19

20 *Recommendations for action*

21
22 The nature and temporal/spatial distribution of
23 climate change itself is highly uncertain, as are
24 the various ways by which a changing climate
25 could influence forests and their growing sites,
26 and the various repercussions this might have
27 on our uses of forests. Moreover, the means by
28 which society might cope with the changing
29 environmental and socioeconomic conditions, in
30 a context in which those conditions are rapidly
31 changing quite independently of climate
32 change, are largely unexplored so far.

33
34 The following major research and assessment
35 initiatives should be developed and pursued in
36 the near future (early 1990s) to begin to shed
37 light on the impacts discussed in this section: (i)
38 more secure regional climate scenarios; (ii)
39 simulation of impacts of climate change on
40 managed forest stands; (iii) modelling studies
41 for better understanding of matches between
42 species and sites; (iv) analyses of the potential
43 role of forest management in mitigating
44 undesirable impacts and capitalising on
45 desirable impacts of climate change; (v)
46 regional analyses of potential disruption of
47 wildlife habitat and recreational potential of
48 forests due to forest-structure changes brought
49 on by climate change; (vi) regional analyses of
50 potential socioeconomic repercussions on rural
51 communities, industrial concerns, markets and
52 trade in forest products, and governments, of
53 timber-supply fluctuations due to climate
54 change; and (vii) synthesis studies of the policy
55 possibilities for the forest sector to prepare for
56 climate change.
57

Potential impacts of climate change on natural terrestrial ecosystems and the socio-economic consequences

Major findings

- Global increases in the atmospheric concentrations of greenhouse gases (GHG) as a result of anthropogenic activity and the associated climate changes pose a serious threat to natural terrestrial ecosystems and related socioeconomic systems.
- Global biological diversity is expected to decrease with projected warming, possibly setting off extinction.
- Vegetation will lag behind climatic shifts by several hundred kilometres over the next 50 years, possibly leading to ecosystem disruption.
- Vegetation-zone losses are greatest at high latitudes where the amount of land classified as polar desert, tundra and boreal forest is expected to decline by approximately 20%; for approximately 35% of current closed forest zones, the climate may become inappropriate as a result of the projected climate changes.
- Montane, alpine, polar, island and coastal communities, remnant vegetation, heritage sites and reserves are particularly at risk.
- Socioeconomic consequences of these changes may include disruption of society and related economies with a major dependence on natural resources as a source of fuel, income, medicine and construction material. Important fibre products and recreation and tourism industries could be adversely affected in some regions.
- The direct effect of increased atmospheric concentrations of CO₂ may increase plant growth, but this positive effect could be reduced over time by air pollution or ecosystem feedbacks.
- Disturbances such as pest outbreaks and fires are expected to increase.

- 1 • Lack of data and understanding limits more
2 quantitative assessments at this time.
3

4 *Principal issues*

5
6 The projected changes in climate will present
7 these ecosystems with a climate warmer than
8 that experienced during their recent evolution
9 and there will be warming at a rate 15-40 times
10 faster than past climate changes. This
11 combination of relatively large and fast changes
12 in climate will cause disruption of ecosystems,
13 allowing some species to expand their ranges
14 while others will become less viable and, in
15 some cases, may disappear.

16
17 Current knowledge does not allow a compre-
18 hensive and detailed analysis of all aspects of
19 the impacts of climate change on natural
20 terrestrial ecosystems. It is possible, however,
21 to make some plausible implications. All
22 estimates presented below are based on
23 scenarios of enhanced atmospheric concen-
24 trations of GHG and related changes in global
25 climate. It is impossible to evaluate the
26 consequences of change in climatic fluctuations
27 since the required climatic analyses are not
28 available.
29

30 *Particularly sensitive species*

31
32 These species which are particularly sensitive to
33 climatic changes are:

- 34
35 • species at the edge of (or beyond) their
36 optimal range;
37
38 • geographically localised species (eg those
39 found on islands, on mountain peaks, in
40 remnant vegetation patches in rural areas,
41 and in parks and reserves);
42
43 • genetically impoverished species;
44
45 • specialised organisms with specific niches;
46
47 • poor dispersers;
48
49 • more slowly reproducing species; and
50
51 • localised populations of annual species.

52
53 This would suggest that montane and alpine,
54 polar, island and coastal communities, and
55 heritage sites and reserves are particularly at
56 risk since their component species may not be
57 able to survive or adapt to climate change

because of the limited number of adaptive
options available to them.

Changes in the boundaries of vegetation zones

Projected changes in global temperature of
1.5°-3.5°C and changes in precipitation will
result in the movement of the boundaries of
vegetation zones, and will impact on their
floristic composition and associated animal
species. Boundaries (eg boreal-tundra,
temperate forests, grasslands etc) are expected
to shift several hundreds of kilometres over the
next 50 years. Real rates of species movement,
however, will be restricted by limits on their
ability to disperse and the presence of barriers
to dispersion and, therefore, will average
approximately 10-100 m/year.

Both coniferous and broad-leaved thermophilic
tree species will find favourable environments
much further north than their current limits. In
the northern parts of the Asian USSR, the
boundary of the zone will move northward
40°-50° of latitude (500-600 km). The tundra
zone is expected to disappear from the north of
Eurasia.

Expected changes in precipitation will allow
species to extend their boundaries southward.
As a result, broad-leaved species range will
expand and these ecosystems will be more
maritime in terms of species composition. The
forest steppe subzone in the European USSR
will move southern portions of western Siberia
the forest-steppe boundary could move up to
200 km.

In the semi-arid, arid and hyper-arid ecoclimatic
zones of the Mediterranean, GHG-induced
climate change will reduce plant productivity
and result in desertification of the North-African
and Near-Eastern steppes due to increased
evapotranspiration. The upper limit of the
deserts would migrate under the influence of
climate change and most likely extend into the
area that currently corresponds to the lower
limits of the Semi-Arid Zone (ie foothills of the
high, Mid and Tell Atlas and Tunisian Dorsal in
Northern Africa, and of the main mountain
ranges of the Near-Middle East - Taurus,
Lebanon, Alaoui, Kurdistan, Zagros and Alborz).

The impact of climate changes on the present
tropical and temperate rainforest is uncertain.
For example, almost all of Tasmania is expected

1 to become, at best, climatically 'marginal' in
2 terms of temperate rainforests largely due to a
3 rise in winter temperatures suggested by
4 climate scenarios. This increase in temperature
5 is unlikely to have a direct effect on the forest,
6 but may facilitate the invasion of less
7 frost-tolerant species.

8 9 **Changes within ecosystems**

10
11 Projected GHG-induced climate changes will
12 profoundly affect hydrologic relationships in
13 natural terrestrial ecosystems, both directly by
14 altering inputs of precipitation, runoff, soil
15 moisture, snow cover and melt, and evapotran-
16 spiration as well as indirectly by altering sea
17 and lake levels which influence water levels in
18 coastal and shoreline ecosystems.

19
20 The seasonality of rainfall also affects its impact.
21 A lengthening of the dry season, or conversely
22 an increase in ground water table levels, could
23 both accentuate salinisation problems. In
24 Mediterranean and semi-arid climates, where
25 evapotranspiration exceeds precipitation for
26 long periods and increased percolation from
27 vegetation clearing or excessive irrigation may
28 have raised the water table, surface soil
29 salinisation can be a major problem. Such
30 salinisation can kill all but the most halophytic
31 vegetation, increase soil erosion, and reduce
32 water quality. Salinisation is already a problem
33 in many Mediterranean and semi-arid regions
34 (eg coastal Western Australia, the
35 Mediterranean, subtropical Africa), and is a
36 major cause of increased desertification.

37
38 GHG-induced climatic changes will affect the
39 structure and composition of natural terrestrial
40 ecosystems as a result of altered relationships
41 within these ecosystems, perhaps leading to the
42 introduction of new species.

43
44 Given the new associations of species that
45 could occur as climate changes, many species
46 will face 'exotic' competitors for the first time.
47 Local extinctions may occur as climate change
48 causes increased frequencies of droughts and
49 fires, and invading species. One species that
50 might spread, given such conditions, is
51 *Melaleuca quinquenervia*, a bamboo-like
52 Australian plant. This species has already
53 invaded the Florida Everglades, forming dense
54 monotypic stands where drainage and frequent
55 fires have dried the natural marsh community.

