

**REDUCING THE IMPACT OF
ENVIRONMENTAL EMERGENCIES
THROUGH EARLY WARNING AND
PREPAREDNESS - THE CASE OF EL
NIÑO-SOUTHERN OSCILLATION
(ENSO)**

CERED | VMHA | IMHEN | UNU

**IMPACTS OF THE 1997-98 EL NIÑO EVENT IN
VIETNAM**

Edited by:

Nguyen Huu Ninh

**Hanoi, Vietnam
2000**

MEMBERS OF THE TECHNICAL WORKING GROUP FOR THIS PROJECT

Nguyen Huu Ninh

Team Leader

Vietnam Center for Environment Research Education and Development (CERED)

Hoang Minh Hien

Contributor

Vietnam Meteorological Hydrological Administration (VMHA)

Tran Viet Lien

Contributor

Vietnam Institute of Meteorology, Hydrology and Climate Change (IMHEN)

Tran Quang Tuan

Contributor

Humanity Magazine and Vietnam Red Cross

Luong Quang Huy

Contributor

Vietnam Center for Environment Research Education and Development

TABLE OF CONTENTS

EXECUTIVE SUMMARY	6
LESSONS LEARNED	8
1 SETTING	11
1.1 COUNTRY PROFILE.....	11
1.2 GOVERNMENT MECHANISMS FOR DEALING WITH CLIMATE-RELATED IMPACTS	12
1.3 CLIMATE-RELATED AND OTHER NATURAL HAZARDS AFFECTING VIETNAM.....	14
1.3.1 <i>Tropical cyclones (typhoons)</i>	14
1.3.2 <i>Floods</i>	16
1.3.3 <i>Drought</i>	17
1.3.4 <i>Other weather-related hazards</i>	18
1.3.5 <i>Diseases and pests</i>	19
1.3.6 <i>Earthquake, depression, cracking and landslides caused by geological activities</i>	19
1.4 LEVEL OF SCIENTIFIC RESEARCH IN VIETNAM RELATING TO EL NIÑO.....	20
1.5 HISTORICAL INTEREST IN EL NINO BEFORE THE ONSET OF THE FORECAST AND/OR IMPACT OF THE 1997-98 EVENT	21
2 THE 1997-98 EVENT	23
2.1 FLOW OF INFORMATION ON THE 1997-98 EL NINO WITHIN VIETNAM	23
2.2 PREVIOUS MENTION OF EL NIÑO IN THE MEDIA	24
2.3 TELECONNECTIONS AND EXPECTED EFFECTS OF EL NIÑO	24
2.4 CLIMATE-RELATED ANOMALIES AND IMPACTS OF THE 1982/83 EL NIÑO EVENT	28
2.5 CLIMATE-RELATED ANOMALIES AND IMPACTS OF THE 1997/98 EL NIÑO EVENT	40
2.6 RELIABILITY OF ATTRIBUTIONS OF DISASTERS TO EL NIÑO.....	65
3 RESPONSES	65
3.1 GOVERNMENT REPORTS OR STATEMENTS ISSUED BEFORE AND AFTER THE IMPACTS OF THE 1997-98 EL NIÑO APPEARED AND RESPONSES AFTER THE EVENT	65
3.2 NATIONAL RESEARCH IN VIETNAM ON CLIMATE-RELATED HAZARDS AND EL NIÑO	66
3.3 NATIONAL PLANS TO RESPOND TO DISASTERS	67
3.4 IS EL NIÑO EXPLICITLY CONSIDERED TO BE A DISASTER IN VIETNAM?	69
3.5 INTERNATIONAL RESEARCH ON EL NIÑO AND VIETNAM	70

4	FORECASTING BY ANALOGY	70
4.1	IF A PERFECT FORECAST HAD BEEN AVAILABLE AS EARLY AS OCTOBER 1996 (KNOWING WHAT IS NOW KNOWN ABOUT THE ACTUAL IMPACT), WHAT COULD HAVE BEEN DONE DIFFERENTLY?	70
4.2	WHAT ARE THE REALISTIC OBSTACLES THAT MIGHT HAVE PREVENTED THESE THEORETICAL ACTIONS BEING TAKEN?	71
4.3	CAN EL NIÑO CONSIDERATIONS BE ADDED EXPLICITLY TO NATIONAL DISASTER PLANS?	71
4.4	IDENTIFY THE STRENGTHS AND WEAKNESSES IN THE WAY YOUR COUNTRY RESPONDS TO EL NIÑO-RELATED CLIMATE ANOMALIES	72
4.5	DID THE 1997/98 EL NIÑO HAVE ANY INFLUENCE ON YOUR COUNTRY'S RESPONSE TO THE FORECAST IN EARLY 1998 OF AN EXPECTED LA NINA EVENT?	76
	REFERENCES	77
	ANNEX.....	81

LIST OF FIGURES

Figure 1. GDP by sectors	11
Figure 2. Governmental Mechanism dealing with climate related disasters	14
Figure 3. Monthly frequency of tropical cyclones in Eastern Sea.	15
Figure 4. Tracks of tropical storms - October - in last ten El Niño years.	26
Figure 5. Tracks of tropical storms - October - in last ten La Niña years	27
Figure 6. Monthly frequency of landfall tropical cyclones in Vietnam. Error! Bookmark not defined.	
Figure 7. Variation of SST anomalies of NIÑO 3 and NIÑO 3.4 regions in 1982-1983 El Niño episodes	29
Figure 8. Variation of SOI in the 1982-1983 El Niño Episode	30
Figure 9. Variation of overall cloud cover anomalies in 1982-1983 El Niño Episode in Caumau, Buon Ma Thuat and Can Tho	31
Figure 10. Variation of low cloud anomalies in the 1982-1983 El Niño Episode in Caumau, Buon Ma Thuat and Can Tho	31
Figure 11. Variation of overall cloud cover anomalies in 1982-1983 El Niño Episode in Phu Lien, Hanoi, Vinh and Dien Bien	32
Figure 12. Variation of low cloud cover anomalies in the 1982-1983 El Niño Episode in Phu Lien, Hanoi, Vinh and Dien Bien	32
Figure 13. Variation of overall cloud cover anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai	33
Figure 14. Variation of low cloud cover anomalies in the 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai	33
Figure 15. Variation of rainfall anomalies in 1982-1983 El Niño Episode in Can Tho, Buon Ma Thuat and Cau Mau	34
Figure 16. Variation of rainfall anomalies in 1982-1983 El Niño Episode in Da Nang and Quang Ngai	35
Figure 17. Variation of rainfall anomalies in 1982-1983 El Niño Episode in Dien Bien and Hanoi	35
Figure 18. Variation of rainfall anomalies in 1982-1983 El Niño Episode in Phu Lien and Vinh	36
Figure 19. Variation of sunshine anomalies in 1982-1983 El Episode in Can Tho, Buon Ma Thuat and Ca Mau	36
Figure 20. Variation of average temperature anomalies in 1982-1983 El Niño Episode in Buon Ma Thuat, Ca Mau and Can Tho	37
Figure 21. Variation of average temperature anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Hanoi	38

<i>Figure 22. Variation of average temperature in 1982-1983 El Niño Episode in Hanoi and Dien Bien</i>	38
<i>Figure 23. Variation of average temperature in 1982-1983 El Niño Episode in Phu Lien and Vinh</i>	39
<i>Figure 24. Variation of evaporation anomalies in 1982-1983 El Niño Episode in Can Tho, Buon Ma Thuat, Da Nang and Hanoi</i>	39
<i>Figure 25. Tropical cyclone number active in El Niño episode</i>	40
<i>Figure 26. Variation of SST anomalies of NIÑO 3 region in El Niño Episodes</i>	41
<i>Figure 27. Variation of SOI in 1982-1983 and 1987-1998 El Niño episodes</i>	42
<i>Figure 28. Variation of overall cloudiness anomalies in 1997-1998 El Niño Episode in Can Tho and Buommathuat</i>	43
<i>Figure 29. Variation of overall cloudiness anomalies in 1997-1998 El Niño Episode in Hue, Da Nang and Quang Ngai</i>	44
<i>Figure 30. Variation of overall cloudiness anomalies in 1997-1998 El Niño Episode in Hanoi, Phu Lien, Vinh and Dien Bien</i>	44
<i>Figure 31. Variation of low cloudiness anomalies in the 1982-1983 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau</i>	45
<i>Figure 32. Variation of low cloudiness anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai</i>	46
<i>Figure 33. Variation of low cloudiness anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai</i>	46
<i>Figure 34. Variation of rainfall anomalies in 1997-1998 El Niño Episode in Can Tho, Buonmathoat and Ca Mau</i>	47
<i>Figure 35. Variation of rainfall anomalies in 1997-1998 El Niño Episode in Hue and Da Nang</i>	48
<i>Figure 36. Variation of sunshine anomalies in 1997-1998 El Niño Episode in Can Tho, Buonmathuat and Ca Mau</i>	49
<i>Figure 37. Variation of sunshine anomalies in 1997-1998 El Niño Episode in Hue, Dang and Quang Ngai</i>	49
<i>Figure 38. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau</i>	50
<i>Figure 39. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Hue, Da Nang and Quang Ngai</i>	51
<i>Figure 40. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Hanoi and Phu Lien</i>	51
<i>Figure 41. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Vinh and Dien Bien</i>	52

<i>Figure 42. Variation of evaporation anomalies in 1997-1998 El Niño Episode in Can Tho, Buonmathuat and Caumau</i>	52
<i>Figure 43. Variation of evaporation anomalies in 1997-1998 El Niño Episode in Hanoi, Vinh and Dien Bien</i>	53
<i>Figure 44. Variation of tropical cyclone number in El Niño episode at Northwest Pacific</i>	54
<i>Figure 45. Tropical cyclone number in average and in 1997-1998 El Niño episode</i>	54
<i>Figure 46. Flow of information, and responsibility, from institutions at the national level to the commune level</i>	69
<i>Figure 47. Resources, proposed activities and information flow regarding El Niño (EN) and La Niña (LN) at and between the international, regional and national levels.</i>	75



EXECUTIVE SUMMARY

Because of its geographical setting, Vietnam has a long history of coping with weather- and climate-related hazards such as storms, floods and droughts. As a result, it has developed a comprehensive system of disaster management, which, although constrained by limited resources and other factors, provides a high level of protection and continues to evolve. Though scientific research has been conducted on the impact of El Niño on Vietnam over the past two decades, it is only since the 1997-98 El Niño event that serious scientific interest in the subject has developed. It is now known that the El Niño Southern Oscillation (ENSO) phenomenon has a substantial effect on the characteristics (frequency, intensity) of certain natural hazards in Vietnam.

El Niño is recognized as a factor that should be considered in disaster management by the Vietnamese Government. This recognition resulted largely from the El Niño predictions received by the government in early 1997 and from El Niño's actual impacts in Vietnam later that year. The Prime Minister's Office then issued instructions to relevant authorities to prepare a report on the impacts in Vietnam of El Niño and La Niña. While this acted to raise official awareness of the issue, the official response to the 1997-98 El Niño event was through the existing disaster management system. In 1999-2000, the government organized an independent study on the phenomenon with the Institute of Meteorology and Hydrology (IMH)¹ as the executive agency. The Hydro-Meteorology Service of Vietnam (HMS) has commissioned sectoral studies and Vietnam has proposed national studies to various international research programs. Public awareness of El Niño is high as a result of the publicity given to the 1997-98 event by the mass media. The first popular ENSO document was released by the Hydro-Meteorology Service and

¹ The Institute of Meteorology and Hydrology is an institution belonging to the Hydro-Meteorological Service of Vietnam.

printed by the Science and Technology Publishing House in the year 2000 as a result of the 1997-98 event.

The broad effect of El Niño on the climate of Vietnam is established but the detailed impacts require more research. In general terms, the main effects on the seasonal climate of Vietnam are that, during El Niño years, cloud cover is decreased and rainfall levels are lower; and temperatures increase as do radiation and evaporation. The impact is generally most evident during the winter half-year, with effects usually developing towards the fall of the year when the El Niño warming of the equatorial Pacific becomes evident. Though affecting the whole country, the effects are clearest in the south of Vietnam and parts of the central region. The frequency and other characteristics of the tropical cyclones that make landfall on the Vietnamese coast are strongly affected by El Niño. Generally, fewer but more intense storms are experienced during El Niño years and frequencies are highest during the earlier part of the cyclone season. There is a suggestion that storms that form or develop close to the Vietnamese coast may be more frequent in El Niño years; these storms are difficult to predict and, therefore, to respond to effectively.

The 1997-98 El Niño event had a major effect on social and economic well-being: drought, water supply, health and storm impacts were the most notable effects. Drought concentrated in 1998 and caused serious impacts, especially on forestry and industrial farming. The total economic loss due to the drought in 1997-1998 was predicted at 5,000 billion VND. Due to the lack of water caused by low rainfall and high evaporation, the area of salty land (i.e., salt water intrusion) increased rapidly in the Mekong Delta. Forest fire was also a serious consequence. Water supply for the winter crop 1997-1998 had many difficulties. At the reservoirs of the Hoa Binh, Tri An, and Thac Ba hydro-electricity plants, the water level decreased to alarming levels so that these plants had to reduce production. Water supply in Hanoi that is already stressed became a more serious problem in the first months of summer 1998. Dengue fever disease spread starting in the South in 1997, and in 1998 the disease came up to the coastal zone of Central Vietnam and the North. The climax occurred in the summer/fall of 1998. The impact of typhoon Linda, though it cannot be reliably attributed to El Niño, resulted in 4502 people dead and missing, the highest number of wounded people caused by a typhoon for decades. There were 440,000 ha of paddy land lost of which 330,000 ha was seriously damaged. 133,000 houses were seriously damaged. The total loss reached thousands of billion-VND.

The main component of disaster management in Vietnam is the system for protection against storms, floods and other natural hazards. This system has four main strengths. First, it represents the culmination of a centuries-long period of learning through experience. Second, the system is the result of an evolving pact between the elite, the government, and the people of Vietnam and has widespread support and commitment. Third, the battle against "invasion" by the tropical cyclone is as ingrained in the Vietnamese psyche as the struggle against human invaders. Finally, the system's structure, though complex, ensures that all levels and sectors of the administration and, indeed, much of Vietnamese society are firmly linked into the process. It contains a degree of duplication or redundancy, increasing the chances that information will be conveyed in the event of failure of any one channel. It also has some weaknesses related to: resource limitations; lack of cooperation and management efficiency; communications problems; cultural difficulties; scale issues; limited scientific and technical understanding; lapses and limitations in public awareness;

and aggravating factors such as environmental degradation. Nevertheless, the system provides a high level of protection to the Vietnamese population.

The existing disaster management system could be strengthened by the availability of reliable, detailed and trustworthy El Niño forecasts, which would provide the basis for, among other things, the more effective allocation of resources. The current system provides a strong basis for the communication of warning information to all sectors of society. If such forecasts were to be used, it would be necessary: to improve understanding of the sectoral impacts of El Niño; to increase awareness among relevant authorities and improve coordination and resourcing; to identify forecast users needs; and to cultivate a change in attitude in support of a pro-active response. Other obstacles to the effective working of the disaster management system, such as resource constraints, must be considered at the same time.

LESSONS LEARNED

- There is a need for impact studies on regions, institutions, disaster management procedures, and economic sectors of society.
- El Niño-related impact studies should be undertaken between El Niño events and not during them.
- El Niño tends to exacerbate existing hazards and disasters that the Vietnamese society has had to cope with for centuries: droughts, floods, fires and typhoon landfall.
- People not only need better El Niño forecasts (more detail at the local level and more accuracy) but they also need better forecasts of El Niño's impacts.
- Researchers need to identify the needs of specific users' needs for early warning.
- It is important for an effective response to an El Niño forecast that the highest levels of government consider El Niño a problem and are willing to take actions based in the forecast in a proactive way.
- It is not possible to be absolutely confident in attributing a particular weather phenomenon to the occurrence of an El Niño. The same is true for attributing societal impacts.
- There is a need for a mechanism that catalyzes awareness into effective public action.
- There is a need to review what the El Niño-related climate impacts were during the 1997-98 El Niño event.
- There is a need for capacity building in climate impacts assessment and in climate-related disaster planning.
- While there are many government agencies in the country dealing with some aspect of El Niño, there is a need for improved efficiency in transmitting warnings and forecasts throughout the government.
- Governments need to prioritize the allocation of resources in the planning stage for El Niño-related impacts, given the scarcity of resources in many developing countries.
- There is a need for capacity building in the area of El Niño forecast use.
- There is a need to convince the government at the highest level of the importance to society of El Niño research, especially on teleconnections (e.g., attributions) and impacts on environment and society.

- One way to reduce the adverse impacts of El Niño on society is to reduce existing environmental degradation, such as deforestation, that tends to exacerbate the impacts of an El Niño.

1 SETTING

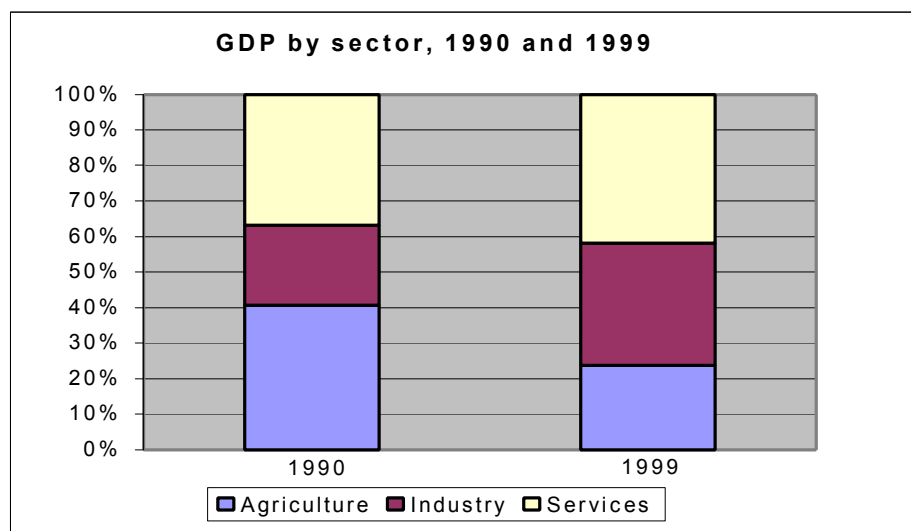
1.1 COUNTRY PROFILE

Vietnam lies on the Eastern Sea, bordering Laos and Cambodia. It has a coastline over 3,000 km in length. The population of Vietnam was estimated at 76.3 million in 1999 and is growing at an average annual rate of less than two per cent. Vietnam's population density is notable, with 231 persons per square kilometer on average. The population is predominantly rural. Around one quarter of the land area is cultivated, with major agricultural centers in the northern and southern deltas. Close to 30 per cent of the land area is classified as forest and woodland. Natural resources include limited but productive agricultural land, deposits of oil, coal, and a variety of mineral resources, hydroelectric potential, forests and marine resources. There is a considerable, but largely undeveloped, tourist potential.

Most of Vietnam has a tropical climate, although subtropical northern areas experience cool winters. Tropical cyclones frequently make landfall in central and northern Vietnam and occasionally in the south. It has been argued that the physical vulnerability of the country and its dependence on delta agriculture has contributed to a very high level of social cohesion. A history of regular invasion and colonization has also played a part.

Vietnam is a Communist state, led by a president, a prime minister, and a cabinet. The Vietnamese Communist Party is the only legal political party. All citizens may vote at the age of 18. The national assembly has 395 seats. In 1986, Vietnamese Communist Party General Secretary Nguyen Van Linh introduced *doi moi*, a program of economic renovation, reducing central planning and encouraging private-sector enterprise and foreign investment.

Figure 1 - GDP by sectors



Source: Development and Cooperation Report 2000, UNDP Vietnam

During the 1990s, and with the lifting of the US trade embargo, the process of *doi moi* has resulted in marked economic growth, surpassing 10 per cent a year during the mid-1990s. According to the UNDP (1999), prospects for strong and sustainable economic growth are promising; the country has a low-cost, highly disciplined and literate labor force, a diverse natural resource base, and a strategic regional location for business and trade. Agriculture employs more than half of the labor force. Vietnam exports a large quantity of rice; other exports include tea and pork. The contribution of services and industry to GDP is growing.

Despite recent economic growth, the population of Vietnam remains poor, with an average GDP per capita of around US\$375 per annum in 1999. Nevertheless, Vietnam has achieved a relatively high level of social development. The UNDP Human Development Report for 1999 ranks Vietnam 110 out of 174 countries based on a composite human development index of life expectancy, educational attainment and income. High life expectancy, a high literacy rate and low infant mortality are the major factors contributing to this high ranking.

The development strategy of the Government of Vietnam is people-centered, aiming to promote the potential of individuals and communities as well as of the nation. As stated at the World Summit for Social Development in Copenhagen in 1995, the strategy is for the people and by the people, "... centered on the task of caring for and developing human potential, which considers human beings as the key to change, the creative energy, the source of material and spiritual wealth of a society and, at the same time, a strategy which sees as its highest goal the well-being, freedom and happiness of human beings." The strategy will be underpinned by an enabling environment of sustainable high economic growth, stability and equity. The current target is that GDP should grow at an average rate of 7-8 percent a year and that poverty will be eliminated by 2010.

1.2 GOVERNMENT MECHANISMS FOR DEALING WITH CLIMATE-RELATED IMPACTS

Because of the scale of the threat posed by storm and rainwater or seawater flooding impacts, disaster management in Vietnam has historically focused on these hazards as they have major impact on societal well-being. Drought impacts, in this nation of large-scale irrigated agriculture, tend to be more restricted in scope but are dealt with through the same system as storms and floods. There is no national mechanism for dealing directly with El Niño, La Niña or climate variability in general. Section 3.3 contains a full account of the system for protection against storms, floods and related hazards; here, administrative responsibilities are summarized. These roles are, to some extent, historic in nature with certain elements dating back to previous centuries, though the detail of the current structure was established in the early 1990s.

The Prime Minister of the Government has elected the Ministries and Ministry-level offices such as Ministry of Agriculture and Rural Development, Ministry of Science, Technology and Environment, Ministry of Transportation, the Government Council, Ministry of Fishery, Ministry of Energy, Ministry of Heavy Industry, National Civil Aviation Agency, Ministry of Defense, etc., and, of the lower level, Department of Agriculture and Rural Development, Department of Fishery, and especially Hydro-Meteorology Service, to be responsible for flood and typhoon prevention in order to protect people and properties.

The Government has also established the National Flood and Storm Prevention Committee (also known as the Central Committee for Flood and Storm Control or the Central Committee for Flood, Storm Control and Disaster Preparedness) that has ministerial status and is led by the Minister of the Ministry of Agriculture and Rural Development, which has responsibility to monitor and control information and data related to flood and typhoon as well as other adverse climate events, including drought, that may affect people, properties and production in the whole country. This committee also proposes the flood and typhoon prevention plans every year as a basis for the allocation of resources and advises the Government to issue Circular Letters, Regulations, Instructions, and other legal documents relating to forecasting and preventing floods and storms. Flood and Storm Prevention Committees exist at the national, city and provincial, and district level and within relevant ministries. Each commune (village) also has a Flood and Storm Prevention officer. The Ministry of Agriculture and Rural Development and Ministry of Fishery and other ministries and institutions have responsibility to instruct their departments at the provincial level to implement the plans on flood and storm prevention proposed by the committee.

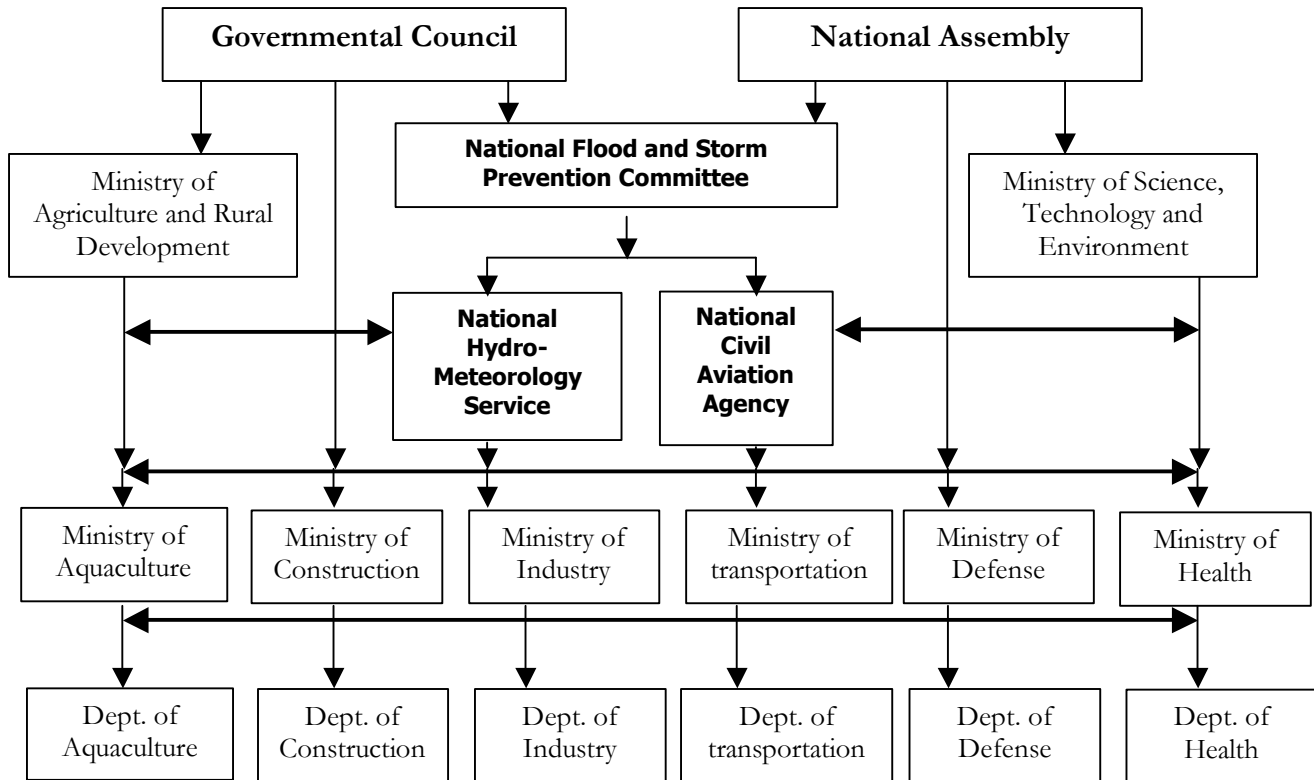
The Hydro-Meteorology Service is responsible for forecasting and consulting the Government and the Ministry about the occurrence and change of any climate and weather patterns related to the appearance of floods and storms in the territory of Vietnam.

The mass media such as television and radio both at the national and local level have responsibility to release and transmit forecasting information and data about flood and storm supported by the Hydro-Meteorology Service.

In 1994, the Government prepared a Strategy and Action Plan for Mitigating Water Disasters in Vietnam (MWR/UNDP/UNHDA, 1994) building on the previous disaster management system. This makes Vietnam one of a handful of countries worldwide to have adopted such a strategy (Benson, 1997). The strategy is based on the themes: forecasting and warning, preparedness and mitigation, and emergency relief. The Disaster Management Unit, established at that time, now supports the operations of the National Flood and Storm Prevention Committee. (For further information, see Section 3.3 and references therein.)

The flow of responsibility is shown in the accompanying chart (Figure 2).

Figure 2 - Governmental Mechanism dealing with climate related disasters



Source: Center for Environment Research, Education and Development

1.3 CLIMATE-RELATED AND OTHER NATURAL HAZARDS AFFECTING VIETNAM

Several kinds of climate-related disasters and other natural hazards affect Vietnam regularly. An understanding of each type of disaster in order to assess and forecast them is one of the imperative needs of not only the Vietnamese Government and authorities but also local communities that disasters affect each year. The need to cope with natural hazards has played a major role in Vietnam's history (*Kelly et al., in press*), but it has only recently been recognized that El Niño and La Niña modulate the occurrence of many of these hazards (*see Section 1.4*).

Major natural hazards, in rough order of importance, include tropical cyclones, floods, drought, weather-related hazards such as heat waves and thunderstorms, pests and diseases and geological hazards. For further information, see DMU (1999).

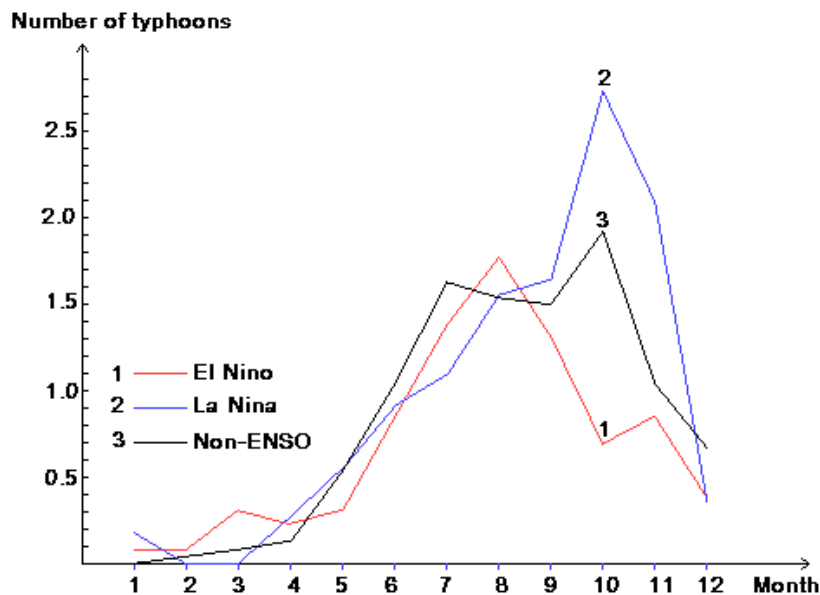
1.3.1 Tropical cyclones (typhoons)

The tropical cyclone is considered one of the most serious natural hazards affecting Vietnam. The results of this phenomenon are high winds, heavy rains, and floods. The geographic scope of

cyclones is concentrated in the Eastern Sea, the Red River Delta and the coastal zone from Quang Ninh to Khanh Hoa provinces.

