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

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IMPACTS OF THE 1997-98 EL NIÑO EVENT IN PAPUA NEW GUINEA

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2000

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Merauke
Weipa
Cooktown
Cairns
Port Moresby
NATIONAL CAPITAL
Kokoda
Popondetta
Kwikila
Abau
Honiara
Base 800495 (A05601) 3-87

El Niño and Papua New Guinea

Executive Summary

Situated close to the normal warm water pool of the southwest Pacific, Papua New Guinea can be seriously, and quickly, affected by El Niño events. Historically the most common direct effect of the eastward movement of the warm water pool appears to be a reduction in cloud cover, resulting from decreased convection. Reduced cloud cover leads to a reduction in rainfall over much of the nearby region, resulting in drought in the worst affected areas.

Reduced cloud cover also leads to faster cooling of the land overnight. In the Highlands of Papua New Guinea, this results in change to the frost pattern in two ways:

- There is an increase the number of frost days in parts of the Highlands above 2,200 meters
- The frosts also extend to lower altitude areas that normally do not experience frost conditions

It may also be surmised that the severity of the frosts at any particular altitude increases, but in the absence of temperature records, this is impossible to confirm.

Depending on their severity, the reduced rainfall and higher frost rate can lead to water shortages, crop losses and famine. These increase the vulnerability of the human population to disease, and dry the vegetation--making it more vulnerable to fire. Surviving vegetation is weakened and, in turn, becomes vulnerable to pest and disease attack. The longer the impact lasts, the longer the recovery period appears to be.

Climate Records

Climate records for Papua New Guinea are fairly limited. Much of the information on past climatic events has to be drawn from available meteorological records (most of which are still on paper), colonial period government and mission records, newspaper articles and personal histories. From these it seems that major droughts occurred in parts of Papua New Guinea in 1896, 1902, 1914, 1941, 1972 and 1982, with less severe events in other years (Allen 1989,1998). All of these years had periods during which the Southern Oscillation Index (SOI) was negative, but negative values of 20 or more are only recorded for 1896, 1941 and 1982/83 (Australian Bureau of Meteorology Web Site April 2000). The droughts of 1902, 1914 and 1972 coincided with much smaller negative SOI value, although the first two did occur when the index had been negative for long periods. There are obviously a variety of factors that influence the occurrence of major drought in Papua New Guinea.

El Niño Research in Papua New Guinea

In the colonial period there was growing scientific interest in the occurrence of drought in Papua New Guinea, particularly after the drought of 1972. International developments in the identification and study of the El Niño/Southern Oscillation (ENSO) relationship were

mentioned in drought research in the 1970s and 80s, the most comprehensive published records of this research being published in the journal Mountain Research and Development, Volume 9, No 3 of August 1989, edited by Bryant Allen, Harold Brookfield and Yvonne Byron and published by the UNU International Mountain Society of Boulder Colorado.

With few indigenous scientists, Papua New Guinea lacked the resources to maintain the momentum of research after independence and only isolated work has continued – mainly within government agencies. The most active agencies appear to be the Department of Agriculture and Livestock, the National Agriculture Research Institute and the National Weather Service. None of the work appears to have been published, but there is a baseline level of experience that is being enhanced by frequent contact with Australian and other researchers, particularly in the agricultural, geographical and meteorological fields.

Following the 1997-98 El Niño drought, the National Weather Office began conducting some low level research on the possibility of predicting serious drought. Comparing the accumulated total rainfall in previous wet seasons at Daru in Western Province, with year-to-date rainfall readings, does this. There is some indication that examination of this relationship permits prediction of dry seasons fairly accurately.

Overseas El Niño Research Relevant to Papua New Guinea

Australian scientists who had been studying the geography, agriculture, meteorology and other relevant subjects in Papua New Guinea have been able to continue their work since independence, often with Australian Government funding, so there is continuing research data. A key institution that has fostered this research is the Research School of Pacific Studies at the Australian National University in Canberra. Drs Bryant Allan and Michael Bourke have studied the geography and agriculture of the country for more than 25 years and have amassed significant information bases on their subjects. Other members of the staff of the Research School have studied a wide range of aspects of the politics, economy, sociology and culture.

The Australian Bureau of Meteorology has also conducted research over many years on weather and climate issues in the region. It has a close relationship with the Papua New Guinea National Weather Office.

In New Zealand, the National Institute of Water and Atmospheric Research in Wellington has conducted extensive research into tropical cyclone occurrence in the Southwest Pacific, including the influence of the Southern Oscillation and sea surface temperature on cyclones.

PAPUA NEW GUINEA

EL NIÑO PROJECT
SETTING

Geography

Papua New Guinea is the largest developing country in the South Pacific region. Located between the equator and 12 degrees south and from 141 to 160 degrees east, it consists of the eastern part of the large island of New Guinea and about 600 individual smaller islands. These range from the large islands of the Bismarck Archipelago, including Manus, New Britain and New Ireland, and the northernmost Solomon Islands of Buka and Bougainville, to the smaller islands of Louisiade Archipelago and the many offshore islands and atolls throughout the country. The total land area is 461,690 sq km.

Most of the larger islands are mountainous. The main range that stretches along the length of the island of New Guinea is one of the great mountain ranges of the world with major peaks over 4,000 meters high and many highland areas over 2,000 meters high. The range is thickly forested but contains well-populated fertile valleys, inhabited for up to 9,000 years that support a large section of the population. The terrain is so rugged that some of these valleys were virtually cut off until this century, and even now many valleys can only be accessed by air or on foot. Mountains on the islands of the Bismarck Archipelago and North Solomon Islands rise to more than 2,000 meters. A chain of volcanoes lies along the north coast of New Guinea and through the Bismarck Archipelago and North Solomon Islands, all of which are close to the tectonic plate boundary. There are a number of major rivers on the New Guinea mainland with the Sepik, Ramu and Markham draining to the north coast and the Fly, Purari and Kikori draining south. The Fly River is navigable for ore barges and small ships as far upstream as Kiunga, about 800 km upstream. Coral reefs fringe many of the coasts and islands, particularly in the east.

Papua New Guinea has a tropical climate. There is a monsoonal rainy season from about November to April. This is significant in the south of the country but the highlands and small islands normally experience year-round rain. Temperatures on the coast and in the islands range on average from a minimum of 21 to a maximum of 32 degrees Centigrade with high humidity. The highlands are cooler with frost being experienced on a few occasions each year above 2,000 meters.

Population

Papua New Guinea has a population of some 4.5 million people. This figure is based on a 1990 census population of 3.61 million and an expected growth rate of 2.3%. A new census has been taken during the year 2000, but the results are not yet available.

Papua New Guinea's population is among the most diverse on earth. Some 600 distinct languages are recognized, and there are clear ethnic differences between the cultural groups that live in different areas. Since colonization in the 19th century, various lingua franca have been

developed. The two most commonly used are Pidgin (known as Tok Pisin) and Motu, but English is widely used in administration and commerce.

The population is scattered throughout the country, but the biggest concentrations are in the fertile valleys of the Highland provinces and in the vicinity of major urban centers of Port Moresby, Lae, Madang and Rabaul. The crude population density of the country is a low 8 persons per square kilometer, however the rugged terrain of the highlands and other limitations lead to estimates that only between 13% (National Statistics Office 1994) and 27% (World Bank 1996) of the land can be considered suitable for productive use. Using the population figures of the 1990 census, the practical density on usable land is considered to be about 62 persons per square kilometer.

Papua New Guinea has a relatively small urban population of about 15% but there is an accelerating urban drift. The Bank of Papua New Guinea estimates that the growth in the urban population between 1966 and 1990 was 6.3% per year.

A large proportion of the rural population lives a semi-subsistence lifestyle with an estimated 75% of rural households selling at least part of their produce for cash (Asian Development Bank 1999). The per capita annual GDP of USD$ 930 per year is a skewed figure, hiding a marked disparity between rural (USD$ 300-350 per year) and urban (USD$ 3500 per year) incomes (World Bank 1999). 36% of consumption is accounted for by 10% of the population, while 50% of the population account for only 19% of consumption. The differences are wider than those of most comparable countries.

Papua New Guinea has a low social indicators ranking in the Asia-Pacific region. Various United Nations agency reports show that life expectancy at birth is 56.8 years (*compared with an average in comparable countries of 67 years*); infant mortality rate is 61 per 1,000 live births *(comparable countries: 40*); fertility rate (children per woman) is 5.9 *(comparable countries: 2.6)*; 87% of school age boys and 67% of school age girls enter primary school (*100% in comparable countries where older people also enrol in primary school*) but this figure drops drastically later with only 16% of boys and 11% of girls entering secondary education (*comparable countries*:*65% and 61%*); latest available figures indicate that only 2% of children achieve tertiary (higher level) education (*comparable countries*: *22%*). Statistics provided from UNDP 1999, WHO 1999, and UNESCO 1997.

Health indicators are particularly poor. There are 1.8 doctors for every 10,000 people *(comparable countries*: *7*); and only 40% of children are immunized against measles (*comparable countries*: *85%*). About 22% of the population has access to sanitation (*comparable countries: 58%*) while 28% has access to safe, clean water (*comparable countries: 84%*). Even this access is not continuous, as the 1997-98 drought revealed.

Political

Independent since 1974, Papua New Guinea is a parliamentary democracy governed by a single parliamentary body in Port Moresby. There is considerably volatility in the Parliament, where changing alliances between small groups can alter the balance of power very quickly. Because

the frequent changes of government were making administration difficult, a change had to be enacted to the constitution, under which an elected party cannot be unseated by a vote of no confidence within 18 months of election. Until 1995 there were also provincial assemblies, but changes to the constitution have led to a more centralized administrative system. Now, provincial assemblies are made up of the elected national members of Parliament from the province, the elected heads of local governments within the province and certain appointed members. The previously separate provincial government administrations have now been absorbed into the national public service.

Economy

The country has many natural resources. Agriculture has been a long-term source of revenue, but in the last 20 years mining has become the primary source of export income. In recent years, forestry, oil and gas resources have also been exploited, although there has been a significant reduction in the demand for timber as a result of the Asian downturn of the past few years. Unfortunately, exploitation and poor administration have meant that the resources have not brought the growth and development that might legitimately have been expected. The country remains relatively poor.

Staple Crops

Staple crops vary according to climate, but the root crops of taro, cassava and yams are most common. Sago is the staple in the northwestern coastal areas. All these crops have long growing periods that are further extended in the low temperature areas of the highlands.

Transport

The geography of the country severely limits movement, particularly on the mainland. Port Moresby has no road links with any of the provincial capitals. The key road transport links are the Highlands Highway, which links the second city of Lae to the Highlands, and a second national highway that links Lae with the north coast at Madang. This road then continues west along the coast in worsening condition, until it becomes indistinct near Sandaun Province between Aitape and the Provincial capital, Vanimo. Vanimo has road links to Indonesia, but not to the rest of the province or the rest of Papua New Guinea. On the other islands, roads tend to be concentrated around the provincial capitals and major centers, although movement is easier in areas where mining and logging operations are taking place.

Air and sea transport are important to the operations of the country, although air transport has declined from the heady days of the 1930s when more airfreight was carried in Papua New Guinea annually than in whole of the rest of the world. Nevertheless, there are still people who are familiar with aircraft but have never seen a motor vehicle.

DISASTER MANAGEMENT

Hazard Profile

Papua New Guinea is at risk from a wide range of natural hazards, all of which can have a significant impact on the daily life of the population and on the economy. In some areas the population accepts the impact of the hazards as part of daily life. Certain traditional strategies provide a measure of protection, but it is difficult to raise more than polite interest in prevention, mitigation and preparedness measures, in a culture in which the struggle for existence is often difficult and the impact of hazards has been an accepted part of life for many generations.