Pests and pathogens in some cases, are
expected to increase their ranges as a result of
climate change and, in the case of insects, their
population densities. This could place at risk
the health of ecosystems and, thereby play an
important role in determining future vegetation
and animal distributions

Pest outbreaks can also be expected as a result
of the increased stress and mortality of standing
vegetation resulting from a combination of
climate-driven stressors. An example from New
Zealand concerns hard beech (*Nothofagus
truncata*). A 3°C rise in temperature would
increase annual respiratory carbon losses by
30%; such a loss exceeds the total annual
amount allocated to stem and branch growth
for this species. With insufficient reserves to
replace current tissue, the tree is weakened,
and becomes more susceptible to pathogens
and insects. Following physiological drought
episodes, several (*Nothofagus*) species
succumbed to defoliation insects.

Since wetlands, particularly seasonal wetlands
in warmer regions, provide habitat for the
breeding and growth of vectors of a number of
serious diseases such as malaria, filariasis and
schistosomiasis, an increase in average
temperature and any change in the distribution
of seasonal wetlands will alter the temporal and
spatial distribution of these diseases.

Wildfire frequency and severity are expected to
increase as a result of the projected increases
in available fuel in those areas where drier
conditions will prevail. This will influence the
rate at which new species appear and
reproduce by providing open areas into which
species can migrate.

In areas with a distinct wet and dry season
(parts of the tropic, and all of the
Mediterranean-climate regions), change in the
amount of precipitation in rainy months could
alter fuel loads by influencing growth. The
altered fuel loads along with changes in
precipitations could effect fire intensities during
the dry season. A shift towards a slightly wetter
climate during the summer rainy season could
increase fuel loadings in most of the subtropical
and temperate woodlands of Mexico, which
would suggest increased fire frequencies.

Global biological diversity is expected to
decrease with possible socioeconomic
consequences as a result of climate change;
however, some local increases may also result,

1 especially over the longer term. The resulting
2 impacts on biological diversity are dependent
3 on the balance between changes in species
4 interactions and adaptation through migration.

5
6 Warming could set off a chain of extinctions by
7 eliminating keystone herbivores or their
8 functional counterparts in other ecosystems.
9 For example in the 100 years following the
10 disappearance of elephants in the Hluhluwe
11 Game reserve in Natal, several species of
12 antelope have been extirpated and populations
13 of open country grazers, such as wildebeest
14 and waterbuck, have been greatly reduced.

15
16 The direct effects of increased atmospheric
17 concentrations of CO₂ may increase the rate of
18 plant growth; however, man-induced changes in
19 the chemical composition of the atmosphere
20 (eg ozone) and ecosystem feedbacks could
21 reduce this positive effect over time.

22 23 *Recommendations for action*

24
25 While the specific impacts of global warming on
26 any one region or a single species are to some
27 degree matters of conjecture, there are some
28 clear conclusions that can be made. Natural
29 terrestrial ecosystems will change in make-up
30 and shift in location, and those species which
31 can adapt and shift will survive. The sensitive
32 species, especially those for which options are
33 limited, will dwindle and disappear.

34
35 Examination of the environmental impacts of
36 climate change on natural terrestrial ecosystems
37 and the associated socioeconomic consequences
38 is in its infancy. The studies that
39 have been done are limited, with only specific
40 regions and sectors having been examined.
41 Further limiting these studies is that, for the
42 most part, existing studies have taken a narrow
43 view of the problem and not looked at it from a
44 multi-disciplinary perspective. In addition, most
45 of these have examined climate change effects
46 on current social, economic and environmental
47 systems and have not considered social and
48 economic adjustments nor impacts and consequences
49 during ecosystem transitional periods.

50
51 These limitations can be addressed by:

- 52
53 • assembling relevant inventories of species
54 and ecosystems;
- 55
56 • initiating and maintaining integrated
57 monitoring programs;

- developing information on relative species
and ecosystems sensitivities to climate
change;
- initiating and supporting regional national and
international research and impacts programs;
and
- educating resource managers and the public
about the potential consequences of climatic
change for natural terrestrial ecosystems.

Potential impacts of climate change on hydrology and water resources

Major findings

- For many watersheds worldwide, especially
those in arid and semi-arid regions, runoff is
very sensitive to small changes and variations
in climate. A 1°C to 2°C temperature
increase coupled with a 10% reduction in
precipitation could conceivably produce a
40-70% reduction in annual runoff.
- Based on empirical data and hydrological
models, annual runoff appears to be more
sensitive to changes in precipitation than to
changes in temperature. However, in regions
where seasonal snowfall and snowmelt is a
major part of the total water supply, the
monthly distribution of runoff and soil
moisture is more sensitive to temperature
than to precipitation.
- The construction of hypothetical scenarios
provides a range of runoff responses and the
characteristics of those responses for
particular areas. However, credible forecasts
are not yet available for any specific region
sufficient to designate either direction or
magnitude of change.
- Vulnerabilities in present water uses (ie where
demand exceeds firm yield) and conflicts
among current uses are likely to be
exacerbated by global warming in most arid
and semi-arid regions.
- The regions that appear to be at greatest
risk, in terms of serious threats to sustaining
the population: are Africa; Maghreb, Sahel,
the north of Africa, southern Africa; Asia:
western Arabia, Southeast Asia, the Indian

subcontinent; North America: Mexico, Central America, southwest US; South America: parts of eastern Brazil; Europe: Mediterranean zone.

- The relative degree of water management (storage versus mean annual flow) is a primary determinant in adapting to changes in the mean annual variability.
- It is essential that future water resource engineering design take into account that climate is a non-stationary process, and that structures with a design life of 50 to more than 100 years to be designed to accommodate climatic and hydrometeorological conditions which may exist over the entire life of the structure.

Principal issues

if meaningful estimates of water resources conditions, appropriate for planning and policy formulation, are to be produced, then studies must include estimates on the frequency, intensity and duration of potential future hydrologic events. This is especially critical for evaluating effects on agriculture, the design of water resource management systems, and for producing reasonably accurate water supply estimates.

In many instances it can be expected that changes in hydrologic extremes in response to global warming will be more significant than changes in hydrologic mean conditions. Thus, attention must be focused on changes in the frequency and magnitude of floods and droughts in evaluating the societal ramifications of water resource changes.

Initial general circulation modelling (GCM) studies indicate that interannual variability and the amplitude of annual temperature is likely to decrease, but interannual and diurnal variability of precipitation may increase. Some recent GCM experiments show increased frequency of droughts, progressively increasing from 5% of the time as for the current climate to 50% of the time by the year 2050. These results are in direct contrast to increased precipitation scenarios based on paleoclimatic reconstructions. Meaningful water resource planning and policy making cannot be implemented in the face of such uncertainty. Clarification and specification of the true information content of the various methods for estimating future

climates must be made available to the management community.

Regional impacts

Continental/national

Based on paleoclimatic analogs coupled with physically based water-balance models, annual runoff over the whole of the USSR is projected to rise, although runoff is expected to decrease slightly in the forest-steppe and southern forest zones. In any case, winter runoff is expected to increase in the regions with snowfall and snowmelt. Serious flooding problems could occur in many northern rivers of the USSR.

An assessment of all the river basins in the US shows that the arid and semi-arid regions of the US would be most severely affected by global warming, even though there is a high degree of water control. The competing uses of agricultural irrigation, municipal water supply and hydropower production have stressed even the present system. All other regions in the US will probably suffer adverse water-resource impacts to some degree, whether for hydropower production, municipal water supply shortages, or agricultural irrigation.

An assessment of the GCM studies for the nations of the European Economic Community (EEC) indicates that precipitation and runoff may increase in the northern nations, possibly causing flooding problems in low-lying countries. The Mediterranean countries of the EEC may experience a decline in runoff, thereby increasing the already serious and frequent water supply shortages occurring in that region. It is most probable that agriculture will suffer the most adverse effects.

In Japan, prolonged periods of droughts and shorter periods of intense precipitation may be likely. Current storage capacity is limited and a large proportion of the population is located on floodplains. Water demand can be expected to increase which will seriously stress the existing water management system.

An increase in precipitation and consequent flooding along with overloads of stormwater/sewerage systems leading to degradation of surface water quality is possible in New Zealand.

