The 1997 Drought and Frost in PNG: Overview and Policy Implications

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Abstract

Major climatic events in 1997–98, including the most serious drought of the past century, significantly affected rural PNG. Widespread and repeated frosts occurred in the highlands, especially at very high altitude locations. In this paper, we give a summary of the impact of the drought and frost, focusing on disruption to village food and water supplies, health, bushfires, water supply for institutions and urban areas, power supply and the national economy. The vulnerability of poor people in certain remote locations is highlighted. The various responses to the drought and frost are summarised, including those of the PNG and Australian governments, other institutions and rural villagers. The assessments of the impacts are described. A series of implications for policy and program development are outlined.

IN 1997–98, the Western Pacific was affected by a major climatic extreme. This led to a very severe drought in much of PNG, with various starting dates in different locations from March 1997. Most of the country received drought-breaking rains between December 1997 and February 1998. Frosts occurred in the highlands from as low as 1450 metres above sea level (masl). At above 2200 masl, repeated frosts caused severe damage to crops. The drought and frost severely disrupted the PNG economy and led to the collapse of normal subsistence food production systems in many places. Many people, from both within PNG and overseas, were involved in assessing the drought and frost impact, in providing relief to rural villagers and in assisting with rehabilitation.

A number of important policy implications have arisen from the events of 1997–98, and from the responses of the PNG people, the PNG national government and provincial administrations, nongovernment organisations (NGOs) and the international community. This paper gives an overview of these issues, together with some policy recommendations to reduce the impact of future climatic extremes. In this section, a series of 17 papers describe the impact of the drought and frost, each from a different perspective and scale.

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Climate and Food Supply in PNG

Rainfall and temperature are the two most important influences on food production in PNG. Rainfall directly affects crop production, with both seasonal and between-year variation. The national network of rainfall observation stations in PNG has shrunk drastically from about 1000 in 1972 to less than 100 in 1997, and many records are broken by missing data. In addition, many clients of the National Weather Office encounter difficulties in accessing data and have to pay excessive amounts for information. Together, these factors mean that it is not possible to provide a detailed description of the changes in rainfall that occurred in 1997.

Rainfall in PNG is heavily influenced by the El Niño Southern Oscillation (ENSO), which has an average return period of about 10 years. ENSO activity involves climatic events due to changes in the sea surface temperature and major air circulation over the Pacific and Indian Oceans. One outcome of moderate ENSO activity is a sequence of heavy rainfall followed by somewhat lower than normal rainfall over a 1–2 year period. Such rainfall patterns can reduce sweet potato production, especially where villagers produce sweet potato continuously (Bourke 1989). The association between rainfall pattern and sweet potato production is often not noticed by villagers due to a time lag of 4–8 months between the two events.

In the highlands of PNG, such food shortages are exacerbated by fluctuations in the sweet potato planting rate, as women vary the planting rate according to the current supply of sweet potato and men vary the amount of land cleared from fallow (Bourke 1988). These food shortages have commonly resulted in localised starvation, and sometimes in widespread famine, especially where people depend on a single major food source such as sweet potato in the highlands. In the lowlands, where regular rainfall seasonality occurs, agricultural systems are designed to ameliorate the effects of variable rainfall (for example, see Food Aid and Traditional Strategies for Coping with Drought: Observations of Responses by Villagers to the 1997 Drought in Milne Bay Province by Jane Mogina, in these proceedings). Today, most rural villagers use cash to buy rice and other food, which also evens out fluctuations in the supply of subsistence foods.

An ENSO event causes widespread, moderate to severe drought in PNG with an average return period of about 10 years. As well, lack of cloud and clear night skies associated with the drought cause frosts in areas above about 2000 masl.

However, once every 50–100 years, an ENSO event causes a drought of such significance that food production is disrupted over wide areas of PNG for periods of up to a year. These droughts are accompanied by bushfires and losses of drinking water supplies. In the past, such events have resulted in large numbers of deaths from starvation and disease. Oral historical and eyewitness accounts of such events have been collected by outside observers, such as patrol officers and missionaries in Southern Highlands, Enga, New Ireland, Milne Bay and Central provinces. Even today, a major drought and frost may overwhelm many people's food and water security.

The 1997 ENSO event was more severe than others recorded over the past 70 years, including those in 1987, 1982, 1972, 1965, 1942, 1941 and 1931. There have also been droughts earlier this century, but we have less information about them. There was a major and widespread drought in 1914, as well as apparently lesser events in 1905, 1902 and 1896 (Allen 1989). The 1997 event was at least as bad as that of 1914, and was probably more widespread and severe. However, we are unable to make more definite comparisons because of the limited records of 1914.

Impacts of the Drought and Frost

The 1997 ENSO event caused serious difficulties to both rural and urban people in PNG, and also affected the national economy. A brief summary of these major impacts follows, and they are discussed in more detail by Bourke (2000). Some of these issues are discussed in more detail in other papers in these proceedings.

Rural food supply

Most rural villagers had their food supply disrupted in 1997, some for many months. By the end of 1997, an estimated 1.2 million villagers (almost 40% of the total rural population) were suffering a severe food shortage, which was life-threatening in some cases. Many others were affected less severely, and some were unaffected (Allen and Bourke 1997b). Food shortages began in mid-1997, became serious by September 1997 for much of the country, and peaked in late 1997 to early 1998. They were largely over by April–June 1998 for most people (Wayi 1998). Recovery was delayed in the highlands to early to mid-1998, because many sweet potato crops that were planted with the return of the rains in late 1997 failed to give normally expected yields (see Postdrought Agricultural Rehabilitation: the 1997–98 El Niño Drought in PNG by Matthew'Wela B. Kanua and Sergei Bang, in these proceedings).

Rural water supply

By December 1997, some 1.5% of rural villagers only had access to limited amounts of drinking water, which was also contaminated or brackish. A further 11.5% of rural people were drinking water of questionable quality or were carrying water for long distances, that is, for more than 30 minutes walk. Thus, over 400,000 people had a grossly inadequate supply of drinking water at the peak of the drought. The situation rapidly returned to normal following rains from December 1997 to January 1998.

Urban and institutional water supplies

The drought had a major impact on many institutions, mainly as a result of water supply problems. For example, four correctional institutions had to be closed in late 1997 because of lack of water. In some locations, almost all community schools were closed. The drought reduced the water supply of a number of small urban locations, including Kerema in Gulf Province and Kundiawa in Simbu Province. Other small urban centres with water supply problems included Balimo in Western Province, Rabaraba in Milne Bay Province and Tambul in Western Highlands Province.

Health

There was much anecdotal evidence from health professionals and villagers that the lack of food and water had an adverse effect on people's health. There were many reports of an increased incidence of diarrhoea, malaria, typhoid, skin diseases and respiratory ailments. There were also some reports of an increased incidence of dysentery.

Bushfires

Extensive fires occurred in forests and grassland. A large number of village houses were burnt by bushfires. There were several accounts of people burnt in these fires, but this was not a common cause of death. Fires were not confined to locations that normally experience a dry season. For example, in the Mt Karimui area in Simbu Province, which normally has a very wet and nonseasonal climate, bushfires had occurred over extensive areas by November 1997. Many airstrips, including Kundiawa in Simbu Province, were closed by smoke and haze in October–November 1997, some for as long as three weeks.