On average, there are about 30 tropical cyclones occurring in the Western North Pacific a year, of which 11-12 tropical cyclones land in the Eastern Sea, and 6-7 storms and tropical depressions affect the territory of Vietnam. For Vietnam as a whole, the cyclone season lasts for about 6 months from June to November (Figure 3). Cyclone seasons are different in different regions in the country and occur increasing later from the north to the south. In a particular region, the cyclone season in each year lasts for 3-4 months on average. Winds within a tropical cyclone on the sea can reach speeds of 60m/s, that in coastal zone about 40-50m/s, the Red River Delta and coastal area of Mid Central Vietnam about 30-40 m/s. Heavy rainfall can reach an amount of 100-300mm/day and total rainfall for each spell can reach 500-1000mm, as happened in many regions of the eastern Red River Delta, the eastern Truong Son Mountains, and especially in the northern coastal zone and Mid Central Vietnam.

Figure 3 - Monthly frequency of tropical cyclones in Eastern Sea



Source: Climate Research Center, Institute of Meteorology and Hydrology (IMH)

The seasonal occurrence of storms in the area of the Western North Pacific, in general, and the Eastern Sea, in particular, as well as their impacts on Vietnam, are unpredictable. In the years that tropical cyclones have developed rapidly, the area of the Western North Pacific could have 40 storms. Within the Eastern Sea, there would be around 10-15 storms annually in these years. The least severe year would have a storm rate of 40-50% in comparison to the average level, even less than 40%. There were 12 storms making landfall in Vietnam in the most severe years, such as 1964. The least severe year was 1976. This clearly complicates disaster management and the allocation of resources on the seasonal timescale. As Section 2.3 indicates, El Niño plays a major

role in affecting cyclone characteristics, and a predictive capacity based on the El Niño Southern Oscillation (ENSO) phenomenon would be of substantial value in improving disaster management.

The losses associated with tropical cyclones or typhoons are generated by damage to infrastructure, boats and plantations, etc. on the continent, the sea and the islands. Heavy rain can create floods in various areas, especially in the coastal zones and the Red River Delta. Heavy rain created by typhoons can also cause flash floods and landslides in the mountains of Northeast and Central Vietnam. The consequences are severe, causing loss of the workforce and property. Severe Tropical Storm Linda in 1997, for instance, caused 4,000 dead, wounded and missing people and the loss of property was estimated at thousands of billions of VND.

Short-term sea level rise and storm surges damage property in the coastal zone. Longer-term sea level rise caused by climate change may also be contributing. In the coastal zone of Central Vietnam, the sea level rise in a storm can reach a level of 3-4 meters, especially at high tide. In the coastal zone of the North, sea level rise in a storm is lower than 2-3 meters. Sea level rise and the associated storm surge have destroyed construction works, especially the sea dyke system, coastal cultivated areas such as agricultural fields, salt fields, mangrove forests and have also caused landslides in coastal areas. The Mekong Delta and Red River Delta are affected regions.

1.3.2 Floods

Floods are usually caused by heavy rain lasting for a long time and over a broad area. The ability to keep water in the forests is increasingly reduced by illegal logging activities. Heavy rains are the result not only of typhoons but also from other disturbances such as weaker tropical storms and fronts, both contributing to floods. Especially when there is a combination of these factors, severe floods can be created. The increase in the Walker Circulation in the La Niña process also contributes to a high frequency and density of heavy rains in downstream areas of the rivers. Continuous floods in the Central region of Vietnam are certain examples of this process.

Floods may happen in almost all areas of the country but the losses mostly occur in the downstream areas of the basins. In the Red River Delta, the flood season is almost the same as the rainy season, but it starts one month later. The flood season extends from June to November every year and the most serious period is in the period from August to November, created within the Red River Delta and Thai Binh catchment. The Red River Delta, in which is located not only the capital city of Hanoi but also many important cities, is protected by an earth dyke system that has a length of thousands of kilometers. The flood season in the basin usually creates high stress on the dyke system. Some dykes have been broken by strong floodwaters, creating serious flooding through some regions within the Red River Delta.

In the Mekong Delta, the flood season has similar characteristics to that of the Red River Delta, but it occurs later. The broad catchment creates a high intensity of floods flowing to the downstream regions. With no dyke system to protect the crops, there can be no planting in the last season. At the current time, irrigation activities, especially drainage systems, have been developing day by day to allow the expansion of extensive crops and to increase the number of

crops annually. However, flood is still a serious consideration for millions of rural people in the Delta.

In the coastal provinces in Central Vietnam, the river systems are short with high slopes so that floods can rapidly reach downstream areas where the forest has been destroyed. In the East side of the Truong Son mountains, especially the area of Northern and central zone of Central Vietnam, heavy bands of showers lasting for a long time create the most serious floods in the territory and in urban areas near the coast.

In the mountainous areas, as a consequence of illegal logging in combination with rainy seasons with a high frequency of heavy rains, there recently have been marked climatic turbulences such as tropical cyclones, cold fronts, etc. causing serious flash floods in many areas, such as those in Lai Chau and Son La provinces in the years of 1995-1996. Thus, flash floods have been taking place sweeping water and sludge down from the mountains and creating landslides and other disturbances in transportation, villages, rice fields, and irrigation works. Landslides in the downstream areas of the Red River Delta and the Mekong River Delta are closely related to floods, also showing a rapid increase in recent times. Annual improvements of the dyke system for flood prevention account for a large part of the budget of both the nation and local regions.

1.3.3 Drought

Drought is a climate phenomenon that occurs in many areas. A meteorological drought takes place in an area that goes without rain for a long time, along with high temperatures. Hot weather created by the effects of the southwest monsoon is the main reason for drought in various areas. However, drought can occur over a broad area because of monsoon failure. El Niño is also one of the reasons that droughts occur. In El Niño years, due to an associated late summer monsoon, the rainy season may be postponed, causing a longer dry season with strong summer sunlight and drought because of the combination of these factors at the beginning of the rainy season. Drought can also occur in the middle of a rainy season, when it is rainless for an extended period of time in combination with high radiation and high temperatures in the summer. Cloudless weather also increases evapotranspiration, causing partial drought in a broad area of the South, Southern plateau, central coastal zone, and sometimes in the north.

Drought can occur in every part of Vietnam. In recent years, drought has often occurred in Central Vietnam and in the Central Highlands. Drought has caused loss of agriculture productivity and production as well as irrigation problems. Forestry, the power industry, and water supply for domestic and industrial uses are the victims of droughts' impacts. Drought in the Southern plateau in 1997-1998 caused thousands of coffee farms to be damaged or lost. Drought caused a waterless situation for the whole of the Quang Binh and Quang Tri provinces in the years 1993-1994 and 1997-1998. In the El Niño episode of 1997-1998, drought caused serious forest fires in the Southern plateau and the Mekong Delta with dozens of thousands of hectares of *cajaput* and pine forests damaged. At the same time, a decrease in rainfall in the Red River Delta in the North also caused a low water level of the Hoa Binh reservoir that directly reduced power generation affecting many provinces, including Hanoi Capital.

1.3.4 Other weather-related hazards

Frost and hoarfrost are climate disturbances that happen mostly in the North, especially the mountain areas, caused by the Northeast Monsoon. The impacts of polar airmass effects on countries in the low latitudes of the Inter-Tropical Convergence Zone (ITCZ) such as Vietnam are abnormal phenomena for this climatic zone. However, in comparison to the high latitude areas, the temperature drop is not so low, and is some degrees lower than 0°C in the mountainous areas. But for people who are adapted to higher temperatures, temperatures lower than 10°C can create negative reactions, affecting normal health and well-being. If this lasts for an extended period of time, the effects can be remarkably more serious.

A continuous Northwest Monsoon flow in the winter can decrease temperatures to below 5°C, and in combination with hoarfrost, can cause serious damage to tropical ecosystems because of their poor ability to adapt to low temperatures. In hoarfrost weather, whole rows of plants have died because of the freezing of plant tissues. Many plant species, especially tropical plants, have died when temperatures have fallen lower than 5°C. Rice, the main food plant of Vietnam, is affected seriously when temperatures drop below 13°C. In weather forecast reports, it is called “hazardous cold.” In the north, hazardous cold usually occurs in the middle of winter, especially when Northwest monsoon comes, as the winter rice crop is mature causing low productivity. It is considered a remarkable hazard in Vietnamese agricultural activities.

For human health, particularly when it involves people accustomed to the hot weather of a tropical area, the adverse effects can be serious. Cold weather in the last half of winter in the North of Vietnam accompanied by high humidity and drizzling rain can have even greater negative impacts on human health and livelihoods. The cost of cold prevention (crop protection) increases in years of cold weather.

In the area suffering the impacts of weather fronts associated with the Southwest Monsoon and the high altitude of the Truong Son mountains as well as the area of Lao-Viet in the northwest, hot and dry periods take place in the summer. This is called the Lao Wind because it comes from Laos. Hot and dry phases usually occur in the development phase of the summer monsoon. In the northwest, the Lao Wind first comes from March to April, when the influence from the west is increasing in place of the Northeast Monsoon from the east. In the central coastal zone, the front occurs later, from May to June, but lasts until August and September. This phenomenon interrupts the rainy season on the east side of the Truong Son Mountains. In combination with tropical cyclones and the Northwest Monsoon, this phenomenon causes a unique change in the rainy season to the east that is different from the north and the south. When the western monsoon develops on the north, hot and dry weather occurs not only in the northwest and northern central region but also in the northern coastal zone.

Along with a hot and dry climate caused by fronts, there are many long-lasting periods of hot weather derived from different sources, such as a domination of high tropical pressure or the western current of the Walker Circulation. In these cases, cloudless weather and high radiation will occur causing a rainless period and high temperatures for a long time, sometimes seriously affecting many areas. Hydrological drought, a lack of water in combination with high temperature and evaporation, not only affects crops but also human health. In the years when the Lao wind

arrives early, the productivity of the winter crop will decrease considerably creating disaster for the rice crop (and farmers) of North and Central Vietnam.

Thunderstorms develop within the hot, wet climate of the tropical atmosphere, especially when there is a combination of disturbances such as polar fronts and tropical cyclones. A thunderstorm can create an electric discharge in the atmosphere or between cloud and the ground, thus lightning. Vietnam is an area with some of the most severe storms. In Vietnam, thunderstorms develop during the summer monsoon with the existence of a hot and humid air mass and a stable atmospheric structure. In the North, thunderstorms occur all the time. They also develop in the mountainous area of the North and midland of the South. In the central area, thunderstorms can occur on 130-150 days in a year. In the coastal zone, the period with the occurrence of thunderstorms is much reduced, to about 40-60 days. It is especially reduced in the area of Southern Central region where it is much lower, only about 20-30 days.

Lightning can damage many technical targets, especially electric and electronic equipment. It also kills people in many areas. Lightning prevention for electric and electronic equipment, especially outdoor equipment, is one of the imperative needs in Vietnam with very high cost. A thunderstorm can also create whirlwinds and waterspouts. Although whirlwinds occur in a restricted area, the velocity is high causing much damage to infrastructure, construction works, plantations, etc. In the sea, large lakes and rivers, whirlwinds cause considerable damage to boats and people.

Thunderstorms and whirlwinds can occur in many part of the Vietnamese territory. The higher the level of economic development, the greater the loss due to whirlwind and thunderstorm damage.

1.3.5 Diseases and pests

The hot and humid climate of tropical areas causes many kinds of human and animal diseases. Many epidemic diseases associated with climate such as malaria, dengue fever, flu, diarrhea, etc. have been on the increase in many provinces. This has cost the Government increasing amounts of money for both cures and prevention. A dengue fever epidemic has been spreading in Vietnam and is considered an El Niño-related disease. Malaria is tending to increase in many mountainous areas. Flu occurs regularly every year, especially in the periods of transition of the seasons.

In agriculture, aquaculture, and forestry, pests have become a very serious problem causing considerable decreases in the productivity of farming and breeding. Vietnam is a suitable environment for pest vectors and for their spreading over a large area and damaging crops, animal breeding activities, and aquaculture. Pests are a hazard every year for many regions all over the country. El Niño events have been associated with the increase in occurrence of various pests. The same is true for La Niña episodes as well.

1.3.6 Earthquake, depression, cracking and landslides caused by geological activities

Earthquakes in Vietnam's mountainous areas can reach 4-5 on the Richter Scale, but no major damage has been experienced because they tend to be centered far from urban and residential

areas. Depression, cracking and landslides caused by geological activities have recently been taking place, but have presented no serious danger to people or construction works.

1.4 LEVEL OF SCIENTIFIC RESEARCH IN VIETNAM RELATING TO EL NIÑO

The El Niño phenomenon has been covered in scientific studies in Vietnam for two decades or more but it is only recently that a concerted scientific effort has been made to study the subject. The introduction of El Niño into scientific studies in Vietnam was initiated in the early 1980s by the Institute of Meteorology and Hydrology by Professor Vu Boi Kiem. There was, though, a lack of information and knowledge about this issue so that it did not attract scientific interest. Thus, the study of the phenomenon was neglected and was not often mentioned in meteorological and hydrological studies in Vietnam. Two papers on the ENSO phenomenon were prepared towards the end of the 1980s by Hoang Minh Hien and Nguyen Huu Ninh (*Hoang Minh Hien and Nguyen Huu Ninh, 1987, 1990*).

The situation changed in the early 1990s with the assistance of UNEP and Dr. Michael Glantz. In November 1991 at the *'International Conference on the Impact of Climate Change and Sea Level Rise'* in Hanoi, organized by the Center for Environment Research, Education and Development (CERED) with support from UNEP, some reports on El Niño presented by international experts attracted the attention of the Vietnamese scientific community to the subject again.

During the 1990s, much research on ENSO-related hazards such as the tropical cyclone, flood and drought was being conducted by various agencies, as had occurred for many years, but these were regarded as single events unrelated to any longer-term or larger-scale process. Knowledge of ENSO itself was acquired and updated mainly from international sources (*such as Bjerknes, 1969; Ramage and Hori, 1981; Philander, 1990; Allan, 1991; Glantz, 1991*).

By the late 1990s, largely stimulated by the 1997-98 event, scientific studies by Vietnamese scientists had begun on various relationships with climate and weather in Vietnam (*see, for example, Bui Minh Tang, 1998, 1999; Dang Tran Duy, 1998, 1999; Hoang Minh Hien, 1998; Nguyen Doan Tho, 1998; Nguyen Viet Pho, 1998; Nguyen Viet Thi, 1998; Pham Duc Thi, 1998, 1999; Le Dinh Quang, 1999; Tran Viet Lien, 1999*). Updating and applying data and information from ENSO forecasts carried out by forecast groups all over the world is also underway within relevant hydro-meteorological sectors. Studies associated with socio-economic issues, including fisheries, forestry, and agriculture, have been implemented by Vietnamese researchers. For example, according to the announcement of National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs (OGP) in January 1999, the Center for Environment Research, Education and Development (CERED) has been involved in forecasting the risk of dengue fever epidemics in the Asia-Pacific Region (*Tran Viet Lien, 1999*).

Now that it has been recognized that assessment and forecast of the impact of ENSO is an important need for the national management authorities in Vietnam, in the period 1999-2000 the Government has organized an independent study on ENSO. The Institute of Meteorology and

Hydrology is the executive agency. The Hydro-Meteorology Service, the Ministry of Agriculture and Rural Development, and the National Center have commissioned several sectoral studies on climatic disasters and ENSO for Natural Science and Technology. In addition, proposals have been put forward for national studies as part of international initiatives such as those supported by U.S. NOAA.

A workshop on "*The Impact of El Niño and La Niña on Southeast Asia*" was organized by the Center for Environment Research, Education and Development on behalf of the Indochina Global Change Network. It was held in Hanoi, Vietnam in February 2000 with support from the Asia Pacific Network for Global Change Research. 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, including the greater involvement of the region's scientists (*Kelly et al., 2000*). They strongly endorsed moves towards a proactive response to such hazards. For further information on the workshop, see <http://www.cru.uea.ac.uk/tiempo/floor0/briefing/igcn/igcn2000.htm>

1.4 HISTORICAL INTEREST IN EL NINO BEFORE THE ONSET OF THE FORECAST AND/OR IMPACT OF THE 1997-98 EVENT

The first popular article on El Niño was written by Dr. Nguyen Huu Ninh and Dr. Hoang Minh Hien and released by The People newspaper on 21 June 1987 (*see Box 1*). However, at that time, El Niño and La Niña were not of concern in Vietnam because their impacts had not been clearly shown. As noted in the previous section, scientific organizations, especially hydro-meteorology and climate study institutions, had noticed and studied El Niño before 1997 but political organizations and policymakers, as well as public institutions and the people, had very little information regarding what El Niño was or even awareness of it as a factor underlying the country's natural hazards.

Box 1. The first article in Vietnamese written on El Niño by Nguyen Huu Ninh and Hoang Minh Hien, released by The People on June 21, 1987

NHÔNG thập kỷ gần đây, hiện tượng En Ni-nhỏ được viết nhiều trên báo chí thế giới, và các nhà khoa học cho đó là nguyên nhân quan trọng gây ra những biến động khí hậu. Vậy En Ni-nhỏ là gì? Ảnh hưởng của nó ra sao, đối với khí hậu? En Ni-nhỏ có ảnh hưởng đến nước ta không?

Hai dòng hải lưu lớn nhất Thái Bình Dương là dòng hải lưu Pê-ru và dòng hải lưu Ca-li-pho-ni-a. Dòng hải lưu thứ nhất chạy sát ven bờ biển tây Nam Mỹ, gây ra quá trình nước trời mát, giàu dinh dưỡng thích hợp cho sự sinh trưởng và phát triển của cá và các loài chim ăn cá. Vùng bờ biển Pê-ru là một trong những trung tâm nước trời giàu dinh dưỡng nhất thế giới. Quá trình này là kết quả tác động kết hợp của gió tín phong đông nam thổi dọc bờ biển tây Nam Mỹ và sự quay của quả đất. Tuy nhiên trong một số thời kỳ, do những nguyên nhân chưa được biết, gió tín phong vùng phía tây và trung tâm Thái Bình Dương yếu đi hoặc đổi hướng khác thường, gây ra những luồng gió tây mạnh đẩy nước ấm bề mặt về phía đông. Sự xâm lấn của nước ấm bề mặt phá đi quá trình nước trời mát ở ngoài khơi tây bắc Nam Mỹ. Những người đánh cá Pê-ru là những người đầu tiên phát hiện ra hiện tượng nước ấm làm xao trộn và xua đi những loài cá sống trong nước lạnh. Họ đặt tên cho hiện tượng này là En Ni-nhỏ (tiếng Tây Ban Nha, nghĩa là chú bé Nô-en). Bởi lẽ họ thường thấy chúng xuất hiện vào dịp gần Nô-en và tồn tại khoảng vài tháng. Khi En Ni-nhỏ diễn ra mạnh và kéo dài, nước ấm bề mặt có thể lan rộng dọc bờ biển Pê-ru và vùng xích đạo Thái Bình Dương và có thể duy trì hơn một năm. Công việc đánh cá bị ngưng hẳn và thường có mưa lớn trên vùng nhiệt đới tây Nam Mỹ. Hiện nay đối với các nhà khí tượng và hải dương học, En Ni-nhỏ được hiểu như là một hiện tượng lớn tượng trưng cho toàn bộ nhiễu động nước ấm bề mặt thỉnh thoảng gặp ở vùng trung tâm và đông xích đạo Thái Bình Dương.

Từ lâu các nhà khoa học đã thấy nhiễu động nhiệt độ mặt nước biển gây ảnh hưởng lớn đến hoàn lưu khí quyển và sự biến đổi của thời tiết, khí hậu. Trong thời kỳ hoạt động của En Ni-nhỏ, nhiệt độ mặt nước biển ở những vùng rộng lớn trên Thái Bình Dương, có thể tăng lên từ 1 đến 7 độ C so với mức trung bình. Tùy vào mức độ thay đổi về nhiệt độ mà nó có thể ảnh hưởng

lớn đến thời tiết trên hành tinh. En Ni-nhỏ gắn liền với những thiên tai như hạn hán, ngập lụt, v.v. Những thay đổi về thời tiết gắn với En Ni-nhỏ là mưa lớn ở Pê-ru, E-cu-a-đo, trung tâm Thái Bình Dương và đông xích đạo Thái Bình Dương; hạn hán ở In-đô-nê-xi-a, Niu Ghi-nê; mùa mưa ở miền nhiệt đới của O-xtrây-li-a đến muộn hơn bình thường và tổng lượng mây ở các vùng biển quanh khu vực Đông-Nam Á giảm xuống rõ rệt.



Hiện tượng En Ni-nhỏ

Sự xuất hiện En Ni-nhỏ rất khác nhau về cường độ, thời gian tồn tại và phạm vi ảnh hưởng. Chu kỳ xuất hiện của chúng khác nhau và đông đảo trong khoảng từ hai đến bảy năm và trung bình từ 10 đến 12 năm có một đợt lớn xuất hiện. Các số liệu thống kê cho thấy từ năm 1890 trở lại đây xảy ra ít nhất 27 En Ni-nhỏ trong đó có bảy lần lớn. Những lần xảy ra gần đây nhất là năm 1957 — 1958, 1963, 1965, 1969, 1972 — 1973, 1976, 1982 — 1983. En Ni-nhỏ còn liên quan đến sự dịch chuyển của các trung tâm phát sinh bão trên Thái Bình Dương, tới thời gian xuất hiện và đường đi của bão. En Ni-nhỏ là biểu hiện của quá trình rộng lớn và rất phức tạp mà cơ chế chưa được sáng tỏ. Tuy vậy các quan trắc khí tượng và hải dương cho thấy rõ mối liên quan chặt chẽ giữa các nhiễu động nhiệt độ mặt nước biển và hoàn lưu khí quyển nam bán cầu. Nếu các biến động thời tiết, khí hậu gắn với En Ni-nhỏ xảy ra ở vùng xích đạo Thái Bình Dương không có gì đáng ngạc nhiên nhưng lại thấy hàng loạt các biến động khí hậu khác nhau xảy ra ở những vùng cách xa xích đạo Thái Bình Dương. Sự liên quan chặt chẽ giữa hiện tượng En Ni-nhỏ và một loạt những biến đổi khí hậu khác thường trên phạm vi toàn cầu ở những vùng địa lý cách xa nhau làm xuất hiện một khái niệm mới: những liên quan xa về khí hậu gắn với ENSO (En Ni-nhỏ dao động Nam bán cầu). Theo đánh giá bước đầu của Trung

tâm nghiên cứu khí quyển Hoa Kỳ về mức độ ảnh hưởng của En Ni-nhỏ thì O-xtrây-li-a, Pê-ru, In-đô-nê-xi-a là những vùng bị ảnh hưởng mạnh, Ấn Độ, Trung Quốc, Bra-xin và đông nam châu Phi là những vùng bị ảnh hưởng trung bình; Mỹ, Nhật Bản, Tây Âu, Liên Xô là những vùng bị ảnh hưởng yếu.

En Ni-nhỏ năm 1982 — 1983 là lớn nhất ghi nhận được từ 100 năm nay. Các biến động thời tiết đã diễn ra với tính chất toàn cầu và với các nước ở ven bờ Thái Bình Dương và Ấn Độ Dương. Các hậu quả của nó lâu dài và có những hậu quả sinh học khó đảo ngược.

Theo ý kiến của tiến sĩ Mi-sen H. Gian, phụ trách nhóm nghiên cứu ảnh hưởng môi trường — xã hội của Trung tâm nghiên cứu khí quyển Hoa Kỳ, thì Việt Nam cũng nằm trong vòng ảnh hưởng của hiện tượng En Ni-nhỏ. Các bản đồ ất-lát về ba En Ni-nhỏ lớn nhất xảy ra gần đây (1957 — 1958, 1972 — 1973 và 1982 — 1983) cũng xác minh ý kiến này. Việc đánh giá bước đầu thông qua các số liệu khí tượng, thủy văn của ta trong những năm gần đây cũng cho thấy nhiều hiện tượng thời tiết khác thường xảy ra trong những thời kỳ hoạt động của En Ni-nhỏ. Ngập lụt lịch sử năm 1971 và ngập lụt nặng năm 1980, là những năm trước khi diễn ra hai En Ni-nhỏ lớn nhất. Các vụ đông xuân ở bắc bộ thường bị ảnh hưởng xấu của nhiễu đợt rét hại và rét đậm kéo dài vào những năm trước và sau năm xảy ra En Ni-nhỏ. Hạn hán khá nặng thường xảy ra vào những mùa có En Ni-nhỏ. Khô hạn và nhiều đợt nóng nắng kéo dài trong thời kỳ 1972 — 1973 và 1982 — 1983. Việt Nam nằm ở vành đai tây Thái Bình Dương, mà nước ấm lại lan truyền từ phía tây sang đông; vì vậy ảnh hưởng và hậu quả có thể xảy ra sớm ở Việt Nam trước khi En Ni-nhỏ chính thức thể hiện.

Cho đến nay việc nghiên cứu bản chất và dự báo sự xuất hiện và cường độ hiện tượng En Ni-nhỏ còn gặp nhiều khó khăn. Việc tham gia phối hợp với mạng lưới nghiên cứu quốc tế về En Ni-nhỏ và đánh giá ảnh hưởng của nó đối với Việt Nam sẽ đem lại nhiều thông tin thiết thực phục vụ dự báo thời tiết dài hạn và chiến lược lương thực, thực phẩm.

Phó tiến sĩ
NGUYỄN HỮU NINH
và Phó tiến sĩ
HOÀNG MINH HIỆN
(Trưởng đại học Tổng hợp Hà Nội, Tổng cục Khí tượng — Thủy văn)

2 THE 1997-98 EVENT

2.1 FLOW OF INFORMATION ON THE 1997-98 EL NIÑO WITHIN VIETNAM

In April 1997 Vietnamese authorities had been given an official document that originated from the U.S Government about the appearance and anomaly of El Niño. At this time, information was also available more widely from the US mass media, NOAA and, for those with access, the Internet. Information picked up from the US mass media was re-published by *Vietnam Voice* as well as other media sources in Southeast Asia. The Hydro-Meteorology Service was receiving El Niño forecasts from international sources throughout 1997. In July and October 1997 reports related to El Niño were presented by Vietnamese scientists to spread the information to the people. For the most part, this news and information concerned El Niño's global effects and not its actual impacts on Vietnam, which would not become clearly evident until the fall.

A government document, "Document on El Niño and its Impact," was released on 28 October 1997 (*Identification Number: 5418/KTN*) from the Prime Minister's Office. Signed by Vice Prime Minister Pham Gia Khiem, this document instructed the responsible authorities—the Ministry of Science, Technology and the Environment and the Hydro-Meteorology Service—to prepare a report on El Niño and La Niña. Throughout the 1997-98 El Niño event, the Hydro-Meteorology Service continued to monitor weather and climate hazards affecting Vietnam following its normal procedures and issued advisories as necessary. The first popular ENSO document was released by the Hydro-Meteorology Service and printed by the Science and Technology Publishing House in the year 2000 (*Nguyen Duc Ngu, 2000*).

On 25 September 1997 *The People* newspaper in Vietnam released the first news of El Niño's impacts in Vietnam. On 5 November 1997, when Severe Tropical Storm Linda landed and destroyed parts of the South of Vietnam, *The People* newspaper released the information and addressed the detailed impacts of El Niño in the Eastern Sea. Also, in *The People* on 11 January 1998, drought in the South of Vietnam was identified as having been caused by El Niño. On 10 July 1998 *The People* mentioned the impacts of La Niña on the rising waters of the Red River and the Lo River in the North of Vietnam.

The Labor newspaper mentioned many events related to El Niño in the same period of 1997-98. "The Second El Niño in the century, El Niño and trends of climate change" released on 25 September 1997 and "El Niño in the final phase" on 6 June 1998 expressed special concern about the phenomenon and placed the current event in the context of previous events. At the same time, many articles mentioning the phenomenon were published by papers such as *The Military* and *New Hanoi* as well as other scientific magazines including *Meteorology and Hydrology Magazine* and *Environmental Study Magazine*.

The broadcast media has also played a role in popularizing information about the impacts of El Niño in Vietnam at the time of the 1997-98 event. Television, especially VTV2 that focuses on scientific topics, developed documentaries mentioning the El Niño and La Niña phenomena and

their potential impacts on the country. However, the documentaries concentrated on climate change and global warming rather than on El Niño and La Niña specifically.

2.2 PREVIOUS MENTION OF EL NIÑO IN THE MEDIA

Prior to the interest generated by the 1997-98 event, there was little if anything published in or broadcast by the media since the first popular article written by Dr. Nguyen Huu Ninh and Dr. Hoang Minh Hien in *The People* newspaper on 21 June 1987.

2.3 TELECONNECTIONS AND EXPECTED EFFECTS OF EL NIÑO

Vietnam stretches along 15 degrees of latitude (from the 8.30°N to 13.20°N) and lies in an area of the western branch of the Walker circulation within the equatorial Pacific where upward motion dominates. In general terms, the location of Vietnam means that, in El Niño years, rainfall and cloud cover decrease as the vertical (upward) motion is reduced and there is an increase in incoming solar radiation, temperature and evaporation. The situation is opposite in La Niña years when severe flooding and low temperatures may occur. The main affected areas are the South and the southern plateau (the western side of the Truong Son mountains in Central Vietnam). Further to the North, such as northern central, the Red River Delta, and the northern midland regions to the mountainous areas of the North, the impact is not manifested as clearly.

In general terms, the main effects during El Niño years on the seasonal climate of Vietnam are as follows:

- (a) Cloud cover decreases and rainfall levels are lower
- (b) Temperatures increase as does radiation and evaporation

The impact is generally most evident during the winter half-year, with effects usually developing toward the fall of the year in which the El Niño warming of the equatorial Pacific becomes evident. *See also Dang Tran Duy (1998), Le Nguyen Tuong (1998) and Pham Duc Thi (1998).*

Vietnam's climate has a tropical monsoon character and is affected by the Asian monsoon structure, of which the Asian Northeast monsoon and Asian South monsoon dominate. The monsoon dominates in the winter over North Vietnam, while the south is affected by the monsoon in combination with the trade winds. This creates a marked difference in the weather between the two regions and accounts for the differential impact of El Niño and La Niña in the north and south of the country.

Recent studies carried out by Nguyen Trong Hieu, Tran Viet Lien, Nguyen Thi Bich Hop, Pham Thi Thanh Huong and others have shown that the ENSO phenomenon has impacts on Vietnam by affecting the activity of the monsoon:

- In El Niño years, the activity of the summer monsoon is much weaker than normal. The beginning of the summer monsoon in the territory of Vietnam often occurs in early May and

sometimes in April. According to a study by Nguyen Thi Bich Hop, in El Niño years the length of monsoon is usually longer.

- For the winter monsoon, there is no specific and complete study of the relationship of the monsoon with ENSO but, recently, in El Niño years, the impact of the winter monsoon on Vietnam has decreased in terms of frequency and intensity.
- The activity of atmospheric turbulence during the monsoon is not only a characteristic of Vietnam's climate but also of Southeast Asia. It consists of tropical cyclones, tropical convergence, polar fronts and tracks and some other local turbulence such as whirlwinds, storm surges and thunderstorms. During El Niño episodes, the occurrence of these phenomena tends to be decreased.

