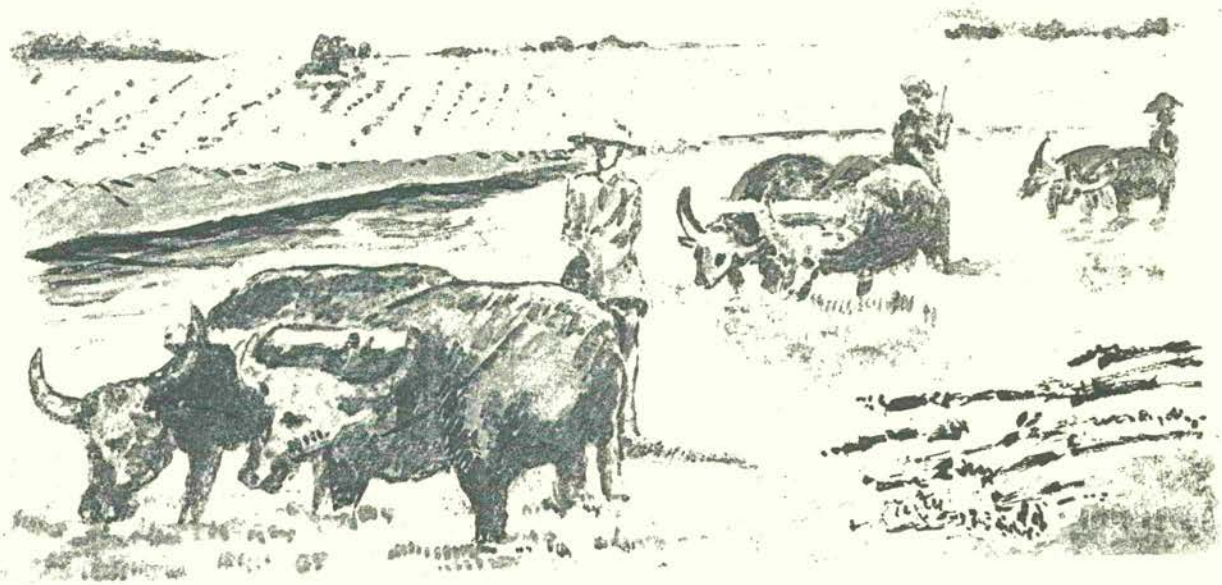
INTERNATIONAL CONFERENCE

ON

CLIMATE CHANGE AND SEA LEVEL RISE

IMPACTS



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Center for Environment
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(CERED)

REPORT OF THE INTERNATIONAL CONFERENCE ON CLIMATE CHANGE AND SEA LEVEL RISE IMPACTS

Hanoi, Vietnam
9-10 November, 1991

Edited by
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The International Conference on Climate Change and Sea Level Rise Impacts was organized by Center for Environment Research, Education and Development (CERED), sponsored by Vietnam Union of Science and Technology Associations (VUSTA), Investment and Development of Technology and Formation Corporation (ITECO), Hydrometeorlogical Service (HMS), and funded by United Nations Environment Programme (UNEP)

I. INTRODUCTION TO THE REPORT

The expressed aims of this conference were to promote scientific exchange and the formation of collaborations between scientists from many different disciplines and countries who share an interest in the impacts of climate changes and sea level rise. It was hoped that through the presentations and discussions of this conference, further research would be stimulated and networks would be formed to facilitate it. The host nation of Vietnam is a country that experiences great climate variability and with its long coastline is particularly vulnerable to sea level rise and other climate changes, therefore it was hoped that the information disclosed at this meeting would be of assistance to the policy makers of Vietnam. Finally, through discussion of the implications of climate change in the Southeast Asian region the conference participants endeavored to provide UNEP with a set of recommendations on how UNEP's World Climate Impact Assessment and Response Strategy Programme can assist the region in being better prepared for adjusting to a changed climate. The following are paraphrased summaries of the speeches and papers presented at this conference.

II. OPENING SESSION: 9 NOVEMBER (MORNING)

After the introduction and welcome by Dr. Hoang Van Huay, Director General of ITECO, the opening speech was presented by Dr. Ha Hoc Trac, chairman of VUSTA:

He mentioned that environment in general including climate

change and sea level rise is a very important problem. It is a global problem and we must make joint efforts to solve it. Human beings are the culprits of this disaster. We must maintain the planet as the cradle of humanity. Through the work of organizations such as UNEP, we are trying to restore the balance. The Vietnamese Government considers the environment in formulating its policies. Vietnamese scientists are researching this serious problem which affects resources, salinity, biodiversity, economic factors and the distribution of population. Our national policies must reflect the need to ensure ecological balance. This conference is devoted to the policy makers of Vietnam. We hope this conference is valuable for the exchange of information between scientists and between researchers and policy makers. We must make a coordinated effort for the sake of the planet. We hereby declare this conference open.

Prof. Dang Huu, Minister, then spoke on behalf of the Vietnamese Government:

He stated that environmental issues in general including climate change and sea level rise are one of the biggest challenges to mankind at present. This is not a problem of one nation, but a global problem. The nations of this planet are joining in efforts to solve the problem. The Earth is facing great threats in the form of environment and climate change. It is regrettable that we, mankind, are the culprits of this catastrophe.

In order to make our planet a gentle and peaceful cradle for humanity, all countries of the world and national and international organizations such as UNEP must strive to prevent environmental deterioration and to restore ecological balance in development.

The Vietnamese government is very much concerned about the

environment and environment policy. Vietnamese scientists have also conducted research in this field.

Climate change and sea level rise are major problems of the environment and relate to a series of other issues such as marine resources, saline and alkaline soil in the coastal regions, mangrove forests, floral and faunal diversity and zoning of economic and populated areas. These are major problems facing researchers of Vietnam and of other countries. Climate and environment changes have greatly influenced the formulation of national development policies because any development policy should ensure ecological balance. That is why this conference will also devote part of its time to Vietnamese policy-makers.

In this spirit, the International Conference on "Climate Change and Sea Level Rise Impacts" is a chance for Vietnamese and international scientists to exchange scientific information and to coordinate the activities of environmental researchers and policy-makers. The conference will surely advance recommendations for coordination of efforts for ensuring the future of our planet.

Dr. Michael Glantz, Director of ESIG at National Center for Atmospheric Research, Boulder, Colorado, USA, made his presentation as a representative of the UNEP:

On behalf of Dr. Mustapha Tolba, Executive Director of UNEP, who deeply regrets being unable to attend this meeting, I would like to thank CERED for joining UNEP in holding this important conference on climate change and sea level rise.

The past 12 months have brought momentous developments in the search for a solution to the problem of a changing atmosphere.

One year ago, the parties to the Montreal Protocol on Substances that Deplete the Ozone Layer agreed on even stronger controls to be finalized shortly. These regulations will provide over time the conditions which allow the ozone layer to repair itself. Chemicals previously considered indispensable are now being replaced by alternative technology and will become historical curiosities within the space of this decade. We no longer need CFCs and they will be gone forever in but a few years.

Last August, the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC) published its assessment on the state of global warming, confirming the contribution of greenhouse gases to global warming and that CFCs destroy ozone. Anthropogenic carbon dioxide, methane and nitrous oxide together with CFCs are warming the planet and expanding the seas bringing about unwelcome, unwanted and in some cases intolerable changes. Can we deal with greenhouse gases as we have dealt with CFCs?

Scientific and technical conferences in Villach, Austria in 1980, 1983 and 1985, in Bellagio, Italy in 1987, in Toronto, Canada in 1988 and in Noordwijk, the Netherlands in 1989 identified problems and specified solutions to global warming that are already technically feasible. We must reduce greenhouse gas concentrations to stable levels.

Seven hundred and forty-seven participants in the technical segments of the 1990 Geneva Second World Climate Conference confirmed the conclusions of the IPCC report and acknowledged the recommendations of Villach, Toronto and Noordwijk. Through conservation of forests and efficient energy use we can make climate change stop. Many hundreds of senior officials and ministers have confirmed this need and the way of action.

There must be an action-oriented convention on greenhouse gases. Under the auspices of the United Nations the

Intergovernmental Negotiating Committee (INC) is now preparing such a treaty for the United Nations Conference on Environment and Development in Brazil in 1992.

Have we the will to carry out our environmental responsibilities? We must ask ourselves to make sacrifices greater and more expensive than those that were made in eliminating CFCs. We have to change our lifestyles. We have to make difficult choices in future development and economic management. Not all of us have the political will to carry out the policies that will limit climate change. Leaders of industrialized countries see such policies as unpopular. Developing countries sometimes complain that essential development might be compromised to solve an environmental problem that is not primarily of their making.

UNEP's World Response Strategy will assist areas to be better prepared for climate change. This concentrates on regional and national impacts of climate change and cost-benefit analyses for adaptation to and limitation of climate change. We want to learn more about the grave issues we face and to share experiences. UNEP wants to learn more about Vietnam and other areas in setting up National Climate Programs. This requires internal cooperation: the formation and maintenance of a national inter-disciplinary network. CERED can assist in decisions on what is best for Vietnam and Southeast Asia.

The World Climate Programme (WCP) is involved in preparing the treaty on greenhouse gases, and supported the conferences that have been mentioned. The second World Climate Conference recommended new policies for WCP which have been confirmed by resolutions of the WMO Congress and by Decision of the UNEP Governing Council. UNEP will take responsibility for the World Climate Impact Assessment and Response Strategy Programme.

In 1992, UNEP plans to integrate national climate experts into

a network and will establish a global climate observation system (GCOS) which will assist UNEP in assessing climate change. UNEP hopes all the participants here will be part of this new programme, and benefit from UNEP's experience in climate change impact assessment in Thailand, Malaysia, Indonesia, Vietnam and elsewhere.

In 1979 the first conference on climate was held in Geneva in response to the decade of drought in Africa. Now it is 1991 and there is still no effective way to predict and respond to drought. Disaster relief is no substitute for preparedness. The climate problems of the present: drought, cyclone, and flood mire the developing world in poverty as surely as conflict and war. We need the world's scientists to deal with the challenges of the present and to guide us to a happy future.

Once again, on behalf of UNEP, I offer my sincere gratitude to Vietnam, to CERED and its Director Dr. Nguyen Huu Ninh, who has been so helpful in making the necessary arrangements for this meeting.

I look forward to a successful conference and to advice on how UNEP can design an effective global programme.

III. PRESENTATIONS: 9-10 NOVEMBER

SUB-COMMITTEE A

CLIMATE CHANGE AND SOCIO-ECONOMIC PROBLEMS

Chairman: Prof. Ha Hoc Trac

1. GLOBAL CLIMATE CHANGE: EVALUATION OF IMPACTS AND RELATED ISSUES IN VIETNAM

Dr. Nguyen Huu Ninh
Center for Environment Research, Education and Development (CERED), Vietnam

Climate - related impacts studies in Vietnam

Regional impact assessments of climate change have adopted a variety of different approaches. For example, in Brazil, the emphasis was on identification of the effects of variability of climate from year to year and from season to season. Impacts from climate variability were taken as analogous to potential effects of future climate change. In contrast, the studies in Indonesia, Malaysia and Thailand took the best estimate of future climatic conditions from the results of the General Circulation Models of the Earth's atmosphere and considered its economic implications. The study in Vietnam has assumed long-term climatic changes and described (rather than modelled) their likely effects.

The purpose of our study was to consider the effects of present day climatic variability on the natural environment and economy of Vietnam and to evaluate the implications of possible long-term changes due to emissions of greenhouse gases.

Meteorological observations over the past 30 years indicate that there has been an increase in annual rainfall in the north and decrease in the south of Vietnam. Temperatures have tended to be higher in the south, with this warming trend being most noticeable in the summer months. Although these observations are consistent with changes that might result from increased concentrations of greenhouse gases, there is no evidence that they are part of a

longer term change in climate.

It is by no means clear how the climate of Vietnam could be affected by global warming. However, most General Circulation Model experiments indicate an increase in the annual temperature of about 0.5-1.5°C for a doubling of atmospheric carbon dioxide. Assuming the IPCC Business-as-Usual scenario which indicates a climate response to a doubling of atmospheric carbon dioxide in 2060, the rate of warming might be in the order of 0.1-0.2°C per decade. Rainfall might increase in the northern half of Vietnam owing to more northward penetration of the summer monsoon. Effective rainfall might decrease in the south due to higher rates of evaporation (estimated to be 5-10% higher). Available moisture is expected to decrease in summer throughout Vietnam, and to decrease in winter in the south but perhaps to increase in winter in the north where increased rainfall may compensate for higher rates of evaporation. The number of droughts may increase, especially in the southern region.

In our study supported by UNEP, we have considered the impacts of climate on agriculture, human health, energy use and production, mangrove forests and fishery.

Future research on impacts of sea level rise in Vietnam

Coastal areas at or below one meter of elevation constitute much of Vietnam's 3000 km coastline. Agricultural lands are concentrated along the coast and are centers of population. Biological resources there are significant for scientific research and ecological balance and are an important base for socio-economic development. Sea level rise threatens these regions and a rise of dozens of centimeters would drastically affect the people and nation of Vietnam.

It is essential to research and evaluate the vulnerability of

the different regions of Vietnam to sea level rise. Data on the impacts of sea level rise on the physical, ecological and socio-economical environment of coastal areas are indispensable.