Power supply

Two hydroelectric stations generate most of the electricity in PNG. The Ramu Scheme at Yonki in the Eastern Highlands supplies power for seven provinces and for the industrial city of Lae, Morobe Province. The Surinumu reservoir near Port Moresby provides both power and water to Port Moresby. The water volume in both the Surinumu and Ramu storage reservoirs fell linearly from April 1997. Water levels in the Yonki reservoir declined, but there was still enough water to allow power generation until the rains returned in December 1997. In contrast, the level in the Surinumu reservoir fell to about 20% of water holding capacity by December 1997. If water continued to be used for power generation, there was a high risk that the water supply for the city would become scarce, or could even stop. Thus power generation for Port Moresby was restricted from October 1997. Even with the use of a gas-powered generator and widespread use of private generators, there was an inadequate electricity supply and this caused considerable disruption in Port Moresby, which continued until late 1998.

The national economy

The temporary closure of two large mines as a result of the drought, and the consequent impact on export income, had a major negative impact on the national economy. The Ok Tedi Mine did not operate from August 1997 to March 1998, since the low water level of the Fly River made navigation by barges or small ships impossible and isolated Tabubil and Kiunga in Western Province, the township and port, respectively, for the Ok Tedi Mine. The Porgera Gold Mine also stopped producing in late 1997, but only for 45 days.

The drought did, however, lead to a significant increase in the coffee export crop in 1998, in contrast to predictions by the Coffee Industry Corporation (see The Influence of Available Water in 1997 on Yield of Arabica Coffee in 1998 at Aiyura, Eastern Highlands Province by P.H. Hombunaka and J. von Enden, in these proceedings).

The drought was reported by the PNG Government to be a contributing factor in the massive slide in the value of the PNG kina (PGK), with the currency dropping against the US dollar from about PGK1=US$0.72 in September 1997 to about PGK1=US$0.40 by April 1998. Other analysts suggest that government mismanagement and the Asian economic crisis are likely to have been more important factors in this devaluation. The cost of many imported goods increased during 1997, increasing the cost of living mainly for urban people, even though Rice Industries Pty Ltd absorbed the cost increases in imported rice during 1997 (see The Role of Rice in the 1997 PNG Drought by Neville Whitecross and Philip Franklin, in these proceedings).

Despite the increased cost of imports, the weaker PGK also increased the prices received for export crops. The prices for coffee and cocoa in 1998 were higher than those of recent years, which both encouraged production and assisted rural people to recover from the drought.

Vulnerable areas

The severity of the ENSO climatic event in 1997 was clearly associated with distance from the equator, with greater rainfall deficits south of 5°South. Some locations north of this latitude were also severely affected. The severity of the impact was mediated by the social, economic and political circumstances that prevailed in different parts of the country. Villagers with access to cash or markets where they could earn cash, or to relatives and family with cash, were best able to reduce the impact of the drought and frost.

Conversely, people who had little or no savings, nor the means to earn cash, and had few or no relatives or family in employment suffered disproportionately (Bourke 1999). People falling into this category live in places with limited access to markets and services. These places are commonly located along provincial boundaries, in the zone between the central highlands and the coast, in isolated inland lowland areas on the mainland, in inland New Britain, and on many of the very small islands. In 'normal' times in these places, education and health services are poor, cash incomes are low and child malnutrition rates are well above the PNG average. In 1997, although the Australian Government targeted such people (in areas with no road access) for the supply of supplementary food by air, there is evidence that an unknown number of people in very isolated areas suffered severely and that death rates increased significantly in some such places.

Responses to the Drought and Frost

PNG Government

The response of the national government to the 1997 drought and frost was somewhat haphazard, due to various limitations (see Responses to the 1997–98 Drought in PNG by Peter Barter, in these proceedings). Before the drought, many parts of the government administration were barely functioning: the added pressures of 1997 exposed serious deficiencies in its political and administrative structures.

Two major factors made the administration of the country more difficult during 1997. Firstly, recent reforms contained in the Organic Law on Provincial Governments and Local-Level Governments in 1995 changed the relationship between the national and provincial governments. Secondly, there were changes to district boundaries, which made administrative districts and electorates into the same unit.

In 1997, some implications of these difficulties included:

- a National Disaster and Emergency Services (NDES) organisation, poorly managed for a number of years, that was unable to adequately respond to the crisis;
- all members of parliament being given money for relief based on the population of their electorate, irrespective of the seriousness of the impact of the drought and frost in their electorates;
- a period of almost three months from the time that the emergency was declared until a national trust fund was established to receive monetary aid from national and international donors;
- public expressions of mistrust, by the international aid community of the national government and by the national government of provincial governments; and
- the appointment of officials, followed by their almost immediate removal for reasons that had nothing to do with their competency.

This situation was confounded by a significant proportion of schools and health facilities being closed well before the drought began, due to lack of staff, funds or supplies, and a majority of schools and health centres at which roofs, gutters and tanks had not been maintained for years, so no drinking water had been collected or stored before the drought began. Recognition must be given, however, to those local school teachers and health staff who stayed at their posts and gave outstanding service to their local communities, who were suffering from a lack of drinking water and food. The staff of numerous missions also provided much assistance to needy villagers.

A national government relief effort finally got under way and around 5500 tonnes of rice was distributed using the NDES. How much of it reached people in need is unknown. In a number of provinces, it was reported that rice continued to be supplied long after the worst of the food shortage was over, mainly because, although it had been ordered during the height of the drought, funds for its purchase and distribution took months to reach the provinces.

Australian Government

The Australian Government's response was largely channelled through the Australian Agency for International Development (AusAID) (Allen 2000; see also Australia's Response to the 1997 PNG Drought by Allison Sudradjat, in these proceedings).

Australian–PNG relations were at a low ebb before the drought, due to the Bougainville conflict and Australia's open disagreement with many national PNG Government decisions. Thus, the Australian Government saw an opportunity to show goodwill and concern to PNG during the drought.

Following a number of articles in Australian newspapers alleging deaths from starvation in PNG, PNG asked Australia for assistance to carry out an assessment of the dimensions of the food and water shortages. The Humanitarian Relief Section of AusAID was assigned the task. AusAID funded a national field assessment of food and water supplies in September and again in November (see below), then the Australian Defence Force (ADF) used Hercules and Caribou aircraft and Blackhawk helicopters to transport food. Meanwhile, PNG light aircraft operators were facing severe financial difficulties because passenger and charter flights had fallen off as villagers used their money to buy food rather than to travel. Staff of the Australian High Commission, including AusAID staff, worked extremely long days and up to seven days a week for a number of months. Without their dedication, the three national drought and frost impact assessments would not have been possible, and neither would the Australian relief program have been carried out so efficiently.

AusAID and the ADF entered into a competitive public relations exercise in the media, on television news in particular, and on the Internet, where both organisations set up web pages. By the end of the drought, the Australian and PNG public were left with no doubt that Australia had come to the rescue of PNG and had saved hundreds of thousands of people from starvation. The truth is more complicated.

Thousands of people in isolated areas, with limited cash resources of their own and few relatives living in towns and earning cash incomes, received food in a timely manner from the Australian program that they would not otherwise have received. This almost certainly reduced death rates in those areas. The PNG Government eventually bought and distributed twice the amount of food distributed by Australia. Furthermore, and most importantly, the private citizens of PNG bought and distributed 22 times more additional rice than the Australian program and 11 times as much relief rice as the PNG government program. It is not widely recognised that PNG commercial companies imported and distributed all the rice consumed during the drought, except for that provided as aid by the Japanese Government.

It is important that these facts become better known in PNG, because many citizens believe that they and their government were helpless in the face of natural disaster and administrative chaos. In fact, however, the great majority of people in PNG who needed food during the drought were 'saved' either by their own ingenuity and cash savings, or by their relatives and families.

