PROJECT REF: APN 99003

The impact of El Niño and La Niña on Southeast Asia: the human dimension, policy lessons and implications for global change

Final Report

An Indochina Global Change Network project funded by the Asia-Pacific Network for Global Change Research

Coordinators for the Indochina Global Change Network

Dr Nguyen Huu Ninh
Centre for Environment Research Education and Development and
Global Environment Programme, Hanoi University of Science
Address: A01 K40, Giang Vo, Hanoi, Vietnam. Tel/Fax: 84-4-8515213.
Email: cered@hn.vnn.vn.
with
Dr Mick Kelly
Climatic Research Unit/Centre for Social and Economic Research on the Global Environment,
University of East Anglia
Address: Norwich NR4 7TJ, United Kingdom. Tel: 44-1603 592722. Fax: 44-1603-507784. Email:
m.kelly@uea.ac.uk

THE PROJECT

The project has addressed the issue of El Niño and La Niña impacts on Southeast Asia. It consisted of two components, one of which will be on-going at no cost after the project funding period:

first, a workshop held in February 2000 examined the impact of the El Niño/La Niña phenomenon on Southeast Asia focusing on the neglected region of Cambodia, Laos and Vietnam taking an interdisciplinary perspective and paying particular attention to social and economic consequences, policy lessons, and implications regarding the longer-term impact of global environmental change; and,

second, an information project directed towards scientists and policymakers that will build on the results of the workshop by promoting further research and policy development to ensure an effective regional response to El Niño and La Niña.

Through its focus on the El Niño phenomenon, the project relates the APN area of interest "Climate System Change and Variability" and it covers a second area of interest, under "Other Important

Topics", "Policy Support Research." It also addresses a present APN area of high priority "Human Dimensions."

BACKGROUND

El Niño and La Niña and the terms used to describe the periodic warming and cooling of the tropical Pacific Ocean and the consequent disruption of the atmospheric circulation bringing extreme weather and climate to many low-latitude areas.

Both El Niño and La Niña events have severe impacts on the Indochina region, affecting patterns of temperature, rainfall and other weather variables such as the frequency of tropical storms. While some consequences may be beneficial, adverse effects on agricultural production, water supplies, flood and storm occurrence and other determinants of human well-being and economic health frequently occur.

At this time, the capacity of the nations of Indochina to protect local peoples, natural ecosystems and national economies against the impact of El Niño and La Niña is limited. Historic means of coping with natural hazards, developed over centuries and millennia, are severely stretched as climate extremes coincide with societal developments that increase the vulnerability of regional populations and economies.

The needs of the region are many and diverse - to ensure access to adequate human, technical and financial resources, to develop the scientific and decision-making infrastructure, to put in place the necessary communication channels between relevant governmental agencies and other stakeholders, including local communities, to promote awareness amongst stakeholders and the general public, to strengthen response strategies at the regional, national and community levels...

The Indochina Global Change Network was formed to strengthen the scientific capacity of the focal nations of Cambodia, Laos and Vietnam to respond to the multiple threats posed by global environmental change and related hazards. The Network is dedicated to the ideal of sustainable development, meeting present-day needs while ensuring environmental security across both space and time.

The workshop *The Impact of El Niño and La Niña on Southeast Asia* was organized by the Indochina Global Change Network to assist the scientific communities of the nations of Cambodia, Laos and Vietnam, and the other nations of Southeast Asia, to play their part in strengthening the capacity of the region to respond effectively to the impact of El Niño and La Niña.

THE WORKSHOP

The workshop *The Impact of El Niño and La Niña on Southeast Asia* was organized by the Center for Environment Research Education and Development, Hanoi, Vietnam, with the assistance of the University of East Anglia, Norwich, United Kingdom, on behalf of the Indochina Global Change Network and was held at the Fortuna Hotel, Hanoi, Vietnam, from February 21st-23rd 2000.

The meeting brought together invited representatives of the scientific and decision-making communities from the focal Indochina Global Change Network nations of Cambodia, Laos and Vietnam and other countries in Southeast Asia with experts from outside the region to assess current understanding and to consider how the scientists of this region, in particular, might promote effective responses. There was strong representation at the meeting from the Southeast Asian meteorological and climatological communities and experts in sectoral concerns, such as agriculture and water supplies, as well as policy analysts and policy makers also attended. The full participants list and meeting agenda is given in the Workshop Report.

By sharing experience both within the Southeast Asia region and further afield, by providing a forum for discussion, by providing access to resources available from the international community, and through specific recommendations for action, it is hoped that the workshop has taken a modest step towards enhancing the region's capacity to respond effectively to short-term climate variability and, in the longer-term, global environmental change.

The workshop participants advanced a series of detailed recommendations, documented in the Workshop Report, regarding practical action that should be taken promptly to strengthen the region's capacity to respond effectively to El Niño and La Niña events. They strongly endorsed moves towards a more proactive response to such hazards.

The workshop took place against a backdrop of changing conditions in the key indicator regions of the tropical Pacific Ocean. Recognizing their responsibility to respond to the latest information regarding the likely breakdown of the prevailing La Niña event, the workshop participants advanced three recommendations for immediate action that constitute a <u>precautionary</u> response to the latest assessment, preparing the ground for a more, concerted response to the next El Niño event, whenever that might occur.

The workshop participants noted that a more definite assessment should be available by June 2000 and strongly supported the existing proposal that a regional outlook forum be held in August 2000.

The recommendations for immediate action are that:

1. In each country, a workshop should be organized bringing together representatives from government agencies and other stakeholders to draw attention to the latest assessment, provide information about potential impacts, open channels of communication, ensure full cooperation, and mobilize support for the strengthening of response strategies, thereby facilitating further action as later developments dictate.

2. In each country, meteorological and climatological agencies should ensure prompt and continual monitoring of El Niño forecasts available internationally, and of local indicators of effects and impacts, and make this information widely available in appropriate forms.

3. Each national meteorological agency should formally request, as a matter of urgency, that the World Meteorological Organization make available regular El Niño advisory reports, as undertaken during the last El Niño event, to ensure a single, consistent, authoritative source of information. It is recognized that the preparation of operational assessments of this nature may not be considered to be within the existing remit of the World Meteorological Organization and will have resource implications. Nevertheless, El Niño and La Niña represent a global problem, requiring a high degree of international cooperation such as is already manifest in support for this agency. Moreover, the multiplicity of forecasts, at times divergent and of varying reliability, warrants the intervention of a single, authoritative agency to provide a clear guide to the scientific consensus.

Finally, the workshop participants endorsed a statement regarding the likely breakdown of La Niña conditions this year. This statement, appended to this report, presents an expert assessment of the current forecasts and is carefully worded, calling for action without being unduly alarmist. It will be used as a basis for reports to relevant agencies and stakeholders, press releases and information for the general public, prepared by workshop participants on returning to their own countries.

INFORMATION ACTIVITIES

Alongside the workshop, the other main activity on this project is follow-up work to ensure that the workshop has a lasting impact on the development of regional policy with regard to averting the worst impacts of El Niño and La Niña and taking advantage of beneficial effects.

The project has produced an 80-page Workshop Report, containing an account of the meeting and the detailed conclusions and recommendations of the participants as well as summary papers from the invited speakers. This will be distributed widely within the region and to key international agencies. Based on this report, shorter briefing documents targeted at the scientific and policy communities of the region are being prepared. All this material will also be available in electronic format at (http://www.cru.uea.ac.uk/tiempo/), through the collaboration of the Tiempo Climate Cyberlibrary, an electronic information service supporting developing country work on climate issues.

Finally, workshop participants are committed to following up the recommendations of the meeting and will keep the workshop organizers informed of their subsequent activities.

The Indochina Global Change Network will now solicit funds from various sources to follow-up two specific recommendations of the workshop concerning:

a) the organization of training workshops on climate prediction techniques and climate impact assessment for the meteorological and climatological communities of Cambodia, Laos and Vietnam; and,
b) short fellowships for scientists from these nations to work with international modeling groups as they produce seasonal forecasts.

Finally, the project organizers, on behalf of the Indochina Global Change Network, would like to take this opportunity to thank the Asia-Pacific Network for Global Change Research for their support for these activities.

BREAKDOWN OF LA NIÑA LIKELY: NEED TO MONITOR KEY EL NIÑO INDICATORS AND OPEN CHANNELS OF COMMUNICATION

Statement issued by participants at the workshop
Impact of El Niño and La Niña on Southeast Asia
Hanoi, Vietnam
23rd February 2000

The latest evidence from oceanographic and atmospheric information from across the equatorial Pacific Ocean is suggesting that the current La Niña pattern will soon wane. Ocean-atmosphere model predictions, together with our understanding of the normal course of the life cycle of La Niña, suggest that the current La Niña will fade out by about June 2000.

Some predictions suggest that there is potential for warming of the ocean in the central and eastern Pacific beyond June 2000. Such warming would indicate a shift toward an El Niño phase (that is, the opposite pattern to La Niña) developing the second half of the year 2000, though of unknown magnitude at this stage.

It should be emphasized that the forecasts that are being made by some agencies of an El Niño in the Pacific Ocean this year are being produced while most indicators are still at a pre-development stage. Therefore, there still exists some time for conditions to take a different course over the next three months to May 2000.

Nevertheless, it is strongly suggested that local meteorological, climatological and other institutions, as a precautionary response to this assessment, should monitor key parameters, such as sea surface temperature and other El Niño indicators, very closely over the next three to six months in order to gauge the further potential, or otherwise, of El Niño development later this year.

It is further recommended that effective communication channels between local meteorological and climatological agencies, other relevant agencies and stakeholders in potentially-affected sectors be set up with some urgency in order to facilitate appropriate means of dissemination of warnings and other information and, if it proves necessary, more concerted action at a later date.

THE IMPACT OF EL NIÑO AND LA NIÑA ON SOUTHEAST ASIA

21 st-23rd February 2000

Hanoi, Vietnam

WORKSHOP REPORT

Organized by the Indochina Global Change Network
Funded by the Asia-Pacific Network for Global Change Research
Sponsored by the Vietnam Union of Science and Technology Associations

THE IMPACT OF EL NIÑO AND LA NIÑA ON SOUTHEAST ASIA

21st-23rd February 2000

Hanoi, Vietnam

Organized by the Center for Environment Research Education and Development with the assistance of the University of East Anglia on behalf of the Indochina Global Change Network

Indochina Global Change Network Secretariat Office:

Center for Environment Research Education and Development

A01, K40, Giang Vo, Hanoi, Vietnam

Tel/fax: 84-4-8515213 Email: cered@hn.vnn.vn

WORKSHOP REPORT

Funded by the Asia-Pacific Network for Global Change Research

Sponsored by the Vietnam Union of Science and Technology Associations

The workshop *The Impact of El Niño and La Niña on Southeast Asia* was organized on behalf of the Indochina Global Change Network by the Center for Environment Research Education and Development, Hanoi, Vietnam, with the assistance of the University of East Anglia, Norwich, United Kingdom

Cover photo: Do Huan

Workshop report:
Edited by Mick Kelly, Sarah Granich and Nguyen Huu Ninh
Published by the Center for Environment Research Education and Development
Hanoi, Vietnam

SUMMARY

El Niño and La Niña are the terms used to describe the periodic warming and cooling of the tropical Pacific Ocean and the consequent disruption of the atmospheric circulation bringing extreme weather and climate to many low-latitude areas.

Both El Niño and La Niña events have severe impacts on the Indochina region, affecting patterns of temperature, rainfall and other weather variables such as the frequency of tropical storms. While some consequences may be beneficial, adverse effects on agricultural production, water supplies, flood and storm occurrence and other determinants of human well-being and economic health frequently occur.

At this time, the capacity of the nations of Indochina to protect local peoples, natural ecosystems and national economies against the impact of El Niño and La Niña is limited. Historic means of coping with natural hazards, developed over centuries and millennia, are severely stretched as climate extremes coincide with societal developments that increase the vulnerability of regional populations and economies.

The needs of the region are many and diverse - to ensure access to adequate human, technical and financial resources, to develop the scientific and decision-making infrastructure, to put in place the necessary communication channels between relevant governmental agencies and other stakeholders, including local communities, to promote awareness amongst stakeholders and the general public, to strengthen response strategies at the regional, national and community levels...

The Indochina Global Change Network was formed to strengthen the scientific capacity of the focal nations of Cambodia, Laos and Vietnam to respond to the multiple threats posed by global environmental change and related hazards. The Network is dedicated to the ideal of sustainable development, meeting present-day needs while ensuring environmental security across both space and time.

The workshop *The Impact of El Niño and La Niña on Southeast Asia* was organized by the Indochina Global Change Network to assist the scientific communities of the nations of Cambodia, Laos and Vietnam, and the other nations of Southeast Asia, to play their part in strengthening the capacity of the region to respond effectively to the impact of El Niño and La Niña.

By sharing experience both within the Southeast Asia region and further afield, by providing a forum for discussion, by providing access to resources available from the international community, and through specific recommendations for action, it is hoped that the workshop has taken a modest step towards enhancing the region's capacity to respond effectively to short-term climate variability and, in the longer-term, global environmental change.

The workshop participants advanced a series of detailed recommendations regarding practical action that should be taken promptly to strengthen the region's capacity to respond effectively to El Niño and La Niña events. They strongly endorsed moves towards a more proactive response to such hazards.

The workshop took place against a backdrop of changing conditions in the key indicator regions of the tropical Pacific Ocean. Recognizing their responsibility to respond to the latest information regarding the likely breakdown of the prevailing La Niña event, the workshop participants identified three key recommendations for immediate action that constitute a precautionary response to the latest assessment, preparing the ground for a more concerted response to the next El Niño event, whenever that should occur.

The workshop participants noted that a more definite assessment should be available by June 2000 and strongly supported the existing proposal that a regional outlook forum be held about that time.

The recommendations for action are that:

1. In each country, a workshop should be organized bringing together representatives from government agencies and other stakeholders to draw attention to the latest assessment, provide information about potential impacts, open channels of communication, ensure full cooperation, and mobilize support for the strengthening of response strategies, thereby facilitating further action as later developments dictate.

2. In each country, meteorological and climatological agencies should ensure prompt and continual monitoring of El Niño forecasts available internationally, and of local indicators of effects and impacts, and make this information widely available in appropriate forms.

3. Each national meteorological agency should formally request, as a matter of urgency, that the World Meteorological Organization make available regular El Niño advisory reports, as undertaken during the last El Niño event, to ensure a single, consistent, authoritative source of information. It is recognized that the preparation of operational assessments of this nature may not be considered to be within the existing remit of the World Meteorological Organization and will have resource implications. Nevertheless, El Niño and La Niña represent a global problem, requiring a high degree of international cooperation such as is already manifest in support for this agency. Moreover, the multiplicity of forecasts, at times divergent and of varying reliability, warrants the intervention of a single, authoritative agency to provide a clear guide to the scientific consensus.

Finally, the workshop participants endorsed a statement regarding the likely breakdown of La Niña conditions this year. This statement presents an expert assessment of the current forecasts and is carefully worded, calling for action without being unduly alarmist. It will be used as a basis for reports to relevant agencies and stakeholders, press releases and information for the general public, prepared by workshop participants on returning to their own countries.

The meeting was an activity of the Indochina Global Change Network, funded by the Asia-Pacific Network for Global Change Research and sponsored by the Vietnam Union of Science and Technology Associations. It was organized by the Center for Environment Research Education and Development, Hanoi, Vietnam, with the assistance of the University of East Anglia, Norwich, United Kingdom, and was held at the Fortuna Hotel, Hanoi, Vietnam, from February 21st-23rd 2000.

THE PROBLEM

Over the past two decades, the term El Niño has become associated with social, economic and environmental crises in many parts of the globe. El Niño events signal major departures from normal seasonal climate patterns, particularly over tropical regions. For some countries, an El Niño event is typically associated with abnormal heat and drought, for others it is persistent rain and devastating flooding.

El Niño, the Christ Child, was originally the name given by local fishermen to the annual appearance of a warm southward flowing current in the surface waters off coastal Ecuador and northern Peru during the Southern Hemisphere summer (December-February). The coastal communities also recognized that in some years the offshore waters were warmer than usual and cold nutrient-rich waters failed to return during the following year, giving a poor fish harvest with disastrous consequences on local food stocks and community welfare. Flood rains that caused loss of life and severe damage often accompanied the periods of abnormally warm coastal waters.

Now, it is the period of prolonged abnormal warming and consequent climate disruption that is referred to as an El Niño event. The related disturbance of the atmospheric circulation, that eventually creates climate extremes throughout much of the tropics and subtropics, is known as the Southern Oscillation. The overall process of Pacific warming and cooling, atmospheric disturbance and climate disruption is sometimes referred to as the El Niño-Southern Oscillation phenomenon or simply as El Niño.

In recent decades, the importance of the opposite phase of El Niño - his sister La Niña - has become more widely recognized. The cooling of the tropical Pacific also brings disruption of weather and climate to many tropical and subtropical regions. In some areas, the disruption may have even greater impacts than in the case of El Niño.

Both El Niño and La Niña events have severe impacts on the Indochina region, affecting patterns of temperature, rainfall and other weather variables such as the frequency of tropical storms. While some consequences may be beneficial, adverse effects on agricultural production, water supplies, flood and storm occurrence and other determinants of human well-being and economic health frequently occur.

For development of sectoral strategies to mitigate the impacts and to take advantage of any favourable opportunities during El Niño events, it is essential for each country to have access to global, regional and national climate monitoring products.

William Kininmonth

At this time, the capacity of the nations of Indochina to protect local peoples, natural ecosystems and national economies against the impact of El Niño and La Niña is limited. Historic means of coping with natural hazards, developed over centuries and millennia, are severely stretched as climate extremes coincide with societal developments that increase the vulnerability of regional populations and economies.

The needs of the region are many and diverse - to ensure access to adequate human, technical and financial resources, to develop the scientific and decision-making infrastructure, to put in place the necessary communication channels between relevant governmental agencies and other stakeholders, including local communities, to promote awareness amongst stakeholders and the general public, to strengthen response strategies at the regional, national and community levels...

The Indochina Global Change Network was formed to strengthen the scientific capacity of the focal nations of Cambodia, Laos and Vietnam to respond to the multiple threats posed by global environmental change and related hazards. The Network is dedicated to the ideal of sustainable development, meeting present-day needs while ensuring environmental security across both space and time.

The workshop *The Impact of El Niño and La Niña on Southeast Asia* was organized by the Indochina Global Change Network to assist the scientific communities of the nations of Cambodia, Laos and Vietnam, and the other nations of Southeast Asia, to play their part in strengthening the capacity of the region to respond effectively to the impact of El Niño and La Niña.

While the focus of the workshop discussion was the response to the impact of the short-term, interannual phenomena of El Niño and La Niña, strengthening the capacity to respond to present-day hazards also represents an effective precautionary response to the longer-term threat of global environmental change, specifically the global warming and related climate change and sea-level rise induced by human activity. If we can cope with present-day climate impacts more effectively then we will be better equipped to manage the long-term threat of climate change and the many other adverse effects of human activity.

The workshop was organized by Nguyen Huu Ninh, Mick Kelly and Sarah Granich on behalf of the Indochina Global Change Network in order to address these critical issues and, thereby, support efforts to promote sustainable patterns of development.

THE WORKSHOP

The workshop *The Impact of El Niño and La Niña on Southeast Asia* considered the implications of El Niño and La Niña events for Southeast Asia. Participants drew particular conclusions regarding capacity strengthening needs for the nations of Cambodia, Laos and Vietnam, the focal nations of the Indochina Global Change Network, in order that these nations are able to respond more effectively to adverse impacts and take greater advantage of beneficial effects. They also gave serious consideration to the position of the other nations of Southeast Asia. Other aspects of short-term climate variability also affect the area and these, too, were discussed at the meeting.

The workshop took place against a backdrop of changing conditions in the key El Niño indicator regions of the Pacific Ocean and this provided a strong focus for discussion of the role of the scientific community in promoting and supporting the wider national and regional response.

The specific question the workshop addressed was - How can the nations of Indochina, and the other nations of Southeast Asia, improve their understanding of the El Niño and La Niña phenomenon so they can predict and anticipate impacts and respond more effectively, thus protecting human life and economic health?

The meeting brought together invited representatives of the scientific and decision-making communities from the focal Indochina Global Change Network nations of Cambodia, Laos and Vietnam and other countries in Southeast Asia with experts from outside the region to assess current understanding and to consider how the scientists of this region, in particular, might promote effective responses. There was strong representation at the meeting from the Southeast Asian meteorological and climatological communities and experts in sectoral concerns, such as agriculture and water supplies, as well as policy analysts and policy makers also attended. The full participants list is given in Appendix 1.

The agenda for the meeting drew on previous discussions with policy makers in the focal nations regarding their views on capacity strengthening priorities and on experience of the most recent El Niño and La Niña events.

We underscore the need for wider use of training resources, development of training and public awareness programmes.

Laos delegation

The meeting considered three specific themes:

- *Impact assessment* - How is the climate of the region affected, including the monsoon circulations? What are the sensitive sectors (agriculture, water supply, coastal protection, natural disasters and so on)? Are there positive as well as negative impacts?
- *Prospects for prediction* - What seasonal climate forecasts are available internationally and how reliable are they? Are these forecasts used in the region? What monitoring and prediction schemes have been developed within the region? How can forecasting capacity be improved? Can forecasts be effectively used?
- *Responding to El Niño and La Niña* - What needs to be done to promote effective response strategies in the region? What can participants at this meeting do to promote an effective, precautionary response to the latest predictions of the likely breakdown of the prevailing La Niña event.

Invited papers identified key conclusions, issues, trends, resources and capacity strengths and weaknesses, providing a sound basis for discussion during the working group sessions. During intensive working group sessions, conclusions and recommendations, including specific action points for the participants, were developed. The agenda for the meeting is presented in Appendix 2.

The workshop took full account of the various initiatives established by national and international organizations and programmes and focused on action that the participants themselves could undertake or promote in the near future.

By sharing experience both within the Southeast Asia region and further afield, by providing a forum for discussion, by providing access to resources available from the international community, and through specific recommendations for action, it is hoped that the workshop has taken a modest step towards enhancing the region's capacity to respond effectively to El Niño and La Niña and, in the longer-term, global environmental change.

Policy makers and the public must be educated and informed on the seriousness of the potential impacts of El Niño and La Niña.

Cambodia delegation

The meeting was an activity of the Indochina Global Change Network, funded by the Asia-Pacific Network for Global Change Research and sponsored by the Vietnam Union of Science and Technology Associations. It was organized by the Center for Environment Research Education and Development, Hanoi, Vietnam, with the assistance of the University of East Anglia, Norwich, United Kingdom, and was held at the Fortuna Hotel, Hanoi, Vietnam, from February 21st-23rd 2000.

Alongside this workshop report, two briefing documents for scientists and policy makers will be made available by mid-2000 as a result of the meeting.

NARRATIVE ACCOUNT

The workshop consisted of two half-day sessions of invited papers covering the three themes of the meeting: impact assessment, prospects for prediction; and responding to El Niño and La Niña. The remaining three half-day sessions were devoted to working group discussions on these three themes (participants were split into two parallel working groups for each discussion) and plenary report-back. In this section, brief accounts are given of the invited papers. Summary papers are given in an appendix to this report. Complete papers or related publications can be obtained from the authors. The workshop conclusions and recommendations are presented in the following section.

Dr. Nguyen Huu Ninh (Center for Environment Research Education and Development) opened the workshop on behalf of the Indochina Global Change Network and welcoming speeches were then delivered by Professor Academician Vu Tuyen Hoang (Chairman of Vietnam Union of Science and Technology Associations), Dr. Vu Minh Mao MP, (Vice-Chairman, Committee on Science, Technology and Environment, National Assembly of Vietnam), Dr. Mick Kelly (University of East Anglia, UK) on behalf of the workshop organizers (Dr. Nguyen Huu Ninh, Dr. Mick Kelly and Ms. Sarah Granich) and Dr. Gerhard Breulmann (Asia-Pacific Network for Global Change Research)

Dr. William Kininmonth (Australasian Climate Research , Australia) presented a global overview of the El Niño-Southern Oscillation phenomenon, describing the physical basis of the process and its impacts world-wide. Understanding of the mechanisms underlying the phenomenon is well-advanced and extensive monitoring and prediction is now undertaken to provide early warning of developments. The impacts of El Niño and La Niña occur throughout the tropical and subtropical belts though the effect on climate varies from region to region. He emphasized the need for each country in Southeast Asia to have access to global, regional and national monitoring products and the need for cooperation at the regional level.