Severe Storms and Floods

These are regular hazards in this heavy rainfall area. Flash flooding is common after heavy rain, while the great rivers of New Guinea regularly flood for long periods in the monsoon season.

Drought

Conversely, the absence of rain for any unexpectedly long period can lead to drought and widespread forest and grass fires. Lowland areas in the south and east coasts of the mainland of New Guinea regularly experience these hazards, while El Niño events are likely to bring drought to much larger areas.

Tropical cyclones

Tropical cyclones form in the Coral and Solomon Seas and affect Papua New Guinea, on average, once per year. Although these are rarely of the intensity experienced in countries further south, they regularly damage villages on islands in Milne Bay Province. On occasions the damage can extend into the mainland of southern New Guinea, where lack of cyclone resistant construction means that there can be extensive housing damage.

Frost

Each year between May and October, the Highlands of mainland New Guinea experiences frosts at altitudes above 2,100 meters. While these remain infrequent, crops can recover from the temporary damage they cause. If the frequency or duration of the frosts increases, crops can be destroyed. As the staple root crops have a long growth period in cooler areas, this can lead to food shortages lasting many months.

Landslides

Much of the terrain on the larger islands is very steep. Heavy rain or earthquakes frequently cause landslides that may occur over a wide area. Casualties and property damage from landslides are not unusual.

Earthquakes

The close proximity of Papua New Guinea to the tectonic plate boundary means that much of the country is very active geologically. There are frequent earthquakes, particularly along the north coast of the main islands and in the vicinity of New Britain. Shallow tremors of higher than Richter Magnitude 6.0 are not unusual, although many occur offshore, so damage may be light.

Tsunamis

Associated with undersea earthquakes and slumps or volcanic eruptions, tsunamis are also a threat in coastal areas. Tsunamis of a height of up to 2 meters are relatively harmless, but larger tsunamis do occur. A major event caused casualties and destruction along the north coast of New Guinea in 1998.

Volcanoes

There are at least 14 active volcanoes in the country and another 22 are considered dormant. Most of the active volcanoes lie close to the tectonic plate boundary that runs just off the coast of New Guinea, New Britain then south into the Solomon Islands. The major urban center of Rabaul, situated within a volcanic caldera at the eastern end of the island of New Britain, was virtually destroyed by eruptions in 1937 and again in 1994. Eruptions have also caused destruction on the islands of Manam and Karkar off the north coast of New Guinea in the last twenty years. An estimated 150,000 people are at risk from volcanic eruptions.

Disease

Papua New Guinea's health resources are limited and epidemics are always a risk. The country lies in a region where chloroquine-resistant malaria is endemic and outbreaks are frequent. AIDS is becoming an increasing problem and other threatening diseases include dengue fever, typhoid, cholera, diphtheria and rabies.

Transport Hazards

In a country with rugged terrain and limited resources, transport links can be hazardous. The heavy dependence on air transport, using small aircraft operating out of basic landing strips, means that aircraft accidents are frequent than in developed countries. Casualties from small (up to 20 passengers) aircraft crashes in remote highland areas are frequently reported. Road traffic accidents can also cause more casualties than might be expected from the number of small vehicles on the roads. Major causes are inexperienced drivers, poorly maintained roads and the practice of carrying too many passengers in the open backs of small trucks.

Agricultural Hazards

Outbreaks of plant and livestock disease can have a devastating effect on both staple and export crops in this region. Quarantine laws are comprehensive, but policing resources are limited so that events like the introduction of coffee rust, which devastated the coffee industry in the 1980s, could occur again in other crops. Insect pest infections can also have a major effect on crops.

Locust swarms form regularly in the Markham Valley and infestations of other pests are experienced in certain seasons including the first rains after a dry period. Livestock diseases could also cause serious damage to the small livestock industry.

Industrial and Mining Hazards

New technology has brought new hazards to Papua New Guinea. Major mining operations have allowed tailings to flow into hitherto pristine rivers, affecting the fishing and crop growing of subsistence populations downstream. The chemicals used in mining can also be a major hazard if released inadvertently. The recent loss of a load of cyanide being carried externally by a helicopter is a typical example. Pollution of water supplies and the air in industrial areas can also be a problem, as there are few controls over the use of chemicals. Additionally, in common with other developing countries, the materials used may often be those that are no longer acceptable in the developed world.

Disaster Management Organization

The Disaster Management Act is the basic disaster management document in Papua New Guinea. It describes the basic disaster management structure and responsibilities and requires disaster plans to be prepared.

The National Disaster Committee meets regularly, and since 1997 has been paying increased attention to disaster preparedness and mitigation matters. The functions of the National Disaster Committee are the following:

a. To supervise the national state of preparedness for emergencies and to report on same to the National Executive Council

b. To maintain the National Emergency Plan of the National Executive Council

c. To assign responsibilities for disaster related activities to Departments and other groups

d. To coordinate Departmental relief actions and collate national relief requirements

e. To advise the National Executive Council if an appeal for international assistance is required

f. To lay down guidelines for the preparation and format of provincial disaster plans

g. To examine and determine when necessary to approve grants from national funds for emergency relief

h. To foster public awareness of the effects of natural phenomena, and to determine measures which can be taken to prevent or mitigate them

i. To supervise the establishment of stockpiles of relief supplies

j. To advise the National Executive Council in the event of a disaster, and to keep them apprised of all developments. To advise the Council as to whether a National Emergency should be declared.

The National Disaster Management Plan also provides for the establishment of Provincial Disaster Committees. The functions of these committees are the following:

a. To assess particular hazards facing the Province

b. To cooperate with the Provincial Executive Council in ensuring the development plans for the Province, taking into account hazards it may face.

c. To prepare emergency plans for the province in accordance with the guidelines laid down by the National Disaster Committee, and supervise the state of preparedness for emergencies in the province

d. To coordinate relief operations and the stockpiling of relief supplies

e. To receive all applications for relief assistance

f. To foster public awareness of the effects of natural phenomena and the measures which can be taken to prevent or mitigate them

g. To organize the training of relief workers and to practice the provincial disaster plans

Nominally these committees exist in all provinces. Some appear not to have met before 1997, and others are of limited effectiveness. Only those in East New Britain and Madang, the two provinces with significant volcanic threats, could be considered effective.

The Papua New Guinea National Disaster Management Plan was prepared in 1987 and has not been amended since that date, despite many changes to government and administrative arrangements. An updated plan has been drafted and is currently being discussed by the government and other agencies involved. The existing plan provides for establishment of a National Disaster Committee, to be chaired by the Secretary of the Department of the Prime Minister, with membership drawn from the heads of key government departments. In recent years the composition of the committee has changed, although the plan has not yet been amended. The Secretary of the Department of Provincial and Local Government Affairs now chairs the committee and its membership has been enlarged to include a representative of the Papua New Guinea Red Cross, who represents the non-governmental organizations (NGOs).

The current plan lists hazards, including frost and drought. It actually pays more attention to the possible effects of the frost hazard, although there is little information provided on either. The latest draft of the new plan also lists both hazards but with even less information. It does not mention El Niño or the Southern Oscillation Index.

The National Disaster Plan makes one brief mention of the existence of the National Disaster and Emergency Service (NDES) that was created under the Disaster Management Act. The NDES was created to conduct secretarial and administrative activities on behalf of the National Disaster Management Committee, and to operate the National Emergency Operations Center. NDES was created in the Department of the Prime Minister, but was transferred to the Department of Provincial and Local Government Affairs when related responsibilities were transferred in the late 1980s. Since the El Niño event, it has been renamed as the National Disaster Management Office, but the change is not widely recognized. It remains a full-time headquarters organization working in support of the National Disaster Committee and runs the National Emergency Operations Center to coordinate provision of emergency and disaster relief. It also coordinates disaster preparedness measures and prepares and distributes the National Disaster Plan.

Disaster-Related Information Management

A clear problem in normal times in Papua New Guinea is the lack of an effective information management system within the disaster management structure. In 1997, and still to a great extent today, hazard warning was minimal except in relation to tropical cyclones. There was no formal system for reporting on hazard impacts on any part of the country, and there was rare and irregular contact between the National Disaster and Emergency Services and Provincial Disaster Management Committees. There was no established system existed for collecting, organizing, analyzing and disseminating disaster management information either within government or to the public and external agencies. There is no standing operating procedures for the National Emergency Operations Center. Staff have received little, if any, training in any aspect of their duties and none whatsoever in information management. No baseline information is collected and maintained, so comparisons with normal times are difficult and likely to be inaccurate. Records of past disasters are poor and hard to trace. Such information as was received during the El Niño event of 1997-98 seems to have been passed to the then Director of National Disaster and Emergency Services, and only released to the media (and presumably his superiors and politicians, although this can only be judged from media reports).

This gaping hole in the management system has serious consequences during disaster response operations. The ability to assess the true effects of a disaster and the best way to counter them is negligible and response is often slow, disorganized, reactive and uncoordinated. There is difficulty in setting priorities, and funds are often committed ineffectively. No national assessment structure or procedure exists, thus that information is gathered piecemeal. Any information that might be of value to those responsible for recovery and mitigation planning does not appear to be passed on in any organized way.

Poor communication of the capabilities of the existing disaster management system has led to the development of unrealistic expectations by government and public. When these expectations are not met, knee-jerk reactions by politicians lead to confusion. There is a widespread lack of understanding at all levels of government and the community about the value to the country of an effective disaster management system.

Disaster Management System Effectiveness

The lack of information management capability is only one symptom of an inefficient disaster management system. In 1997 NDES, which was responsible for developing the system under the guidance of the National Disaster Committee, was overstaffed, under-trained and widely recognized as ineffective. It concentrated on response activities, and these were handled in a reactive fashion with no proper assessment and planning. Evidence of the government's opinion of its effectiveness is shown by the fact that for both the major volcanic eruption at Rabaul in 1994, and the El Niño impacts of 1997, overall responsibility for coordination of response measures was delegated to someone outside the service. However, NDES was involved in the coordination of logistical support.

Even for response activities, the lack of standard operating procedures meant that there was no existing system for formally recording, assessing, prioritizing and responding to requests for assistance from provincial authorities. Responses were handled on an ad-hoc basis with decision-making centralized at the top of the organization. Decisions and the reasons for them not always communicated to other staff. No evidence of formal logistics training and practices was apparent.

Disaster preparedness does not appear to have been addressed to any significant extent since the Disaster Plan was prepared in 1987. The only training provided was the annual dispatch of one or two senior provincial officials to the Disaster Management Training Course at the Asian Disaster Preparedness Center in Bangkok under scholarship arrangements. No record of those who have attended appears to have been maintained, and there was no debriefing at the end of each course to learn any lessons gathered and pass them on. The only training that took place in the country was conducted by non-government organizations for their staff.

It should be mentioned that during the 1997-98 response operation major changes were made to NDES. The Director General retired and his first replacement was replaced some months later. Early in 1998 all of the old staff of NDES was eliminated or suspended, and the new Director General had to build a new organization using staff seconded from other parts of government. Recruitment of permanent staff for a smaller, leaner organization continues in 2000, having been delayed by the untimely death of the new Director General.

A program for development of the national disaster management system was drawn up in 1995 on the basis of recommendations of a workshop held in 1995, and had been discussed with AusAID, which was willing to fund the program. Unfortunately, the draft appears to have become lost in the machinations of the Papua New Guinea bureaucratic system, and was never finalized and agreed upon. It was revived in 1998/99 and a revised version has been developed. In August 2000 tenders (bids) were sought for managing the revised project.