Other organisations

Many other organisations were heavily involved in both drought relief and rehabilitation. Most provincial governments had a significant input (for example see The El Niño Drought: an Overview of the Milne Bay Experience by Allen Jonathon; and The Experience of the 1997–98 Drought in Simbu Province: Lessons Learnt by Edward Kiza and Mathias Kin, in these proceedings). Some of the experiences of provincial administrations have been documented (for example Western Highlands Province 1998). All of the major churches were involved, as were both the international and local NGOs that operate in PNG. Some of their involvement is summarised in another paper in these proceedings (The Role of Humanitarian Organisations in PNG Drought Response by Royden Howie). Other NGOs that do not normally operate in PNG, including Medecins sans Frontieres, also sent representatives to PNG. A number of people with extensive experience in famine situations elsewhere in the world participated in the impact assessment (see below) and advised local NGOs. All of the major aid donors to PNG were involved in relief and recovery operations, including Australia, the United States, Japan, New Zealand, the European Union, the World Bank and the United Nations Development Programme.

Rural villagers

In PNG, 85% of the population live in rural areas. This simple but very important statistic must not be overlooked. People affected by food and water shortages responded in a number of ways. At first they changed their diets to include more food not normally eaten in large amounts, including cassava, coconuts, mango, ferns, fig fruit, fig leaves, sea almond (*Terminalia catappa*) and *tulip* nuts (*Gnetum gnemon*). When these foods were depleted, they then began to eat what are commonly called 'famine' foods, including banana corms (the basal portion of the stem), self-sown yams, green pawpaw and *pueraria* roots. Some people moved locally, to be nearer water or to land with a higher water table. They tried to preserve planting

material by planting along river banks or in drying swamps. One of the first responses that many people made was to feed less food to their domestic livestock, especially pigs. Because of this, many pigs died from lack of food and heat exhaustion and were then eaten. People also killed their pigs in some locations, and ate or sold the meat.

There was significant migration from rural villages to other rural locations and to towns and cities. The decision to move to a particular place was made on the basis of traditional links that are used to cope with food shortages, or as to where relatives were living, including in towns. The rural to rural migration has occurred previously during subsistence food shortages in recent decades, but the large-scale movement into towns is unprecedented. In the badly frosted areas, people followed historical patterns and migrated to lower altitudes. However, in 1997, they found that conditions there were also marginal because of the drought. After relief food was provided, many moved back to their higher altitude homes.

The most important mediator of the impact of the drought was the amount of money that people had available with which to buy imported food, mainly rice and some flour. The money came from savings, the sale of crops, waged employment or small business. During 1997, rice imports into PNG increased over the predicted sales by 66,000 tonnes. Of this extra rice, the PNG Government purchased 5500 tonnes, the Australian Government purchased 2700 tonnes, the Japanese Government donated 8000 tonnes and 50,000 tonnes was sold through commercial outlets. This means that more than 75% of the extra rice imported during 1997, to make up the shortfall in food from gardens, was purchased by the people of PNG from savings or earnings (see The Role of Rice in the 1997 PNG Drought by Neville Whitecross and Philip Franklin, in these proceedings). A similar situation applied with flour sales, with the bulk of the extra flour purchased through normal commercial outlets (Jim Gregg, Associated Mills, Lae, Morobe Province, pers. comm. 1998). People either bought the additional food for themselves, or bought it for relatives who did not have the means to buy it for themselves.

If no food could be found and no relief food was forthcoming, then people died. Reports of deaths and symptoms of distress, fainting, vomiting and violent stomach pains received by assessment teams in the field became more common as time went on. In a number of locations where a local census had been conducted before and after the drought, there was strong evidence of a significant increase in the death rate. This was documented for remote locations in inland Gulf Province (see Drought, Famine and Epidemic Among the Ankave-Anga of Gulf Province in 1997–98 by Pierre Lemmonier, in these proceedings), the Lake Kopiago area of Southern Highlands Province (see Subsistence at Lake Kopiago, Southern Highlands Province, During and Following the 1997–98 Drought by Rebecca Robinson, in these proceedings) and the Hewa area of Southern Highlands Province (see Impact of the 1997 Drought in the Hewa Area of Southern Highlands Province by Nicole Haley, in these proceedings). Most credible accounts of increased death rates were recorded in isolated locations, where cash income was very limited, people had few relatives living in urban areas or with wage incomes, and there were no alternative food sources, such as coconuts, breadfruit or fish. In the central highlands, where many pigs were killed and eaten, a number of reported deaths of adults and children were associated with symptoms similar to those caused by *pigbel*, a gangrenous condition of the bowel caused by *Clostridium* toxins. This condition can be triggered by a sudden intake of meat protein by people on mainly vegetarian diets.

Assessments

Three national assessments, funded by AusAID, of the impact of the drought and frosts on food and water supplies were undertaken in September1997, November–December 1997 and April 1998 (Allen and Bourke 1997ab; Wayi 1998; see also PNG Disaster Management: 1997–98 Drought and Frost Impact Assessment—Methods Used and Experiences by Sharryl Ivahupa; and Personal Reflections on the Effect of the 1997 Drought and Frost in the Highlands of Central Province by Passinghan Igua, in these proceedings). Teams were rapidly put together, briefed and sent into the field. Reports were sent by telephone and fax to Port Moresby, where a database had been established at the Department of Provincial and Local Government Affairs. In order to assess the number of people affected, the database was based on the 1990 census divisions, and the assessment of food and water supplies was undertaken at the census division level. This was mapped using a geographic information system established during a previous project that has identified and mapped PNG agricultural systems (see Dimensions of PNG Village Agriculture by Bryant J. Allen, R. Michael Bourke and Luke Hanson, in these proceedings). Before they went into the field, teams were given information from this database about the agricultural systems that they would be assessing.

Team members were drawn from Department of Agriculture and Livestock (DAL) research scientists, provincial government departments, Ok Tedi Mining Limited, other agricultural institutions such as the Cocoa and Coconut Extension Agency, and a number of NGOs. The success of the assessments was an outcome of their training, professionalism, courage, determination and experience working in rural areas.

The assessments were criticised in an AusAID review of the Australian drought relief program as exaggerating the impact of the drought and frosts (Lea et al. 1999). The grounds for that judgment are unclear, except for the retrospective knowledge that PNG citizens bought most of the extra rice and flour imported into PNG in 1997. It is probable that the assessments did not take adequate account of the cash reserves or the ingenuity of village people in getting themselves through the shortages, but it is difficult to see how that could have been done at the scale at which the assessments were carried out. This review concluded that there were few, if any, deaths as a result of the drought. However, research in a number of remote locations has confirmed the evidence presented to the field teams: that is, that the death rate increased greatly in some places (see Impact of the 1997 Drought in the Hewa Area of Southern Highlands Province by Nicole Haley; Drought, Famine and Epidemic Among the Ankave-Anga of Gulf Province in 1997–98 by Pierre Lemmonier; and Subsistence at Lake Kopiago, Southern Highlands Province, During and Following the 1997–98 Drought by Rebecca Robinson, in these proceedings).

The assessment teams were troubled by how to deal with the often striking differences in the capacity between individuals and families in quite small communities to support themselves. Within a single community, some people were clearly in serious difficulties, while others appeared to be in a much better position. Thus, the overall assessment at the census division level was made to reflect the worst-affected people in the division.

However, the details of these local situations were recorded on the field forms used by the teams, together with lists of foods being eaten and the means of finding drinking water. At least one form was filled out for most census divisions in the country, and in some divisions up to four forms were completed. Some were filled in by local missionaries or other observers, since the assessment teams also distributed forms to other concerned people.

It was assumed by the coordinators of the assessments that the details on the forms would be used in discussions with PNG and Australian officials to qualify the raw numbers of the estimated populations affected at the census division level before decisions were made about what the response should be. However, once these figures were given to the Australian relief program organisers, no further consultation took place and the decision to supply or not supply food and water were made on the crude five-point scale used in the overall assessment.