Mr. Sidup Bin HJ Sirabaha (Brunei Meteorological Service, Brunei) discussed the impact of El Niño and La Niña on Southeast Asia. The climate effects are diverse and widespread but more needs to be done to define the precise response of the Southeast Asian climate, particularly at the national and local level. The losses due to the 1997/98 El Niño amounted to more than US$1.38 billion and considerable human suffering occurred as a result of food shortages, landslides and persistent smog. He advanced various areas in which regional capacity needed to be strengthened.

> *There are major requirements needed in capacity building before an effective systems approach to climate forecasting can be realized.*
>
> Roger Stone

Dr. Hoang Minh Hien (Hydro-Meteorological Service of Vietnam) reported on recent work on the effect of El Niño and La Niña on the occurrence and characteristics of tropical cyclones in the Western North Pacific, Bien Dong Sea and the coast of Vietnam. The impact of La Niña on the typhoons which make landfall on the Vietnamese coast is more serious and more complicated than the effect of El Niño. In La Niña years, the number of storms making landfall is higher, affecting the south of the country in particular during the latter months of the typhoon season.

Mr. Sengdeuane Phomavongsa (National Disaster Management Office, Laos) presented a report on El Niño impacts on Laos on behalf of his nation's delegation. He noted that floods and droughts are a regular occurrence in his country but observed that particular droughts do seem to be associated with El Niño, causing low river flow and water supply shortages, especially for rice production during the dry season. He underscored the need for regional cooperation, stronger regional information systems, including warning systems, a wider use of training resources and public awareness information and the sharing of experts.

Mr. Mak Sideth (Ministry of Environment, Cambodia) discussed the situation of Cambodia with regard to El Niño and La Niña impacts on behalf of his country's delegation. He observed that there had been very little work undertaken on this topic in Cambodia but noted that related concerns include forest loss, flooding, less predictability in the weather, atmospheric pollution and climate change. Dependence on rice production makes Cambodia particularly vulnerable to any change in climate conditions, whether seasonal or long-term, and it is very important to strengthen the ability to respond to climate variability.

Mr. U Tun Lwin (Department of Meteorology and Hydrology of Myanmar) described the impact of El Niño and La Niña on Myanmar. The effect of El Niño is apparent in temperature, rainfall and drought indices and affects monsoon climatology. As an agricultural nation, any change in monsoon rainfall is also of great importance to this country. During major La Niña events, the monsoon is weakened and minimum temperatures fall far below normal. He called for better understanding of

We need to develop education and training of scientists and decision makers skilled in the use and interpretation of new forecast capabilities and analysis techniques.

Nguyen Van Thang

the impact of El Niño and La Niña on Myanmar and for further research globally on this phenomenon.

Dr. Simon Mason (University of California at San Diego, USA) discussed forecasts of the El Niño-Southern Oscillation phenomenon, describing their production and assessing their accuracy. There are two main means of predicting El Niño and La Niña: statistical methods and dynamical, model-based, techniques. Both approaches have strengths and weaknesses, related to the level of physical understanding on which they are based, technological and financial requirements, and the nature of the forecast product. He observed that both types of forecasting method perform about equally well but each one is appropriate for different circumstances. For Southeast Asia, statistical forecasting represents a good starting point but access to, and skill in interpreting, the products of model-based forecasts is also essential.

Dr. Roger Stone (Queensland Centre for Climate Applications, Australia) described two prediction methods in use in Australia. He proposed an efficient and practical approach using observed values of the Southern Oscillation Index or sea surface temperatures to predict future temperature and rainfall and, hence, secondary impact variables such as crop yields. This method might be particularly appropriate at this time for many of the meteorological services in Southeast Asia experimenting with seasonal climate prediction. He stressed the need for an overall systems approach, staff trained in relevant statistical and analytic techniques and the engagement of forecast users in all stages of the forecast process.

Professor Wang Shaowu (Peking University, PR China) described the historical development of the seasonal forecasting techniques that have been applied in China since the late 1950s. Statistical methods, informed by physical understanding of the processes that are involved, are now employed to predict a range of seasonal variables. There have been notable successes. The severe flood on the Changjiang River in the summer of 1998, for example, was successfully predicted. But, he concluded, knowledge is far from complete and the variable skill of the statistical forecasts, which may be the result of the varying influences on seasonal climate, must be understood. There is hope

There is an urgent need to strengthen capabilities at national and regional levels for effective emergency preparedness, prevention, mitigation, response, and recovery.

Sanny Jegillos

that the ongoing development of dynamical models, used to accurately predict summer rainfall in recent years, may prove a significant advance.

Dr. Nguyen Van Thang (Climate Research Center, Vietnam) discussed the development of a seasonal climate forecasting capability in Vietnam. Dynamical-statistical methods of prediction are used to forecast parameters such as winter season temperature, Hanoi rainfall, summer rainfall and the onset of severe cold in the winter. Medium-range (10-day) forecasting is also being developed. There is no specific dynamic climate prediction model available in Vietnam. At this time, climate prediction is considered experimental, rather than operational, but considerable efforts are being made to improve databases, identify physically-plausible predictors and evaluate skill levels so that forecast capacity can be strengthened.

Ms. Louise Bohn (University of East Anglia, UK) described research undertaken in Swaziland in southern Africa which has attempted to define user needs and the value of climate forecasts. She stressed the importance of considering user needs throughout forecast development. Timelines, charting month-by-month user operations, decisions and sensitivity to climate conditions can act as an effective guide in the assessment of requirements. Finally, she emphasized the various physical and human constraints that determine, in the real world, whether a forecast will be taken seriously and, indeed, whether it has any value at all.

Professor Tran Thanh Xuan (Institute of Meteorology and Hydrology, Vietnam) discussed the experience of the two big floods that occurred in central Vietnam towards the end of 1999. In some rivers, the flood levels were the highest seen in the past 70-100 years. Serious damage occurred for people and properties in the coastal provinces of central Vietnam. According to preliminary estimates, there were 700 killed and missing people and total economic losses reached 4.7 billion VND (US$ = 14,000 Vietnamese Dong). The floods also changed the natural environment, eroding mountains and riverbanks, filling cultivable land with sediment and creating new estuaries. The events of November and December 1999 may or may not have been generated by La Niña (which

> *The World Meteorological Organization has recommended to all nations that any accurate forecasts for tropical storms would become meaningless if the necessary steps for protection were not taken.*
>
> Duong Lien Chau

generally brings increased rainfall to central Vietnam) but most certainly highlight the need for strengthened disaster management, here and in other nations.

Dr. Duong Lien Chau (National Center for HydroMeteorological Forecasting, Vietnam) described the impact of a previous disaster affecting southern Vietnam: Tropical Storm Linda in November 1997, the most disastrous tropical storm this century in Vietnam. While the progress of Linda was forecast accurately and warning issued promptly, the unusual nature of this storm (such a strong storm rarely occurs in the affected region and it struck at high tide), communication problems (particularly with fishermen at sea) and lack of awareness amongst the local communities and of experience in relief and rescue activities heightened its impact with thousands of lives lost, livelihoods destroyed and considerable economic damage. She noted that lessons had been learnt from the experience of Tropical Storm Linda and that the Government of Vietnam has carried out a series of activities aimed at the reduction of damage and minimizing the loss of human life.

Mr. Sanny Jegillos (Asia Pacific Disaster Management Centre, Philippines) described the priorities in managing risks associated with El Niño and La Niña. Natural and human-induced disasters have had a devastating effect on the people of Asia and on national economies. In Southeast Asia, disaster-related issues are increasingly linked to growing environmental degradation, population growth, poverty and unplanned rapid industrialization, compounded by economic slowdown and shrinking public budgets. Responding to El Niño and La Niña impacts is still largely reactive, hampered by poor cooperation between neighbouring nations as well as heavy reliance on international humanitarian assistance. There is now, though, a shift towards a more proactive response, towards a development approach that incorporates hazard mitigation and vulnerability reduction. He outlined the key aspects of this 'disaster risk management approach' and stressed the need for regional cooperation.

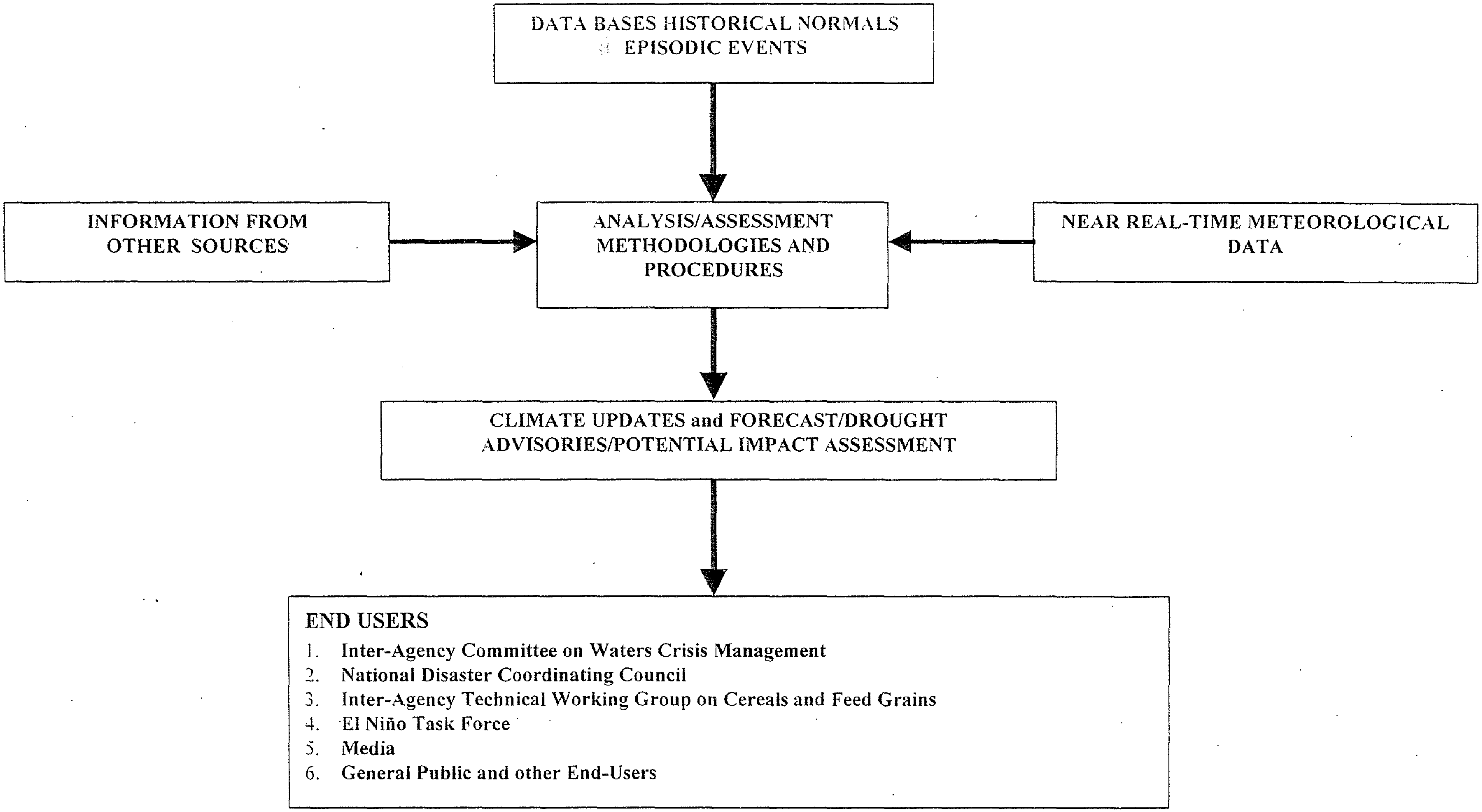
During the course of the working group sessions, short presentations were made by Dr. Ooi See Hai (Malaysian Meteorological Service), Dr. Aida Jose (Climatology and Agrometeorology Branch,

> *Disasters are truly cross border issues, and their management is a matter of concern for all countries situated in vulnerable areas and beyond.*
>
> Sanny Jegillos

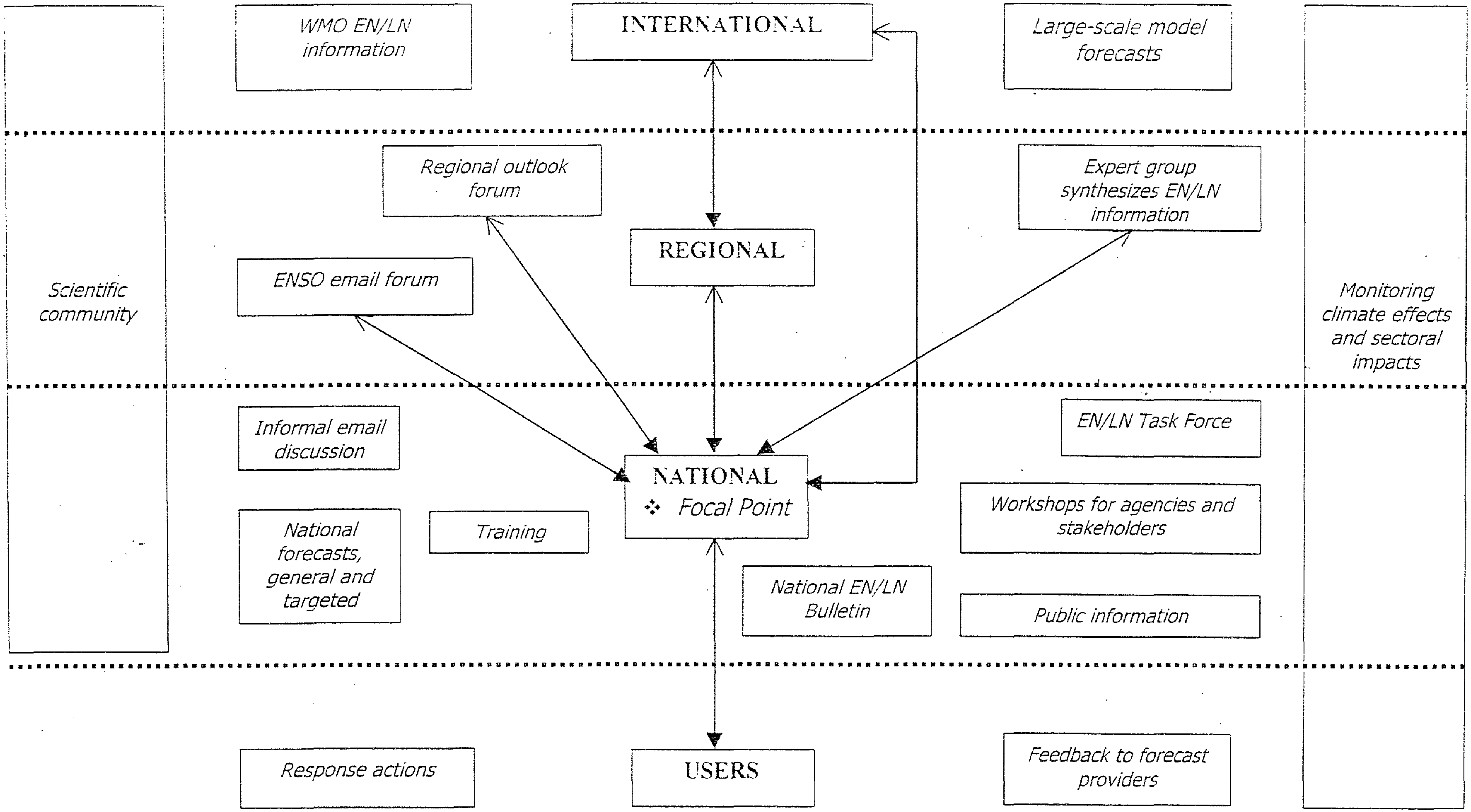
Philippines) and Dr. Patipat Patvivatsiri (Meteorological Department, Thailand) on the impact of El Niño and La Niña and associated research in their respective countries. Dr. Nguyen Van Viet (Institute of Meteorology and Hydrology, Vietnam) described the significant impact of El Niño and La Niña on rice production in Vietnam. Dr. Aida Jose discussed work on monitoring and early warning in the Philippines and Dr. Le Van Sanh (Vietnam Committee for the International Hydrological Program) presented an account of the recommendations of the Vietnam Committee for the International Hydrological Program with respect to the El Niño-Southern Oscillation phenomenon.

During the closing session of the workshop, Dr. Nguyen Huu Ninh and Dr. Mick Kelly summarized the development of the Indochina Global Change Network and plans for the next phase of activities, which will focus on training workshops covering climate prediction, impact assessment and land-use and land-cover change, were endorsed by the workshop participants. The aims and principles of the Indochina Global Change Network are presented in Appendix 3. Finally, after a vote of thanks from Dr. William Kininmonth on behalf of the workshop participants, expressing gratitude to the staff on the workshop registration desk, the staff of the Fortuna Hotel and the workshop organizers, Dr. Nguyen Huu Ninh closed the meeting, thanking the Asia-Pacific Network for Global Change Research for their support and the participants for their very active involvement.

In recognition of the significance of the workshop, a formal reception was held on the first evening at the Office of the National Assembly of Vietnam, hosted by the Vice-Chairman of the Committee on Science, Technology and Environment of National Assembly of Vietnam, during which the issues before the meeting were discussed. The reception was followed by dinner at the Hilton Hanoi Opera Hotel. On subsequent evenings, dinner was held at the Cha Ca La Vong and Lau Tu Xuyen restaurants. Dr. Nguyen Cong Thanh, Director-General of the Hydro-Meteorological Service of Vietnam was the honoured guest on the final evening.



Components of the National Drought Early Warning and Monitoring System in the Philippines. Presented by Dr. Aida Jose.



Resources, proposed activities and information flow regarding El Niño (EN) and La Niña (LN) at and between the international, regional and national levels. Solid arrow head: Forecast, monitoring and other scientific information. Open arrow head: Feedback.
Prepared by Louise Bohn, Mick Kelly and Luong Quang Huy on behalf of the workshop participants.

CONCLUSIONS AND RECOMMENDATIONS

Preamble

Climate extremes are a major cause for loss of life, destruction of infrastructure, depletion of food and water resources, displacement of communities, outbreak of disease and economic hardship around the globe. El Niño and La Niña events are the most important cause of climate extremes lasting from a season to a year or more in the tropics and subtropics. Responding effectively to the challenge posed by these events is essential if sustainable development is to be secured.

The workshop participants recognize the important step the United Nations has taken through Resolution 52/200 in calling for action to develop a strategy to mitigate the harmful effects of the El Niño and La Niña phenomena and to develop capabilities to better manage the impacts of climate extremes.

The workshop participants recognize the significant contribution of the scientific and technical assessments of the 1997/98 El Niño event made by the World Meteorological Organization and other United Nations agencies to review human dimensions and implications for policy development, as documented, for example, in report WMO-No.905.

The workshop participants also recognize the contribution made by other agencies, as evident in the International Decade for Natural Disaster Reduction and other international and regional initiatives, in promoting the development of response strategies with regard to natural disasters, some of which are directly caused by El Niño and La Niña events.

Finally, the workshop participants recognize Decision 10/CP5, resulting from international efforts to implement the UN Framework Convention on Climate Change, which calls for capacity building in developing countries to promote an effective response to the threat of long-term climate change induced by human activity. The participants emphasize that developing effective response strategies to manage short-term climate impacts represents a critical, precautionary step in responding to long-term change. The participants also note that Decision 10/CP5 states that the capacity-strengthening process "must be country-driven, reflecting their national initiatives and priorities, and that it is primarily to be undertaken by developing countries and in developing countries in partnership with developed countries."

With this in mind, the workshop participants arrived at the following conclusions and recommendations. Most of the conclusions and recommendations concern all nations of the Southeast Asia region, though, in keeping with the workshop's purpose, specific attention was paid to the particular situation of Cambodia, Laos and Vietnam.

Impact assessment

The workshop participants concluded that El Niño and La Niña have an extremely serious impact on Southeast Asia, with some of the most important impacts relating to typhoons, flooding and drought with seasonal incidence, frequency, severity and timing affected.

The overall severity of El Niño and La Niña impacts on the countries of the region is beyond question. Impacts can be readily observed in terms of human suffering and economic loss. Nevertheless, over the region as a whole, there are many different climatological effects and societal consequences that may be completely opposite in sense and differ significantly in timing from one area to the next.

Many countries report that the most severe impacts are in the agricultural sector through flooding and drought. Some countries report severe impacts on water resource availability affecting hydroelectric power generation and domestic and industrial consumption. Impacts on transportation, fisheries, population movements and health also occur.

It is apparent that there are both positive and negative impacts. Even a single effect on climate may have diverse consequences. A greater frequency of tropical storms, for example, may bring essential rain for crop development whilst causing serious dislocation to the same agricultural system through storm damage and flooding.

Local factors such as topography can mitigate, reinforce or transform the overall pattern of climate disruption and this process must be better understood. Relatedly, some areas are more sensitive to impacts that others. In Vietnam, for example, it is the central region of the country that appears most sensitive to El Niño and La Niña.

The workshop participants noted that sensitivity to climate extremes can be exacerbated by human activities such as deforestation and land clearing (increasing runoff and erosion), building of dykes (restricting flow and adding to flooding) and over-reliance on inadequate and fragile infrastructures, especially for housing, food storage and transport of goods. This process, too, needs to be monitored and understood.

The workshop participants concluded that, although much work had been done already in the region, improved understanding the geographical and temporal distribution of effects on climate and societal consequences on Southeast Asia must be a priority. Furthermore, in view of the difficulties in responding to extreme El Niño and La Niña impacts following in close succession, as has recently been experienced, the participants called for increased efforts to understand the effects of long-term climate change on the characteristics - the frequency, magnitude and regional effects - of these phenomena.

Finally, workshop participants noted that El Niño and La Niña are processes of global dimension with cross-border impacts, underlining the need for cooperation between the nations of the region. Neither El Niño nor La Niña respects national frontiers.

- It is recommended that more studies be undertaken at the country-level to define the complex spatial and temporal variability of the effect of El Niño and La Niña on climate. The availability of national climate records is an essential prerequisite to support such studies.

- It is recommended that research be undertaken to identify more precisely which aspects of regional climate variability are related to El Niño and La Niña and which to other processes. Without this information, the simple application of El Niño-based forecasts may be risky.

- It is recommended that more impact studies are undertaken to quantify social and economic consequences and the processes that link climate effects to sectoral impacts. This information will support accurate assessment of the scale of the problem, the effective allocation of resources, and the development of a rational response strategy. Such studies should cover sectoral indicators (agriculture, water supplies, storm damage to infrastructure, health, and so on) including both economic estimates and broader measures of human welfare. It is noted that economic estimates are of particular importance in mobilizing governmental and intergovernmental support.

- The collection and archiving, in readily-accessible format, of relevant biophysical and socio-economic data, covering, for example, crop production, health, storm damage and losses and emergency assistance, is essential to monitor quantitatively impacts and develop appropriate policies and strategies for mitigation.

- It is recommended that training opportunities in climate impacts assessment be increased, covering both biophysical and socio-economic aspects, to support expanded study of El Niño and La Niña impacts.

- It is recommended that significant input be obtained from end users, from government ministries through to individual farmers, regarding their perception of impacts to determine precisely what information is needed concerning climate effects and impacts on sectoral activities to support the development of effective response strategies.