The effects of sea level rise are many. It will have serious effects on ecology, arable land will be reduced, more areas will be salinated, bio-physical characteristics of coastal regions will be affected, several unique habitats will be lost, and the development of coral reefs will be affected. Mangrove forests (an important ecosystem) and cajeput forests will be reduced. Marshy areas in river estuaries are habitats and resting places for birds, and these will be threatened by sea level rise. Likewise, sandy stretches where sea turtles lay their eggs may be flooded.

People living in flooded areas will have to be relocated and this will in turn lead to increased forest destruction. Biodiversity will be degraded, land erosion will increase, and flooding will worsen as a result of that deforestation.

Sea level rise changes soil characteristics, meteorological conditions important for agriculture, and will affect agricultural production in the coastal plains. These changes will lead to changes in policies, for example, in the zoning of urban areas and industrial centers in the coastal plains, and in the formulation of strategies for the socio-economic development of these areas. Supervision of sea level changes should be strengthened. Forecasting of possible flood-prone regions should be done and plans should be made for prevention or reduction of losses caused by sea level rise. Projects should be devised which anticipate the effects of sea level rise. Concrete solutions to anticipated problems should be arrived at according to the characteristics and demands of each coastal area in order to provide protection for and sound management of vulnerable areas in the new conditions.

2. CLIMATE IMPACT AND ENVIRONMENT

Dr. Michael Glantz
Environmental and Societal Impacts Group,
National Center for Atmospheric Research, USA

There has been considerable concern about climate change over the past decade and there have been many activities on related issues all over the globe. Decision makers want to know what the impacts of global warming will be on their regions, but are faced with scientific uncertainties. We must ask ourselves whether we as a global scientific community have done sufficient research in the fields of physics, sociology, biology, ethics and so on to enable us to answer questions on climate change and its impacts on society, the economy and ecology. We have not. The research task remains before us.

Most speakers at this conference will discuss climate change issues directly, but I want to bring attention to the importance of climate variability from year to year and from decade to decade.

People feel contact with climate through extreme events. It is the exceptional frost or drought that is remembered. Societies have learned to accept such events as acts of God over which they have no control. We are now at a turning point. We no longer have to accept climate passively. Although we can't stop a meteorological flood or drought, information on their occurrences can help us cope with their impacts effectively.

No society to date has developed a system of protecting itself from climate variation. Vietnam has severe floods and droughts as do other countries. All nations must cooperate to decrease the negative impacts of climate change and extreme events. This is not

an easy task: in one area drought is the main problem, elsewhere, floods or typhoons or frost. We must consider the whole set of problems even though only a subset affects us as individual nations. The role of international agencies such as UNEP, WMO, UNESCO, UNDP and so on is to assist in the coordination of this effort.

Societies become attuned to their own climates, and we may feel that we know how to deal with our present conditions, but there may be unprecedented climate change at such a rate that adjustment cannot keep pace. We must reassess the relationship between climate and society because that relationship is changing. We must gain an understanding of the strengths and weaknesses of our responses to extremes of climate in order to correct our weak points and build on our strengths. We must be pro-active, not simply reactive to climate change.

Climate has significant effects on economic development. Research shows how a drought one summer can hold back development for a number of years. We should neither blame all the ills of society on climate nor play down the role of the climate factor. Furthermore, we must examine social factors and determine the ways in which societies make themselves more vulnerable to climate.

More information on the interplay between society and climate would help in the formulation of economic development strategies. This requires multi-national, multi-disciplinary research cooperation as well as national and international support (moral, technical and financial) and understanding. At this conference are people interested in energy, bio-diversity, sea level rise, human settlements, and so on. This conference will have long term value and the conversations begun here should continue long after the conference ends.

Vietnam is a success story in climate impact research

networking. Recent reports to UNEP from Vietnam have been praised for their high quality. The network itself has been praised. It is hoped that this network will expand further through this conference. We must maintain interest in climate related issues by increasing awareness of the problem. Assessment of climate change and social processes can help us to prepare better for climate change should it occur, or for extremes in climate variation.

3. SYSTEM OF OBSERVATION, TESTING AND STUDY OF CLIMATE CHANGE AND THE ENVIRONMENT IN VIETNAM

Dr. Nguyen Duc Ngu
Hydrometeorological Service, Vietnam

This report introduces the activities of the Hydrometeorological Service. This is an administrative service which is responsible for meteorology, hydrology and environmental monitoring and management. There is a system to observe climate change, climate change research is carried out and the National Action Plan of Vietnam for climate and climate change issues is carried out by this service.

The National Action Plan (NAP) has two main roles. The first is to assist in the formation of socio-economic development strategies which take into account climate change. The aim is to balance development demands and environmental protection. Global strategies are also taken into consideration. The second is to control the diffusion of greenhouse gases which cause global warming.

The main activities of the NAP are as follows: to strengthen the observation network and to control climate change; to establish a National Committee for Climate issues; to expand the NAP in which the Climate Change Research Programme is administered; to encourage the use of modern technology to reduce emissions of greenhouse gases; to plan economic development strategies for the coastal regions which may be affected by sea level rise; to raise awareness on the impacts and causes of climate change; to strengthen international cooperation, for example by preparing for the Framework Convention on Climate Change and by responding enthusiastically to the International Decade for Natural Disasters

Reduction.

The National Committee for Climate is responsible for national coordination of work on climate and climate change; construction of national policies to deal with the impacts of climate change and the encouragement of international cooperation in climate and climate change issues.

Data for this work is collected through a large network of hydrometeorological stations. These include 83 synoptic, 86 climatological, 90 hydrological, 163 stage measuring, 21 marine, 50 aquatic environmental and 20 atmospheric environmental stations. There are 30 stations which are under the World Weather Watching System. These stations are distributed over the entire area of Vietnam.

This network system cumulated many data on climate, weather, hydrology and environment. It serves socio-economic activities such as agriculture, forestry, fishery, construction, transportation, industry,health... It is the only data bank which is used to research climate change and environment in Vietnam.

Under the NAP is the Research Climate Change Programme. It is concerned with both research on the accumulation of greenhouse gases and with the development of databases on the atmosphere, hydrosphere and biosphere. This information is used to assess the level of climate change in Vietnam, and to propose methods of restricting greenhouse gas emissions. Other work includes forecasting the impacts of climate change on socio-economic activities and the environment in Vietnam, and research to find methods of adapting to climate change. These studies are the basis of the Vietnamese sustainable development strategy.

4. CLIMATE IMPACTS AND POLICY RESPONSES IN BRAZIL

Dr. Antonio Rocha Magalhaes
Dr. Eduardo de Castro Bezerra Neto
Esquel Foundation, Brazil

This report is part of a worldwide effort supported by UNEP aimed at improving knowledge of the impacts of climate variability and change on society and on the environment. In 1988, UNEP and the government of the State of Ceara cooperated in undertaking a comprehensive project: Socio-economic Impacts of Climate Variations and Policy Responses in Brazil. Fourteen case studies were undertaken by 28 researchers, comprising four Brazilian regions: the semi-arid northeast, the industrialized southeast and south and the agricultural frontier of the midwest. The northern region (the Amazon) was not included because it is the subject of a specific UNEP study in the Latin American Humid Tropics programme. For the selected cases, several different types of socio-economic impacts of climate change were examined. The aim was to improve the understanding of the impact of climate variability on the Brazilian economy and environment, to evaluate possible responses to mitigate adverse effects on socio-economic systems, and to encourage widespread application of climate knowledge and data to human activities.

The UNEP/SEPLAN-CE Project is a bench mark in climate impacts research in Brazil. For the first time, a group of academics and experts working in different regions joined together as an inter-disciplinary team to study how society and the economy react to a variety of adverse climatic events.

Several case studies dealt with the problem of droughts, especially in the northeast region. Droughts are a major problem

here because 60% of the region is semi-arid and because this is an over-populated and under-developed region. Droughts were also studied in relation to other regions.

Dry spells are particularly devastating to the new agricultural frontier in the midwest. They are closely associated with losses in the production of some of Brazil's most important crops.

Floods are a phenomenon that is present in all the regions studied, but they are particularly serious in the south and southeast. Floods have caused serious damage in the two biggest cities of the country, namely Sao Paulo and Rio de Janeiro.

Freezes are usual in the south and southeast where the climate is temperate. In some years, they cause significant economic losses to the agricultural activities of those regions.

Extensive data on the ramifications of these problems on the regions studied has been compiled and reported, making it evident that substantial impacts of climate variability affect Brazilian society, the economy and the environment. Every year, much human suffering has been caused by climatic hazards and billions of dollars have been lost. Therefore, climatic variability is a very important issue in Brazil and deserves to be the object of much concern and the basis for policy making.

Knowledge of how climate affects distinct regions, activities and social groups and of how society and government react to the impacts of adverse climatic events proves to be of great value in policy making with regard to reducing the negative effects of present climate variation. It is also useful in the design of responses to climate change, so that future generations will be able to cope with their climate.

The study results stress the fact that unplanned and environmentally unsound anthropic action is a cause of increased societal vulnerability to climate variation. Deforestation in the northeast made that semi-arid region more prone to floods. Deforestation in the Upper Paraguay River basin may be altering the pattern of floods and droughts in the Pantenal (Great Swamp) region, contributing to ecological imbalance.

On the other hand, some action has been taken to increase the resilience of regions to climate variability. The modernization of the salt industry in the state of Rio Grande do Norte has made that industry more resilient to heavy rains. Agricultural research has led to the development of several new crop varieties which are more resistant to variations in climate. Relief action in northeast Brazil has reduced the impact of droughts on the poor rural population.

One very important lesson that these studies have taught us is that the same climatic event may have different impacts depending on the local socio-economic and environmental characteristics. Rainfall that brings terrible floods to Rio de Janeiro is a beneficial event in the Pantanal area. The same drought may cause huge losses in the northeast agricultural domain, but benefit the salt industry in the same region. Furthermore, whereas the majority of the poor population will suffer from droughts, a small group of landowners and businessmen may profit by them. Climate variations therefore have different effects on different regions, ecosystems, crops, economies, and economic classes.

In northeast Brazil the design of the drought response programs was more heavily influenced by those groups that benefitted from the droughts than by those who suffered from them. Nevertheless, the experience of participatory planning in Ceara proved to be successful. In that state, the needs of the most severely affected social groups were met with greater efficiency.

So the impacts of climatic variation are not always negative, though they are predominantly so. In most cases there will be winners and losers. This can be said of present climatic variability and may be even more true of future climatic change.

Societal and governmental responses are dependent on the level of organization of society and government, on the types of climatic phenomena, and on the intensity of their impacts. There is a clear need for a long-term, stable policy to guide responses to climatic variability encompassing both short term relief actions during extreme climatic events and long-term actions aimed at increasing societal resiliency to climate variability and change.

The concept of sustainable development - economic, social and environmental - is advocated as a goal to be pursued by societies and governments in order to increase the capacity of those societies to cope with adverse climatic phenomena. It can do this by making the society economically more resistant, and by increasing the capacity of the natural environment to face the climatic event. For example, eradicating poverty and increasing living standards will reduce social vulnerability to an extreme event.

Sustainable development will also be the appropriate answer to climate change. In this case, responses must be aimed at limiting the causes of climate change and at adapting to changes that may already be inevitable. For each of these, sustainable development may constitute the framework for policy responses.

Such policies will include plans to reduce emissions of greenhouse gases and to improve the capacity of the environment to withstand climatic variability. Since economic development is associated with increases in the production of greenhouse gases, for some time developing countries must have the right to a higher level of emissions. There is however an urgent need to balance

economic development requirements with the global need to reduce atmospheric concentrations of greenhouse gases. International cooperations is compulsory in order to provide developing countries with the technology and resources to enable them access to the most appropriate tools for their development processes.

SUB-COMMITTEE B

CLIMATE FLUCTUATIONS, CHANGES AND INFLUENCES

Chairman: Dr. Nguyen Duc Ngu, Dr. Ata Qureshi, Dr. Garry Sharp

1. EL NINO/SOUTHERN OSCILLATION TELECONNECTIONS OVER SOUTHEAST ASIA

Dr. George Kiladis
Cooperative Institute for Research in Environmental Sciences,
Colorado University, USA
Dr. Henry F. Diaz
National Oceanic and Atmospheric Administration,
Environmental Research Laboratory, Boulder, Colorado, USA

Composite temperature and precipitation anomalies during various stages of El Nino/Southern Oscillation (ENSO) event have been compared for several hundred stations around the globe. Twenty-five El Nino events were examined as well as 23 La Nina or cold events. The three years around such an event were focussed on with year o being the year of the event, year -1 being the year before, and year +1 the year after. These events were determined by sea temperature in the equatorial Pacific ocean and sea level pressure.

Large regions of coherent significant signals are shown to exist for both extremes of the SO, with warm event signals generally opposite to those during cold events. In addition, during a -1 year, climatic anomalies tend to be opposite to those in year 0. This confirms the biennial tendency of the ENSO over the Pacific/Indian ocean sectors is also present in more remote regions with climatic signals related to ENSO. Many of the signals are consistent enough from event to event to be useful for extended range forecasting purposes.

For example, in June, July and August of an El Nino year 0, India and Southeast Asia are dry and the West Pacific is wet. In September, October and November, Australia, the west Pacific and

the south of Southeast Asia are dry. In December, January and February, it is dry in north Australia and the west Pacific and this dryness extends into year+1 when it is also dry in the south of Africa.