The forms also contained information on possible local resources and communications that could be used in the distribution of food, such as missions, the names of local administrators, radio facilities and airstrips to be used to get access to particular groups. None of this information was used by the relief program organisers. These field forms have been saved and copies are held within PNG. They are a rich and detailed source of information on how the drought and frost affected people at the local level.

An attempted assessment of the food shortages on the growth of children under five years old, using the 1982–83 National Nutrition Survey as a baseline, was seriously flawed by poor methodology, a lack of knowledge of the difficulties of carrying out anthropometric measurements in PNG and a lack of any recent baseline information. This survey did not take advantage of the large amount of knowledge of this subject that exists within PNG and Australia (see Some Methodological Problems with the Nutritional Assessment of the 1997–98 El Niño Drought in PNG by Robin Hide, in these proceedings).

Conclusions

The 1997 drought and associated frost had a major impact on food supply for many rural villagers and, to a lesser degree, on urban people. There are many lessons to be learnt from our combined experience during this event. We have drawn up some implications for policy and program development, as follows.

Climate and food supply in PNG

- The PNG National Weather Office must improve the quality and availability of its data.
- PNG should instigate or maintain membership of international weather organisations that monitor ENSO events. In particular, close relationships should be maintained with the Australian Bureau of Meteorology Research Centre, with a free exchange of data and professional development programs.

- PNG weather-observation stations must be stabilised and then increased in number to give good national coverage.
- An organisation within PNG (probably the National Agricultural Research Institute) should be funded to oversee the monitoring of the prices of key foods in local markets. Rises in prices can indicate a shortage in the surrounding area.
- The same organisation should bring together rainfall, temperature and food price information, possibly within a Food Insecurity and Vulnerability Information Mapping System (investigated by the Food and Agriculture Organization of the United Nations and AusAID in 1999), or something similar.

The impact

- 'Poor' areas, that is areas where villagers have poor access to services and markets and very low cash incomes, should be identified. Policies to assist people living in these areas should be developed.
- There should be a national roads policy. Roads already constructed should be maintained as a national priority. The temptation to build new roads into areas with low populations and difficult environments should be resisted. In many cases it is not economically feasible to improve road access, because of small population and rugged country that makes road building and, importantly, road maintenance very costly.
- Policy should stress the importance of educational and health services in such areas. A good education and good health are the best chances people in such areas will have in overcoming the disadvantages of their locations. Programs must give greatly improved support to teachers and health workers in isolated places.
- A policy on the construction and maintenance of light aircraft landing strips in such areas should be revised with the view to giving assistance in some areas.
- High value-to-weight cash crops that can be transported by air should be promoted in such areas, but government at all levels should stay out of purchasing or marketing. The involvement of private enterprise should be encouraged.

Responses by the PNG Government

- The difficulties of administration and governance under the current political reforms must be communicated to government. Of particular importance is the inability of the national government to institute and implement national policies or to ensure that critical services such as education and health are delivered effectively across the whole country.
- NDES is being strengthened, but there remain indications that more has to be done to improve its effectiveness.
- Policies must recognise the importance of imported food in establishing food security in PNG. The great economic costs involved in becoming self-sufficient in rice and flour must also be acknowledged. The money that would be spent on becoming self-sufficient, not withstanding the very high risk that the goal of self-sufficiency will not be achieved, could be better spent in other ways. These could include providing better health and education services in rural areas, and improving the production and marketing of locally grown fresh food, especially staple foods.
- The temptation to make political advantage out of disasters must be resisted at all levels because overall it reduces the capacity of people to cope on their own and increases their vulnerability.

Responses by the Australian Government

- AusAID must take seriously the lessons offered by the 1997 drought and frost in PNG. These include problems of how to deal with national sovereignty; and the need to use people with experience in PNG who can speak pidgin and who have a fundamental respect for PNG culture and people.
- Continued support is needed of research in agriculture and the social sciences by Australian organisations in PNG. The Australian Centre for International Agricultural Research (ACIAR) is a key organisation in this matter. ACIAR could consider widening its programs to include the relevant social sciences.
- Australian politicians and others must resist the temptation to make disasters in PNG into a public relations exercise.

Responses by rural villagers

- The ability of people to cope with extremely difficult conditions should be recognised and publicised. The people of PNG should be proud of their own efforts during 1997 and should not be left thinking that they were rescued from disaster by another country.

- The importance of imported food (in particular rice) and the logistical infrastructure associated with it must be acknowledged.
- The way in which people responded to the 1997 event should be properly documented and published. Similar information about previous events in 1982, 1972 and 1941 should be included.
- The role played by cash earnings and savings should be recognised. This has implications for policies on rural commercial and banking services; on rural telephone systems that allow rural people to communicate with family elsewhere in PNG; on cash crops; and on access to markets and services.
- The very low level of services to rural people, exposed by the 1997 drought and frosts, must not be forgotten.

The assessments

- The success of the assessments depended critically on the availability within PNG of well-educated, professional agricultural and social scientists, with experience in rural areas. Policies that continue to train young PNG people to top professional levels and to give them solid field experiences are very important. Some means must be found to fund the universities, or to train PNG scientists overseas, and then to bring them into organisations that operate at high levels of professionalism and competency in rural areas.
- The 1997 assessment was based on a good knowledge of PNG agricultural systems and some knowledge about what had happened in similar events in the past. This knowledge should be brought together and be made widely available. In 1997–98, many people involved in assessing the impacts and providing relief and rehabilitation drew on the published experiences during earlier climatic extremes, especially those in 1982 and in 1972. The 17 papers published in this section are a contribution towards improving responses to future climatic extremes for the welfare of all Papua New Guineans.

References

Allen, B. 1989. Frost and drought through time and space, Part I: the climatological record. Mountain Research and Development, 9(3), 252–278.

Allen, B.J. 2000. The 1997–98 Papua New Guinea drought: perceptions of disaster. In: Grove, R.H. and Chappell, J., eds, El Niño—History and Crisis. Cambridge, White Horse Press, 109–122.

Allen, B.J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Port Moresby, Australian Agency for International Development.

Allen, B.J. and Bourke, R.M. with Burton, J., Flew, S., Gaupu, B., Heai, S., Igua, P., Ivahupa, S., Kanua, M., Kokoa, P., Lillicrap, S., Ling, G., Lowe, M., Lutulele, R., Nongkas, A., Poienou, M., Risimeri, J., Sheldon, R., Sowei, J., Ukegawa, K., Willson, N., Wissink, D. and Woruba, M. 1997b. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea—Phase 2. Port Moresby, Department of Provincial and Local Government Affairs.

Bourke, R.M. 1988. *Taim hangre*: variation in subsistence food supply in the Papua New Guinea highlands. PhD thesis. Canberra, Department of Human Geography, The Australian National University.

Bourke, R.M. 1989. Influence of soil moisture extremes on sweet potato yield in the Papua New Guinea highlands. Mountain Research and Development, 9(3), 322–328.

Bourke, R.M. 1999. The 1997 drought in Papua New Guinea: development and food security. Development Bulletin, 49, 40–41.

Bourke, R.M. 2000. Impact of the 1997 drought and frosts in Papua New Guinea. In: Grove, R.H. and Chappell, J., eds, El Niño—History and Crisis. Cambridge, White Horse Press, 149–170.

Lea, D., Broughton, B., Murtagh, B., Levett, M., McMurray, C. and Amoako, J. 1999. Australian Assistance to the 1997–98 PNG Drought. Canberra, Australian Agency for International Development.