- It is recommended that more attention is paid to how El Niño and La Niña characteristics (frequency, magnitude, regional effects) are related to natural climate trends and, in the longer-term, to the effects of climate change induced by human activity. Additional research and expertise on this issue is needed not only within the region but also world-wide.

- It is recommended that training courses, workshops and fellowships are organized to assist the research community of Southeast Asia to take advantage of the latest techniques and analyses available internationally for the identification of climate effects and sectoral impacts and that, through this process, the scientists of the region share their own experience and expertise with other nations.

- It is recommended that scientists involved in the study of the El Niño and La Niña phenomena actively engage with the policymaking community in order to disseminate appropriate information and promote awareness of the need for an effective response.

- It is noted that the scientific community has a clear responsibility to convey information and findings within each country and in regional fora to all stakeholders - politicians, government agencies, end users in agriculture, industry and so on, the media and the general public. Because of the widespread nature of the consequences of El Niño and La Niña, the stakeholder community should be considered to extend across the entire population.

- Finally, it is necessary to emphasize that not all the impacts of climate variability are negative and that an effective response strategy must contain elements directed towards taking full advantage of potentially beneficial effects as well as mitigating adverse consequences.

Prospects for prediction

The workshop participants noted that monitoring of climate developments and societal impacts is a critical prerequisite for an effective response strategy for El Niño and La Niña. They also concluded, with concern, that in some, if not many, countries no point of responsibility for these important activities exists.

Maintaining and, where appropriate, strengthening weather and climate monitoring networks throughout the Southeast Asian region is of critical importance if early warning systems are to be successful.

Over 700 stations in Vietnam are already monitoring effects on climate. However, there is a need for improvements in certain monitoring devices and data sources such as radar and satellite-based systems. The situation with regard to monitoring is not so good in Cambodia and Laos and this point requires attention.

The workshop participants emphasized that regional cooperation between national meteorological agencies in sharing data, information and techniques is essential to support an effective response whether at the national or regional level.

The situation with regard to monitoring sectoral impacts, on agriculture, water supplies and so on, requires attention in many countries. While impacts are generally reported, there is no coherent mechanism for collating this information and ensuring an appropriate degree of consistency.

The workshop participants concluded that, while climate prediction on the monthly and seasonal timescales is, for the most part, at an experimental stage, forecasts can, if developed and disseminated with due care, prove an essential component of the response to El Niño and La Niña. The development of a monthly to seasonal climate forecasting capability should be pursued in all nations of the region.

Climate forecasts can be made by statistical or dynamical, usually model-based, methods. For many of the nations of the Indochina region, statistical forecasting represents an appropriate first step in developing a local predictive capacity. Attempts to forecast directly secondary impact variables, such as agricultural yields, rather than, say, rainfall (often a very difficult variable to predict) may prove worthwhile in situations where that secondary variable integrates over time what may be diverse climate effects. Exchange of ideas and techniques between nations must be an important component of the development of forecast capacity.

Model-based forecasts, developed by regional groups or the broader international community, can also be of considerable value and every effort should be made to access, and most importantly acquire the skills to interpret, these products. These forecasts provide the first warning of developments within the global climate system that may lead to an El Niño or a La Niña event, its progress and ultimate breakdown.

Finally, the workshop participants emphasized that there is a critical need to involve forecast users in the process of forecast development. Too often, forecasts are issued in an inappropriate form or without adequate information to enable reliable end-use. Without this involvement, it is unlikely that forecasts will be effectively used, to the detriment of all concerned.

- It is recommended that all countries continue to maintain and upgrade, as necessary, their weather and climate monitoring facilities and that appropriate agencies also take responsibility for monitoring of El Niño and La Niña impacts. Particular attention should be paid to the situation in Cambodia and Laos.

- It is noted that, given the widespread nature of effects on climate and their geographical progression, regional cooperation must continue to ensure appropriate exchange of meteorological and climatological data within the Indochina region and between all the nations of Southeast Asia in support of region-wide monitoring and early warning. Data exchange should be carried out in real-time whenever possible. The distribution of data on-line should be pursued in order to achieve more efficient data exchange, though this will require the expansion of Internet access in certain countries.

- It is recommended that further means of funding data exchange should be pursued with international agencies such as the World Bank and other international bodies, programmes and initiatives. The Grant Support Scheme to Protect the Mekong River, for example, should be encouraged to develop, or modify existing, data collection or dissemination systems relevant to the impact of El Niño and La Niña.

- It is recommended that monitoring of the state of the global climate system be ongoing in all countries of the region - the most accurate 'forecasts' of the occurrence of El Niño and La Niña at this time are derived from direct observations of key indicators - and that extra effort be made to place the potential impact into a regional context. Access to information on El Niño and La Niña should be facilitated by the Internet and, in this context also, access to the Internet should be expanded, where necessary.

- It is recommended most strongly that useful statistical forecasts be developed as a matter of urgency in the Indochina nations. Vietnam, for example, though pursuing energetically seasonal forecasting using statistical techniques, does not believe it has forecasts of sufficient skill for public delivery. Yet this capability is available elsewhere and valuable lessons may be learnt from international experience. Seasonal forecasts of local rainfall, temperature, floods and storms should be given high priority, with prediction of selected secondary (that is, impact) variables, such as crop yields or water availability parameters, explored.

- It is recommended that every effort be made to access, and to gain the skills to interpret in the local context, the dynamical predictions of the El Niño-Southern Oscillation phenomenon and the related occurrence of El Niño and La Niña events that are now available. The skills to interpret these forecasts reliably, assessing their local implications, are essential because of the multiplicity of predictions that are available and their large-scale and temporally-averaged nature.

- It is recommended that research be undertaken to develop ways of 'downscaling', through statistical means or regional models, the dynamically-produced large-scale forecasts to a regional, national and local scale. Similarly, generalized seasonal forecasts must be interpreted in terms of synoptic-timescale processes (for example, the onset and decay of the rainy season) until a seasonal predictive capability that generates synoptic-scale information directly is developed.

- It is recommended that efforts are made to ensure that those concerned with developing dynamical predictive schemes in the major centres recognize the strong demand for localized and synoptic-scale forecasts and that, despite the technical challenges this will involve, devote considerable efforts to extending performance in this area.

- It is recommended that, whatever the predictive technique that is used, due attention be paid to the estimation of levels of forecast skills. Skill estimates should be made available to users as an intrinsic part of forecast delivery and may be designed to reflect user interests (for example, expressed in terms of secondary, impact variables).

- It is recommended that an assessment be carried out in the Indochina nations to determine training needs with regard to forecast capacity.

- It is recommended that local meteorologists and climatologists gain experience of interpreting model-based forecasts by working 'on the bench' in modelling institutions during the actual production of these forecasts.

- It is recommended that the World Meteorological Organization be formally approached by national meteorological services, and other organizations such as forecast groups in China, Japan, Australia, the United States, the United Kingdom and elsewhere contacted on an informal basis, to provide El Niño and La Niña assessments in advance to the countries of the region. It is recognized that the preparation of operational assessments of this nature may not be considered to be within the existing remit of the World Meteorological Organization and will have resource implications. Nevertheless, El Niño and La Niña represent a global problem, requiring a high degree of international cooperation such as is already manifest in support for this agency. Moreover, the multiplicity of forecasts, at times divergent and of varying reliability, warrants the intervention of a single, authoritative agency to provide a clear guide to reliability and community consensus. Furthermore, the World Meteorological Organization is encouraged to hold: 1) an expert meeting; and 2) a sessional meeting on El Niño and La Niña during the year 2000.

- It is recommended that a small regional task force be established to interpret the many forecasts available from the international scientific community and make this information available at the national level in the Southeast Asia region. A roster of experts should also be established to exchange information, views and forecasts regarding El Niño and La Niña. This process may be facilitated through the development of an e-mail list or similar and could result in a regular outlook bulletin.

- It is recommended that regular, regional climate fora be held in Southeast Asia to review developments and exchange ideas, with each country actively involved.

- It is recommended most strongly that climate forecasts be developed in both generalized and targeted formats. While generalized climate forecasts will be of interest to some user groups, more targeted climate forecast information relevant to the more precise needs of users (in agriculture, water supply, natural disaster planning and so on) must also be developed. Accordingly, action should be taken by forecast providers and others to identify just who are the relevant user groups.

- It is noted that, if climate forecast information is to be used effectively, users must gain 'ownership' of forecast products. Discussion groups involving forecast providers and forecast users should be established so that appropriate and effective feedback and interaction occur. It is recommended that scientists from data and forecast centres go into the field and interact with users at all scales to appreciate user needs.

- It is recommended that the necessary expertise be gained and, perhaps, a task group be set up in each country to interpret model-based dynamical forecasts models for local user needs, translating effects on climate into estimates of potential sectoral consequences.

- It is recommended that, through workshops or other means, users become familiar with probabilistic forecast information. This is necessary because of the potentially greater value of probabilistic information compared to forecasts expressed as a single definite outcome.

- It is recommended that efforts be made to ensure that end users and policy makers respond positively and appropriately to forecast information, so achieving maximum benefit. This may require changes in practice and attitude. Studies are required to identify the most appropriate responses. There are diverse biophysical and socio-economic constraints on user responses: these constraints must be addressed directly if forecasts are to be used effectively.

- Finally, it is recommended that strenuous efforts be made to raise general public awareness of the availability and meaning of El Niño and La Niña assessments and forecasts.

Responding to El Niño and La Niña

Recognizing that the coming months may prove a critical period in the development of conditions in the key El Niño indicator regions of the tropical Pacific, workshop participants took the decision to focus on what is needed to prepare the ground for a concerted response to avert the effects of the next major development in the El Niño/La Niña process, whenever that should occur. Specific action points are outlined in the following section. Here, more general conclusions and recommendations are advanced.

The workshop participants noted that awareness of the significance of El Niño and La Niña is far higher in the region as a result of the events of the past few years and that there is considerable regional experience and expertise in coping with related hazards gained through historical time. Nevertheless, it is clear that much must be done to improve existing response strategies.

The workshop participants strongly endorsed moves towards a proactive approach to managing the impact of climate hazards in general and the impact of El Niño and La Niña in particular. The development of effective national and regional frameworks to facilitate prompt action is essential.

The workshop participants noted that three issues - improving communications at all levels, mobilizing government support, and raising the awareness of key stakeholders and of the public at large - must be acted upon with some urgency to lay the groundwork for an effective response.

The workshop participants recognized the critical role the scientific community must play through the provision of sound, technical advice.

Finally, the workshop participants noted that any activities should be undertaken in full awareness of, and coordinated with, efforts already being undertaken by institutions such as the United Nations, the Food and Agriculture Organization and other international, regional and national organizations.

- It is recommended most strongly that communication channels within each nation, and between the nations of the region, be opened with some urgency and cover all responsible agencies and sectoral interests both within government, the private sector and wider community. Integrated systems management must be a critical aspect of an effective response strategy; the cooperation that is necessary can only be ensured when communication channels are fully open and operate without distortion.

- It is recommended most strongly that, with government support, a national focal point within an appropriate agency be established in each country. Each focal point will maintain an information database available to national users and will act as a link point for international support, information dissemination and the mobilization of national and international experts. The national focal point could also act as a communication point for a regional network covering the Indochina region or Southeast Asia as a whole.

- It is recommended that governments and existing task forces, institutions and all stakeholders be alerted to the likely breakdown of the prevailing La Niña event, and that political commitment be mobilized to ensure an effective response to the next El Niño event, whenever that might occur. Initially, a workshop may be the most appropriate means of opening communication channels, raising awareness of the issue, encouraging participants to consider their capacity to respond and identifying constraints and barriers. At the next stage, a task force may be established to promote and coordinate activities. Every effort should be made to inform and educate those in government regarding the possibility of impacts and to encourage the development of contingency plans and a national response strategy.

- In Vietnam, it is recommended that an interagency task force be established involving the Hydro-Meteorological Service of Vietnam and other stakeholder agencies.

- In Laos, it is recommended that a specific El Niño task force be established by the Natural Disaster Management Committee and involve all stakeholders such as the meteorological, agricultural and environmental agencies.

- In Cambodia, it is recommended that a task force be established involving relevant institutions and committees such as those responsible for agriculture, hydrology, meteorology, environment, health and disaster management.

- It is recommended most strongly that these national task forces be adequately resourced and be supported by firm political commitment. Full use should be made of existing institutional structures, wherever possible, to avoid duplication of effort. Full use should also be made of existing understanding, including traditional knowledge, of response measures and strategies. These national task forces could usefully share experience with one another through the national focal points and a wider regional network.

- It is recommended that each nation assess its capacity to respond to El Niño (and La Niña) impacts. Experience of the impact of the 1997/98 El Niño event within each nation should be reviewed and an assessment made of whether or not lessons learned from that event have been acted upon as a preliminary assessment of the effectiveness of existing response strategies. The possibility of financial support to underpin the necessary further development of regional response strategies from international agencies concerned with disaster management and related issues, such as the Asian Development Bank and the World Bank, should be explored.

- It is recommended that national governments, as member states of various international organizations, encourage the development of an international policy framework or action plan on El Niño and La Niña, mirroring the development of the International Decade for Natural Disaster Reduction Action Plan for the Future, International Strategy for Disaster Reduction, and similar initiatives. National and regional strategies should be coordinated with existing frameworks and there may be benefits to further integration.

- It is recommended that El Niño and La Niña training and public awareness activities be developed and implemented covering effects, impacts and response actions. These activities will require funding from government or other sources. Where possible, materials developed elsewhere should be used and adapted to local needs. User specific information and approaches should be employed through workshops, the media, booklets, and all other means that are available. Advantage can be taken of special occasions (such as WMO 2000, 23rd March 2000, the golden jubilee of the World Meteorological Organization) to educate the public, relevant agencies and key stakeholders regarding El Niño and La Niño by holding events, publishing articles in newspapers, issuing pamphlets, and so on.

- It is noted that any national response strategy ultimately depends on the mobilization of support and action at the community level. Care must be taken that 'top-down' organization does not exclude the 'grassroots' on which action at all levels must ultimately depend.

- It is recommended that, in each nation, a publication, entitled "El Niño Outlook" or similar, be published in the national language(s) on a regular basis and be distributed to key agencies concerned so that those agencies are kept informed of developments.

- It is recommended that full use be made of the comprehensive report *The 1997-1998 El Niño Event: A Scientific and Technical Retrospective* (WMO-No. 905, available from the World Meteorological Organization, 7 *bis*, avenue de la Paix, P O Box 2300, CH-1211, Geneva 2, Switzerland, fax: 41-22-7332829, e-mail: ipa@gateway.wmo.ch). This report contains valuable lessons from the last El Niño event including recommendations based on this experience, as well as a guide to the global climate system, El Niño processes and techniques for forecasting climate variability. It also provides textual and display materials that may, with due acknowledgement, be used in developing local materials.

- Finally, it should be noted that, in transmitting any information regarding El Niño and La Niña, care should be taken that the wording is not unduly alarmist but presents a carefully-crafted and authoritative assessment. There are still uncertainties in predicting these events. Moreover, even if an event does occur, there are still differences in impacts among, and within, different countries. There are regions where signals are strong but in others signals are weak.

Action points

Recognizing their responsibility to respond to the latest information regarding the likely breakdown of the prevailing La Niña event, the workshop participants identified three key recommendations for immediate action that constitute a precautionary response to the latest assessment, preparing the ground for more concerted action as circumstances require.

The workshop participants noted that a more definite assessment should be available by June 2000 and strongly supported the existing proposal that a regional outlook forum be held about that time. By then, it may be possible to provide clearer guidance regarding future prospects.

The recommendations for action are that:

1. In each country, a workshop should be organized bringing together representatives from government agencies and other stakeholders to draw attention to the latest assessment, provide information about potential impacts, open channels of communication, ensure full cooperation, and mobilize support for the strengthening of response strategies, thereby facilitating further action as later developments dictate.

2. In each country, meteorological and climatological agencies should ensure prompt and continual monitoring of El Niño forecasts available internationally, and of local indicators of effects and impacts, and make this information widely available in appropriate forms.

3. Each national meteorological agency should formally request, as a matter of urgency, that the World Meteorological Organization make available regular El Niño advisory reports, as undertaken during the last El Niño event, to ensure a single, consistent, authoritative source of information. It is recognized that the preparation of operational assessments of this nature may not be considered to be within the existing remit of the World Meteorological Organization and will have resource implications. Nevertheless, El Niño and La Niña represent a global problem, requiring a high degree of international cooperation such as is already manifest in support for this

agency. Moreover, the multiplicity of forecasts, at times divergent and of varying reliability, warrants the intervention of a single, authoritative agency to provide a clear guide to the scientific consensus.

Finally, the workshop participants endorsed a statement prepared by Simon Mason and Roger Stone regarding the likely breakdown of La Niña conditions. See accompanying box. This statement presents an expert assessment of the current forecasts and is carefully worded, calling for precautionary action without being unduly alarmist. It will be used as a basis for reports to relevant agencies and stakeholders, press releases and information for the general public, prepared by workshop participants on returning to their own countries.

BREAKDOWN OF LA NIÑA LIKELY: NEED TO MONITOR KEY EL NIÑO INDICATORS AND OPEN CHANNELS OF COMMUNICATION

Statement issued by participants at the workshop
Impact of El Niño and La Niña on Southeast Asia
Hanoi, Vietnam
23rd February 2000

The latest evidence from oceanographic and atmospheric information from across the equatorial Pacific Ocean is suggesting that the current La Niña pattern will soon wane. Ocean-atmosphere model predictions, together with our understanding of the normal course of the life cycle of La Niña, suggest that the current La Niña will fade out by about June 2000.

Some predictions suggest that there is potential for warming of the ocean in the central and eastern Pacific beyond June 2000. Such warming would indicate a shift toward an El Niño phase (that is, the opposite pattern to La Niña) developing the second half of the year 2000, though of unknown magnitude at this stage.

It should be emphasized that the forecasts that are being made by some agencies of an El Niño in the Pacific Ocean this year are being produced while most indicators are still at a pre-development stage. Therefore, there still exists some time for conditions to take a different course over the next three months to May 2000.

Nevertheless, it is strongly suggested that local meteorological, climatological and other institutions, as a precautionary response to this assessment, should monitor key parameters, such as sea surface temperature and other El Niño indicators, very closely over the next three to six months in order to gauge the further potential, or otherwise, of El Niño development later this year.

It is further recommended that effective communication channels between local meteorological and climatological agencies, other relevant agencies and stakeholders in potentially-affected sectors be set up with some urgency in order to facilitate appropriate means of dissemination of warnings and other information and, if it proves necessary, more concerted action at a later date.

APPENDIX 1

PARTICIPANTS

The Impact of El Niño and La Niña on Southeast Asia

Fortuna Hotel, Hanoi, Vietnam

21 - 23 February 2000

NAME	COUNTRY	ADDRESS	TEL	FAX	EMAIL
ROGER C STONE	Australia	Principal Research Scientist, Queensland Center for Climate Applications, Department of Primary Industries, PO Box 102, Toowoomba, Qld 4350, Australia	61-7-46881293	61-7-46881193	stoner@ dpi.qld.gov.au
WILLIAM R KININMONTH	Australia	Australasian Climate Research, 23 Holroyd Street, Kew, Vic 3101, Australia	61-3-98539395	61-3-98539295	w.kininmonth@ bigpond.com
HJ SIDUP HJ SIRABAHA	Brunei	Brunei Meteorological Service, Department of Civil Aviation, Ministry of Communications, Brunei Darussalam, 261 Kg.Bebatek, Jalan Bebatik Kilanas, Brunei Darussalam BF 2320 Current address: Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK	6732-330142	6732-332735/ 331706	spd2205@ brunet.bn
CHEA SINA	Cambodia	Deputy Director of Pollution Control Department, Ministry of Environment, 48 Samdech Preah Sihanouk, Tonle Basac, Chamkar Morn, Phnom Penh, Cambodia	855-23-427844	855-18-822134	minenvlb@ forum.org.kh, swtsmo@ camnet.com.kh
LONG RITHIRAK	Cambodia	Technical Advisor and Chief of Coordination Unit, Ministry of Environment, 48 Samdech Preah Sihanouk, Tonle Basac, Chamkar Morn, Phnom Penh, Cambodia	855-23-720371 /724901	855-23-427844	minenvlb@ forum.org.kh
MAK SIDETH	Cambodia	Chief Office, Environmental Education and Training, Department of Environmental Education and Communication, Ministry of Environment, 48 Samdech Preah Sihanouk, Tonle Basac, Chamkar Morn, Phnom Penh, Cambodia	855-23-427844	855-23-427844	minenvlb@ forum.org.kh, mak_sideth@ hotmail.com
WANG SHAO WU	China	Department of Geography, Peking University, Beijing, 100871, People's Republic of China	86-10-62755568	86-10-62754294	swwang@ pku.edu.cn
GERHARD BREULMANN	Germany	Programme Manager, APN Secretariat, 5th Fl, IHD Center Bldg., 1-5-1 Wakinohama Kaigan Dori, Chuo-ku, Kobe 651-0073, Japan	81-78-2308017	81 78 2308018	gbreulmann@ apn.gr.jp
MIKIYASU NAKAYAMA	Japan	United Graduate School of Agricultural Science, Tokyo University of Agriculture and Technology, 3-5-8 Saiwai-cho, Fuchuu-city, Tokyo 183-8509, Japan	81-42-3675667	81-42-3607167	mikiyasu@ cc.tuat.ac.jp

NAME	COUNTRY	ADDRESS	TEL	FAX	EMAIL
KHAMPAO HOMPANGNA	Lao PDR	Project Manager of National Disaster Management Office, Ministry of Labor and Social Welfare, PO Box 347, Vientiane, Lao PDR	856-21-219450	856-21-219525	ndmo@ pan-laos.net.la
PHETSAVANG SOUNNALATH	Lao PDR	Deputy Director General, Director National Disaster Management Office, Pangkham Rd, PO Box 347, Vientiane, Lao PDR	856-21-219450/ 222778/213005	856-21-219525	ndmo@ pan.laos.net.la
SENGDEUANE PHOMAVONGSA	Lao PDR	Training Manager of National Disaster Management Office, Ministry of Labor and Social Welfare, PO Box 347, Vientiane, Lao PDR	856-21-219450	856-21-219525	sengdeuane@ hotmail.com
SITHA PHOUYAVONG	Lao PDR	Acting Director General of Cabinet, Science, Technology and Environment Agency, PO Box 2279, Vientiane, Lao PDR	856-21-218738/ 213470	856-21-213472	sitha@ steno.gov.la
OOI SEE HAI	Malaysia	Malaysian Meteorological Service, Jalan Sultan, 46667 Petalang Jaya, Selangor, Malaysia	60-3-7549462	60-3-7563621	osh@ kjc.gov.my
U TUN LWIN	Myanmar	Director, Department of Meteorology and Hydrology, Ministry of Communications, Posts and Telegraphs, Mayangon PO Box 11061, Kaba-Aye Pagoda Road, Yangor, Myanmar	095-01-660526/ 660468	095-01-665944	
AIDA M JOSE	Philippines	Chief, Climatology and Agrometeorology Branch, 7th Floor Asia Trust Bank Bldg., PO Box 2277 Manila, Quezon City, Philippines	63-2-3733434	63-2-3733433	cab@ philonline.com. ph
SANNY R JEGILLOS	Philippines	Director Asia Operations, Asia Pacific Disaster Management Centre, PO Box 1005, Makati Central Post Office, 1250 Makati City, Philippines	63-2-8260389	63-2-8209202	sannyj@ nsclub.net, apdmc@ nsclub.net
PATIPAT PATVIVATSIRI	Thailand	Deputy Director General, Meteorological Department, 4353 Sukumvit Road, Bangna, Prakanong, Bangkok 10260, Thailand	66-2-3992355	66-2-3989229	tmd@ metnet.tmd. go.th
JOHN CAESAR	United Kingdom	Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK	44-1603-593161	44-1603-507784	j.caesar@ uea.ac.uk
LOUISE BOHN	United Kingdom	Climatic Research Unit, University of East Anglia, Norwich, Norfolk, NR47TJ, UK	44-1603-593161	44-1603-507784	l.bohn@ uea.ac.uk
MICK KELLY	United Kingdom	Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK	44-1603-592091	44-1603-507784	m.kelly@ uea.ac.uk
SARAH GRANICH	United Kingdom	Environmental Consultant, 7 Ames Court, Cawston, Norwich NR10 4QD, UK	44-1603-870788	44-1603-870788	sarah.granich@ virgin.net
SIMON JAMES MASON	United States	Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0235, USA	1-619-8222574	1-619-5348087	simon@ lacosta.ucsd. edu