In the El Nino year-1, From June to November it is wet in the south of Southeast Asia and east Australia as well as in the south of Africa. It is dry in South America but wet on the western South American coast and in the east Pacific.

In El Nino-1 there is a tendency for decreased temperature in the tropics of south Asia. In year 0 these below normal temperatures become weaker and as year 0 develops, increased temperatures are observed in all the eastern hemisphere tropics. Much the same occurs in the western hemisphere. There is a slow return to normal temperatures in the year +1. La Nina shows a similar pattern with opposite warming and cooling effects.

The effects of 12 ENSO events have been studied for Ho Chi Minh City. In the year after an El Nino event, the mean temperature was 26.8°C and the mean precipitation was 17 mm per month. Data for the March, April, May period shows an average temperature of 29°C and 0.7 mm precipitation, so it was dry and warm with enhanced transpiration and irradiation. For the year after a La Nina event, the average temperature was 25.8°C and the average monthly precipitation was 24 mm. The March, April, May data for this +1 year shows an average temperature of 28.3°C and 102 mm of precipitation, so it was wetter and cooler.

It can be seen from the above example that the influence of ENSO is very significant for agriculture in Southeast Asia. The effect of ENSO on Vietnam is stronger than on perhaps 80% of the tropics with the most strongly affected countries being Australia and Peru. It is predicted that one effect of global warming may be a magnification of the anomalies associated with ENSO.

Although the predictive skill for ENSO events is quite high, there are exceptions and every event is different. Nevertheless, the precipitation signals in Southeast Asia and the North American tropics are remarkable and can be used to a great extent for forecasting. Other signals are weaker and less reliable.

As far as Vietnam is concerned, there are only three reporting stations here. The fluctuations measured in Hanoi are less pronounced than those in Ho Chi Minh City. Vietnam is cooler before development of an ENSO event. Because of the variation between the north and the south, Vietnamese climate is a good opportunity for research.

2. INFLUENCES OF CLIMATE FLUCTUATIONS AND CHANGES ON AGRICULTURE IN VIETNAM

Dr. Hoang Minh Hien
Hydrometeorological Service, Vietnam

Introduction

On the basis of tropical agro-climate, Vietnam's climate may be divided into seven major climate sectors belonging to two specific regions: northwest uplands; Vietbac and Northeast uplands; lowlands; midlands of Bac Bo and Thanhhoa; Nghetinh - Binhtrithien; Central coastal areas and the southern part of the central region; Nam Bo and Tay Nguyen uplands. Existing positive agro-climatic characteristics including available solar radiation, high temperature, large rainfall and availability of nitrogen stand together with more negative conditions which as typhoons, floods, droughts, hot-dry and moist hot weather which favor pest development.

Impacts of climate variability

Analysis of crop yields shows that productivity of food crops and cereal crops of Vietnam greatly vary. Crop productivity variations are more distinct in the north than in the south. Cereal crop productivity varies more distinctly than rice productivity.

Many factors are influence crop yields, among which climate and weather play the most important roles. Besides such environmental forces, there are natural and technical factors and patterns of product management and consumption, which are more stable and consistent. In general, crop yields are growing, and there is an increasing trend in productivity.

Data from 20 provinces has been analyzed and the following remarks can be made:

- The productivity of almost all crops is increasing, however, this increase is not constant and there are occasional periods of productivity decline.

- The coefficient of variation of productivity (Cv) varies largely between 0.05-0.30 depending on the plant species and region. The coefficient of variation of cereal crops productivity is higher than that of rice.

- The coefficient of variation of rice (major crop) productivity is diverse. In the Bac Bo plain, Cv reaches its highest value of from 0.15 to 0.20 with winter-spring crops. The next highest value is for the coastal areas of the central region. In the Nam Bo plain, it reaches a value of only 0.06-0.09. This illustrates the fact that the Red river delta is not only and intensely farmed region, but is greatly affected by climate variability.

In meteorological agricultural studies, indexes of departure of yields are often used to evaluate crop yields. On the basis of productivity data, we have assessed yearly crops in different provinces. The results are summaries as follows:

- On the average, low crop yields occur every two years.

- Extremely high or low crop yields with frequencies of occurrence from 3% to 7% are closely related to climatic anomalies with return periods of from 13 to 30 years. It is noticeable that years of very low crop yields are more frequent than years of very high yield. This is logical since high yields take require and extended period of favorable conditions, whereas a short-term natural disaster can destroy crops.

- Losses in rice yields and cereal yields are caused by weather vary in their severity. At the maximum severity, yields may fall by hundreds of thousands of tons in each province, and total losses in each sector may sum up to millions of tons.

- Crop losses are often caused by an accumulation of factors. However, the most serious losses are caused by typhoons (20-50%) which affect only limited regions. Droughts, long periods of sunshine in winter, and water-logging caused by inter-tropical convergence zones produce less serious damage (10-30%) but affect much larger areas. Cold spells, dry spells and dry hot winds affect narrower areas and cause less severe damage (5-20%).

- Rain anomalies produce more serious damage than temperature anomalies in key agricultural areas.

Climate variability and the sensitivity of different regions

Climate variability has major impacts on agriculture through temperature and rainfall. Therefore, impact assessments should be based on changes in these two factors. Analyses show that rainfall is most variable in the plain of northern Vietnam and along the coastal areas of central Vietnam. Meteorological disasters typified by typhoons, cold weather and hot dry winds also have their strongest effects on the plain of northern Vietnam and along the northern coastal areas of central Vietnam.
Analyses of a series of yields, coefficients of variation of regional productivity and cropping variability of several representative provinces reveal that variability of climate is linked with productivity in agricultural sectors of eastern Bac Bo and the northern part of central Vietnam.

Forecasting of some agro-climatic characteristics of Vietnam

Analyses of climatic trends in Vietnam over the past decades

allow some forecasts to be made. The number of typhoons hitting or affecting Vietnam will increase, and the typhoon season may be prolonged. Areas affected by typhoons will remain the same, but they will cause more damage to coastal areas along the northern part of the central region. Floods caused by typhoons will have greater effects in this area. Due to an increase in temperature, evaporation will increase by 5-10%, especially during the summers both in the north and south of Vietnam. In the winter, temperature is not expected to significantly increase, but a strong increase is predicted for the south. Increasing evaporation together with temperature rise will create drought conditions, especially in the south.

Potential impacts of climate change on agriculture in Vietnam

In Vietnam, climate changes could seriously affect agricultural production, In particular, the effects of sea level rise, the effects of change in intensity and increased frequency of extreme events (typhoons, droughts, floods, and cold spells in the north), temperature rise and changes in rainfall. There is also a potential for desertification in the southern region. Agricultural pests may increase, there will be increased erosion and changes in soil fertility, and increased carbon dioxide will also have an effect.

Studies have shown that the northern regions, especially the Red river delta are the most vulnerable to climate change. However, this region experiences a relatively diverse process, the rate of change is low and reverses rarely occur.

In the south and along the coast in the southern part of the central region, climate changes are occurring at a higher rate. In particular, rainfall and temperature are changing rapidly. The Mekong delta and coastal areas in the north of the central region are very vulnerable to climate changes which are expected to occur

as a result of global warming.

The first signs of change which we have discussed here are not sufficient to allow comparisons between the effects of climate change on different crops. It should be noted that the major crop, rice, is planted almost the year round and has various stages of development and could therefore be greatly affected by climate change.

Conclusion

Climate change resulting from global warming does and will continue to affect man's everyday activities including agricultural production. Records should be made and further research should be done in order to formulate the optimal response strategy to reduce the rate of change and to adapt to the new conditions. Due to the scarcity of data available, only preliminary studies have been made here. If further examination of this problem is to take place, considerable support will be required from the Vietnamese government as well as from concerned international organizations.

3. RELATIONSHIPS BETWEEN SEA ENVIRONMENT AND MARINE RESOURCES IN VIETNAM's TERRITORIAL WATERS

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El Nino, an oceanographic phenomenon, is an important element of the circulation system that causes global climate fluctuation, the El Nino/Southern Oscillation (ENSO). The ENSO phenomenon has an extreme effect on socio-economic conditions in marine fisheries in many regions of the world. When El Nino occurs, surface temperature and rainfall in South America increase suddenly, causing decreases in bird life, fish and other marine products. Meanwhile, Australia and some countries in Africa suffer extreme drought. ENSO also causes increased intensity and occurrence of typhoons in the western Atlantic, eastern and southeastern Pacific oceans. Many scientists throughout the world are now studying ENSO in order to understand its great effects.

This is a preliminary study of the effects of ENSO on Vietnam. We have used information from the following sources:

-The Viet-Xo general investigation in Tonkin Gulf (1960-1961) and Viet-Trung (1961-1962).

-Coastal survey of fish in the western Tonkin Gulf (1962-1965 and 1974-1976).

-General investigation off Thuanhai (Institute of Marine Products Research, 1978-1980).

-The information on the environment and marine organism resources in the EEZ surveyed by Vietnamese and Soviet scientists

in 1979-1988.

-Statistical data on oceanography and meteorology in the past 30 years, from the Hydrometeorological Service, Hanoi.

- In the year before and in the year of an El Nino occurrence the mean temperature of the surface was warmer than normal, but in the year after, it is cooler. During the summer of an El Nino year, the surface temperature is remarkably warmer but in the winter it is cooler.

- Salinity is higher in the year of El Nino and in the year after.

- The upwelling and downwelling areas off the south and the central parts of Vietnam are usually stable, but in El Nino years their locations change. The upwelling in the south off Con Son disappears and the one off Nhatrang narrows and moves southward. The downwelling off Nhatrang moves towards the open sea. Due to the fluctuations of upwelling and downwelling, the current direction is also altered in El Nino years.

- Temperature and rainfall affect fish spawning. In El Nino years the climate is favorable for this process.

- The spawning of Gilt sardine in the Gulf of Tonkin takes place from March to June. Temperature is crucial. Spawning starts when the surface temperature reaches 19°C. Therefore, El Nino affects the starting time of this event.

- Rich fishing grounds are often located around upwelling and downwelling centers. The changes in these areas in El Nino years affect fisheries.

4. REGIONAL CLIMATE SCENARIOS FOR USE IN IMPACT STUDIES

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The challenge facing southern nations in responding to climate change is compounded by the fact that information concerning both the potential impact of global warming and the means by which that impact might be reduced is often uncertain and, in many cases, simply not available.

This report is a contribution to a two-year project intended to assist southern nations in obtaining the information that is needed to respond to climate change.

The project is being undertaken by the International Institute for Environment and Development (London, UK) and the Climate Research Institute at the University of East Anglia (Norwich, UK) with funding from the Swedish International Development Authority.

The aims of the projects are:

-to promote awareness of the issue of global warming in the southern nations and to enhance flow of information on this issue between north and south (in both directions)

-to identify situations in which policies that might be adopted to deal with the impact of global warming are consistent with current development priorities and

-to advance recommendations for aid funding.

Three regional case studies are being undertaken: in Central

America, Southern Africa and Southeast Asia. These case studies are being carried out in collaboration with local centers of excellence and with the Department of Environmental Studies at the University of Virginia in the United States.

In each case study, the policy implications of global warming are being considered for a specific issue which is of current concern such as forestry or food production. This ensures that the implications of climate change will be considered firmly in the context of present-day needs and spirations.

This work covers the development of regional climate scenarios for the region of Vietnam. The parameters considered are surface air temperature and precipitation. Estimates of global-mean sea level rise are also presented. These scenarios are being made available to support regional impact studies and the assessment of policy responses.

The scenarios are based, in part, on parallel research projects in the Climatic Research Unit at the University of East Anglia and on research at a number of other institutions. The assistance of Mike Hulme and the numerous groups that provided climate model results is gratefully acknowledged.

In deriving regional climate scenarios, two major sources of uncertainty have been taken into account; first, in the response of the climate system to increased greenhouse forcing (the climate sensitivity) and second, in the projection of the regional response to the change in global climate (as measured by differences between the various climate model simulations that have been used).

It is clear from our results that Vietnam faces a range of possibilities as far as the climatic future is concerned. General conclusions concerning the likely scale of the consequences of global warming for the region can, however, be drawn on the basis

of these projections.

- The climate models are in fair agreement concerning the relationship between the regional change in temperature and that affecting the global average. The degree of inter-model disagreement, as measured by the temperature scaling factors for the upper, central and lower cases, amounts to 20% either side of the most likely central case.

- According to the moderate climate sensitivity projection, annual temperatures in the area of Hanoi may rise by 1.6°C by the year 2050 and 3.1°C by the year 2100. In the high climate sensitivity projection, the rise in temperature may be 2.3°C by the year 2050 and 4.6°C by the year 2100. The low climate sensitivity projection suggests a rise in temperature of 1.1°C by the year 2050 and 2.1°C by the year 2100. As noted above, the uncertainty in these projections due to inter-model differences is about 20% either way.

- In comparison there is considerable disagreement between the climate models as far as the regional precipitation change is concerned. Although the forecasts tend towards an increase in precipitation amounts on balance, the range of possibilities spans a decline of approaching 20% below the present day average through to an increase of over 40%. This is a reflection of the present state of accuracy of regional precipitation modelling.