Wayi, B.M. 1998. Interim report on the impact of frost and drought in Papua New Guinea—Phase III. Unpublished report. Port Moresby, Department of Agriculture and Livestock.

Western Highlands Province 1998. Lessons learned from the drought and frost workshop. Mt Hagen, 19–20 March 1998. Mt Hagen, Western Highlands Provincial Administration and CARE Australia.

Drought, Famine and Epidemic Among the Ankave-Anga of Gulf Province in 1997–98

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Abstract

The food supply and health of the people in some inland locations in Gulf Province were very severely affected by the drought in 1997. In February 1998, I visited the 1100 Ankave-Anga horticulturalists. My aim was to supplement the emergency food supplies they were receiving, especially in the Ikundi Valley. The government estimates that 105 people live in this area, but in fact 300 people live there. Rain fell in late 1997; by February the gardens were green and luxurious, but almost empty of food. However, the Ankave were confident that the gardens would carry food soon and they were no longer reluctant to harvest the small quantities that could be found. In consequence, the food shortages were over. Due to the isolation of the Ankave area and to the lack of health services, the death toll was extremely high in 1997. Malaria, and probably dysentery, killed 7% of the population in about a year, an extremely high death rate. The biggest epidemic took place after the food supplies had been brought into the area.

Introduction

SINCE 1982, I have been regularly conducting anthropological fieldwork among the Ankave-Anga people, who live in the mountains in the far north of Gulf Province. Numbering about 1100, they are spread unequally between three steep-sided valleys that run in the direction of the Gulf of Papua on the southwest flank of the central cordillera. Some 95% of the area is covered in tropical forest; the altitude ranges from 600 to 2800 metres above sea level. The population density is variable but never exceeds 3 people per square kilometre and averages about 1.2 people per square kilometre. Villages and hamlets are situated at altitudes of between 800 and 1400 metres above sea level; they are small, the biggest comprising only about 15 domestic enclosures. Each family owns a house in a hamlet, but it is rarely occupied all year round. For many activities, such as opening a new garden, making and setting eel traps, beating bark capes (*tapas*), preparing lime to be chewed with betel nuts or gathering and preparing wild or cultivated fruit and nut trees, a shelter is constructed in the forest, several hours' walk from the village, where people spend days, weeks or even months.

The Ankave are horticulturalists and gatherers and they raise a few pigs (a mean of 0.5 pigs/person) that they feed with cooked taro. Though they live in or near forests and streams, the people practise hunting and fishing only irregularly. Nevertheless, wild pigs (rarely), cassowaries (even more rarely), marsupials and eels feature in most social exchanges, and are essential for life cycle rituals (for example, marking the birth of a child or the end of mourning). Meals consist mainly of *Xanthosoma* taro (*Xanthosoma sagittifolium*), introduced 50 years ago or so; sweet potato; less frequently, banana (*Musa* cultivars) eaten raw or cooked; and *pitpit* (*Saccharum edule* and *Setaria palmifolia)*. To these are added wild or cultivated leafy

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vegetables (*Amaranthus*, *Diplazium* sp., *Cyathea* sp., *Gnetum gnemon*, *Rungia klossii* and others) and sometimes mushrooms and gourds. Maize was introduced about 40 years ago but remains a marginal part of the diet. Crops are cultivated in temporary gardens at altitudes of 600 to 2000 metres above sea level. Gardens are cleared but not burned over.

In addition to the cultivated plants consumed all year round, the Ankave eat seasonal fruits and nuts from several trees. These trees may occur naturally and be maintained by the people or they may be planted. They include *Artocarpus altilis*, *Pangium edule* and *Pandanus conoideus*. *Pandanus julianettii* trees are found at the top of the mountains (over 2000 metres above sea level), but grow on the no-man's land that lies between Ankave territory and that of their former enemies; these trees are only exploited in the course of two- or three-day expeditions in November, during which only the syncarps fallen on the ground are said to be collected. *Artocarpus altilis*, *Pangium edule*, and *Pandanus conoideus* grow at different altitudes (600–800, 600–1000, and 600–1500 metres above sea level respectively); the fruits of one or another are always available.

The Ankave live at the boundary of three provinces (Gulf, Morobe and Eastern Highlands), so they have remained on the margins of 'development'. At the time of writing (December 2000) they are still without a road, an aid post or a school.

A Plea for Assistance

Since a pastor from the Markham Valley taught about 20 of them to read and write in *Tok Pisin*, the Ankave people from Ikundi write to me once or twice a year. In 1997, at about Christmas time, I received a scribbled note that said something like '*Sun i kukim olgeta gaden na Gavman em i no save helevim mipela*' ('A drought has destroyed all our food gardens, but the government is not assisting us with food aid'). When I rang the town of Menyamya, I found that the situation was serious, even though once or twice the Ikundi Ankave had received food brought in by the Australian Agency for International Development (AusAID).

Being aware of the importance of the message that had reached me, I apparently found the right words to obtain almost immediate financial assistance from the French Ministry of Foreign Affairs, which funded my travel from Marseilles to Ikundi and arranged for the helicopter transport of one tonne of food. (At the beginning of March, the French Government had 60 tonnes of food delivered by Transall aircraft within the framework of an emergency relief agreement between France, Australia and New Zealand. However, the aid delivered to the Ankave preceded this operation.)

The role of researchers was essential to the implementation of this assistance. Reports written for AusAID by a geographer and an agriculturalist from The Australian National University revealed the extent of the problem (Allen and Bourke 1997ab). Dan Jorgensen, from University of London, Ontario, Canada, provided copies of documents that he had made available to researchers from the Association for Social Anthropology in Oceania. The French authorities appreciated the involvement of these scientists and the quality of the information that I was able to pass on to them. Without such extremely precise data, it would have been difficult for me to convince the French Ministry of Foreign Affairs to assist an almost unknown ethnologist to bring food aid to a tiny PNG population.

The Situation at Ikundi

I arrived in Ikundi on 21 February 1998. The rains had started again at the end of December, allowing cracks in the ground to close up so the cultivation of new gardens could begin. From March onwards, there was no water supply problem; the gardens were generally lush, but empty of any food plants. At that point, in spite of the lushness of the vegetation, no garden produce was harvestable: banana plants bore only shrivelled bunches, although the plants were two metres tall; the *Xanthosoma* taros produced only a single tuber, a quarter of the normal thickness, eaten away by insects and 'going to water' when cooked; the sugarcane was poorly developed, rotten inside and shot through with galleries dug out by large white larvae; and the sweet potato produced only leaves and roots, but no tubers. Traditional 'famine food' was in use everywhere.

I did not hear of marsupial animals that had died of thirst, but where mountain torrents normally flowed the Ankave gathered together around stagnant water holes where fish and eels rotted in pools that had progressively dried up. For the first time in their lives, people travelled in the forests, carrying water with them in bamboo tubes. The valleys were spared from the smoke that affected other parts of PNG during the drought, but I was told that the sun and the moon were constantly red. Most of the time, the Ankave were bewildered and distressed by these phenomena, for which the elders had no cultural response. They certainly mentioned the '*time bilong darkness*'—the 17th century eruption of the volcano on Long Island that

plunged New Guinea into darkness for several days—but only in the sense of recalling another-unheard of catastrophe.

Most fortunately, it was during this delicate period that international aid became effective. I was told that the people of Ikundi had twice received food before my arrival, probably in November 1997 and January 1998. The Lutheran Health Service nurses had been there in 1998. To my great surprise—and great delight—the Ankave village of Buu' was known by those responsible for Australian aid. These people had already landed at Buu' twice in large helicopters. From Buu', food was carried to Ikundi, in the next valley, some eight hours' walk away. Unfortunately, the Ikundi Valley was believed to have a population of only 105 people, when in fact there were nearly 300, about 50 of whom lived in the isolated Saa' valley (shown as New Year Creek on the maps). The 50 Yoye-Amara-Ankave from New Year Creek (who are often taken by *kiaps* and sensation-seeking journalists to be stone-age men) told me that they had not received any aid.