NAME	COUNTRY	ADDRESS	TEL	FAX	EMAIL
BUI KIM OANH	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-515213	84-4-8515213	cered@ hn.vnn.vn
BUI THE GIANG	Vietnam	People International Relationship Department, Hanoi, Vietnam			
DANG DANH ANH	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8252821	84-4-4227593	
DANG HUU HUNG	Vietnam	National Scientific Magazine, 53 Nguyen Du, Hanoi, Vietnam	84-4-8264953	84-4-8264953	
DO THI VAN	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
DO TRONG KHUE	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
DOAN NANG	Vietnam	Director, Department of Law, Ministry of Science, Technology and Environment, 39 Tran Hung Dao, Hanoi, Vietnam	84-4-8250 640		
DUONG DUC DUNG	Vietnam	International Relationship Department, Ministry of Science, Technology and Environment, 39 Tran Hung Dao, Hanoi, Vietnam	84-4-8228751	84-4-8252733	
DUONG LIEN CHAU	Vietnam	National Hydro-Meteorology Service of SR Vietnam, Hanoi, Vietnam	84-4-8254278	84-4-8254278	met_srf@ fpt.vn
HA NGHIEP	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam			
HOANG MINH HIEN	Vietnam	National Hydro-Meteorology Service, Hanoi, Vietnam, 4 Dang Thai Than, Hanoi, Vietnam	84-4-9330249	84-4-8254278	hmh@ netnam.vn
LE DINH QUANG	Vietnam	Institute of Meteorology, Center for Research on the Tropical Meteorology and Typhoon, 57 Nguyen Du, Hanoi, Vietnam	84-4-8263873	84-4-4430006	ctmtr@ hn.vnn.vn
LE DUC NHUAN	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
LE TUYET HANH	Vietnam	Science and Life Newspaper, 70 Tran Hung Dao, Hanoi, Vietnam	84-4-8253427, 8251377	84-4-8220900	
LUONG QUANG HUY	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-515213	84-4-8515213	huy8477@ vol.vnn.vn
NGO CAM THANH	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
NGUYEN DAI KHANH	Vietnam	International Cooperation Department, National Hydro-Meteorology Service of SR Vietnam	84-4-8264087	84-4-8260779	icd.hms@ fpt.vn

NAME	COUNTRY	ADDRESS	TEL	FAX	EMAIL
NGUYEN DUY HUU	Vietnam	National Scientific Magazine, 53 Nguyen Du, Hanoi, Vietnam	84-4-8264953	84-4-8264953	
NGUYEN HUU NINH	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
NGUYEN LAM HOE	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
NGUYEN MANH DON	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-226435		
NGUYEN THANH HA	Vietnam	Thanhha Investment Consultancy and International Trading Company Ltd., 21 Nguyen Chi Thanh, Hanoi, Vietnam	84-4-7715655	84-4-7715661	thhn@ hn.vnn.vn
NGUYEN THANH HUONG	Vietnam	News Division-Vietnam Television, Giangvo, Hanoi, Vietnam	84-4-7715300		
NGUYEN THANH VINH	Vietnam	Vietnam Marine Science Association, Hanoi, Vietnam	84-4-7760752	84-4-8230915	
NGUYEN THI DUOC	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8257785	84-4-4227593	
NGUYEN THI HAI	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
NGUYEN THUC NHU	Vietnam	Geographical Association, Hanoi, Vietnam	84-4-8351211		
NGUYEN TRONG KHANH	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
NGUYEN TRONG THANH	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
NGUYEN VAN HAI	Vietnam	Hydro-Meteorology Service of SR Vietnam	84-4-8244120	84-4-8260779	hai.nv@ fpt.vn
NGUYEN VAN THANG	Vietnam	Deputy Director, Institute of Meteorology and Hydrology, Climate Research Center, Lang, Dongda, Hanoi, Vietnam	84-4-8359415	84-4-8355993	thang@ crc-imh.ac.vn
NGUYEN VAN TUAN	Vietnam	Dean, Hydro-Meteorology Department, Faculty of Geography, HUS. 334 Nguyen Trai, Hanoi, Vietnam	84-4-241016		
NGUYEN VINH THU	Vietnam	National Hydro-Meteorology Service, Hanoi, Vietnam, 4 Dang Thai Than, Hanoi, Vietnam	84-4-261187	84-4-8254278	
TO BA TRONG	Vietnam	Member of Presidium, Chairman of The Inspection Committee, Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
TRAN BANG TAM	Vietnam	Department of Soil Information, Hanoi Agriculture University, Chauquy, Gialam, Hanoi, Vietnam	84-4-765588		tbtam@ hn.vnn.vn
TRAN DUC HAI	Vietnam	Deputy Director, International Co-operation Department, Hydrometeological Service of SR Vietnam	84-4-8242603	84-4-8260779	icd.hms@ fpt.vn

NAME	COUNTRY	ADDRESS	TEL	FAX	EMAIL
TRAN DUY BINH	Vietnam	Director, Institute of Meteorology and Hydrology, Nguyen Chi Thanh, Hanoi, Vietnam	84-4-8359540	84 4-8355993	tdbinh@ imh.ac.vn
TRAN QUANG NGOC	Vietnam	National Hydro-Meteorology Service, Hanoi, Vietnam, 4 Dang Thai Than, Hanoi, Vietnam	84-4-261187	84-4-8254278	
TRAN QUANG TUAN	Vietnam	Vietnam Economic Times, Hanoi, Vietnam	90445292		tuantq@ fpt.vn
TRAN SY QUY	Vietnam	Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8257785	84-4-4227593	
TRAN TAN TIEN	Vietnam	Deputy Dean, Faculty of Hydro-Meteorology, Hanoi University of Sciences, Hanoi, Vietnam			
TRAN THANH XUAN	Vietnam	Deputy Director, Institute of Meteorology and Hydrology, Nguyen Chi Thanh, Hanoi, Vietnam	84-4-8343419, 8343538	84-4-8355993	
TRAN THI TY	Vietnam	International Relationship Department, Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	
TRAN THU TRANG	Vietnam	Center for Environment Research, Education and Development, A01, K40, Giangvo, Hanoi, Vietnam	84-4-8515213	84-4-8515213	cered@ hn.vnn.vn
TRAN THUC	Vietnam	Institute of Meteorology and Hydrology, Water and Atmospheric Environment Research Center, Langtrung, Dongda, Hanoi, Vietnam	84-4-8359491	84-4-8355993	thuc@ netnam.org.vn
TRAN VO CHAU	Vietnam	Geological Association, 6 Pham Ngu Lao, Hanoi, Vietnam	84-4-8260752	84-4-8260752	
TRUONG QUANG HAI	Vietnam	Faculty of Geography, Vietnam National University	84-4-581420		haithu@hn.vnn.vn
TRUONG QUANG CUONG	Vietnam	People-to-people Relations Department, 1C Hoang Van Thu, Hanoi, Vietnam	84-4-8453764	84-4-7330129	
VU MINH MAO	Vietnam	MP Vice Chairman, Committee on Science, Technology and Environment, 35 Ngoquyen, Hanoi, Vietnam	84 80 42842	84 80 46997	ubkhcnmt@ hn.vnn.vn
VU TUYEN HOANG	Vietnam	President, Vietnam Union of Science and Technology Associations, 53 Nguyen Du, Hanoi, Vietnam	84-4-8262108	84-4-4227593	

APPENDIX 2

WORKSHOP AGENDA

THE IMPACT OF EL NIÑO AND LA NIÑA ON SOUTHEAST ASIA

FORTUNA HOTEL, HANOI, VIETNAM

21 - 23 FEBRUARY 2000

VUSTA/CERED/APN/UEA WORKSHOP AGENDA

DAY 1, FEBRUARY 21ST 2000

8.15-9.00
Registration

OPEN SESSION: INTRODUCTION AND GLOBAL OVERVIEW

9.00-10.00
Chair: Dr. Nguyen Huu Ninh

* **Opening address**: Professor Academician Vu Tuyen Hoang, Chairman of Vietnam Union of Science and Technology Associations (VUSTA), 10 mins
* **Welcome speech**: Dr. Vu Minh Mao, MP, Vice Chairman, Committee on Science, Technology and Environment, National Assembly of Vietnam, 10 mins
* **Introduction to meeting**: Dr. Nguyen Huu Ninh, CERED/ Dr. Mick Kelly, University of East Anglia, 10 mins
* **APN introduction**: Representative of the Asia-Pacific Network for Global Change Research - Dr. Gerhard Breulmann, 10 mins
* **Global overview of the El Niño Southern Oscillation (ENSO) phenomenon:** Dr.William Kininmonth, Australasian Climate Research, Australia, 25 mins

10.10-10.30
Refreshment break

OPEN SESSION: CLIMATE EFFECTS AND SOCIETAL IMPACTS

10.40-12.30
Chair: Dr. Mick Kelly

* **Significance of El Niño and La Niña for Southeast Asia:** Mr. Sidup Bin HJ Sirabaha, Brunei Meteorological Service, Brunei, 20 mins
* **Natural hazards in Laos**: Mr. Sengdeuane Phomavongsa, National Disaster Management Office, Laos, 20 mins
* **Natural hazards in Cambodia**: Mr. Mak Sideth, Ministry of Environment, Cambodia , 20 mins
* **Effect on typhoon occurrence in Vietnam:** Dr. Hoang Minh Hien, Hydro-Meteorological Service, Vietnam, 20 mins
* **Open discussion**

12.30-14.00
Buffet lunch

CLOSED SESSION: IMPACT ASSESSMENT

14.00-16.00
Chair: Dr. Mick Kelly

* **Working group discussion I - Impact assessment**

Refreshments served 16.00

16.30-17.00
Chair: Dr. Nguyen Huu Ninh/Dr. Mick Kelly
* **Summary of working group recommendations and general discussion**

18.00-20.00
Reception for international participants hosted by the Vice-Chairman of the Committee on Science, Technology and Environment of the National Assembly of Vietnam at the Office of the National Assembly of Vietnam.
Followed by dinner at the Hilton Hanoi Opera Hotel.

DAY 2. TUESDAY, FEBRUARY 22ND 2000

OPEN SESSION: SEASONAL CLIMATE FORECASTING

9.00-10.40
Chair Dr. William Kininmonth
* **International forecasts of the ENSO phenomenon:** Dr. Simon Mason, UCSD/IRI, United States, 20 mins
* **Practical aspects of forecasting rainfall in eastern Australia and Southeast Asia using ENSO indicators:** Dr. Roger Stone, Queensland Centre for Climate Applications, Australia, 20 mins
* **Climate forecasting in China:** Prof. Wang Shaowu, Peking University, PR China, 20 mins
* **Climate forecasting in Vietnam:** Dr. Nguyen Van Thang, Climate Research Center. Vietnam, 20 mins
* **Use of seasonal forecasts:** Ms. Louise Bohn, University of East Anglia, UK, 20 mins
* **Open discussion**

10.40-11.00
Refreshment break

OPEN SESSION: RESPONSE STRATEGIES

11.00-12.20
Chair: Prof. Mikiyasu Nakayama
* **Responding to El Niño and La Niña:** Priorities for the region. Dr. Sanny Jegillos, APDMC, Philippines, 20 mins
* **The response to the flooding in Central Vietnam in 1999:** Dr.Tran Thanh Xuan, Institute of Hydro-Meteorology, Vietnam. 20 mins
* **The lessons of Typhoon Linda, Vietnam** – Ms. Duong Lien Chau, Hydro-Meteorological Service, Vietnam, 20 mins
* **The impacts of El Niño and La Niña on Myanmar** – Mr. U Tun Lwin, Department of Meteorology and Hydrology of Myanmar, 20 mins
* **Open discussion**

12.20-14.00
Buffet Lunch

Afternoon free

18.00-20.00
Dinner at the Cha Ca La Vong restaurant

DAY 3, WEDNESDAY, FEBRUARY 23RD 2000

CLOSED SESSION: PROSPECTS FOR PREDICTION

9.00-11.45
Chair: Dr. Mick Kelly

* **Working group discussion II - Prospects for prediction**

Refreshments served 10.30

11.45-12.30
Chair: Dr. Nguyen Huu Ninh/Dr. Mick Kelly
* **Summary of working group recommendations and general discussion**

12.30-14.00
Buffet lunch

CLOSED SESSION: RESPONDING TO EL NIÑO AND LA NIÑA

14.00-15.30
Chair: Dr. Mick Kelly
* **Working group discussion II - Responding to El Niño and La Niña**

15.30-16.00
Refreshment break

OPEN SESSION: CONCLUSIONS AND CLOSE OF MEETING

16.00-17.00
Chair: Dr. Nguyen Huu Ninh/Dr. Mick Kelly
* Summary of working group recommendations and general discussion
* Workshop statement on latest assessment of La Niña breakdown
* Evaluation of workshop outcome
* The next stage of the Indochina Global Change Network
* Close of meeting

18.00-20.00
Dinner at the Lau Tu Xuyen restaurant

Additional presentations
During the course of the working group sessions, short presentations were made by Dr. Ooi See Hai (Malaysian Meteorological Service), Dr. Aida Jose (Climatology and Agrometeorology Branch, Philippines) and Dr. Patipat Patvivatsiri (Meteorological Department, Thailand) on the impact of El Niño and La Niña and associated research in their respective countries. Dr. Nguyen Van Viet (Institute of Meteorology and Hydrology, Vietnam) described the significant impact of El Niño and La Niña on rice production in Vietnam. Dr. Aida Jose discussed work on monitoring and early warning in the Philippines and Dr. Le Van Sanh (Vietnam Committee for the International Hydrological Program) presented an account of the recommendations of the Vietnam Committee for the International Hydrological Program with respect to the El Niño-Southern Oscillation Phenomenon.

APPENDIX 3

THE INDOCHINA GLOBAL CHANGE NETWORK

THE INDOCHINA GLOBAL CHANGE NETWORK

The overall goal of the Indochina Global Change Network is to strengthen the scientific capacity of Cambodia, Laos and Vietnam and hence the ability of these nations to respond to the threat posed by global environmental change and related hazards. Network activities include policy-relevant information provision, training and research on global change issues.

The Network has three main aims:

- to foster and provide support for focused capacity-strengthening projects, directed at specific regional needs;
- to provide training in global change studies through workshops, studentships and fellowships and to promote the development of relevant educational materials for the scientific community, policy makers and the general public; and,
- to foster and, where appropriate, coordinate regional research on global environmental change, providing high-level expertise in support of policy development.

The Network is pledged to interdisciplinary research and, in particular, the fusion of biophysical and socio-economic methods. The Network is also committed to a long-term perspective since the problems of global change have characteristic timescales of decades to centuries. The Network recognizes that an effective precautionary response to long-term environmental change must be based on action to reduce present-day vulnerability and that this is, in many cases, a more immediate development priority. Finally, the Network is dedicated to the ideal of sustainable development, meeting present-day needs while ensuring environmental security across both space and time, through the fostering and coordination of regional activities on global environmental change and related hazards.

Past Network activities have been supported by the Netherlands Foundation for the Advancement of Tropical Research (WOTRO) and the Asia-Pacific Network for Global Change Research. Activities planned for the coming period include training workshops on climate prediction and impact assessment and training, information provision and research on land-cover change, coastal zone management and other issues.

The Indochina Global Change Network is coordinated by Dr. Nguyen Huu Ninh of the Center for Environment Research Education and Development, Hanoi, Vietnam, with technical support from Dr. Mick Kelly and Ms. Sarah Granich.

Secretariat Office:
Indochina Global Change Network
Center for Environment Research Education and Development
A01, K40, Giang Vo, Hanoi, Vietnam
Tel/fax: 84-4-8515213 Email: cered@hn.vnn.vn

APPENDIX 4

SUMMARY PAPERS

GLOBAL OVERVIEW OF THE EL NINO SOUTHERN OSCILLATION PHENOMENON

William Kininmonth
Australasian Climate Research
Melbourne, Australia

Over the past two decades the term El Niño has become synonymous with social, economic and environmental crises in many parts of the globe. El Niño events signal major departures from normal seasonal climate patterns, particularly over tropical regions. For some countries an El Niño event is typically associated with abnormal heat and drought, for others it is persisting rain and devastating flooding.

El Niño was originally the name given by local fishermen to the annual appearance of a warm southward flowing current in the surface waters off coastal Ecuador and northern Peru during the Southern Hemisphere summer (December-February). The coastal communities also recognised that in some years the offshore waters were warmer than usual and cold nutrient rich waters failed to return during the following year, giving a poor fish harvest and with disastrous consequences on local food stocks and community welfare. Flood rains that caused loss of life and severe damage often accompanied the periods of abnormally warm coastal waters. Now it is the periods of prolonged abnormal warming that are referred to as El Niño events. However, it was not until the mid-1960s that the El Niño phenomenon was recognised as of more than local significance. New global data sets have established linkages between the El Niño of the eastern equatorial Pacific Ocean and the Southern Oscillation that affects weather patterns across the tropical Pacific Ocean.

The fluctuating characteristics of the ocean and atmospheric circulations across the equatorial Pacific Ocean arise because of the coupling of the ocean and atmosphere through wind stress and from the transfer of heat, moisture (latent energy) and momentum. Positive feedbacks assist in maintaining the Walker Circulation of the atmosphere and surface layer characteristics across the equatorial Pacific Ocean. During an El Niño event, however, warm surface water spreads eastward across the equatorial Pacific Ocean towards South America and upwelling of cold water is reduced. The combined effect of the influx of warm water and the reduction of upwelling is to produce a warmer than normal surface layer over an extensive area of the central and eastern equatorial Pacific Ocean. The reduced equatorial cross-Pacific sea surface temperature gradient weakens both the overlying surface atmospheric pressure gradient and the strength of the surface Trade Winds.

Studies associated with the TOGA project have identified that the positive anomalies of tropical sea surface temperature act as an abnormal source of heat, moisture and momentum to the atmosphere and force the tropical circulation in a direct sense. As an outcome of the improved climate monitoring capability arising from the TOGA project many aspects of the forcing of the atmospheric circulation by the 1997-98 El Niño can be readily identified. Early in the event (June to August) there was enhanced deep atmospheric convection over the central equatorial Pacific Ocean and a reduction in deep atmospheric convection over the western Pacific. As the El Niño event developed (September to November) there was a strengthening of the intensity of abnormal convection over the central equatorial Pacific Ocean. At the same time there was a continuing reduction in the intensity of deep atmospheric convection and cumulative regional rainfall over the western Pacific Ocean. During the mature phase of the El Niño event (December to February) the region of anomalous deep atmospheric convection extended eastward to coastal South America. At this time there was also a reduction in the deep atmospheric convection associated with the intertropical convergence zone (ITCZ) north of the equator across the Pacific Ocean. The islands of the equatorial western Pacific Ocean that generally receive high rainfall were drier than normal and many experienced drought. The generally dry coastal regions of Ecuador and Peru received copious rain that caused much damage. Also, seasonal tropical storms of the western Pacific Ocean tended to form further east than usual over the abnormally warm ocean and made little contribution to the seasonal rainfall of the Philippines.

Empirical teleconnection patterns have been derived that imply physical/dynamical processes account for the simultaneous variation of weather patterns over various parts of the globe in response to distant ocean forcing. During El Niño events the patterns of anomalous deep tropical convection over the central and eastern equatorial Pacific Ocean are able to persist on seasonal timescales and develop large-scale overturning circulations. Strong upper atmosphere divergence over the regions of convection in the tropics and convergence in the subtropics act as a Rossby wave[1] source. The February 1998 upper atmosphere (250 hPa – about 10.5 km altitude) geopotential height anomalies had, over the eastern Pacific ocean, similarities to the forcing necessary to generate Rossby waves. A persisting feature over East Asia was the strong anticyclonic circulation over northern China and the cyclonic circulation to its south.

In the comparison of different El Niño events there is a set of broadly repeating patterns of significant anomalies in the occurrence of deep atmospheric convection and these indicate a characteristic response to El Niño forcing in some regions of the globe. In other parts of the globe there are significant responses but the characteristics are not the same for each event.

For development of sectoral response strategies to mitigate the impacts and to take advantage of any favourable opportunities during El Niño events it is essential for each country to have access to global, regional and national climate monitoring products. The Global Climate Observing System (GCOS) based on the World Weather Watch (WWW) is an outcome of international cooperation and already provides an array of products accessible over the Internet. More detailed assessments of the scale and extent of climate anomalies affecting countries will require cooperation at the regional level and this would be assisted by the establishment of regional climate centres. National climate centres are necessary to manage the essential climate data archives and provide a focus to ensure that national needs for climate information and prediction services are met and that essential products are available for other agency and industry needs.

[1] Rossby waves are large scale (planetary) waves in the horizontal flow of the atmosphere that grow in amplitude as a result of the change in relative spinning motion of the earth from lower to higher latitudes.

SIGNIFICANCE OF THE EL NINO SOUTHERN OSCILLATION FOR SOUTEAST ASIA

S. Sirabaha[1]
Brunei Meteorological Service
J. Caesar
Climatic Research Unit, School of Environmental Sciences
University of East Anglia

SUMMARY

The El Nino Southern Oscillation (ENSO) phenomenon is highly significant for the countries of Southeast Asia (SEA). On intraseasonal and interannual time-scales, ENSO forcing has a profound impact on climate and weather in this region. During El Nino and La Nina events the warming and cooling of the tropical Pacific Ocean causes large-scale changes in the atmospheric circulation in the region. One of the contributors to drought conditions in SEA appears to be a major eastward shift of the upper anticyclonic at 200mb whose location is related to a major shift of the east-west Walker Circulation. The velocity potential at the higher level (200mb) is used to diagnose the divergent outflows with respect to monsoonal and ENSO forcing. Through the velocity potential, displacement of convective areas with respect to weakening of the Walker Circulation due to El Nino can easily be determined, and vice-versa during La Nina events.

An El Nino event is associated with droughts in most parts of the region including Indonesia, Brunei, Malaysia, Philippines, Vietnam, Myanmar, Cambodia, Loas, Thailand and Papua New Guinea. La Nina events are more likely to be excessive monsoon rain and more likely to cause flooding, especially in low lying areas. Climatic anomalies associated with ENSO events are particularly important to Southeast Asia because of the agrarian economics of the region. Agricultural outputs are severely affected if there is a serious deficit in water supply due to major displacement of the monsoon rain. Socio-economic losses to SEA countries attributed to major ENSO events can be enormous, due to prolonged drought, forest fires, environmental damage, wildlife deaths, tourism reduction, increased health hazards, loss of crops and floods.

ENSO-related precipitation is especially well indicated in Indonesia, East Malaysia, Papua New Guinea, Philippines and Brunei. This area is one of core tropical regions in the world which has strong ENSO related precipitation. Rainfall across Indonesia is strongly modulated by ENSO, with above (below) normal occuring during cold (warm) episodes. This ENSO-related interannual variability is consistent with the suppressed (enhanced) equatorial Walker Circulation, typical of Pacific warm (cold) episodes. During El Nino, some countries experience an increase of surface temperature of around 0.25°C. During La Nina, there is not much cooling over the region except over northern Vietnam and northern Philippines, of around -0.25°C.

