

November 15, 1983

Report of the Working Group on the Study of
Climatic Fluctuations in the Dry Margins

INTRODUCTION

The Study Conference on the Sensitivity of Ecosystems and Society to Climate Change was convened from September 19-23, 1983 at Villach, Austria. It was organized jointly by United Nations Environment Programme (UNEP), World Meteorological Organization (WMO), and International Council of Scientific Unions (ICSU), and cosponsored by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Institute for Applied Systems Analysis (IIASA), the World Resources Institute (WRI), and supported by the Government of Austria. The Study Conference was one activity of the UNEP plan of action for the World Climate Impact Programme.

As part of this Conference, two workshops were organized to focus specifically on climate impacts in the dry and in the cold margins; that is, "the transitions from humid to dry climate in tropical and subtropical latitudes and from temperate to arctic temperatures at high latitudes..." (Villach II mimeo). This focus developed in part because of the general belief that the cold and the dry margins are good places to look for the impacts of climate variability and of climate change, and in part because it is believed (by some climate modelers) that the first signal of a CO₂ warming will be detectable in the dry margins of the low latitudes and in the cold margins of the high latitudes. In this sense, the Study Conference followed "a recommendation from the 1980 CO₂ meeting in Villach (WMO, 1981) that attention should be focussed on marginal areas, these being the areas where impacts from CO₂ warming are likely to be most pronounced, and thus more easily detected" (Villach II mimeo).

The broad objectives of the dry margins group were as follows: to introduce explicit considerations of climate into the formulation and development by decisionmakers of policy alternatives, to improve our understanding of the sensitivities of ecosystems and of human societies to climate variability and climate change (on the decadal scale), to stimulate interest among researchers to undertake new or additional national as well as international climate impact studies, and to widen the spectrum of researchers from different disciplines and different countries involved in climate impacts research.

With these broad objectives in mind the dry margins workshop participants met for 2-1/2 days to examine the sensitivity to climatic variability, climate change, and climate change due to CO₂ of ecosystems and human activities in the world's "dry margins." The participants had prepared in advance brief discussion papers presenting their views about various aspects of climate impact assessment in the dry margin areas. In addition, they presented overviews of their research activities. The participants discussed the relative importance of the impacts of climate variability on varying time scales (interannual, decadal and long-term) and the relevance of dry margins for such studies; as well as how the results of climate-related impact assessments might be relayed most efficiently to local, national, and international decisionmakers. This report serves as a record of the workshop participants' deliberations.

SUMMARY OF MAJOR OBSERVATIONS

1. The linkages between climate variability or climate change and changes in human activities must be determined with greater care to enable decisionmakers to pursue policies to adapt to, mitigate, or even prevent the stresses on society related to climatic factors.

2. In order to do climate impact assessments, researchers are in need of regional information about climate variability and climate change (especially with regard to precipitation). General circulation models at this time, however, have limited capability to provide such information.

3. Climate variability on interannual and decadal time scales was of most immediate concern to policymakers in Third World countries in the dry margins. Studies of long-term changes in climate that might eventually be attributable to a CO₂-induced global warming could benefit from climate impact studies related to interannual variability.

4. The climate impacts research community should focus on the more subtle changes in ecological and societal processes (e.g., wind erosion) and not only on the relatively more spectacular, abrupt step-like changes (e.g., major dust storms).

5. There are often long historical records of at least a qualitative nature that can be used to evaluate societal responses to climate anomalies, even in the absence of long-term reliable meteorological records.

6. Climate can be a hazard or a resource to society. Both of these aspects of climate should be identified in climate impact assessments to better understand the climate setting of a region so that over the long run human activities developed there will be compatible with climate.

7. Decisionmakers must be made aware that the impacts of climate on society and ecology often have long-lasting effects that extend well beyond the traditional time horizons of policymakers. It is important for policymakers to extend their time horizon to include future decades.

8. Climate information is only one input into the decisionmaking process. Because a favored (to the climate impacts community) decision has not been taken does not necessarily mean that climatic factors were not considered.

9. The end result of a climate impact assessment should not be the publication of a report but should include a follow-up period for the dissemination of research results to the proper "target" audiences.