El Niño and Papua New Guinea
Report

El Niño Research in Papua New Guinea

In the colonial period there was growing scientific interest in the occurrence of drought in Papua New Guinea, particularly after the drought of 1972. International developments in the identification and study of the El Niño/Southern Oscillation (ENSO) relationship were mentioned in drought research in the 1970s and 80s, the most comprehensive published records of this research being published in the journal Mountain Research and Development, Volume 9, No 3 of August 1989, edited by Bryant Allen, Harold Brookfield and Yvonne Byron and published by the UNU International Mountain Society of Boulder Colorado.

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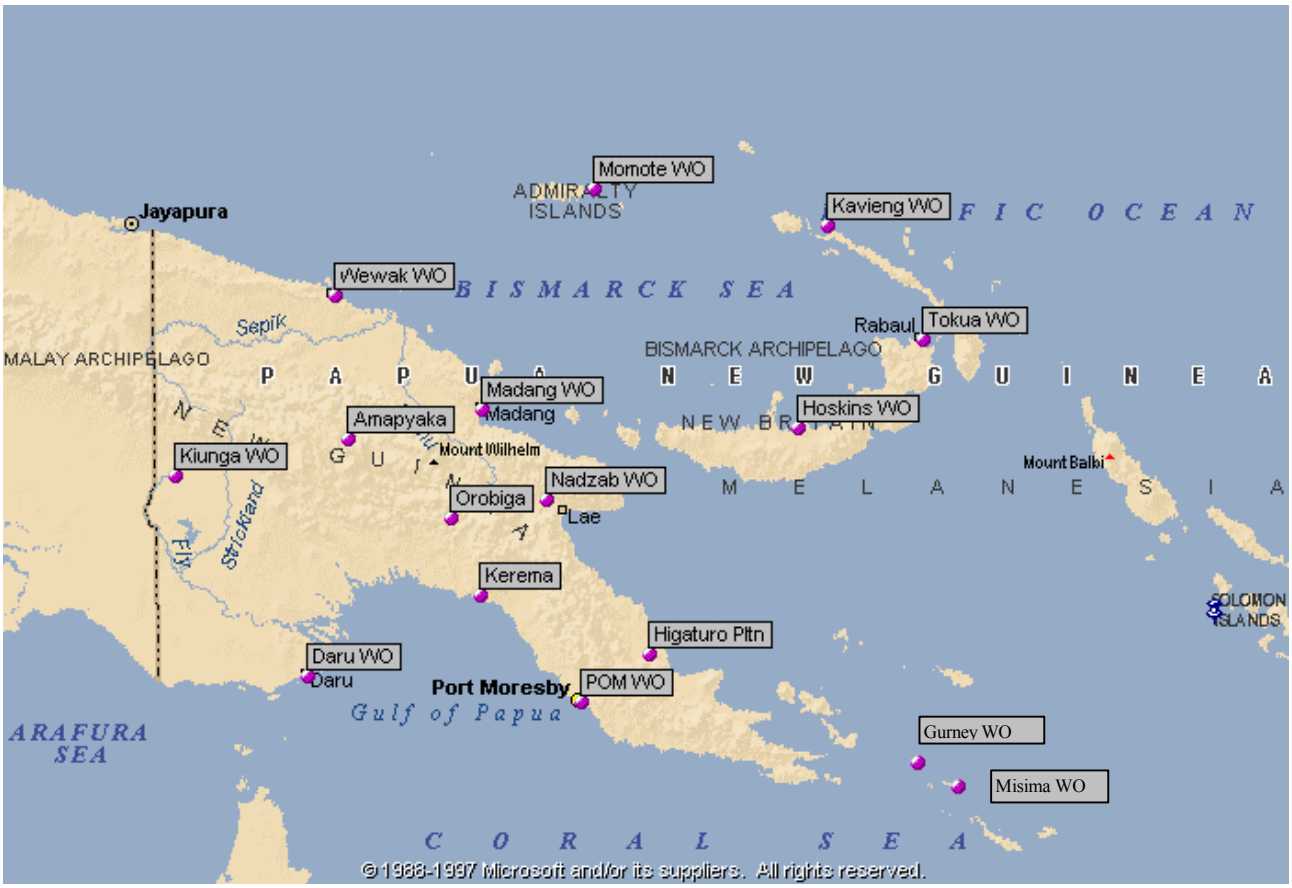
The 1997-98 ENSO Event

Drought

The National Weather Service of Papua New Guinea has limited human and material resources and is significantly under-funded. It is short of professional staff and has only a limited climate monitoring capability. The onset of the El Niño, while undoubtedly communicated to the Service, does not appear to have been monitored formally for some time. The Service, in common with the rest of the government, became aware of a developing drought from media and provincial government reports. Reports of water shortages and poor crop development had been passed to government by various provincial authorities, but there were insufficient staff to carry out an investigation. Occasional media reports spoke of power reductions caused by reduced water flows in hydroelectric systems, increases in the price of fresh produce in markets (in Lae July 77) and mine production losses due to low water levels in the Fly River (also July 97). None of these reports seem to have been linked and there appears to have been no public awareness that this was an exceptional drought or that it might be linked to the growing worldwide discussion of El Niño.



Weather Reporting Stations in Papua New Guinea

The National Weather Service apparently did not note the increasing seriousness of the drought. It was extremely short-staffed, particularly in the climate section, and monitoring was made difficult by the shortage of rainfall reports. Monthly rainfall figures are collected from 21 stations around Papua New Guinea but only 12 of these stations are at weather offices or airports and conduct regular rainfall readings. Rainfall records are not noted daily by the climate section. Instead the report awaits the receipt of monthly summaries from each of the 12 official stations. These are often returned some weeks after the end of the relevant month, and may have to be actively sought. There are not enough funds for the climate section to pay regular visits to stations to brief staff on the value of their records and the importance of rapid reporting. The reports from the remaining 9 stations are spasmodic, although they do provide some useful information on trends in their areas. Lack of continuity makes them of limited value for monitoring purposes. Rainfall statistics for the period January 1997 to March 1998 supplied by the Papua New Guinea National Weather Service are shown in Annex A, together with graphs showing the rainfall trends in various regions of the country.

It was not until August 1997 that a National Weather Service staff member returning from studies overseas could be spared to examine the El Niño reports coming from overseas, then was able to prepare a briefing for the government and a report on the drought and severe frost.

The first measurable effect on Papua New Guinea of the 1997-98 ENSO Event appears to have been in March 1997 when there was low rainfall at nine of the twelve official weather stations,

including all those situated on mainland New Guinea. While most of the country receives high to very high rainfall distributed fairly evenly through the year, periods of up to two months of lower rainfall are not unusual. When the low rainfall continued in April there was no undue concern, although all except one of the stations was now recording below average rainfall. Above-average rainfall was recorded at a few stations during July (reportedly as a result of short-term events) and in one station in August, but this was not enough to make an impression on the situation. The shortfall continued for the rest of the year. Some specific examples include Tabubil, with one of the highest rainfalls in the country, which received 78.6 mm in August compared to an average of 684.3 mm; Port Moresby recorded no rain at all in August, October and November and only 7.8 mm in September (compared with an average of about 164 mm for this period).

The area that experienced the least impact from the drought was around Wewak on the north coast of New Guinea, which only had occasional months in which rainfall was significantly low, although the rainfall for the whole period from August 1997 to January 1998 was below average.

Nationally, rainfall started to recover in January 1998 and by early April most stations were recording significant falls. The increase was such that there was flooding in some areas, including the Ramu valley, during March and April.

Frost

As there are no weather recording stations in the frost-prone zone above 2,100 meters, all reports of frost over this period are anecdotal, but it is clear from these reports that there was an increase in the number and severity of frosts, with some periods in which frost was experienced over a number of successive nights – a most unusual occurrence.

The Papua New Guinea government first became seriously concerned in early in August 1997 as it received increasing numbers of reports of drought from various parts of the country and severe frosts in the Highlands. A report was requested from the National Weather Service and this was provided on 7 August. It gives background information on El Niño, and then provides the first recorded recognition of the severity of the drought in Milne Bay and the Western Provinces. Unfortunately, there appears to have been little information on rainfall in most other provinces at that stage, because the report states that rainfall in the New Guinea Islands was only marginally below normal. The Wewak rainfall figures were taken to indicate that the drought hardly affected the northern provinces.

A further report on 18 August discusses the reasons for severe frosts and links these to El Niño. For the reasons given above, it is not clear how many frosts occurred and the areas affected could only be described in general terms. Subsequent research by (Allen and Bourke 1997) indicates that frosts occurred above 2,200 meters in the Western Highlands as early as June and were experienced every month until at least October. At Tabubil in September there were eight successive nights of frost in an area that normally experiences only occasional frosts.

Fire

A secondary result of the El Niño drought and frost was the increased incidence of bush fires in many parts of the affected areas of mainland New Guinea. Initially these fires appear to have been started by landowners burning off the remains of their crops, so as to be ready to plant new crops when rain returned. Some of these fires got out of control in the unusually dry conditions and spread far beyond the originally planned areas. Later fires are reported to have been lit by many landowners in response to a belief that smoke would bring cloud, which would bring rain. As the vegetation was even dryer when these fires were lit, they often spread further and the calm conditions left much of mainland shrouded in smoke haze.

Initial Impact Reports

While the original reports of El Niño impacts on provinces are no longer available, a summary prepared in September 1997 (Barr), and shown in Annex G, lists information provided by the Departments of Health, Provincial Affairs and Local Government, provincial authorities, churches and the media. These cover all nineteen provinces and reveal food and water shortages, power rationing, school and health clinic closures, outbreaks of disease linked to the use of brackish or untreated water, or to dust and smoke inhalation. It was apparent that subsistence farmers were having to search for wild or 'famine' foods in some areas and that normal water sources were low or unavailable, so people had to travel long distances to obtain supplies for drinking and cooking. It should be noted that as reports became more prevalent, a spirit of competition appears to have developed between provincial authorities, with each province trying to highlight the impact of the drought on its population in the hope of attracting relief funding and other support. This degraded the reliability of the reports and showed the need for a standardized national assessment.

Impact Assessment

Late in August 1997 Drs Bryant Allan and Mike Bourke of the Australian National University in Canberra, who, with over 20 years experience of studying geographical conditions and agriculture in Papua New Guinea, and are acknowledged experts on the subject, were asked by the Papua New Guinea Government to investigate the situation. A request was also made for Australian assistance with the Allan and Burke investigation as part of this assistance. Their investigation was expanded to become the first national assessment of the situation.

The First Drought Assessment. (Allen and Bourke 1997)

The Australian Agency for International Development (AusAID) agreed to fund a rapid first assessment of the impact of the drought and frost covering the priority sectors of food and agriculture, water and health. The assessment was to be facilitated by a team led by Allen and Bourke, and supported by experts on community health, water supply and relief logistics. Another consultant was engaged to assist NDES to develop its response coordination capability.

The team arrived in Port Moresby between 19 and 21 September. Team members were given access to reports from provincial authorities and to a collection of media and other reports on the situation. These reports were not in any standard form and many reports were anecdotal with limited corroboration and few statistics. Nevertheless, it was clear that significant hardships were being experienced in most parts of the country. The information in the various reports was collated and condensed into spreadsheet form (see Annex G) for immediate analysis and briefing. Although numbers of people affected were being reported, these often conflicted. Additionally, the type and extent of effects were not always reported. The impacts being reported at that time included the following:

- Deaths (73 reported but not confirmed)
- Population movements in the Highlands Provinces
- Water levels falling in rivers, creeks and wells, with reports of polluted and brackish sources
- Increased sickness in some areas and a general shortage of medical supplies
- Food gardens (the food source for subsistence farmers) drying up
- Bush fires in dry areas
- Schools closed, usually due to water shortages, or reducing their hours to allow staff and pupils to look for food and water
- Power rationing

The anecdotal nature of the reports made it difficult to compare the severity of the impact of frost and drought on different parts of the country. It was considered vital that the assessment be carried out on a national basis, and both the Papua New Guinea and Australian Governments sought a report as quickly as possible.