The monetary losses attributed to the 1997/98 El Nino for SEA were more than US$1.38 billion. In Malaysia and Singapore, the tourism industry was badly affected by migrant smog haze which incurred losses of around US$360 million. While drought in Vietnam, which lasted about eight months, caused around 4,000 people in the mountain and central Vietnam to be close to starvation. In Papua New Guinea, about 80,000 to 300,000 people were at life threatening risk due to prolonged drought. Conversely, in Burma there was flooding and landslides which caused thousands of people to die. About two million people were affected and 500,000 forced from their homes. The SEA transboundary smoke haze problems are usually exacerbated during warm events years. The seasonal haze causes many parts of the region to be shrouded with a prolonged thick layer of seemingly threatening smog. The occurrence of haze is not uncommon in Indonesia, Brunei and Philippines, threatening the health of millions of people and closing airports due to poor visibility.

The La Nina impact in the region is manifest in the form of excessive monsoon rainfall. During this period, the ITCZ and ascending Walker Circulation is far more active over the western Pacific, particularly over the maritime countries of SEA. This areas experience an increase of rainfall of up to 150%. Frequent flash floods have been reported in SEA countries related to La Nina events. It has been estimated that La Nina displaced many thousands of people and many casualtied have occured within flood prone areas. In terms of general casualtied, La Nina is still less documented compared with El Nino.

A regional climate outlook for SEA region is becoming a necessity in order to be able to assess in advance on likely impact of climatic variability. The SEA countries should be given more access to long range seasonal forecast products from the international centers in order to be more prepared in facing impending climatic events such as El Nino or La Nina. The scientific communities in the region would then have a basis to convince or brief the policy makers within their respective countries on likely impact of adverse climatic conditions. At the same time, the region itself should be encouraged to generate it own climate model either using simple coupled ocean-atmosphere models or physically-based statistical models by pooling available resources from ASEAN member countries. Such opportunity has been laid down by the establishment of the ASEAN Specialised Meteorological Center (ASMC) in Singapore. The regional-based product can be more sensitive to regional and national climate variability, spatial and temporal variability, as compared to international centers.

Bilateral and cross regional cooperation on mutual interests in the aspect of climatic variability is crucial because climatic impacts do not recognize national boundary as has been proven in the recent forest fires in Indonesia during 1997/98 El Nino. Information and data exchange amongst the SEA member countries should be further enhanced. This will help to provide a basic input for the common people to know about climatic events as well as to foster small scale research related to ENSO. Better informed society and high accessibility to seasonal forecast products to users and policy makers could contribute more feedback on the need to establish proper policy and response strategies concerning the adverse impact of climatic events such as ENSO. Rapport among the scientific bodies, mitigation agencies, policy makers and the media could be the key factors in providing an effective and precise information to different levels of users and general public at large.

In order to develop an appropriated response strategy for ENSO impacts on the socio economy of the SEA countries, research on the monsoon interaction with ENSO is particularly important. As such, the deep understanding of the physics of ENSO interaction with the monsoons systems on intraseasonal and interannual time-scale is needed. This can be unveiled through multidisciplinary research involving all aspects of ENSO and monsoon mechanisms. The physical systems of the SEA monsoon, which involve ocean and atmosphere interaction, have yet to be fully understood. The mechanisms through which climate anomalies are connected to impacts on agriculture and water supplies must be better understood.

ENSO'S EFFECTS ON ACTIVITY OF TYPHOONS IN WESTERN NORTH PACIFIC, BIEN DONG SEA AND VIETNAM

Hoang Minh Hien
National Centre for Hydro-meteorological Forecasting
Hydro-meteorological service of Vietnam

The Western North Pacific region is one of the most productive and violent of tropical storm formations in the world accounting for 36% of the global average. The Vietnam and Bien Dong, coast are exposed to typhoons from two source regions, namely the North Pacific Ocean and the Bien Dong Sea. This study aims to identify whether there is distinct relationship between ENSO and typhoon characteristics in Western North Pacific Bien Dong Sea and Vietnam. The typhoon track data used in this study is based on the information given by the Typhoon Center of Japan. This database contains details of all recorded tropical cyclones for the western North Pacific for the 48-year period from 1951-1998.

The ENSO events have impacted to the different characteristics in typhoon's activity in the Western North Pacific Bien Dong Sea and in Vietnam. The appearance of warm and cool sea surface anomalies in large area in central equatorial Pacific have caused the changes in the origin of typhoon formation, frequency, intensity, track and in other characteristics of acted typhoons in these regions.

In the time before most of people are concerned mainly only to the impacts of El Nino events, however, the analysis in this study shows that the impacts of La Nina on typhoon's activity are serious too. The Impacts of La Nina on typhoons are very different than impacts of El Nino events, even more complicated than El Nino's impacts. The analysis of typhoon's activity in different scenarios (El Nino, La Nina and Non-ENSO) gives us a more complete view of ENSO's impacts.

In El Nino years:

The activity of typhoons has a tendency to shifts eastward. The activity of typhoons in Bien Dong Sea and in Vietnam is weaker than in La Nina years. The number of landfall in Vietnam typhoons in El Nino years is less than in other years, however there exits the probability that in some years there are many typhoons (including, unseasoned typhoons) to make landfalls in Vietnam. There were typhoons made landfall in most southern part of Vietnam.

To pay attention about landfall of typhoons in summer months, especially in September the rate of landfall in Vietnam typhoons is very high. In September, almost of landfall in Vietnam typhoons are formatted at the longitudes much closer to Vietnam than average.

The average intensity and the strongest intensity of typhoons in El Nino years are higher than in other years. The typhoon's intensity at the moment of landfall is higher than in other years too.

In El Nino years, the frequency of landfall in all regions of Vietnam typhoons is lower than in other years.

In the late months of year, the frequency of landfall in Vietnam typhoons is much lower than average value. In October there were little typhoons made landfall in Vietnam however they have made landfall in higher latitudes than usual and caused impacts to Bac Bo region of Vietnam.

In La Nina years:

The activity of typhoons has a tendency to shifts westward. In La Nina years the annual number of landfall in Vietnam typhoons is higher than in El Nino years. For all scenarios, the activity of typhoon in Bien Dong Sea is most strong in La Nina years.

There exits probability that there are unseasoned typhoons to make landfall in Vietnam, however with lower frequency than in El Nino years. As a whole there were no typhoons made landfall in Vietnam in the first four months of year.

The typhoons are formatted in different regions of Western North Pacific more difficult for prediction than in other years. In Bien Dong Sea the typhoons can be formatted at lower latitudes than normal with higher probability to make landfall in Vietnam than in other years.

The intensity and the class of typhoons in La Nina years are quite weaker than in El Nino years. In La Nina years the frequency of landfall in all regions is higher than in El Nino years. Especially for the southern Trung Bo the frequency of landfall typhoons is near two times higher than in El Nino years.

The activity of typhoons is strongly in the period from September to November; two months later than in El Nino years. The frequency of landfall in Vietnam typhoons is high in October and November. In La Nina scenario the November is the month with highest frequency of landfall in Vietnam typhoons in comparison with all scenarios. In those months Vietnam is under most dangerous threaten of typhoons in comparison with all regions in Western North Pacific. Probably in the short period of time in those months there are many typhoons to make landfall to the same area in southern Trung Bo of Vietnam, causing serious flood for this area. It is important to pay high attention on landfall of typhoons in those months in southern Trung Bo.

Up to now there was still low attention to the impacts of La Nina on the typhoon's activity. However the analysis in this study shows that just impacts of La Nina on activity of landfall in Vietnam typhoons was very serious and more complicated than El Nino's impacts. In La Nina years the number of landfall in Vietnam is higher than in El Nino year. The typhoons have made irregularly landfalls in different regions of Vietnam. As a whole, in La Nina years, the monitoring, prediction and protection of typhoons in Vietnam will be more difficult than in El Nino years.

COUNTRY PAPERS

By

Lao delegates on the Impact of the El Nino and La Nina on Southeast Asia Fortune Hotel, Hanoi, Vietnam 21-23 February 2000

BACKGROUND

The Lao People's Democratic Republic is landlocked country , situated in the center of the Indo- Chinese peninsula and sharing borders with China , Vietnam , Cambodia, Thailand and Myanmar . The country covers an areas of 236,800 Km^2 much of which is mountainous , forested and covered by rivers . According to population census conducted in 1995 the population is 4,7 million people , the annual growth rate is 2.6 per cent , the average population density is only 20 persons per km^2 , the Lao people are known for their considerable cultural and ethnic diversity , with more than 47 different distinct ethnic language groups live in Lao P.D.R. life expectancy is only 51 years. The country, however, suffers from the widespread effects of poverty and natural disasters with an estimated GDP per capital of 333 USD , the Lao P.D.R is classified as one least developed countries in the world .

I. The Impact of El Nino and La Nina in Laos .

1. In the past El Nino events have been occurred several times throughout the twentieth century and they are not well known or familiar in Lao PDR. It is also rare to observe a normal year that means no drought or no flood in recent years. Based on general concepts El Nino have direct impact on weather conditions in Lao PDR, very dry in 1957-57, extreme low flow in 1965 and large flood in 1966, alternatively drought and flood in 1972-73.

2. Strong ENSO events during 1982-83
Extremely heavy rainfall in Southern province (Pakse, Paksong). Daily rainfall of more than 500 mm were observed on the 25-26 June 1983 during the mature stage of the event. Severe flooding conditions were reported between the lower Sedon and Pakse urban area. However damages on rice crop were not important because It's happened in the beginning of the transplantation season but delayed the planting period.

3. Drought during El Nino 1987-88
Severe drought occurred in northern region of Lao PDR during the 1987 monsoon while central and southern regions have precipitation above normal. precipitation observed at Nape station was only 1200 mm (normal annual rainfall 1943. 2mm) this location is situated in a high forest coverage area 64 %. Yet no stress to the forest vegetation could be casually noted in this high coverage(note: based on multivariate ENSO index of the 1986-87 was in the positive phase and the effect was prolonged to the end of 1988)

4. Drought during El Nino 1991-92

In 1991, annual precipitation was above normal and flooding condition was observed in southern province, but in 1992 the weather conditions was completely different, low rainfall and very low river runoff throughout the country some examples are given below:
Rainfall Luangnamtha province was only 500 mm/year compared with normal about 1500mm/year. The peak flood staged of the Mekong river at Vientiane was only 6.67m on 7 $^{Th.}$
August 1992(the lowest of this century was 7.34 in 1906). The annual discharge of the Mekong River in 1992 at Pakse was 74% of the average.

5. Severe flooding episode from 1994-1997.

In 1994 annual precipitation in central and southern provinces were above normal in some provinces twice higher than normal as resulted severe flooding conditions in Borikhamxay, Khammuane provinces. In some districts of the northern provinces, landslide condition occurred in several section of the roads was impracticable during August- September.
The 1995 flood was the most severe for Vientiane plain after the historic large flood occurred in August - September 1966.
1996 flood in central and southern provinces affected and damages were important and there were loss of lives. Provinces affected: Borikhaxay, Khammuane, Savanaket, Champasak, Saravanh, Attapei and Sekong. Special phenomenon was observed from unusual flooding condition in Khamkeuth district(more than 470msl high) from flash flood and from Namcaking River.
1997 flood again in central and southern provinces where Borikhamxay, Khammuane and Champasak were heavily affected in September damages were more severe than 1996 flood for this provinces. For Vientiane plain, flooding downstream of Nam Ngum Dam's powerhouse , houses, public offices, paddy field and orchards by the bank of NamNgum River were flooded.

1997.The recent El Nino 1997-98
Dry condition prevails throughout the country in 1998,as resulted from the late stage of the 1997-98 El Nino. In some areas precipitation was only 50% of normal. an extreme low flow condition occurred in several rivers. Annual discharge of the Mekong River at Pakse was only 72% of the average of 9651.6m3 from period of 1961-1998)

Effects of El Nino and La Nina on:

From climate data is concluded the 1997-98 El Nino has serious impacts on weather condition, river runoff(extreme low flow), shortage of water supply especially for rice plantation in the dry season. It is noted that during the 1998 raining season no typhoon or tropical storm hit in Lao PDR and during the dry season1998-99 severe forest fires reported.
Statistic of impact:

On environmental issue : Climate changed and led to a much higher incident of forest fires nationwide

- 1996 50,000 ha
- 1997 40,000 ha
- 1998 134,995 ha

On Agricultural production: Damages reported from flooding in Vientiane plain,1995:

- persons affected 153,398;
- households 26,603;
- villages affected 427.
- Land use total flood area 102,912 ha,
- rice crop total area 61,142 ha,
- flood affected 34,471 ha,
- damaged area 30,962c ha and
- other crops 17,167 ha.

II. INSTITUTIONAL FRAMEWORK FOR CHALLENGES

a).National Disaster Management Office(NDMO) started in September 1997 and its function and responsibility

- Provide of secretariat and expert services to National Disaster Management Committee.
- Promotion of disaster prevention / mitigation and preparedness within all agencies and levels of government and NGOs as well.

- Providing guidelines , organizing disaster training & awareness , and promoting the preparation of disaster action plan.
- Operating the national Emergency Operations Center at time of Disaster.

b).National Disaster Management Committee(NDMC) has been formulated consisting of key Ministries:

- Minister of Labor and Social Welfare Chairman
- Ministry of Agriculture and Forestry Vice Chairman
- Ministry of Foreign Affairs Vice Chairman
- Ministry of Defense
- Ministry of Interior
- Ministry of Education
- Ministry of Finance
- Ministry of Communication Transportation and Construction
- Ministry of Industry
- Ministry of Public Health
- Ministry of Culture and Information
- Department of Ministry of Labor and Social Welfare MLSW
- Lao Red Cross

with its roles and responsibilities:

- defines priorities and criteria for the allocation of resources
- Implements policies and decisions on an inter- ministries basic
- Co-ordination by all government consisted of representatives of the concerning government ministries and agencies the roles and responsibilities
- Establishes policies, including the national disaster management plan, and provides overall direction for al aspects policies and has overall direction of the activities of the NDMO
- Responsible for major operational decisions during an emergency
- Decides on allocations of relief resources

C). COUNTER MEASURES TAKEN :

Awareness and preparedness against the impacts of El Nino and La Nina is recently observed in 1997-98 event. This event begins to draw attention from government and general public. At the Seminar on Hydrological work and Pumping irrigation in the Mekong River basin held in Vientiane 23-27 February 1998. The Department of Meteorology and Hydrology has announced the weather conditions during the first 3 months of 1998. The general out look for the seasonal climate outlook forum conveyed in Bangkok on the 2 February 1998. The general tendency is dry for year 1998 that coincide with a return period of 50 years 1957-58
(extreme dry year).Consequently the Nam Ngum Dam operation was reduced turbine generating to nearly 50 % in order to keep the water level of the reservoir closely the previous year.
In the agricultural sector, especially for farmers, advice or warning were frequently issued to be prepared against shortage of water for paddy rice during the growing season.
Flood control activities have been implementing in the flood prone areas
Drought measures were taken with providing early warning to farmers and technical assistant, irrigation systems, water storage with waters pumps to dry season cropping

III. CONCLUSION AND RECOMMENDATIONS:

In Lao PDR the El Nino cycle of 4-5 years was frequently observed 1991-92,1997-98. and affected rainfall distributed, the rivers runoff. However, due to different occurrences of the phenomenon, the variation in arrival times of the Southwest monsoon, is of major consequence to

the agricultural sector of the country. Rice production occupied over 80 % of cultivated. For the foreseeable future the agricultural sector remain a key to providing food self-sufficiency at the national level and employment to the majority of the population and to alleviating poverty.
In Additional the afford can be minimized through the following measures:

- Create and effectively early warning and public awareness to communities of El Nino and La Nina events;
- Project watersheds against environment degradation;
- Increase the flood control and irrigation systems to minimize flood and drought;
- Design and locate specific water harvesting and management system;
- Adopt after flood rice cropping followed by irrigated dry season rice cropping in flood prone areas.

IV. THE WORKSHOP ON THE IMPACT OF EL NINO AND LA NINA ON SOUTHEAST ASIA

The Lao delegation underscores the need for:

- Regional co-operation on the impact of El Nino and La Nina preparedness among the " Southeast Asia countries". .
- Strengthen regional co-operation Information Systems in order to be well prepared against these phenomenon including Warning Systems
- Wider use of training resources, development of training and public awareness modules
- "Sharing experts": Rosters of Experts and establishment of Expert Groups

Table 5: Areas affected by forest fires nationwide

Location	1996	1997	1998
Luang Prabang*	-	-	- 3,000 ha
Bokeo*	-	-	4,200 ha along the Lao – Thai border
Oudomxay*	35,000 ha	25,000 ha	20,000 ha
Luang Namtha*	-	-	17 mountains along the Lao - Chinese border
Phongsaly*	-	-	-
Saygnabuly*	15,000 ha slash-and-burn	15,000 ha slash-and-burn	127,360 ha
Viengtiane**			710 ha
Viengtiane Pre-fecture**			1,240 ha
Xieng Khouang**			10,000 ha
Houaphane**			
Saysomboune**			
Bolikhamsay**			.
Khammouane**			58 ha
Savannakhet**			600 ha
Salavane**			100 ha
Champasack**			200 ha
Sekong**			67,527 ha
Attapeu**			
TOTAL	50,000 ha	40,000 ha	134,995 ha

Source: * Provincial adiministration
** **Ministry of Agriculture/Forestry, Dept. of Forestry**

YEAR	TYPE OF DAMAGE	DAMAGE COST (US$)	LOCATION OF DAMAGE
1966	Large flood	13,800,000	Central
1967	Drought	5,200,000	Central and Southern
1968	Flood	2,830,000	Southern
1969	Flood	1,020,000	Central
1970	Flood	30,000	Central
1971	Large flood	3,573,000	Central
1972	Flood and Drought	40,000	
1973	Flood	3,700,000	Central
1974	Flood	180,000	Southern
1975	Drought	not available	
1976	Flash flood	9,000,000	
1977	Severe Drought	15,000,000	
1978	Large flood	5,700,000	
1979	Drought and Flood	3,600,000	
1980	Flood	3,000,000	Central
1981	Flood	682,000	Central
1982	Drought	not available	
1983	Drought	50% below normal production levels	
1984	Flood	3,430,000	
1985	Flash Flood	1,000,000	Oudomsay
1986	Flood and Drought	2,000,000	
1987	Drought	5,000,000	Central and Northern
1988	Drought	Crop losses of 40,000,000 Reduction in Electricity Production (Hydro) 10,500,000	Southern
1989	Drought	20,000,000	Southern
1990	Flood	100,000	Central
1991	Flood and Drought	3,650,000	Central
1992	Flood, Forest Fires, and Drought	302,151,200	Central, Northern
1993	Flood and Drought	21,827,927	Central, Southern
1994	Flood	21,152,400	Central, Southern
1995	Large Flood	35,700,000	Central, Southern
1996	Large Flood; Flash floods and landslides	34,400,000	Central & Southern Northern

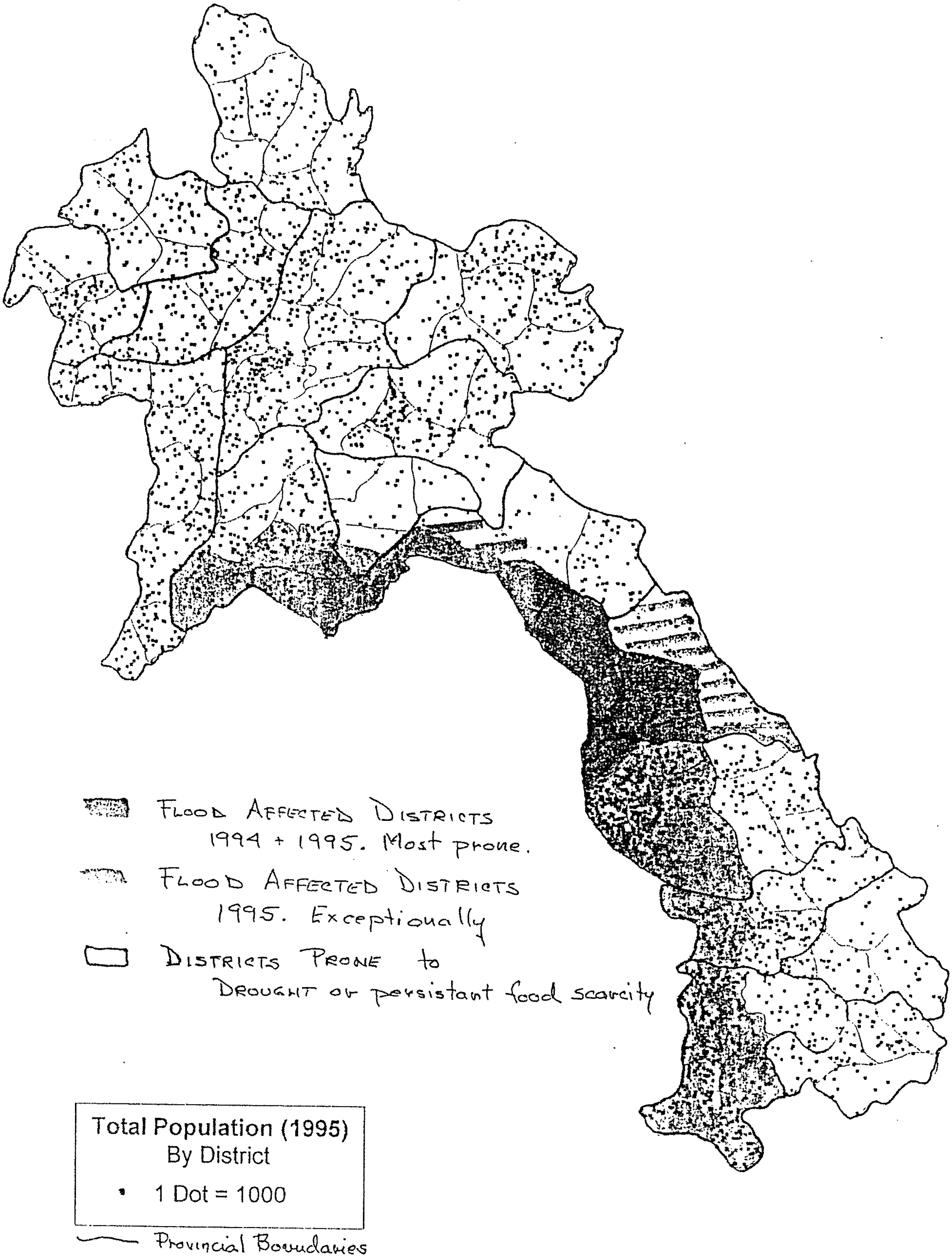
Source: [DMH; MAF]

(file:damagea)

LAO PEOPLE'S DEMOCRATIC REPUBLIC

Population by District, 1995

Showing Primary Hazards



SCALE: 1 cm = 50 kilometers

GIS Training & Service, Vientiane, Lao PDR

Factors Contributing to Climate Change in Cambodia.

Workshop on
the Impact of El Nino and La Nina on Southeast Asia
21-23 February 2000, Hanoi, Vietnam
Prepared by Mr. Long Rithirak, Mak Sideth, Chea Sina.

Cambodia's climate is tropical monsoonal with a pronounced wet and dry season. Each season is six months: the wet season starts from May until October and the dry season is from November to April. The temperature is approximately from 20-32°C. The temperature rarely falls below 10°C.

Unfortunately, there is little data in Cambodia that relates specifically to climate change, making this a difficult topic to research. However, there are a number of factors that could contribute to climate change in Cambodia.

Forestry

The forests are a priority resource that supports the livelihood of the Cambodian people and is the main natural resource that can regulate and maintain the quality of the environment in a sustainable way. At the present, almost 40% of the forest (from what was13,2 million ha) has been degraded and cut due to the increase in logging activities, uncontrolled forest fires, increase demand for agriculture land, and the collection of fuelwood for charcoal production and other domestic use. The result from the survey estimated 2 million hectares of forest have been lost (about 100,000 hectares per year (MoE, 1994)). Therefore, the loss of forest in the country can cause a phenomenon disaster.

Flooding

The climate of Cambodia is determined by monsoons that can play a triggering role in the annual flooding of the Mekong-Tonle Sap Basin. A flash flood in central Cambodia, August 1991, caused an estimated US$ 150 million in damage to roads, reservoirs and irrigation structures in the central provinces of Cambodia (Dannis and Woodsworth, 1992).