10. Decisionmakers at all levels of government, from local to national to regional, should be considered as targets for the results of such studies. Often, it is the local policymakers that are most affected by and, therefore, interested in understanding how climate affects human activities at their levels of political and social organization.

11. Joint sponsorship of climate-related impact assessments could provide an opportunity to undertake such studies for longer periods of time than might be the case for a sole-source funded project. Multiple sponsorship of such studies could help to assure that they remain less influenced by the research interests and biases of any one funding agency.

CONCEPTS AND TERMINOLOGY

The participants recognized the need to discuss, as an integral part of the workshop's deliberations, several key concepts that have been used

repeatedly, but not always consistently, within and outside the climate impacts research community. Confusion about meanings attributed to these concepts often becomes an obstacle to increased interaction between natural and social sciences. It would be futile to seek the general acceptance of a single definition, especially for terms for which there is little or no agreement between disciplines, or for that matter within the same discipline, or between researchers in different countries. However, it is important to clarify them at the outset of each study so that others will know the meanings that an author attributes to the terms being used. Doing so will also make it possible for researchers to see the similarities and differences between their works and the works of others.

Climate Impacts

In our workshop, as well as in the cold margins workshop and in the plenary session, the term 'climate impacts' was continuously used to encompass both climate impacts on ecosystems and climate impacts on society. Sometimes those primary direct impacts on ecosystems also directly affect society, while other times they indirectly affect society; that is, the climate affects ecosystems (managed as well as unmanaged) which in turn has an impact on human activities. In addition, the primary direct effects of climate on society can have indirect effects on the environment as, for example, when short-term favorable weather conditions encourage decision-makers to expand agricultural activities into unexploited yet marginally productive areas. In order to avoid misinterpretation and confusion, it is important to keep these two types of primary impacts (i.e., on ecology and on society) separate.

Dry Margins

The participants also discussed some of the various classification schemes that have been developed during the past decades to identify, at least analytically, different climate-based regions. The workshop participants agreed to consider the dry margins, for the purpose of the workshop, to be the arid and semi-arid areas (as, for example, defined climatically by Meigs in 1953).

The concept of marginality drew considerable attention and debate. It was recognized that, while the functional (as opposed to geographic) concept of marginality had value for socio-economic research, for the purpose of the deliberations of the workshop, the term "marginal" (as used in the original working-group title) was restricted to considerations of biological productivity or to geographic or climatic factors but was rejected for social and economic uses on the grounds that it could be construed in some cultures as a subjective, ethnocentric concept. The workshop participants were, however, aware of the complex interrelationships of social, economic, and political activities in arid and semiarid areas and assumed that these factors would obviously be included in any study of climate impacts in those zones.

Climatic Variability, Climatic Fluctuation, and Climatic Change

With respect to investigating the impact of climate on ecosystems and society, the participants who represented disciplines other than the atmospheric sciences felt that there was a need to clarify the different meanings attributed to such concepts as climatic variability, climatic fluctuations, and climatic change. It was agreed that for the purposes of the dry margins workshop the following terms would be used:

climatic variability would be interpreted as the observed interannual differences in climatic variables that would occur naturally even if the climate were not changing;

climatic fluctuation would be interpreted as a variation lasting a decade or more in which the elements then return to their original value;

climatic change would be interpreted as a permanent change in the level of central tendency or variability (e.g., a change in the mean or the standard deviation) over periods of a decade or more, perhaps manifested as a gradual trend.

The participants in the dry margins workshop agreed that they would be primarily concerned with the impacts on ecosystems and on society of inter-annual variability of climate, and of climate changes or fluctuations over a decade or more. In addition, they would consider the impact on ecosystems and on societies of climate changes which might occur on timescales of up to 100 years that would affect the biological resource base of countries in the arid margins.