An assessment questionnaire in basic English (see Annex B) was prepared and 13 assessment teams, made up mainly of staff from the Department of Agriculture and Livestock, began their assessments on 25 September. The assessments were completed by 11 October. The teams visited a representative selection of villages in all provinces and returned a total of 638 questionnaires. Team members were asked to use personal observations as well as discussions with villagers in order to complete the answers to the set questions and to complete one questionnaire for each village visited. In order to provide some measure of standardization on the basis of critical needs, teams were asked to complete the questionnaire by making an objective assessment of the situation in the village and allocating a category on the basis of a five-point scale.

The scale consisted of the following:

1. Unusually dry, but no major food supply, drinking water or health problems.
2. Some inconvenience; staple food is short but other food available; must travel further to collect drinking water, but health is okay.
3. Difficult, with food short and some famine food being eaten, water available at a distance, some babies and old people unwell. No lives at risk.
4. No food in gardens, famine food only being eaten, water in short supply and possibly polluted, increasing sickness, the lives of small children and old people at risk.
5. Extreme situation; no food available at all, water very short, many people ill, small children and old people dying.

Although the assessment questionnaire was fairly comprehensive, time, equipment and staff capabilities did not permit all the information to be entered in a database in time to be useful. Fortunately, the capacity was available to enter the summary ratings into a database and use a Geographical Information System to map the results (Annex C). This enabled the most critical areas to be identified easily, and priority areas for response agreed upon.

The findings of this first rapid assessment indicated that about 77,000 people were in a critical life-threatening situation due to food shortages and a further 100,000 were expected to be in a critical situation by the end of October 1997. If the rain did not return, a further 250,000 people were expected to enter the critical category in November and another 170,000 in December. The assessment also showed that at least 100,000 people were experiencing critical water shortages, some in places where there were food shortages but many in places where food was still available.

The health situation was harder to assess because the health status of rural people in Papua New Guinea is already poor by international standards, and because the health system had been allowed to deteriorate over the previous few years. Some health centers had received no funding for more than twelve months, and a number had been forced to close, as staff was not paid. In general, the assessment reports indicated an increase in diarrhea and skin infections, but no widespread reduction in the already poor nutritional status of young children. The reports did not confirm the reported number of deaths and although some deaths were reported, it was not possible to link these directly to the drought.

A complicating factor in assessing the impact of the drought was population movement from high altitudes to lower altitudes. It appears that the fertile high valleys were originally settled from lower levels, and the people who live in the high valleys maintain kinship or 'wontok' relationships with others who live at lower levels. Downhill migration during hard seasons is a regular occurrence, so some displacement was expected. It was clear from a number of reports that the migration in 1997 was much greater than usual, although it was not mentioned in the reports from all villages where migration might have been expected. It was not clear whether this was because the local villagers did not think it worth mentioning, or because the migration

had gone elsewhere. There were certainly media and provincial reports indicating that there had been an urban migration to the major center of Mount Hagan, but numbers were not collected.

Supplementary Reports

The report of the First Assessment covered mainly the food and water situations, along with three specialist reports on health, and members of the Australian Team prepared Water and Logistics situations. The reports were not published, but some of their content was included in the main report.

Health (Henderson 1997)

Henderson visited parts of Western Highlands, Enga, Southern Highlands and Morobe Provinces. He used middle-upper arm circumference measurements to assess the impact of the emergency on the nutritional status of young children, and found no direct effect at that stage. He also visited selected aid posts, sub health centers, health centers and rural hospitals, as well as two area medical stores. He found that many of the health centers were run down. Some lacked essential drugs and equipment, water supply, or an effective children's health monitoring system. A few facilities had closed completely. A health information system was operating but with varying quality of data. Henderson recommended that to avoid a major health crisis, that a) the existing health system needed augmenting to monitor the health situation, particularly the nutritional status of young children; b) to prepare for any major disease outbreak with adequate supplies of essential drugs and equipment; c) to provide information and resources for sterilizing water for drinking and cooking; and d) to provide information about hygiene. He suggested that emergency food supplies should be assessed and monitored by a nutrition expert. No such expert was in the country and although discussions between the Papua New Guinea Health Department and the World Health Organization continued over many weeks, no suitable expert could be recruited for the task.

Water (Jacobsen 1997)

Jacobsen visited 25 islands in the Provinces of Manus, New Ireland and Milne Bay during the assessment period. Transport between these islands is difficult, so he was unable to visit all those areas he would like to have assessed. He found 7 islands with no fresh water at all, where people were drinking from coconuts or brackish water from beach springs and wells. The supply of coconuts was diminishing on some islands including one with a population of 1,000 people. On the other islands, he found only three places that had 15 litres of water per person per day, the UN refugee camp standard. Three others possibly met the standard but 12 did not meet the UN standard. The strategies being adopted by those suffering water shortages varied. Some were travelling by canoe to the nearest water point to collect water; others were walking up to several kilometers to obtain water from distant creeks, beach springs and cave-pools. This water was not always fresh.

During the visits, Jacobsen noted the following particular concerns:

- Lack of water for hygiene (with increasing incidence of diarrhea and skin diseases and a fatal epidemic of dysentery at one village)

- Health clinics and schools closed because of a lack of water

- Possible bad effects on in-country water experts from government agencies, non-government organizations, donor and other aid groups, and industry, searching to explore ways of involving them in relief efforts. As a result of these meetings, a Water Task Force was eventually created that had some impact on water relief policy, but no responsible agency has yet been nominated more than two years later.

- Shortage of water to process sago, a staple food.

Responsibility for water supplies in Papua New Guinea is not defined on a national basis. There is a water authority responsible for providing water to Port Moresby and some other urban centers, but no national agency has responsibility. During his visit, Jacobsen convened meetings of water experts and those interested in water supply matters from government and non-government agencies, donor-funded development teams and industry, in order to form what became the Water Coordinating Sub-Committee of the National Drought Relief Committee.

Logistics (Hill 1997)

Hill identified stocks of 9,145 tons of rice available in country, considerably less than the normal stock level due to the increase in demand. In discussion with the Department of Health and others, he suggested that only supplementary rations of food should be issued and these should be confined to locations identified as Categories 4 and 5 according to the assessment, with locations in Categories 3 and 4 being monitored for any deterioration in their status. He identified the likelihood that there would be major problems in monitoring distribution of rations, and recommended the use of 'village books' as a basic source of information. In the time provided, it proved impossible to provide more than a basic report, but other factors identified as requiring attention included these:

- Establishment of a registration system for the needy

- An accounting system to follow supplies from warehouse to issue

- Possible security problems as food is carried through lower category areas

- The need for a village-level awareness campaign to explain the basis for distribution

- The potential need for distribution of a special high protein biscuit to vulnerable groups

The Second Assessment (Allen, Bourke, et al., 1997)

After the first assessment was completed, it was agreed in discussions between Papua New Guinea and Australian officials that further assessments would be needed to monitor developments. Australia agreed to fund consultants to conduct the second assessment in November, but expressed a view that Papua New Guinea should have developed the expertise to conduct any later assessments--although financial support could be made available.

The second assessment, again led by Allen and Bourke, was conducted between 25 November and 12 December 1997. 18 teams were deployed for this assessment, which achieved better coverage than the previous event. The questionnaire was reduced from 8 pages to 1 page because of difficulties experienced in processing data from the first assessment. Although the questionnaire was shorter, the new form required assessment teams to provide a written assessment of the situation, taking into account a number of factors in which team leaders were briefed at a workshop before starting the task. The assessment categories were also changed. Teams were now asked to provide separate assessment categories to describe the severity of the food situation and the water situation.
The new categories were as follows:

Food Supply

1. Unusually dry, but no real food supply problems
2. Some inconvenience, staple food is short, but other food is available and health is okay.
3. Difficult, with food short and some famine food being eaten. Some babies and old people may be unwell. No lives at risk.
4. Very little food in gardens and that food will not last for more than 3 weeks. Famine food being eaten by many people. There is said to be increasing sickness and there are signs of poor nutrition. The lives of small children and old people are at risk.
5. No food left in gardens. Only famine food available. An extreme situation with many people not eating and small children and old people dying.

Water Supply

1. No local drinking water problems
2. Local water sources dry. Good alternative sources available elsewhere.
3. Local water sources dry. Alternative sources available, possibly slightly polluted, and at some distance.
4. Either small amounts of poor quality water available locally, or better quality water available only at very long distances.
5. Water supply extremely limited and of very poor quality, salty or dirty, and probably contaminated, possibly available only at long distances.

The results of this assessment indicated that almost 1.24 million people, 40% of the rural population, had little or no food available while about 410,000 people either had very limited supplies of contaminated water or had to collect water of variable quality from long distances. Although some rain started to fall in November and December, there was only enough at that

stage to make a significant difference to water supplies in two highland provinces. There had not been time for the rain to make any difference in food supplies. Some replanting had been carried out in highland provinces that had received rain, but there was a critical shortage of planting material.

Although health was not specifically surveyed in this assessment, the reports indicated that there appeared to be an increase in diarrhea among people eating 'famine' foods. Most health workers reported an increase in severe malaria. Although nutritional status was not measured, there were reports of adults and children fainting while carrying out their daily activities. These people, whether children at school or adults working in their gardens, were said to recover after a rest. There were more reports of people dying from unexplained symptoms and a reported increase in deaths among young and middle-aged adults. However, in the absence of health statistics, the reports could not be confirmed.

The Third Assessment (Wayi, et al., 1998)

Rain continued to fall in many districts from December 1997 onwards, but there were still areas of concern and a third assessment was carried out between 20 and 31 March 1998. The Papua New Guinea Department of Agriculture and Livestock conducted this assessment. This assessment differed from the earlier two in that a) it covered only those areas identified as critical (Category 4 and 5) in earlier assessments, and b) the manner in which it addressed recovery issues. 14 teams were deployed to visit 17 provinces and 244 Census Divisions. The teams did not visit some areas that had been receiving relief deliveries by air, as these had been reassessed during relief delivery visits.

The questionnaire used on this occasion asked specific questions relating mainly to the amount of rain that had fallen and the needs of the people for both relief and recovery. A summary sheet was provided on which teams were again asked to categorise villages both at the time of the assessment and potentially in 2 months time.

There were only minor changes to the definitions of the categories, which were as follows:

Food Supply

1. No unusual food supply problems
2. Some Inconvenience; staple food is short but other food is available and health is okay.
3. Difficult, with food short and some famine food being eaten. Some babies and old people may be ill. No lives at risk.
4. Very little food in gardens and it will only last up to 3 weeks. Famine food being eaten by many people. Reports of increasing sickness and signs of poor nutrition. Lives of old people and young children at risk.
5. No food left in gardens. Only famine food available. An extreme situation with many people not eating and some people (usually small children and old people) dying.

Water Supply

1. No local drinking water problems
2. Usual water sources dry. Good alternative sources available elsewhere.
3. Usual water sources dry. Alternative sources available but slightly polluted or at a distance.
4. Either small amounts of poor quality water available or better quality water available but at a very long distance.
5. Water supply extremely limited, of very poor quality, salty or dirty, and probably contaminated. Possibly only available at a long distance.