In July 1994, the floods hit some provinces including Battambang, Kompong Speu, Kompot and Kandal caused around US$ 200 million in damage to roads, reservoirs and irrigation structures. This estimate did not include the environmental and social costs.

Some provinces along the Mekong River and Tonlesap Basin were flooded in 1996. This flood caused a lot of damage to houses, rice and livestock productions. Floods caused, again, damage in some provinces along the river and Tonle Sap Basin during 1997.

Flooding has been caused in Cambodia for a series of reasons including: deforestation, changes in weather patterns, soil erosion and sedimentation in the Tonle Sap Lake.

Changes in weather

Although no one is exactly sure if weather patterns are changing in Cambodia, it has been noticed by many people that the weather is less predictable then it once was. For example, last years (1999) rainy season was initially quite light yet lasted far longer than expected (into late October). This left many people's rice fields flooded.

Carbon Dioxide

From year to year the number of vehicles in Cambodia are increasing. More and more cars are driven on the road, and the number of motorbikes continues to increase.

Another issue is open burning that occurs in Cambodia. People burn their garbage, land is burned for agriculture and people often cook with charcoal.

It is difficult to say if industry is adding to carbon dioxide emissions.

The effects of climate change on Cambodia

There is no concrete data in Cambodia relating to climate change. However, should weather patterns remain unpredictable or should temperature's rise, this will affect Cambodia greatly. It is quite possible that rice production would decrease, and coastal areas could become flooded. This will significantly threaten the coastal population. Already in December of 1999 and January of 2000 coastal communities in Kampot and Koh Kong province were seriously flooded.

THE IMPACTS OF EL NIÑO AND LA NIÑA EVENTS ON THE CLIMATE OF MYANMAR

Mr. U Tun Lwin (Department of Meteorology and Hydrology of Myanmar)

The period between May 1997 and June 1998 was a major El Niño event. During this period many countries around the world suffered, to some extent, from climatic calamities in terms of loss of lives, properties and economy. The impact on the climate of Myanmar was evident during 1997 and 1998.

Out of the six major El Niño events, the mean annual temperature for Myanmar showed four events which were above normal. Only a single episode in 1972 showed a below normal mean annual temperature. Therefore, it could be suggested that the mean annual temperatures during El Niño years are generally above the normal.

Studies on the mean annual rainfalls in six episodes of the major El Niño events show that four (five) events have below normal rainfall occurring during the preceding (following) years of the peak El Niño episode. Therefore, from this information, we can see that 70% (80%) of the El Niño events show below normal annual rainfall in Myanmar during the preceding years.

We can confidently say that the relation of monsoon rainfall to El Niño events clearly reveals that the monsoon rainfalls in Myanmar are below normal in most of the El Niño years. This is particularly true in the preceding year of the peak episode. However, even in the following year the possibility of below normal rainfall is still rather high with a statistic of five out of six events.

Studies on the drought index in relation to El Niño events show a good relationship. In most of the El Niño events, four (five) out of the six events show a positive drought index in the preceding (following) years of the episode. Thus, it can be confidently stated that during El Niño years the drought index in rainfall shows positive (dry) values.

Studies on the relationship between the frequency of storms and El Niño events have been controversial for a long time. The present study indicates that the annual storm frequency in preceding years of the peak of El Niño events are below normal. However, during the following years of a peak El Niño event, the annual storm frequency is below normal to normal.

The relationship between early monsoon intensity and El Niño events does not perform very well, although one would expect below-normal intensity, especially during the second (following) year of a peak El Niño period. The present study shows that only 16% (33%) of the events have below-normal intensity in the early monsoon period in preceding (post) years of the peak El Niño events. However, 67% (51%) of El Niño events show normal monsoon intensity in pre- and post peak periods.

The noteworthy fact is that only 16% of the cases in pre- and post years of the peak El Niño events show above normal monsoon intensity in early monsoon periods of the respective years. Therefore, it can be concluded that the monsoon intensity in the pre-monsoon periods of both the preceding and following years of the peak of major El Niño events could be below normal to normal.

To summarize this paper and to conclude, we can see that the impacts of El Niño events on weather parameters such as annual temperature, annual precipitation and the drought index are evident. Moreover, the El Niño event also has an impact, to some extent, on monsoon climatology.

Myanmar benefits from the southwest monsoon and it is an agricultural country so, as almost 90% of the country's annual rainfall is received from monsoon rains, Myanmar's economy will be affected.

El Niño events have been more frequent than ever during the 1990s. This definitely calls for a better understanding of this phenomenon. Myanmar is also starting to notice that the reverse of El Niño, La Niña, is having a reverse effect on the climate of Myanmar. For example, the weather in 1998 and the weather in 1999 was very different, with 1998 being an El Niño year and 1999 being a La Niña year. It is obvious that more research and studies are needed in respect to El Niño and La Niña.

International Forecasts of the ENSO Phenomenon

S. J. Mason
Scripps Institution of Oceanography, University of California, San Diego

1. Introduction

In the mid-1960s, observational and diagnostic studies of the ocean and atmosphere began to make it clear that certain behaviors of the coupled system might be predictable on seasonal time-scales, including in particular the El Niño–Southern Oscillation (ENSO) phenomenon (Latif *et al.* 1998; Neelin *et al.* 1998). The aim in this paper are to describe how forecasts of the ENSO phenomenon are made, and how accurate they are.

2. Statistical models

a. Model design

The implicit assumption behind statistical models for predicting the future state of the ENSO phenomenon is that antecedent or expected future values of predictor variables can be used to predict the future evolution of the predictand, based upon historical observations of mathematical relationships between the predictors and predictands. Most of these models involve prediction of a field of tropical Pacific sea-surface temperatures, or a simple area-average of representative regions of the equatorial Pacific, such as the NIÑO3 (5°N-5°S, 150°-90°W) or NIÑO3.4 (5°N-5°S, 170°-120°W) areas. The predicted sea-surface temperature anomalies usually are derived from previously observed sea temperatures, and/or wind stress anomalies over the equatorial Pacific, although relationships with atmospheric anomalies further afield, particularly in the Indian Ocean and over Eurasia, often are considered (Barnett *et al.* 1991). The most frequently used statistical models include:

- regression, involving a linear relationship between a single predictand (such as the NIÑO3 index, and a set of precedent predictands (such as surface wind stress and/or sea-surface temperature anomalies throughout the tropical Pacific);
- canonical correlation analysis, involving linear relationships between a set of predictands (such as tropical Pacific sea-surface temperatures) and a set of precedent predictands;

Although probabilistic methods of statistical prediction have been used in forecasts of precipitation anomalies (Ward and Folland 1991; Mason 1998), there are few examples of their application in forecasting the ENSO phenomenon per se. Many of the statistically based forecasts are published in the *Experimental Long-Lead Forecast Bulletin*, which is available on the worldwide web at http://grads.iges.org/ellfb/.

b. Strengths and weaknesses

Positive attributes of statistical approaches to predicting ENSO (and to predicting climate anomalies) mainly are based on the inherent relative simplicity of such models. In most cases statistical models can be constructed, applied, interpreted and diagnosed, and run with ease. There are, however, a number of negative attributes. Perhaps the most serious problems with statistical forecasting methods result from the fact that such models are not explicitly linked to physical processes. The statistical relationships that are identified do not necessarily indicate causal relationships, and so:

- model skill may be artificial;
- it is difficult to get a true estimate of operational skill (most estimates of the skill of statistical models over-estimate operational skill);
- if background conditions change, the models may no longer give good forecasts;
- different models are required for different seasons and regions.

An additional problem associated with most statistical models, is that the output is in the form of a deterministic prediction, and they thus provide little indication of forecast uncertainty. While confidence intervals are sometimes provided, these are defined in terms of the mean-square error of the model over the training period (Wilks 1995) rather than being direct indications of the inherent uncertainty in the prediction of the current season (Mason 1998).

3. Dynamical models

Dynamical approaches to the prediction of the ENSO phenomenon involve a fundamentally different approach to the problem, and are based upon attempts to model the physical processes responsible for tropical Pacific variability using the first principals of the laws of physics. In many cases the physical processes involved, rather than being explicitly modelled, are parameterized in the form of statistical or mathematical relationships. A hierarchy of dynamical models can be defined based upon increasing levels of complexity.

a. Intermediate models

Intermediate models involve a simple shallow water model, coupled to a simple atmospheric model. Such models do not attempt to include all the physical processes involved in ocean and atmospheric circulation and coupling, but rather focus on attempting to model only those processes that form key components of the ENSO system. In most cases intermediate models are consistent with the delayed-oscillator model of ENSO variability (Neelin *et al.* 1998), which implies that the mechanism for inter-annual variability is associated with the subsurface memory of the equatorial Pacific. External forcing, from the Eurasian land mass for example (Barnett *et al.* 1991), therefore is explicitly excluded.

Probably the best known example of an intermediate model of the ENSO phenomenon is the Cane-Zebiak model (Cane and Zebiak 1985). This model involves a simple atmospheric model in which winds are driven by convective heating, which in turn is parameterized in terms of sea-surface temperatures and surface wind convergence. The ocean component to the model is more complex, and involves ocean waves and currents represented by physical laws that are consistent with the delayed oscillator model. Variability in sea-surface temperatures is modelled as a function of advection, heat fluxes, and thermocline depth. The Cane-Zebiak model is an anomaly model, and so biases in model climatology and errors in the representation of the seasonal cycle can be avoided.

b. Hybrid coupled models

Hybrid coupled models involve a more comprehensive physical ocean model than intermediate models, but have an empirical atmospheric model. Because hybrid coupled models are confined to the tropical Pacific, there is the assumption that ENSO physics is inherently rooted in the tropical ocean-atmosphere system (as is the case for intermediate models). Hybrid coupled model strengths and weaknesses are very similar to those for Intermediate models, and are discussed below.

c. Fully coupled models

Fully coupled models involve a physical ocean model coupled to a physical atmosphere model. The oceanic model may be global, as in the case of ECMWF (Stockdale *et al.* 1998), or confined to the tropical Pacific, as in the case of the NCEP model (Ji *et al.* 1998). Such models are no longer constrained by the assumption that the physics of ENSO variability are confined to the tropical ocean-atmosphere system. The ECMWF forecasts are available from http://www.ecwmf.int/services/seasonal/forecast/.

b. Strengths and weaknesses

Positive attributes of dynamical approaches to predicting ENSO (and to predicting climate anomalies) include:

- less susceptibility to bias in skill estimates because the models are harder to tune, and the parameters generally are constrained by physical laws;
- ability to model the effects of the non-linear behaviour of the ocean-atmosphere system;
- less affected by changes in the background state;
- ability to provide probabilistic forecasts, and therefore to give better estimates of forecast uncertainty (although in practice it is only the fully coupled models that are run operationally in ensemble mode);

Negative attributes of dynamical models are based largely on the inherent relative complexity of such models:

- they are difficult to build, maintain, and operate;
- they are expensive to operate;
- it can be difficult to understand their behaviour;

Although the dynamical models are harder to tune than the statistical models, in general the hindcast skill estimates, at least from the intermediate and hybrid coupled models, are over-estimated because model parameterizations are fine-tuned to optimize model skill.

4. Skill Levels

In practice, the various model types perform approximately equally well. Despite the greater complexity of the dynamical models, although theoretically, the dynamical models hold greater promise for forecast improvement. For all types of models forecast skill is limited by:

- model flaws;
- gaps in the observing system;
- inherent limits to predictability.

However, the skill of the dynamical models additionally is restricted by data assimilation and initialization problems. Improvements in data assimilation in both the Cane-Zebiak model and the NCEP coupled model have resulted in demonstrable improvements in forecast skill. There still is considerable scope for improving model initialization, which should contribute further to increases in skill.

Although there have been claims of high skill in forecasting ENSO events with lead-times of twelve months or more, operational skill estimates, which provide the only truly unbiased indications of forecast skill, suggest that ENSO events can be forecast qualitatively only a few months in advance (Barnston et al. 1999), and usually only after an event has begun. In addition to be a function of the ENSO phase, skill levels have varied inter-decadally, with high skill levels in the 1980s, but relative poor skill in the 1970s and 1990s (Balmaseda *et al.*, 1995; Kirtman and Schopf, 1998). This low-frequency variability in the predictability of ENSO events may be a reflection of changes in the role of the delayed-oscillator mechanism in equatorial Pacific ocean-atmosphere dynamics (Goddard and Graham 1997). Some evidence suggests that there may be seasonal variability in the predictability of the equatorial Pacific, involving a loss of predictability in about March, and is referred to as the "springtime barrier" (Balmaseda *et al.*, 1995; Webster, 1995; Latif *et al.*, 1998). The spring barrier is most well defined during decades of relatively poor predictability, but is not evident all ENSO-prediction models, and so may not be an inherent feature of the ENSO phenomenon (Chen *et al.* 1995).

References

Balmaseda, M. A., M. K. Davey, and D. L. T. Anderson, 1995: Decadal and seasonal dependence of ENSO prediction skill. *J. Climate*, **8**, 2705–2715.

Barnett, T. P., L. Dümenil, U. Schlese, E. Roeckner, and M. Latif, 1991: The Asian snow cover–Monsoon–ENSO connection. *Teleconnections Linking Worldwide Climate Anomalies: Scientific Basis and Societal Impact*, M. H. Glantz, R. W. Katz, and N. Nicholls, Eds., Cambridge University Press, 191–225.

Barnston, A. G., Y. He, and M. H. Glantz, 1999a: Predictive skill of statistical and dynamical climate models in forecasts of SST during the 1997–98 El Niño episode and the 1998 La Niña onset. *Bull. Amer. Meteorol. Soc.*, **80**, 217–244.

Cane, M. A., and S. E. Zebiak, 1985: A theory for El Niño and the Southern Oscillation. *Science*, **228**, 1085–1087.

Chen, D., S. E. Zebiak, A. J. Busalacchi, and M. A. Cane, 1995: An improved procedure for El Niño forecasting: implications for predictability. *Science*, **269**, 1699–1702.

Goddard, L., and N. E. Graham, 1997: El Niño in the 1990s. *J. Geophys. Res.*, **102**, 10423–10436.

Ji, M., A. Leetmaa, and V. E. Kousky, 1998: An improved coupled model for ENSO prediction and implications for ocean initialization. Part II: the coupled model. *Mon. Wea. Rev.*, **126**, 1022–1034.

Kirtman, B. P., and P. S. Schopf, 1998: Decadal variability in ENSO predictability and prediction. *J. Climate*, **11**, 2804–2822.

Latif, M., D. L. T. Anderson, T. P. Barnett, M. A. Cane, R. Kleeman, A. Leetmaa, J. O'Brien, A. Rosati, and E. Schneider, 1998: A review of the predictability and prediction of ENSO. *J. Geophys. Res.*, **103**, 14375–14393.

Mason, S. J., 1998: Seasonal forecasting of South African rainfall using a non-linear discriminant analysis model. *Int. J. Climatol.*, **18**, 147–164.

Moore, A. M., and R. Kleeman, 1996: The dynamics of error growth and predictability in a coupled model of ENSO. *Quart. J. Roy. Meteor. Soc.*, **122**, 1405–1446.

Neelin, J. D., D. S. Battisti, A. C. Hirst, F. F. Jin, Y. Wakata, T. Yamagata, and S. E. Zebiak, 1998: ENSO theory. *J. Geophys. Res.*, **103**, 14 261–14 290.

Stockdale, T. N., D. L. T. Anderson, J. O. S. Alves, and M. A. Balmaseda, 1998: Global seasonal rainfall forecasts using a coupled ocean–atmosphere model. *Nature*, **392**, 370–373.

Ward, N. M., and C. K. Folland, 1991: Prediction of seasonal rainfall in the north Nordeste of Brazil using eigenvectors of sea-surface temperatures. *Int. J. Climatol.*, **11**, 711–743.

Webster, P. J., 1995: The annual cycle and the predictability of the tropical coupled ocean-atmosphere system. *Meteor. Atmos. Phys.*, **56**, 33–55.

Wilks, D. S., 1995: *Statistical Methods in the Atmospheric Sciences*. Academic Press, 467 pp.

PRACTICAL ASPECTS OF FORECASTING RAINFALL IN EASTERN AUSTRALIA AND SOUTH EAST ASIA USING EL NINO/SOUTHERN OSCILATION (ENSO) INDICATORS.

Extended Abstract.

ROGER C STONE
Queensland Centre for Climate Applications, PO Box 102, Toowoomba, Queensland, AUSTRALIA 4350.

Introduction

ENSO is often predicted with an aim that this prediction may then be used to estimate rainfall or temperature on a seasonal time scale. However, while ENSO has a strong influence in the tropical genesis regions of the Pacific Ocean, the effects of ENSO in extra-tropical regions is less certain. Thus, in extra-tropical regions an ENSO event should be thought of as 'putting a bias in the system rather than as a certain cause' (Cane, 2000).

Prediction of ENSO impacts is currently made with physical or statistical models or other empirical methods. Fully coupled global General Circulation Models (GCMs) may predict global impacts associated with ENSO along with the prediction of the changes to ENSO itself in the tropical Pacific. Another method is to take a "two-tiered" approach whereby a more simple oceanic GCM predicts tropical Pacific sea-surface temperatures. A global atmospheric GCM then uses the predicted SSTs as boundary conditions to calculate variations in rainfall or temperature or other variables of interest.(Cane, 2000; Barnett *et al.*, 1994; Hunt *et al.*, 1994). Forecasting ENSO using empirical approaches may also be two-tiered. This may take the form of producing a forecast of rainfall at a location or for a region by combining the prediction of the Southern Oscillation Index (SOI) or of the NINO3 SST anomaly pattern with the historical relationship with rainfall.

However, in this paper I am proposing a more efficient and practical approach is the do the entire prediction at once, using known, observed values of the SOI or SST to predict a future rainfall or temperature. This approach also avoids the problem of compounding errors (a multiplicity of errors associated with the prediction of ENSO in the first place combined with the error in predicting the outcome given that ENSO did in fact occur).

Examples of ENSO-based prediction methods used in Australia.

Two main approaches are employed in Australia to produce seasonal climate forecast output. These are:

- a base 'phase' system that incorporates the SOI as predictor. 5 SOI phases based on a Principal Components and Cluster Analysis of the time series of the SOI have been identified and these are used as predictors (Stone and Auliciems, 1992; Stone *et al*, 1996a; Stone *et al*, 1996b). The prediction of Australian and global rainfall of Stone *et al.* (1996a), based on the phase system uses values of the SOI at 2 different times to predict rainfall a season or more ahead.

- an SST-based system that employs empirical orthogonal functions (EOFs) of Pacific and Indian Ocean SSTs as predictors. These EOFs of SST are matched with principal components of rainfall patterns in Australia using a 1 month and 3 month lag. (Drosdowsky, 1993; Nicholls *et al*, 1998).

The important point is that neither of these approaches is necessarily 'concerned' over whether an 'El Niño' or La Niña' is forecast or is even underway. Both of the above methods use lag-relationships between the SOI 'phase' or SST EOF and the predictand (e.g. rainfall, temperature, dates of first and last frost). Additionally an SST pattern system that incorporates 9 patterns of SST in the Pacific and Indian Oceans is being developed (Drosdowsky, personal comm.).

The skill of both of the above climate forecast systems has been assessed using cross-validated LEPS Scores (LEPS stands for Linear Error in Probability Space) (Potts, *et al.*, 1996). An interesting issue is that both of these systems seem to have equivalent skill in forecasting rainfall in Australia, although the SST-based system seems to have higher skill over southern Australia than the SOI-based system. Conversely, the SOI-based system appears to have higher skill over northern Australia than the SST-based system, although direct comparison is not as simple as might first seem apparent. We also know that the nature of the climate system does not allow unlimited predictability, so that even a perfect forecasting system would not be able to deliver precise forecasts. Thus to be correct a forecast must be phrased as a probabilistic statement and considerable effort is made in Australia to always refer to climate forecasts in a probabilistic manner (also from Cane, 2000).

A further benefit of employing the above approaches (especially the 9-pattern SST system and the 5-phase SOI phase system) is that each month for the last 100 years can be categorised into which SOI phase or SST pattern it belongs. This result then allows analogue seasons or years to be extracted easily from the data. This result also allows for considerable transportability of the forecast systems across different variables (e.g. frost, number of raindays, streamflow, dam in-fill rates). This approach also allows the connection of the climate forecast system to crop and pasture and other simulation models that require input of analogue seasons for their use.

Indeed, one of the reasons for the modest success of climate forecasting in Australia is that the methods that have been developed have been directly able to produce outputs of key variables in agricultural risk management. These include the probability of pasture growth, probability of attaining certain crop yield values for many crops grown in Australia (e.g. sugar, wheat, sorghum, cotton, peanuts, maize, chickpeas), the value of adding fertilzer inputs to a crop given the likelihood of a certain type of season, the amount of irrigation water that will be available for a coming season, the amount of water likely to flow into a dam, and so on. They also include estimates of disease and waterlogging.

In other words, the more direct approach of doing the entire prediction at once without necessarily forecasting a major El Niño or La Niña has facilitated a particularly practical and useful climate forecasting industry to quickly become established in Australia. .

We have also applied these climate forecasting methods to many other world regions including South-East Asia with interesting results.

Figure 1 shows rainfall probability distributions for Hanoi, Vietnam for the March-May period associated with SOI phases for the immediately preceding January/February. This type of analysis shows that the probability of exceeding 300mm total rain during March/May following a consistently negative SOI phase is 30% while following a 'rapid rise' SOI phase the probability of exceeding 300mm is 80%. This analysis simply extracts the rainfall records for Hanoi for the last 70 years and determines the rainfall distributions associated with those seasons following the respective SOI phases.

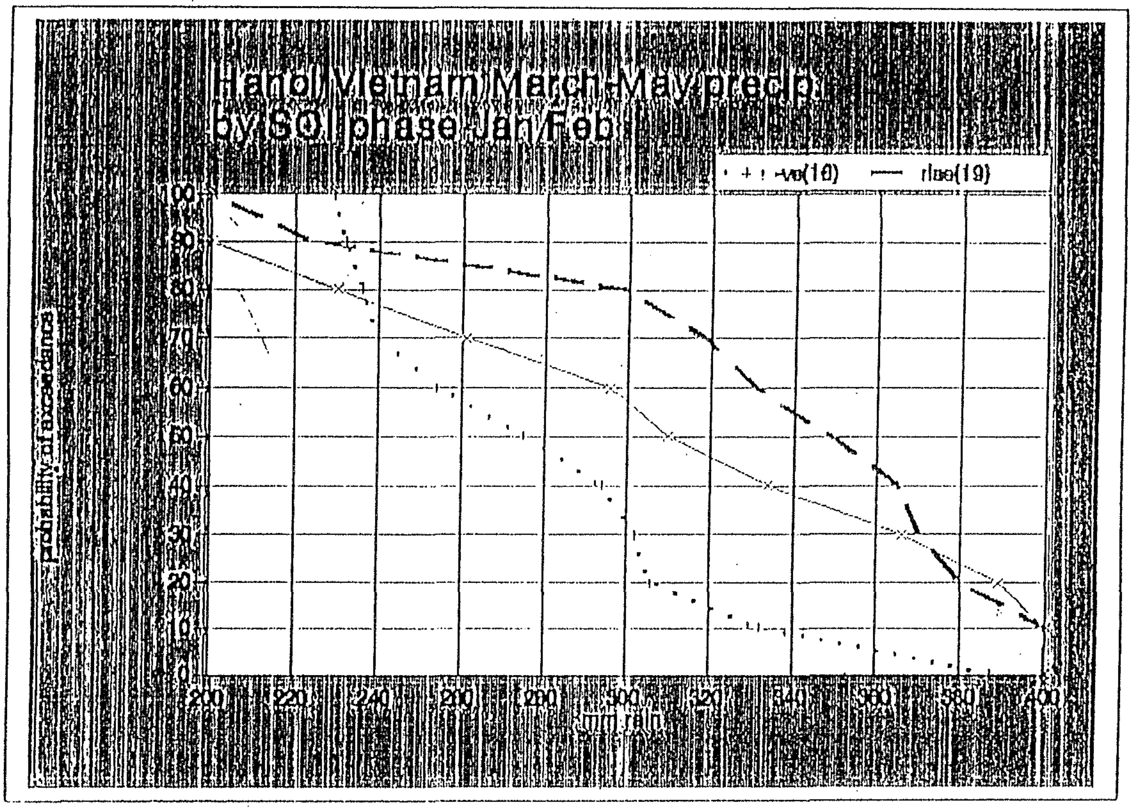


Figure 1. Rainfall probability distributions for Hanoi, Vietnam, for the March-May period associated with two SOI phases ('consistently negative' and 'rapid rise' SOI phases). It is suggested we are currently (February 2000) in a 'rapid rise' SOI phase. Similar analyses have been completed for a number of locations in South-East Asia and will be presented at the Conference.