Drawing on the experiences of the participants, it became evident that governments in the dry margins have been concerned mainly with climatic variations from one season to the next and with somewhat longer term (e.g., decadal) trends. At present they appear to be much less concerned with the possible impacts of a more gradual climatic change occurring over a longer time scale such as might accompany a CO₂-induced global warming. Uncertainties that surround climate changes resulting from natural factors or from CO₂ increases, as well as the gradual nature of the CO₂ increases and the hypothesized induced changes in ecosystems and society, tend to place

the CO₂ issue in a relatively speculative light, especially when compared with the more immediate stresses on communities and governments in the dry margins that result from the large interannual climate variability. This view was taken by the participants partly because the projected average changes in temperature in the tropics associated with a CO₂ increase were considered to be relatively small; partly because changes in precipitation that might be attributable to CO₂-induced climatic changes are uncertain; partly because of the natural variability of precipitation in the zones separating the dry and wet regions in the tropics make the detection of possible-CO₂ induced changes in precipitation quite difficult; and partly because food production systems in these countries are adversely affected by drought every few years or so, keeping their attention focused on near-term problems.

RELEVANCE OF DRY MARGINS TO STUDIES OF CLIMATE IMPACTS

It has often been suggested that the dry margins are a good place to assess the impacts on society of climate change (regardless of cause). These areas, that have been proposed for decades as natural laboratories, have gained a new found importance with the increased interest in the CO₂ issue. It has been hypothesized that the arid and semiarid areas are most susceptible to changes in climate and that such changes would be easiest to detect in these areas. While the latter point continues to be debated in scientific circles, the dry margins clearly do provide an extremely important focus of attention for climate impact studies concerned with inter-annual climate variability and climate change (on the order of 10 to 100

years). In fact, many studies have already been undertaken in those regions to assess the influence of climatic factors on human activities and on ecosystems. Many states in the dry margins possess considerable historical information about, and experience in, dealing with the impacts of climate on society. The use of historical as well as proxy information to identify the interactions between climate and society for the past century can provide insights into the responses of earlier generations to climate variability, fluctuations, and change.

It appears that in many areas where the meteorological record is relatively short, qualitative information is available about how societies have been affected by, and have responded to, the impacts of climate over time. Thus, there appears to be a wealth of information available for carrying out climate impact assessments even in those regions with a paucity of climate data.

An additional value of focusing on the dry margins became evident during our discussion of case studies of the impacts on society of past climate variability. Such historical cases might serve as useful analogies for the development of scenarios about the future.

The average seasonal positions of the dry margin zones appear to be reasonably well simulated by current general circulation models (GCMs) of the atmosphere. The dry margin zones represent a relatively stable feature of the global climate. In both nature and GCMs, however, these zones are characterized by a very large interannual variability of precipitation which makes the prediction of changes of the mean precipitation in the dry margins difficult. GCMs suggest that if the atmospheric CO₂ content were

to double, there might be shifts of several hundred kilometers in the positions of the dry margins.

- Climate Impact Analysis in the Dry Margins =

It is important to note that while research attention may focus directly on climate impacts in and around arid and semiarid zones, secondary effects of those impacts may carry the researcher outside these zones. For example, climate anomalies, such as droughts and floods, can stimulate outmigration from these dry regions. It is important to remember, however, that unemployment and outmigration can also be caused by factors other than climate, or that climate may be one of several factors occurring simultaneously. Such was the case in the American Great Plains in the 1930s, when drought was coupled with economic depression. It was also mentioned that in the case of tropical cyclones in the Bay of Bengal international assistance to inhabitants of those areas affected by coastal flooding served to draw people back into these high risk (flood-prone) areas. Thus, it was not just the return to normal weather conditions that brought people back into the high risk coastal areas. An Australian example presented at the Workshop highlighted the linkage between Australian wheat production and climatic factors not only within Australia but in other parts of the world as well, as Australia is one of the world's major wheat exporting nations.

Like the other cases discussed, a Brazilian case study showed that impact studies are not constrained by the specific geographic area of research, because the impacts of climate often have implications beyond the spatial boundaries identified at the outset of a study. Specifically, in

the Brazilian Northeast there has been outmigration due to drought, with migrants going to nearby coastal cities and to other major cities that represent hope such as Rio de Janeiro or Sao Paulo. As another example, deforestation along the Sao Francisco River, one of two major rivers crossing the drought-plagued Brazilian Northeast, has apparently had the river's flow patterns altered to the extent that it may be less reliable in providing a source of water for people and livestock during extended drought episodes. Thus, decisions taken far from the region of concern can affect society's ability to respond (or adjust) to the vagaries of climate.