- According to the moderate climate sensitivity projection, annual precipitation in the area of Hanoi may increase by 4% by the year 2050 and by 8% by the year 2100 taking the central value derived from the model estimates. The range of inter-model variation, however, spans a decline of 12% to a 28% increase. In the high climate sensitivity projection, the precipitation increase may be 6% by the year 2050 and 12% by the year 2100. The low climate sensitivity projection suggests a precipitation increase of

3% by the year 2050 and just over 5% by the year 2100. Again the inter-model range around these central estimates is considerable in these latter two projections and the possibility of a decline in precipitation levels cannot be rejected.

- Analysis of future conditions in the area of Ho Chi Minh City indicates that the change of climate in this region may be less severe, suggesting a gradient in vulnerability across the latitudinal extent of Vietnam.

- By 2100, global mean sea level may stand between 33 and 114 mm above the present-day level, with a rise of 69 mm the most likely estimate. In considering the regional implications of this change in global-mean sea level, it is necessary to take into account local tectonic and anthropogenic factors.

Finally the reader is reminded that these scenarios are presented not as firm predictions of potential change in regional climate resulting from global warming, but simply as a broad indication of the possible magnitude and rate of change of future variation.

Impact analysts can use these projections to derive physically plausible estimates of changes in relevant climate variables for use in sensitivity studies. As understanding of the climate system's response to greenhouse forcing improves, it is hoped that these scenarios will be further refined and the considerable range of uncertainty narrowed.

5. CLIMATIC VARIATIONS AND THEIR EFFECTS ON WATER RESOURCES IN VIETNAM

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Long-term annual runoff for the Da and Red river basins in the North Vietnam doesn't show any marked periodicity or trend. An annual water-balance equation, making use of predicted component values provides us with an useful method [4] for assessing the sensitivity of water resources to climate change up to the year 2030 in different regions of Vietnam: the small increase in the North and the large decrease in the South in annual mean runoff. The long-term standard deviation of runoff for the Red river basin shows a decrease in intra-annual runoff variability. Thus will lead to a considerable reduction in both the frequency and severity of droughts and an increase in the intensity of the floods in the Red river. The analysis of peak flow time series and low flow time series of the Red river as well as long-term variation of the thornwaite moisture index and the drought index PDI1 (used by Ped) in different regions has demonstrated these tendencies for the North while in the South, drought severity will increase.

Our studies can be summarized and combined with information on water resources planning to assume scenarios of future changes in different regions by the year 2030.

North Vietnam

Most water resources in the North come from the Red river and Thaibinh river systems (F = 168,700 km^2) with an annual flow of 137,000 million cubic metres from which 90,600 million cubic metres are generated in the territory of Vietnam [1].

With the two existing Hoabinh and Thacba reservoirs, the 250-years flood (1971) can be reduced and kept under the critical level of 13,30 metres above mean sea level at Hanoi, a level which still threatens the dike systems in the delta. The low flow can be increased by 700-1,200 cubic metres per second, i.e the increment of flow exceeds the flow in the natural situation, the normal flow in the dry season being Q = 918 cubic metres per second and the minimal flow in 1963 was 676 cubic metres per second.

The construction of more cascades in the Da and Lo rivers will certainly provide more flood control and more water for hydroelectricity and irrigation.

In this context, the predicted increase in annual mean runoff (3 to 10%) and flood seasonality and the decrease in vulnerability to drought due to climate change would suggest some problems:

1. The reservoir operation rules need to be reviewed and made more flexible to control flooding in high areas of the flood plain, at the same time to avoid the risk of filling the reservoirs too soon in the summer and the risk of not filling the reservoir in the autumn.

2. The sea level rise associated with climate change [2] would compensate for the increase in low flow along estuaries and would exceed the sedimentation rate in the coast (because sediments are trapped in the reservoirs). At the present sedimentation rate, the expansion of shorelines is 50-100 metres per year. However, in the future they would retreat through inundation of the land presently at the margins of the tide and wave action and also through accelerated erosion of the dunes in response to higher wave action associated with higher water levels.

Central Vietnam

In the northern region of central Vietnam, the increase in annual runoff would be roughly 6-15% and would result from an intensification of typhoon activities and the severity of floods. In the middle and southern parts of the central region, annual runoff would decrease by 9-19%, particularly in the Thuanhai province by 16-33%. The vulnerability to drought would increase and desertification would be the most serious problem.

South Vietnam

Most of the land in the south is drained by the Mekong river and the Dongnai river. The lower Mekong basin covers an area of 620,000 square kilometers and yields an annual flow of 475,000 million cubic metres. The territorial part of Vietnam, the Cuulong delta covers an area of 64,300 square kilometers of which 2.4 million hectares are cultivated. This region is inhabited by some 17 million people, representing 37% of the total population of the basin [3]. Its annual flow is only 50,000 million cubic metres.

The Cuulong delta suffers from drought almost every year from January until May and is damaged by floods every 7 to 12 years as floods in 1966, 1978, 1984 and 1991.

The predicted marked decrease in annual runoff (11-31%) would enhance the vulnerability of this region to drought unless large reservoirs are built upstream.

The cascade established in 1970 including 7 projects would yield an increase of roughly 6,000 cubic metres per second over the period of January to May at a reliability level of 90%. In the cascade project of 1987 where high Pamong 250 m was replaced by the combination of low Pamong 210 m and Upper Chian Khan 250 m, the corresponding figure is 4,400 cubic metres per second. The most successful project during this decade is the low Pamong which increases the low flow by 257 cubic metres per second representing

only 13% of the natural flow at Kratie (Q = 2,025 cubic metres per second) [3].

Beside the drought problem caused by future climatic change, the delta also suffers from acid sulphate soils and saline intrusion which would be aggravated by the predicted sea level rise. The construction of reservoirs upstream can repel the advance of salt water up the estuaries but the reduction of sediment would accelerate the flooding of coastal areas and the reduction of the mangrove forests.

Conclusion

Preliminary studies on the variability of water resources in Vietnam prove that the effects of climatic variations and by implication of climate change are complicated and diversified. Albeit still in the speculative stages, they reveal different trends of mean conditions and of extreme events in different regions of our country. These trends agree with general agreements on tropical zones which have been arrived at by climatologists throughout the world in recent years.

From extreme events in the past, we have gained experience to deal with short-term variability: change of existing reservoir operating rules, flood and drought preparedness. But for long-term variation and change in water resources, more studies need to be made in order to have reliable assessments from which water resource managers and planners will construct policies for the future.

Changes in demand of water resources induced by climate change also need to be studied. For regions where rainfall decreases and temperature increases, this concerns increasing demand for irrigation and for industrial cooling, etc. All these factors play an important role in long-term planning.

6. A REVIEW OF CLIMATE CHANGE IN VIETNAM OVER THE PAST 100 YEARS

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Introduction

Vietnam is a peninsula in the tropical northern hemisphere with a coastline of about 3.000 km. Most socio-economic activities concentrate on the Red River and Mekong River deltas and other narrow plains.

Long ago important climate abnormalities were recorded in historical documents. Recently most of climate variations has been expressed in meteorological station network data.

Studies of climate change in Vietnam analyze the following fluctuations:

a. Number of typhoons
b. Frequency of cold fronts
c. Air temperature
d. Precipitation
e. Sea level

Analyses of these fluctuations involve investigation of the following:

a. Grade of fluctuation
b. Timing of seasons
c. Comparison of decade mean

Climate series from the following main stations were used to

express the long-term fluctuation of above mentioned elements:

a. Hanoi (North Vietnam)
b. Danang (Central Vietnam)
c. Tansonnhat (South Vietnam)

Characterization of current climate

1. Typhoons affecting Vietnam

The annual average number of typhoons is 4.7 but in many years there are more than 10 and in some years, none. The number seems to have increased over the last 2 or 3 decades and there has been a distinct increase of typhoons coming the northern part of central Vietnam.

2. Frequencies of cold fronts affecting Vietnam.

Cold front influence is limited mostly to the northern part of the country with the annual number of cold fronts affecting the north being 30. The maximum and minimum are, respectively, 39 and 24, making the frequency rather stable.

3. Air temperature

Standard monthly temperature deviations are small in summer and relatively great in winter, especially in the north but the greatest value of this parameter is less than 2°C. Temperature variations among decades are not very distinct but during the last two to three decades summer monthly temperatures have been somewhat higher than previously.

4. Precipitation

Variation coefficients for rainfall are greater than those for

temperature, generally being 15 to 20 percent. Rainy and dry seasons may begin or end two or three months earlier or later than usual.

Differences in rainfall among various decades are significant, but rainfall of the most recent several decades is not indicative of a trend. Major floods appeared in the Red River Delta in 1913, 1915, 1917, 1926, 1945 and 1971 while the Mekong River Delta flooding was distributed evenly in 1911, 1937, 1943, 1961, 1966, 1978 and 1984.

From many years drought has always been a common phenomenon in High-land of Central Vietnam and South Vietnam during the dry season. In North Vietnam frequency of drought has not significant fluctuations in the last decades. However in the coastal regions of Central Vietnam droughts accompanied by hot-dry western winds seems to increase in the last two or three decades.

7. CLIMATE CHANGE AND IMPACTS IN SOUTHEAST ASIA

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Climate is a resource and forms part of what can be defined as a benefit or exploitation zone which represent the ability of people to exploit or benefit from the environment. Such zones can be defined in many ways and by many terms (eg. plants, animals, people). The beneficial exploitation zone for humans (HBEZ) depends on a number of input variables such as climate, environment, social structure, economic factors and technology. A wide zone indicates that a community has great resilience to adverse climate, and would result from access to natural, financial and technological resources. Perturbations in the input variable, such as decreases in productivity, security, markets for products, will narrow the HBEZ.

We are concerned here with the effects of climate change on the HBEZ in the Southeast Asian and Southern Pacific regions. An impact will occur when the climate moves out of the HBEZ and alters the zone of benefit or exploitation. Both positive and negative impacts will occur. Positive impacts will result in a widening of the HBEZ thereby increasing the resilience of a community to the impacts of any future change. In contrast, negative impacts will reduce the HBEZ and may increase the community's vulnerability to future impacts.

Within the long-term mean climate, there is a level of inter-annual variability around the mean. Climate in the Asia Pacific region exhibits a high degree of variability as a result of the El Nino/southern Oscillation. Little is known about how climate variability may change in the future. Nevertheless, it is

recognized that some of the most significant impacts may occur as a result of changes in variability and the frequency of occurrence of extreme events such as tropical cyclones. Such changes will have important implications for the socio-economic welfare and the HBEZ in the Asia Pacific region.

In addition to the direct effects of a changed climate, there are a number of indirect effects, such as sea level rise, which may also influence the HBEZ. For many areas in the Asia Pacific region, the most severe impacts of climate change may occur as a result of sea level rise. An increase in sea level and in salination would result in irreversible degradation of natural resources. Inundation of coastal areas will affect fisheries and agriculture and the populations in those areas. Sea level rise would increase erosion, especially of coral reefs, beaches and brackens. Flooding would affect agriculture, sewerage and irrigation systems and infrastructure such as roads and bridges. Salination of ground water and land would occur.

Many of the most important impacts resulting from climate change will lead to loss of natural resources such as productive land, forced shifts in land use, loss of living resources, and loss of social and cultural resources and consequently a reduction of HBEZ. As a result of reduced HBEZ, people may be forced to migrate. Migration and resettlement may be the most threatening short-term effects of climate change on human settlements (Hashimoto et al, 1990). The vulnerability of human settlements to climatic events is particularly great in 'developing' countries where high population densities and growing urban congestion are likely to increase the sensitivity of the HBEZ to disasters such as flooding or tropical cyclones. "Environmental refugees" or people displaced as a result of land degradation or the effects of drought or flooding are already a large factor for many developing countries (Hashimoto et al, 1990). Communities on Pacific atolls are particularly vulnerable to inundation because they are generally below 3 metres

in elevation and narrow, implying few possibilities for landward migration (Roy and Connell, 1989). In such cases, out migration may be the only solution. Considerable social, economic and political disruption is likely to follow any forced migration of large populations from areas which are seriously hit.

The IPCC scientific assessment of climate change stresses throughout the scientific and other certainties underlying its conclusions. Unknowns include future human behavior, particularly with regard to future rate of use of fossil fuels, future forest management programs, and future agricultural practices. In addition, there is considerable uncertainty about the level of impact of technological advances and, still more important, of technological transfer from 'developed' to 'developing' nations. The final and single largest factor of importance is that of human population growth and the relative distribution of that growth amongst nation states. All these factors determine the HBEZ. and at the same time will influence the rate and magnitude of any climate change. The effects of climate change are not the only causes of impacts on the HBEZ and any full assessment must include all the underlying factors.

Nations are influenced by a number of different changing "climates". The underlying causes of disturbance to the physical and chemical climate system are most clearly defined and probably the best understood of these. Nevertheless, a great deal more information is required before any accurate predictions of the rate and magnitude of climate change can be made. The economic climate is now just as much a global phenomenon as the level of greenhouse gases. Indirect impacts of climate change which profoundly affect commodity prices, resource exploitation and world trade will impact on all nation states. In addition, non-climatically related economic forces, including global world recessions, will be of crucial importance.

The social and technological "climate" will have a global impact because population and rapid industrialization will have a great impact on global greenhouse gas emissions. The international political "climate" including the potentially serious problem of environmental refugees and the increasingly urgent need for international aid will be compounded by rapid population growth and a deteriorating global environment. Finally, the "climate" of response strategies is rapidly becoming at least as important a factor as physical climatic changes. Increasing pressures on primary industries and on other such sectors of society induced by policies designed to mitigate and/or adapt to perceived future climatic changes will be a vital factor in future development.