International food aid and the harvesting of food plants planted as soon as the rains arrived (maize, beans and pumpkins) allowed the Ankave to hold on until the taro and sweet potato, normally the main food crops, were ready to harvest (April–August). With regular rains, the gardens once more produced sufficient food. Harvests were normal in 1999. However, the Ankave paid a high price during the 1997–98 drought, with a great number of deaths recorded during that period.

Death Rate from the Drought

It is widely believed that few people died of starvation as a result of the drought despite the destruction of most of the 1997 harvest. Nevertheless, mortality rose dramatically: people in a weakened physical condition were more susceptible to pneumonia, tuberculosis and dysentery. Moreover, a major consequence of the drought was an abnormally high number of mosquitoes, resulting in a renewed outbreak of malaria, which is the main indirect cause of illness among the Ankave. In addition, people who were accustomed to drinking directly from watercourses with pure water were forced to drink from pools of polluted water. This was probably responsible for the epidemic that decimated the people from Angai, perhaps due to typhoid.

When I first visited Angai after the drought, I was told that 83 people had died in the Angai Valley alone. I could not verify this figure as I have never carried out a census in that valley. However, I have complete confidence in the person who reported it to me: 'Peter' from Angai, whose extraordinary conscientiousness and eye for detail I have appreciated since 1982. In November 2000, I again raised the question with him, and he listed for me the names of 20 adult males, 24 women and 20 children who had died during the drought, just in the village of Angai. In the village of Ikundi, where I carried out a census in June 1997, I estimated that 13 people had died between June 1997 and February 1998: 4 adults, and 9 children under 6 years of age. With an estimated population of 1100 in 1997, these 77 deaths alone represent a loss of approximately 7% in one year, an enormous percentage. Dr. P. Bonnemère and I have previously estimated the infant mortality rate as about 350 per 1000; unfortunately, it has been stable for almost 20 years. This indicates that the Ankave occupy an area with some of the worst health problems in PNG, even if there are no official figures.

It is particularly worrying to note that at the time these deaths occurred the rains had begun again and the local population had received a great quantity of rice. According to the people of Angai and Ikundi, they consumed only part of what had been provided for them. This was partly because they kept some back as a hedge against a possibly worsening situation if the rains had failed to arrive at the beginning of 1998, but also because the need for the rice was not yet being dramatically felt, even though they were only a few weeks away from such a situation. An abundant food supply was no barrier against the epidemic once it was unleashed. The greatest need was for health care, but inadequate communication meant that health teams arrived several days, and sometimes several weeks, after the start of the epidemic. I believe the health services of the Australian Army encountered a similar situation among another Anga group, in the upper Tauri Valley, towards Tsewi.

Conclusion

The people of Ikundi have had a radio since November 1994 (donated by the neighbouring Morobe Province). The Angai people obtained one only in June 1998 (donated by the French Embassy). Radios can produce marvellous results: for example, in 2000, a measles epidemic was effectively and rapidly arrested following a message sent from Ikundi.

The authorities of Gulf Province believe there are approximately 10,000 people in the 'noncensused, noncouncil areas' situated right along the northern

boundary of the Gulf. These people—unknown to anyone, even to demographers—are at the mercy of dramatic episodes such as those of 1997–98. It is good that these conference proceedings provide an opportunity to draw attention to the anomalies.

Acknowledgments

On behalf of the Ankave people of Ikundi, Angai and Sinde, I wish to thank Bryant Allen, Mike Bourke and Dan Jorgensen. It is only because of the timely reports they published that I took seriously the emergency messge which the Ankave sent me. Darryl Tryon of The Australian National University translated part of this paper into English.

References

Allen, B.J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Australian Agency for International Development, Port Moresby.

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. Poienou, J. Risimeri, R. Shelton, J. Sowei, K. Ukegawa, N. Willson, D. Wissink and M. Woruba. 1997b. 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.

Impact of the 1997 Drought in the Hewa Area of Southern Highlands Province

Nicole C. Haley*

Abstract

This paper gives an account of the 1997 drought and the way it impacted upon the Hewa-speaking peoples of the Lagaip and Upper Strickland river valleys, situated in the most northwesterly corner of Southern Highlands Province, PNG. It examines the strategies used by Hewa people during the drought and the losses they sustained. Central to this discussion is a consideration of how gardens and bush resources were affected by the drought and the extent to which they ultimately recovered. The paper evaluates the provision of food aid in the Hewa area. It also comments on the actual number of Hewa deaths that may be directly attributed to the drought, and the so-called 'witch killings' and violence that were a consequence of the deaths.

DURING 1997–98, Rebecca Robinson and I spent four months in the Hewa area undertaking a social and genealogical study for the Porgera Joint Venture (PJV) project. The first 11 weeks of the fieldwork were conducted during the drought between July and September 1997; the remaining six weeks were conducted after the drought, in the immediate post food-relief period from April to June 1998. In the course of the study, we spent three days to two weeks in each of the major Hewa settlements, mapping clan boundaries, recording histories and genealogies and conducting a household census. We also recorded deaths that had occurred in the period 1987–98, held daily health clinics, held community meetings, surveyed gardens and tried to identify plants and animals. These activities allowed us to monitor the 1997 drought and its impacts upon the lives of the Hewa people.

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Food Security Issues and the Hewa

Hewa subsistence and food security

The Hewa are a remarkably mobile highlands fringe people, numbering approximately 3000. They inhabit the area north and south of the lower Lagaip River in the most northwesterly corner of Southern Highlands Province, extending from the junction of the Lagaip, Strickland and Ok Om rivers east into Enga Province to roughly the Lagaip–Porgera river junction (see Figure 1). The Hewa engage in pig husbandry and practise low-intensity swidden (slash and burn) agriculture based primarily on sweet potato cultivation. They also supplement their diets through hunting, gathering and sago production, which until quite recently were relied upon more than gardening.

Today, the Hewa live in communal houses with up to 40 occupants. These households maintain their own gardens, which tend to be planted only once before a long fallow. In addition to sweet potato, the Hewa cultivate a variety of local and introduced crops, including taro, banana, sago, pumpkin, cassava, breadfruit, corn, pawpaw and a number of leafy greens. Table 1 lists the Hewa crop varieties that we recorded