The workshop participants shared their dry margins research experiences, based on a variety of sources of information including archival as well as field-derived data, incorporating graphic, statistical, oral, and literary materials. Each participant provided a brief review of his or her experience of climate impact analysis by briefly addressing the following questions: (1) The location, size, and current population of the study site; (2) the dominant current economy in the area; (3) the kind, quantity, and quality of data available for the site with respect to (a) climate, (b) ecosystems, (c) society; (4) the constraints on undertaking a study of climate impacts in their study area; (5) and the optimum length to complete such an assessment.

Based on the experiences of the participants, four studies in Africa were described and discussed, together with two from Latin America and one from Australia. Although large differences were obvious with respect to

the availability of data for long time periods and for different geographic locations, it was nonetheless quite evident that a large body of data (in a variety of forms) was available for each research site discussed.

AREAS OF CONCERN IN CLIMATE IMPACT STUDIES

The introduction of climate considerations into the policymaking process was considered by the participants as one of the objectives of UNEP's World Climate Impact Studies Program. In light of this objective, the group made the following observations about climate impact studies at the local, national, and international levels.

1. Methodology and the Study of Climate Impacts

There is a need to determine with greater accuracy the linkages between climate variability and changes in human activities and to improve the methods by which such linkages are assessed. By improving the understanding of those linkages, decisionmakers may be able to mitigate the stresses that climate variability and climate change portend for human communities. In addition, not all groups in society are affected in the same way by a given climatic anomaly. Some individuals or groups, for example, might benefit during drought situations, at the same time that others may be suffering.

The participants recognized the importance of the development of methods to improve the reliability of the results of climate impact studies, with particular reference to the arid and semiarid areas. Dry ecosystems present problems for those undertaking climate impact studies because of geological, geomorphological, anthropological, sociological and

political factors that often make it difficult for the researcher to isolate the climate impact component. While many of these factors may be of only secondary concern to a climate impact study, they all at the least should be identified, and if possible, studied to some degree as part of the climate impact assessment.

It is important to assess these impacts at all levels of society--local, state, national, regional and global--in order to gain insights into how the same climatic anomalies affect the various levels of social and political organizations in different (or similar) ways.

Studies that can draw upon a sequence of data over time are especially important to the understanding of climate-society interrelationships. These studies might include investigations of the relationships of climate and human activities that occurred in the historical past, or from the recent past to the present, or from the present into the future (either monitoring or scenario construction). Longitudinal studies (studies maintained over time) can also be of great value in understanding the interactions between climate and human activities.

Climate impact studies need to be multidisciplinary in order to assess meaningfully the complex interrelationships between climatic factors, ecosystems, and human activity. While many studies eventually become disciplinary in focus, it is necessary to assure that the linkages and relationships between the various disciplinary components are identified.

Those undertaking impact studies could benefit from existing research on problems in which climate may be only an implicit consideration, such as, for example, desertification or deforestation. A point which may seem

too obvious to be stated, but is nevertheless of great importance, is that it is necessary to be aware of research activities that have been completed or are in progress in climate-related impact assessments so that the research community can build on, fill in, or validate existing research results. All too often studies have been undertaken with little regard to, or awareness of, similar research activities that have been undertaken in the past. Related to this is the fact that many studies have been written only in the language of the country that commissioned the study or from which the researchers come and little attention is paid to having research reports or at least their conclusions translated into other languages.

With respect to tropical dry zones, the participants felt that GCM climate experiments might be used to suggest, on a global scale, regions which might be susceptible to an increasing frequency of drought episodes as a result of climatic fluctuations on the decadal time scale and perhaps even as a result of climatic change. At this point in time, however, GCMs do not provide reliable information about the possible impact of a CO₂-induced global warming on regional precipitation in the low latitude dry areas (or in any region for that matter). It is important, however, to be aware of GCM outputs at the same time that we assess other sources of climate information. The aim of such modeling would be an improved understanding of the processes involved in the acceleration of existing, as well as the initiation of new, climate impacts as a result of climate change.

While the workshop participants minimized the present importance of a CO₂-induced climate change, the view was expressed that Third World countries must keep abreast of the issue as it develops so that if it proves to

be an actual cause of climate change, it will be possible to apply what has been learned from climate impact studies concerned with climate variability and climate change on the shorter (i.e., decadal) time scale. Thus, additional attention should focus on seeking to understand the way in which carbon dioxide increases in the atmosphere may affect not only the climatic means (or other measures of central tendency) but also climate in the dry margin areas.