8. CLIMATE INFLUENCE ON HUMAN HEALTH IN VIETNAM

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Impacts of climate on human health in Vietnam

1. Physiology

Living in areas of low latitude with the solar regime of an intertropical area, Vietnamese are accustomed to the hot climate of the tropical region. Together with differences in heat sensitivity, the hot and humid climate affects other parameters of Vietnamese physiology, such as the ratio between skin coverage and weight, the concentration of salt in sweat, the maximum speed of oxygen consumption with respect to body weight, heat produced in the consumption of energy, etc. The hot and humid climate limits the diffusion of heat from the body to the environment. This has affected the physical development of the Vietnamese people.

2. Disease

The relationship between climate and disease is complicated. Sunstroke is very common in the hot seasons, especially among people working outside in low-lying areas, or in poorly ventilated areas such as mines. Asthenia also results from prolonged exposure to extreme heat. If excess fluid is lost through sweating, the mineral balance may be disrupted leading to exhaustion.

In the northern winter, the cold climate contributes to such disorders as tuberculosis, whooping cough and bronchitis. Sudden

changes in weather such as before a cold front, typhoon or thunderstorm can affect blood pressure and can cause cardiac infection, and can stimulate diseases of the respiratory and nervous systems.

Hot humid weather encourages the development of bacteria and disease carrying insects and rodents. Diarrhoea and dysentery occur predominantly in such conditions. Mosquitoes and other insects are associated with the spread of malaria, dengue fever, Japanese B encephalitis, etc.

3. Housing

The design and zoning of accommodation is important in lessening the impact of climate on human health. Natural ventilation should be encouraged in hot humid areas. Fans are also important. Cold in northern mountain regions must also be considered in designing homes. In particular, they should be wind-proof.

4. Clothing

In the summer, clothing should facilitate heat discharge. They should absorb moisture, be loose fitting and be of bright colors. In the winter in mountain areas, dark close fitting thick clothing is required.

5. Rest and Tourism

Tourism depends to a large extent on climate. The diversity of climate in Vietnam contributes greatly to opportunities for rest and tourism here. Vietnamese beaches with their beautiful scenery and fresh air are good for the health as well as in the treatment of many diseases. In the mountains, the high level of solar radiation, low atmospheric pressure and fresh air are beneficial,

particularly in summer and in the south of Vietnam. The tourist potential seems greatest in the Mekong delta and in the coastal regions.

Climate change and possible impacts on human health in Vietnam

Much research has been done on climate change in Vietnam over the past decades. However, these data do not allow forecasting of climate and bio-climatic changes in the future because factors that have led to change in the past century are not the same factors as will cause change in the coming decades. In order to make accurate forecasts we need to know both the present conditions and the future state of key factors such as energy use. However, it is expected that there will be an increase in temperature in Vietnam. Rainfall is expected to increase in the north and decrease in the south. Summer will be warmer and the hot season will be prolonged, but it will continue to be cold in the north in the winter. The negative effects of hot humid conditions will be intensified as regards their effects on human health.

Conclusion

The impacts of climate on health is a matter of great importance and is a new issue of concern in many countries. In Vietnam it has not yet received much attention. .We hope that more research will be carried out on this topic in order to formulate an effective strategy for health care in the different regions of Vietnam.

9. PRELIMINARY STUDIES ON INTER-RELATIONS BETWEEN ENVIRONMENT AND ENERGY IN VIETNAM

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A study of the relationship between the environment and energy has been in progress since 1990 at the Center for Natural Resources and Energy at the Hanoi University. This study is still in its initial stages. The first stage was to formulate the research on environment and the development of energy with the World Development Bank. Secondly, the environment near hydroelectric stations was examined. Thirdly, the effects of temperature change on energy consumption in Hanoi and in Ho Chi Minh was undertaken. All of these studies have been translated into English and are available.

To summarize, waste gases especially carbon dioxide from thermal electricity generating plants are creating a greenhouse effect and are damaging the ozone layer. It is estimated that approximately 50% of greenhouse effect producing gases come form thermal electricity generating plants. These plants also produce millions of tons of dust. This is a very significant problem for developing countries such as Vietnam. The production of energy in Vietnam is likely to double in a very short time.

The total area of Vietnam is 330.347 square kilometers. Its population is more than 64 million (1990). Population growth stands at 2% annually. Per capita income is approximately 264 US dollars (1990). Its energy potential is relatively diversified. However, energy production and consumption are still low.

Coal

Vietnam coal deposits are estimated at 2.258 million tons, mainly anthracite of high quality with 70% carbon content and a sulphur content of 10-15%. In the past ten years, coal yields have fluctuated around 5 million tons per year but coal production over the past two years has decreased remarkably. Coal is used mainly in electricity production, then in industry, transport and communication and for civilian purposes. There is some export of coal.

Oil and gas

Oil and gas exploration and exploitation have been conducted in recent years. In 1989, 1.5 million tons was tapped and in 1990, the yield was 2.5 millions tons. Crude oil is exported as Vietnam does not yet have an oil refinery. Petroleum and oil for home consumption has been imported with a total import volume of 1.5 to 2 million tons. Petroleum is used mainly in transport and communication, electricity production and civilian use.

Electricity

By 1990, Vietnam electric power plants boasted a total capacity of 2.553 MegaWatts of which 45% was from hydro-electric sources; 35% were thermo-electric (690 MegaWatts coal-generated; 200 MegaWatts oil-generated) and 20% was from diesel gas turbine sources.

Among the power plants, the Hoabinh hydro-electric power plant is the biggest one with a capacity of 1920 MegaWatts. By 1991, all four of the 240 MegaWatt turbines should be in operation. This constitutes one half of its designed capacity. The Phalai thermo-power plant supplies 440 MegaWatts, the Trian hydro-power plant supplies 400 MegaWatts, the Danhim hydro-power plant supplies 160

MegaWatts, and the Thuduc thermo-power plant supplies 160 MegaWatts.

Annual electricity productivity for 1988 was 6.7 billion kiloWatts; for 1989: 8 billion kiloWatts; for 1990: 8.9 billion kiloWatts.

Future development

Oil and gas are a promising branch of Vietnam future energy development. It is estimated that offshore oil deposits offer great commercial prospects. Thanks to a policy that fosters cooperation with foreign countries, and especially since the enactment of the law on foreign investment in Vietnam, many contracts have been agreed on for exploration and exploitation of this resource on a profit-sharing basis. If the output target is achieved, 20 to 23 million tons of crude oil will be exported in the 1991-1995 period. In 1995, it is expected that 7 million tons of crude oil will be exported and that an oil refinery with a capacity of 3 million tons per year will be constructed. It is hoped that in coming years Vietnam will no longer have to import oil, and that oil production will provide an ample supply for home consumption.

Electricity, especially hydro-electricity is also a growing resource. In the future, Vietnam plans construction of additional hydro-electric power generating plants including the Sonla in the north with a capacity of 3000 to 3500 megaWatts; the Yaly in the central region with a capacity of 700 MegaWatts; and the Hamthuan in the south which will have a capacity of 360 MegaWatts. Some coal and oil powered generating plants are also planned.

Regional electric grids will be connected into an integrated national electric network by cables of 500 and 220 kilovolts.

Vietnamese coal is of high quality which can be exported or

used for home consumption. In coming years, new technology and increased financial investment will be applied to this industry.

Research success in the field of new and renewable sources of energy will substantially assist in supplying energy to the countryside and mountain areas and will contribute to efforts to protect the environment.

Some options which will limit waste gases released from energy production are proposed:

1. Effectively using basic energy sources, especially coal on the basis of improving technology as well as equipment efficiency and striving to replace coal with other forms of energy which produce less carbon dioxide.

2. Stepping up the exploitation of hydro-electric resources on a country-wide scale while taking into consideration the impact of hydro-electricity projects on the environment.

3. Using new and renewable energy sources (biomass, solar, wind) and attending to research on the subject of technological advances in the production of low cost energy.

There is a growing demand for energy in the world, especially in developing countries. It is necessary to establish a policy of energy development which takes into account the importance of environmental protection.

10. CLIMATE CHANGE AND BIO-DIVERSITY IN VIETNAM

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There has been much debate both internationally and in Vietnam on the impacts of climate on society and the economy. Here we focus on the impacts of climate on nature, specifically on bio-diversity.

Bio-diversity is a vital base for human survival. Any species reduction is a degradation of this base and decreases the quality of human life. This problem has more impact in developing countries such as Vietnam because of a lack of technical and financial resources. Survival of present day and future generations depends largely on how natural resources, especially biological resources are exploited.

Vietnam possesses diverse biological resources which are particular to Southeast Asia and many of them are endemic species. These resources have been indispensable to Vietnamese stability and development. However, they are being depleted for a number of reasons.

Forest and wetland species are being rapidly reduced and 355 plant species as well as 365 animal species are now threatened. Vietnam's ecosystems include tropical forests which are both diverse and fragile. They can easily deteriorate with irregular climate fluctuations.

The Institute of the Environment in Stockholm has stated that natural ecosystems can only adapt to temperature change if the change does not exceed a rate of 0.1°C per decade. IPCC's

estimation also reveals that if the discharge of greenhouse gases continues to increase, the temperature rise will occur at a rate two or three times higher than this. Such a rate of change in global temperature has not occurred over the past 10,000 years. A great number of species may be on the verge of extinction because they will not have had enough time to adapt to the swift rise in temperature. Resistance to climate change in species which have a small population appears to be very low. Inventories made by the International Union for Conservation of Nature and Natural Resources show that the number of endangered species worldwide extends to the thousands, while the figure for Vietnam is 600. Biological species extinction and biodiversity degradation are irreversible losses. Global warming and climate change favor the proliferation of pests and viruses including those that cause human and veterinary diseases, and crop damage in tropical areas.

Global warming will also cause the sea level to rise. The sea level of Vietnam has increased by 10 cm. IPCC estimates that the sea level will rise another 20 cm by the year 2030 and 65 cm by the end of the next century. Hence, inundation will occur in alluvial and deltaic areas.

Vietnam embraces approximately 3,000 km of coastline and large areas less than one meter above sea level such as the deltas of the Red and Mekong rivers. More than half of the country's population converges in these two areas. Vietnam also includes small coastal islands and many large coral reefs.

Based on its current understanding, IPCC working group I suggests an average rate of sea level rise of 4-6 mm per year by the year 2050. This projected rise of 25-40 cm by the year 2050 is 2 to 6 times faster than any experienced during the past 100 years.

The variety of biological resources in these areas are not

only of scientific significance but also of importance for environmental protection and ecological balance. They serve as a vital base for socio-economic development.

If sea level rises as predicted by the IPCC, it will pose a significant problem for the natural resources and society of Vietnam. It may be relatively easy for humans to change their habits, but animals and plants cannot and are easily destroyed.

A rise in sea level would inundate wetlands and lowlands, erode shorelines, exacerbate flooding of coastal regions, increase the salinity of estuaries and aquifers and otherwise impair water quality, alter tidal ranges in rivers and bays, and change the locations where rivers deposit sediment. All such environmental changes will affect local species. The main potential effect of sea level rise in shallow coastal waters is an increase in depth. Intertidal zones may be modified radically and mangroves could disappear. The physical and morphological boundary conditions of shallow waters may change considerably, affecting the functioning of ecological systems. In turn this may cause loss of natural resources such as bird life, fish spawning and nursery grounds and fish and shellfish production.

The mangrove forests of Vietnam extend over 200,000 hectares, mainly in the south, providing habitats for many animal species and providing marine products such as shrimps and fish and creating prosperity for the locality. Consequently sea level rise will be to the detriment of those marine resources. It should be noted that it takes about 100-1000 years to form a mangrove ecosystem.

An accelerated rise in sea level would have direct effects in the coastal zone. While the rise in sea level would most likely be incremental, the principal damage from flooding and erosion related to this rise will affect not only marine resources, but also, food chains, components of which live in the damaged habitats. Ocean

thermal expansion of 2°C will also destroy a number of marine species.

The area of mangrove forests in the Mekong delta has already been reduced from 250,000 to 116,000 hectares. This is a type of wetland, represents the ecosystem of the locality and is the basis for economic activity there. Melaleuca and many other plant and animal species in mangrove forests are of high economic and scientific value. Sea level rise would increase the risk of habitat destruction in Mangrove forests.

Climate change and sea level rise are also threatening lagoons, spawning places for sea turtles in Phuquoc and Condao. Coral reefs are expected to suffer from temperature change and sea level rise.

Like many other developing countries, Vietnam depends largely on natural resources among which biological resources have a very important role. Losses of biological resources will significantly impair socio-economic development.

Climate change is a global problem that can only be solved through international cooperation, although each country must set its own goals in an effort to slow global warming by decreasing emissions of greenhouse gases.

This issue should be taken seriously in Vietnam in order to arrive at timely and appropriate solutions and to mitigate likely losses.

11. CLIMATE IMPACT, EXAMPLES FROM THAILAND

Dr. Suwanna Panturat
Srinarkharinwirot University, Thailand

Climatology has played and increasingly important role in man's activities worldwide over the past few decades. Thailand is undoubtedly affected by climate variability. The climate of Thailand is impacted by two major circulations: the southwest and northeast monsoons, global warming and the El Nino/Southern Oscillation. The areas we have studied are the climate impacts on crop production, society and the economy. High humidity and rainfall are associated with the southwest monsoon and therefore create the rainy season in Thailand. Maximum rainfall normally occurs in August to September. On the other hand, the northeast monsoon brings the dry, cold continental air from Siberia and so develops the dry season in Thailand. Very little rainfall is experienced anywhere in the country during this period with the exception of the east coast of southern Thailand.