1 The United Kingdom can expect an increase in
2 mean annual runoff over most of Britain, but
3 with a stronger seasonal variation in peak flows,
4 imposing the need for redesigning existing
5 water management systems.

6 **River basins and critical environments**

8
9 Runoff in the Volga River basin, after under-
10 going an initial decrease through the year 2000,
11 is expected to increase after that year.

12
13 Studies indicate that hydrological conditions in
14 the Sahelian zone are very sensitive to climatic
15 conditions, especially precipitation. Research
16 suggests, for example, that a 20% to 30%
17 decrease in precipitation could lead to a 15% to
18 59% reduction in runoff. As for potential
19 changes in water resources in the future, it can
20 be mentioned that the situation is very
21 uncertain. Therefore, additional comprehensive
22 studies on this problem, which is very important
23 for the region, are required.

24
25 A study of the Sacramento-San Joaquin River
26 basin showed how a highly managed water
27 resources system, dependent on snowmelt-
28 generated runoff, would be affected by global
29 warming. Air temperature increases changed
30 the timing and increased the magnitude of
31 snowmelt-generated runoff by 16% to 81%,
32 severely stressing the flood-control capabilities
33 of existing reservoirs. However, summer runoff
34 decreases of 30% to 68%, coupled with soil
35 moisture decreases of 14% to 36% and a
36 doubling of water demand by the year 2020,
37 suggest that serious water use conflicts and
38 periodic shortages are a distinct possibility for
39 this system.

40
41 In the Murray-Darling basin of Australia, the use
42 of spatial analogs indicates that precipitation
43 could decrease by 40% to 50%. However,
44 based on GCM outputs, the summer-dominant
45 rainfall area of Australia will possibly expand to
46 encompass 75% of the continent by 2035.
47 Runoff could double on the Darling River.

48
49 A water supply-demand stochastically-based
50 sensitivity analysis was conducted for the
51 Delaware River basin, a highly urbanised
52 watershed in the northeastern US. Basin-wide
53 estimates of annual runoff indicate a possible
54 decrease of 9% to 25%. Also, the probability of
55 drought increases substantially throughout the
56 basin. The Delaware River supplies a large
57 percentage of New York City's water supply
58 which is already operating below its safe yield.

Reduced flows in the Delaware River would threaten the city of Philadelphia's water supply intakes in the estuarine portion of the river through upstream movement of the freshwater-saltwater interface.

Large lakes/seas

The Caspian Sea, which is the largest closed water body in the world and receives nearly 80% of its runoff from the Volga River, will respond to the initial decrease in projected Volga River flows to the year 2000, but will increase thereafter. This will greatly improve the severely degraded water quality and ecological conditions in the Sea.

Based on GCM results, the Great Lakes are expected to incur net basin runoff decreases of 23% to 51% under a doubled CO₂ climate scenario. Hydroelectric power production, the very important commercial navigation uses, and lake water quality due to thermal stratification, are expected to be adversely affected.

The Aral Sea would continue to experience water-quality degradation by polluted irrigation return flows, as the precipitation-runoff increases projected for the area would not be enough to compensate for increased expansion of irrigated agriculture.

Recommendations for actions

The most essential need is for more reliable and detailed (both in space and time) estimates of future climatic conditions. These estimates must be regionally specific and provide information on both the frequency and magnitude of events.

Increased understanding of relations between climatic variability and hydrologic response must be developed. Such work should include the development of methods for translating climate model information into a form that provides meaningful input data to watershed and water resource system models.

Areas particularly vulnerable to even small changes in climate must be identified worldwide. Vulnerabilities must be ascertained considering both natural and anthropogenic conditions and potential changes. This work should also include evaluations that focus not just on climate change effects, but also on effects associated with shorter term variability and patterns of persistence.

1 Intensive assessments of water resource
2 sensitivities are necessary in developing
3 countries, especially those located in
4 environmentally sensitive arid and semi-arid
5 regions, where the potential for conflicts
6 associated with low water-resource system
7 development and rapidly increasing water
8 demands is high.

9
10 Studies are needed that produce improved
11 procedures for operating water-management
12 systems in consideration of climate uncertainty.
13 A related aspect of this work is the development
14 of design criteria for engineered structures that
15 specifically incorporate estimates of climatic
16 variability and change.

17
18 Very little is currently known about the effects of
19 climate change on water quality. Although
20 water quality concerns are becoming
21 increasingly important, the separation of human-
22 induced versus climate-induced changes in
23 water quality is a very difficult problem.
24 Specifically, there is an immediate need to
25 identify those aspects of this problem that hold
26 the most promise for yielding credible evalu-
27 ations of climatic effects on water quality.

28 29 30 **Potential impacts of climate** 31 **change on human settlement,** 32 **the energy, transport and** 33 **industrial sectors, human health** 34 **and air quality, and likely** 35 **impacts of changes in UV-B** 36 **radiation**

37 38 *Major findings*

- 39
40 ● Climate change and even a modest global
41 sea-level rise can be expected to prove
42 disruptive to human settlement in many
43 vulnerable coastal areas of some island
44 nations and communities where drought,
45 floods and changed agricultural growing
46 conditions have affected water resources,
47 energy, public health and sanitation, and
48 industrial or agricultural production.
- 49
50 ● Global warming can be expected to cause a
51 significant shift in the permafrost zone. Such
52 change will prove quite disruptive to roads,
53 railways, buildings, oil and gas pipelines,
54 mining facilities and infrastructure in the
55 permafrost region.

- Global warming can be expected to affect the
availability of water resources and biomass,
both major energy sources in a large number
of developing countries. Such changes in
areas which lose water may jeopardise
energy supply and materials essential for
human habitation and energy.
- Vector-borne diseases such as malaria,
schistosomiasis, leishmaniasis, dengue and
Japanese encephalitis can be expected
under warmer climatic conditions to shift to
higher latitudes.
- Should severe weather, even such as tropical
cyclones, occur more frequently or become
more intense as a result of climate changes,
human settlement and industry may be
seriously affected, with large loss of human
life.

Principal issues

The impact on developing countries, many of
which lack resources for adaptation, may be
particularly disruptive. Understanding likely
impacts of climate change on human settle-
ment, energy, transport, industry and human
health in such countries should be a high
priority.

The impacts of climate change on human settle-
ment and related socioeconomic activity,
including the energy, transport and industry
sectors, will differ regionally, depending on
regional distribution of changes in temperature,
precipitation, soil moisture, patterns of severe
storm, and other possible manifestations of
climate change. As the GCM's scenarios
provided by Working Group I have indicated,
change in some of these climatic characteristics
may differ considerably among regions. In
addition, the vulnerability to change in climate
of human settlement and related economic
activity varies considerably among regions and
within regions. For example, coastal areas may
generally be more vulnerable to climate change
than inland areas within the same region.

Development of effective strategies to respond
to climate change will require much better
capability to predict and detect regional climate
change and occurrence of severe meteorolo-
gical phenomena.

Human settlement

The largest impacts on humanity of climate change may be on human settlement with the existence of entire nations such as the Maldives, Tuvalu, and Kiribati imperilled by a rise of only a few metres in sea-levels and populous river delta and coastal areas of such nations as Egypt, Bangladesh, India, China and Indonesia, threatened by inundation from even a moderate global sea-level rise. Coastal areas of such industrialised nations as the United States and Japan will also be threatened, although these nations are expected to have the requisite resources to cope with this challenge, just as the example of The Netherlands has demonstrated.

Besides flooding of coastal areas, human settlement may be jeopardised by drought which could impair food supplies and the availability of water resources. Water shortages caused by irregular rainfall may especially affect developing countries, as seen in the case of the Zambezi river basin. Biomass is the principal source of energy for most of the nations of sub-Saharan Africa and changed moisture conditions in some areas reducing this biomass could pose grave problems for domestic energy production and construction of shelter.

Although there has been only a handful of city-specific studies, they suggest that climate change could prove very costly to major urban areas in industrialised nations. A study has projected that an effective CO₂ doubling could produce a major water shortfall for New York City equal to 28% to 42% of the planned supply in the Hudson River Basin, requiring a \$3 billion project to skim Hudson River flood waters into additional reservoirs.

Although in the permafrost region global warming may result in expansion of human settlement poleward, thawing of the permafrost may also produce major disruptions for infrastructure and transport and adversely affect stability of existing buildings and conditions for future construction.