2. Improving the Reliability of Climate Impacts Assessments

It was recognized that at present the accuracy and the reliability of climate predictions are not high. There exists nevertheless a considerable body of data on probabilities of occurrence of future climate phenomena (under the assumption that the climate is not changing), as well as information on critical thresholds for climate parameters required to maintain certain human activities or existing ecosystems. Decisionmakers need to be made aware of the potential value of using climate data to determine the likelihood of particular impacts of climate on human activities.

Researchers should be reminded that climate variability can often accelerate or intensify existing environmental processes as well as initiate new ones. Climate variability and climate fluctuation on the decadal time scale can lead not only to shifts in boundaries between, for example, wheat and corn production, or wheat production and rangelands (meaning that people will have to shift to different types of agricultural production), but can also exacerbate existing environmental processes such as wind or water erosion. Attention, therefore, needs to be focused not

only on abrupt step-like changes, but on the more subtle changes in existing processes. For example, there have been major dust storms in the American Great Plains on the order of every 20 to 30 years. However, each year there is damage in that region due to wind erosion, even though it is usually much less spectacular than the big, more visible, storms.

Human activities are often introduced into areas well before adequate knowledge about the climate of those areas becomes available. Then the newcomers to these dry margins seem to expect the climate of the area to accommodate itself to their activities. For example, clearing of vegetative cover can initiate or exacerbate soil erosion by wind and water; deforestation can also exacerbate these processes and can adversely alter the regional water balance; crop yields can decline creating a need to clear the vegetative cover in the more marginally productive areas in order to maintain production levels.

While one observer suggested that the interrelationships between climate and society were so complex and intertwined that it might be impossible to separate them, others felt that the task (i.e., to separate climate impacts from social impacts on the ecology) was difficult but that it was nonetheless important to attempt to determine the extent to which climate affects society. In sum, it was felt by the participants that human activities in the dry margins should be developed to best utilize the climate characteristics of a region, keeping in mind that such characteristics can sometimes be a hazard and sometimes a resource.

3. Improving the Communication and Application of Knowledge of Climate Impacts

The ultimate purpose of climate-related impact assessments is to identify for policymakers at all levels of government ways in which societies may better prevent, mitigate, or adapt to the impacts of climate variability and climate change regardless of cause.

Some participants suggested that the climate impacts research community had overfocused on climate as a hazard and that policymakers would be more interested in climate impact research if they could be shown that it was also a resource. The impacts on society of climate as a hazard and climate as a resource, however, are not symmetric concepts. It was suggested that there may be greater risk to policymakers if they fail to respond to the hazardous aspects of climate than if they fail to capitalize on climate as a resource. Referring to climate as both a resource and a hazard will give a more correct representation of what the effects of climate variability and climate change might be on human activities. How society chooses to accommodate its activities to climatic factors often determines the frequency with which those factors will be a hazard or a resource.

In fact, over time, climate can be both hazard and resource in the same area, even without a change in human activities. For example, the human activities dependent on climatic factors might be altered (usually unwittingly) in such a way as to shift the prevailing climate from resource to hazard; e.g., a shift to high yield variety crops in a particular region may make agricultural production more sensitive, for example, to variations

in temperature. Researchers, too, need to be reminded that climate is a resource as well as a hazard and their credibility as advisers to decision-makers may be enhanced by their advice on how to take advantage of climate's potentials as much as the more common advice on how to avoid climate's liabilities.

The group observed that the time horizon of concern of many decision-makers tended to be confined to periods between elections or as long as their tenure in office. Climatic impacts and the need for reliable climate information over long periods does not coincide, in general, with that time horizon. The time horizons of decisionmakers should be expanded to include at least a few decades into the future, so as to enable them to gain a better perspective of the impact of climate variability, climate change, and climate change due to CO₂ on, for example, their economic development planning processes. One participant suggested that a useful time period for assessing climate impacts on society might be that of a generation of a human population (i.e., 20 to 30 years).