Although this was not a nation-wide assessment, some indications were obtained of the numbers of people in the worst affected areas who were still in need. More than 53,000 people were still considered to be in Category 5 for food, with the majority being in Milne Bay (30,723), Madang (13,149) and Goilala (5,632) areas. The assessment report suggested that these people would continue to need food relief but no period was suggested. Another 336,000 people were assessed as being in Category 4. Most of these were in the highlands provinces of Eastern Highlands (121,798), Western Highlands (28,391), Southern Highlands (28,621) and Enga (29,240) but there were others in Central (53,360), Chimbu (50,262) and Milne Bay (14,319) Provinces.

The food situation was found to have improved considerably since the previous assessment, with cultivation of staple crops underway and excess supplies available in the markets in at least one island province. Numbers of people in the critical categories were expected to fall by at least 30% during the following two months, with rapid recovery in most areas in later months. Shortages of seeds and other planting materials were still reported, while recovery was also being affected by increasing insect pest attacks. In areas where sweet potatoes are the staple food, the sudden release of nutrients and excess soil moisture had led to excessive growth of leaves and vines at the expense of edible tubers. This phenomenon has been reported after previous droughts and is usually solved at the subsequent planting (Bourke personal comment 1999).

In Manus and Milne Bay Provinces, increased rainfall had led to an increase in the numbers of insect pests, and these were affecting agricultural production. Locust swarms had also formed in the Markham Valley, eventually reaching plague numbers and delaying commercial crop production.

Water availability and quality had improved in most areas with only 75,000 people now experiencing critical or serious shortages of safe water. Water shortages were still being experienced in some atolls, but the problem in Gulf Province was mainly excessive salinity. As normal rainfall patterns returned, the remaining problems were expected to ease, although the onset of the normal dry season in May could prolong the impact in some areas.

Once again diarrhea was the main health problem reported, although the return of the rain had also brought an increase in mosquito numbers with consequent increases in malaria outbreaks. There were also reports of increased malnutrition in some areas, notably in Western Province, but the lack of baseline data made this difficult to confirm. The Department of Health lacked the resources to carry out a nutritional survey at any stage during or after the drought, so reports of this nature remain subjective.

Other Impacts

Food Availability and Prices in Urban Centers

The three assessments carried out between September 1997 and April 1998 concentrated on the impact of the drought and frost on rural communities. Urban communities were not subject to the same food shortages because most urban income is from salaries and relatively small amounts of food are grown. Nevertheless, the variety of fresh produce available from markets was significantly reduced and prices increased. Urban populations became more dependent on trade stores and supermarkets, where many of the goods sold are processed (canned or frozen) and many are imported. Prices are naturally higher for many of these goods, but the prices of domestically-sourced goods in these establishments also increased.

Support for 'Wontoks"

In the Papua New Guinea culture, kinship relationships are close and people who migrate to urban centers usually maintain their relationships with their home villages. In an event as serious as this drought, this kinship places cultural obligations for those with resources to help those who are experiencing difficulties. Consequently urban dwellers had an obligation to send food or money to their rural 'wontoks', in order to help them through the drought. This certainly had an impact on all urban-dwellers, and reduced the effects of the drought on recipients.

Power Restrictions

Another major impact on urban populations, particularly in the capital, Port Moresby, was the extent of power restrictions caused by reduced availability of water for hydroelectric purposes.

Port Moresby relies for power on water from the Sirinumu Reservoir in the Owen Stanley Ranges east of the city. In April 1997 the reservoir contained more than 250 million cubic meters of water, which was used to supply both power and fresh water to the city. The volume of water held declined steadily from April, and by November the dam was down to 80.9 million cubic meters – a reduction of some 66%. It was estimated that at current usage rates the dam would be empty by January 1998 if there were no rain in the watershed.

To reduce water use, local load shedding measures began on an unscheduled basis from 4 August 1997, but on 17 November 1997, after discussions with the Government, the Electricity Commission, Elcom, implemented more drastic power rationing to reduce demands on the remaining water stocks in the dam. The city was divided into two supply areas. From that day, each was subject to power stoppages for half of the working hours of each weekday. A schedule was published in the press and supply cuts were programmed to each area for the morning or afternoon of each day. Elcom also began seeking diesel generators to supplement the hydroelectric system and even replace it if necessary. A typical rationing schedule is shown in Annex D.

This program significantly reduced water usage and made it unnecessary to ration domestic water supplies at that stage. However, public education campaigns encouraging people to save water were initiated.

Elcom's exploration of alternative sources of supply was successful and new generators were located, but their installation was likely to take some time. Until they were on line, it was still expected that the reservoir would run dry by July 1998 if conditions did not change. By December 1997 there had only been sporadic rain in the ranges, and this had been insufficient to arrest the falling water level in the reservoir. There was increasing concern that serious water shortages could soon occur. Accordingly, government made a policy decision that the water in the Surinumu Reservoir would be reserved for domestic water supply, once water reduced to a specified level. No further water would be available for hydroelectric generations from that time.

Before these measures had to be implemented, some old generators were repaired and new generators began to be installed so that the demands on the hydroelectric system could be reduced. No further rationing was needed. Although significant rain began falling in the Owen Stanley Range in late December and early January, replenishment of the reservoir took time. It was not until April 1998 that significant easing of the rationing could be permitted. Further reductions were implemented in June 1998, and by the end of the year power had returned to normal. A new power station was opened in April 1999 to reduce the need for such drastic measures in the future.

Economic Impacts

On March 4 1998 the Treasury Minister of Papua New Guinea, Mr Iairo Lasaro, advised the Papua New Guinea Parliament that the country had lost 500 Million Kina (USD$ 278 million) in foreign exchange reserves as a result of the prolonged drought. This was approximately 62% of

the previous 800 million Kina reserve, thus, this left the country with only enough money to cover the cost of two months of imports (East West Center, March 1998).

In his statement, the Minister highlighted the impact of the drought-induced closures of the Ok Tedi Copper Mine and Porgera Gold Mine. He also mentioned other factors that had contributed to the situation, including the minimal currency inflow from traditional export sources, and the downturn in the timber industry.

No detailed study appears to have taken place in Papua New Guinea to ascertain the economic impact of the El Niño impacts of 1997-98. A number of newspaper articles mentioned threatened export crop losses, but these reports tended be based on statements from individuals, and no specific studies with authoritative statistics were traced during this study.

The following table, which is drawn from the information in the September 1998 Quarterly Economic Bulletin of the Bank of Papua New Guinea, summarizes the total exports of the major agricultural and mineral exports for 1997 and 1998.

TOTAL EXPORTS OF THE MAJOR AGRICULATURAL AND MINERAL EXPORTS FOR 1997 AND 1998

Commodity	**1997**				**1998**			
	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Cocoa ('000 tons)	10.1	9.2	7.8	11.5	6.4	3.9	11	4.8
Coffee ('000 tons)	5.5	25.8	17.3	10.6	7.9	8.4	19.7	19.0
Tea ('000 tons)	2.3	2.0	1.1	1.1	0.8	2.3	2.2	1.3
Copra ('000 tons)	31.7	17.9	18.5	22.2	18.6	12.9	11.7	14.9
Copra Oil ('000 tons)	14.7	12.2	14.5	7.2	16.8	12.7	11.5	12.2
Palm Oil ('000 tons)	66.7	66.1	107.1	35.0	61.4	51.8	59.0	40.8
Rubber ('000 tons)	0.9	1.6	1.0	0.9	1.8	0.9	1.5	0.7
Export Value (Kina mill)	129.3	251.4	244.3	152.2	227.5	395.7	306.6	228.9
Copper ('000 tons)	32.8	30.2	14.8	0	9.1	39.9	25.7	34.8
Gold (tons)	12.5	10.6	10.3	10.9	13.0	15.4	13.7	16.1
Logs ('000m^3)	590.3	702.6	569.0	514.0	294.6	265.5	111.7	
Marine Products ('000 tons)	0.7	0.8	0.3	0.4	1.7	2.2	5.5	
Crude Oil ('000 barrels)	8046.6	6544.8	7627.3	5753.5	5789.9	6939.3	7982.2	7322.2
Total Exports (K million)	817.4	843.0	780.7	618.2	654.7	944.4	1089.5	999.1

Data source: Quarterly Economic Bulletins of the Bank of Papua New Guinea.

It should be noted that the income from exports did not rise and fall at the same rates as the volume of exports, because the world price of a number of commodities increased during the period, and because the value of the Kina was continuously falling. Those commodities that were exported actually increased in value, but Papua New Guinea was often unable to take full advantage of these increases due to the impact of the drought.

Probably the most comprehensive reports available are the relevant annual reports on the Papua New Guinea economy published by AusAID (AusAID 1998 and 1999). Both reports, although discussing the whole Papua New Guinea economy, pay significant attention to the impact of the El Niño drought and frost events. In the view of the writers, the impact of the drought would have a delayed impact on the production of the main cash crops. The 1998 report points out that the 1997 coffee harvest (coffee provides around 42% of agricultural exports) started early in 1997, partly because of high prices available at the time, and was largely finished by the time the drought began to have its main impact. The sharp fall in export quantities in the second half of the year was the usual seasonal pattern. Of the other major agricultural export crops, copra exports were initially assisted by the drought, as it brought longer periods of sun to dry the crop. Small producers without access to drying plants were able to enter the market and exports actually rose during the second half of 1997. Copra oil and palm oil exports fell during the last quarter of 1997, but only the palm oil decline appeared to be caused by the drought, as producers had neglected their trees to spend more time seeking water.

The longer-term impact of the drought on agricultural exports is clear in the Bank of Papua New Guinea statistics for 1998. They show that, when compared with 1997, coffee exports fell by 11.8%, cocoa exports by 32.9%, copra exports by 35.7% and palm oil exports by 22.6%. Only copra oil exports increased (by 9.5%), and this increase was accounted for by an increase in the delivery of copra to the mills. The tea exports were almost exactly the same as those of 1997.

The drought had a more direct effect on mineral exports. The most dramatic impact was brought about by the drying up of the Fly River, which is normally navigable for about 800 km, up to the port of Kiunga, which is the supply port for the huge Ok Tedi Mine at Tabubil in Western Province. The water level fell to such an extent in August 1997 that ore barges were marooned at various points along the course of the river, and the only vessels capable of movement were canoes. Not only did this mean that ore could not be carried down to the river mouth for export, but also that the bulk of supplies for the mine could not be brought in. Some supplies were airlifted in, but this was not economical and the mine closed in early September. Limited movement of barges on the river was able to start again in November after the mine site received about 54% of its November rainfall, but sales did not recommence until February 1998 when a stockpile began building up. As a result of the closure, no copper was exported from Papua New Guinea in the 4th quarter 1997, and there were significantly reduced exports in the 3rd quarter of 1997 and the 1st quarter of 1998.

The other major mine to be affected by the drought was the Porgera Gold Mine in Enga Province, which supplies about half of Papua New Guinea's gold exports. Mining continued throughout the drought, but processing had to cease on a number of occasions between May and November 1997 when there was insufficient water available for crushing and extraction operations. A total of about 80 processing days were lost, and although the national export loss

was modified by the increasing production from the new Lihir Gold Mine in New Ireland, the impact of the drop in Porgera production can still be seen in the table above.