However, a key point in applying this type of analysis in climate forecasting is that the analogue years or seasons associated with these SST patterns or SOI phases can also be extracted. This enables crop simulation models to use the daily data associated with these analogue seasons to grow crops in the computer. Figure 2 provides an example from Queensland, Australia where this type of method is currently applied successfully to predict not precipitation but crop yield. Figure 2 shows the potential yield for a crop planted on the 1st of June according to the various SOI phases known *before planting*. This analysis clearly shows the potential yield following a 'consistently negative' SOI phase is comparatively low (just over 1 tonne/ha) compared, for example, with the potential yield following a 'rapid rise' SOI phase where the potential yield is over 3 tonnes/ha (planted on a half-full profile of moisture.

It is suggested, there is some advantage in applying the type of seasonal climate forecasting procedure outlined above over the type that aims for a precise forecast of an El Niño or La Niña. The type of analysis outlined above can also be applied across a large range of requirements ranging from 'simple' rainfall analysis to more complex crop yield analysis. The latter type of output is often the type of information the user is actually seeking from climate forecast information. A systems approach to climate forecasting appears to be the most rewarding. This certainly applies from the users point of view where the climate forecast output directly applies to his decision system. This approach also helps when seeking funds from Government. Government may often be more predisposed to granting of funds for this type of climate forecasting research if it can clearly be shown where the payoffs lie in rural or other industries. The type of systems analysis outlined above using direct forecasts of precipitation or such as crop yield has greater capability in defining *value* (as opposed to forecast skill) in climate forecasting (Hammer, *et. al*, 1996).

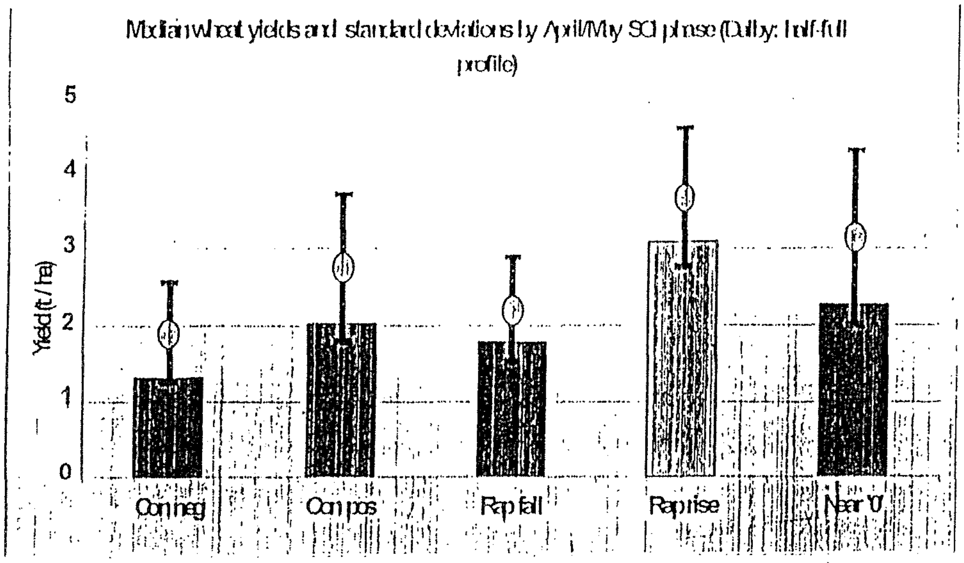


Figure 2. Potential yield values (median at the top of the bar, mean values the circle) for a wheat crop planted at Dalby, Australia on the 1st of June. The respective values are those associated with the data partitioned according the SOI phase known before planting.

Capacity building.

It is suggested there are some major requirements needed in capacity building before an effective systems approach to climate forecasting can be realised. The first is to do the climate research within an overall systems framework so that the end-to-end requirements of the entire climate forecasting-user-output value can be addressed properly. It is not much use if the climate forecasting system is unable to interact with other vital biophysical models that can provide forecasts of crop or pasture growth or to interact with power demand models or dam-in-fill rate models (see Hammer, *et al*, 1996)

A major need in capacity building is to employ appropriate staff with the necessary statistical modelling and analytical skills in climatic analysis. Finally, continued user engagement is required for this systems approach to gain user ownership from the outset of the climate forecasting research and development work.

References:

Barnett, T.P., Bengtsson, L., Arpe, K., Flugel, M., Graham, N., Latif, M., Ritchie,J.,Roeckner, E., Schlese, U., Schulzweida, U., and Tyree, M. (1994) Forecasting global ENSO-related climate anomalies. *Tellus* 46A, 381-397.

Cane, M. A (2000) 'Understanding and predicting the world's climate system' in Hammer, G.L., Nicholls, N, and Mitchell, C (eds) *The Symposium on Applications of Seasonal Forecasting in Agricultural and Natural Ecosystems: The Australian Experience.* Brisbane, 10-13 November 1997. Kluwer Academic Press.

Drosdowsky, W., (1993) 'An analysis of Australian seasonal rainfall anomalies: 1950-1987. II: Temporal Varibility and teleconnection patterns. *Int. J Climatol.*, **13**, 111-149.

Hammer, G.L., Holzworth, D.P., and Stone, R.C. (1996) 'The value of skill in seasonal climate forecasting to wheat crop management in a region with high climatic variability' *Australian Journal of Agricultural Research,* 47, 717-737.

Hunt, B.G., Zebiak, S.E., and Cane, M.A. (1994) Experimental predictions of climatic variability for lead time of twelve months. *International Journal of Climatology* 14, 507-526.

Nicholls, N, Foster, I.,, and Stone, R. (1998) 'Development of Improved Seasonal Climate Forecast Systems. LWRRDC Project report BOM1. Bureau of Meteorology Research Centre, Melbourne, Australia, January 1998.

Potts, J.M., Folland, C.K., Jolliffe, I.T., and Sexton, D. (1996) ' Revised "LEPS" scores for assessing climate model simulations and long-range forecasts', *Journal of Climate*, **9**, 34-53.

Stone, R.C., Hammer, G.L., and Marcussen, T. (1996a) Prediction of global rainfall probabilities using phases of the southern oscillation index. *Nature* 384, 252-255.

Stone, R.C., Nicholls, N., and Hammer, G.L. (1996b) 'Frost in north-east Australia: trends and influences of phases of the Southern Oscillation' *Journal of Climate*, 9, 8, 1896-1909.

Stone, R.C. and Auliciems, A. (1992) 'SOI phase relationships with rainfall in eastern Australia' *International Journal of Climatology*, 12, 625-636.

Authors address;

Dr Roger C Stone
Principal Research Scientist

Queensland Centre for Climate Applications
PO Box 102
Toowoomba, Queensland, Australia 4350.

Email: stoner@dpi.qld.gov.au

OVERVIEW OF THE CLIMATE FORECASTING IN VIETNAM

I/ INTRODUCTION

Vietnam is located in the area affected by the transverse and lateral components of monsoon system and the Walker circulation and the country is often threatened by storms, flood, inundation and salinity intrusion. So we strongly support the research activities to predict and assess the impacts of ENSO on climate and socio-economic in Vietnam and Southeast Asia, and endorse a vigorous international programme of research to improve understanding and prediction of the climate system and its variability.

Due to the importance of climate variability and climate change to Vietnam, the country pays more attention to serving and monitoring the climate and atmosphere to provide the data for climate research, monitoring and prediction, supports applications of climate information such as seasonal and interannual prediction and has actively responded to the issues of climate change raised by scientific researchers throughout the world.

II/ CLIMATE PREDICTABILITY AND PREDICTION IN VIETNAM

Upon on the grade of historical climate data, and by using the dynamical and statistical methodologies, there are series of studies had been published and applied to predict climate variations and tendency in Vietnam such as

- The prediction of monthly and winter season average temperature (from December to February);
- Prediction of rainfall in Hanoi;
- Medium-range forecasting (10 days) processes on medium and heavy rainfall in the North of Vietnam;
- Establishing medium- and long- range forecast of winter and summer season temperatures in North regions of Vietnam;
- Predicting onset of the first severe cold of winter season;

- Tendency of summer rainfall;
- Forecasting trends of climatic change in Vietnam;...

But almost studies based on the computation of averages and particularly trends for each data time series and the analysis of correlation coefficients, linear regression, or multi-regression,..., and there is no climate specific prediction model (global or regional) applied in Vietnam.

Due to the insufficiency of the computerizing capacity including computer hardware and software for model operations and shortages of skilled personnel and expertize in development of numerical modeling experimentation, and the Climate Research Center (CRC) has just been established since 1995, so its ability to predict climate on the short and long time scales as well as further changes is still limited. The present research programme prepared by the Climate Research Center (for 1999 - 2002) on establishing technology base for empirical study on climate prediction and issue of climate bulletin (Initial Implementation Plan) in Vietnam had been approved to implement.

III/ CLIMATE PREDICTION EMPIRICAL STUDY

Climate prediction empirical study is an initial implementation plan, continues the development of Climate Prediction Programme (CPP) and provides a necessary step towards its implementation.

The goals of programme are to:

1. foster the production and use of seasonal climate forecast information, thereby reducing societal losses due to climate variability and assisting to achieve sustainable development;
2. modernize the CRC and strengthen its capacity for research and application to provide seasonal climate prediction and climate information.

The overall scientific objectives of the CPP are following:

1. Establishing climate data base (historical and real time data) to serve the climate prediction activities and to issue the Climate Bulletin or Outlook Fora;
2. Experimenting in application of climate forecasts: monthly,

seasonal, annual based on empirical or statistical models. Forecast criteria are necessary for empirical methods:

- Predictors should be physically plausible and based on current scientific understanding;
- Assessing the skill in real - time is controversial, but some estimate of skill independent of model training is needed;
- Satellite records are generally considered too short to be used in empirical models;
- A data set of 30 - 40 years is considered necessary to derive reliable skill estimates; and
- A number of methods for testing skill levels are available, including cross - validation and retroactive real - time validation.

3. Issuing the Climate Bulletin;
4. Education and training of scientists and decision makers skilled in the use and interpretation of new forecast capabilities and analysis techniques;
5. Considering and examining the regional climate simulations to understand and evaluate the strengths and weaknesses of regional climate models through systematic comparative simulations (Reg CM2, ECMWF Ensemble Simulation CD-ROMs,...).

However, we are waiting for benefits that will come from successful completion of the World Climate Research Programme (WCRP): especially CLIVAR, CLIPS; IRI - NOAA Proposal for Capacity building in Seasonal Climate Prediction for ASEAN: Regional Modeling, Applications studies, Training and others to develop the ability to predict the climate system on "seasonal, interannual, decadal, and centennial time scales", and to "predict the response of the climate system to human influences.

Dr. Nguyen Van Thang
Deputy Director, Climate Research Center
Lang, Dong Da, Ha Noi, Vietnam.
E-mail : Thang@crc-imh.ac.vn

Climate forecasting in China

Wang Shaowu
(Department of Geophysics, Peking University,)

Abstract

Statistics indicated that 70%• 80% of the annual loss of natural disaster in China can be attributed to the droughts and floods. The annual loss ranged from 1.0 to 2.0 hundred bullion of Chinese Dollar in 1990's. Summer rainfall consists of about 60%• 70% of annual precipitation in north, and 40%• 50% in south China. Therefore, forecast of summer rainfall anomaly pattern has critical in service to the society. Operational forecast on summer drought and flood was firstly issued in 1958 by the Section of Long Range Forecast, Central Meteorological Observatory, National Meteorological Administration, for severe flood along the Changjiang River in 1954 and along the Hui River in 1956 had made significant lose in the economy.

Development of seasonal forecast operations for the last 42 years (1958• 1999) has undergone three stages. In the first stage, from late 1950's to the middle 1960's, statistical method of Namias (1953) was used in China in preparing prediction of monthly mean 500hPa level height. However, only monthly prediction was made in that time, so it is impassable to issue seasonal forecast by using of this method. Then, a lot of statistical method was applied, for example, regression equation or periodicity analysis.

The Second stage lasted nearly 30 years from middle 1960's to middle 1990's. Physical mechanism responsible for the development of summer rainfall anomaly was extensively examined not only in the Meteorological Observatories, but also in the Institutes and Universities. Experiences in operational forecasting indicated that the following factors may used as precursor: ENSO, snow corer over Tibet plateau, SST of kuroshio, solar activity. For example, it has been established that summer rainfall will greater than the normal along the middle reaches of the Changjiang River and south of it when snow fall was greater than the normal over the Tibet plateau and SST in equatorial eastern Pacific was higher than the normal in previous winter. 1997 was a year of El Niño, and snow cover over the Tibet plateau was significantly greater than the normal in the winter of 1997-1998. Then, severe flood along the Changjiang River in summer of 1998 was successfully predicted. Unfortunately, it was only an example in operational prediction service rather than a rule, though of summer rainfall forecast has increased about 10% from 1980's to 1990's. Correlation coefficient between observed and predicted rainfall anomalies remained relatively low for the period of 1988-1997(Table 1). 0.1 of averaged correlation coefficient relates to about 55% of accuracy. Only in a few case accuracy can equal or greater than 60%.

It infers that our knowledge is far from complete. Some times, the main reason of development of summer rainfall anomaly was not fairly understood even when the phenomena have been happened. Only half of the variance of seasonal rain fall anomaly can be interpreted by simultaneous seasonal mean 500hPa level heights. Table 2 illustrates clearly the limitation of our understanding on the mechanism of development of summer rainfall anomaly.

Table 1 skill score and anomaly correlation coefficient of summer rainfall forecasts

Summer	SS	ACC
1988	0.24	0.21
1989	0.02	-0.04
1990	0.13	0.13
1991	-0.03	-0.09
1992	0.14	0.10
1993	0.17	0.06
1994	0.32	0.45
1995	0.20	0.20
1996	0.11	0.05
1997	-0.03	-0.08
average	0.13	0.10

Table 2 Interpretation of summer rainfall along the middle and lower reaches of the Changjiang River by the simultaneous circulation factors.

No	Circulation factor	Single correlation Coefficient	Variance Interpreted
1	Subtropical High	0.50	20.0%
2	Trough over east Asia	-0.51	15.3%
3	High over Okhotsk	0.45	9.7%
4	High over Tibet Plateau	-0.19	4.4%
Total	Complex correlation coefficient	0.68	47.0%

Therefore, hope of improvement of seasonal prediction is placed to dynamic model. Atmospheric or Coupled General Circulation Model (AGCM or CGCM) have gradually inter the practice of seasonal prediction. From this started the third stage of seasonal prediction studies.

Probably, scientists of Institute of Atmospheric Physics (IAP) have made the first seasonal rainfall prediction experiment in China in the middle of 1980's. Successful prediction on the summer rainfall anomaly of 1985 proves the possibility of seasonal prediction by using of AGCM. Later, CGCM had developed in 1988 and used in making summer rainfall prediction. Prediction is usually made in middle of March, it ensures two and a half month lead time. The products of prediction of IAP and other models were used in forecast synthesis in National Climate center (NCC). It shows that including the GCM products into operational prediction has great benefit. At present time prediction products of eight models were joined into operational prediction, which is made by NCC and other institutions, for example IAP.NCC has developed a series of AGCM, CGCM, regional GCM and CGCM used in making ENSO prediction.

THE USE OF SEASONAL FORECASTS

Louise Bohn,
Climatic Research Unit,
University of East Anglia, UK.

The climate effects and societal impacts of climate variability such as those resulting from ENSO in this region have already been covered. Seasonal forecasts are one way to decrease our vulnerability to, and help us deal with, climate variability. Increases in the availability and accuracy of seasonal climate forecasts, such as those referred to previously, has resulted in a greater interest in their use and application. ENSO related climate forecasts are intended, and in many cases do, help us to cope with climate variability. Indeed there is no doubt that forecasts have the potential to help combat the effects of climate variability but efficient use is essential.

There are a variety of applications of climate forecast. Some of the initial larger scale uses included the famine early warning system predicting food security status in vulnerable regions with climate forecasts as a major input. Other documented uses include power utilities who use temperature forecasts to predict energy demand and water resource managers who can benefit from rainfall forecasts for a river catchment. The agricultural sector with its vulnerability to climate variability is an area for which forecast use potentially has great implications. Indeed in some regions, especially north America and Australia (Stone this report) the application of climate forecasts to aid in farm management decisions is well documented. This leads to the questions how are, and how could, climate forecasts be used?

Climate forecasts are often used as input into a decision making process. They can be the sole deciding factor but more commonly they are only one input, of many feeding, into the process. Because of the variety of inputs going into decision making and the very specific needs of the users the commonly made assumption that forecasts by default must be useful is not necessarily correct. In the past few decades research has concentrated on the climate science side of forecasting but more recently attention has also turned towards a multidisciplinary approach that addresses the issue of the actual use of the forecast. For example the National Research Council (US) has noted that

"Scientific activities [e.g. forecasts] that are intended to be relevant to practical decision making are more effective and useful when they are designed in a process that integrates the needs and perspectives of those who would use the scientific results..."

Research is necessary therefore not only for improving climate prediction methods but also in ensuring that the intended recipients of this information can actually use it. If we want to determine how forecasts can be effectively used we need to turn to the user.

In terms of agriculture users can range from government ministries down to the individual small scale farmer. A case study can be used to illustrate the complexity of individuals needs and some of the major challenges to forecast use that can arise. Although this study is business and country specific (commercial agriculture in Swaziland) the findings have a much broader implication. The first step in assessing users requirements is to determine how the users operations are affected by climate variability, the sort of climate influenced decisions that the user makes, what climate information is used by the user and the climate information the users requires throughout the agricultural year. This can all be included in seasonal timelines, also known as seasonal calendars. As a tool in the field they provide a simple yet effective means of focusing interviews to gain this information.

So what do these timelines tell us? Well, a three month subsection for example gives us an indication of the climate side of things but it should be noted that as with the rainfall the operations change throughout the year. This can be seen from one 3 month profile to the next. If we compare two businesses for example, forestry and sugar the periods within the year that are busiest vary for each operation. A number of points ca be illustrated through this case study. Namely that the influence of climate varies between users, the users needs are very specific and that these needs vary between users.

After gaining an understanding of the role climate has on a sector – in this case commercial agriculture some of the limitations or constraints to the utilisation of forecasts can be assessed. It is these constraints that complicate forecast use and create a barrier between the forecast and its efficient use. These constraints can be divided into two classes – the human and the physical dimension. The physical dimension relates to the actual forecast, its timing and scale for example whereas the human dimension relates more to economic and social factors that may influence use.

The fieldwork from the case studies mentioned highlighted a number of constraints which can be summarised as a list of questions that the farmer might ask:

- Is the forecast at the right time to act?
- Is the Temporal and spatial scale of the forecast sufficient?
- What is the forecast reliability?
- What event is being forecast - wet or dry?
- Is there enough certainty to risk acting on it?
- Are there other factors more important then the forecast?
- Where is the forecast available from ?

This is only one level of the agricultural sector. In theory commercial agriculture should have the greatest access to resources and the greatest ability to cope with climate variability. This may be why the constraints listed mainly relate to problems with the forecast. This is not to say that these constraints are not applicable to say a small scale farmer but there may be other constraints that have a greater impact. Thus different sectors experience different constraints.

To enable the full utility value of a forecast to be met we need to consider how to overcome constraints. One of the most commonly cited constraints in this field of research for example is the lack of access to the forecast. Research can therefore be carried out in more detail to determine the access routes a user has to information and how these can be improved. In parts of Africa for example research has shown the most common means of forecast communication is through the radio. Thus resources can be concentrated on developing suitable radio broadcasts.

Is there any actual value in this information? It only has some kind of value if people can change their actions in a beneficial way based on that information. A number of studies have addressed this issue but in most cases, however, it is unlikely that these cover the full utility value. There is no doubt that forecasts can be valuable in some sense to decision makers at any level but there are constraints. To address this issue a thorough understanding of the users needs is necessary as well as the potential role that forecasts may have. The utility of forecasts can be increased if the forecasts and the users needs are brought closer together. This includes identifying :

- ✓ the climate parameters to which a sector or group is highly sensitive,
- ✓ the forecast products available and their limitations,
- ✓ the processes that encourage interaction between forecast producers and users,
- ✓ the constraints – both human and physical which limit use,
- ✓ a means of narrowing these constraints and maximising the use value.

In conclusion this presentation and those of the previous speaker have shown that there is a need to undertake interdisciplinary projects that integrate both forecasters and users to be able to fully benefit from the application of such information.

TWO BIG FLOODS OCCURRED AT THE END OF 1999 IN CENTRAL VIETNAM

Prof. Dr. Tran Thanh Xuan
Dr. Tran Thuc
Institute of Meteorology and Hydrology

Within only one month, from the early November to the beginning of December 1999, there were two special floods occurring successively in Central Vietnam. Historical flood appeared in some rivers, they were the biggest ones within recent 70 - 100 years.

This report will describe general characteristics of these two floods.

1. CHARACTERISTICS OF RAINFALL

At the beginning of November 1999, due to the influence of cold air combine with strong activities of inter-tropical zone going through South Vietnam from 1st to 4th and tropical depression landed in South part of Central Vietnam on 5th evening, throughout provinces of Central Vietnam and Central Highlands of Vietnam, a heavy rainfall with high intensity occurred in a short time from 1st to 6th of November 1999. Amount of rainfall unequally distributed from day to day, normally 50 - 150 mm at Thanh Hoa, Nghe An, Ninh Thuan, Binh Thuan, Kontum, Daklak provinces, 150 - 300 mm at Ha Tinh, Phu Yen, Khanh Hoa, Gia Lai provinces, 300-800 mm at Quang Binh, Binh Dinh, 500 - 2000 mm at provinces from Quang Tri to Quang Ngai, the center of rainfall is at Thua Thien-Hue province (A Luoi: 2270 mm, Hue: 2288 mm, Phu Oc: 1826 mm, ...)

Subsequently, at the beginning of December 1999, with the impacts of cold air and rather strong activities of Eastern wind zone combine with tropical depression moving though the sea of south part of Ca Mau province, from 1st to 7th of December, there was an extreme rainfall widely spreading in coastal provinces of Central Vietnam, focusing on 3rd - 5th of December. Precipitation and rainfall intensity in some places were extremely large.

Total amount of rainfall in days of 1st to 7th ranged from 200 to 2000 mm. At region from South Quang Nam to Quang Ngai: greater than 1000 mm, at the center of rainfall in upstream Tam Ky river: greater than 2000 mm (Xuan Binh: 2192 mm), Ve river basin (Ba To: 2011mm). Normally, at Thua Thien Hue, Binh Dinh, Phu Yen, Khanh Hoa provinces, rainfall is about 400 - 600 mm. Exceptionally, at Hinh River (Phu Yen province): 600 - 800mm, at Quang Tri province:

150 - 250 mm.