The fact that the time required for completing various kinds of climate impact assessments often exceeds the tenure of office of government decisionmakers, sometimes places pressure on researchers to produce results prematurely. Because funding may be available only for a limited time, government administrators may sometimes be eager to obtain research results, especially for climate-induced problems, such as droughts. Sometimes this hurried demand for results may lead the researchers (or consultant) to make findings more assertive than their data at a given point in time might support. While there is a strong case, and in many

instances the practical necessity, for studies of climate impacts to require several years for completion, researchers nonetheless must be prepared to provide interim results for decisionmakers periodically throughout the research program. This provision of interim reports on a regular basis can be an important aid to policymakers. A compromise is clearly needed here between researchers, government administrators, and funding groups, and these groups must make themselves aware of each other's limitations, strengths, and needs.

Policymakers must calibrate incoming information from a host of interest and pressure groups at the same time that they constantly contend with the many problems that confront them from day to day. They are often forced to make ad hoc responses to crisis situations. However important we (in the climate impacts community) believe climatic considerations to be, in fact they represent only one input into the policymaking process. Interest expressed by policymakers, for example, in a particular drought is often not precipitated by the lack of rainfall, but by the impacts on specific groups (not all groups) within their societies at a given time. Remove drought related pressures on that group and interest in the drought could evaporate rather quickly, even though the problems related to the drought's impacts often merit sustained interest and attention.

Decisionmakers have seemingly exhibited more interest in seeking solutions that may work in the short term, without considering whether they are appropriate for long-term resolution of problems. It is important to get the decisionmakers to consider at least the longer-term implications of their ad hoc responses to either a seasonal or an interannual climate impact.

It is important to identify the perceptions that policymakers have toward the societal impacts of climate variability, climate change, and climate change due to CO₂. These perceptions should be identified and made explicit, because the consequences of actions taken based on these perceptions will be real, whether or not the perceptions themselves prove to be accurate reflections of reality.

Producing a climate impact study should not be the end result of the research process. Getting research findings into the hands of properly identified "target" audiences is also extremely important. Therefore, funding support for a follow-up period must be maintained to enable the research findings to be widely disseminated as well as peer-reviewed. Otherwise the climate impacts community may, in the last analysis, produce reports for the bookshelf and not for application.

Concern was voiced about whom the impact researchers should make aware of the results of their investigations. Many people consider the top political actor at the national level to be the main target. Yet such a person is influenced by advisers and staff members. Thus, they too should be targets for the dissemination of the research results of climate impact assessments. Economic planners were specifically recommended as potential gatekeepers. Pressure groups, such as the Consultative Group for International Agricultural Research (CGIAR) responsible for worldwide agricultural research were also identified as appropriate targets for climate impact research findings.

It was agreed that it was important to interact with decisionmakers at all levels of government. Research suggests that greater attention should

be paid to local and regional decisionmakers, as it is often at this level that responses to climate impacts are made. Decisionmakers at the local and regional level (e.g., province, department, or state) often exhibit greater, or at least more sustained, interest in the variability of climate that affects human activities and ecology within their regional or local jurisdictions. In addition, policymakers at all levels of government constantly change. It is important to develop a way to keep the occupants (whoever they may be) of a particular policymaking role (position) aware of the importance of the climate factor in policymaking.

4. Financial Support for Impact Assessments

Long-term funding for climate impact studies (required for completion and dissemination of research results) could perhaps be more easily maintained if such projects were supported by more than one national and/or international agency. Joint sponsorship could lighten the financial burden placed on any one agency. A potential problem with joint agency sponsorship, however, is that these agencies have interests, agendas, and goals that frequently differ, and their advice to recipients often conflicts. Each agency's approach may reflect national or disciplinary biases as well as constrain the preferred actions of the recipient country's decisionmakers. Groups and agencies supporting climate impact studies, it was observed, should look beyond their own disciplinary, institutional, or national biases to ensure that the climate impact investigation will be as thorough, objective, and, therefore, as useful as possible. A recent World Bank representative commenting on this noted that "There is a need for donors to clearly recognize that they have to be more disciplined in terms

of their selection of projects so only high priority projects are funded" (New York Times, 18 September 1983).

Yet another constraint imposed by the funding of such studies is the often sensitive political, economic, or cultural issues that different international agencies or governments may not wish the researcher to investigate. Government decisionmakers may be reluctant to support investigations into research topics that might discuss problems which they then may be forced to address.