Irregularity of rainfall results in the occurrence of dry spells and flooding over time and space. Both events have severe impacts on crops during their flowering/reproduction stage while flood can be caused by either heavy monsoon rain or tropical depression or tropical cyclones called typhoons. The drought early warning program developed by NOAA and the University of Missouri Cooperative Institute for Applied Meteorology (CIAM) has been a subject of study for us. This program provides valuable assessments of the potential impacts of weather variability on agricultural crops. We have formulated model estimates of impacts on rice production given specific changes in genetic coefficients, sowing date, and fertilizer application date. An example has been calculated for Phitsanulok, Thailand. In addition, a model has been

developed for base and gauze climate data yields in kilogram per hectare for the years 1973 to 1988. The impact of climate change on rice variety selection in Thailand has also been studied by Panturat and Eddy.

12. PRELIMINARY ASSESSMENTS OF WEATHER AND HYDROLOGY UNDER INFLUENCE OF CLIMATE CHANGE

Dr. Dinh Van Loan
Hydrometeorological Service, Vietnam

Over the past three decades, adverse weather events and anomalies have been frequent. Prolonged drought from 1968 to 1984 in some regions of Africa has caused levels of hardship unprecedented on that continent. Two strong typhoons causing storm surge of tens of metres in the Gulf of Bengal in late 1970 and in May 1985 claimed 300,000 lives in Bangladesh. Heavy rain caused flash flooding in the Duongtu river in China in 1983. Heavy rains in India in 1985 and hurricanes of grade 12 in the USA and the Philippines in 1985 are also anomalous events. These catastrophes have caused considerable losses of life and property. In order to help in the clarification of the consequences of climate variability and climate change, we bring up here some preliminary assessments of some major meteo-hydrological factors and events recorded in Vietnam in recent decades. Over the past century and especially in recent decades, there have been an increasing number of anomalies.

Analysis of statistic data collected over 100 years (1891-1990) show an evidently increased influence of the tropical cyclones in Vietnam. It is noticeable that among those which influence Vietnam, those with strong intensity is on the increase. On the basis of statistic data collected during 1891-1990, Vietnam was influenced by 475 tropical cyclones. Among those occurring in the past 37 years (1954-1990), 31 typhoons of grade 10-12 with strong winds at grade 12.

Anomalies of intensity and duration of heavy rains have also

been recorded in recent decades. As far as intensity is concerned, heavy rain over some days has resulted in rainfalls of over 500 mm, surpassing the designed capacity of many irrigation constructions. Especially, unprecedented rains were caused by typhoon Andy (October 1, 1985) which hit Binhtrithien resulting in rainfall of from 600 to 800 mm. In some places such as Kyanh and Baunuoc in Nghetinh province, rainfall was more than 1200 mm. As far as time is concerned, out of season rain occurred for the first time in 100 years from November 9 to 10, 1984 in the Red River delta. This caused inundation of from 0.5 to 1 meter on the streets of Hanoi, an unprecedented phenomenon for November. In addition to this anomaly, there have been many instances of waterlogging and floods in recent years. The number of flash floods of degree 3 has increased remarkably in the past decades. The magnitude of the floods is also uncommonly high. In 1971, historic floods occurred in many rivers in the north. In 1978, historic floods occurred in Ca and Hoang Long rivers and rare flash floods were recorded on rivers in the North Vietnam and on the Mekong river. In 1980, notable flooding of the Ma river and flash flooding of the Thaibinh river occurred. In 1984, substantial flooding occurred in three areas of Vietnam, including small rivers such as the Hoang Long and the Buoi.

Besides the above-mentioned phenomena, there were other weather extremes such as drought, excessive heat, and cold spells. Cold spells occurred in three consecutive winter seasons (1982-83; 1983-84; 1984-85). It was also unusually cold in the winter-spring of 1986-87. This is an unprecedented event in the northern provinces over the past century. A hot dry spell occurred in May 1983 in the north Vietnam and the north of the central with temperatures in several places exceeding 40°C (Hue: 41.3°C; Donghoi: 40.1°C; Quangngai: 40.5°C; Hanoi: 40.1°C). These anomalies caused great losses of life and property in Vietnam. They may be warnings of climate change. We have a responsibility to actively take part in the common cause of nature and environment protection.

13. CHANGES IN THE RED RIVER AND MEKONG RIVER FLOWS OVER A PERIOD OF MANY YEARS

Dr. Tran Thanh Xuan
Hydrometeorological Service, Vietnam

The Mekong and Red rivers are the two largest rivers in Vietnam and are also among the largest in the world. The average annual total volume of the two rivers constitutes about 75% of that of all Vietnamese rivers. therefore they have an important role in socio-economic development in Vietnam as well as in the Red and Mekong river deltas.

In order to exploit and manage water resources and to prevent natural disasters, we need to ascertain the variation of runoff in space and time. In this report, the long term variation of annual and monthly runoff of the Red and Mekong rivers is discussed.

Assessing the variability of runoff

In the past 70-80 years there have been periods which showed increases and decreases of runoff. Those periods did not occur at the same time in the monthly data series of one station or from one station to another on the same river.

The tendency to increase was long and clear and appeared during the period from the beginning of the 1930's (at Red River) and from the end of 1930's (at Mekong river) to the beginning of the 1950's. After that there was a diminishing trend in both rivers. This tendency has lasted up to the present. From 1968 until now, however, the runoff of the Lo river has been increasing and from 1963 to now the runoff of the Mekong at Vientiane has been changing somewhat. The average values for those periods in which

increase (high water phase) or decrease (low water phase) was larger (or smaller) than the average value of all data series was calculated. It was observed that there was more variability in the monthly data series.

Variations in annual runoff and annual rainfall

Rainfall is the main water source for rivers in Vietnam. The long-term variation of runoff depends on rainfall. We have some comments on the residual mass curve of annual runoff in the Red river and annual rainfall at some representative stations in its catchment area from the mid-1950's to now:

During the last four decades, the variation of annual rainfall was not in the same phase in all of the catchment.

The situation was the same for the annual runoff in the Red river system. From 1956 to 1965 at Son Tay and until 1967 at Ghenh Ga (new position of Tuyenquang station) there was a low water phase. At Hoabinh and Yenbai however, the trend was not clear. From 1966-1968 to 1973 there was a high water phase in the three rivers. After that, a low water phase persisted until now. At Lo river, however, there has been a high water phase form 1978 until now.

About 40% of the annual total volume of the Red river is created inside Chinese territory. However, the distribution of annual rainfall in space is very complicated. That is why the variation of annual rainfall at some positions in the catchment is not representative of all of the catchment. These comments are preliminary.

Conclusion

From the beginning of this century until now there has been increasing and diminishing periods of runoff as determined by data

series for the Red and Mekong rivers. Especially from the mid-1950's to the present, runoff from the Red and Mekong rivers in almost all stations has been diminishing. This variation corresponds to the variation of annual rainfall. This is natural. The variation of runoff, however, in the Red and Mekong rivers as well as in the other rivers in Vietnam are influenced by human activities. Especially, climate change in the world has a major impact on annual flow and other elements of runoff.

Research and assessment of the influence of climate change on water resources and other hydrological factors are very important. On the basis of this work, response strategies to negative impacts of climate change can be proposed in order to effectively control and manage water resources.

SUB-COMMITTEE C

SEA LEVEL RISE

Chairman: Prof. Vo Quy

1. SEA LEVEL AND CLIMATE CHANGE

Prof. Nguyen Ngoc Thuy
Hydrometeorological Service, Vietnam

In the opinion of many scientists around the world, sea level will rise by 25-50 cm by the year 2000 and by 30-110 cm by the year 2100. This is a very grave problem and response strategies must be developed, especially for countries with low islands and coastal plains. The report on sea level rise and coastal strip management formulated in 1990 by 69 countries and 7 international organizations contains the following statement:

Global climate change may raise sea level by as much as one meter over the next century and in some areas increase the frequency and severity of storms. Hundreds of thousands of square kilometers of coastal wetlands and other lowlands could be inundated. Beaches could retreat as much as a few hundred metres and protective structures may be beached. Flooding would threaten lives, agriculture, livestock, buildings and infrastructure. Salt water would advance landward into aquifers and up estuaries, threatening water supplies, ecosystems, and agriculture in some areas.

Some nations are particularly vulnerable. Eight to ten million people live within one meter of high tide in the unprotected river deltas of each of Bangladesh, Egypt and Vietnam. Half a million people live on archipelagoes and coral atolls such as the Maldives that lie almost entirely within three metres of sea level.

According to Japanese scientists, 10-30 billion dollars will be necessary to protect Japan's sea coasts. In Holland, protection against a sea level rise of 60 cm is estimated at 7.5 billion

dollars.

Scientists have proposed three main coping mechanisms:

1. Retreat from seacoast regions without the implementation of protective measures. Thus, total or partial loss of the coastal regions.

2. People remain on the seacoasts, but take some protective measures against inundation.

3. Solid protective engineering projects such as dikes and sea barrages are undertaken with the goal of preserving the coastal land.

To carry out these strategies requires consideration of environmental, economic, social, legislative and organizational aspects of the problem and potential solutions. It is important for coastal countries to begin this process immediately.

Calculations by Dutch scientists indicate that the total expenditure required for the protection of all the seacoasts in the world stands at 495 billion dollars. This price is set for the 1989 market and according to engineering requirements estimated by the authors (dike height of 1 meter, width 4 metres, inclination of roof 1:4 for a cost of o.4 million dollars per kilometer). At this estimation, Vietnam 3657 km coast would cost 4,628 million dollars to protect. In Vietnam, low labor costs may mean that the price estimated by the Dutch scientists is higher than the real cost here.

Due to Vietnam high population, there is a crucial need to protect the coastal regions. However, due to a shortage of capital, large engineering projects may be out of reach and the best strategy may be small protective measures and accommodation.

We examined a multi-year data series in the chief stations of the two low plains of Vietnam: Hondau in the north and Vungtau in the south. The longest and most reliable data series is for Hondau. Assuming that there is no change in the earth's crust here, a sea level rise of 0.19 cm per year was observed for the period between 1955-1990. This agrees with the observed rise in global sea level. Three scenarios were considered: sea level rise may continue at this same rate, it may increase at three times this rate, or at ten times this rate.

The station at Vungtau, while an important low deltaic region, has an unreliable data series due to changes in the position of the station. However, the data indicate that sea level rise trends here are not the same as at Hondau. This also seems to be true for stations in the central region of Vietnam, but we question whether this apparent difference is artefactual.

According to the chart of the South China sea level (edited by the Center of Sea Level, TOGA in Honolulu) there is a point of suction several months of the year on the southern Vietnam seacoast. Could this explain the observations at Vungtau? These questions and many more about fluctuations in sea level in Vietnamese coastal waters require us to undertake and to consider more meticulous research. Only then will we be able to predict the sea level rise in the coming decades.

If sea level increases at three or ten times of the present rate, the problem becomes extremely grave for Vietnam. The consequences which will include natural calamities and migration of populations should be thoroughly examined. In order to accurately determine the optimal coping strategy for the coming decades, it is very important to closely study past changes in sea level and to study the future effects on each region of Vietnam.

2. SOME PROBLEMS OF VIETNAM SEASHORE EROSION

Prof. Le Duc An
Institute of Geography and Natural Resources
Vietnam National Center for Sciences

The areas where sedimentation take place strongest are Day river mouth with a rate of 100 metres per year. Balat river mouth, shoreline from Camau cape to Bay hap estuary at a rate of from 20 to 40 - 50 metres per year. The coastline southwest of Bac Lieu, the 2 banks of Rachgia Gulf are also sedimented at a smaller scale. This situation also takes place in some river mouths in the Central of Vietnam.

The most seriously destroyed beaches are in Haihau, Cathai island, especially the beaches eastern of Ngochien district, stretching along 60-70 km. The coastline in Cangio, Gocongdong are also similarly eroded.

Analysis shows that

- Sedimentation takes place strongest in river mouths where there is much alluvium carried there by river flows and where there are favorable conditions for their sedimentation.

- Erosion is severe in the verge of the Red river Delta and the Mekong river Delta.

- Sedimentation rate is slowing down in the deposited banks.

- Many sedimented banks are being eroded but only a few eroded banks become sedimented.

- Eroded coast and area have been expanded.

- New Eroded beaches are found in the Central of Vietnam where sedimented coastline is stable.

- As far as morphology is concerned, many river mouths, especially in the Mekong river delta, are widened. And not only that, the river reach along the estuary is also widened.

It is concluded that, there exists a great uptrend in coast erosion in Vietnam in the recent period.

The tendency of sea invasion of land is clear. Usually, coast erosion is caused by one of the following main causes: human activities (decreasing sedimentation, increasing pressure on the coast), tectonic subsidence of the seashore, increase of sea dynamic, and sea level rise.