Social Impacts

The social impacts of the El Niño event are difficult to identify in the absence of any available study of the subject. Many of the people affected most by the drought and frost are subsistence farmers who still live a traditional lifestyle, whether in the highland or island provinces. As shown by the social indicators, their lifestyle can be hard and they often withstand hardships that would have a severe impact on people used to a more comfortable lifestyle. During the drought, many of the subsistence families were forced to survive on so-called famine foods: wild leaves, roots and animals that are not normally eaten. Searching for these foods can be very time-consuming, and the normal standard of living falls, but the people displayed great resilience, and recovery appears to have been faster than forecasted by any of the assessments. Their capability to survive the drought without any of the relief that was provided is born out by the experience of some villagers in a remote part of Central Province, who decided not to walk to the aid delivery point (which admittedly was some distance away) to collect supplies of rice and oil. Their experience is reported to have been little worse than those of communities that received relief supplies.

EL NIÑO REPORT –ANSWERS TO QUESTIONS

1. What is the socioeconomic setting of Papua New Guinea?

Papua New Guinea is the largest developing country in the South Pacific region. It has a land area of 463,000 sq km made up of the eastern part of the large island of New Guinea and about 600 smaller islands. Its population of some 4.5 million people is among the most diverse on earth.

The largest single part of the country is the eastern half of the island of New Guinea which is dominated by a central spine of rugged mountains that stretch from West Irian Province of Indonesia through to the south east tip of the island. Rising to more than 4,000 meters they are thickly forested but contain well-populated fertile valleys, inhabited for up to 9,000 years that support a large section of the population. The terrain is so rugged that some of these valleys were virtually cut off until this century and even now many valleys can only be accessed by air or on foot. The rest of the main island consists mainly of coastal lowlands with swampy alluvial plains in the southwest. The other 600 islands range in size from small coral atolls and single volcanic cones to major mountainous islands up to 450 km long. A chain of volcanoes lies along the north coast of New Guinea and through the Bismarck Archipelago and North Solomon Islands all of which are close to the tectonic plate boundary. There are a number of major rivers on the New Guinea mainland with the Sepik, Ramu and Markham draining to the north coast and the Fly, Purari and Kikori draining south. The Fly River is navigable for ore barges and small ships as far upstream as Kiunga, about 800 km upstream. Coral reefs fringe many of the coasts and islands, particularly in the east.

Papua New Guinea has a tropical climate. There is a monsoonal rainy season from November to April. This is significant in the south of the country, but the highlands and small islands normally experience year-round rain. Temperatures on the coast and in the islands range between 21^{o} and 32^{o} C daily with high humidity. The highlands are cooler with frost being experienced on a few occasions each year above 2,000 meters.

Staple crops vary according to climate but root crops of taro, cassava and yams are most common. Sago is the staple in the northwestern coastal areas. All these crops have long growing periods that are even longer in high altitude/low temperature areas.

The nature of the country severely limits movement, particularly on the mainland. Port Moresby has no road links to any of the provincial capitals. The key road transport links are the Highlands Highway, which links the second city of Lae to the Highlands, and a second road that links Lae with the north coast at Madang. This road then continues along the coast in a worsening condition until it eventually ends in Sandaun Province between Aitape and the Provincial capital, Vanimo. Vanimo actually has better road links to Indonesia than to the rest of Papua New Guinea. On the other islands, roads tend to be concentrated around the provincial capitals and major centers, although movement is easier in areas where mining and logging operations are taking place.

Air and sea transport are important to the operations of the country although air transport has declined from the heady days of the 1930s when more airfreight was carried in Papua New Guinea

than in the rest of the world. Nevertheless, there are still people who are familiar with aircraft, but have never seen a car.

Independent since 1974, Papua New Guinea is parliamentary democracy governed by a single assembly in Port Moresby. Until 1995 there were also provincial assemblies, but changes to the constitution have led to a more centralized system of administration.

Some 600 distinct languages are recognized, and there are clear ethnic differences between the cultural groups that live in different areas. A large proportion of the population is rural-dwelling, with many existing on a subsistence lifestyle. Consequently, the per capita annual GDP of USD$ 1,150 per person is a skewed figure. 36% of consumption is accounted for by 10% of the population, while 50% of the population accounts for only 19% of consumption. The differences are wider than those of most comparable countries.

Papua New Guinea ranks lowest in the Asia-Pacific region in many social indicators. Life expectancy at birth is 58 years (*compared with an average in comparable countries of 67 years*); infant mortality rate is 62 per 1,000 live births (*comparable countries: 40*); fertility rate (children per woman) is 4.7 (*comparable countries: 2.6*); 80% of school age boys and 67% of school age girls enter primary school (*100% in comparable countries where older people also enroll in primary school*) but this figure drops drastically later with only 15% of boys and 10% of girls entering secondary education (*65% and 61%*). The latest available figures indicate that only 2% of children achieve tertiary (higher) education (*22%*).

Health indicators are particularly poor. There is one doctor for every 10,000 people (*2 per thousand in comparable countries*); and only 55% of children under 1 year old are immunized against measles (*86% in comparable countries*). About 22% of the population has access to sanitation (*58%*), while 28% has access to safe, clean water (*84%*). Even this access may not be continuous as the 1997-98 drought revealed.

The country has many natural resources. Agriculture has been a long-term source of revenue, but in the last 20 years, mining has overtaken this. In recent years forestry and oil and gas have been exploited, although there has been a significant reduction in the demand for timber as a result of the Asian downturn of the past few years.

2. What are the climate-related and other natural hazards affecting Papua New Guinea?

Papua New Guinea is subject to a wide range of natural hazards. Tropical conditions bring risks from storms, floods and rain-induced landslides. The absence of rain for any unexpectedly long period can lead to drought and the risk of forest and grass fires. Milne Bay Province in the southeast is a tropical cyclone development formation area. Although these storms are rarely as intense as in countries further south, they can cause damage to islands in the province and affect parts of southern New Guinea. The highland provinces experience frosts that damage or even destroy crops. The steep terrain makes much of Papua New Guinea subject to landslides, particularly after heavy rain.

The proximity of Papua New Guinea .to the tectonic plate boundary makes much of the country geologically very active. There are frequent earthquakes, particularly along the north coast of the main islands and near the island of New Britain. In addition to casualties and property damage, these earthquakes can trigger landslides on steep or unstable slopes. Associated with undersea earthquakes, tsunamis are also a threat in coastal areas. There are a number of active volcanoes in the country and the major center of Rabaul situated within a volcanic caldera, being virtually destroyed in 1994.

Other hazards in the country include human, animal and crop diseases as well as the transport and technological hazards found in most developing countries.

3. What was the level of scientific research in Papua New Guinea relating to El Niño?

Little national research on El Niño was carried out in Papua New Guinea in recent years, but Australian researchers did some work in the colonial period. Australians have also carried out post-independence research with some national participation. The main subjects for research appear to have been the impacts on agriculture of the droughts and frosts in the highlands, resulting from the 1972, and 1981/82 and 1997-98 ENSO events.

4. Identify and document (by citations) the historical interest, if any, in Papua New Guinea (popular, political, media) in El Niño before the onset of the forecast and/or impact of the 1997-98 event?

Main historical interest seems to have been inspired by the drought that was associated with the ENSO event of 1982. The published material on ENSO history in Papua New Guinea is dominated by the material created by the UNU International Mountain Society, Boulder, Colorado by Allen, Bryant, Brookfield, Harold, and Byron, Yvonne (eds). 1989. Mountain Research and Development, Vol 9, No 3: "Frost and Drought in the Highlands of Papua New Guinea."

Major articles of interest in this publication include the following:

Allen, Bryant, "Frost and Drought through Time and Space Part I – The Climatological Record". pp 252-278.

Allen, Bryant, Brookfield Harold & Byron, Yvonne. "Frost and Drought through Time and Space Part II – The Written, Oral and Proxy Records and their Meaning", pp 279-305.

Allen, Bryant, Brookfield Harold & Byron, Yvonne. "Frost and Drought through Time and Space Part III – What were the high valleys like when first settled?". pp 306-321.

Brookfield, Harold & Allen, Bryant. "High Altitude Occupation and Environment", pp 201-209.

Waddell, Eric. " Observations in the 1972 frosts and subsequent relief programs among the Enga of the Western Highlands" pp 210-223.

Allott, Chrissy & Morgan, Mic. May 1982. "PNG Highlands Frost Bibliography". Nutrition Section, Department of Health, Konedobu. 37 pp unpublished.

Other documents of interest appear to be unpublished governmental and conference documents of which the only ones sighted have been these:

Eng, Jean. July 1980. "Highlands Frost – 1972 – Papua New Guinea" Nutrition Section, Department of Health Konedobu. 5 pp unpublished.

Morgan, Michael and Gallagher Carolyn. June 1981. "Frost in the Highlands – a case for food and nutrition planning". Paper presented to the National Nutrition Conference, Madang.

A further publication of interest, although not relating directly to any major ENSO event is this:

Wohlt, P.B., Allen, B.J., Goie, A., & Harvey, P.W. 1982. IASER Special Publication No 6: "An Investigation of Food Shortages in Papua New Guinea 24 March to 3 April 1981." Institute of Applied Social and Economic Research, Boroko.

5a. When did the various agencies first hear about this developing El Niño?
Reports of drought appeared in the Papua New Guinea media from July 1997, although mining operations had obviously been hindered by drought during the previous month. Reports from provincial administrations were forwarded to the Department of Provincial and Local Government Affairs during August. While there was some general talk about the 1997-98 El Niño event in 1997, there appears to have been no serious interest in its potential impact on Papua New Guinea, until a weather forecaster returned from overseas studies, to Port Moresby in July 1997. Short of professional staff, the National Weather Office had been unable to commit resources to examine possible impacts until that time. The forecaster researched the event and examined material from the Australian Bureau of Meteorology and the Internet in conjunction with media and provincial reports, before preparing a paper on 7 August for the Director-General of National Disaster and Emergency Services. This paper was shared with the National Disaster Committee, which includes representatives from the major government departments and non-government organizations.

5b. Where did this information come from?
See above.

5c. When did they first hear that it was going to be a strong event? From whom?
The report from the National Weather Office recognized that this was a strong event, but the extent of the impact was not recognized until the results of the first assessment were collected.

5d. Which agencies first received the information?
Department of Provincial and Local Government Affairs (which included National Disaster and Emergency Services) and Department of Agriculture and Livestock first received the information. Through these agencies it was passed to the National Drought Committee and the National Disaster Committee.

5e. Were these the appropriate agencies to get this information first?
Yes

5f. How was the information obtained?
See above re: the first paper. The later information on the impact was obtained from a national assessment of drought impact mounted in October 1997 to examine the validity of escalating claims of drought impact. 13 teams carried out assessments in all provinces, visiting a representative group of communities and assessing against a standard questionnaire. Later assessments were carried out in December 1997 and March/April 1998, although the latter only visited the areas listed as worst affected in previous assessments, and paid more attention to recovery aspects.

5g. How was the information transmitted?
Information was recorded on standard forms. Summaries were faxed back to Port Moresby where possible, otherwise air delivered. The summary information was entered in a database from which maps and general analysis of impacts were prepared. The information from the first two assessments was widely circulated by Department of Provincial and Local Government Affairs, and from the third assessment by the Department of Agriculture and Livestock.

5h. When did the media first report the developing El Niño?
There was a report in The Post Courier newspaper on 2 July of a lack of rain in parts of the Highlands affecting vegetable crops. A report on 7 July that production at one of the gold mines had resumed after being stopped on 19 June due to a water shortage appears to be the first mention of this aspect of the drought. The first mention of El Niño as a phenomenon appears to be in a statement from the then Director General of Natural Disaster and Emergency Services, reported in the Papua New Guinea Post Courier on 29 August 1997. This statement clearly reflects the information provided by the National Weather Office.