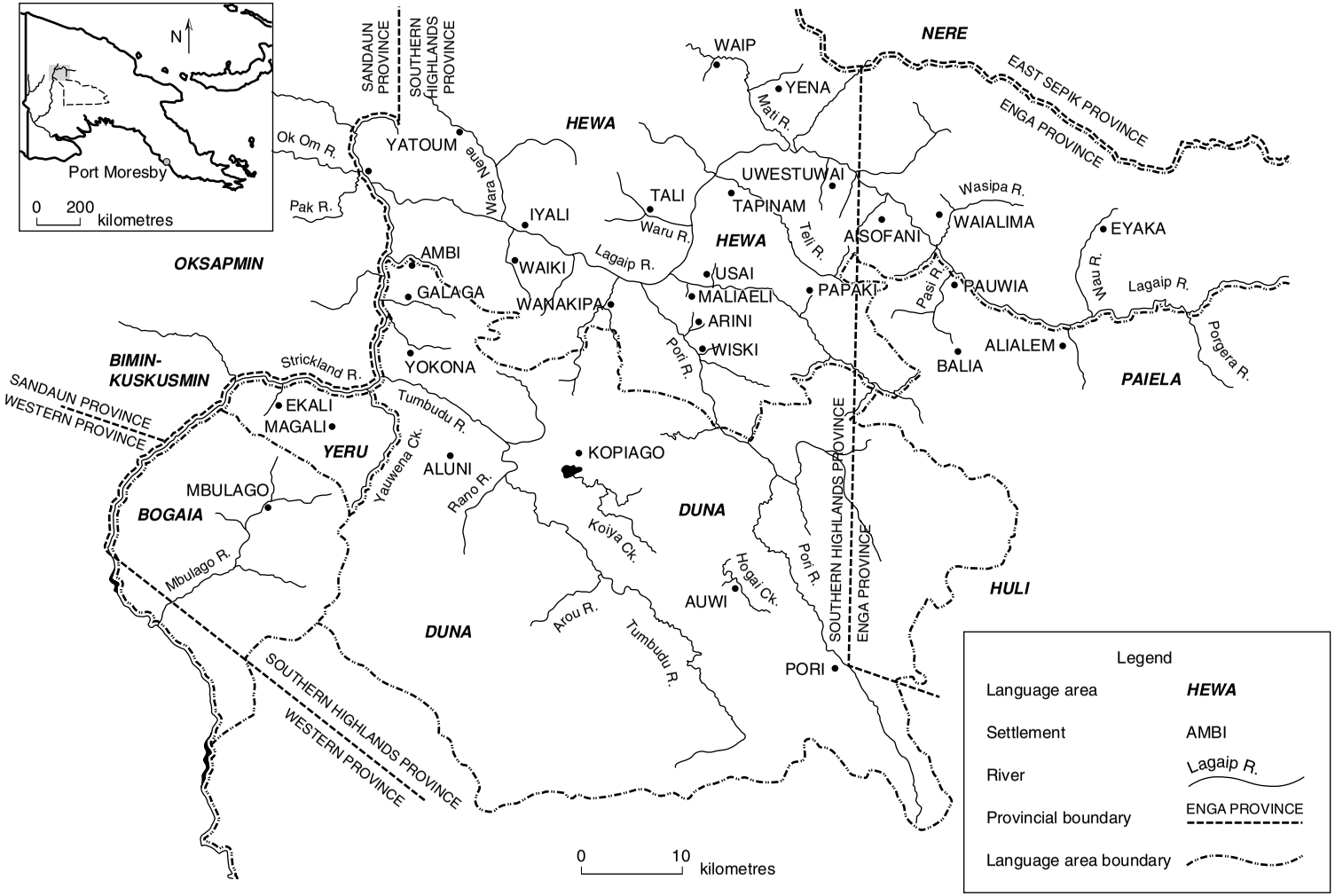

Figure 1. Hewa and neighbouring areas.

in 1997–98 and Table 2 provides a sample of the garden surveys conducted. These give an indication of the range of crops cultivated in individual Hewa gardens. Important food crops gathered by the Hewa on a regular seasonal basis include *marita* pandanus (*Pandanus conoideus*), breadfruit, *pangi* (*Pangium edule*) and sago. When in season, these foods contribute significantly to the diet, as does hunting. Hewa men regularly hunt wild pigs in the grasslands of the Strickland Gorge and in the lower altitude bushland alongside the Lagaip River. As well as hunting, the Hewa engage in spearfishing and collect prawns from the oxbows of the Lagaip River. This range of food sources generally affords the Hewa food security in times of environmental stress.

Factors that threaten food security

Another paper in these proceedings ('An Overview of Food Security in PNG' by R. Michael Bourke) notes that food security in PNG has been enhanced by access to cash and the ability to migrate to better endowed urban and periurban areas when local food security is threatened. Whilst this is generally the situation, neither applies in the Hewa case. Apart from occasional and fleeting reminders that they are part of the PNG state, the Hewa have been all but left to their own devices during both the colonial and postindependence periods. They lack even the most basic services. Indeed, because their area is remote, sparsely populated[1] and not easily accessible except by air, the Hewa have received little attention from either missions or government, and have neither a regular school nor government-funded health facilities. Their main sources of external contact, to date, have been with mineral prospectors and developers or with law enforcement agents seeking to apprehend or punish those responsible for witchcraft-related killings (see Hatanaka and Bragge 1973; Pascoe 1975ab; Haley and Robinson 1998).

Part of the reason why the Hewa lack even the most basic services lies in confusion as to which local government authorities are responsible for administering them; despite being few in number, the Hewa extend into two provinces (Enga and Southern Highlands), four census divisions and four local council areas. Apart from the six easternmost settlements, all Hewa settlements are actually located within Southern Highlands Province, although Sandaun (West Sepik) Province is often reputed to be responsible for the Sisimin Hewa and the North Hewa groups as far east as Waialima (see Brutti 1998ab; Kanua and Liripu 1997).

Whatever the reasons for their neglect, it remains the case that few Hewa have had any formal schooling, lived in urban areas or ever engaged in paid employment. Hence they have little cash. At Tali, for example, in January 1998, the combined cash resources of the then 57 residents was only 156 PNG kina (PGK).[2] That the Hewa are poor, even by rural standards, is also evidenced by the small amounts of cash included in bride price and compensation payments. For example, when a 30-year-old North Hewa man recently drowned in the Lagaip River, his family was compensated with five live pigs, 160 PGK, and three bows (author's unpublished data). These examples show that, even if the Hewa had had access to store-bought foods during the drought, which they did not because there are no trade stores in the Hewa area, their capacity to purchase food would have been very limited.

Hewa health

Another factor relevant to the way the Hewa managed during the drought was their general state of health. The Hewa face extreme hardship in terms of health. Government health workers have long since left, government health patrols have all but ceased, and aidposts have either been abandoned or lack basic supplies. Together, these factors have contributed to death rates that are higher than those generally expected for rural populations in PNG and population growth rates that are lower than those recorded elsewhere in Southern Highlands Province. In the decade from 1987, for example, South Hewa people died at an average rate of 15 per 1000 per year, and North Hewa people died at an average rate of 23 per 1000 per year. This compares with a crude death rate of 12 per 1000 per year in the Tari area of Southern Highlands Province (Lehmann et al. 1993).

1. Based on our census data collected in 1997–98 (Robinson and Haley 1998ab), Robinson (1999) has calculated that the Hewa population density varies between 0.5 and 3.5 people per square kilometre of arable land in the North Hewa and South Hewa areas, respectively.

2. In 1998, 1 PGK = approx. US$0.49 (A$0.77).

Table 1. Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
Abelmoschus manihot	*Aibika*	*Taiyu/fangua*	*Hanguli*	na	na	
			Kokmatai	na	na	
			Kuk	na	na	
			Mbetala	Pale stem	na	
			Namania	na	na	
			Noulap	na	na	
			Tailalap	na	na	
			Wanmuni	na	na	
Acorus calamus	Bog iris	*Wap*	na		Old variety	
Albizia sp.	na	*Sipai*	*Waimo*	Edible leaves	Old variety	
			Yunuwaima		Old variety (Waialima)	
Allium cepa	Onion/shallot	*Aniani*	na	na	Kopiago	
Alocasia sp.	Taro	*Panei/sau*	Kenal	Yellow and red tuber	Old variety	
	Giant taro	*Kenal*	na		Old variety	
Amaranthus tricolor	Amaranth spinach	*Lupalupa/paitala*	na	na	na	
Arachis hypogaea	Peanut	*Pinat/galipa*	*Mopiima*	Red variety	PNG Government	
Araucaria cunninghamii	Hoop pine	*Yalu*	na	na	Old variety	
Artocarpus camansi	Breadfruit	*Anua*	na	na	na	
Bambusa sp.	Bamboo	*Wapeyai/kakain*	na	na	Old variety	
Brassica chinensis	Chinese cabbage	*Wat sich*	na	na	na	
Capsicum frutescens	Chilli	*Sili*	na	na	PNG Government	
Carica papaya	Pawpaw	*Mopiaiyo/popo*	na	na	na	
Castanopsis acuminatissima	Chestnut	*Tiyal/piala*	na	na	Old variety	
Casuarina oligodon	She-oak	*Yowal*	na	na	Old variety	
Citrullus lanatus	Watermelon	*Wataplen*	na	na	na	
Citrus sp.	Citrus	*Muli*	na	na	na	