In general, over the past centuries, especially the recent decades, the deforestation is increasing, hence the loss of most of tropical forest cover and severe land erosion. Therefore, more alluvia are transported to the sea, and this is favorable to sedimentation. Especially in the North and North Central Vietnam, where there is a system of river dikes, more alluvium is brought to the sea, this is favorable for the process of seashore sedimentation and plain expansion. But in reality, coastline erosion is increasing. Every year, rivers flowing through Vietnam carry more than 200 million tons of sediment (not accounting for 96,4 million tons of soluble substana). This amount of sediment is capable of expanding the shoreline of the Red river and Mekong river deltas 450 km of length with a rate of 100 m/year.

Man also develops this process through the construction of reservoirs on the diversion of the flow, thus reducing the volume of alluvia flowing to the river mouths. Construction of project by

the seaside also increases nearshore current intensity. Exploitation of raw materials on the seaside (sand, gravel, coral...), tree cutting also lead to erosion. Erosion as a result of those activities is local level.

It is possible that erosion may be caused by tectonic subsidence but this is not in national scale but in local scale.

Sea dynamic may increase due to change in atmospheric circulation, currents, waves, tides... However, global change of sea dynamic conducive to coastal erosion has not been identified by scientific research. Changes in sea dynamic in each region only cause local erosion.

It is necessary to mention a view point that coastal development rule (sedimentation and erosion) character has rhythmical (stationary) and sudden (stochastical) there is prompt sedimentation period when near shore submerged beaches appear on severe erosion period when these destroyed submerged beaches are not reconstructed. This takes place only in some particular river mouth because not all submerged beaches develop in the same period in all estuaries and not all the river mouths have the same submerged beaches.

It is concluded that erosion in the Vietnamese coastline is caused by many different local reasons but there is ground to assume that it occurs in the common basis - sea level rise. This phenomenon is rather clear, not only in the eroded length and area which are increasing but also in the seashore relief. This problem need systematic and comprehensive study to produce reliable and scientifically - grounded conclusions.

3. PRELIMINARY STUDY ON THE INFLUENCES OF SEA LEVEL VARIATIONS ON MANGROVE FORESTS IN VIETNAM

Prof. Phan Nguyen Hong
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Hanoi, Vietnam

Analysis of remote sensing data from Landsat shows that certain mangrove coastal areas have been severely eroded. For example:

Conloi (Bentre province) 460 ha; Haugiang river mouth, 350 ha; east coast of Camau peninsula 9,630 ha. In recent years, erosion has increased, especially at the Camau cape. According to the data of the remote sensing satellite SOYUS from 28/4/1982 to 17/6/1983, the Camau coast eroded more than 600 ha from the river mouth at Bode to Rachgoc, with the width at some locations reaching 200 m. The main source of this erosion is the impact of the northeast monsoon which creates strong waves. A large area has been eroded and some mangroves have fallen down.
Sea level rise increases the impact of waves and causes the flooding of mangrove forest with sea water. Waves transport sand into mangrove areas, covering pneumatophores and killing trees.

At the north end of the Mekong estuary at Hamluong, Dinhan and Tranhde erosion is also caused by the northeast monsoon and sea level rise. At some places on the Camau peninsula, the mudflats along the river banks have been eroded, leaving the mangroves isolated. Within a short time, all the trees were dead.

In coastal zones with brackish water, people often transplant rice in the wet season and lay waste in the dry season due to the lack of fresh water. High lands which were rarely flooded with sea

water were used for coconut planting. Sea level rise has made these agricultural activities impossible. After several years, Nipa palm and other mangrove species have invaded these areas.

Predicting the effects of sea level rise on mangroves in the future:

a/ Possible effects on sea grass:

Sea grass beds are common in the intertidal zone along the coast of Vietnam. The bio-productivity of sea grass and sea weed beds is high in the low tide area. The present distribution of sea weed before mangrove shows that the community is well adjusted to changes in climate and other marine conditions [1]. It is predicted that sea level rise may result in a landward shift in sea grass. Increased water depth will reduce light penetration, impeding photosynthesis, and the sea weed community may perish. If wave action is strong, the existing community may be uprooted. These changes would affect fish and shrimp species and their production.

b/ Sea level rise and increased salinity is predicted to affect agriculture in low lying areas. Rice, coconut and pineapple cultivated in these areas may perish. Brackish mangrove species like Nipa palm, Sonneratia caseolaris and Cryptocoryne ciliata may gradually invade the areas. Generally speaking, mangroves can extend landward in response to sea level rise provided there is an adequate supply of fresh water in the rainy season.

c/ A slow rise in sea level may impede seaward extension of mangrove, especially Avicennia, because their pneumatophores will be submerged preventing gas exchange. An intermediate rise in sea level may cause the mangroves to retreat to the shoreline, bringing changes in zonation. If sea level rise is rapid, mangroves would be completely overtaken by the sea and total destruction would result [1].

d/ More floods in the coastal plains and low-lying islands and erosion of coastal areas threaten crops, houses, and other structures.

e/ Increasing salinity of surface waters and river upstream will affect drinking water, and irrigation supplies in some locations.

f/ Sea level rise will impede the growth of deltas, shorelines will be cut back, and many rivers will be partly or totally destroyed [1]. Geographical land area will be reduced.

Remedial measures:

a/ Stringently control and restrict to the lowest level the degradation of mangrove forests, conversion of mangrove areas to shrimp ponds and agriculture, in order to limit the coastal erosion resulting from sea level rise.

b/ Clarify the trends of various mangrove forests at present in terms of their advancement, stagnation or retreat.

c/ Restore degraded mangrove areas by afforestation.

d/ Monitor changes in mangrove areas, their floristic and faunal compositions, and their physiographic changes.

e/ The meteorological bureau should plan to regularly monitor the sea level rise and effects of climate on the oceanographic stations along the coast and inside the river mouths.

f/ Consider different causes of sea level rise and assess the effects on the mangrove system.

g/ The attention and assistance of international organizations should be applied to research on sea level rise in Vietnam which

has a complicated climate and topography. The results of such studies would provide good experience for the study of the impacts of sea level rise in other areas.

4. USING REMOTE SENSING MATERIALS TO STUDY COASTAL AREAS IN VIETNAM

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This report presents some results on using remote sensing materials to study coastal land use and variability of soil salinity, making. References include aerial films and imageries, MSS films and magnetic tapes, false color composite from Landsat satellite, imageries from French satellite Spot and Soviet satellite Cojur. Study is carried out in 4 steps: general survey of study area, visual interpretation of imageries, interpretation by optical equipment or by computers, field survey according to routes and lines identified on imageries and improving of the legend and preparation of thematic maps.

Study of coastal land in Hanamninh province

The development of sea dike system in 1927, 1934-1936, 1945, 1956-1959, 1981-1986 shows the trend and rate of shore line expansion at the Day estuary. Every year, the coastal areas in Day river's estuary encroach on 80-100 m to the sea. On the contrary, the coastline belonging to Ngason, Thanhhoa has been eroded. During the period of 10 years, from 1975 to 1986, about 40-60 metres were eroded, therefore the annual average rate was 5 m.

Changes in land use: under the cycle of from I to II years, people built sea dyke to prevent sea water, and improve saline soil into cultivable land. Photos wich were taken in 1975 showed that in this area, there has been large area of mangroves. By now this area is replaced by rush field, some areas under rush previously are now

improved for rice cultivation.

Sea dyke prevents sea water: Sea dyke project began in 1981 with large investment from the State budget and labor force. But it was broken several times. The main causes of this situation were found on the basis of the development trend of the coastline and field study. First of all, location of sea dyke in some places was unsuitable due to poor result of initial survey. The dyke was estimated to stretch along 14 km through grounds of different material component and structure, but had the same design. The broken dyke portion was situated in a ground, which is not coalesced and composed of mud, irresistible to pressure. It is prone to Southwest wind and typhoon and was not covered by vegetal carpet to prevent sea waves action.

Similar study results were found in many provinces and districts in coastline of Vietnam such as Haiphong, Thaibinh, Quangbinh, Thanhhoa and Songcau.

Study on salinity variability of soil

Some remarks are drawn from study of salt soil in coastal area of Vietnam:

Most of the salt soil in coastal areas of Vietnam are created by river alluvium and salinated by sea water. Due to the characteristics of the monsoon tropical climate, rainfall concentrates mostly in rainy season. Flooding have help desalinate soil and decrease salt intrusion in river estuaries. This factor leads to seasonal soil salinity which depends on rainfall.

Salinity is also closely related to the salinity of the shallow aquifer salt soil along coastal areas of delta which having mild slope or are flat.

However, the difference in altitude is of great significance to soil salinity Usually, the high-lying areas are less saline.

Salinity is related to vegetal cover. Study of coastal saline land in the Red river delta showed a relation between the soil and some indicative plants. Land salinity also depends on the ways of land use and cultivation.

Study in some coastal districts of Thaibinh, Hanamninh provinces showed soil salinity increase of area under rice production.

Two basic remarks can be drawn from those preliminary studies:

Remote - sensing method is a suitable and effective tool in studying coastal land.

Salinity increase in some coastal area may be a result of many different causes (the change in pressure balance between river and sea water, change in the shallow aquifer level, change of vegetal cover or land use), and one possible cause is sea level rise. A more reasonable study can only be achieved on the basis of more detail study on the whole coastal areas of Vietnam.

5. A MODEL OF SEA LEVEL RISE CAUSED BY OCEAN THERMAL EXPANSION

Dr. Gilbert Tucker
Natural Resources and Environment Research Center, Australia

The greenhouse effect is due to increased human population and increased use of energy by that population. The world's population has been increasing exponentially. The developing countries' populations are growing more rapidly, but the people in developed countries use proportionally much more energy, and are the principal source of the problem. Concentrations of carbon dioxide over the past years can be assessed by examination of bubbles of gas in the ice of polar regions. By this method, atmospheric gases can be measured from 1600 to the present. Increases in methane and carbon dioxide parallel the growth of population. Methane is produced largely from agricultural activity and carbon dioxide is associated with the production of energy. Since it is the natural desire of developing countries to increase their standard of living, the problem of accumulation of greenhouse gases is bound to worsen.

There are four possible responses to the greenhouse effect: ignore it; try to stop it; try to modify it or try to adapt to it. The fact that we are discussing the problem here is evidence that we are not ignoring it. It is unlikely that we can stop it. If we increase the efficiency with which we use energy we can try to modify it to give us time to find a solution. However, the most likely cause is the fourth. Humans have a great ability to adapt.

In adapting to climate change resulting from the greenhouse effect, there are several points to consider. It is important to keep things in perspective so as not to confuse climate variation with climate change. There is a strong tendency to do this as the

two are very difficult to distinguish. When making predictions on climate change, it is important not to always quote the worst case scenario. We must keep in mind the time scale of climate change predictions, and we must bear in mind that for many countries the pressing needs of the moment must have priority over the problems of the future. So plans for adaptation must include strategies for improving the efficiency of energy use and also for adapting to a changed climate.

In predicting the effects of sea level rise, it is important not to exaggerate the extent of rise expected. Sea level studies have never recovered from a 15 year old assessment that suggested that a doubling of atmospheric carbon dioxide would produce a 7 meter rise in sea level. These conclusions were based on the suggestion that the antarctic ice sheet is unstable. Since then, no study has confirmed this estimate. In 1986, the worst case scenario was an increase of 120 cm in 2050 or 2080. In April of this year, a report by John Church in the journal "Climate" describes a model which accounts for the observed increase in sea level from 1900 to 1980 of 8 cm. This model was used to calculate the geographical distribution of sea level rise for 2050. The first result from this model for increase in sea level by 2050 due to thermal expansion only, not taking into account glacial meltwater, etc, was for a maximum increase of 40 cm in the region of Vietnam and Japan. Taking into account surface stress and rainfall, this figure was adjusted to 25-30 cm. If glacial meltwater and some other minor effects are also considered, a conservative estimate of 25 cm and a worst case estimate of 45 cm sea level rise is predicted for the western Pacific.

Fifteen years ago, the extent of sea level rise for the year 2050 was predicted to be 7 metres. In 1986 it was predicted at 120 cm, and the latest prediction is 45 cm. The estimates made today are still not 100% reliable, but we must be careful not to always quote the worst case figures in reporting predictions.

As a result of different sample groups, the IPCC has published two reports. The first is "The Seven Steps to Vulnerability Assessment of Coastal Areas to Sea Level Rise" and the second is "Criteria for Conducting Case Studies to Interpret Vulnerability". The key is to delineate zones at risk, list resources in these areas, and to identify non-climate factors operating in these areas. From this information, a response strategy should be formulated and decisions can be made on how to implement it. The Vietnamese scientists should be congratulated on the progress of approaching these tasks.

SUB-COMMITTEE D

STRATEGY AND POLICY RESPONSES

Chairman: Dr. Gilbert Tucker

1. VIETNAM's ENVIRONMENT POLICY TOWARDS CLIMATE CHANGE

Dr. Nguyen Ngoc Sinh
Environment and Resources Department,
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Vietnam is now trying to formulate and implement policies for natural resources and environmental protection. To this end, resolution 246 of the Council of Ministers was passed in 1985 delineating the responsibilities and duties of the different levels of government. Sustainable development is the national strategy and policies for the period from 1991 to the year 2000 emphasize environmental protection. A plan has been contributed to by many domestic and foreign specialists and has been approved at the conference on the environment and sustainable development that was held in Hanoi in 1990. Many documents have been prepared on laws protecting the environment.

The national committee for scientific research is the unified body for environmental protection. Other scientific societies are looking at related issues. Many projects focus attention on this problem. As a result, awareness of the environment is higher now, but there are still acute challenges. There is not enough education on the subject.