The effect of El Niño and La Niña on storm occurrence is one of the most important impacts of these phenomena as far as Vietnam is concerned.

The Western North Pacific is one of the most productive (and violent) areas of tropical cyclone formation in the world accounting for 36% of the global average cyclone numbers. The Vietnamese and South China coastal areas are exposed to storms from two source regions, namely the North Pacific Ocean and the Eastern Sea (i.e., South China Sea). ENSO events affect various characteristics of storm activity in the Western North Pacific, Eastern Sea and in Vietnam. The appearance of warm and cool sea surface temperature anomalies over a large area of the central equatorial Pacific causes changes in the origin of formation and in the frequency, intensity, track and other characteristics of observed cyclones in these regions. The cyclone season extends from June to November and the month with the highest frequency of formed storms, on average, is August.

The following are the main characteristics of storm climatology during El Niño years, expressed relative to the climatology in La Niña years. This assessment is based on recent work by Hoang Minh Hien (*reported in Nguyen Huu Ninh et al., 2000*); see also Pan (1981, 1986), Chan (1985), Li (1987), Chontyin (1988), Hoang Minh Hien and Nguyen Huu Ninh (1990), Nishimori and Yoshino (1990), Lander (1994), Schroeder and Yu (1995), Bui Minh Tang (1998), Harris (1998) and Nguyen Duon Toan (1998).

- In El Niño years, when there are warm anomalies of sea surface water in the central equatorial Pacific, the origin of storms has a clear tendency to shift to the southeast. The storms are formed further from the Eastern Sea, especially in the later months of the year, so less storms impact on the Eastern Sea and Vietnam than in normal or La Niña years (Figures 4 and 5).

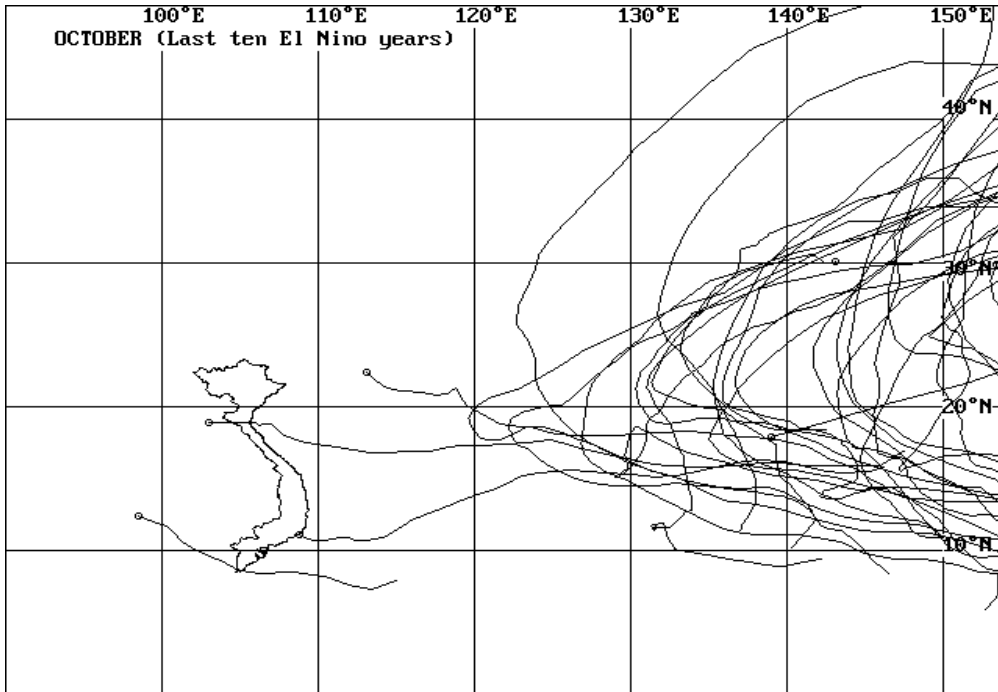


Figure 4 - Tracks of tropical storms - October - in the last ten El Niño events

Source: Climate Research Center, Institute of Meteorology and Hydrology

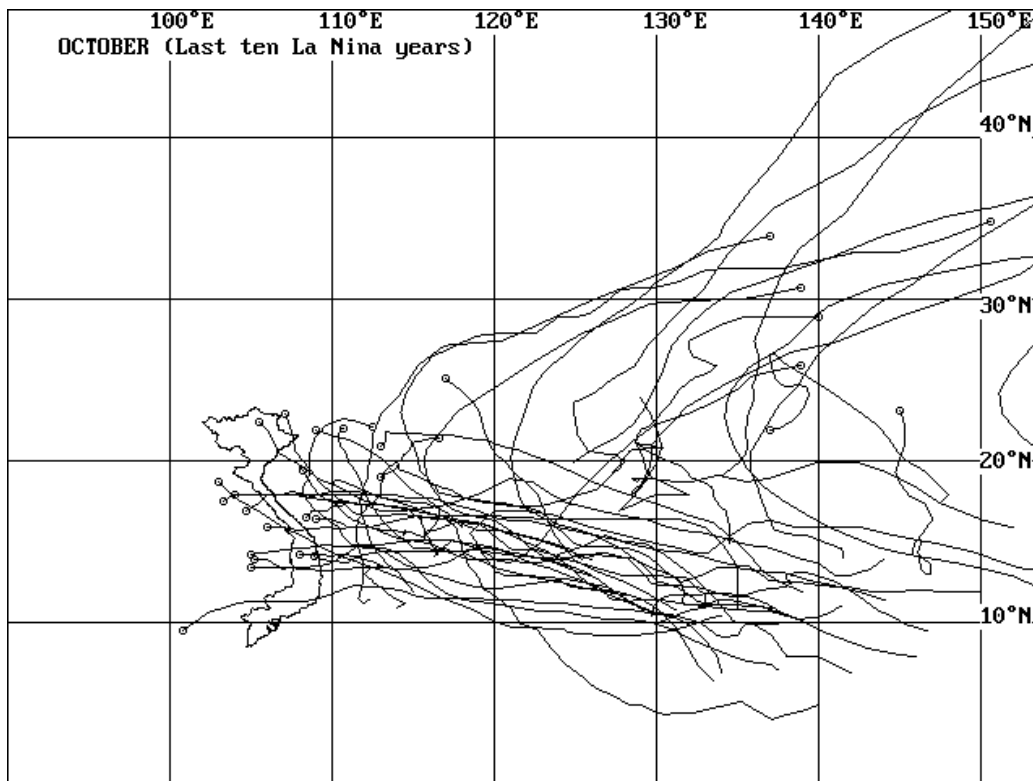


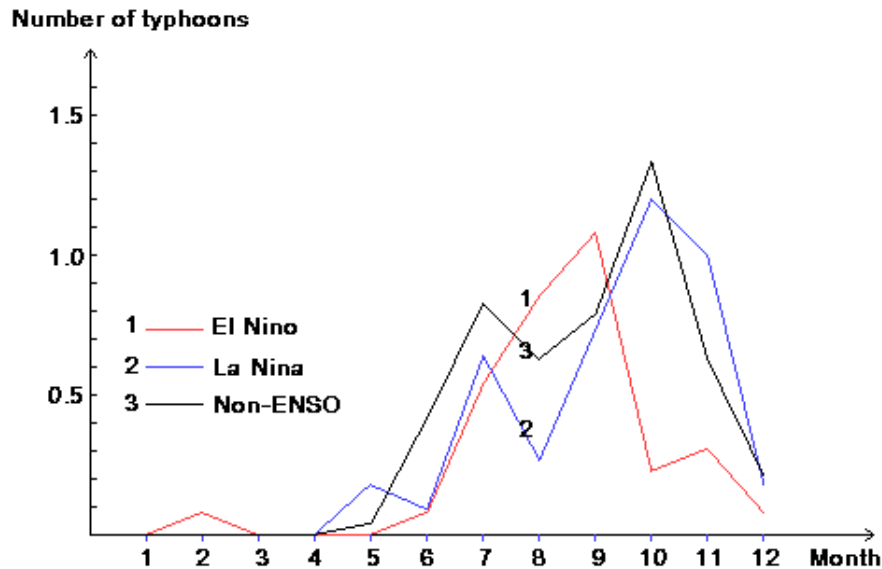
Figure 5. Tracks of tropical storms - October - in last ten La Niña years

Source: Climate Research Center, Institute of Meteorology and Hydrology

- In El Niño years the average intensity and the strongest intensity (the highest class) of storms are stronger than in La Niña years, and the place where the storms reach their strongest intensity shifts clearly to the southeast, nearer to the warm sea surface temperature anomalies in the central equatorial Pacific.
- In El Niño years the activity of storms is concentrated in three summer months from July to September; the activity of storms in October and November is much weaker (Figure 2). In La Niña years, it is most strong in October and November.
- In El Niño years the number of cyclones making landfall on the Vietnamese coastline in all parts of Vietnam is lower than average (Figure 6). In La Niña years, the number of landfall storms in all regions of Vietnam is higher than in El Niño years, especially for the southern region where the frequency of landfall storms is nearly two times higher than in El Niño years.
- In El Niño years, the storms making landfall in Vietnam are concentrated in summer months (Figure 5). The month with highest frequency of landfall in Vietnam storms is September. In October and November, the number of landfall in Vietnam storms decreases. In La Niña years, the landfall storms are concentrated in the later months of the typhoon season. The month with highest frequency of landfall storms is October. The frequency of landfall cyclones in November is also high, nearly equal to the frequency in October.

- In El Niño years, the intensity of cyclones at the moment of landfall is strongest, whereas in La Niña years it is weakest.

Figure 6 - Monthly frequency of landfall tropical cyclones in Vietnam



Source: Climate Research Center Institute of Meteorology and Hydrology

- In September in El Niño years, landfall storms are formed at longitudes near to Vietnam, more than a thousand kilometers closer to Vietnam than in other years. It is the month with the highest ratio of storms occurring in the Eastern Sea that make landfall in Vietnam.

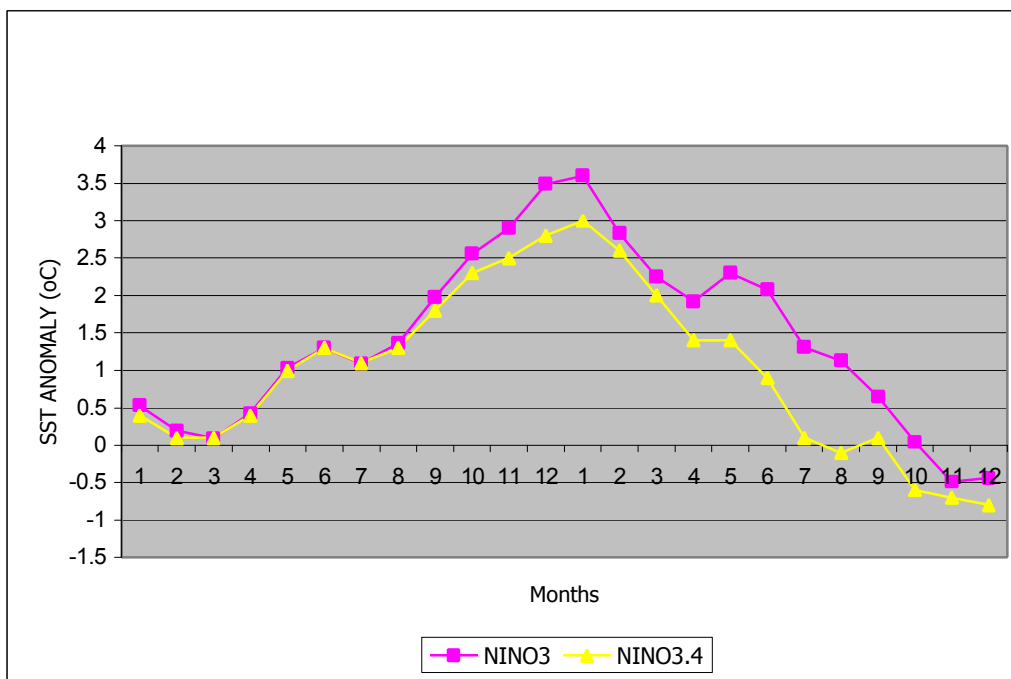
The impact of the ENSO phenomenon on Vietnam is a complicated issue and the above comments are based on initial research. Many other studies are in the beginning phases. There should be more advanced studies for the whole region in order to develop comprehensive reliable conclusions that would serve as a basis for future research, especially concerning weather and climate forecasts and environment. Overall, the Vietnamese scientific community would conclude that El Niño has a serious impact on Vietnam, but much remains to be understood about its direct and indirect effects on the country.

2.4 CLIMATE-RELATED ANOMALIES AND IMPACTS OF THE 1982-83 EL NIÑO EVENT

This account of the impact of the 1982-83 El Niño event is based on recent analysis of climate data for the period. There is no record of socio-economic impacts directly related to the event at that time, as the phenomenon was not recognized then. The impact of the 1982-83 El Niño on Vietnam was, however, relatively clear in the country's climate records.

The 1982-83 El Niño event started in April 1982 when the sea surface temperatures (SSTs) in the NIÑO3 and NIÑO3.4 indicator areas increased by 0.5°C. At the same time, the Southern Oscillation Index (SOI) was converting from positive to negative values, with the value lower than -5. Based on the anomalies of SST and SOI, the El Niño of 1982-83 started in April 1982 and ended between June and July 1983. The peak of El Niño occurred in January 1983 when the maximum of the SST variation in NIÑO3 reached +3.6°C and then decreased a little but increased in May and reached a second maximum of +2.4°C. By the end of June 1983, the SST anomaly in NIÑO3.4 decreased to 0.5°C (Figure 7).

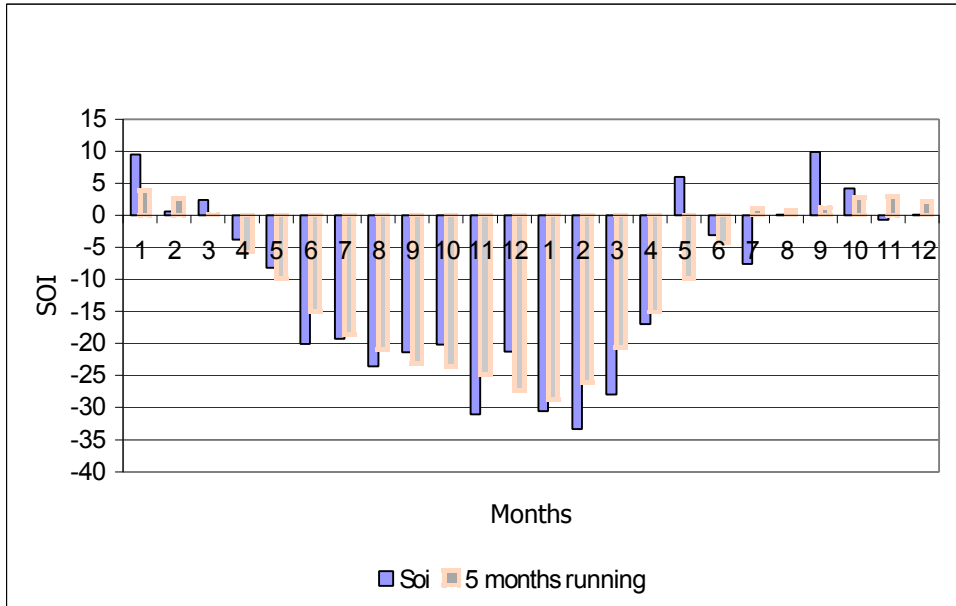
Figure 7 - Variation of SST anomalies in NIÑO 3 and NIÑO 3.4 regions in the 1982-83 El Niño episode



Source: Climate Research Center Institute of Meteorology and Hydrology

If the Walker circulation in the Pacific is assessed by SOI, the converse episode of the Walker circulation correlative to El Niño started in May when the SOI decreased to -10. This index reached a minimum in February 1983 and then increased. In May 1983 the SOI passed the value of 0 and then decreased a little and reached a second minimum in July with a value of -5. This showed that the Walker circulation anomaly reached its strongest point in July and then decreased rapidly. In May 1983 the Walker circulation returned to a normal situation. Afterwards, it decreased a little and reached a second minimum in July. The circulation was in a stable, normal situation by September 1983 (Figure 8).

Figure 8 - Variation of SOI in the 1982-83 El Niño Episode



Source: Climate Research Center Institute of Meteorology and Hydrology

Therefore, the changes related to this El Niño were evident in both the sea and the atmosphere and lasted for 12-13 months (May 1982 to April/May 1983).

Changes in Vietnam's climate associated with the anomaly of the 1982-83 El Niño were as follows:

During an El Niño episode, the decrease of convection in the west branch of the Walker circulation in the western Equatorial Pacific, especially with the appearance of subsidence in combination with the decrease of monsoon activity in Southeast Asia, reduces the cloud cover. In Vietnam, the reduction of cloud cover was clear in some regions, such as the South and the southern plateau, from September/October 1982 to May/June 1983. This is shown by variation in both low clouds and cloud cover in general (Figures 9 to 14). The anomaly of low clouds from September 1982 to June 1983 and the cloud cover from October 1982 to May 1983 were both negative. The effects occurred 4-5 months later than suggested by the onset of the El Niño event in the Eastern Pacific. In other regions such as in the North, there were no clear indications of El Niño impacts; those in the South and the southern plateau were clearer. In Central Vietnam, reactions of regional and local climate conditions to the impact of El Niño were not typical for the whole country but the cloud cover was sharply decreased for a longer time than elsewhere.

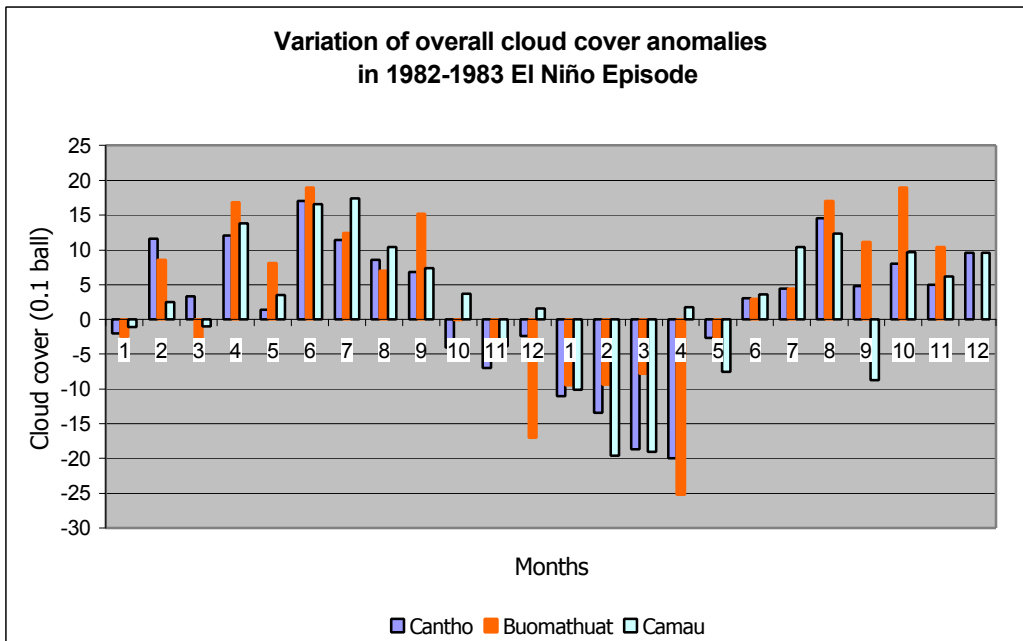


Figure 9. Variation of overall cloud cover anomalies in 1982-83 El Niño Episode in Cau Mau, Buon Ma Thuat and Can Tho

Source Figures 9-45: Climate Research Center Institute of Meteorology and Hydrology

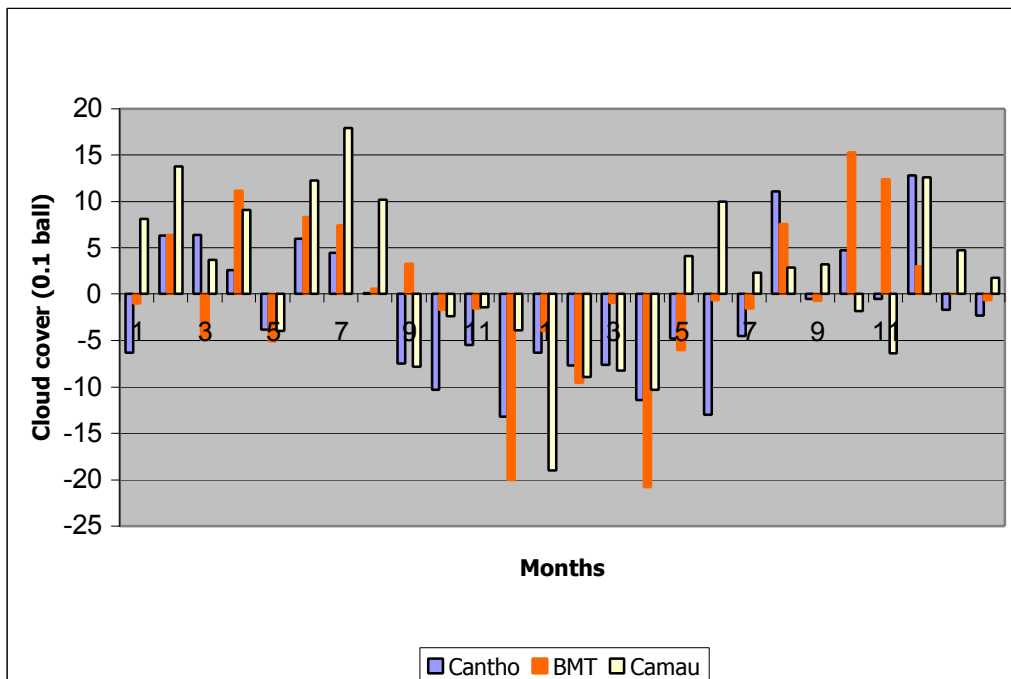


Figure 10. Variation of low cloud anomalies in the 1982-83 El Niño Episode in Caumau, Buon Ma Thuat and Can Tho

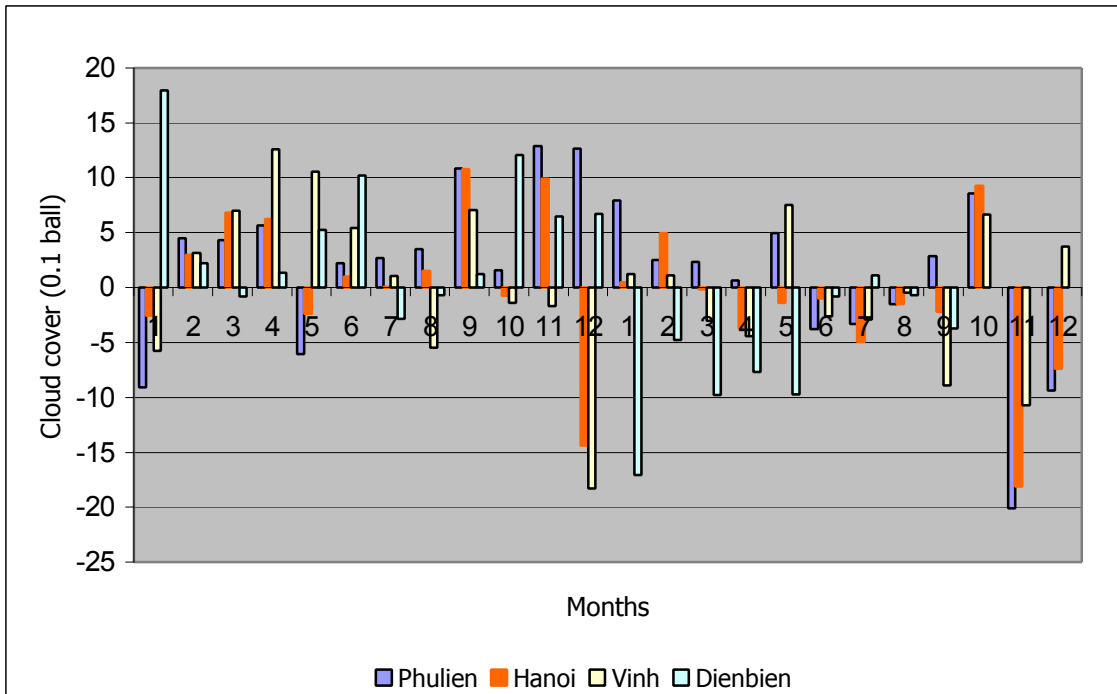


Figure 11. Variation of overall cloud cover anomalies in 1982-83 El Niño Episode in Phu Lien, Hanoi, Vinh and Dien Bien

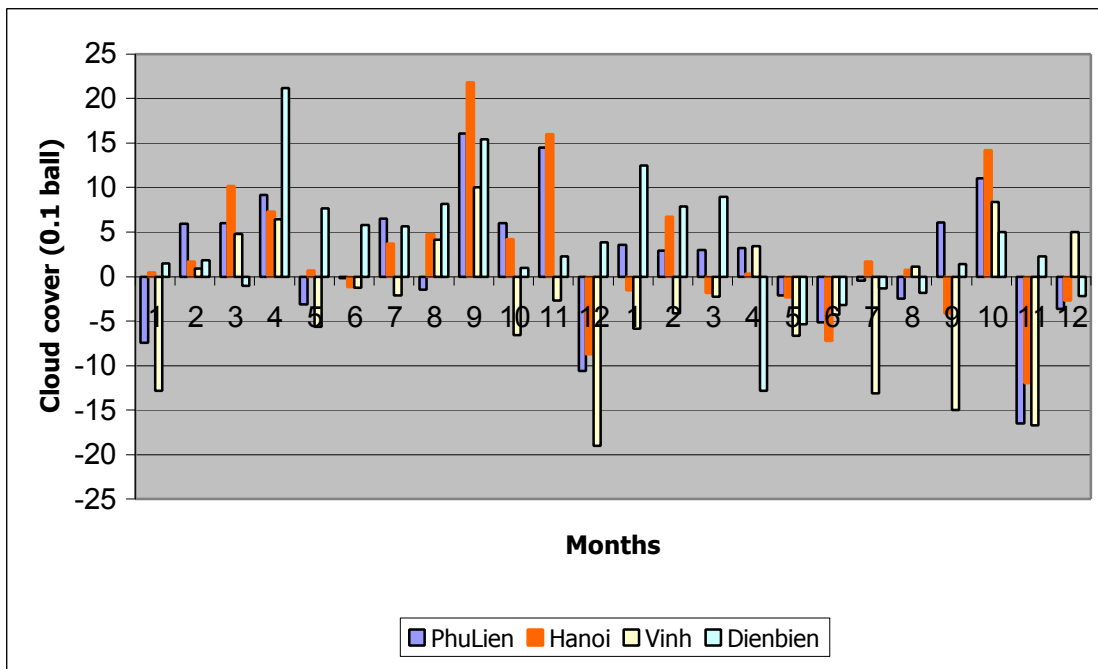


Figure 12. Variation of low cloud cover anomalies in the 1982-83 El Niño Episode in Phu Lien, Hanoi, Vinh and Dien Bien

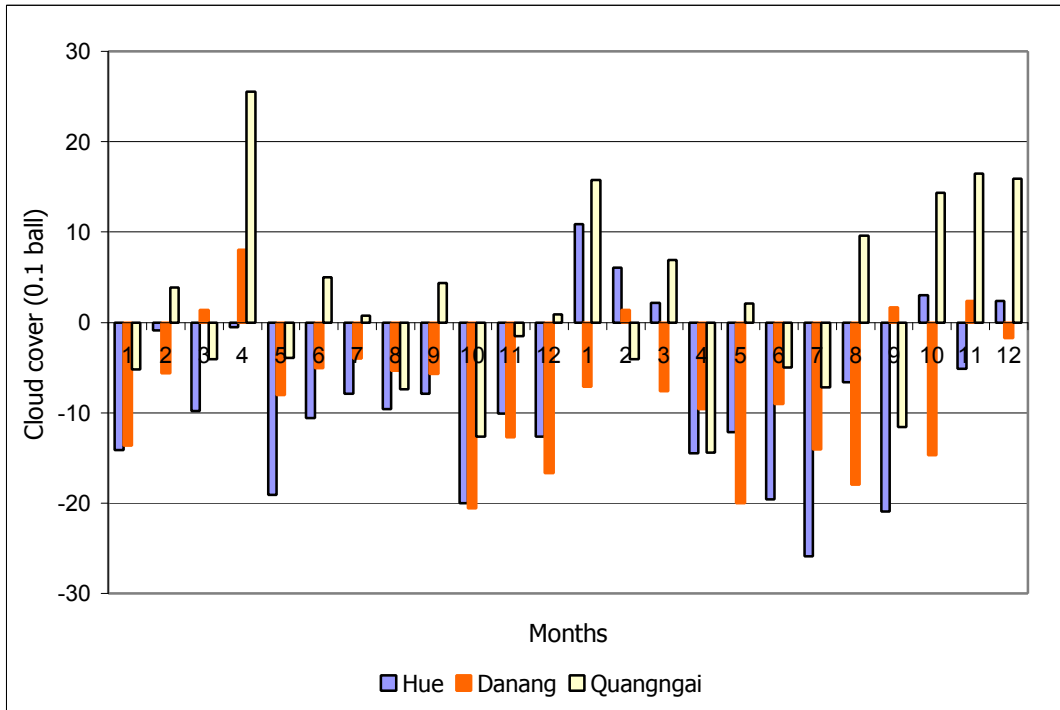


Figure 13. Variation of overall cloud cover anomalies in 1982-83 El Niño Episode in Hue, Da Nang and Quang Ngai

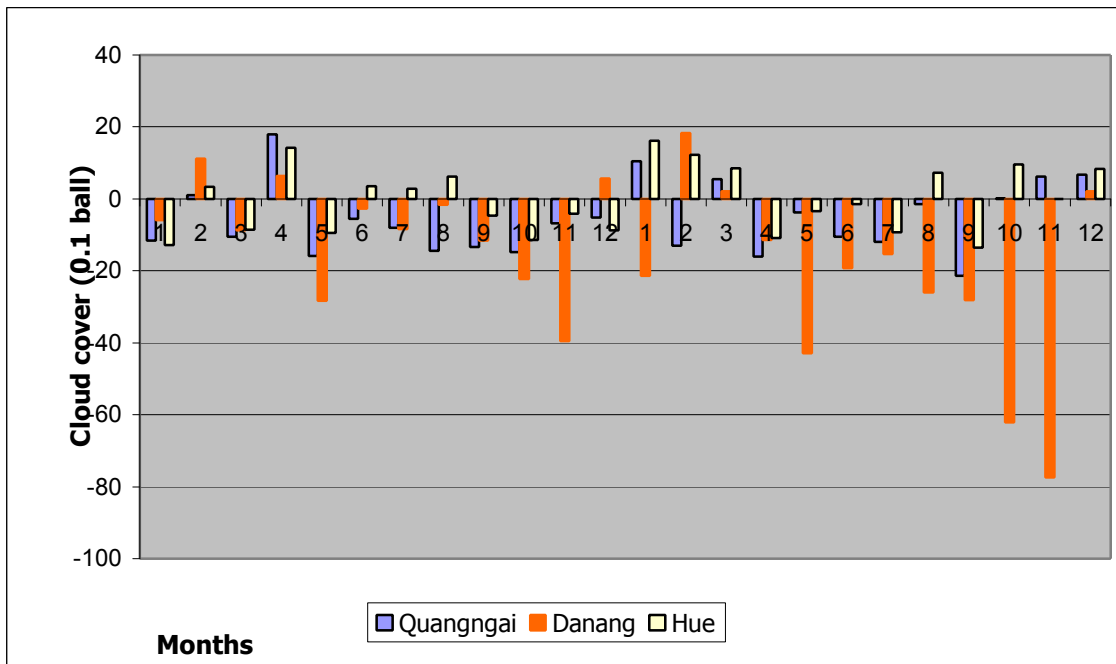


Figure 14. Variation of low cloud cover anomalies in the 1982-83 El Niño Episode in Hue, Da Nang and Quang Ngai

As a consequence of the decrease of low clouds, rainfall was reduced. Rainfall in 1982 was remarkably lower than the average value in many regions in the South and Central Vietnam, including the coastal zone and the southern plateau. Rainfall was reduced around October 1982 to May 1983 for the South and southern plateau. In the southern coastal zone and the midlands, rainfall was reduced earlier than elsewhere, even in the rainy season toward the end of the year, from June/July 1982 to May 1983 (Figures 15 to 17).