5i. How did the media cover the event over time? (Quote headlines, names of radio and TV programs, etc., with dates) Please see the following pages.

The Post Courier Newspaper

2 Jul 97 Dry **weather affecting vegetables**. Report that there had been no rain in Kundiawa and Goroka since early May – March and April were also dry. Highlands were suffering with lettuce, English potato, zucchini and broccoli scarce. *This was the first report traced that could attributed to the El Niño.*

7 Jul 97 Mines **back at full pace**. Porgera Gold Mine back in production after reduced production since 19/6 due to water shortages. Ok Tedi back to exporting after scaling back in mid-June. Rain from 27/6 allowed copper to move down river again.

13 Aug 97 Get **out edict. Dry season strictures hit Ok Tedi mining towns**. Processing plant was closing down at Ok Tedi Mine and workers were being sent home.

21 Aug 97 Frost **destroys food crops in Highlands**. 90% of food gardens reported destroyed in some parts of the Highlands, notably around Tambul and in parts of Enga Province.

28 Aug 97 Ok **Tedi Mine to shut down**

29 Aug 97 (1) **Drawn Out Dry and Frost hit half a million**. Prime Minister expresses concern about the extent of reports of hardships. Director of NDES discusses the impact of El Niño. *This is the first mention of the El Niño phenomenon that was traced in any medium in PNG and obviously stems from the briefing provided to the Director by the National Weather Office*.

(2) **Australian farmers bracing for new El Niño**

3 Sep 97 Government **asked to find K4m for aid help**. Report of the NDES submission to government for K400 million for drought and frost relief activities.

12 Sep 97 (1) **PNG hit by Rash of Disasters**. Reports of frost, drought and bushfires.

(2) **Frost blankets Highlands**. (Village elder reports nothing left in gardens)

(3) **Mine pipeline runs dry.** (Fly River now below 2.5 meters deep – 5 meters is needed for ore barges from Ok Tedi Mine.

22 Sep 97 Central**, Milne Bay hit by drought**. Provinces not considered part of the Highlands affected by the drought. *No mention of El Niño in the report*

5 Oct 97 Heavy **haze linked to El Niño effect**. Report on the persistent smoke haze around Port Moresby

10 Oct 97 Weather **Man: "No relief in sight**". Report of a statement by the head of the National Weather Service Climate Office in Port Moresby.

23 Oct 97 Useful **Rain may be 12 months off** – Experts. Report of a statement by an Australian geographer academic interviewed at the time of the release of the results of the first drought assessment. (*in which he had no role)*

Oct 97 (day not shown) Drought **fuels health crisis: Assessment is nearly complete: Lafanama**. Statement by Chairman of Drought Relief Committee, Peti Lafanama, that typhoid, malaria and diarrhoea were already at epidemic level before the current drought set in.

13 Nov 97 Haze**, Drought may persist until March** – Weather Man. Further statement from National Weather Service Climate Office.

17 Nov 97 Start **of load shedding rationing**. Report on the new rationing system for power in Port Moresby. *From this time until restrictions were eased in 1998, daily papers had regular adverts showing the city divided into regions and indicating when and where power shedding will take place.*

24 Nov 97 **Highlands rejoice at first raindrops**. Report of continuous rainfall since 9 Oct.

27 Nov 97 (1) **Bearing the brunt of El Niño**. Report of the Institute of Global Environment and Society President's briefing. The report mentions that India, Australia and Papua New Guinea were bearing the brunt of the impact. The report was accompanied by a graph showing the falling water level of the Surinumu Reservoir See Annex C.

(2) **NCD facing worst drought ever**. Report of the impact of the drought on the National Capital District within which Port Moresby is situated.

3 Dec 97 **AusAID to continue relief aid.** Australia expects to continue spending AY$ 1 million (US$) per week until March 1998 for drought relief operations AU$ 8 million spent to date delivering 623 tonnes of food to 60,000 people. Report includes mention of second assessment mission, assistance with training for National Disaster and Emergency Services, Australian NGO assistance of AU$ 3 million, planned delivery of food by France, statement from National Weather Service that there was no major change to weather patterns but rain had fallen in some parts of Western Province, Western Highlands Province, Milne Bay Province and some of the islands.

23 Dec 97 **Impact of drought has Kina under stress**. Bank of Papua New Guinea statement that the Kina had been losing value since September.

13 Jan 98 **Food gardens lack planting material**. Shortage of planting material to start staple crops growing in areas where rain had fallen.

3 Feb 98 **El Niño to fade after May, La Niña may follow** Report of WMO statement

8 Apr 98 **Aid rolls in as gardens go green**. Increased rainfall had turned the Highlands green although some parts of the country were still recovering from the drought. Food aid deliveries continued.

9 Apr 98 **Insects devour island food gardens**. The newly growing crops in the island provinces were under severe attacks from large numbers of newly hatched insect pests.

16 Apr 98 **End in sight for El Niño devastation**. Report of a WMO statement

20 Apr 98 **Power all day Wednesday**. First weekday with no power shedding in Port Moresby since restrictions started.

8 May 98 **Drought, frost, still here, says AusAID**. Statement from AusAID reminding people that although rain was falling, crops can take up to 9 months to mature so there will be food shortages in some areas for many more months.

The National Newspaper

8 Jul 1997 **Vegetables, fruits dearer in Lae** Prices of vegetables and other garden crops had risen in Morobe Province under the effects of a long dry spell. Price rises of 200-400% were reported for some items.

11 Sep 97 (1) **Smoke haze may shut Kakamega**. Smoke haze starting to have an impact on air transport operations

(2) **Governors to meet in city today**. Provincial governors, who are also members of Parliament, planning to meet in Port Moresby to discuss their approach to the national government.

12 Sep 97 (1) **Fire rages on Mount Wilhelm.**
(2) Provinces must also pay for drought relief,
(3) **Starvation looms for Barolla people**
(4) **Chambri Lakes go dry – 6 die in East Sepik**
(5) **SHP workers seek help to solve water problem**
(6)**Seek aid from foreign donors says Peipul**

17 Sep 97 **K20m more for drought relief**. Report that Kina 20 million (US$ 13.9 million) could be made available by government for relief if needed.

2 Oct 1997 **Put off bride price compo payments**. Highlanders being urged by government to postpone all bride price and compensation payments and to stop gambling and smoking in the light of the serious effects of the drought to the province

23 October 1997: " Australian air force starts mercy flights" (contains first identified mention of El Niño in this newspaper)

9 December 1997: "El Niño effects may last till March say experts"

6 January 1998: "El Niño showing signs of weakening"

13 May 1998: "Food supply situation recovers after drought"
(Note: in a review of 1997 published on 2 January 1998, the paper mentions that the drought started to "take its toll" in July but by January 1998 rain for six weeks had brought some vegetables back to markets)

Later reports similar to The Post Courier:

Radio and Television
Papua New Guinea's national radio and television networks gave extensive coverage to the effects of the El Niño, although with only occasional mentions of the overall phenomenon. Reports from provinces became commonplace from September 1997, and the airlifts provided many opportunities for TV news coverage of relief operations from October onwards. Details of the programming are still not available, although efforts to obtain them are still being made.

5j. Was the 1997-98 El Niño compared with any previous events?
Not in the media, but in the reports by Bryant and Allen of the U.S., listed below, make comparisons with earlier events.

6. Before the mention of the 1997-98 El Niño, when was the previous mention of El Niño in the media?
None traced but records pre-1997 are poor.

7. What are the scientific views about the existence and the strength of El Niño teleconnections in Papua New Guinea?
Observations of weather and other conditions are very limited in Papua New Guinea, and there is only limited research being carried out – most of it in other countries. The direct impact of major El Niño events on Papua New Guinea appears to be a reduction in cloud cover, which leads to lower rainfall in many parts of the country and increased frequency of frosts in the highlands.

The lower rainfall not only brings drought to some areas but also the drying of the vegetation leads to increased frequency and intensity of bush fires. Some of these are naturally caused, but subsistence farmers who believe that the smoke will bring an increase in rainfall start many.

The smoke haze resulting from the fires tends to remain in many parts of the country over extended periods, which is an indication that there may be a reduction in wind strengths during a major event. The lack of cyclone generation in the Milne Bay Province during such events, probably due to the reduction in water surface temperature, may also be considered likely to extend to a lower incidence of storms of all types. This in turn will reduce the availability of wind generating mechanisms. In the absence of any recorded observations, it is impossible to confirm these views.

In the aftermath of a major El Niño event, there is some evidence that the first plantings of sweet potato in the Highlands of Papua New Guinea will not set tubers and it is not until a later planting that the food supply will start to recover.

8. If known, what were the climate-related anomalies and impacts in Papua New Guinea of the 1982-83 event?
All literature discusses the impact of frost and drought in the Highlands during the 1982-83 event, but there appears to be no information on impacts in other parts of the country. Personal comment indicates that the drought was worse in the Port Moresby area than in 1997-98, but no scientific

confirmation has been identified.

9. What were the 1997-98 climate-related, physical and social impacts of the 1997-98 El Niño in Papua New Guinea? (Include agriculture, health, water supply, migration, etc.)
Climate related impacts were the following:

1. A significant reduction in rainfall over much of the country
2. An increased incidence of frost in all Highlands provinces

These impacts led to drought in many important food-growing areas, and water shortages for communities relying on natural springs and small streams and creeks for water supplies. Communities on atolls also suffered water shortages due to the lack of rain to replenish the fresh water base upon which they rely.

In drought areas there was an increasing incidence of bushfires, which damaged and destroyed surviving crops and also forest areas that might have provided alternative sources of food.

Water shortages also caused a fall in major river levels. The largest mine in the country, which makes a significant contribution to export income, had to close down for an extended period when the level of the Fly River fell so far that barges could no longer carry ore to the loading port.

The level of the major dam that provides water and hydroelectric power for the capital, Port Moresby, fell so far that power rationing in the city was necessary for a period from November 1997 to June 1998. This event had a significant impact on commercial activities.

As a result of food shortages in the densely populated Highlands provinces, the periodic migration of villagers from high altitudes to lower areas was much greater, and many of those who moved congregated in major population centers.

Supplementary food relief deliveries began in October 1997 and continued until May 1998 in some areas. Although priority was given to the worst affected areas, there were some losses in supplies transported by road, when food was stolen while passing through less affected areas.

Papua New Guinea's health system was already run down before the El Niño began to have an impact, and no formal information about the impact of the event on health is available. However, assessment teams reported an increase in diarrhea, skin diseases and upper respiratory tract infections. Although there were reports of deaths caused by the famine, there has been no confirmation of these reports. However, weakness resulting from hunger appears to have made affected people more vulnerable to other diseases, and may have increased the death rate from other causes.

10. What is the reliability of these attributions?
Weather station observations in various parts of the country confirm the drop in rainfall. Three national assessments of the impact of the drought were carried out in September/October 1997, November/December 1997 and March/April 1998. These confirmed the existence of food and water shortages and provided information on other impacts. Confirmation of these reports was

received from government and non-government agencies and from the media.

11. Were any government reports and statements issued before the impacts of the 1997-98 El Niño appeared?
No formal statements, although the Director of National Disaster and Emergency Services did brief the media on expected impacts in August 1997.

12. Were any reports issued after the impacts appeared?
Allen, B. and Bourke, R.M. with J. Burton, S. Flew, B. Gaupu, S. Heai, P. Igua, S. Ivahupa, M. Kanua, P Kokoa, S. Lillicrap, G. Ling, M. Lowe, R. Lutulele, A. Nongkas, M. Poeinou, J. Risimeri, R. Shelton, J. Sowei, K. Ukegawa, N. Willson, D. Wissink and M. Woruba. 1997. "Report of an Assessment of the Impacts of Frosts and Drought in Papua New Guinea – Phase 2." Department of Provincial and Local Government Affairs, Port Moresby.