The gravest effects of climate change may be those on human migration as millions are uprooted by shoreline erosion, coastal flooding and agricultural disruption. Many areas to which they flee are likely to have insufficient health and other support services to accommodate the new arrivals. Epidemics may sweep

through refugee camps and settlements, spilling over into surrounding communities. In addition, resettlement often causes psychological and social strains, and this may affect the health and welfare of displaced populations.

Energy

Among the largest potential impacts of climate change on the developing world are the threats in many areas to biomass, a principal source of energy in most sub-Saharan African nations and many other developing countries. More than 90% of the energy in some African countries depends on biomass energy (fuelwood), and a large proportion of the labour of women in such African countries is expended to collect fuelwood for cooking. Due to uncertainties in water resource projections derived from current climate models, it is very difficult to provide reliable regional projections of future moisture conditions in these countries. Drier conditions could be expected in some countries or regions, and in those situations energy resources could be severely impaired. Analysis of this threat should be a top priority for energy planners.

Developing countries, including many in Africa, depend significantly on hydropower. By changing water resource availability, climate change may make some present hydropower facilities obsolete and future energy planning more troubled.

The studies to date of the likely impact of global warming on the energy sector in developed countries are confined largely to six countries: Canada, the Federal Republic of Germany, Japan, the United Kingdom, the USSR and the US. Generally, they show differing overall aggregate impacts depending on how much energy use is related to residential and office heating and cooling. Climate warming will increase energy consumption for air conditioning and conversely lower it for heating.

In addition, the energy sector may be affected by response strategies against global warming, such as on emissions stabilising policy. Controversy on the way to obtain CO₂-free energy has already been arising, particularly the options of increased reliance on nuclear power or hydropower weighed against related safety and environmental concerns.

1 Although vital to many developing countries that
2 may find existing supplies of biomass or
3 hydroelectric energy jeopardised by changing
4 climatic conditions, such studies would also
5 prove useful to energy planners in industrialised
6 nations.

8 **Transport**

9
10 Generally, the impacts of climate change on the
11 transport sector appear likely to be quite
12 modest with two exceptions. Ultimately, the
13 largest impact of climate change on the
14 transport sector would appear to be changes
15 produced by regulatory policies or consumer
16 shifts designed to reduce transport-related
17 emissions of greenhouse gases. Because of
18 the importance of the transport sector as a
19 source of greenhouse gases, it seems certain to
20 be targeted as a major source of potential
21 reductions in greenhouse gas emissions.

22
23 The second large impact on the transport sector
24 concerns inland shipping where changes in
25 water levels of lakes and rivers may seriously
26 affect navigation and the costs of barge and
27 other transport. Studies to date, focused
28 entirely on the Great Lakes region of Canada
29 and the US, have shown quite large potential
30 impacts. Climate scenarios have shown a likely
31 drop of lake levels of as much as 2.5 m
32 resulting from an effective CO₂ doubling. Such
33 changes could increase shipping costs for such
34 principal cargoes as iron ore, grain, coal and
35 limestone, as well as adversely affecting
36 recreational boating.

37
38 Generally, impacts on roads appear likely to be
39 quite modest, except in coastal areas where
40 highways or bridges may be endangered by
41 sea-level rise. Studies in Atlantic Canada and
42 Greater Miami, US indicate that such infra-
43 structure costs could prove very costly to
44 highway infrastructure in such exposed coastal
45 areas. Reduced snow and ice and lessened
46 threat of frost heaves should generally produce
47 highway maintenance savings as suggested by
48 a study of Cleveland, Ohio, US. These savings
49 might be offset in some cases by increased
50 demand for air conditioning in public transport
51 vehicles.

52
53 Impacts on railways appear likely to be modest,
54 although heat stress on tracks could increase
55 summertime safety concerns on some railways
56 and reduce operational capability during
57 unusually hot periods.

Reduced snow and ice conditions in colder
regions on the other hand could result in better
operating conditions in those areas.

There has been little analysis of likely impacts
on ocean transport. The largest effect would
appear likely to be some jeopardy to such
shipping infrastructure as ports and docking
facilities, threatened both by sea-level rise and
storm surge. Some climate projections indicate
the possibility that tropical cyclone intensity may
increase. This could have adverse implications
for ocean shipping and infrastructure.

Generally, there is very little analysis of likely
impacts of climate change for the transport
sector in developing countries. Remedying this
oversight should be a top priority, as efficiency
of the transport sector is likely to be an
essential element in countries ability to respond
to climate change.

Industry

Studies of likely impacts of climate change on
the industrial sector tend to be concentrated
heavily in certain sectors such as recreation and
only in a handful of industrial countries,
principally Australia, Canada, Japan, the UK and
the US. There is very little analysis of the likely
impacts of climate change on industry in
developing countries, although there is some
evidence to suggest that industry of developing
countries may be especially vulnerable to
climate change. An especially important factor
is the likely change in the production map of
primary products as a result of climate change.

Changes in availability and cost of food and
fibre may significantly affect the competitiveness
and viability of such derivative industries as
food processing, forest and paper products,
textiles and clothing. Climate change may be
expected to have differential impacts on the
availability and cost of food, fibre, water and
energy.

Just as the motor vehicle and the energy
sectors are likely to be influenced by regulatory
decisions and shifts in consumer patterns
emanating from concerns about limiting
greenhouse emissions, heavy manufacturing
may face readjustment to new situations such
as transboundary siting constraints and
international mechanisms for development and
transfer of new technology. Efficiency in use of
energy may become an even more significant

1 competitive factor in steel, aluminium and other
2 metals industries and automotive manufacturing.
3 Public concerns about limiting greenhouse
4 emissions may also create opportunities for
5 energy conservation or 'clean technology'
6 based industries. Studies of likely impacts of
7 climate change on industry tend to be clustered
8 in the recreational sector where direct impacts
9 of climate change are more ascertainable.

10 Generally, global warming can be expected to
11 affect adversely snow skiing facilities and
12 expand the summer recreation season. With
13 sufficient lead time industry may be able to
14 adjust to many of the changes accompanying
15 global warming. Shortages of capital in
16 developing countries which may be vulnerable
17 to flood, drought or coastal inundation may,
18 however, constrain such industry's ability to
19 design effective response strategies.

21 Human health

23 In principle, human beings have a capability for
24 adaptation, but episodic cold weather and
25 heatwaves cause a risk of excess mortality.
26 Increased heat stress in summer is likely to
27 increase heat-related deaths and illnesses.
28 Generally, the increased hot weather mortality
29 appears likely to exceed any reduced mortality
30 from hypothermia and other cold weather
31 related illnesses, although these conditions may
32 vary among regions. Global warming and
33 stratospheric ozone depletion appear likely to
34 worsen air pollution conditions, especially in
35 many heavily populated and polluted urban
36 areas. Climate change-induced alterations in
37 photochemical reaction rates among chemical
38 pollutants in the atmosphere may increase
39 oxidant levels, adversely affecting human health.

41 There is a risk that increased UV-B radiation
42 resulting from depletion of the stratospheric
43 ozone layer could raise the incidence of snow
44 blindness, cataracts and skin cancer. The
45 increased skin cancer risks are expected to rise
46 most among fair-skinned Caucasians in high-
47 latitude zones.

49 Another major effect of global warming may be
50 the movement poleward in both hemispheres of
51 vector-borne diseases carried by mosquitoes
52 and other parasites. Parasitic diseases have the
53 potential for increase and reintroduction in
54 many countries.

56 Changes in water quality and availability may
57 also affect human health. Drought-induced

famine has enormous consequences for human
health and survival.

The potential scarcity in some regions of
biomass used for cooking, and the growing
difficulty in securing safe drinking water due to
drought, may increase malnutrition in some
developing countries.