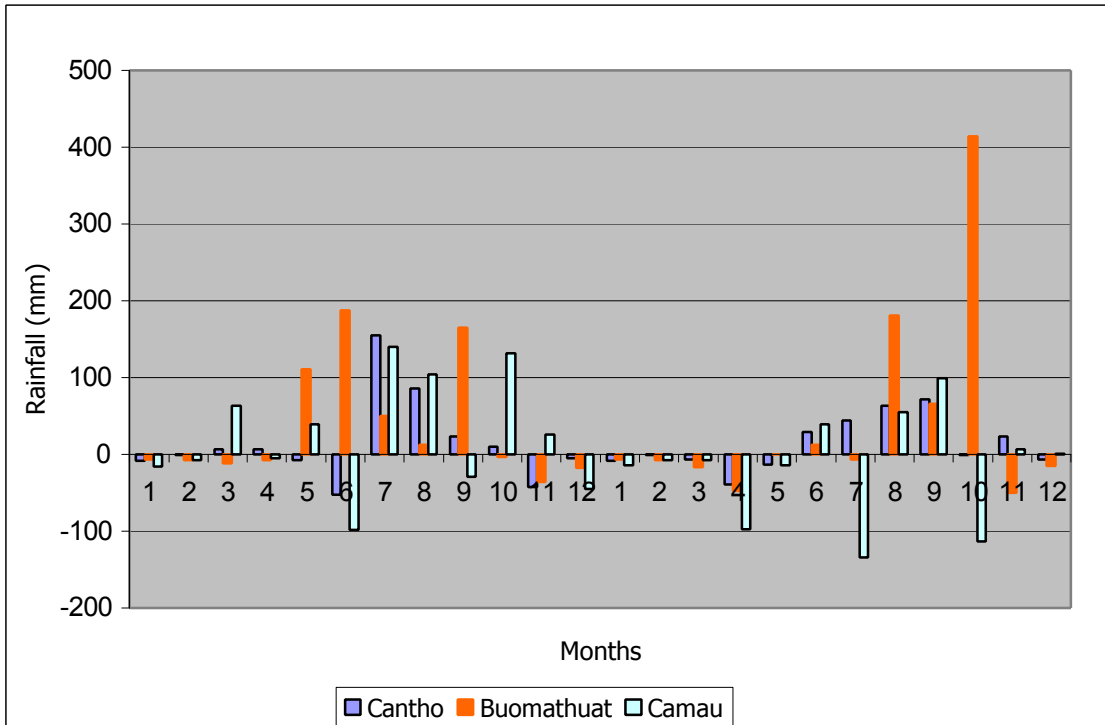


Figure 15. Variation of rainfall anomalies in 1982-83 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

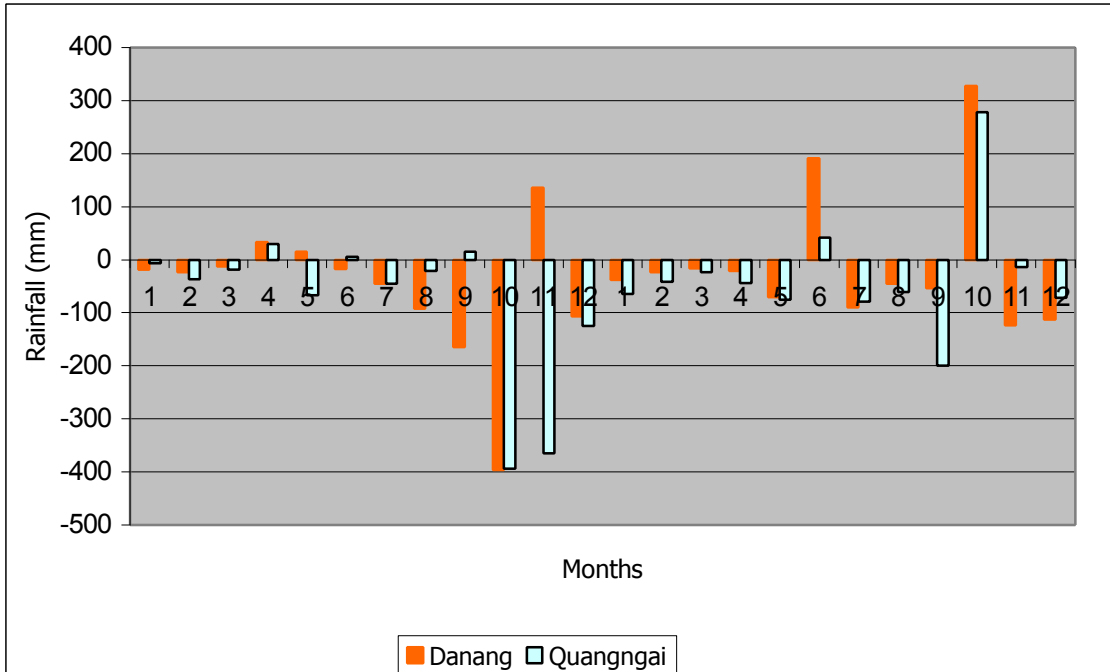


Figure 16. Variation of rainfall anomalies in 1982-83 El Niño Episode in Da Nang and Quang Ngai

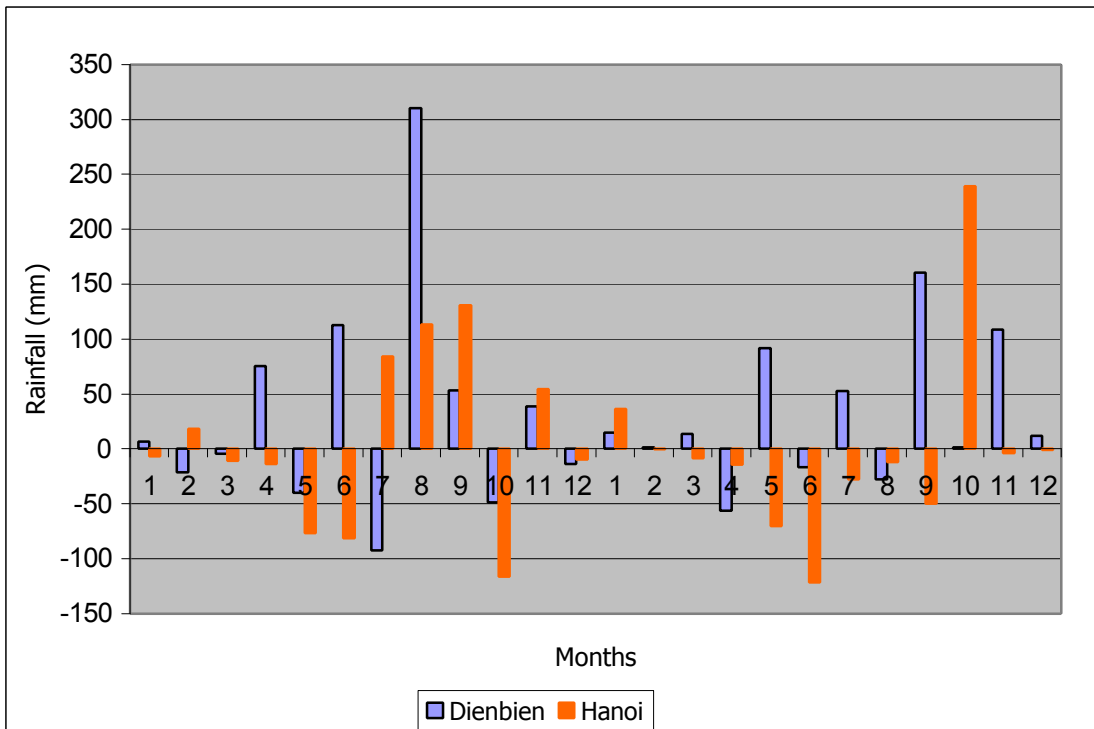


Figure 17. Variation of rainfall anomalies in 1982-83 El Niño Episode in Dien Bien and Hanoi

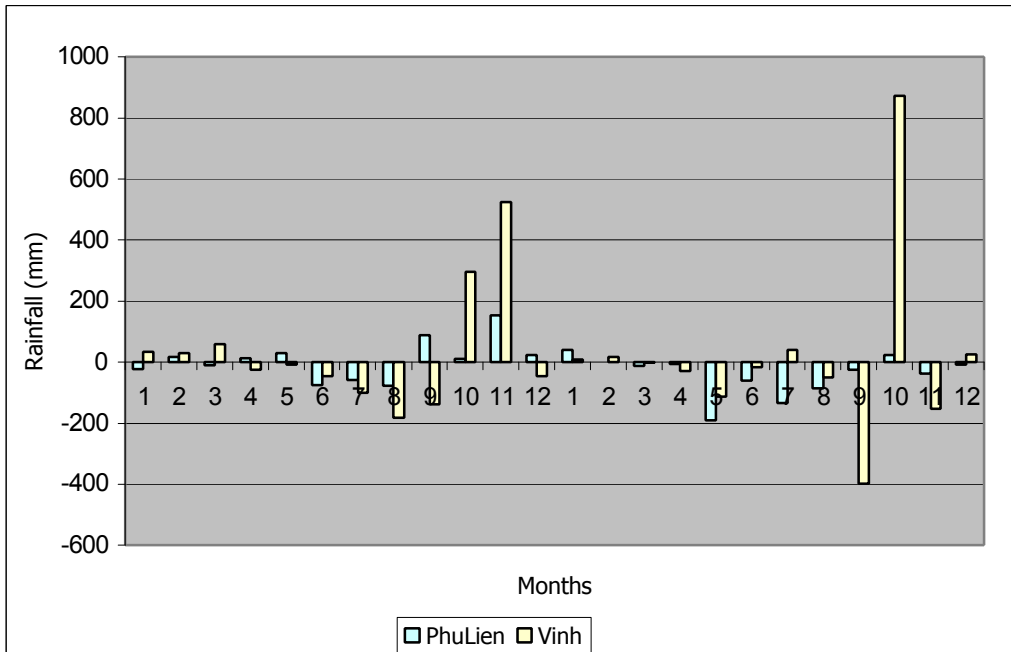


Figure 18. Variation of rainfall anomalies in 1982-83 El Niño Episode in Phu Lien and Vinh

Due to the decrease of cloud cover and rainfall, solar radiation levels increased and the period of generally sunny days lasted longer than normal. An estimation of total sunshine duration in 1982 and 1983 carried out by meteorological stations in the South and southern plateau shows that sunny days dominated from November 1982 to June/July 1983 (Figure 19)

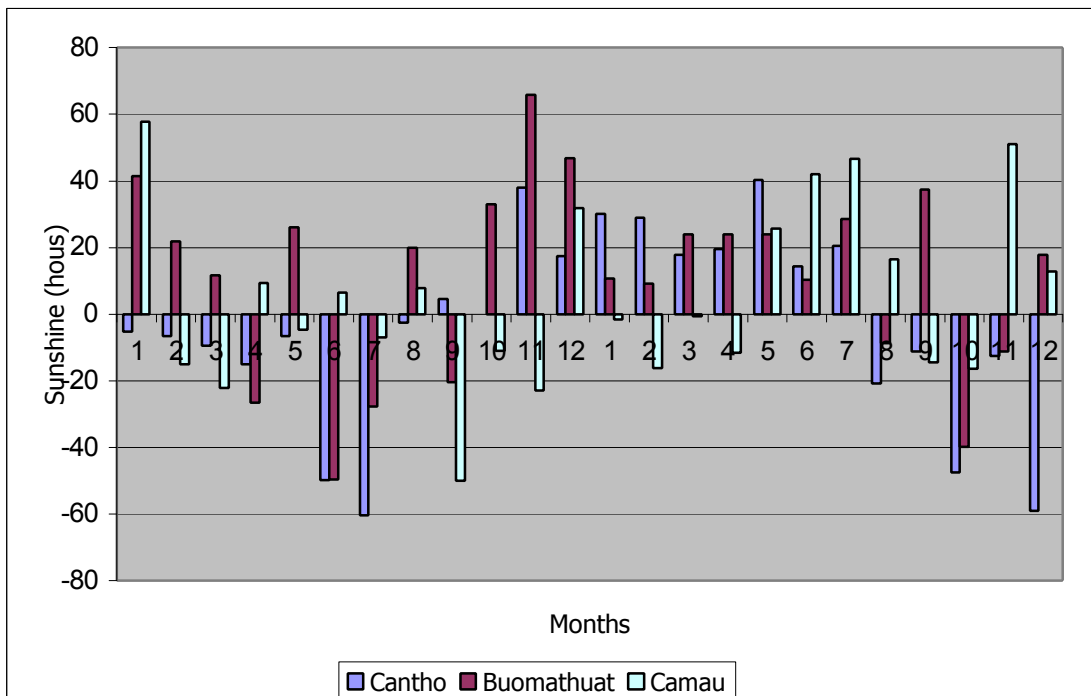


Figure 19. Variation of sunshine anomalies in 1982-83 El Niño episode in Can Tho, Buon Ma Thuat and Ca Mau

These impacts caused increasingly high temperatures. This is easy to detect by the variations in the data. Temperatures increased clearly from September/October 1982 to September 1983, especially by the end of winter and the beginning of spring. The coastal zone of the Central and the northern part of the South were affected slightly but the impacts were not typical or as concentrated as those of the south and southern plateau (Figure 20 to 23).

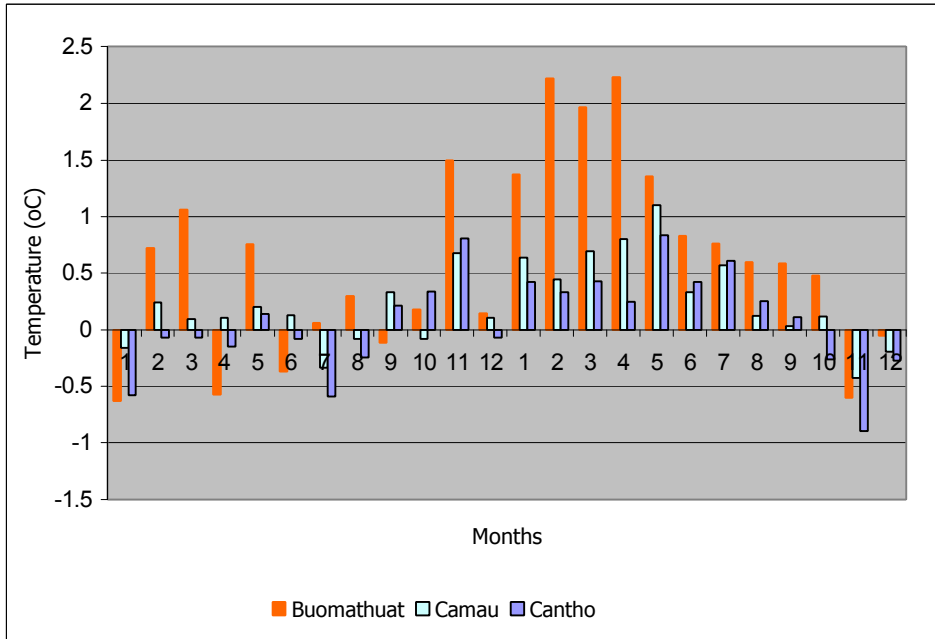


Figure 20. Variation of average temperature anomalies in 1982-83 El Niño Episode in Buon Ma Thuat, Ca Mau and Can Tho

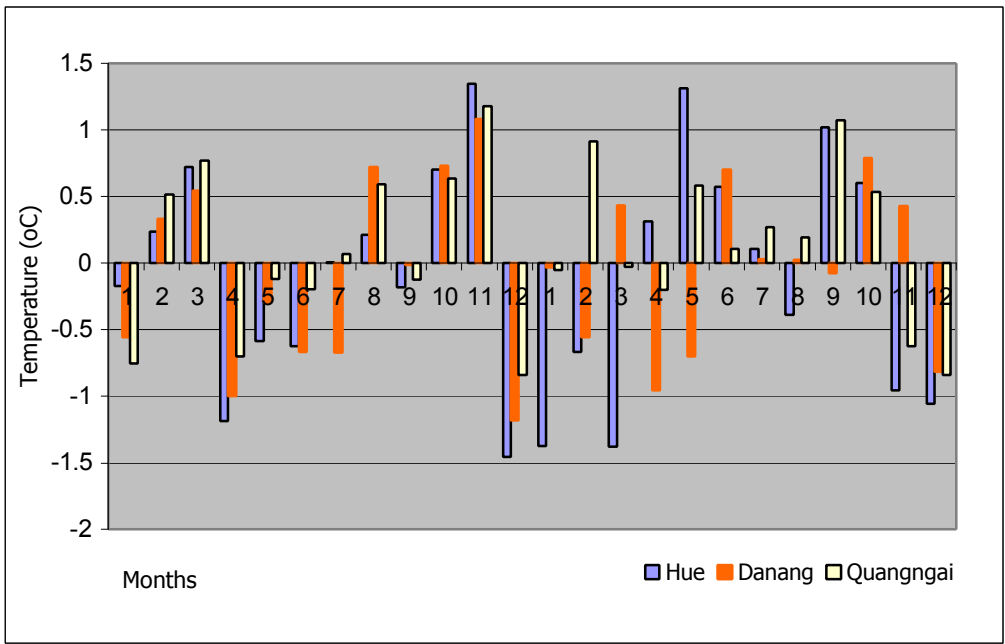


Figure 21. Variation of average temperature anomalies in 1982-83 El Niño Episode in Hue, Da Nang and Hanoi

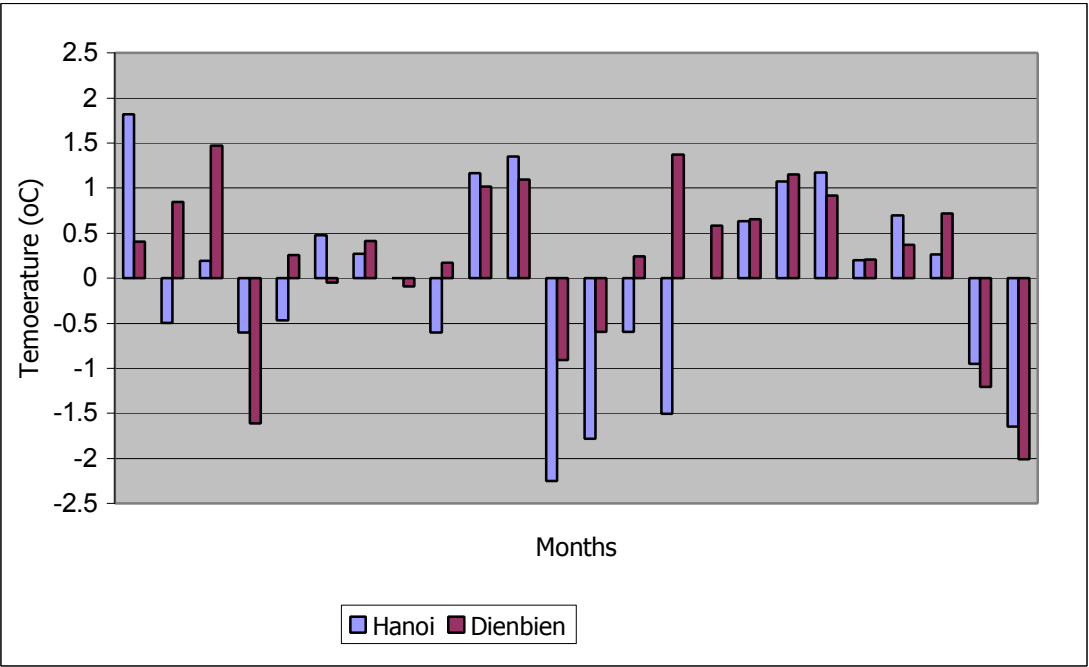


Figure 22. Variation of average temperature in 1982-83 El Niño Episode in Hanoi and Dien Bien

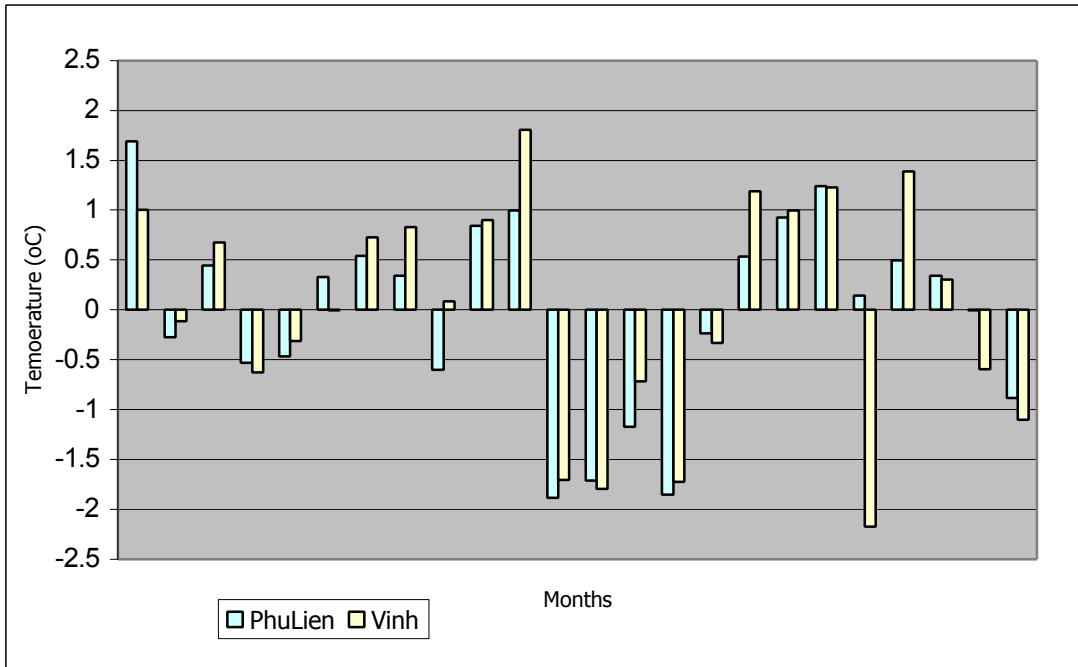


Figure 23. Variation of average temperature in 1982-83 El Niño Episode in Phu Lien and Vinh

Evaporation in 1982 and 1983 was affected partly by the integrated impacts of El Niño in Vietnam (Figure 24).

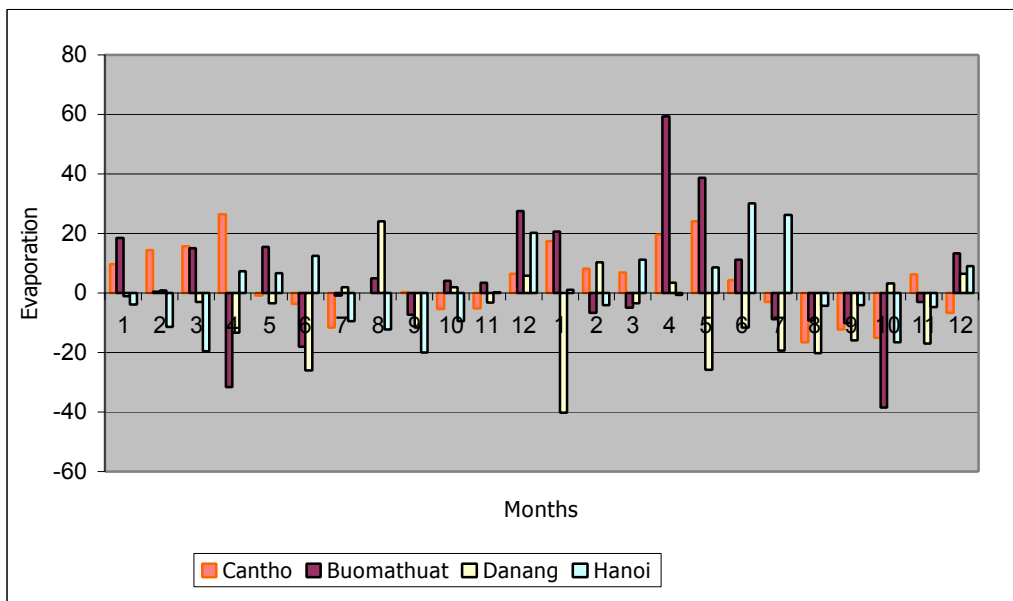


Figure 24. Variation of evaporation anomalies in 1982-83 El Niño Episode in Can Tho, Buon Ma Thuat, Da Nang and Hanoi

The number of tropical cyclones in Western North Pacific in 1982 and 1983 was less than average. For the Eastern Sea and Vietnam, the impact of tropical cyclones was clearly reduced in 1982. However, in 1983 the number of cyclones was not reduced clearly and more than the average occurred as the typhoon season in 1983 was associated with the beginning of La Niña (Figure 25).

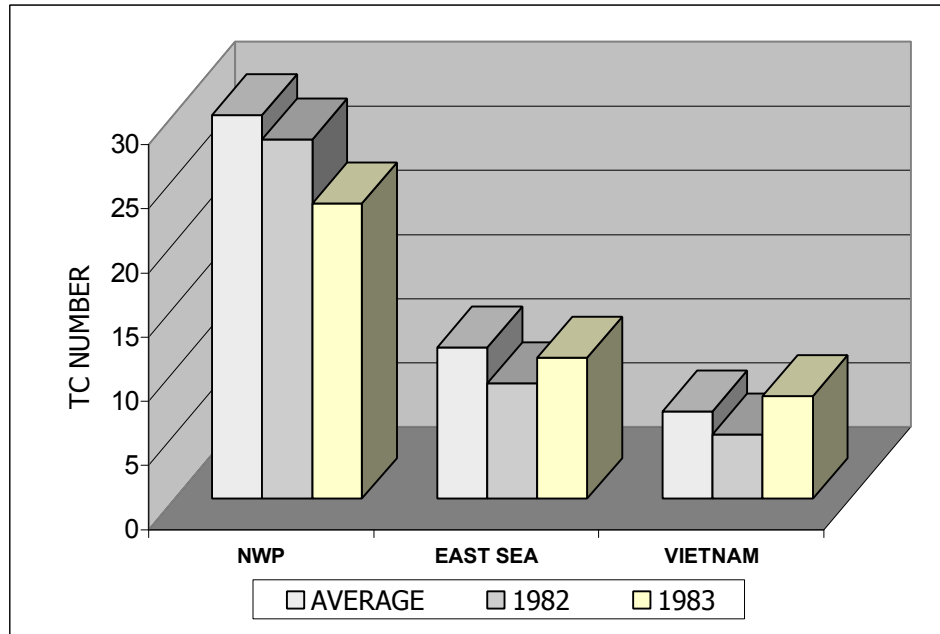


Figure 25. Tropical cyclone number active in 1982-83 El Niño episode

In short, El Niño in 1982 and 1983 had serious effects on Vietnam. The impact of El Niño had been typically that indicated by the anomaly of climate elements including temperature, cloud cover and rainfall. However, according to this assessment, the impact of El Niño in 1982 and 1983 took place 4-5 months later than indicated by the start of the event in the eastern Pacific. The impacts were clear in the South while those in the North were not as well expressed. The impacts on the coastal zone in Central Vietnam were different from those in the South and the North.

2.5 CLIMATE-RELATED ANOMALIES AND IMPACTS OF THE 1997/98 EL NIÑO EVENT

El Niño 1997-98 started in May 1997 and finished around June/July 1998, lasting for 12-13 months. The intensity of the El Niño episode reached its climax in December 1997 until January 1998. Though similar to El Niño 1982-1983, the 1997-98 El Niño in the beginning was stronger and the event finished relatively earlier (Figure 26).