Environmental protection policies must take into account climate change. Vietnam policy must be adjusted because this country has a complicated climate. This climate might become even more diverse, and the economy depends on climate. In the future, the productivity of Vietnam will continue to depend on natural conditions. Requirements are high: the population growth rate is over 2% per year and an increased rate of per capita growth is required. This demographic pressure is heavy. Vietnam policies must

reflect the changing world conditions. Economic policy must take into account climate change and sea level rise.

With increases expected in disasters, storms and other extreme climate events, and with an expected decrease in land area, careful consideration is called for. We have to look at the long term. Research is needed to help us avoid over or under reaction. Ten steps must be taken:

1. Consider different strategies to protect those vulnerable to climate change and sea level rise.

2. Control coastal ecosystems.

3. Consider protection of bio-diversity.

4. Pay attention to technical measures to sustain productivity in vulnerable areas.

5. Push forward research on climate change and preventative measures.

6. Consider the impacts of climate change on health.

7. Increase social awareness and arm everyone with knowledge.

8. Push forward research on sea level rise.

9. Increase cooperation on national and international level, especially among nations sharing southeast Asian monsoon climate. An international organization to encourage this work would be useful.

10. Modify the current organizational structures to facilitate reactions to climate change and sea level rise.

2. CLIMATE CHANGE AND OCEAN CONSEQUENCES

Dr. Garry Sharp
Center for Ocean Analysis and Prediction, Montery
California, USA

The principal means for climate change to be noticed is through its effects on hydrological cycles, insolation and the timing and duration of freezes. Sediment geologists have documented such changes in seasonal forcing at all time and space scales. For example, there are cores from dry lake beds in the southwest USA that have continuous laminae with strong seasonal signals. These are the results of hydrological and eolian processes which have left behind annual cycle records. These records extend back in time for in some cases ten to twenty thousand years, and in one case for two hundred thousand years. These records are coherent across the basins, and provide insight into climate variabilities on decadal, centennial and millennial time scales.

Recently, ice cores from mountain glaciers in Greenland, Antarctica, the Andes and the Himalayas have been collected and analyzed to show that the patterns of climate over large areas of the globe are coherent and in phase if not always of the same sign. these records have been compared to tree ring records, sediment records, and to laminae in tropical corals, and have provided great insight into the climate variability of the recent one to two thousand years. The histories of societies parallel these records and certainly will continue to do so as long as we can cope with the climates that create them.

The consequences of climate change depend on the form and magnitude of changes. If global warming continues as projected, there will be increased surface winds due to the differentials

between ocean and terrestrial energy absorption. This will stimulate coastal up-welling and hence coastal marine production. Extension of the tropical oceans will diminish overall oceanic fisheries production. There will be more typhoons in some areas with floods, droughts, freezes, etc, occurring in others as extreme weather events increase in both frequency and magnitude.

There will be displacements of complete climate-related hydrology, hence shifts in seasonal patterns that will affect all levels of agriculture, aquaculture and both fresh water and sea fisheries. Sea level rise will inundate much arable coastal land and salt intrusion will affect aquifers.

If cooling ensues, surface winds will decline, promoting less evaporation from the ocean surface, and less plant evapotranspiration which, along with the cold, will decrease plant production in affected areas as well as result in less atmospheric moisture. Therefore, widespread drought will occur.
Some parts of the globe will be more affected than others in that there will be equatorward shifts in biomass and collapses of populations that are not able to adapt to the changes, such as fresh water fish and sessile species. Marine fisheries may well expect to increase overall production, as the transfer of energy and materials in cooler oceans is much more efficient than that which occurs in warmer tropical seas, ie, less energy is lost in metabolism and more gets passed up to higher tropic levels.

We are nearing the apparent apex warm phase of current long-term (centennial) patterns of heating and cooling, and a cooling period is due. However, the good news is that human greenhouse contributions may offset these expectations.

3. STRATEGY RESPONSE TOWARDS ENVIRONMENT AND CLIMATE CHANGE IN VIETNAM

Prof. Nguyen Van Huong
Office of Coucil of Ministers, Vietnam

Due to the significant and long-term impact of climate change on the natural resources and socio-economic conditions in this country, the formulation of a suitable strategy to minimize negative consequences of such change is important. In formulating such policies it is important to draw input not from subjective accounts of the problem, but from concrete data derived from studies of the environment and of society.

To this end several theories have been put forth on environment and climate change and sea level rise in the world and in Vietnam. The consequences of these changes on the socio-economy of Vietnam has been considered from now until the year 2000, and these effects have been broken down into the subjects of:

- agriculture
- water resources
- energy
- transport and communication
- industry

On the basis of this work, strategies have been proposed to deal with climate change and environmental protection in the context of sustainable development. These are as follows:

- strategy of survey and research

- strategy of environmental protection against all negative impacts of climate change.

- strategy of prevention or minimizing of climate change

Responses to those elements of climate change that cannot be prevented may be as follows:

- changing or selecting suitable technology for the new conditions

- rezoning or changing production organization, crop-pattern and crop-variety

- resettling population centers, rezoning urban areas, industrial areas and the communication and transportation networks.

Additionally, education and international cooperation must be fostered.

These are the general features of the strategy for reacting to climate change and sea level rise. It is important to retain flexibility in this plan in order to adapt it to differing circumstances.

4. INTERNATIONAL COORDINATION IN GLOBAL ENVIRONMENT CHANGE RESEARCH

Dr. Ata Qureshi
Climate Institute, Washington, USA

The conference participants have discussed many important issues and as the last speaker it is my pleasure to briefly summarize the topics that have been discussed.

In the first group of papers, scientific research on the nature and extent of climate change in Vietnam and in the world was presented. This work is important if we are to understand the current climate situation and is crucial in predicting the effects of climate change.

Secondly the impacts of climate change and climate fluctuation were discussed. It was emphasized that a distinction must be made between short-term fluctuations and long-term changes in weather, a distinction that is very difficult. The ocean environment was focussed on, reflecting the significance of the sea to Vietnam, a country with a long coastline. Discussions of long-term climate change in Vietnam as well as of impacts on society and on human health were featured, and the connection between energy use and climate change was highlighted.

Thirdly, sea level rise was examined. The impacts on Vietnam were predicted and models of future changes in sea level were discussed. Finally, the strategies to respond to these changes were presented.

I have been most impressed with the high quality of the research that has been presented here and would like to

congratulate all those that have taken part in this important exchange. It is hoped that conferences such as this one will lead to greater cooperation in coming to terms with the global implications of climate change and sea level rise.

CONFERENCE RECOMMENDATIONS

Considering Vietnam's history and exposure to frequent climatic perturbations, identification of climate change within the context of extreme climate variability will require considerable multidisciplinary and international research effort. It is important not to misinterpret climatic variation as climate change. Therefore, we wish to propose the following eight recommendations.

1. The conference participants strongly recommend that further international conferences with a regional focus on climate change be held in developing countries. these meetings provide an extremely valuable means of stimulating research and exchange of ideas and information, education, coordination and networking.

2. Given the scarcity of information on the regional consequences of climate change in developing countries, the provision of information of scientific methods and tools ranks as a high priority. Scientists from such countries are advised to participate in international centers providing such information and tools.

3. International cooperation in research on climate change is essential. This should bear in mind the specific situation of Vietnam, with its internationally known rivers, the Red and the Mekong, variable monsoon, tropical climate, El Nino influence, long coastline and great biodiversity.

4. Regional research and cooperation with other nations of Southeast Asia and the East China Sea is also of great importance. It is recommended that an East China Sea conference encompassing such topics as monsoons would be an appropriate means of initiating

greater collaboration.

5. National research programs require further support from the international community. Funding is required not only for the research itself but also for associated training and technology transfer. The UNEP projects on sea level rise impacts on Vietnam and Southeast Asia provide a good example.

6. Further research is needed on the prevention of and response to natural inter-annual weather and climate calamities such as flood and drought. This may take place in coordination with the UN Decade for Decreasing Disasters. It is important to increase the reliability of research results concerning sea level rise and climate change in Vietnam with reference to and in comparison with other countries in the region. Of immediate social benefit, these studies provide valuable information for use in climate change studies.

7. There is a clear need for further research concerning both control and adaptation in many areas by Vietnamese scientists. This should be encouraged by frequency meetings, coordination between institutes and disciplines and networking as supported by decisions of the UNEP governing council.

8. Consideration of long-term climate change should be an integral part of the formulation of a national strategy for sustainable development. Climate change is related to the production and use of energy and highlights the pressing importance of the need for sustainable development strategies.

APPENDIX I

Agenda

CLIMATE CHANGE AND SEA LEVEL RISE IMPACTS

9-10 November 1991
Hanoi, Vietnam

Saturday November 9, 1991.

8:30-9:00	Registration
9:00	Conference Opening
9:00-9:10	Participants Introduction Dr. Hoang Van Huay
9:10-9:25	Opening Speech Prof. Ha Hoc Trac
9:25-9:45	Speech by Representative of S.R. Vietnam Prof. Dang Huu
9:45-10:05	Speech by Representative of the United Nations Environmental Program Dr. Michael Glantz
10:05-10:20	Break

<u>Sub-committee A:</u> Climate change and socio-economic problems

Chairman: Prof Ha Hoc Trac

10:20-10:45	1.	Global Climate Change: Evaluation of Impacts and Related Issues in Vietnam Dr. Nguyen Huu Ninh
10:45-11:10	2.	Climate Impact and Environment Dr. Michael Glantz
11:10-11:35	3.	System of Observation, Testing and Study of Climate Change and the Environment in Vietnam Dr. Nguyen Duc Ngu
11:35-12:00	4.	Climate Impacts and Policy Responses in Brazil

Dr. Eduardo de Castro Bezerra Neto

12:00-13:30 Mid-Day Break

Sub-committee B: Climate fluctuations, changes and influences

Chairman: Dr. Nguyen Duc Ngu

13:30-13:50 1. El Nino/Southern Oscillation Teleconnections Over Southeast Asia
Dr. George Kiladis

13:50-14:10 2. Influences of Climate Fluctuations and Changes on Agriculture in Vietnam
Dr. Hoang Minh Hien

14:10-14:30 3. Relationships Between Sea Environment and Marine Resources in Vietnam's Territorial Waters
Dr. Dao Manh Son

14:30-14:50 4. Regional Climate Scenarios for Use in Impact Studies
Dr. Phillip Michael Kelley

14:50-15:10 5. Climatic Variations and their Effects on Water Resources in Vietnam
Mr. Dao Van Le

15:10-15:30 Break

Chairman: Dr. Ata Qureshi

15:30-15:50 6. A Review of Climate Change in Vietnam over the Past 100 Years
Dr. Nguyen Trong Hieu

15:50-16:10 7. Climate Change and Impacts in Southeast Asia
Dr. Julia Porter

16:10-16:30 8. Climate Influence on Human Health in Vietnam
Dr. Tran Viet Lien

16:30-16:50 9. Preliminary Studies on Inter-Relations Between Environment and Energy in Vietnam
Prof. Nguyen Minh Due

Sunday, November 10, 1991.

Sub-committee B (Continued)

Chairman: Dr. Garry Sharp

8:30-8:50	10.	Climate Change and Biodiversity in Vietnam Prof. Vo Quy
8:50-9:10	11.	Climate Impact, Examples from Thailand Dr. Suwana Panturat
9:10-9:30	12.	Preliminary Assessments of Weather and Hydrology Under Influence of Climate Change Dr. Dinh Van Loan
9:30-9:50	13.	Changes in the Red River and Mekong River Flows over a Period of Many Years Dr. Tran Thanh Xuan
9:50-10:20	Break	

Sub-committee C: Sea level rise

Chairman: Prof. Vo Quy

10:20-10:40	1.	Sea Level and Climate Change Prof. Nguyen Ngoc Thuy
10:40-11:00	2.	Some Problems of Vietnam Seashore Erosion Prof. Le Duc An
11:00-11:20	3.	Preliminary study on the influences of sea level variations on mangrove forests in Vietnam Prof. Phan Nguyen Hong
11:20-11:40	4.	Using Remote Sensing Materials to Study Coastal Areas in Vietnam Dr. Vu Ngoc Quang
11:40-12:00	5.	A Model of Sea Level Rise Caused by Ocean Thermal Expansion Dr. Gilbert Tucker

Sub-committee D: Strategy and policy responses

Chairman: Dr. Tucker

13:30-13:50	1.	Vietnam's Environment Policy Towards Climate Change Dr. Nguyen Ngoc Sinh
13:50-14:10	2.	Climate Change and Ocean Consequences Dr. Garry Sharp
14:10-14:30	3.	Strategy Response Towards Environment and Climate Change in Vietnam Prof. Nguyen Van Huong
14:30-14:50	4.	International Coordination in Global Environment Change Research Dr. Ata Qureshi
14:50-15:10		Break
15:10-16:00		Discussion of Recommendations
16:00		Conference Closing Dr. Michael Glantz, UNEP Dr. Nguyen Huu Ninh, CERED Prof. Ha Hoc Trac, VUSTA
19:00		Banquet in honor of participants organized by UNEP/VUSTA/ITECO/CERED

APPENDIX II

International Conference on

CLIMATE CHANGE AND SEA LEVEL RISE IMPACT

Hanoi, Vietnam, November 9-10, 1991

LIST OF PARTICIPANTS

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   Hydrometeorological Service, Vietnam

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