Air pollution

SO_x, NO_x and auto-exhaust controls are
expected to be implemented parallel with CO₂
control measures. Concerns about possible
energy penalties and CO₂ emissions implica-
tions of such control measures will need to be
incorporated into such planning. Moreover,
global warming and stratospheric ozone
depletion appear likely to aggravate tropo-
spheric ozone problems in polluted urban areas.
The tropospheric temperature rise induced by
the Greenhouse Effect could change homo-
geneous and heterogeneous reaction rates,
solubility to cloud water, emission from marine,
soil and vegetative surfaces and deposition to
plant surfaces of various atmospheric gases,
including water vapour and methane. A change
in water vapour concentration will lead to
changes in the concentration of HO_x radicals
and H₂O₂, which are important for the oxidi-
sation of VOC, SO₂ and NO_x in the atmosphere.
Climate change could induce change in wind
and pressure patterns, humidity, atmospheric
stability, cloud, precipitation, and distribution of
arid lands. The predicted change of the
patterns of cloud cover, stability in the lower
atmosphere, circulation and precipitation could
concentrate or dilute pollutants, and change
their distribution patterns and transformation
rates in regional or local sectors. A change in
aerosol formation by atmospheric conversion
from the VOC, NO_x, and SO₂ and windblown
dust from arid land could lead to changes in
visibility and planetary albedo.

UV-B radiation

Besides the human health implications of
increased UV-B radiation already discussed,
such radiation may also significantly affect
terrestrial vegetation, marine organisms, air
quality and materials. Increased UV-B may
adversely affect crop yields. There are some
indications that increased solar UV-B radiation
which penetrates into the ocean surface zone
where some marine organisms live may
adversely affect marine phytoplankton.

1 potentially reducing marine productivity and
2 affecting the global food supply. Increased
3 UV-B radiation can also be expected to
4 accelerate degradation of plastic and other
5 coating used outdoors. Global warming is
6 expected to decrease stratospheric
7 temperatures and this may affect the state of
8 the stratospheric ozone layer.

10 *Recommendations for action*

- 12 • Assessment of vulnerability of countries,
13 especially in the developing world, to
14 possible loss of energy resources such as
15 hydropower and biomass and an examination
16 of available substitutes under new
17 climate conditions should be a high priority.
- 18
- 19 • Research is critically needed into the
20 adaptability of vulnerable human populations,
21 especially the elderly and the sick to the
22 occurrence and intensity of changes in the
23 heat and cold waves as well as the potential
24 for vector-borne diseases to shift
25 geographically.
- 26
- 27 • Identification of coastal areas subject to
28 inundation from sea-level rise of various
29 magnitudes and to storm surge, and of the
30 extent of populations and affected agricultural
31 and industrial production, should be given
32 high priority by policy makers.
- 33
- 34 • It is important that developing countries have
35 the capability to assess climate change
36 impacts and to integrate this information into
37 their planning. The world community should
38 assist countries in conducting such
39 assessments and work to create indigenous
40 climate-change impact assessment
41 capabilities in such countries.
- 42
- 43

44 **Potential impacts of climate** 45 **change on the world ocean and** 46 **coastal zones**

48 *Major findings*

- 49
- 50 • A 30-50 cm sea-level rise (projected by the
51 year 2050) poses serious problems for the
52 low-lying island nations and coastal zones.
53 Protecting these areas entails considerable
54 cost.
- 55
- 56

- A 1 m sea-level rise (the maximum projected
by the year 2100) would displace
populations, destroy low-lying urban
infrastructure, inundate arable lands,
contaminate fresh water supplies and alter
coastlines. These effects could not be
prevented. The severity would vary among
coastal nations.

- Coastal ecology is affected by the rate of
sea-level rise - too rapid a rise could disrupt
life cycles of many estuarine biota.
- Erosion of wetlands and organic matter from
sea-level rise can increase estuarine and
near-shore productivity in the short-term.
- Global climate warming can lead to changes
in physical (upwelling in the ocean), chemical
(increased degradation of organic matter in
polar and subpolar regions, possible change
in biogeochemical cycles of vital elements)
and biological (redistribution of marine
organisms, shift of productive areas towards
the poles and possible decrease of primary
production) conditions.
- Adverse ecological and biological
consequences (eg loss of habitat) will vary by
geographic zone.
- A rise in both water temperature and sea-
level may lead to the redistribution of
commercially important fish species and
benthic organisms. Fisheries production may
not change significantly, but there could be
important regional dislocations.
- Shipping and ocean transportation will benefit
from less sea ice, but some land and marine
mammals and birds will lose migratory and
hunting routes.

Impacts of sea-level rise (impacts on coastal zone)

The sea-level rise effects of global warming are more certain than the terrestrial consequences of temperature, precipitation and evapotranspiration changes. The magnitude and rate of sea-level rise will determine the ability of social and natural ecosystems to adapt to the rise. Direct effects of the rise are straightforward: inundation of low-lying coastal areas; erosion and recession of sandy shorelines and wetlands; increased tidal range and estuarine salt-

front intrusion: increases in sedimentation in the zone of tidal excursion; and increase in the potential for saltwater contamination of coastal freshwater aquifers. The predicted changes in climate may also affect the frequency and intensity of coastal storms and hurricanes, which are the major determinants of coastal geomorphic features.

The socioeconomic impacts of these direct physical effects are uncertain and more difficult to assess, and are region- and site-specific. There are three general impact categories that encompass their physical effects:

- threatened populations in low-lying areas and island nations.
- alteration and degradation of the biophysical properties of beaches, estuaries and wetlands.
- inundation, erosion and recession of barrier beaches and shoreline.

Threatened populations in low-lying areas and island nations

The most important socioeconomic impact of sea-level rise is the inundation that the projected magnitude of 0.5-1.0 m could have on intensively utilised and densely populated coastal plains. A 1 m rise would produce a coastline recession of several kilometres in a number of countries. Other countries have a substantial proportion of land area between 1 m and 5 m above sea-level, with high density coastal populations. For example, a 1 m sea-level rise could inundate 12-15% of Egypt's arable land and 14% of Bangladesh's net cropped area, displacing millions of inhabitants.

Sea-level rise would also expose a greater proportion of low-lying areas to coastal storm-flooding from storm surges. Densely populated urban areas could be protected at great costs, but less densely populated areas stretched out along the coastline could be protected. In these situation, large-scale resettlement might be necessary. Another consequence of sea-level rise is greater incursion of saltwater into freshwater estuarine areas, along with larger tidal excursion. This would reduce the freshwater portion of estuarine rivers, especially during drought periods, adversely affecting municipal and industrial freshwater supplies, and could contaminate coastal groundwater

aquifers, which also supply water for municipal purposes in many areas. Many estuarine areas, worldwide, with large population centres would be affected, particularly those where a decrease in net freshwater runoff is also projected as a consequence of global warming.

Finally, as sea-level rises, much of the infrastructure in low-lying urban areas would be affected, requiring major engineering design adjustments and investments. In particular, stormwater drainage and sewerage systems of many cities will be affected. Coastal protection structures, highways, power plants and bridges may require redesign and reinforcement to withstand increased flooding, erosion, storm surges and wave attack.

Alteration of the biophysical properties of estuaries and wetlands

An accelerated rise in sea-level could severely redistribute coastal wetlands. Salt, brackish and fresh marshes as well as mangrove and other swamps would be lost to inundation and erosion; others would transform and adapt to the new hydrologic and hydraulic regime or would migrate inland through adjacent lowlands not impeded by protective structures. The value of these wetlands as habitat for wildlife would be impaired during the transitional period and their biodiversity may decrease. Although many wetlands have kept pace or have increased in area under the historic rate of sea-level rise owing to sediment entrapment and peat formation, vertical accretion of wetlands has not been observed to occur at rates comparable to those projected for sea-level rise in the next century.

Wetlands are vital to the ecology and economy of coastal areas. Their biological productivity is equal to or exceeds that of any other natural or agricultural system, although little of that productivity may be available to marsh animals and coastal fisheries. Over half the species of commercially important fishes in the south-eastern US use salt marshes as nursery grounds. Wetlands also serve as sinks for pollutants and provide a degree of protection from floods, storms and high tides. Based on these functions, marshes can provide a present value to society of as much as \$US5500/acre or over \$US10,000/ha.

Coastal wetlands and estuaries are important to many species. If sea-level rise is too rapid,

1 natural succession of the coastal ecology will
2 not take place and will lead to great disruption
3 in life cycles. In the short term, production of
4 fisheries could rise as marshes flood, die and
5 decompose, thus improving fisheries habitat in
6 some cases and providing more nutrients.
7 Further nutrients will become available from the
8 leaching of soils and peat which become more
9 frequently flooded. This temporary increase in
10 productivity appears to be happening now in
11 the southeast US where sea-level rise is
12 compounded by land subsidence. However,
13 this temporary benefit for fisheries may be
14 balanced by negative impacts on birds and
15 other wildlife as the habitat area is decreased.
16 In the longer term, by 2050 the overall impact
17 on fisheries and wildlife is likely to be negative.