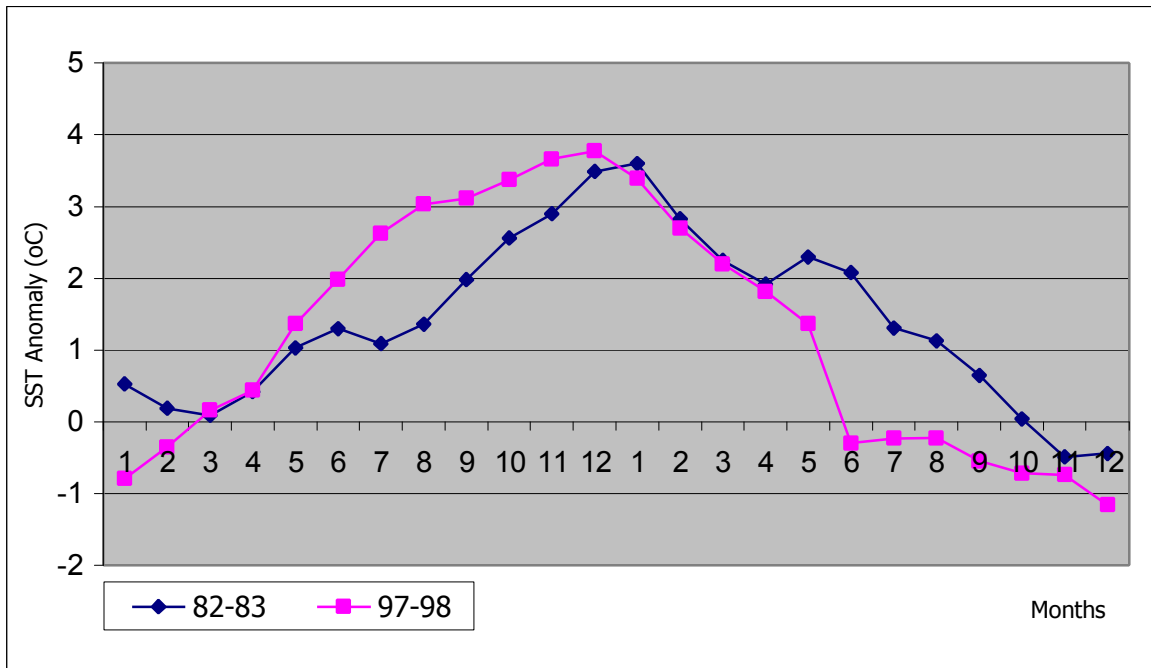


Figure 26. Variation of SST anomalies of NIÑO 3 region in El Niño Episodes

The SOI had some similar properties. However, as shown in Figure 27, El Niño 1997-98 started sooner than normal, from April 1997 *before* the SSTA of NIÑO 3 region passed 0.5°C, and reached its climax later than expected in February 1998. Based on the anomaly of the SOI, the end of the 1997-98 El Niño was in May 1998, which was earlier than for the El Niño 1982-83. Then it changed to a new La Niña episode. This transition was slightly different from the situation following the 1982-83 event. The Walker circulation anomaly in this El Niño episode showed a relatively weaker period, from July to December 1997 after the SOI had reached its first minimum in July 1997. The anomaly of the Walker circulation in its reverse state would have had some specific impacts on the climate anomalies in the western equatorial Pacific in general and Vietnam in particular.

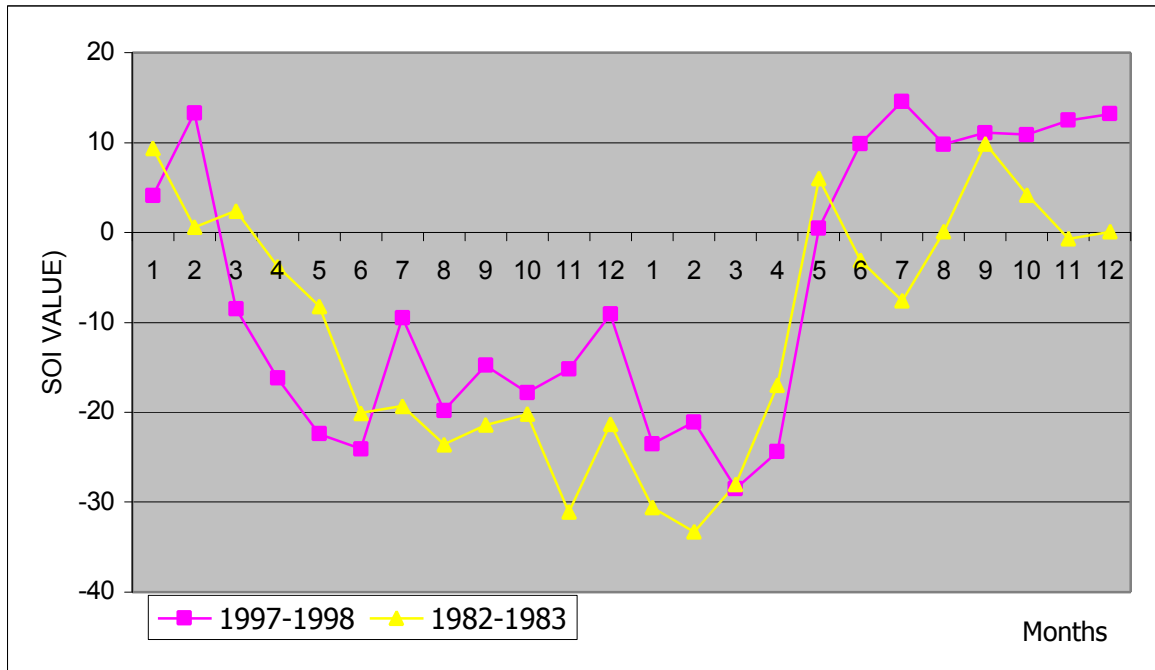


Figure 27. Variation of SOI in 1982-83 and 1997-98 El Niño episodes

The following is the initial assessment on Vietnam's climate, during El Niño, in some of the main regions.

As noted above, the appearance of El Niño affected changes in the Walker circulation in the equatorial Pacific. Under normal conditions, the western equatorial Pacific is where upward motion of the atmosphere dominates. The air mass at low levels from the east is lifted in the west then descends when returning to the east. The upward motion creates condensation caused by the reduction of temperature. Massive clouds are developed, especially cumulous clouds with potential for a high volume of rainfall. Low clouds under the altitude of 2km also have a tendency to form.

When El Niño occurs, the Walker circulation is reduced, even reversed. In the western equatorial Pacific, the upward motion anomaly is decreased notably, even changed to a downward direction due to changes in the circulation. In this area, clouds are developed in great number; cloud cover is relatively high, especially low clouds. Annual rainfall is fairly high. But when El Niño occurs, the cloud cover is reduced; it may even be cloudless in areas of upward motion of the atmosphere. Therefore, clouds are a relatively sensitive climate element with regard to ENSO. Thus, in order to analyze the impact of ENSO in Vietnam, cloud must be analyzed first, especially low clouds.

According to the anomaly of cloud variation, the low cloud amount estimated at the meteorological stations in 1997-98 shows that in the South and southern midlands, low cloud cover decreased from November 1997 - May 1998 with a negative variation indicated at most stations. This proves that, in these areas, the anomaly of convective motion in the atmosphere has decreased remarkably. The overall cloud cover indicates continuously negative variations in March (Figures 28, 29, and 30).

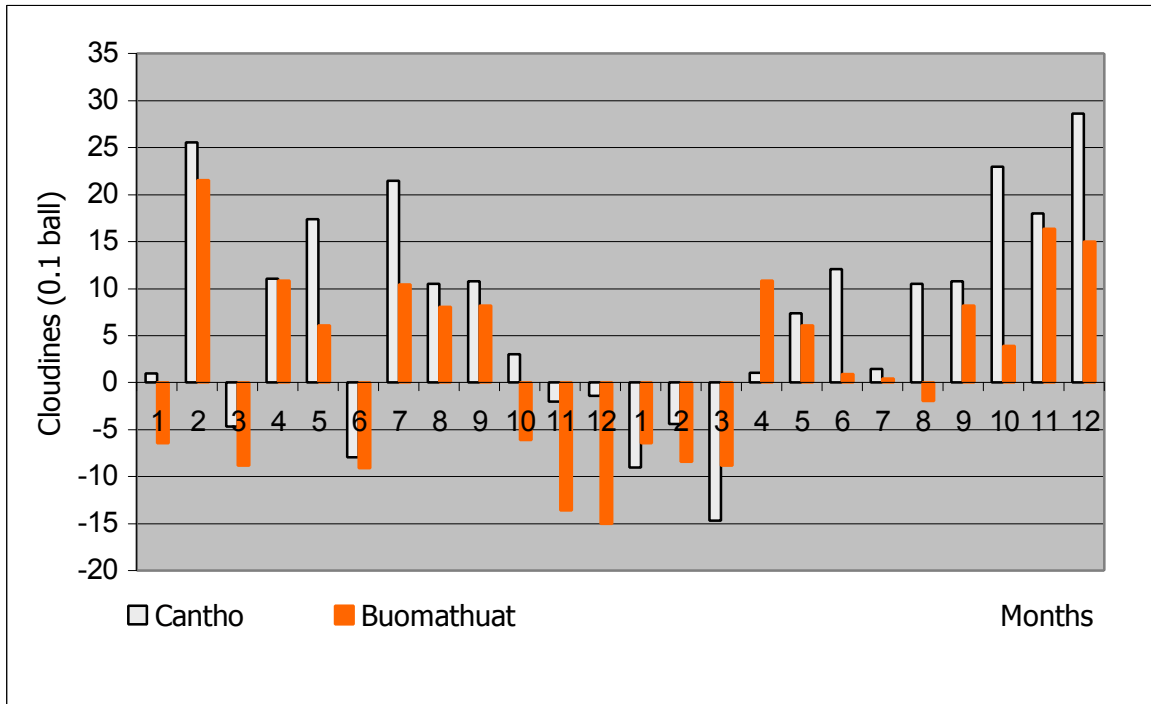


Figure 28. Variation of overall cloudiness anomalies in 1997-98 El Niño Episode in CanTho and Buon Ma Thuat

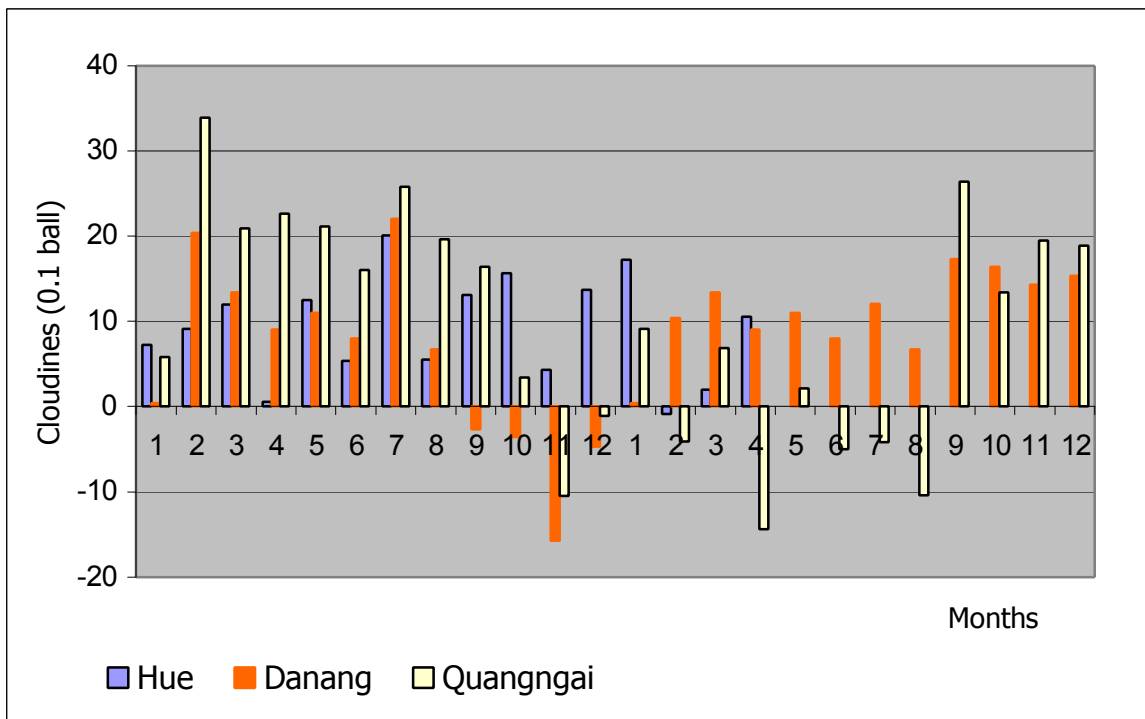


Figure 29. Variation of overall cloudiness anomalies in 1997-98 El Niño Episode in Hue, Da Nang and Quang Ngai

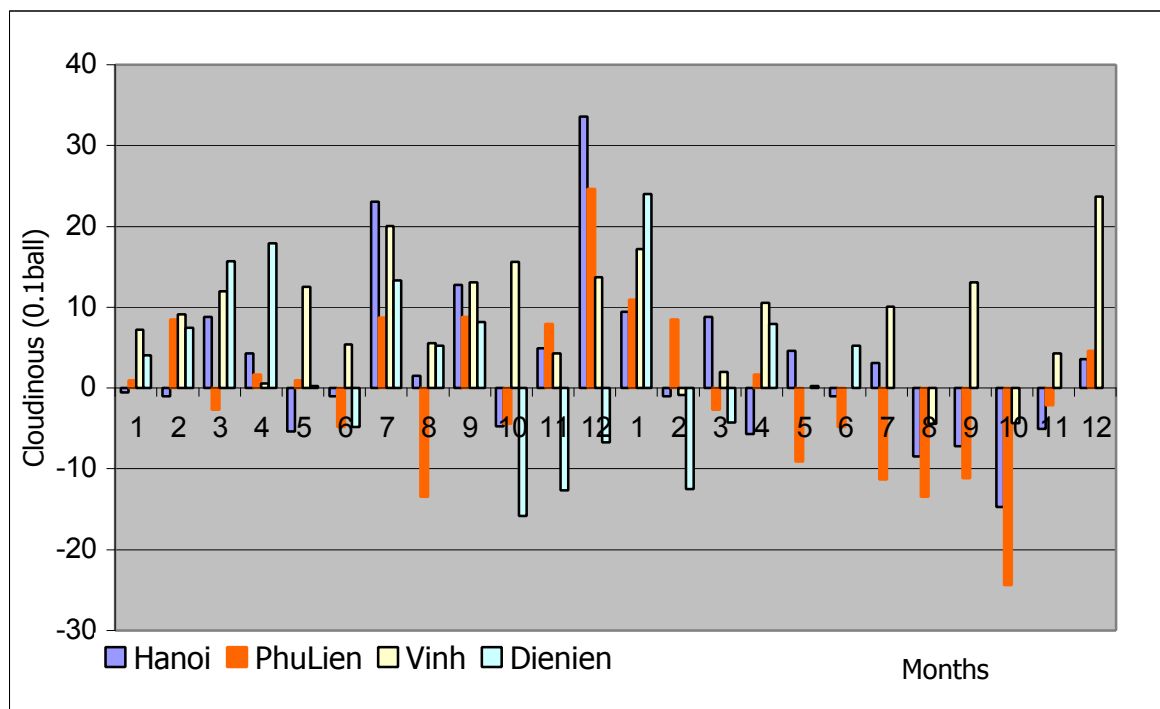


Figure 30. Variation of overall cloudiness anomalies in 1997-98 El Niño Episode in Hanoi, Phu Lien, Vinh and Dien Bien

This was similar to the 1982-83 El Niño—despite the fact that the 1997-98 El Niño was active from May to November 1997; it was only by the end of this year that the impact on Vietnam was clearly seen. This proves that the impact of El Niño 1997-98 was less and happened in a later phase in comparison to the main adjacent areas of the equator in Indonesia, New Zealand and Australia.

Farther to the north, the impact of El Niño 1997-98, as expressed by cloud cover, was not as clear as in the South. In the North, negative variations of low cloud amount also occurred in some months but it was not continuous. This assessment is not true, if only the overall cloud cover is analyzed (Figures 31, 32 and 33). In the coastal zone of Central Vietnam and in the South, the low cloud anomaly clearly expressed the impact of El Niño. Negative variations were estimated in many regions from October 1997 until the end of the episode (May/June 1998). But this property, however, is not shown if assessing the overall cloud cover.

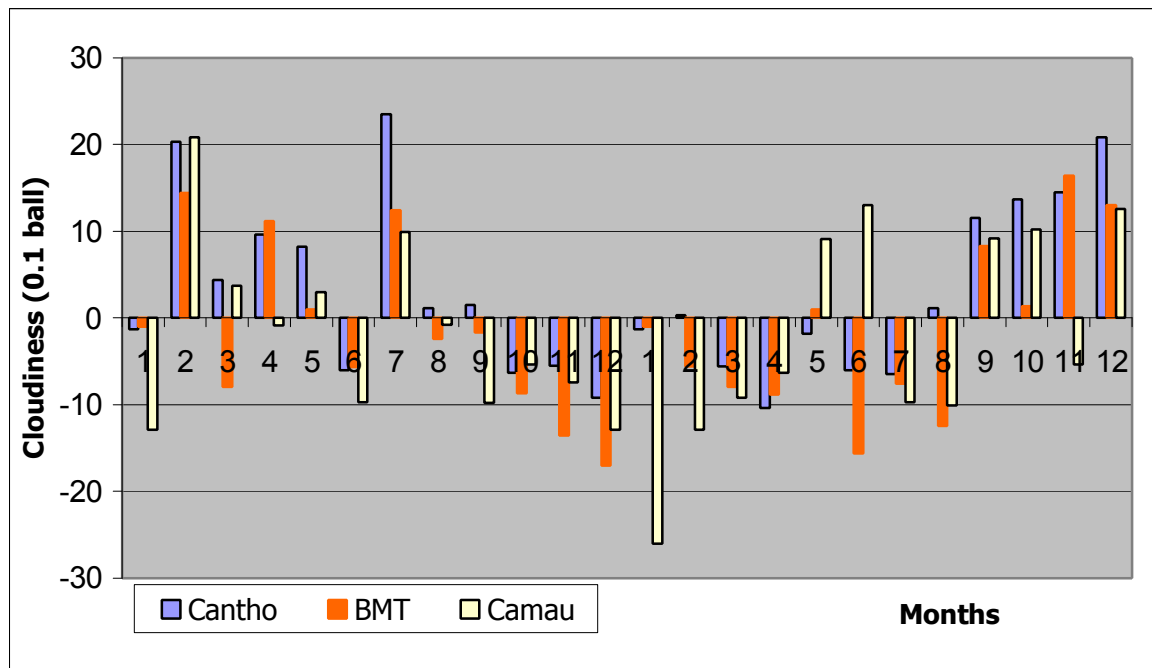


Figure 31. Variation of low cloudiness anomalies in the 1982-83 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

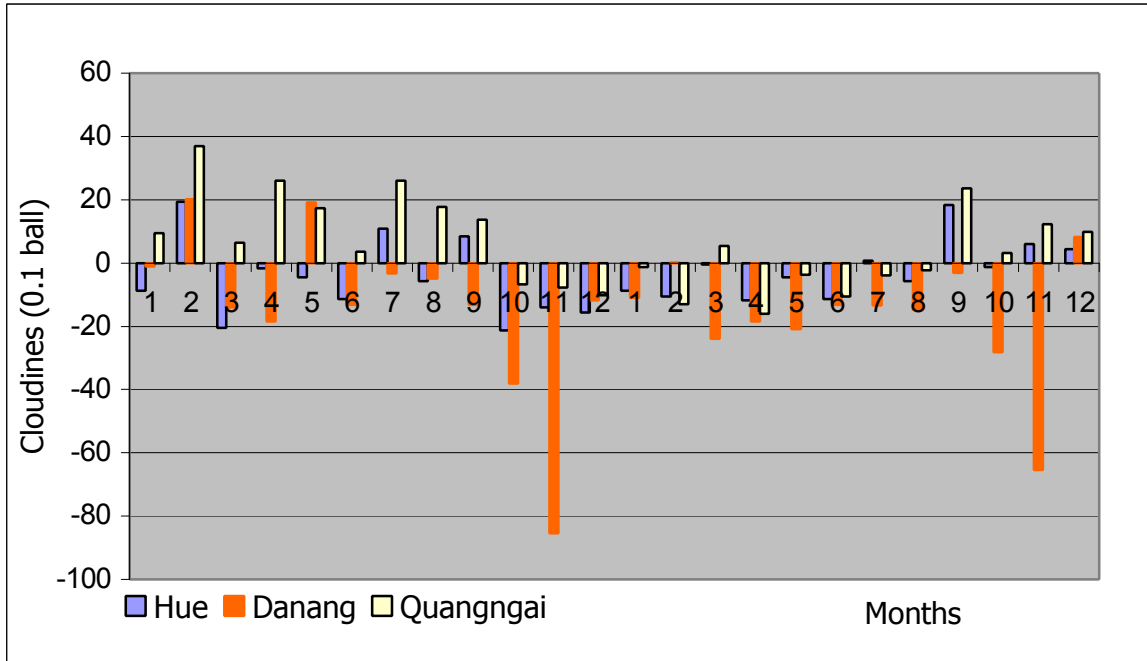


Figure 32. Variation of low cloudiness anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai

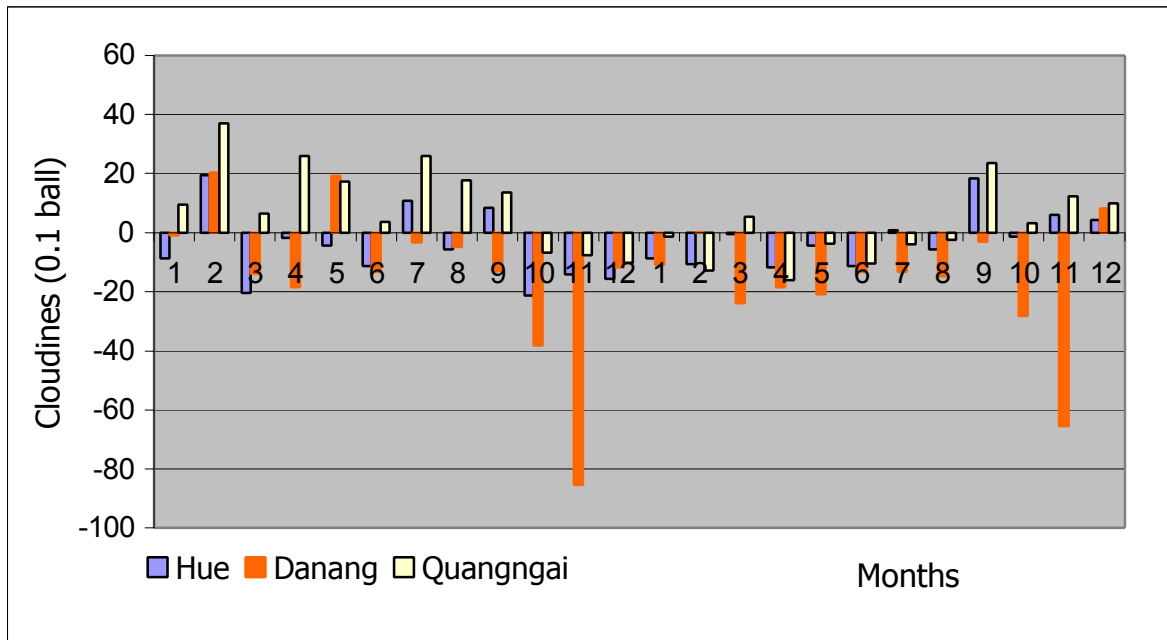


Figure 33. Variation of low cloudiness anomalies in 1982-1983 El Niño Episode in Hue, Da Nang and Quang Ngai

Sea level rise in general and rainfall in particular are other indicators of the anomaly in convection. The convective cloud anomaly is the basis of a different type of rain, particularly heavy showers and high rainfall amounts. Therefore, a decrease in convection in the western branch of the Walker circulation during El Niño episodes will reduce cloud cover, especially low cloud, and decrease rainfall.

An assessment of rainfall variation estimated by meteorological stations in the South and southern plateau shows lower rainfall in comparison to the average during the period of November 1997 to May 1998. In the South and southern plateau, the dry season is the hottest period of the year. The climax occurs in March and May in which May is the beginning of the period where the summer monsoon and rainy season take place. In the coastal zone of Central Vietnam, the beginning of the period is a short period of 'gentle' rain, separated from the main rainy season, which starts from August to September by a hot and dry period caused by weather fronts. After the hot and rainless period, the onset of the rainy season becomes very important to ecosystems in general and agricultural activities in particular. The onset of the rainy season is a relatively sensitive period in the demand for water supplies in many regions in Vietnam, especially in the southern plateau and coastal zone of Central Vietnam. When the rainy season comes late, the dry season lasts longer; and in combination with the climax of the hot period, is likely to cause drought. In the coastal zone of Central Vietnam, the loss of the early 'gentle rain' means the loss of a summer crop (Figures 34 and 35).

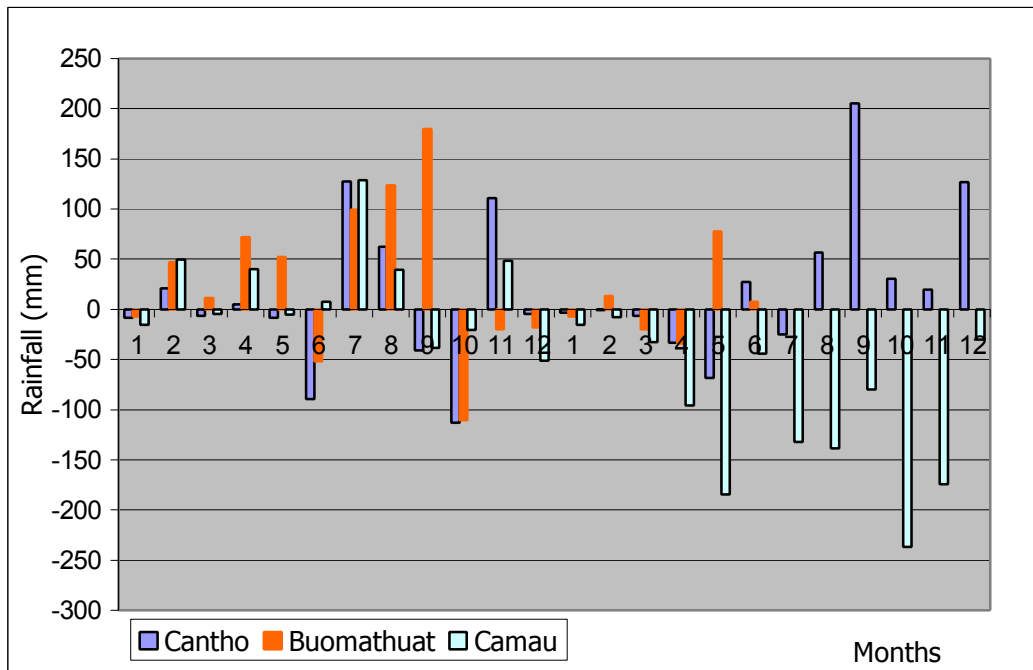


Figure 34. Variation of rainfall anomalies in 1997-98 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

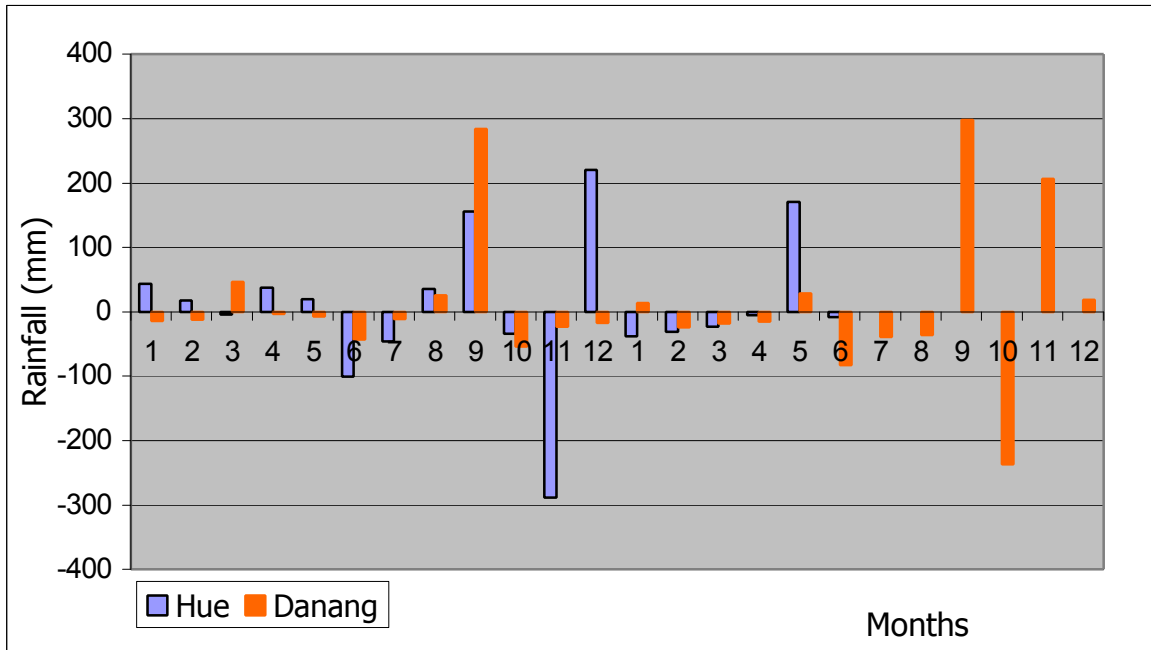


Figure 35. Variation of rainfall anomalies in 1997-98 El Niño Episode in Hue and Da Nang

In the South, low rainfall during the dry season does not affect the balance of water needed in the year, but it does serve to decrease the impact of the hot season in the region. Especially when the water supply in the beginning of a dry season is lost, water needs would be an important consideration. El Niño in this region, however, did not decrease the rainfall of the whole year but greatly affected water needs in the beginning of the rainy season or shortened the rainy season. All of these anomalies caused serious impacts on forest ecosystems and the areas of industrial plantations.

In addition to decreased clouds and rainfall, sunny days are increased as well. This is indicated clearly in the South and southern plateau. Most of the meteorological stations in the South estimated that the sunny hours from November 1997 to June 1998 were all higher than average monitored through years. During this period, December 1997 and January 1998 had the highest perturbations (Figures 36 and 37).