Allen, B.J. and Bourke, R.M. 1997. "Report of an assessment of the impacts of frost and drought in Papua New Guinea." Australian Agency for International Development, Port Moresby

Bierwith, Phil. N., & McVicar, Tim, R. 1998. "Rapid Monitoring and Assessment of Drought in Papua New Guinea using Satellite Imagery." Consultancy Report to the United Nations Development Program, Port Moresby. Australian Geological Survey Organization, Canberra.

Wayi, B.M. et al. 1998. "Interim Report of the Impact of Frost and Drought in Papua New Guinea – Phase III." Papua New Guinea Department of Agriculture and Livestock, Port Moresby

13. What were the major responses to the event?

1. Power rationing in Port Moresby November 1997-June 1998
2. Supplementary food relief deliveries to worst affected areas from October 1997 to May 1998.
3. Water deliveries to some islands in Milne Bay Province in December 1997

15. Identify (with citations if possible) the extent of national research (in the last 20 years) on climate-related hazards?
No national research identified.

16. Is El Niño explicitly considered to be a disaster in Papua New Guinea?
No

17. Identify (with citations if possible) any international research about the impacts of El Niño events on Papua New Guinea.
Some research into the impact of El Niño events on Papua New Guinea has been carried out by overseas scientists, and this is reported in the reports by Allen and Bourke mentioned above, as well as in Allen, Bryant, Brookfield, Harold, and Byron, Yvonne (eds). 1989. Mountain Research and Development Vol 9 No 3: "Frost and Drought in the Highlands of Papua New Guinea", Published by UNU International Mountain Society, Boulder, Colorado.

18. If a perfect forecast had been available as early as October 1996 (knowing what is known now about the actual impact), what could have been done differently about information flow? (Do not take into consideration at this time any restrictions on possible actions)

Improve reporting flow from districts and provinces to central collecting point. Monitor build-up and identify main points using GIS. Provide regular situation reports to government, provinces and districts.

19. If a perfect forecast had been available as early as October 1996 (knowing what is known now about the actual impact), what could have been done differently about preparing for the forecast impacts? (Do not take into consideration at this time any restrictions on possible actions)

1. Providing training for Highlands farmers on water conservation and irrigation techniques.

2. Identification and improved availability of drought resistant varieties of staple crops and promotion of increased plantings of European potato crops in Highlands areas.

3. Promoting mulching and other soil water conservation practices

4. Promoting improved maintenance and repair of water storage tanks at schools and clinics and the development and improvement of roof water collection systems

5. Developing water collection systems and storages for atolls and dry islands

6. Identifying storages that could be used for relief supplies, if needed

7. Improving the rainfall and other weather observation network and developing improved monitoring and analysis systems

8. Conducting workshops to familiarize emergency management staff at national and provincial levels, on the impact of past El Niño events and expectations for the forecast event.

9. Finalizing responsibilities in an event of this type and establishing the necessary committees and communication systems to make them operate

10. Collecting baseline data so that changes can be easily identified

11. Boosting funding for the health system

12. Improving the reserve power generation capability for Port Moresby.

13. Developing relief polices and ration scales for various eventualities

21. Can El Niño considerations be added explicitly to national disaster plans?
Could be mentioned as a factor in the increased likelihood of serious impacts from other hazards. The plan is a generic plan, which only has a short section on hazards and their characteristics.

22. Identify the strengths and weaknesses in the way the government system responds to El Niño related climate anomalies

Strengths
Availability of enough staff who could develop and manage an ad hoc system when the designated system could not deal with the impact of the El Niño event

Cultural awareness of the coping ability of its population

Understanding of the culture within which provincial pressure for assistance was being presented.

Weaknesses
Failure to provide sufficient financial and other support for the National Weather Office

Failure to develop, monitor and support an effective emergency management system

Nomination of a new structure to deal with the impact of the event, but without clarifying its roles, responsibilities or relationship with the existing system

Lack of political leadership and policy setting, but political interference in operational matters

Failure to clarify and lead the relationship with major donors

Poor relationship between national, provincial and district levels of government

Inadequate and out of date emergency planning

Lack of policy on relief arrangements and issue scales

Lack of a relief distribution and monitoring network

Lack of emergency management training at all levels

Lack of a national authority with responsibility for water supply management and administration

Lack of understanding of the potential impact of a major El Niño event

Lack of any 'lessons learned' from previous events and an inability to trace any records of them.

Limited administrative infrastructure and shortage of suitably trained public service staff

23. Did the 1997-98 El Niño have any influence on Papua New Guinea's response to the forecast in early 1998 of an expected La Niña event?
It was discussed, but no record of any action was traced.

LESSONS LEARNED

A number of lessons were learned from the impact of the 1997-98 El Niño event on Papua New Guinea. Implementation of some of these has begun, but others await the completion of an emergency management development package that is being discussed with Australia in 1999-2000.

Major lessons learned include the need for the following:

A. EMERGENCY MANAGEMENT

1. An emergency management structure with agreed roles and responsibilities that extends from Cabinet level down through national, provincial and district to village level, and encompasses not only the official sector but also the non-government organizations and the business sector.

2. Comprehensive updated national disaster plans that are regularly exercised, tested and reviewed to meet changing threats, administrative arrangements and requirements. These plans should include supporting plans, not only at the provincial and district levels, but also in the various specialist sectors including health, transport, agriculture and water.

3. A comprehensive training program for all those involved in emergency and disaster management

4. A standardized, trustworthy and auditable approach to dealing with funds donated by the public and by donors after a disaster

5. A standardised disaster impact assessment system and teams trained in its use

6. Arrangements under which funds for response operations can be made available quickly in an emergency

B. HAZARD MONITORING

7. A review of current hazard monitoring capabilities and procedures and development of improved systems that will provide early warning of developing threats and regularly updated information on their characteristics and progress

8. A system that ensures that the warnings reach the right people in a timely manner

9. Agreed and widely promulgated arrangements for communicating threat information to the general public, accompanied by appropriate background information and action recommendations

C. PUBLIC INFORMATION AND EDUCATION

10. Public education about the hazards that threaten Papua New Guinea, their origins, causes and characteristics

11. Community education programs, using a variety of channels, that advise the population of the appropriate protective measures to take to protect themselves from the hazards that may threaten them

D. DISASTER PREVENTION AND MITIGATION

12. National hazard and vulnerability analysis followed by a risk management process that identifies the most appropriate management strategies to reduce the impact of the various threats

13. Collection of baseline information that will enable the impact of hazards to be forecast and, if necessary, monitored to enable the most appropriate prevention, mitigation, preparedness, response and recovery actions to be taken

14. Greater attention to be paid to maintenance of existing infrastructure, so that requirements of the population can be dealt with efficiently in an emergency

15. A coordinated approach to dealing with the water supply needs of both rural and urban populations

16. Supplementation of the existing power generation arrangements to keep pace with increasing public and commercial needs in all centers of population;

E. INFORMATION MANAGEMENT

Particular attention to be paid to the management of information in relation to hazards and disasters. This requires the definition of channels for collection, organization, analysis and distribution of information and delegation of appropriate responsibilities. It will require an information management structure that extends from the top to the bottom of society. It should also provide for a two-way flow of information, with a change in culture that encourages understanding of the information needs of others, along with a willingness to share information for the greater good.

There must be improved communications systems between national, provincial and district level disaster managers that would continue to be available in an emergency.

REFERENCES

Allen, Bryant. 1998. "The 1997-98 Papua New Guinea Drought: Perceptions of Disaster". Australian National University, Canberra.

Allen, B.J. and Bourke, R.M. 1997. "Report of an Assessment of the Impacts of Frosts and Drought in Papua New Guinea." Ministry of Provincial and Local Government Affairs, Port Moresby.

Allen, Bryant, Bourke, R Michael et al. 1997. "Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea – Phase 2." Papua New Guinea Department of Provincial and Local Government Affairs. Port Moresby.

Allen, Bryant, Brookfield, Harold, and Byron, Yvonne (eds). 1989. "Frost and Drought in the Highlands of Papua New Guinea", a dedicated edition of Mountain Research and Development, Vol 9, No. 3. The International Mountain Society, Boulder Colorado.

AusAID (Australian Agency for International Development). 1999. "The Economy of Papua New Guinea, Macroeconomic Policies: Implications for Growth and Development in the Informal Sector". International Development Issues, No 53. Canberra.

AusAID (Australian Agency for International Development) 1998. "Papua New Guinea: Coping with Shocks and Achieving Broad-Based Economic Development". International Development Issues, No 52. Canberra.

Australian Bureau of Meteorology, 2000, "SOI Archives – 1876 to Present" http://www.bom.gov.au/climate/current/soihtm1.shtml. [Accessed April 2000]

Bank of Papua New Guinea. 1997 and 1998 Quarterly Economic Bulletins. Port Moresby.

Bank of Papua New Guinea. 1996 Money and Banking in Papua New Guinea. Port Moresby

Basher, R.E., and Zheng, X. 1995. "Tropical Cyclones in the Southwest Pacific: Spatial Patterns and Relationships to Southern Oscillation and Sea Surface Temperature" in Journal of Climate, Vol 8, No 5, Part II May 1995.

Bierwith, Phil. N., & McVicar, Tim, R. 1998. "Rapid Monitoring and Assessment of Drought in Papua New Guinea Using Satellite Imagery". Consultancy Report to the United Nations Development Program, Port Moresby. Australian Geological Survey Organization, Canberra.

Bourke, R. Michael. 1998. "Impact of the 1997 Drought and Frost in Papua New Guinea" Australian National University, Canberra.

Grove, Richard H., and Chappell, John (eds). 2000. El Niño – History and Crisis: Studies from the Asia-Pacific region. The White Horse Press, Cambridge, England.

Henderson, Graham. 1997. "Papua New Guinea. *Operation Ples Drai*". Report of a Rapid Health Assessment, 21 September – 15 October 1997. Care Australia Port Moresby (unpubl).

Higgins, Charles, Barr Joe, and Ratuvuki, Luke. 1997. "Papua New Guinea – Famine Caused by Drought and Frost", United Nations Disaster Assessment and Coordination Team Mission Report, 21 November to 6 December 1997. United Nations Office for Coordination of Humanitarian Affairs, Geneva.

(Hill, David) 1997. "Papua New Guinea Drought Relief Logistical Report". (Unpubl manus)

Jacobson, Gerry. 1997. "Rapid Assessment of the PNG Drought: Severe Water Shortages in the Islands." (Unpubl)

Lea, David, Broughton, Bernard, Murtagh, Brian, Levett, Malcolm, McMurray, Christine, Amoako, Johnson. 1999. Review. Australian Asisstance to the 1997-98 PNG Drought. Canberra.

National Statistics Office. 1994. "Report on the 1990 National Population and Housing Census in Papua New Guinea." Port Moresby.

Ngaffkin, Cletus. March 1998. "Drought Drains Papua New Guinea Foreign Reserves in Pacific Islands", Development Center for Pacific Islands Studies, East West Center, Hawaii http://pidp.ewc.Hawaii.edu/pireport/1998/March/03-11-03.html. [Accessed 23 May 2000]

Wayi, B,M. et al. 1998. "Interim Report of the Impact of Frost and Drought in Papua New Guinea – Phase III." Papua New Guinea Department of Agriculture and Livestock, Port Moresby

World Bank. 1999. World Bank Atlas. Washington