18
19 While considering potential changes in the
20 biogeochemical cycles of chemicals from sea-
21 level rise, it should be noted that (i) growth of
22 nitrogen and phosphorus concentrations on a
23 regional scale (in subpolar and mid latitudes, in
24 the Bering Sea in particular) would result from
25 flooding of coastal areas and from soil erosion;
26 and (ii) many pesticides which are presently
27 held in sediments could be released into the
28 marine environment by coastal flooding.

29
30 The combination of climatic changes will cause
31 coastal ecosystems to move inland, unless
32 humankind intervenes, and poleward. Also, if
33 sea-level rise is rapid, as predicted, productivity
34 will likely fall, but there may be some decades
35 during which wetlands-based productivity
36 increases before it falls. Once the ocean begins
37 to stabilise at its new level productivity will
38 begin to decrease.

39 40 **Inundation and recession of barrier** 41 **islands, coral atolls and other** 42 **shorelines**

43
44 Sea-level rise would cause inundation and
45 recession of all types of shorelines, especially
46 low-lying coastal areas. Many beaches have
47 very small gradients of 1:100 or less. A 1 m rise
48 in sea-level would inundate 100 m of beach.
49 Additional shoreline recession would result from
50 normal erosive processes including storm
51 surges and wave attack. The potential
52 destruction of coral atolls is perhaps most
53 significant, because these island areas serve
54 both as contained human habitats as well as
55 important ecological habitats with high
56 biodiversity. Unlike continental areas with
57 receding coastlines, where areas for

resettlement are available landward of the
coasts, coral islands have very limited
possibilities. If the rate of sea-level rise exceeds
the rate of vertical coral growth (~ 1 cm/yr),
then inundation and erosive processes begin to
dominate, leading to the demise of the coral
atoll. Although there are engineering solutions
for retarding erosion and protecting against
storm damage of continental coasts, coral atolls
cannot be effectively protected.

Barrier beaches are important for human use,
both for subsistence and recreation, and as
protection for lagoons and mainland areas from
coastal storms. Coastal areas have always
been hazardous. Societies have adapted to or
sought to control the most extreme conditions
resulting from natural climate variability. The
loss of habitable coastal areas, which are
typically densely populated will undoubtedly
lead to large-scale resettlement. Since most
commercial and subsistence fisheries are de
facto located in the very same vulnerable areas,
the impacts are twofold: reduction in ecological
(wetlands) habitat that sustains fish populations,
coupled with increased threats to habitable
coastal areas. Many areas around the globe,
comprising thousands of shoreline and affecting
millions of people would be adversely affected
by a rise of 1 m, or even 0.5 m. For the most
part, prevention of the primary physical effects
is not economical for most of the threatened
coastline. Therefore, the prospect for adverse
impacts should be considered to be extremely
important and virtually irreversible.

Impacts on the world ocean

Global climate warming can change the
physical, chemical and biological processes in
the oceans, and affect productivity of the
oceans and fisheries. Atmospheric CO_2
doubling can increase sea-surface temperature
by $0.2^\circ\text{--}2.0^\circ\text{C}$ and change heat balance
components. Impacts will differ among
geographic zones.

In addition, an increase in atmospheric CO_2
could cause an increase in sea water acidity up
to 0.3 pH and elevation of the lysocline
(because of solution of additional amounts of
 CaCO_3). These processes might be
accompanied by a decrease in the stability of
the complexes of trace metals with aquatic
humus, strengthening the toxic impacts of these
substances on marine organisms as well as a

1 change in the conditions of accumulation of
2 deposits.

3
4 Coastal ecosystems will be exposed to the most
5 severe impact due to a water temperature
6 increase and especially to sea-level rise.
7 Disturbances by hydrological and hydro-
8 chemical conditions in these regions will be
9 accompanied by a shift of feeding zones of
10 many commercial fish species and benthic
11 organisms, a change in the trophic structure of
12 coastal communities, and as a consequence, a
13 decrease in their productivity. At the first stage,
14 as the flux of nutrient increase, in the process of
15 land flooding, a certain increase in the
16 productivity of coastal areas might be observed.

17
18 A change in heat balance and the circulation
19 system in the oceans will produce a direct effect
20 on the productivity of marine ecosystems.
21 Taking into consideration the fact that 45% of
22 the total annual production is in the zones of
23 oceanic and coastal upwellings and subpolar
24 regions, a change in these regions would
25 determine the future productivity of the oceans.

26
27 According to the results of numerical
28 experiments with the use of global circulation
29 models of the atmosphere-ocean system, as
30 well as paleo-oceanographical data, the global
31 warming would be accompanied by a
32 weakening of the intensity of oceanic upwellings
33 because of a decrease in the meridional
34 temperature gradient. This process will involve
35 a decrease in the productivity of these
36 ecosystems. However, some increase in the
37 intensity of coastal upwellings as a result of
38 increasing temperature difference between land
39 and water surface, would partially compensate
40 for the reduction of oceanic upwellings.
41 Besides, an increase in the temperature at high
42 latitudes will be accompanied by an increase in
43 their productivity. As a result of the above
44 changes, the redistribution of productive zones
45 will probably occur. This could lead to
46 disturbances in the trophic structure of marine
47 ecosystems and to a change in the conditions
48 of the formation of the stocks of commercial
49 fishes.

50
51 An increase in the zone of the area of warm
52 equatorial and tropical waters would cause the
53 movement of pelagic and benthic communities
54 of these areas to the boreal and temperate
55 regions. This circumstance might significantly
56 affect the structure of world fisheries. Under
57 conditions of climate warming, the intensi-
58 fication of biodegradation processes will occur

by up to 30-50% in the zone of high latitudes.
This factor, along with the expected increase of
UV-B radiation, resulting from the depletion of
the ozone layer, could accelerate bacterial and
photochemical degradation of pollutants and
reduction of their 'residence time' in the marine
environment. Ecological and biological
consequences of climate changes will vary
among geographic zones. A regional approach
is needed to study the biogeochemical carbon
cycle, especially in the most productive and
vulnerable ecosystems of the ocean.

The highly productive subpolar and polar
ecosystems of the Bering Sea, Arctic Seas and
Southern Ocean are important to study because
of the high-latitude areas will see the greatest
changes. These areas are important to the total
global carbon cycle in the ocean, in climate
forming processes, in fisheries, and in marine
mammal and bird production.

International investigations, planned for the
region of the Bering Sea, will contribute to the
determination of the role of subpolar
ecosystems in the formation of earth's climate,
as well as to a more comprehensive study of
possible ecological impacts of global warming
on the ocean, in particular an impact on
fisheries.

Many fisheries and marine mammal populations
are heavily stressed from fishing pressure.
Climate changes will increase stress and the
chance of collapse. However, for some
species, the new climate may be more
advantageous to their well-being.

One benefit of warming will be the reduction of
sea ice and its impact on shipping. However,
there are ecological concerns. Land animals
use sea ice for migratory and hunting routes,
while for many species of marine mammals (eg
seals, polar bears, penguins) sea ice is an
essential part of their habitat and thus reduction
of the amount or duration of ice can cause
difficulties for such animals.

Recommendations for action

- Identification and assessment of the risks to coastal areas and islands and living resources of a 0.3-0.5 m rise in sea-level.
- Assessment of potential leaching of toxic chemicals with sea-level rise.

- Improvement of the methods for analysing the major components of oceanic branch of carbon cycle (the carbonate system and organic carbon).
- Assessment of the possible impacts of increased UV-B radiation from stratospheric ozone depletion on oceanic and estuarine ecosystems.
- Determination of ecological impacts of Arctic and Antarctic sea ice reductions.
- Development of methodologies to assess the impacts on living marine resources, and socioeconomic impacts, of changes in the ocean and coastal zone.
- Development and implementation of multinational systems to detect and monitor expected environmental and socioeconomic impacts of ocean and coastal zone changes.