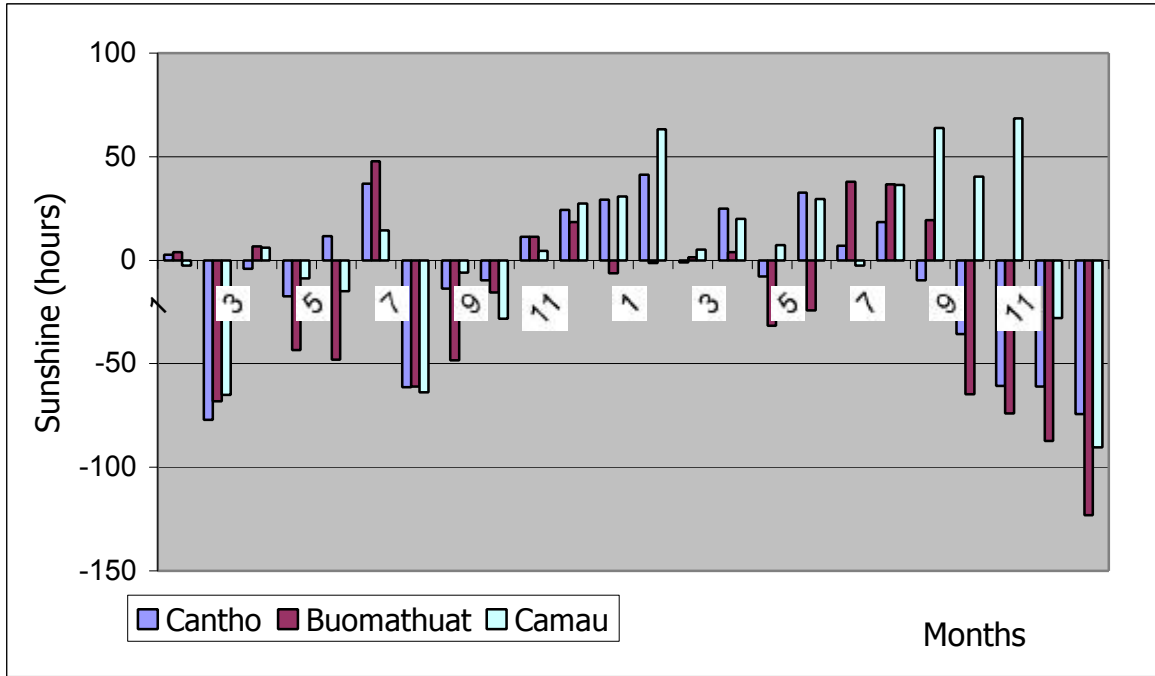


Figure 36. Variation of sunshine anomalies in 1997-98 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

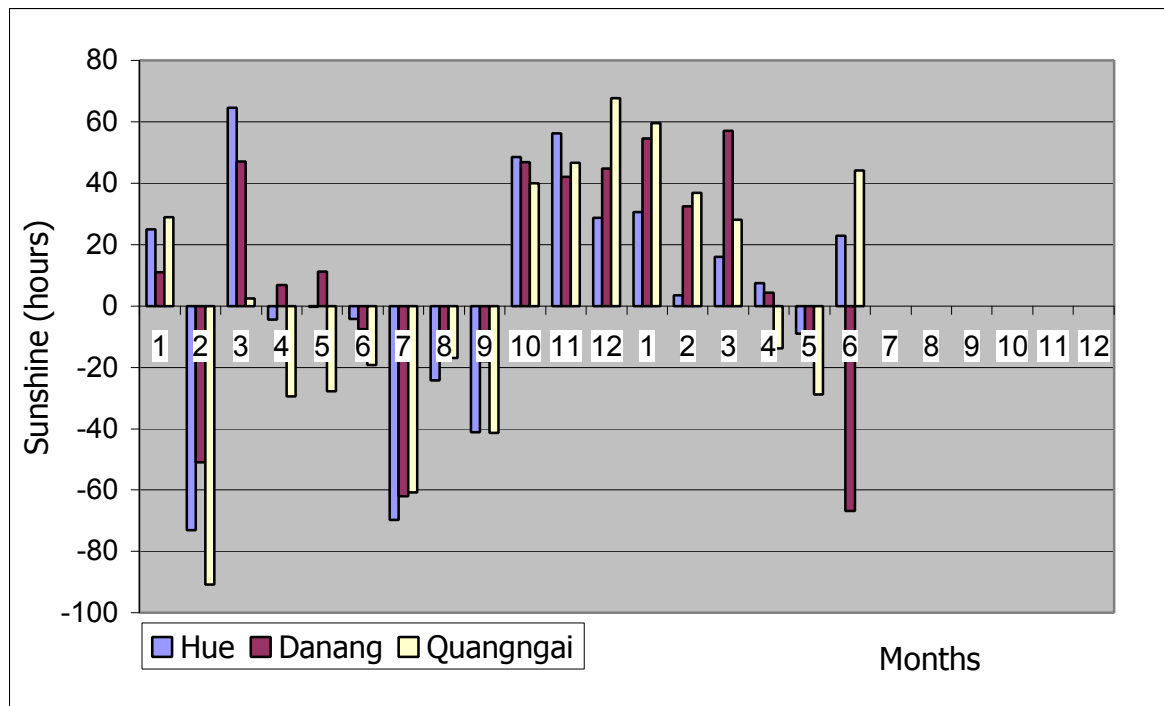


Figure 37. Variation of sunshine anomalies in 1997-98 El Niño Episode in Hue, Da Nang and Quang Ngai

An integrated assessment of these elements has been carried out and shows that there is an increase of temperature in many regions during an El Niño episode. In the South and southern plateau, positive anomalies of temperature began in August 1997 and lasted to August 1998. During this period, temperatures increased rapidly in January and February 1998. Positive variations reached a peak in January 1998. In the coastal zone of Central Vietnam, positive variations were stable from October 1997 to August 1998 and the peak was reached in the first 3 months of 1998. In the provinces of the North, particularly, positive variations lasted for the whole year and did not occur in a concentrated period as happened in the South.

According to an announcement of the World Meteorological Organization, on 16 December 1999, global warming is still occurring and is increasing. The decade of the 1990s had the highest average global temperature in the 20th century. During this decade, the last 5 years reached the highest average temperature. The year 1998, in particular, was the year of peak of global warming in the 20th century with a global temperature anomaly that reached 0.58°C over the 1961-90 mean. This indicates that the atmospheric temperature anomaly in the year 1998 contributed to the global warming process. In many regions, positive variations were not recorded or not clearly expressed. This is shown in the North of Vietnam, as above-mentioned, where El Niño did not greatly affect other climate elements. However, positive anomalies of temperature occurred during 1997-98. The anomalies of temperature in 1997 and 1998 in the South show that, during the El Niño episode (October 1997 to May 1998), the positive temperature anomalies increased remarkably with the peak in January 1998 (Figures 38 to 41).

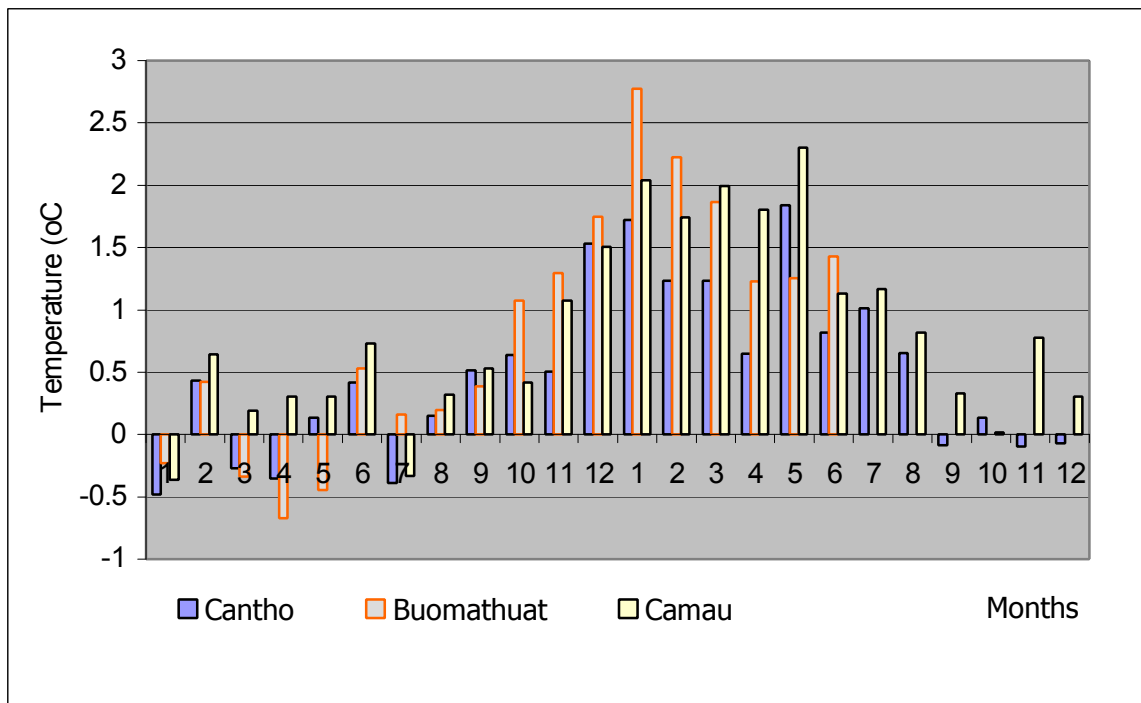


Figure 38. Variation of average temperature anomalies in 1997-98 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

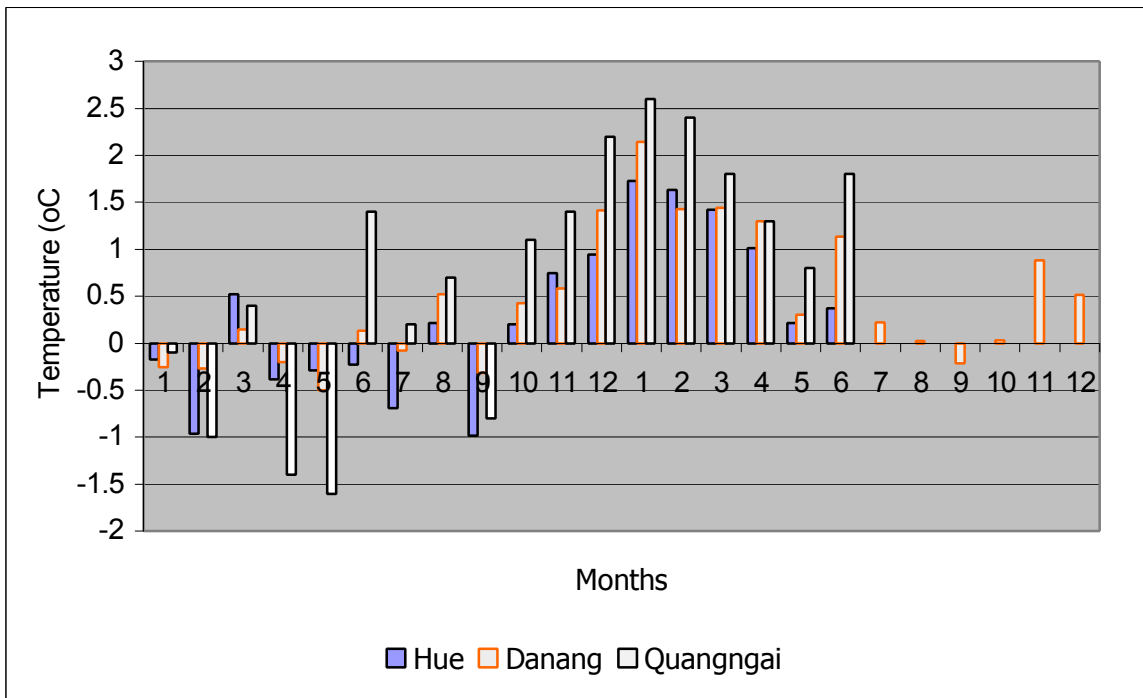


Figure 39. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Hue, Da Nang and Quangngai

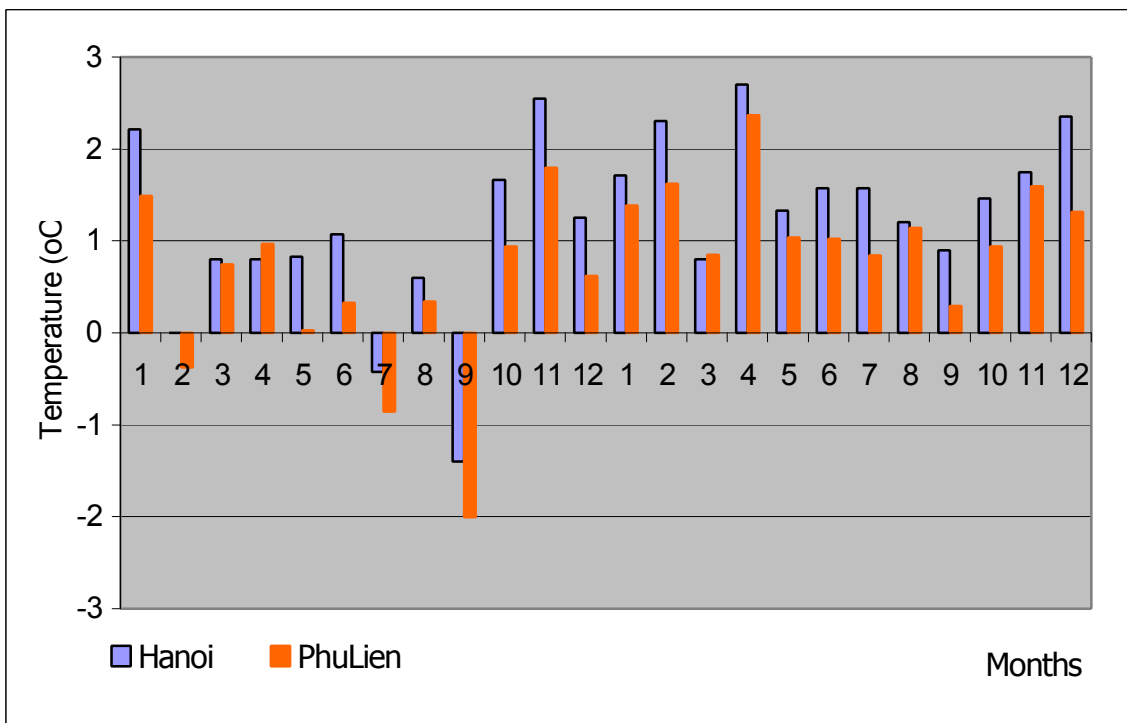


Figure 40. Variation of average temperature anomalies in 1997-98 El Nino Episode in Hanoi and Phu Lien

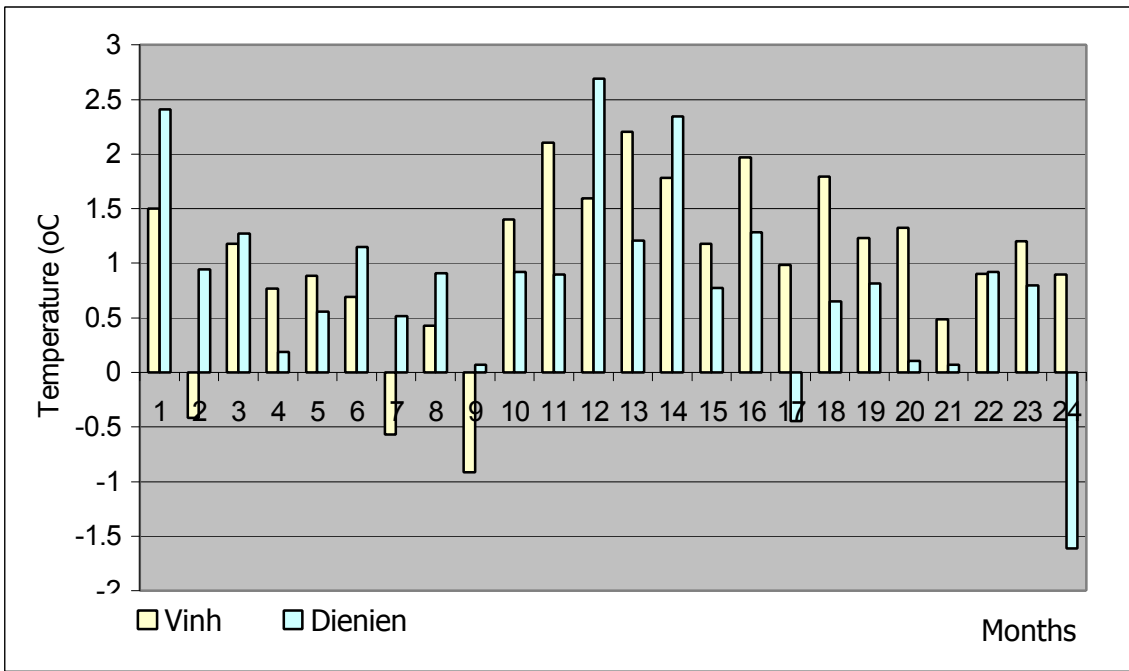


Figure 41. Variation of average temperature anomalies in 1997-1998 El Niño Episode in Vinh and Dien Bien

Due to the increase of radiation and temperature, evaporation also increased from water surfaces. The anomaly of evaporation was evaluated for some meteorological stations in Vietnam. Despite the data from these stations, it is not possible to express the amount of evaporation from the water surface but there is an overview of the anomaly of this element (Figures 42 and 43)

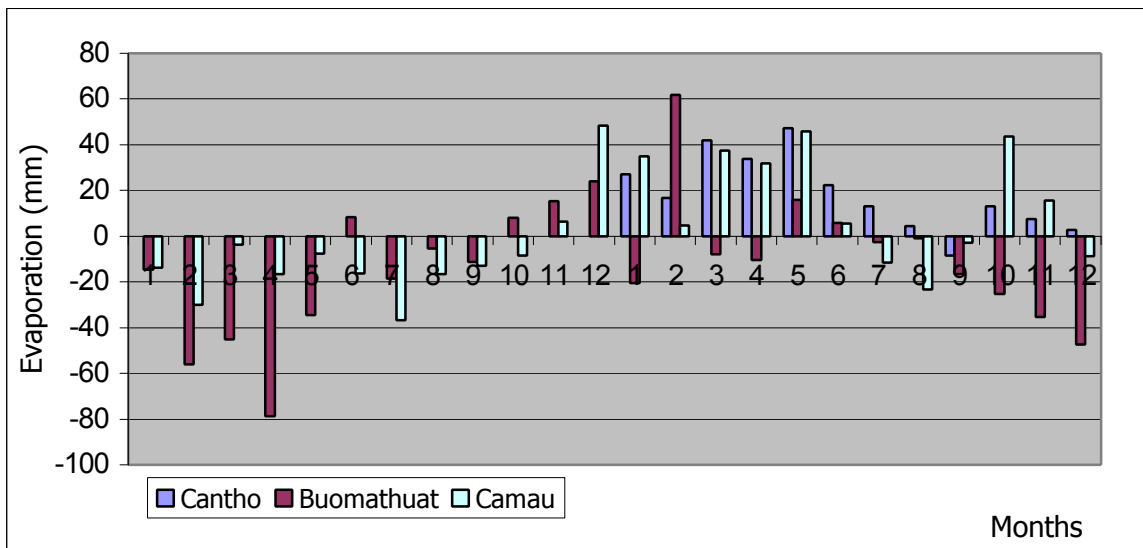


Figure 42. Variation of evaporation anomalies in 1997-98 El Niño Episode in Can Tho, Buon Ma Thuat and Ca Mau

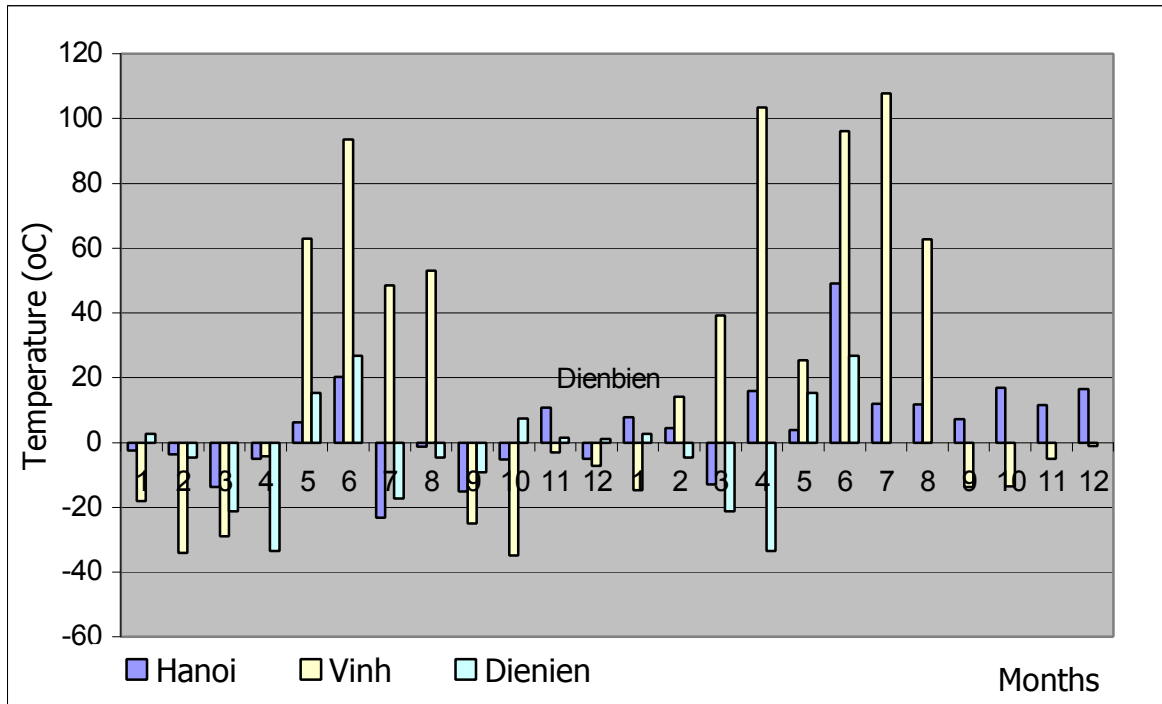


Figure 43. Variation of evaporation anomalies in 1997-98 El Niño Episode in Hanoi, Vinh and Dien Bien

Alongside the basic climatic elements, some of which were analyzed above, El Niño 1997-98 also affected other climatic elements in Vietnam. First of all, the impact of El Niño on tropical cyclones in the Western North Pacific, especially tropical cyclones in the Eastern Sea affecting the Vietnamese territory, was considered (Figures 44 and 45). El Niño 1997-98 started in May 1997. May is the beginning of typhoon season in the Western North Pacific in general and the Eastern Sea in particular. Therefore, in the year 1997, El Niño affected the typhoon season. In the Eastern Sea, the typhoon season came later than normal (in June) when tropical cyclones occurred in the area. [The total number of tropical cyclones in 1997 was less than the average estimated through the years].

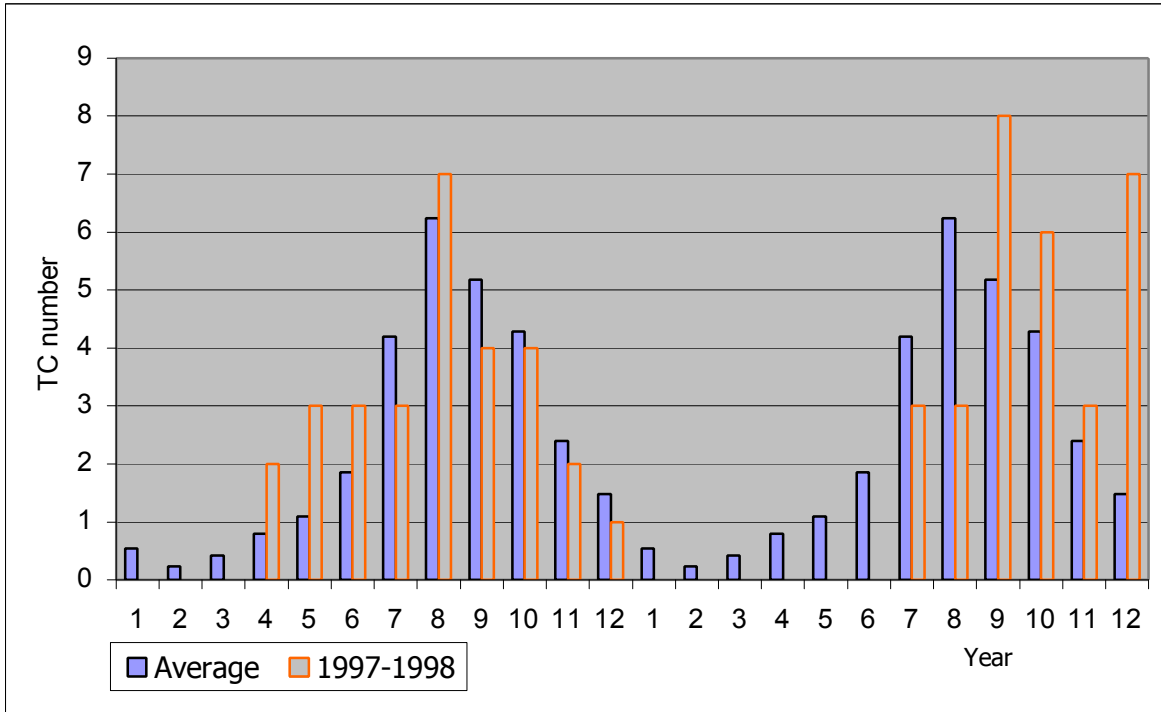


Figure 44. Variation of tropical cyclone number in El Niño episode in the Northwest Pacific

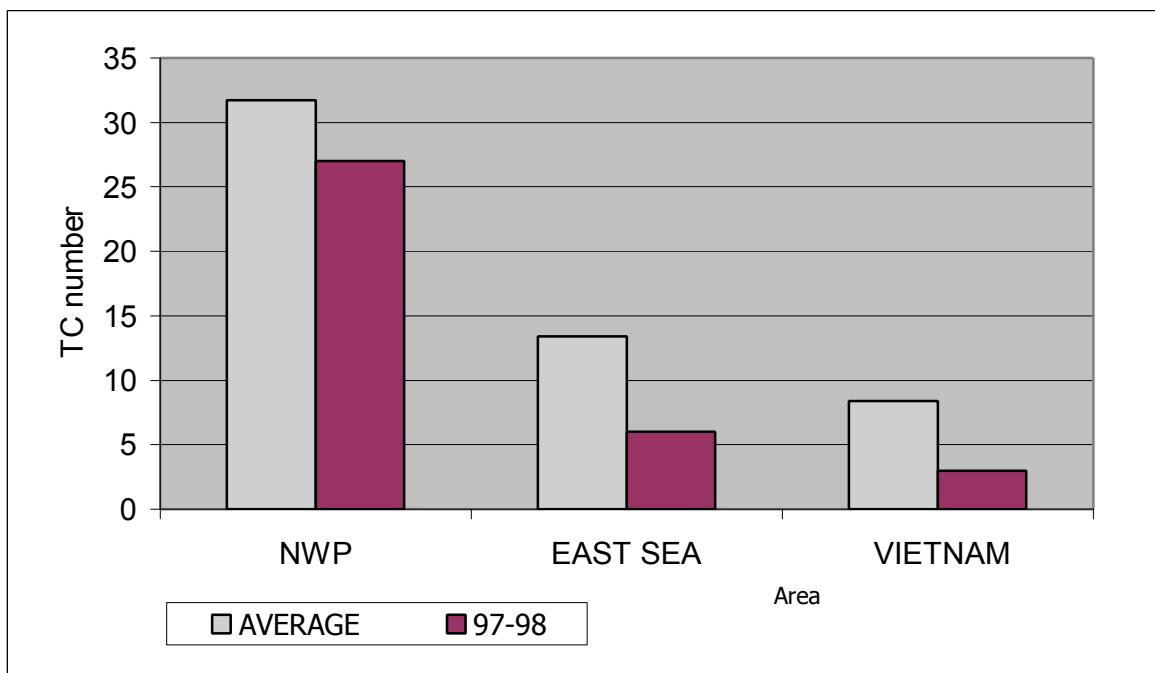


Figure 45. Tropical cyclone number in average and in 1997-98 El Niño episode

Severe Tropical Storm Linda landed on the southern tip of Vietnam on 1 November 1997, with winds among the highest of the 20th century, bringing about the loss of labor productivity and property. Linda was an unusual phenomenon due to the late appearance of tropical cyclones in November in the southern part of the Eastern Sea. As mentioned above, the typhoon season was active in Western North Pacific and the Eastern Sea and lasted from June to November with the peak occurring in August and September. November is the end of the typhoon season in the Eastern Sea with the active center shifted to the south near the Equator.

Tropical cyclones that occur in this region tend to be weak and are considered as low-pressure depressions, especially transversal tropical cyclones that could reach the coast of Vietnam. Because of this, fishermen in Vietnam's coastal zone did not notice the storm. Severe Tropical Storm Linda landed in Vietnam with a high intensity; its highest wind speeds reached force 10. Tropical cyclone landings in the south of Vietnam with force 10 winds are fairly rare. The probability of force 10 winds is about 0.01 or once every 100 years. Although tropical cyclone numbers may be decreased, the appearance of unusual typhoons will generate unpredictable losses.

In 1998, due to the impact of La Niña, the number of tropical cyclones in Western North Pacific in general and in the Eastern Sea in particular has increased in comparison to the year 1997. The impact of El Niño caused the typhoon season in 1998 to begin later than normal.

Overall, during the main part of El Niño (May 1997 to May 1998), the total number of tropical cyclones that occurred in Western North Pacific in general and in the Eastern Sea in particular was lower. Thus, the impacts on Vietnam during the 1997-98 El Niño were weaker than the average estimated through the years.

Drought is a serious climate and is often associated with El Niño. First of all, the decrease in rainfall, especially in the South and the coastal zone of Central Vietnam, occurred in the beginning of the rainy season (the short period of 'gentle rain') and caused the harsh dry season to last for a long time, even extending into the next dry season in the coastal zone of the Central. Along with the decrease in rainfall, continuous rainless periods lasting for many days developed with high temperature and high evaporation and caused the development of drought. El Niño 1997-98 brought about a serious drought that lasted from the end of 1997 to mid-1998 in the South, southern plateau and the coastal zone of Central Vietnam.