These rainfalls had a very large total amount of rainfall, widely affect and the rainfall intensity also was very high. The maximum daily rainfall can attain to 500 - 1000 mm at some places. Especially, the maximum rainfall in 24 hours duration at Hue station was 1384 mm (7 o'clock on 2nd - 7 o'clock on 3rd November 1999), at Son Giang station (Quang Ngai province): 1009 mm (13 o'clock on 3rd - 13 o'clock on 4th November 1999, etc... . The maximum values of rainfall in 24 hours duration is the biggest in Vietnam and rarely recorded in the world (1870 mm at Cilaos, Rennim Island, Pacific Ocean on 16th March 1952, and 1166 mm at Baguio, Luzon Island, Philippine on 15th July 1911).

2. CHARACTERISTICS OF FLOOD

These rainfalls mentioned above caused two special big floods in rivers of Central Vietnam, historical flood occurred in some places. The general characteristic are complex flood (having 2 - 5 peaks), large amplitude, flood rising in a sort time but falling very slowly. Water level on some rivers were over third alert level from 0.3 to 3 meters, approximately equal or higher than historical flood. The high water level was maintaining in several days in almost rivers.

The flood on early November had many peaks. The largest peak happened on 2nd in Quang Tri, Thua Thien Hue provinces, on 3rd in Quang Nam, Da Nang province, on 5th and 6th in Quang Ngai, Binh Dinh provinces. The maximum water levels (H_{max}) in almost rivers were greater than the third alert level, even 1.5 to 2m in some places (Huong, Thu Bon, Tra Khuc River). The maximum water levels on rivers of Quang Tri, Thua Thien Hue provinces were higher than H_{max} in 1983 from 0.18 to 1.06m. Especially, H_{max} at downstream of Huong river (Kim Long station) exceeded 0.46m compared to H_{max} of historical flood in 1953. On Thu Bon, Tra Khuc, Ve river, H_{max} greater than H_{max} in 1998, but lower than H_{max} of historical flood in 1964. Flood amplitude greatly oscillated from 4 - 5m to 8 - 10 m. Flood rose in a short time, it can be reached to 1meter/hour at some places. However, due to rising tide, flood falls down very slowly; water levels which were greater than third alert level maintained 3 days at downstream of Thu Bon river, and 4 days at downstream of Huong river (Table 1, Fig.1).

The flood occurred at the beginning of December 1999, was also a complex flood, amplitude was large but flood rising intensity was in average range at Tra Khuc river. H_{max} appeared mainly on 4, 5[th] ; but at some places appeared on 3[rd]. Floods on Tra Khuc, Ve and probably on Tra Bong river were greater than historical flood occurred in 1964. The maximum value of water level exceeded H_{max} of historical flood (in 1964) 0.35 meters in Tra Khuc river (at Tra Khuc hydrological station) and 0.24 meter in Ve river (at Ve hydrological station). Also, because of rising tide, flood falls down very slowly; water levels maintained above third alert level, even 3-4 days at some locations. Moreover, flash flood occurred at the middle and upper part of some river basins.

Table 1 ***Maximum water level of two special big floods occurred at the end of 1999 in some rivers of Central Vietnam***

Station	*River*	*Flood in November*		*Flood in December*	
		Hmax (cm)	Duration	Hmax (cm)	Duration
Le Thuy	Kien Giang	315	19h 3-11		
Quang Tri	Thach Han	**729**	**20h 2-11**		
Phu Oc	Bo	**518**	**15h 2-11**	409	2h 4-12
Hue	Huong	**594**	**14h 2-11**	373	23h 3-12
Ai Nghia	Vũ Gia	1027	5h 3-11	943	11h 4-12
Cau Lau	Thu Bon	523	13h 3-11	454	15h 4-12
Hoi An	Thu Bon	320	12h 3-11	259	20h 4-12
Tra Khuc	Tra Khuc	777	3 h 6-11	**836**	**8h 4-12**
SongVe	Ve	541	24h 5-11	**599**	**16h 5-12**
An Hoa	An Lao	2388	13h 5-11	2508	10h 3-12
Thach Hoa	Con	836	8h 6-11	855	6h 4-12
Phu Lam	Da Rang	310	5h 6-11	383	15h 3-12

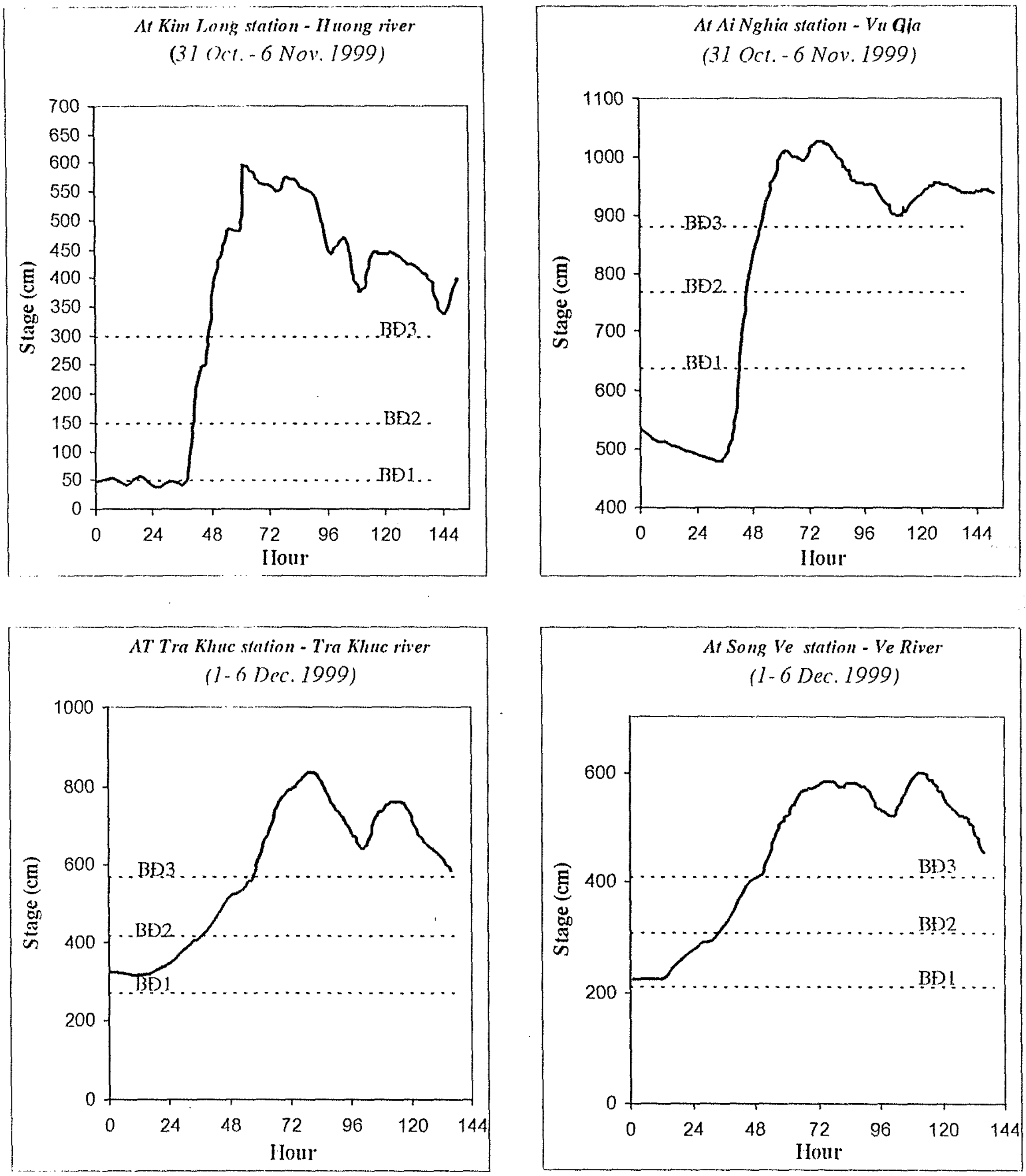
3. DAMAGE SITUATION

Two floods mentioned above caused serious damage for people and properties in Coastal Provinces of Central Vietnam, especially in Thua Thien-Hue, Quang Nam, Quang Ngai, Quang Tri, Binh Dinh provinces and Da Nang city.

According to preliminary estimation, there were 700 killed and missing people, hundreds of injured. Flood swept away and collapsed 48967 houses, 5914 classrooms, and 50506 boats. There were 28779 hectares rice inundated, a lot of structures, bridges, culverts, roads destroyed. Total economic losses was estimated about 4.7 billion VND.

On the other hand, floods caused damage for natural environment, cracked and crumbled mountains, eroded river banks and thousands hectare of cultivation land were filled up with alluvia. Especially, big flood in Huong river made some new estuaries such as river mouth Hoa Duan (width: 600m), strongly affect to ecological environment of Tam Giang lagoon and Cau Hai bay.

These two floods left below bad consequences which will impact for a long time to human's life as well as socio-economical development in provinces of Central Vietnam.



Note: BĐ1, BĐ2, BĐ3: Water level at warning grade 1, 2, 3.

Fig. 1 ***Hourly water level of two floods in November and December 1999 at some hydrological stations in several rivers of Central Vietnam***

LESSONS FROM SEVERE TROPICAL STORM LINDA

Duong Lien Chau
National Center for Hydrometeorological Forecasting

Formed in a relatively low latitude in the South China Sea at the beginning of November 1997, developed rapidly into a severe tropical storm whose life lasted for only 30 hours from the formation to the landfall, Linda was an unusual event in the historical data set in this region. Landed on Ca Mau province (in the southern Vietnam) on 2 November 1997, Linda was the most disastrous tropical storm in this century in Vietnam. Many years have passed since then, but what Linda brought to us as lessons in the forecasting as well as in the disaster prevention and preparedness activities is still worth to consider.

1. Overview of the tropical cyclones landfall in Vietnam

According to statistic data during the period from 1954 to 1989, 224 tropical cyclones (including tropical depressions) landed on Vietnam which indicated the average number of 6,22 T.C per year (See Table 1).

Table 1: The landfall of tropical cyclones in Vietnam (Period 1954 - 1989).

Year	Number	Year	Number	Year	Number	Year	Number
1954	4	1964	11	1974	8	1984	7
1955	4	1965	8	1975	6	1985	5
1956	6	1966	2	1976	0	1986	5
1957	2	1967	5	1977	3	1987	5
1958	4	1968	7	1978	12	1988	4
1959	4	1969	3	1979	6	1989	12
1960	10	1970	8	1980	9		
1961	7	1971	8	1981	6	Total	224
1962	7	1972	6	1982	5		
1963	6	1973	11	1983	8		

It clearly showed a minimum of zero in 1976 and only 2 T.C in 1957 and 1966. A maximum of 10 dropped in 1960; 11 in 1964 and 1973 and even 12 T.C in 1978 and 1989.

Table 2: Monthly distribution of tropical cyclones landfall
(Period 1954 - 1989)

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total year
Total	0	1	1	2	3	24	21	40	48	52	30	2	224
Average	0	0.03	0.03	0.06	0.08	0.67	0.58	1.11	1.33	1.44	0.83	0.06	6.22

According to Table 2, it can be said that the tropical storm season really began from June to November where an approximately of 1 T.C occurred per month. Although the landfall of T.C was possible for the rest of months (except January), it rarely occurred : once for 30 years in February and March and for 17 to 25 years in April, May or December.

2. Some features of 1997's tropical storm season

Tropical storms affected to Vietnam in 1997 relatively late and ended rather earlier than normal. Although the number of T.C affecting to our country was small, but the damages brought by them were very serious.

In overview, there were 28 tropical storms and 1 tropical depression having their activities in the Northwest Pacific in 1997 which was approximately the average number. But in the South China Sea, there were only 5 T.S and 1 T.D which were less than the average number. Unlike other years, all T.C in 1997 were originated in the South China Sea (normally only 50% of the total T.C having their activities in the South China Sea were formed in this region) and there was no typhoon (T.S with maximum sustained wind ≥ 64 Kts) in this year (normally typhoons accounts for 40% of the total T.S number).

3. Severe tropical storm Linda and its forecasting

Being the tropical storm No. 26 in the Northwest Pacific in 1997, Linda developed into a T.C from a tropical depression in the southern part of the South China Sea, just about 50 km south of Truong Sa station (48820) at noon of 1 November 1997. It initially took a westnorthwesterly track at about 27 km/h and intensified gradually. Then it turned slightly to the westsouthwest and reached intensity of minimum pressure of 985 mb and maximum sustained wind of 50 knots (force 10 on the Beaufort scale) on the morning of the next day just about 100 km of Con Dao (48819). Moving westwards, by the noon of the same day, Linda passed very close to this station where maximum sustained winds of 30 m/s (force 11), gust 42 m/s (force 14) and minimum pressure of 989,1 mb were recorded. Six hours later, it made landfall on Ca Mau province (the southern extreme of Vietnam) then continued its way in the Gulf of Thailand.

With the high resolution satellite images received hourly from GMS-5 (Japan) and the warnings received from other foreign forecasting centers, together with synoptic maps and a skillful forecaster team, Linda was watched from very early in her formation stage. Warnings were issued timely 4 times/day by the National Center for Hydrometeorological Forecasting as required by a Decree of the Government.

4. Damages caused by severe tropical storm Linda: See Table 3

5. Causes of damages

- Linda was a strong tropical storm rarely found landed in this region in this century.
- It landed in the late afternoon when the tide was strongest (from 3.5 to 4.5 m).
- It landed on a place where the people have little experiences in the disaster prevention and preparedness activities.
- Lack of effective means to communicate to the fishermen in the open sea of the danger of approaching tropical storm.
- Fishermen had no experiences on finding shelters and in anchoring their boats.
- Limited means and experiences in relief and rescue activities.

6. Lessons from Linda

The WMO has recommended all nations that the tropical storm's accurate forecasts would become meaningless if necessary steps for prevention were not taken, and Linda was an example. In the case of Vietnam where the infrastructure is not good enough, the education for the people to have knowledge for their own protection is very importance. It includes the knowledge about natural phenomena, about how to find shelters in case of tropical cyclones especially when found in the open sea, how to help other people in such case ... Providing fishermen with communication means like radio or by other means to help fishermen to receive weather forecasts is also necessary. Aware of the importance of the disaster prevention and preparedness activities, the Government of Vietnam has carried out a series of activities aimed to the reduction of damages and minimize human life loss such as promoting every form of education on the mass media to raise awareness of the public on natural disaster and measures for reducing damages, establishment of funds for flood and storm control in provinces and cities in Vietnam...

TRACK OF SEVERE TROPICAL STORM
LINDA(No. 5)

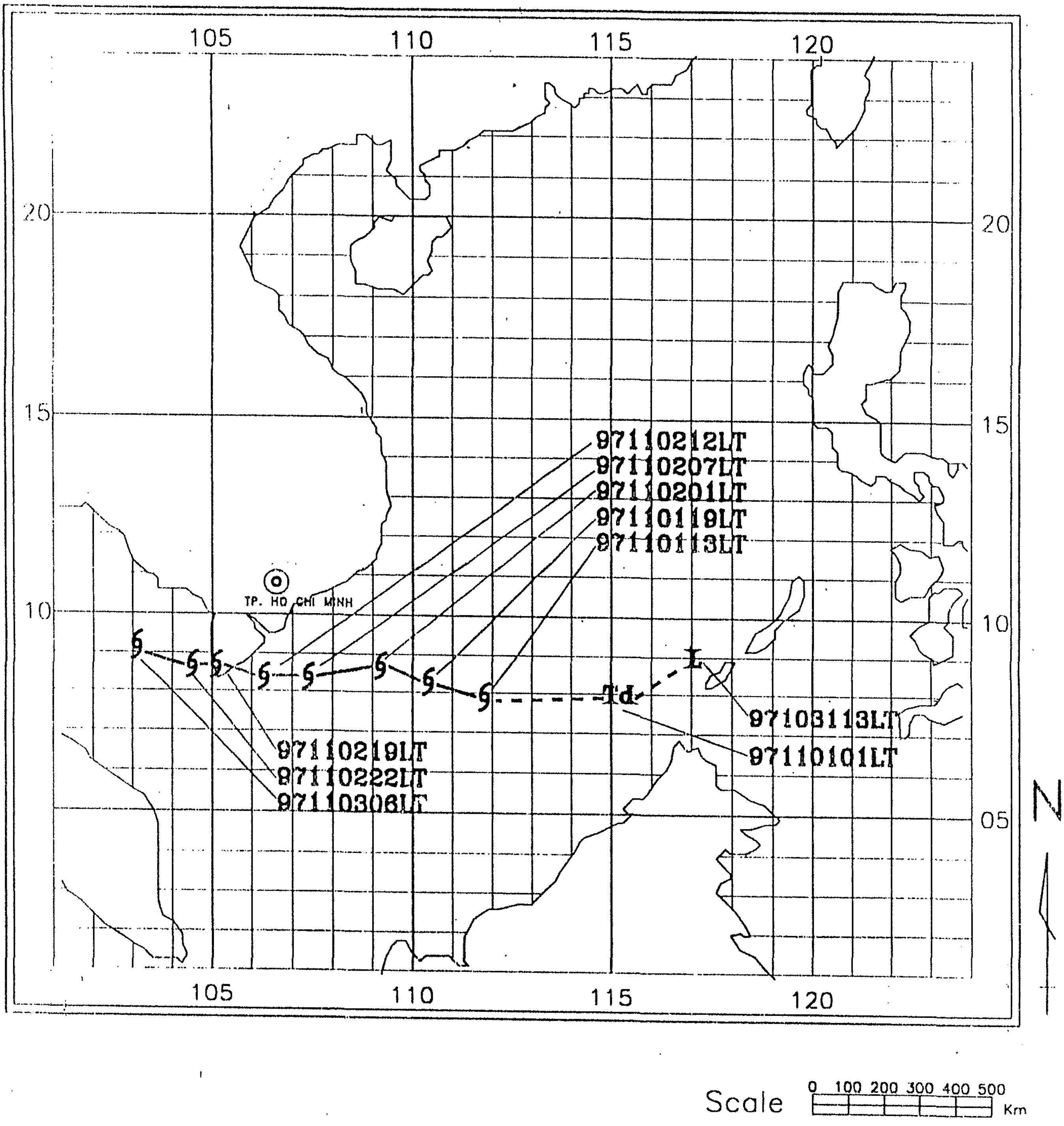


TABLE 3: DAMAGES CAUSED BY LINDA ON SOUTHERN PROVINCES
(Up to 15 January 1998 by CCFSC)

Category of damage	Item	Unit	Total
People	Killed Injured Missing Affected	Person	778 1232 2123 495,495
Housing	Destroyed Submerged and damaged	House	107892 204564
School	Destroyed Damaged	Room	1424 5727
Clinic	Destroyed Damaged	Room	76 308
Agriculture	Rice fields inundated Rice fields washed away Farmland inundated	ha ha ha	323,050 21,742 57,751
Transportation	Bridges destroyed Bridges damaged	unit unit	302 1846
Fishery	Shrimp and fish pond broken Fishing ships sunk Fishing ships damaged	ha unit unit	136,334 2897 1856
Total damage		million VN dong	7179,615

MANAGING RISKS ASSOCIATED WITH ENSO: PRIORITIES FOR THE REGION

Mr. Sanny Jegillos, Asia Pacific Disaster Management Centre, Philippines

In Asia, natural and human-induced disasters have had a devastating effect on the region's people, environment, and national economies. Global disaster statistics for 1998 are staggering yet, on an average, 60% of all disaster-related economic losses, deaths, injuries and displacement are absorbed by Asia.

In Southeast Asia, emerging disaster-related issues are increasingly linked to growing environmental degradation, population growth, poverty and unplanned rapid industrialization. These are compounded by the impact of Asia's economic slowdown and shrinking public budgets resulting to competing investment priorities for these countries.

The dominant disaster management capacities in Southeast Asia have been focused on post-disaster activities particularly emergency response. This can be traced to the association of disasters with sudden, violent and uncontrollable and natural phenomena such as earthquakes, typhoons, and volcanic eruptions. In addition, the front-runners of disaster management (such as the Red Cross and Civil Defense Authorities) emerged largely in response to war and civil conflicts. As a result, disaster management was generally regarded as the responsibility of neutral and/or mandated authorities.

Since then, there has been a significant improvement in the emergency response systems in Southeast Asian countries such as the Philippines; this has resulted in decreasing death and injuries. However, despite such progress, disaster-related economic losses are increasing dramatically while the efficiency of social services continues to decline.

In Southeast Asia, disaster occurrences often uncover and highlight unsustainable relationships between affected communities and their surrounding environment. This dynamic extends far beyond the duration of a specific emergency, affecting the ability of communities to resist and recover from natural and other human-induced disasters.

In this context, research conducted in South America since the 1970s has closely associated the causes of disasters with unsustainable development patterns. Flawed development increases the risk faced by large sectors of the population. The fact that past emergency management practices have not adequately addressed this relationship underlines the need for a new vision of disaster management. This is called disaster risk management.

This strategy focuses on the emergency itself and on actions carried before and after the emergency including emergency preparedness and recovery. Its objectives are to reduce the losses, damage and disruption when disasters occur and to facilitate a quick recovery. This approach assumes that disasters are recurring and inevitable. The concept of emergency management is often repeated in international and national training activities and this constitutes the prevailing thoughts and actions among professionals involved in disaster or humanitarian assistance.

It focuses on the underlying conditions of risk generated by unsustainable development which lead to disaster occurrence. Its objective is to increase capacity to identify, manage and reduce risk and hence the occurrence and magnitude of disasters. It recognizes that people have coping capabilities and expertise and aided with other stakeholders, they are in the best position to anticipate hazards impact and manage risks.

The regional situation with regard to an El Niño event, its associated fire and smoke haze disaster in Indonesia, and the host of emergency response and planning activities this generated in Southeast Asia underlines several significant issues.

First, there is an urgent need to strengthen capabilities at national and regional levels for effective emergency preparedness, prevention, mitigation, response and recovery.

Second, regional cooperation is increasingly viewed by national governments as a key modality for mobilizing assistance in weak areas and for sharing material and technical resources more efficiently.

This conclusion was reached by the ASEAN Regional Forum in Wellington, New Zealand, in January 1997, and was further reiterated in Bangkok, Thailand, in February 1998. The regional importance of disaster management is further reflected by its placement on the priority agenda of APEC, as well as ASEAN.

Third, in spite of the great advances made by the International decade for Natural Disaster Reduction, there is a great need for accelerated human resource development, and technical assistance for planning at the national, local and community levels. There is growing demand for general and specialized training in natural and human-induced disaster management. This is accompanied by increasing national investment in a sector previously dominated by the international humanitarian assistance community.

Professional and technical resources for training and technical assistance, on the other hand, remain either scarce or largely uncoordinated. There are pressing needs for a mechanism to advocate, plan for, and engage countries in their own action plans, and for an institutionalized programme which mobilizes the region's existing professional capabilities.

Finally, the need has been identified for a regional focal point to assist in the facilitation of regional coordination between various regional (and international) organizations and institutions. The primary role for such a facilitator would be in the areas of research and information dissemination among key stakeholders. Regional trends also include increased global and regional competition for a share of available opportunities in the disaster management sector. There are positive trends towards regional and subregional cooperation, as well as new possibilities for strategic alliances and partnerships. These developments, combined with improved access to new markets through information technology, are generating a range of new risk reduction projects, products, and innovative arrangements.

Major technological advances are now opening new frontiers in the area of information applications to training and education. This includes a wide range of new distance learning tools, such as video and teleconferencing and virtual classrooms. The demand for distance education at the tertiary level for disaster management professionals is increasing and is a cost-effective training strategy for the public sectors of countries from Southeast Asia.

Overall, there is recognition among countries in the region that greater effort is needed to improve the coordination and sharing of human, technical and material resources of better risk management of impacts of El Niño and La Niña. Further, it is increasingly recognized that it is unaffordable to duplicate scientific and technical research. In the same way, there are pressing needs for closer cooperation in areas of common interest such as early warning systems, and in exchanging valuable knowledge and information between countries. Disasters are truly cross border issues, and their management is a matter of concern for all countries situated in vulnerable areas and beyond.