Impacts of climate change on the terrestrial cryosphere and socioeconomic consequences

Major findings

- The areal coverage and duration of seasonal snow cover are expected to decrease in most locations (except in areas of the Arctic and Antarctic) resulting in regional changes in the hydrology and adverse effects on snow-dependent activities, such as transportation and recreation. Activities such as agriculture dependent on water from spring snowmelt could also be negatively affected, particularly in areas at lower latitudes. Less snowfall could reduce transportation costs by road, rail and air, but could increase those costs for those activities which rely on winter roads for access.
- Glacier recession is expected over the next 50 years in most locations; however, this response is complicated by the effect of increased snowfall in some areas and local terrain characteristics. This has significant implications for those areas which rely on glacial melt for water and hydroelectric power.
- Greenland and Antarctic ice sheets will be brought out of balance as climate changes;

however, actual impacts will depend on the balance between increased temperature and snowfall. Significant ice losses, however, are unlikely until after 2100.

- Degradation of permafrost is expected with an increase in the depth of the seasonal freeze-thaw (active) layer and a recession of permafrost to higher latitudes. The depth of the active layer is expected to increase by 1 m over the next 40-50 years. Although major shifts are expected in climate zones, movement of permafrost boundaries will significantly lag behind that of the climatic zones, receding only 25-50 km during the next 40-50 years.
- Increases in depth of the active layer and recession of permafrost poleward will have significant implications for existing and planned structures, facilities and infrastructure, as well as concurrent ecosystems.
- Changes in the terrestrial cryosphere will enhance global warming (positive feedback on global and local climate) through influences on the radiation and heat balance and release of greenhouse gases.
- The terrestrial cryosphere, because of its relative responsiveness to climate, provides an effective means of monitoring climatic change.
- Lack of knowledge and understanding limits more quantitative assessments at this time.

Principal issues

The terrestrial component of the cryosphere consists of seasonal snow cover, glaciers, terrestrial ice sheets, permafrost and seasonally frozen ground. These ice masses currently cover approximately 41 million km² (percentage of land area) with seasonal snow cover covering as much as 62% of the Eurasian continent and virtually all of North America north of 35° latitude.

Projected changes in climate will dramatically reduce the areal extent and volume of the terrestrial cryosphere. This not only has implications with respect to changes in the availability of fresh water, changes in sea-level and in terrain characteristics, but also has implications for societies and related economic

1 systems which have become dependent on, or
2 are limited by, the existence of a terrestrial
3 cryosphere. Another important consideration is
4 the feedback mechanisms with climate-induced
5 changes in the terrestrial cryosphere affecting
6 the climate itself.

8 Seasonal snow cover

9
10 Global circulation models (GCM) indicate that in
11 most parts of the Northern and Southern
12 Hemispheres the duration of snow cover is
13 expected to decrease as a result of increased
14 temperature and, in most regions, a
15 corresponding decrease in total mass of the
16 snow. Areas where snow cover is projected to
17 increase include latitudes south of 60°S and
18 higher elevations of inland Greenland and
19 Antarctica.

20
21 A reduction in the areal snow coverage and in
22 the snow cover season will result in a positive
23 climatic feedback increasing global warming.

24
25 Loss of snow cover has both negative and
26 positive socioeconomic consequences.
27 Decreases in snow cover will result in increased
28 risks of damages and losses for those systems
29 which rely on snow as protection (ie insulation)
30 from cold winter climates. Included are
31 agricultural crops such as winter wheat, trees
32 and shrubs, hibernating animals and
33 construction and maintenance of municipal
34 infrastructures.

35
36 Reductions in both the temporal and spatial
37 coverage of seasonal snow cover will have
38 significant ramifications for water resources as
39 the amount of water available for consumptive
40 (eg potable and irrigation water) and non
41 consumptive (eg hydroelectric and waste
42 management) uses decreases. Particularly
43 sensitive are those areas such as the Alps and
44 Carpathians, the Altai mountains of Central Asia,
45 the Syr Darya and Amu Darya region of the
46 USSR, the Rocky Mountains and the North
47 American Great Plains all of which are
48 dependent on snow melt for the majority of their
49 water resources.

50
51 Changes in snow cover will also affect tourism
52 and recreation-based industries and societies,
53 particularly winter recreation sports such as
54 skiing. Projected climate change could
55 eliminate a \$50 million ski industry in Ontario,
56 Canada.

From a positive impacts perspective, reductions
of seasonal snow cover will reduce expendi-
tures on snow removal and will increase access
opportunities.

Ice sheets and glaciers

The relationships between climate and ice
sheets and glaciers are not completely
understood owing to their complexity, the
number of related variables and the lack of
information. Increased temperatures generally
result in increased ablation and hence a
decrease in ice mass. Conversely, increased
snowfall usually increases ice mass. Since
projected changes in climate for some ice-
covered regions include both increases in
temperature and snowfall, understanding the
impact of climatic changes on glaciers and ice
sheets must consider the combined impact.

The bulk of the earth's ice mass is stored in the
Antarctic ice sheet divided between an eastern
portion resting on bedrock and a western
portion resting on the sea bed. Much of the
remaining ice mass is contained in the
Greenland ice sheet with smaller quantities
stored in glaciers throughout the world.

Although observed data are limited, it is
estimated that both Antarctic and Greenland ice
sheets are at present roughly in equilibrium,
with annual gains close to annual losses.
GHG-induced climatic change will tend to bring
these sheets out of balance with the new
climate regime. Change in ice-sheet volume is
likely to be slow, however, with significant loss
unlikely to until after 2100. Calculations for
Greenland suggest a 3% loss of ice volume in
the next 250 years is possible based on the
projected changes in climate. In the case of the
Antarctic ice sheet the situation is more
complex. The mass of the eastern ice sheet is
expected to remain virtually the same or
increase slowly as a result of expected
increases in precipitation and temperatures. In
contrast the western ice sheet appears quite
vulnerable to climate change, with mass losses
expected at a relatively rapid rate as a result of
melting and iceberg calving. Collapse of the
western ice sheet as a result of warming from
the ocean is also possible, but highly
speculative and unlikely to occur for thousands
of years.

The response of glaciers to climatic change will
depend on their type and geographic location.

In general, however, they have been shrinking for the last 100 years and are expected to continue to do so in response to projected changes in climate. In Austria a 3°C warming by 2050 is projected to cause a reduction by about one-half in the extent of alpine glaciers. Melting of glaciers in the Soviet arctic archipelagos may result in their disappearance in 150-250 years. In contrast, an assessment of mountain glaciers in the temperate zone of Eurasia indicates that up to 2020 these glaciers will, in general, remain essentially unchanged with increased precipitation compensating for increased melt.

Ice sheet and glacier melting will result in higher sea-levels. Observations over the last century indicate that levels have been rising between 1-3 mm/year primarily as a result of mass loss from alpine glaciers. Current projections suggest an accelerated rise with GHG warming to a most probable increase of 0.2-0.9 m by 2100.

Glacial melting can act as a negative feedback to regional and global warming, with heat extracted from the air to melt glacial ice and snow thereby reducing the degree of warming.

The melting of glaciers will also alter regional hydrologic cycles. In New Zealand it has been estimated that a 3°C increase in temperature would in the short term increase glacier fed river flow in some western rivers, increasing hydroelectric generation by 10%. Another effect of glacier retreat is possible increased debris flows. Large amounts of debris masses on steep slopes will become exposed as a result of glacial retreat and, therefore, would be unstable and vulnerable to the effects of erosion. Landslides would result leading to burial of structures, traffic routes and vegetation. Obstructions of river flows and increased sediment loads resulting in changes in water quantity (eg local floods and reduced flows downstream) and water quality would also be likely to occur as a result of debris flows.

Permafrost

Permafrost is the part of the terrestrial cryosphere consisting of ground (soil and rock) that remains at or below freezing throughout the year. It usually contains ice which can take a variety of forms varying from ice held in soil pores to massive bodies of more or less pure ice many metres thick. The presence of this ice

in the ground makes it behave uniquely as an earth material, and makes its properties vulnerable to climatic warming.

At present about 20-25% of the land surface of the earth contains permafrost, primarily in the polar regions but also in the alpine areas at lower latitudes. It occupies approximately 10.7 million km² in the USSR, 5 million km² in Canada, 2 million km² in China and 1.5 million km² in Alaska. Present and past climate is the major determinant of permafrost occurrence and characteristics; however a variety of other factors is also important, for example, the properties of the soil, and overlying terrain, vegetation and snow cover.