The following is a listing of the impact of El Niño and La Niña 1997-98 in Vietnam

Table 1 - The Impact of El Niño and La Niña 1997-98 on Vietnam

Date reported	Event	Description
06/30/97	Sea level rise and high tide	Dike landslides in Bach Long commune, Giao Thuy district and Hai Trieu Commune, Hai Hau district, Nam Dinh Province, 500 meters slide
06/30/97	Heavy rain	20,000 ha of cultivated land flooded in Kinh Mon, Kim Thanh, Thanh Ha, Tu Ky and Chi Linh districts, Hai Duong Province
06/30/97	Water level rise in the rivers, 3 alarm level	Dike collapsed in Ha Nam Province, 1,500 ha of cultivated land completely flooded, 1,500 ha partially flooded
06/30/97	Heavy rain and high tide	2,000 seeded field flooded in Tien Lang, Vinh Bao, An Lao districts, 3,000 ha of paddy land in Hai Phong flooded
06/30/97	Tropical low pressure, water level rise	Effects on paddy land in Mekong Delta
07/10/97	Sunny and hot weather continuously, low water level	Dike collapsed and cracked in Phu Thinh, Mai Dong, Tong Tran districts, Hung Yen Province, Ly Nhan district, Ha Nam Province, Yen Phong district in Bac Ninh Province, Viet Tri district, Ha Tinh district and many others
07/31/97	Lo River level rise	Floods in Tuyen Quang Province, 1000 ha of cultivated land flooded in 34 communes of Chiem Hoa, Ham Yen, Yen Son, Son Duong districts and Tuyen Quang township
09/26/97	Typhoon Fritz	30 houses damaged in Da Nang city
09/26/97	Typhoon Fritz	30 houses damaged in Quang Ngai Province 200 ha of cereal land lost 10 boats sunk, 7 broken, 3 stranded TV station, cultural house, schools, police station and households broken-down in Quang Ngai Province

Date reported	Event	Description
11/05/97	Typhoon Linda in Cau Mau	27 people dead in Ca Mau Province 130 people missing 133 people wounded in Ca Mau 19500 ha of paddy land rotten, 4,400 ha. of aquacultural farming destroyed 84 boats sunk and damaged
11/05/97	Typhoon Linda in Kien Giang	39 people dead 217 people missing 18 people wounded 2427 houses dilapidated, 76 school classes, 4 warehouses destroyed 1031 boats missing
11/05/97	Typhoon Linda in Bac Lieu	9 people dead 10 people wounded 17000 houses damaged 47000 ha of paddy land with rotting crops
11/05/97	Typhoon Linda in Dong Thap	3 people dead 10 people wounded 300 houses damaged 2000 ha of garden rotted
11/05/97	Typhoon Linda in Ben Tre	14000 ha of sugarcane rotted Road damaged and destroyed affecting transportation
11/05/97	Typhoon Linda in Tra Vinh	200 houses damaged 6 boats sunk Road flooded to 0.8 meter, 100 km of highway damaged
11/05/97	Typhoon Linda in Soc Trang	153 meters of dyke destroyed, 100 km of sea dyke landslide, flooding in broad areas
11/05/97	Typhoon Linda in Tien Giang	16 boats sunk 105 meters of stone embankment damaged in Tien Giang Province
11/05/97	Typhoon Linda in Can Gio, Ho Chi Minh City, sea level rise	11 people missing 142 houses destroyed

Date reported	Event	Description
11/05/97	Typhoon Linda in Ba Ria, Vung Tau	248 houses flooded
11/05/97	Typhoon Linda in Ba Ria, Vung Tau, Con Dao island	383 houses destroyed
03/07/98	Whirlwinds in the South	Whirlwinds broke 4,128 rubber trees during harvesting. The hot drought lasted for a long time; 5064 rubber trees dead; 4000 ha lost leaves; lost 1200 tons of latex
07/03/98	High rainfall in Muong Te, Lai Chau Province, 372mm in 10 days	Flash floods in Yen Bai, Lao Cai, Lai Chau. In June in Hanoi the rainfall reached 614 mm, 155.8% compared to average annual. In Central average rainfall volume about 100-105 mm, in Ho Chi Minh city from 21 to 30 June is 233mm
07/14/98	Water level rise in the Red River, Hanoi, 10.97m	Flooding in residential areas
07/14/98	19-30 June, flash flood on highway No32	50000 m ³ landslide in Lao Cai and Yen Bai Provinces
07/21/98	Low water level in the Red River, Thai Binh, Pha Lai	Low water level in the reservoirs
07/21/98	Dry and hot weather in the Central, low rainfall	23600 ha of summer crops affected by drought in the Central Lack of water supply in parts of Ha Tinh, Quang Binh and Quang Tri
07/22/98	Drought in the Central region	7000 ha in Quang Binh, 10,000 ha in Quang Tri and 7000 ha in Ha Tinh and 15000 ha in Hung Yen affected 31 shallow reservoirs in Quang Binh

Source: *The People* newspaper in 1997 -1998

Table 2 - Loss caused by disasters in 1997

Events	Date reported	Affected Provinces	Description
River Flood 5 November 1997	05-Jan-98	Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa	Flood in the central part of Vietnam, resulting in 28 people killed, 983 houses destroyed and over 10,000 ha of paddy destroyed
Typhoon Linda 1 November 1997	06-Jan-98	An Giang, Ba Ria - Vung Tau, Bac Lieu, Ben Tre, Binh Dinh, Binh Thuan, Ca Mau, Can Tho, Dong Thap, Ho Chi Minh City, Khanh Hoa, Kien Giang, Long An, Ninh Thuan, Phu Yen, Quang Binh, Quang Ngai, Soc Trang, Tien Giang, Tra Vinh, Vinh Long	Major disaster in the southern tip of Vietnam with 778 people killed and 2132 people missing. Over 300,000 houses and almost 22,000 ha of paddy destroyed. Economic damage almost US\$600 million
Flash Flood 5 October 1997	10-Oct-97	Yen Bai	1 person killed, 4 houses destroyed
River Flood 25 September 1997	25-Sep-97	Binh Thuan	2 persons killed, 78 houses destroyed
Typhoon Fritz 25 September 1997	02-Oct-97	Da Nang, Quang Ngai, Quang Nam, Hue, Quang Tri, Quang Binh, Kon Tum	Typhoon in the central part of Vietnam resulted in 42 people killed, 2 persons missing and 482 houses destroyed
Storm 4 September 1997	05-Sep-97	Quang Nam	1 person killed, 8 injured and 168 houses destroyed
Storm 1 September 1997	10-Sep-97	Phu Tho	1 person killed
Flash Flood 29 August 1997	10-Sep-97	Lai Chau	26 houses destroyed in the North of Vietnam
River Flood 28 August 1997	28-Aug-97	Soc Trang	74 houses destroyed and more then 5000 ha of paddy destroyed
Storm 23 August 1997	29-Aug-97	Ca Mau	2 persons killed and 9 persons missing. 500 ha of paddy destroyed
River Flood 23 August 1997	23-Sep-97	Quang Nam	River flood in Quang Nam
Typhoon Zita 23 August 1997	26-Aug-97	Ha Noi, Hai Phong, Lang Son, Ha Tay, Hai Duong, Hung Yen, Ha nam, Thai	6 persons killed and over 4500 ha of paddy destroyed

Events	Date reported	Affected Provinces	Description
		Binh, Thanh Hoa, Binh Dinh	
Storm 20 August 1997	25-Sep-97	Nghe An	2 persons killed and 7 persons missing
Flash Flood 20 August 1997	27-Aug-97	Kien Giang	405 houses destroyed
River Flood 18 August 1997	18-Aug-97	Phu Tho	9 persons killed, over 6800 houses destroyed and over 4000 ha of paddy destroyed
Flash Flood 11 August 1997	11-Aug-97	Lai Chau	78 houses destroyed
River Flood 9 August 1997	09-Aug-97	Dong Thap, An Giang	12 persons killed, 5238 houses destroyed and over 3000 ha of paddy destroyed
Typhoon Victor 7 August 1997	07-Aug-97	Binh Thuan	3 persons killed and 1 person missing
Storm 3 August 1997	13-Aug-97	Can Tho	48 Houses destroyed
Storm 3 August 1997	03-Aug-97	Thai Binh	9 schools destroyed
River Flood 31 July 1997	31-Jul-97	Ha Noi, Hai Phong, Vinh Phuc, Bac Giang, Bac Ninh, Hai Duong, Hung Yen, Nam Dinh, Ha Nam, Ha Tay, Ninh Binh	1915 houses destroyed. Over 53,000 ha of paddy inundated
Flash Flood 30 July 1997	01-Sep-97	Son La	1 person killed and 96 houses destroyed
Hail Storm 30 July 1997	30-Jul-97	Lao Cai	2 persons killed and 151 houses destroyed
Flash Flood 28 July 1997	28-Jul-97	Binh Phuoc	1 person killed and 635 houses destroyed
Flash Flood 22 July 1997	30-Jul-97	Lao Cai, Thai Nguyen, Tuyen Quang	2 persons killed and 13 houses destroyed
Hail Storm 21 July 1997	08-Apr-97	Ninh Binh	2 persons killed
Hail Storm 15 July 1997	05-Aug-97	Ben Tre	15 houses destroyed
Flash Flood 9 July 1997	01-Oct-97	Bac Can, Lai Chau, Yen Bai, Ha Giang, Son La	1 person killed and 111 houses destroyed
Flash Flood 24 June 1997	01-Aug-97	Lai Chau	15 houses destroyed
Hail Storm 14	25-Jun-97	Lam Dong	2 persons killed and 11

Events	Date reported	Affected Provinces	Description
June 1997			houses destroyed
Hail Storm 7 June 1997	19-Jun-97	Phu Tho	53 houses destroyed
Flash Flood 2 June 1997	01-Aug-97	Lai Chau	7 persons killed
Hail Storm 1 June 1997	26-Jul-97	Ha Giang	1 house destroyed
Hail Storm 19 May 1997	19-May-97	Cao Bang	24 persons injured and over 5000 houses damaged
Hail Storm 17 May 1997	30-May-97	Phu Tho	1 person killed and 5 houses destroyed
Hail Storm 13 May 1997	27-May-97	Quang Nam, Quang Tri	3 persons killed and 117 houses destroyed
Hail Storm 8 May 1997	30-May-97	Ha Tay	2 persons injured and over 1000 houses damaged
Hail Storm 4 May 1997	04-May-97	Quang Ngai	45 houses destroyed
Hail Storm 4 May 1997	12-May-98	Cao Bang, Vinh Phuc, Lang Son	1 person killed and 6 houses destroyed
Hail Storm 1 May 1997	01-May-97	Lam Dong	5 persons killed and 33 houses destroyed
Hail Storm 1 May 1997	01-Aug-97	Lai Chau	135 houses destroyed
Hail Storm 24 April 1997	24-Apr-97	Son La	7 houses destroyed
Hail Storm 23 April 1997	23-Apr-98	Ha Tinh	7 persons killed and 511 houses destroyed
Hail Storm 21 April 1997	21-Apr-98	Thai Nguyen	1 person killed and 31 houses destroyed
Hail Storm 17 April 1997	18-Apr-98	Quang Binh, Nghe An	7 persons killed and 375 houses destroyed
Hail Storm 13 April 1997	13-Apr-97	Vinh Long	26 houses destroyed
Hail Storm 6 April 1997	01-Apr-98	Son La, Phu Tho	4 persons killed and 289 houses destroyed
Hail Storm 3 April 1997	03-Apr-98	Hoa Binh	16 houses destroyed
Hail Storm 1 April 1997	01-Apr-98	Ha Giang, Lang Son, Vinh Phuc	80 houses destroyed

Events	Date reported	Affected Provinces	Description
Flash Flood 27 March 1997	08-Jan-97	Lai Chau	Paddy inundated and fish ponds destroyed
Hail Storm 17 March 1997	17-Mar-97	Ha Tinh	1 person killed and 9 houses destroyed
Flash Flood 17 March 1997	08-Jan-97	Lai Chau	21 houses destroyed
Hail Storm 16 March 1997	16-Mar-97	Ha Giang, Tuyen Quang, Bac Can, Son La	6 persons killed and 125 houses destroyed
Hail Storm 5 January 1997	27-Jan-97	Thanh Hoa	2 persons killed

Source: UNDP Disaster Management Unit, Vietnam

According to the above assessment, the following conclusions can be made:

- El Niño 1997-98 was one of the strongest in the 20th century. It was relatively similar to El Niño 1982-83 and lasted about 13 months from May 1997 to May 1998. It ended quickly and the sea surface conditions were conducive to a La Niña episode.
- El Niño 1997-98 had serious impacts on Vietnam, especially in the South of Vietnam of which Mekong Delta and southern plateaus are typical regions.
- The typical impact was a decrease in cloud cover and, therefore, convective cloud formation, accompanied by a decrease in rainfall and in the total number of rain days. There was also an increase in radiation at the ground and in air temperatures.
- Besides the surface temperature anomaly due to the impact of the 1997-98 event, it is necessary to consider extreme phenomena considered as disasters, e.g., tropical cyclones and drought.

The impact of El Niño 1997-98 on socio-economic conditions in Vietnam is highlighted in the following paragraphs.

Tropical cyclones. The landfall and impact of Severe Tropical Storm Linda was one of the extreme phenomena in El Niño 1997-98. This storm resulted in 4,502 people dead and missing, the highest number of injured people. There were 440,000 ha of paddy land lost of which 330,000 ha were seriously damaged. 133,000 houses were seriously destroyed. Total losses reached into the thousands of billions VND.

Drought. Drought occurred in 1997-98, concentrated mostly in 1998 and had serious impacts, especially on forestry and industrial farming. According to an assessment of the Ministry of Agriculture and Rural Development (estimated to May 1998), 74,400 ha of coffee farms in the southern plateau region were lost of which 14,000 ha has been totally lost. The southwest area had 2,300 ha of coffee farms lost, of which 1,300 ha were totally lost. The area of paddy land lost to drought in the southern plateau was 5,200 ha and that of southwest 2800 ha. The lack of water

caused by low rainfall and high evaporation caused an increase in the area of salty land in the Mekong Delta. In the whole Mekong Delta, 15,900 ha of winter crop were lost to drought and salt water encroachment of which 7,777 ha were completely lost and 7,100 ha lacked of water.

In the coastal zone of Central Vietnam, serious drought occurred. Drought statistics show winter crops lost from Nghe An Province in Central Vietnam to Binh Thuan in the South. The northern half of the south was not affected by El Niño. Based on the monsoon anomaly, the impact of the monsoon affected many provinces in the North. The impact was indicated by drought in 1997-98. In the North and in Thanh Hoa Province, there were 4,200 ha of paddy land lost. The total loss because of drought in 1997-98 was estimated at 5,000 billion VND. According to a NOAA assessment, the number of households affected by El Niño in Vietnam was about 600,000 and the total population of these households is about 3 million people. Total paddy land lost was 64,008 ha, with a total loss predicted to be around 407 million USD.

Forest fires. Forest fire was another serious consequence for Southeast Asian countries during the 1997-98 El Niño. In Vietnam, damage by forest fires was less than in Indonesia, Malaysia, and the Philippines. Nevertheless, the forest fire destruction was still serious. In the first six months of 1998, there were 60 forest fires in Dong Nai, damaging 1,200 ha of forest; at the same time, in Daklak Province, the area of forest fires was estimated at about 320 ha. In the South, the statistics were not available but the amount of cajuput forest lost was about 1,000 ha during two years (1997 and 1998).

Fishing and ecosystem in the coastal zone. There are no statistics on fishing and ecosystem loss but, according to an integrated assessment, both of these were affected considerably. [In the Vietnamese Territorial Sea, there are 4 sea level rise areas and 2 low sea surface areas in winter and those of summer are 3 and 1, respectively]. In El Niño years, surface water temperature is higher than normal and, in the winter, it is lower. This situation affects the reproduction of many fish species such as sardine and reduces productivity on the fishing grounds. This El Niño also affected wetland ecosystems, especially the mangrove forests in the Mekong Delta. Salt water encroachment occurred both in river basin and along the coast damaging the habitat of some fresh-water species and broadening the habitat of marine and brackish water species.

Water resources. In many countries, water is a valuable resource. Water is used in many fields both in livelihoods and productions. Lack of water affects agricultural production, power generation, etc. Livelihoods and urban areas are mainly affected. Vietnam has abundant water resources but is still in its developing phase. Thus, pressure on water resources is not a major consideration nowadays. However, in some specific areas and at some specific times, serious situations occur. According to a study of Tran Thanh Xuan, in El Niño years, water reserves in the river and stream basins and rainfall over most of Vietnam decrease. Drought occurred in all three regions of Vietnam (North, Central and South). This situation seriously decreased the ability to supply water for many kinds of needs during El Niño.

Water supply for the winter crop (1997-1998) had many difficulties. Being not able to supply water for irrigation in rice and other cereal crops, there were thousands of hectares of paddy land damaged, even completely lost to production. Industrial plantations, of which coffee is the main

one, were lost due to a sustained lack of water lasting for several months leading to thousand coffee farms damaged, even lost in the southern plateau and Southeast region. Other industrial plantations such as pepper, rubber, and tea, specifically in the southern plateau and southeast region and the coastal zone of Central Vietnam, were affected. Agricultural productivity was reduced by the lack of sufficient water supply and hot weather and no rain.

Electricity in Vietnam is generated by many large hydroelectric plants. The contribution of hydroelectricity plants is about 60% of the total electricity generated in the country. Therefore, difficulties in the production at these plants affect the operation of the national electricity grid. During the 1997-98 El Niño, at many reservoirs of Hoa Binh, Tri An, and Thac Ba hydroelectricity plants, the water levels had decreased to alarming levels. As a result, these plants had to reduce their power production. As this electricity is transferred to the National Electricity Network, serious power cuts occurred in both the North and the South of Vietnam. The situation caused serious impacts on production and livelihoods in many regions, especially in the big cities and industrial zones such as Hanoi, Ho Chi Minh City, Da Nang, and Bien Hoa. The total loss has not as yet been evaluated completely but the amount is predicted to be considerable.

Water supply for both domestic and industrial production needs in urban and residential areas is taken from surface and underground water. El Niño caused extreme drought in many regions, affecting riverflow and reducing the underground water level in most regions and affecting the production of winter crops. Therefore, an already difficult water supply in Hanoi became a more serious problem in the first months of summer 1998. Lack of water supply for both domestic and industrial uses occurred in many areas. Other cities faced the same situation. In some rural areas in Central Vietnam and the southern plateau, prolonged drought occurred causing an extended lack of water supplies. In some locations, trucks had to be used to transport water.

Health. The 1997-98 El Niño affected livelihoods and production directly and indirectly, one aspect of which—human health—is one of the most important. Disasters, like those mentioned above, that are all related closely to El Niño resulted in more than 5000 dead and thousand people injured. That is the most serious loss of life as a result of a natural hazard (e.g., El Niño) in Vietnam recently. Drought did not cause hunger related directly to El Niño but it did happen in some areas. Along with lack of water, lack of food had many negative effects on human health in the southern plateau, the coastal zone of Central Vietnam and in some regions in the mountainous areas of the North and in the Mekong Delta.

In addition to illnesses created by the lack of food and water supplies, some diseases became epidemics during 1997-98. The outbreak of these diseases can be related to climate anomalies. They are diseases caused by hot weather that lasts for a long time. This hot period lasted for several months to the end of spring and early summer in 1998. Outdoor temperatures reached 35-37°C in March to May in the South and some areas in the southern plateau, and in May to July in the coastal zone of Central Vietnam and the North. In combination with high radiation caused by cloudless weather, temperatures increased. Hot weather causes loss of temperature balance and effects on excretion, water balance and salt elements in the body.

The endemic disease related closely to El Niño is dengue fever. According to a study of Tran Viet Lien, El Niño has a close relationship with the spread and development of dengue fever in Vietnam and in 1997-98 the disease spread to the whole country. As estimated by archival statistics of the Ministry of Health, 233,661 people caught dengue fever in Vietnam. Dengue fever spread starting in the South in 1997 where the number of dengue fever cases reached 109,463. In 1998, the disease continued to spread seriously into the coastal zone of Central Vietnam and the North. Ben Tre Province had the highest number of patients, 24,562 people; Dong Nai and Ha Tinh provinces reached over 10,000 people. The rate of dengue fever patients in 100,000 is about 300 (0.3%). The peak of the disease occurred in the summer/fall of 1998. In comparison to either the average estimated for years or the estimation for 1996, the death rate due to dengue has multiplied. This supported the conclusion of a study by Dr. Tran Viet Lien carried out in 1995-1997 (Tran Viet Lien, 1999) to develop a forecast model for the disease in Vietnam based on the climatic data and statistical estimates of the Climate Research Center, Institute of Meteorology and Hydrology (see *tables 1 and 2 also*).

2.6 RELIABILITY OF ATTRIBUTIONS OF DISASTERS TO EL NIÑO

It is not possible to be absolutely confident in attributing the occurrence of a particular weather phenomenon to a large-scale, long-term process such as El Niño. In the case of Severe Tropical Storm Linda, for example, there has been much debate regarding whether or not this was an El Niño-related event. On the one hand, storm occurrences tend to be reduced during El Niño events and many factors, not just El Niño, control individual storms. On the other hand, there is some evidence that storms that form and develop close to the Vietnamese coast may be more frequent during El Niño years. In the case of the longer-term departures from normal, such as low seasonal rainfall and high seasonal temperature, considerable confidence can be placed in the attribution to El Niño. As far as shorter-term or local perturbations are concerned, attribution is far less certain. When identifying secondary, socio-economic impacts resulting from the effects of climate, attribution becomes even more complicated as levels of sensitivity and vulnerability are determined by numerous factors, and those factors can change over time.

3 RESPONSES

3.1 GOVERNMENT REPORTS OR STATEMENTS ISSUED BEFORE AND AFTER THE IMPACTS OF THE 1997-98 EL NIÑO APPEARED AND RESPONSES AFTER THE EVENT

The impact of the 1997-98 El Niño event was not felt in Vietnam until autumn 1997. As noted earlier, Vietnam authorities had been given an official document from the U.S Government on the appearance of El Niño in April 1997. The government document "Document On El Niño and its Impacts" was released on 28 October 1997 (Identification Number: 5418/KTN) from the Prime Minister's Office and instructed the responsible authorities—the Ministry of Science, Technology and the Environment and the Hydro-Meteorology Service—to prepare a report on El Niño and La Niña. Though this acted to raise official awareness of the El Niño phenomenon (and climate-related hazards in general), the official response to El Niño-related hazards during the 1997-98 period was carried out through the existing disaster management structure rather than through any new initiatives. The first popular ENSO document was released by the Hydro-Meteorology

Service and printed by the Science and Technology Publishing House in the year 2000 as a result of the 1997-98 event (*Nguyen Duc Ngu, 2000*).

Reports of El Niño-related impacts during the 1997-98 event were prepared as part of the normal mechanism of hazard reporting but no formal report on the effect of the 1997-98 El Niño on Vietnam has been published as yet. The impact of the event was reported in climate summaries for the period, and assessments will appear as part of the expanded research effort on the topic in general (*e.g., Pham Duc Thi, 1998*).

A major response to this El Niño has been in an expansion of the national research effort on the topic of El Niño and La Niña. Continual efforts are made to improve Vietnam's disaster management system, and the impacts during 1997-98 provided an additional motivation for this process, but not for the development of El Niño-specific measures. Public awareness of the threats posed by El Niño is certainly higher than before the 1997-98 event, although whether this has been translated into a more effective response to, say, cyclone impacts is not yet possible to determine. It is reasonable to conclude that climate-related hazards experienced during the 1997-98 event, whether or not they can be directly attributed to El Niño such as the impact of Typhoon Linda, have resulted in a greater level of international assistance for disaster management (but this would likely have occurred regardless of El Niño).

3.2 NATIONAL RESEARCH IN VIETNAM ON CLIMATE-RELATED HAZARDS AND EL NIÑO

Vietnam is a country affected by many kinds of hazards of which climate-related ones play an important role. Therefore, the Hydro-Meteorology Service of the Socialist Republic of Vietnam has been implementing many plans and projects related to the issue of climate-related hazards. Some examples follow:

Under the National Program in 1985-1990 code 42A commissioned by Hydro-Meteorology Service, Vietnam has carried out some studies on the impacts of tropical storms in Vietnam such as: 42A.03.04, studies on structure and methodologies of typhoon forecasting implemented by National Center for Meteorology and Hydrology Forecast; and, 42A.03.05: studies on zoning of strong and stormy winds serving the construction sector carried out by Institute of Meteorology and Hydrology Research. Pests are considered as a disaster related closely to the environmental conditions, especially climatic conditions. Therefore, studies on pests have also been implemented in the National Program commissioned by the Pesticide Prevention Agency, in the Ministry of Agriculture and Rural Development.

In the National Program for 1991-95 on water resources, studies were done on flooding caused by heavy rain. These were also studies of flood forecasting in the rivers through the Ministry of Water Resources, by the University of Water Resources, and the Institute of Water Resources Planning and Management, among others.

In the National Environment Program for 1995-2000 two drought studies for North Central and South Central Vietnam were carried out by Institution of Hydro-Meteorology and Institute of Geography, and the National Center for Natural Science and Technology.

In recent years, the Hydro-Meteorology Service has been commissioned by the Government to carry out the methodology to forecast storms and floods in Vietnam. Drought and solutions for drought in the coastal zone of the Central have also been an imperative need. Thus, the Institute has carried out a study on drought assessment in the area from Ha Tinh to Binh Thuan Province for Water Resources in cooperation with the Institute of Meteorology and Hydrology.

As far as El Niño itself is concerned, early work was published by Hoang Minh Hien and Nguyen Huu Ninh (1988, 1990). The 1997-98 event stimulated a large amount of scientific research in Vietnam as evident in the numerous publications that appeared in the late 1990s (*Bui Minh Tang, 1998a,b, 1999; Dang Tran Duy, 1998, 1999; Hoang Minh Hien, 1998; Le Nguyen Tuong (1998); Nguyen Doan Tho, 1998; Nguyen Viet Pho, 1998; Nguyen Viet Thi, 1998; Pham Duc Thi, 1998, 1999; Le Dinh Quang, 1999; Tran Viet Lien, 1999*).

After 1997, assessments and forecasts of the impacts of ENSO have become an important need for national management authorities in Vietnam. Therefore, in the period of 1999-2000, the Government organized an independent study on ENSO with the Institute of Meteorology and Hydrology as the agency executing the study. Recently, there have been several sectoral studies on climatic disasters and ENSO in Vietnam, commissioned by the Hydro-Meteorology Service, the Ministry of Agriculture and Rural Development, and the National Center for Natural Science and Technology.

In addition to these scientific studies, considerable efforts have been made to improve disaster management and this involves a research component. For example, the 1998 UNDP Red River Basin Flood Management Programme supports ongoing disaster mitigation efforts in Vietnam by developing an international quality flood forecasting system suitable for all rivers in Vietnam, commissioned and tested as a pilot project for the Red River basin. In financial terms, it is probably the case with the greatest investment in research in this kind of development-oriented study backed by international funding and frequently undertaken by foreign experts rather than Vietnamese scientists.

3.3 NATIONAL PLANS TO RESPOND TO DISASTERS

Vietnam has a comprehensive national system that has evolved over centuries for responding to the threat of storms, floods and other natural hazards. The system has been described as one of the most well-developed institutional, political and social structures in the world for mitigating water disasters (DMU web site, http://www.undp.org.vn/dmu/dm-in-vietnam/en/institutional_framework.htm). The account of the system in this section and following sections is drawn from Kelly et al. (in press) and is based on the literature, as cited, and interviews with key informants.

Alongside the extensive dyke system, the main elements of the disaster management system have, historically, been monitoring, mobilization of the population, and the stockpiling of materials. The system continues to evolve. During the 1990s, the *Strategy and Action Plan for Mitigating Water*

Disasters (MWR, UNDP, UNDHA, 1994, 1995) defined the current framework for emergency response. The 1994 Strategy adopted a three-pronged approach based on forecasting and warning systems, preparedness and mitigation, and emergency relief, emphasizing non-structural solutions on a short- and medium-term basis.

As far as institutional roles are concerned, *monitoring and forecasting* is the task of the Hydro-Meteorological Service (HMS), with the primary responsibility in the main offices at the national level in Hanoi and secondary responsibility at the regional and provincial level. The HMS is responsible for monitoring and forecasting tropical cyclone characteristics (position, movement, severity, likely landfall, and so on) and for issuing warnings to the general public and the relevant authorities. This work is undertaken at the national level, in Hanoi, by the National Center for Hydro-Meteorological Forecasting (NCHF), and at the regional (city and provincial) level by the local HMS offices. The NCHF is divided into two divisions or branches, responsible for meteorological forecasting and hydrological forecasting. Tropical storm forecasting is the responsibility of the meteorological division, although the hydrological division may become involved in the event of, for example, river flooding. With a total staff of around 150, the NCHF is further divided into sectors responsible for, for example, administration (including issuing warnings to the general public), communications (issuing warnings to regional HMS offices), research and development (information and methods), satellites and computing (data provision and analysis), and short-, medium- and long-term forecasting.

Coordination is the task of the Committees for Flood, Storm Control and Disaster Preparedness (CFSC), which exist at the national, city and provincial, and district level and within relevant ministries. Each commune (village) also has a CFSC Officer. These committees are responsible for pre-storm season preparations (including maintenance of the physical defences and resource allocation), implementation instructions as a storm approaches, coordination of relief at the relevant level in the aftermath of a storm, collation of impact information, and post-season assessment of effectiveness.

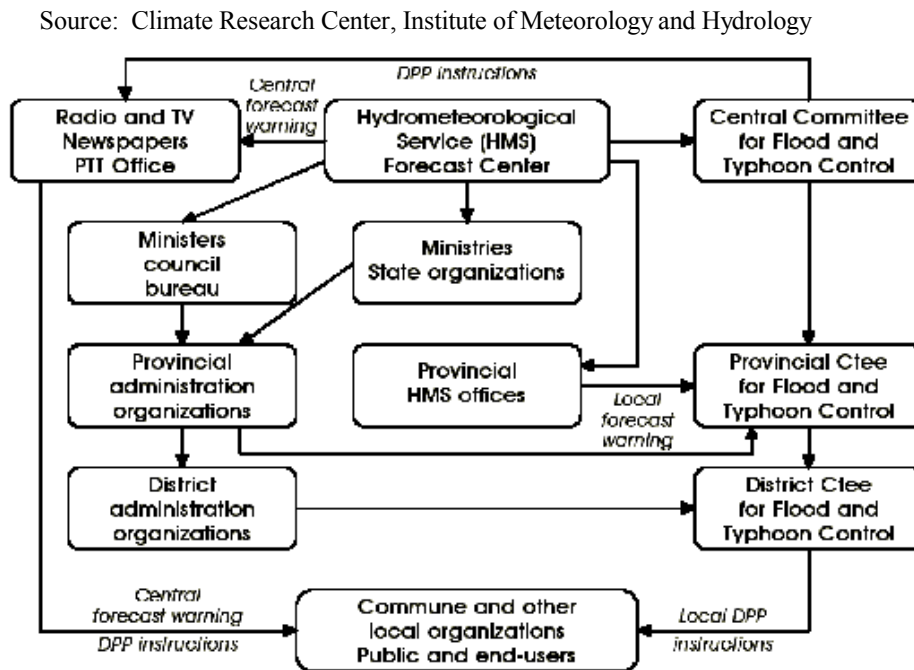
The Central CFSC was established in May 1990, succeeding the Central Committee for Dyke Maintenance. There is a permanent Secretariat for the Central CFSC with a small staff, run by the Department of Dyke Management and Flood Control (DDMFC) under the Ministry for Agriculture and Rural Development. The Central CFSC is primarily responsible for the emergency response to floods and storms. It is chaired at vice-minister level and includes representatives from a wide range of relevant ministries as well as the Chair of the HMS. Longer-term planning is the responsibility of the National Committee for the International Decade of Natural Disaster Reduction (NCIDNDR), set up in January 1991, also chaired by the MWR. The Secretariat of the NCIDNDR is also run by the DDMFCSP with the MWR. Funding for the activities of these organizations and the measures they instigate comes from three sources: government, local communities and international assistance. The Flood and Storm Preparedness Fund, contributed by city and provincial resources, supplements central government funding and totalled 7.8 billion VND as of September 1994.