Permafrost is usually present where the mean annual air temperature is less than -1°C. At temperatures near this value it is discontinuous in extent (discontinuous permafrost zone). Both its extent and thickness increase at progressively higher latitudes where temperatures are lower. It has been found to extend to depths of approximately 1000 m or more in parts of Canada, approximately 1500 m in the USSR and 100-250 m in China.

Permafrost can also exist in seabeds. There is extensive ice-bound material in the continental shelf beneath the Arctic Ocean; however, this permafrost is relic (ie if formed under past conditions and would not form under current ones).

Permafrost is to a large extent inherently unstable since it exists so close to its melting point. Most responsive to changes in climate would be those portions nearest the surface. Climate warming would deepen the active layer (the layer near the surface subject to annual freezing and thawing) leading to a decrease in soil stability. This permafrost degradation would lead to thaw settlement of the surface (thermokarst), ponding of surface water, slope failures (landslides) and increased soil creep. This terrain instability would result in major concerns for the integrity and stability of roads, airfields, dams, reservoirs and other facilities in areas which contain permafrost. In addition slope failures, thermokarst and loss of near-surface moisture, as the increased depth of the active layer would move limited water supplies further from the surface, would have detrimental effects on vegetation and could lead to significant decreases in plant populations. In the longer term, permafrost degradation would allow the growth of deeper rooted, broad-leaved

species and the establishment of denser forest of coniferous species. Wildlife could also be affected through changes in terrain, surface hydrology and food availability.

Assessment of the effects of climate change on permafrost in any particular location must consider factors other than temperature, eg changes in summer rainfall and snow cover. In general, however, the projected warming during the next several decades would significantly deepen the active layer and initiate a northward retreat of permafrost. It is expected that a 2°C global warming would shift the southern boundary of the climatic zone currently associated with permafrost over most of Siberia north and northeast by at least 500-700 km. The southern extent of permafrost will lag behind this, moving only 25-50 km in the next 40-50 years. The depth of the active layer is expected to increase by 1 m during the next 40-50 years. Projected changes in permafrost in Canada are of similar magnitude.

The melting of permafrost will result in the release of methane and to a lesser extent CO₂ from previously frozen biological material and from gas hydrates. The extent to which this will enhance the greenhouse effect is uncertain, but one estimate is about 1°C by the middle of the next century.

The socioeconomic impacts of permafrost degradation will be mixed. Maintenance costs of existing northern facilities such as buildings, roads and pipelines will tend to rise with relocation needed in some cases. Change in current construction practices will be needed, as may be changes in sanitary waste disposal. Benefits from climate warming and permafrost melt are likely on agriculture, forestry and hunting and trapping.

Recommendations for action

Projected GHG-induced changes in climate will lead to ablation of global ice masses. Uncertainty exists, however, regarding how this global response will be reflected at the regional/local level and how the individual ice masses and seasonal ice and snow will respond. The most important effects of climatic change at high latitudes and elevated regions will be on, and through changes in the terrestrial cryosphere. Furthermore, the terrestrial cryosphere is particularly suited for early detection of the effects of climate change. These two points

necessitate a better understanding of the nature and dynamics of these ice masses and the factors that control them. This will require:

- establishment or enhancement of integrated, systematic observation programs commensurate with research on the use of more efficient ground-based systems and remote sensing technologies designed to provide baseline information and trends;
- concurrent monitoring of those facilities, structures and natural resources that are at risk due to projected changes in the terrestrial cryosphere;
- establishment of new guiding materials and instructions on design and future construction practice in permafrost zones, taking into account projected climate change;
- concurrent monitoring of those facilities, structures and natural resources that are at risk due to projected changes in the terrestrial cryosphere;
- international cooperative efforts on the relationships between components of the terrestrial cryosphere and climate in conjunction with other determining factors including feedback mechanisms;
- cryosphere models;
- impacts assessments nationally and regionally that will provide data and information on the impacts of climate change on areas in which components of the terrestrial cryosphere occurs and the resulting socioeconomic consequences; and
- development and distribution of relevant educational material on climate changes, its impacts on the terrestrial cryosphere and socioeconomic consequences as well as a wider distribution of research results.

Outstanding issues and future actions

- The key element which could improve our assessment of vulnerability of future agricultural production, land and water uses, as well as distribution of waters resources, are regional predictions of changes in soil moisture, precipitation, surface and subsurface runoff regimes and their interannual distributions. Uncertainties and shortages in our knowledge of this regard, limit our ability to judge conclusively and quantitatively of socioeconomic and environmental impacts of climate change on agriculture and forestry, water and food supply, irrigation and hydro energy. The lack of sufficient knowledge and understanding of many processes in cryosphere and their reaction to global warming is considerably limiting the possibility to make a quantitative assessment of consequences of climate change.
- Assessments of climate change impacts on any field of human activities or ecosystems in each specific region are, in general, a matter of conjecture, and thus mean that efforts must be made to develop analytical tools and methods and impact assessments for achieving trustworthy and reliable conclusions. Major research initiatives should be developed for providing more reliable regional scenarios of future changes, including issues of aridisation and desertification and assessment of adaptation of agricultural practices and water supply systems to new climatic conditions through the use of advanced agricultural and irrigation technologies.
- Enhanced research efforts are needed, especially in developing countries, to devise effective alternative adaptation measures to climate change, and to identify critical climatic factors in agriculture and for ecosystems that determine the level of variability and sensitivity to climate change.
- An immediate launch is needed of a cooperative international program of long-term monitoring and systematic surveillance to obtain information and identify trends. In the first instance it should cover systematic observations of terrestrial ecosystems, world oceans and, particularly, cryosphere, which are most sensitive to climate change.
- Enhancement of integrated systematic observations is needed for providing studies of baseline information and trends through the use of more efficient ground-based systems and remote sensing technologies.
- Criteria should be developed for evaluation the significance of impact. Sensitivity indicators to detect vulnerability of the environmental and socioeconomic systems to climate change should also be developed. Such assessments should facilitate the development of systematic action plans to ameliorate these impacts.

Concluding remarks

Humankind is under threat from a man-induced climate change. Each country should take steps to understand the impact on its population and resources due to such a change, and the consequences of sea-level rise, the changed character of atmospheric circulation and the resulting changes in typical weather patterns, reduction of fresh water resources, increased UV-B radiation and spreading of pests and diseases. These can affect the potential of food and agricultural production and adversely affect human health and well-being.

Similarly, ecosystems on earth are also under threat from man-induced climate change. Too rapid a change in climate may not allow species to adapt and, thus, biodiversity could be lost on land, on sea and in the air. These losses could occur equally in the cryosphere regions, where melting of sea ice could accelerate, and in the equatorial regions where sea surface temperatures could increase.

The world community recognises the need to undertake certain actions to reduce and mitigate impact of climate change. Specific measures should follow the assessments of potential impact on the biosphere and on human activity, and a comparison of the net costs of adaptation and mitigation measures.

Despite the uncertainties in assessment of potential impacts, as emphasised in this summary, it is clear that measures can be taken which are cost-effective and which can mitigate the rate of climate change. Thus, energy conservation, improved fossil-fuel combustion and exhaust gas treatment, use of renewable energy and reforestation can provide short-term options for reduction of greenhouse gas emissions. The transfer of technology in these areas, coupled with financial support from developed countries, is vital for the developing countries so that they can contribute to the global approach to meeting the challenge of climate change.

Longer term options must emphasise development and use of renewable sources of energy. Such technologies are especially needed in many African nations, where the possibility of reduction in availability of water would reduce the amount of biomass, which is their main source of energy. In addition, other

longer term technologies such as safer nuclear power systems and fusion energy systems, need to be pursued actively by the developing countries.

The majority of nations in tropical and mid latitude zones, all coastal and island states should ensure that prospective climate change and related sea-level rise are taken into account in long-term planning of hydraulic and irrigation constructions, in particular in decision making about proposed development and settlement of coastal zones.

The capacity of less developed nations to adapt to likely climate change, and to minimise their own contributions to it through greenhouse gas emissions, is constrained by their limited resources, by their debt problems and by their problems in developing their economies on a sustainable and more equitable basis. These nations will need assistance in development, use and maintenance of technologies applicable to their particular energy, industrial, forest and agricultural infrastructure.