In 1994, the Disaster Management Unit (DMU), with UNDP support, was established to assist the work of the CCFSC and the NCIDNDR. The role of the DMU is to serve as a reference

center for information exchange (through the DMU Information System, based on a computer communications network) and to work to secure data and voice communication with disaster-affected areas and establish a National Disaster Management Training Team for provincial, district and local leaders.

Implementation of disaster prevention and preparedness activities is the responsibility of all government departments and organizations at all levels, as relevant, as well as the general public. Given the spatial scale of the maximum impact of an individual storm (a few hundred kilometers) and the nature of the Vietnamese administrative system, primary responsibility for implementation, i.e., the actual defensive measures, has to be taken at the district and commune level. Figure 46 shows the flow of information, and responsibility, from institutions at the national level to the commune level. The need for coordination, between ministries and between administrative levels, has driven the formulation of this complex chain of communication, although it has been criticized in that the transfer of forecast information, for example, between agencies and administrative levels can, at times, be unacceptably slow (MWR/UNDP/UNHDA, 1994).

Figure 46. Flow of information, and responsibility, from institutions at the national level to the commune level



3.4 IS EL NIÑO EXPLICITLY CONSIDERED TO BE A DISASTER IN VIETNAM?

While El Niño and La Niña are officially recognized as affecting the occurrence of many forms of natural hazard in Vietnam and therefore are to be incorporated in the planning process, they are not dealt with as disasters in their own right.

3.5 INTERNATIONAL RESEARCH ON EL NIÑO AND VIETNAM

There has been little international research that focuses *directly* on the issue of El Niño impacts on Vietnam, although many papers provide information on the regional scale that is relevant to Vietnam (*for example, Allan, 1991*). Collaborative work by Vietnamese scientists in the context of international initiatives has resulted in some research specific to Vietnam.

For example, in 1990-91, within the framework of a project on the assessment of climate-related impacts sponsored by the United Nations Environment Program (UNEP), there was an initial assessment about ENSO and its impacts on some socioeconomic factors in Vietnam by Dr. Nguyen Huu Ninh, Dr. Hoang Minh Hien and Dr. Tran Viet Lien. At a related international conference on climate change and sea level rise held in Hanoi in 1991, there were several papers on ENSO and forecasting presented by international experts. In 1995, a regional conference on ENSO and extreme phenomena sponsored by NCAR and UNEP was organized in Ho Chi Minh City. At both of these conferences, several papers and scientific reports on ENSO and its impacts on the weather, climate and socio-economic factors of the region, including Vietnam, were presented.

In 1999, in Hanoi, within the International Hydrology Program, a conference on ENSO, flood and drought in the 1990s in Southeast Asia and Pacific took place. There were several international and domestic experts presenting papers on the relationship among ENSO, flood, storm and drought. Recently, in Hanoi, as mentioned earlier, an international conference on the impact of El Niño and La Niña in Southeast Asia was organized by Center for Environment Research, Education and Development and sponsored by Asia-Pacific Network for Global Change Research (APN). A regional overview of ENSO impacts, including effects on Vietnam, as well as papers on sectoral impacts in Vietnam were presented at this meeting.

Two chapters authored by Vietnamese scientists and an international collaborator covering the impact of ENSO on Vietnam will be published (*Kelly et al., in press*). (Also see, ADPC Report, 2000).

4 FORECASTING BY ANALOGY

4.1 IF A PERFECT FORECAST HAD BEEN AVAILABLE AS EARLY AS OCTOBER 1996 (KNOWING WHAT IS NOW KNOWN ABOUT THE ACTUAL IMPACT), WHAT COULD HAVE BEEN DONE DIFFERENTLY?

If a perfect forecast of the timing of the next El Niño *and* its detailed impact on Vietnam, including effects on climate and socio-economic consequences had been available, then the provision of detailed warnings to relevant sectors would have occurred and more effective allocation of resources in dealing with related hazards during the 1997-98 event would have been possible, making use of the existing disaster management structure. This is, however, an ideal and extremely unrealistic scenario. If a credible forecast of the occurrence of an El Niño event with no estimate of detailed effects on Vietnam was available, then, again, this information would have

been conveyed to relevant parties but it is less likely to have affected the allocation of resources. In a situation such as in Vietnam where the response to hazards is constrained by limited resources, being able to prioritize the allocation of resources ahead of time on the basis of forecast information would be the major benefit of a perfect forecast. This presupposes that the perfect forecast is trusted, of course, and is sufficiently detailed to be of value to users in different sectors.

4.2 WHAT ARE THE REALISTIC OBSTACLES THAT MIGHT HAVE PREVENTED THESE THEORETICAL ACTIONS BEING TAKEN?

The obstacles that might have prevented a more effective response include the following (not in order of importance):

- There are very few studies on the impact of El Niño on different aspects of ecosystem and social well-being in Vietnam. Without this information, re-allocation of resources would not be possible.
- Awareness of the national management authorities as well as of scientific agencies relating to the issue remains limited.
- There is a need for greater governmental coordination and resourcing of relevant scientific and disaster management studies. This requires greater recognition of the importance of this work.
- There is no single agency responsible for forecasting the impacts of ENSO in Vietnam.
- Up-to-date access and use of international forecast information are still in the initial phase and expertise and equipment to make use of this information is lacking.
- Forecasts must be made relevant to user needs. Current forecasts are too general in nature. They must also be believable and this requires a history of forecasting success.
- The response to hazards tends to be reactive not pro-active so a change in attitude is required to ensure that those affected anticipate possible impacts and act in advance.
- Resources - human, financial and technical - are limited.

Annex 1 contains recommendations from the Hanoi Workshop on the Impact of El Niño and La Niña on Southeast Asia concerning ways of ensuring a more effective response.

4.3 CAN EL NIÑO CONSIDERATIONS BE ADDED EXPLICITLY TO NATIONAL DISASTER PLANS?

As mentioned previously, the availability of reliable, detailed and trustworthy El Niño forecasts would contribute directly to disaster prevention if incorporated into the monitoring, warning and planning stages, for example, of existing national disaster management plans. This could be achieved without difficulty. The current system provides a strong basis for the communication of information to all sectors of society. Clearly, the obstacles to forecast use listed above would have to be dealt with and this may be difficult to do. There would also be the question of priorities in resource allocation as other efforts, as discussed below, might be more beneficial in strengthening the disaster management system. Whether or not it would be wise to create a parallel structure based on El Niño as has occurred in some countries is not clear. There could well be problems due to overlapping responsibilities, etc.

4.4 IDENTIFY THE STRENGTHS AND WEAKNESSES IN THE WAY YOUR COUNTRY RESPONDS TO EL NIÑO-RELATED CLIMATE ANOMALIES

Apart from the obstacles that might prevent effective use of any perfect El Niño forecast as noted in Section 4.2, the main strengths and weaknesses of Vietnam's response to El Niño-related climate anomalies are the same as those affecting its existing disaster management system. The following assessment is based on Kelly et al. (in press) and concerns the system for protection against storm and flood. Similar considerations apply in the case of the response to other hazards, although the national system is not as well developed as in the case of storms and floods, which are considered the major threats.

There are four main strengths of the current system for protection against storm and flood. First, the system has developed over many centuries and represents the culmination of a lengthy period of learning through experience. Second, the system is the result of an evolving pact between the elite, the government, and the people of Vietnam and, as such, has widespread support and commitment. Third, the battle against "invasion" by the tropical cyclone is as ingrained in the Vietnamese psyche as the struggle against human invaders. Finally, the system's structure, though complex, ensures that all levels and sectors of the administration and, indeed, much of Vietnamese society are firmly linked into the process. It contains a degree of duplication or redundancy, increasing the chances that information will be conveyed in the event of failure of any one channel. At a deeper level, it controls the "social amplification of risk", ensuring, to the extent possible, that the nature and scale of the societal response to a hazard is appropriate.

The system is, however, subject to various constraints and weaknesses. These can be summarized as follows:

- *Resource limitations*
- *Lack of cooperation and management efficiency*
- *Communications problems*
- *Cultural difficulties*
- *Scale issues*
- *Limited scientific and technical understanding*
- *Lapses and limitations in public awareness*
- *Aggravating factors such as environmental degradation*

Clearly, the limits on the financial resources and technical facilities that are available present a major problem (*Benson, 1997*). The principal effect is on the level of physical protection that can be provided by maintaining, strengthening and improving existing coastal defenses.

Despite the comprehensive institutional framework that has been developed, or, some would argue, because of the complexity of this framework, there is scope for better co-operation and more efficient organization and communication throughout the system. At all levels, information flow is occasionally interrupted despite the redundancy built into the system. The increased involvement of international agencies in the system has, at times, resulted in very clear tensions between these groups and the various national institutions as the storm response system itself

adjusts to greater foreign involvement. At the local level, there are scale issues to be dealt with regarding the implementation of preventative measures at the commune, district and provincial level.

There remains considerable scope for enhanced understanding of the storm risk and its impacts, ranging from an improved forecast capability, through more effective coastal protection techniques, to more comprehensive assessment of damage costs. As far as impacts are concerned, there has long been an obligation on the part of the communes to report losses and damage to central government via the district and province level, but there is some concern regarding the quality of the resulting data. The Disaster Management Unit has developed comprehensive procedures for damage assessment at the provincial level, although there is, apparently, a reluctance to relinquish the older methods.

Improved public understanding of the risk posed by cyclone landfall and of the protective measures that may be deployed to reduce that risk is considered essential (*Benson, 1997*). The impact of Severe Tropical Storm Linda was exacerbated by the fact that the local population had little experience of cyclone landfalls and did not heed the warnings that were issued (*Duong Lien Chau, 2000*).

Better communications is a critical issue at many levels. For example, as a storm approaches the point of landfall, hourly telephone communication between the provinces and individual members of staff in the National Center for Hydrometeorological Forecasting has represented the main, and often only, way to acquire the latest information. Improving communications between the central and provincial authorities, making use of computer communications backed up by satellite communications, is a priority of the Disaster Management Unit. Any form of communication with small boats at sea is frequently cited as the single, most effective way to provide protection to the fishing community. Without radio, these boats rely on their own forecasting ability and sporadic contact with larger radio-equipped ships. There is the need to improve communication between organizations at all levels.

Finally, reducing degradation of the natural environment that exacerbates the risk of flooding impacts could have a significant effect on the performance of the system. Deforestation, for example, has increased the risk of flash floods in coastal areas backed by mountainous country and the loss of the coastal mangrove has increased dyke maintenance costs and the probability of saltwater flooding.

It should be noted that the storm response system faces new challenges as Vietnam goes through a period of rapid social and economic change. The process of economic renovation, *doi moi*, has had a profound effect on the capacity of the agrarian communities to respond to disaster, particularly with regard to the erosion of forms of collective action and the broader loss of social capital (*Adger, 1998*).

Finally, we draw attention to the conclusions and recommendations of the Hanoi Workshop with regard to means of improving national responses to El Niño (*Annex 1, from Kelly et al., 2000*). Figure 47 shows a schematic structure for the response at the international to national levels. For

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

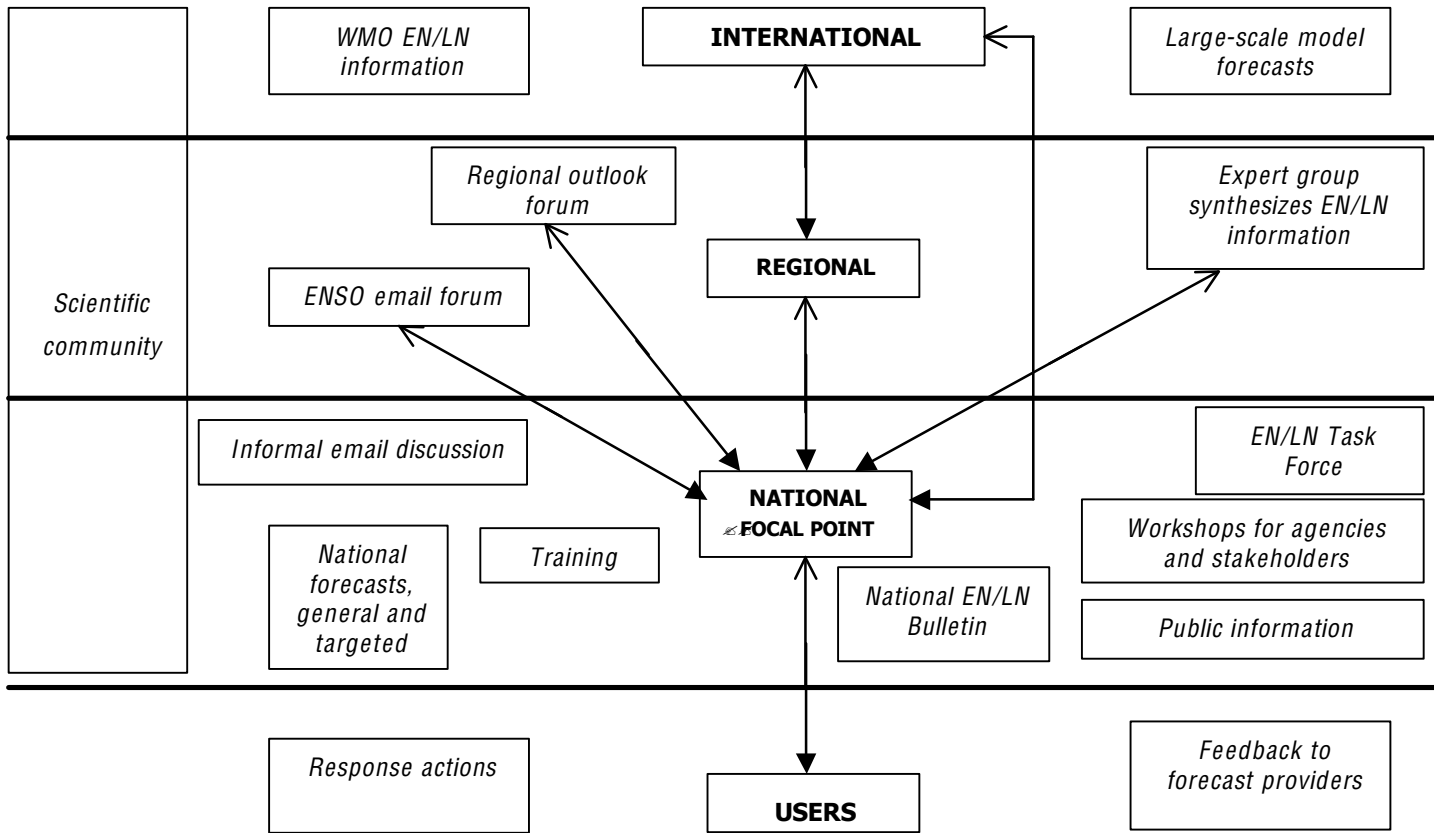


Figure 47. Resources, proposed activities and information flow regarding El Niño (EN) and La Niña (LN) at and regional and national levels.

Note: *Solid arrowhead:* Forecast, monitoring and other scientific information.

Open arrowhead: Feedback

Source: International Conference “The Impacts of El Niño and La Niña on Southeast Asia. APN/CERED, February 1999.

4.5 DID THE 1997-98 EL NIÑO HAVE ANY INFLUENCE ON YOUR COUNTRY'S RESPONSE TO THE FORECAST IN EARLY 1998 OF AN EXPECTED LA NIÑA EVENT?

The 1997-98 El Niño event strongly affected the reaction of Vietnam agencies, from national management agencies to professional agencies such as the Hydro -Meteorology Service, the Ministry of Agriculture and Rural Development, the Ministry of Science, Technology and Environment, to the La Niña forecast. La Niña forecasts of some American and Australian forecast centers in 1998 were transferred through reports of the Hydro -Meteorology Service to relevant national agencies and were used in long-term forecasts and propagation in mass media such as newspaper, radio, television.

Forecasts of the breakdown of the current La Niña and of the next El Niño event were discussed at the international conference on the impact of El Niño and La Niña in Southeast Asia in February 2000, organized by the Center for Environment Research, Education and Development, and a statement on the future prospects was issued from the meeting (Kelly et al., 1999).

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.

REFERENCES

1. Adger, W. N. (1998) Observing Institutional Adaptation to Global Environmental Change: Theory and Case Study from Vietnam. Working Paper GEC 98 -21 Centre for Social and Economic Research on the Global Environment, University of East Anglia, and University College London, Norwich and London.
2. ADPC (2000) Report on ENSO Climate Forecast Applications Project in Vietnam, October. Bangkok, Thailand: Asia Pacific Disaster Center (ADPC).
3. Allan, R.J. (1991) Teleconnections linking worldwide climate anomalies. In Glantz M.H, Katz R.W., & Nicholls N. (ed.), Cambridge.
4. Benson, C. (1997) The economic impact of natural disasters in Vietnam. Working Paper 98 Overseas Development Institute, London.
5. Bjerknes, J. (1969) Atmospheric teleconnections from the equatorial Pacific. *Mon. Wea. Rev.* 97, pp. 63-72.
6. Bui Minh Tang (1998) ENSO - Factors related to global climate change. *Hydro -meteorology Magazine* Vol. 2 pp. 1 -6 (in Vietnamese).
7. Bui Minh Tang, Pham Duc Thi (1999) ENSO and its relationship with winter temperature in the North of Vietnam. *Hydro -meteorology Magazine* Vol. 2, pp. 6 -8 (in Vietnamese).
8. Cane, M.A. (1992) Tropical Pacific ENSO Models in, *Climate System Modelling*. Trenberth, K. E., (ed.), Cambridge.
9. Chan, J.C.L. (1985) Tropical Cyclone activity in the Northwest Pacific in relation to the El Niño Southern Oscillation phenomenon. *Mon. Wea. Rev.* 113, pp. 599-606.
10. Chongyin L. (1988) Actions of Whoons over the western Pacific (including the Eastern Sea) and El Niño. *Inst. Atmos. Phys.*, pp. 108 -115.
11. Dang Tran Duy (1998) El Niño and seasonal weathers in Vietnam. *Hydro -meteorology Magazine* Vol. 2, pp. 7 -11 (in Vietnamese).
12. Dang Tran Duy (1999) Archival statistics on El Niño and La Niña. *Hydro -meteorology Magazine* Vol. 4, pp. 15 -20 (in Vietnamese).
13. Disaster Management Unit (DMU) (1999) Regular Disaster in Vietnam, Hanoi.
14. Duong Lien Chau (2000) Lessons from Severe Tropical Storm Linda. In Report of the Workshop "The Impact of El Niño and La Niña on Southeast Asia", 21st -23rd February 2000, Hanoi, Vietnam, ed. M. Kelly, S. Granich and Nguyen Huu Ninh. Center for Environment Research Education and Development, Hanoi.
15. Glantz, M.H. (1994) Forecasting El Nino : Science's Gift to the 21st Century. The potential Use and Misuse of El Nino information in North America. Workshop report. Boulder, Colorado, pp. 1-7.
16. Gray, W. (1975) Tropical Cyclone Genesis. Dept of Atmos. Sci, Paper No. 234, Colorado State Univ., Ft Collins, Colorado.
17. Gray, W.M. (1984) Atlantic seasonal Hurricane frequent. Part 1, El Niño and 30 mb quasi - biennial oscillation influences, *Mon. Wea. Rev.* 112, pp. 1649 -1668.
18. Harris, P.A. (1998) Typhoons, ENSO and the Western North Pacific. Master Thesis, University of East Anglia, Norwich.
19. Hastenrath, S. (1991) *Climate Dynamics of the Tropics*. Atmospheric Science Library, Kluwer Academic Publishers.
20. Hoang Minh Hien (1998) El Niño Southern Oscillation. *Hydro -meteorology Magazine* Vol. 3, pp. 27-31 (in Vietnamese).
21. Hoang Minh Hien, Nguyen Huu Ninh (1988) El Niño and the Climate Variabilities. *Hydro - meteorology Magazine* Vol. 330, pp. 22 -28 (in Vietnamese).

22. Hoang Minh Hien, Nguyen Huu Ninh (1990) ENSO and change of Typhoon regime in Northwest Pacific and Bien Dong Sea, Hydro -meteorology Magazine Vol. 11 (in Vietnamese)
23. Hoang Minh Hien, Nguyen Huu Ninh (1990) ENSO and the fluctuations of Typhoon's activities in Western North Pacific and Eastern Sea, Hydro -meteorology Magazine Vol. 359, pp. 10 -14 (in Vietnamese).
24. Kelly, M., Granich, S. and Nguyen Huu Ninh (eds.) (2000) Report of the Workshop "The Impact of El Niño and La Niña on Southeast Asia", 21st -23rd February 2000, Hanoi, Vietnam. Center for Environment Research Education and Development, Hanoi.
25. Kelly, P. M., Hoang Minh Hien and Tran Viet Lien (in press) Responding to El Niño and La Niña - Averting tropical cyclone impacts. In Living with Environmental Change: Social Vulnerability, Resilience and Adaptation in Vietnam, ed. W. N. Adger, P. M. Kelly and Nguyen Huu Ninh. Routledge, London.
26. Le Nguyen Tuong (1998) An assessment on the impact of ENSO on rainfall in Vietnam. Hydro - meteorology Magazine Vol. 9, pp. 36 -43 (in Vietnamese).
27. Li, C. (1987) A study on the influence of El Niño upon Typhoon Action over the western Pacific. Acta Meteorological Sinica, 45, No. 2, pp. 229 -236.
28. Ministry of Water Resources (MWR)/United Nations Development Programme (UNDP)/United Nations Department of Humanitarian Affairs (UNDHA) (1994) Strategy and Action Plan for Mitigating Water Disasters in Viet Nam. DHA/94/1 United Nations, New York and Geneva.
29. Ministry of Water Resources (MWR)/United Nations Development Programme (UNDP)/United Nations Department of Humanitarian Affairs (UNDHA) (1995) First Update of the Strategy and Action Plan for Mitigating Water Disasters in Viet Nam. Ministry of Water Resources, Hanoi.
30. National Institute of Hygiene and Epidemiology (1993) Dengue Fever. Statistics of transmissible diseases 1979 - 1990, Hanoi, p. 90 (in Vietnamese).
31. Neumann, C.J. (1993) Global Overview - Chapter 1, Global guide to Tropical Cyclone forecasting. WMO. TC, No. 560, TCP -31, WMO, Geneva.
32. Nichols, N., (1993) ENSO, drought and flooding rain in South -East Asia. In *South-East Asia's Environmental Future: The Search for Sustainability*, ed. H. Brookfield and Y. Byron, pp. 154 - 175. Tokyo, Japan: United Nations University Press and Oxford University Press.
33. Nguyen Dinh Ninh (1999) ENSO and Drought in the 1997, 1998 and 1999 in Vietnam. Proceedings of "Asian Pacific Network -CERED Joint Workshop on ENSO, floods and droughts in the 1990's in Southeast Asia and the Pacific. Hanoi 23 -26 March 1999, pp. 118 -125.
34. Nguyen Doan Toan (1998) El Niño and surface water changes, tropical cyclones in the Eastern Sea and the Philippines. Hydro -Meteorology Magazine Vol. 1, pp. 18 -25 (in Vietnamese).
35. Nguyen Duc Ngu (2000). Knowledge of El Nino and La Nina. Science and Technology Publishing House, Hanoi.
36. Nguyen Thi Bich Hop (1997) Study on the discontinuous Summer Monsoon and its impacts on weather and climate of Vietnam. IMH, p. 85 (in Vietnamese).
37. Nguyen Trong Hieu (1996) Distribution of Droughts and their impacts in Vietnam. IHM. Hanoi, p. 42 (in Vietnamese).
38. Nguyen Viet Pho (1998) ENSO 1982 -1983 The damages of climate and ocean anomalies in winter 1982-1983. Hydro-meteorology Magazine Vol. 2, pp. 12 -17 (in Vietnamese)
39. NOAA (1999) An Experiment in the Application of climate forecasts: NOAA -OGP activities related to the 1997 -1998 El Nino Event. NOAA, p. 134.
40. NOAA (1999) Compendium of Climatological Impacts. Final Draft. NOAA -US DC.
41. Pan, Y. (1981) The effect of the Thermal State of eastern equatorial Pacific on the Frequency of Typhoons over the western Pacific. Acta. Met. Sin, 40, pp. 24 -32.
42. Pan, Y. (1986) Typhoon, Monsoon in Asia and SST in the Equatorial Pacific Ocean. Climates of Asia, Wiley, Chichester.

43. Pham Duc Thi (1998) El Niño and winter temperature in Vietnam. Hydro -meteorology Magazines Vol. 5, pp. 23 -27 (in Vietnamese).
44. Pham Duc Thi (1998) Temperature of the spring and winter in El Niño 1997 -1998. Hydro -meteorology Magazines Vol. 10, pp. 19 -25 (in Vietnamese).
45. Philander, S.G.H. (1990) El Niño, La Niña and the southern oscillation. Academic Press.
46. Quinn, W.H., & Neal, V.T. (1995) The historical record of El Niño . In Bradley R.S. & Jones P.D., (ed.), Climate since AD 1500, Routledge.
47. Quinn, W.H., Zoff, D.O., Short, K.S. and Kuo -Yang, R.T.W. (1978) Historical trends and states of the Southern Oscillation, El Niño and Indonesian Droughts. Fishery Bulletin Vol. 3, p. 26.
48. Ramage, C.S., & Hori. A.M. (1981) Meteorological aspects of El Niño. Mon. Wea. Rev. 109, No. 9, pp. 1827-1836.
49. Schroeder, T.A., & Yu, Z. (1995) Interannual variability of central Pacific Tropical Cyclones. Pre-prints of the 21st conference on Hurricanes and Tropical Meteorology, Amer. Met. Soc Vol. 74, pp. 437-439.
50. Tran Thanh Xuan (1999) Preliminary analysis of the influence of ENSO on river flow in Vietnam. Proceedings of Asian Pacific Friend and Game joint workshop on ENSO, floods and droughts in the 1990's in Southeast Asia and the Pacific. Hanoi 23 -26 March 1999, pp. 112 -117.
51. Tran Van Tien (1993) Recent status of Dengue Fever and Dengue Haemorrhagic Fever and Recommendations for control strategy. National Institute of Hygiene and Epidemiology. Hanoi, p. 10
52. Tran Viet Lien (1991) Climate impacts on Human Health in Vietnam. International Conference on "Climate change and sea level rise impacts" in Hanoi, UNEP/CERED, Hanoi.
53. Tran Viet Lien (1992) The Change of bio -climate Conditions in Vietnam. Report of regional Seminar on "Climate Change and its impacts to Ecological Environment in Southeast Asian ", Hanoi September 16-17, 1992. Hydro -meteorological Service, pp. 91 -97 (in Vietnamese).
54. Tran Viet Lien (1993) Impacts of Climate change on Human Health. National Seminar on Climate change. UNITAR/HMS, Hanoi, pp. 20 -26 (in Vietnamese).
55. Tran Viet Lien (1994) Characteristics of Building climate of Vietnam. HMS. Hanoi, p. 125 (in Vietnamese)
56. Tran Viet Lien (1998) Variation of Dengue Fever in Vietnam and its relationship with ENSO event. Proceeding of the 7th Scientific Conference of IMH Vol 2, pp. 50 -58 (in Vietnamese).
57. Tran Viet Lien (1999) Estimation of Global and local factors influenced to Drought in the Coastal areas of the Centre. Report of National Project Workshop on "Drought in the Centre (from Hatinh to Binhthuan)" University of Water Resources, Hanoi, (in Vietnamese)
58. Tran Viet Lien (1999) Initial study on dengue fever in Vietnam related to El Niño. Hydro-meteorology Magazine Vol. 3, pp. 29 -33 (in Vietnamese)
59. Tran Viet Lien (1999) Relation between Forest Eco -system and Hydro -climate in Highland of the Centre of Vietnam. Report of National Program " Forest Inquire and Planning of the period 1995-2000". Institute of Forest Investigation and Planning", Hanoi, p. 145 (in Vietnamese).
60. Tran Viet Lien (1999) Relationship between ENSO and Dengue Fever epidemic in Vietnam. Hydro-meteorology Magazine Vol. 5 (in Vietnamese)
61. Trenbreth, K. E. (1997) The Definition of El Niño. Bullentin of the A.M.S. Vol. 78, No. 12, pp. 2771-2777.
62. Trenbreth, K. E., and Shea, T.J. (1987) On the evolution of the Southern Oscillation. Mon. Wea. Rev. 115, pp. 3078-3096.
63. Trenberth, K.E. (1991) General characteristics of the El Niño Southern Oscillation. In Glantz M.H, Katz R.W., & Nicholls N., (ed.), Teleconnections linking world -wide Climate anomalies, Cambridge.

64. Trinh Quang Hoa (2000) Preliminary study on elements created drought and drought classification of coastal Provinces in Centre of Vietnam. Report of National Project Workshop on "Drought in the Centre (from Hatinh to Binhthuan)". University of Water Resources, Hanoi, (in Vietnamese).
65. UNDP Vietnam (1998) Development and Cooperation Report, Country Background, Hanoi.
66. United Nations Development Programme, UNDP (1999) *Development and Cooperation Report 1999*. UNDP Vietnam, Hanoi.
67. WMO (1999) The 1997-1998 El Nino Event. A scientific and technical retrospective. WMO - No95. WMO-UNEP-ICSU-UNESCO Geneve, p. 94.
68. Zhang, Z., and Lin, Z. (1992), *Climate of China*. Wiley, Chichester.

ANNEX

Conclusions and recommendations regarding national response strategies from the workshop "The Impact of El Niño and La Niña on Southeast Asia," organized by the Center for Environment Research, Education and Development on behalf of the Indochina Global Change Network and held in Hanoi, Vietnam, in February 2000 with support from the Asia Pacific Network on Global Change. From Kelly et al., (2000).

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 are 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 marked differences in impacts among, and within, different countries. There are regions where signals are strong but, in others, signals are weak.