Continued on next page

Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
Colocasia esculenta	Taro	*Panei/sau*	*Ainowa*	na	Old variety	
			Eleleyan	Yellow tuber	Old variety	
			Elipali	na	Old variety	
			Inai	na	Old variety	
			Invetai	na	Old variety	
			Kanaiya	na	Old variety	
			Lan	White tuber	Oksapmin pre-1934	
			Makaperei	na	Old variety	
			Miyan	Red tuber	Old variety	
			Mos	na	Old variety	
			Simbu	Large tuber	Simbu Province	
			Sinai	White tuber	Paiella Hewa pre-1934	
			Tapli	na	Old variety	
			Tsinali	na	Old variety	
			Yiyai	na	Old variety	
Cordyline fruticosa	Cordyline	*Yafuf*	na	na	na	
Cucumis sativus	Cucumber	*Pene*	na	Large, white skin	North Hewa	
			Fimalu	Small, green skin	Old variety	
Cucurbita moschata	Pumpkin	*Papkin/papwoi*	*Flipambo*	Long pumpkin	Papaki 1996	
			Mbisel	na	Kopiago 1970	
			Mis	Really long pumpkin	Kopiago 1967	
			Sepik	Round, green skin	Kopiago pre-1965	
Cyathea sp.	Tree ferns	*Utam*	na	na	Old variety	
Cyclosorus sp.	Bush ferns/greens	*Wutame*	na	Edible fronds	Old variety	
Cyrtosperma chamissonis	Wild/swamp taro	*Tal*	na	na	Old variety	

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Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
Dioscorea sp.	Yam	*Akwei ta*	na	na	Old variety	
			Masei	Wild yam	Old variety (Yena)	
Eugenia malaccensis	Malay apple	*Uwai*	na	na	Old variety	
Ficus copiosa	*Kumu musong* fig	*Likya/toptop*	na	Edible leaves	Old variety	
Finschia sp.	Finschia	*Wuapsal*	na	Edible kernels	Old variety	
Gnetum gnemon	*Tulip*	*Ilai/talu*	na	Edible leaves	na	
Ipomoea batatas	Sweet potato	*Akoi*	*Aluni*	na	Aluni	
			Andakap	White skin, white tuber	Kopiago/Galaga 1992	
			Apiam	Red skin, yellow tuber	Hagen/Sisimin 1984	
			Bespele	na	na	1997
			Bone	na	na	1997
			Bumtek	na	na	1997
			Kakali	Red skin, white tuber	Old variety	1997
			Kambim	Yellow skin, yellow tuber	Kopiago/Papaki 1983	
			Kapanau	na	Old variety	1983
			Kena kena	White skin, red tuber	Kopiago	1997
			Koman	na	Kopiago	1997
			Kuana	na	Kopiago	1997
			Madang	White skin, yellow tuber	Sisimin 1991	
			Mamim	Red leaves, yellow tuber	na	
			Mendi	na	na	1983
			Metene	Red skin, white tuber	na	1997
			Metipan	Red skin, red tuber	Old variety (Waiki)	
			Mindi	na	Old variety	
			Nalu	Red skin, white tuber	Hagen/Sisimin 1984	1997
			Omora	na	Oksapmin	

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Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
			Paiapua	Red skin, white tuber	Old variety	
			Palala	na	Kopiago	
			Pan	Yellow skin, yellow tuber	Hagen/Sisimin c1984	
			Pati	na	Arini 1995	
			Patu	Yellow skin, yellow tuber	Paiella Hewa 1990	
			Pisam	White tuber, white skin	Goroka 1973	1997
			Pokoli	na	Kopiago	
			Pom	na	na	1983
			Sakala	na	Old variety	1983
			Tataka	na	Old variety	1983
			Tatawi	na	Old variety	1983
			Tau	na	Old variety	1983
			Tei	na	na	1997
			Tulien	Red skin, white tuber	Waranene	
			Tumon	White skin, red tuber	Old variety	
			Walitako	na	North Hewa	
			Walmin	Red skin, cream tuber	Oksampmin 1967	1997
			Wanmun	Purple skin, white tuber	Old variety	
			Wipiak	na	North Hewa	
			Wiski	Red skin, white tuber	Wiski	
			Wome	na	na	1997
Lagenaria siceraria	Bottle gourd	*Ataoi kouta/ataoipwoi*	na	na	Old variety	
Lithocarpus rugi-villosus	Oak	*Niki*	na	na	Old variety	
Lycopersicon esculentum	Tomato	*Tamato*	na	na	PNG Government	
			na	na	na	

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Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
Manihot esculenta	Cassava	*Paikuwa/topapu*	*Epalu*	Brown skin, yellow tuber	Kopiago 1985	
			Lobal	White skin, yellow tuber	North Hewa 1960	
			Toi	White skin, white tuber	Old variety	
			Tokolapia	Brown skin, white tuber	Sepik/Sisimin 1940	
Metroxylon sagu	Sago	*Kahpi/angiawe*	*Kap*	na	Old variety (Yena)	
			Angiawe	na	Old variety (Eyaka)	
			Waip	na	Old variety (Yena)	
Musa sp.	Banana	*Kuan*	*Atuwao*	Sweet	Old variety	
			Hogong	Cooking, long	Old variety	
			Kaiyo	Cooking	Old variety	
			Kotao	Sweet, short	Kopiago 1972	
			Lelekeno	Sweet, long	Sepik	
			Liyao	Cooking, short	Old variety	
			Mam	Sweet/cooking, short	Old variety	
			Meku	Cooking	Old variety	
			Muwei	Cooking, long	Old variety	
			Nenekaino	Sweet	Old variety	
			Nenekoma	Sweet, long	Old variety	
			Oma	Sweet/cooking, long	Old variety	
			Pakai	Cooking, long	Old variety	
			Pei	Cooking, long	Old variety	
			Petei	Sweet, short	Old variety	
			Pis	Cooking	Old variety	
			Pisaka	Sweet, short	Old variety	
			Pisokol	Sweet/cooking	Old variety	
			Sakal	Sweet	Old variety	

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Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
			Sakan	Sweet, short, pale leaves	Old variety	
			Silao	Cooking	Old variety	
			Sugu	Sweet/cooking	Wanakipa 1945	
			Suksuk	Cooking, long	Old variety	
			Tali	Cooking, long	Old variety	
			Taru	Cooking, fast growing	Old variety	
			Telemap	Cooking, long	Old variety	
			Tiwei	Cooking, short	Old variety	
			Toku	Sweet, red skin	Old variety	
			Tsakal	Cooking	Old variety	
			Tuwa	Sweet/cooking, red leaves	Old variety	
			Ungolo	Cooking	Paiella 1982	
			Wakananem	Sweet	Old variety	
			Wampelei	Cooking, long	Old variety	
			Wanop	Sweet/cooking	Old variety	
			Wanuf	Cooking	Wuoane 1967	
			Wifal	Cooking, long	Old variety	
			Wifam	Cooking	Old variety	
			Wuaka	Cooking	Old variety	
			Wuakapa	Cooking, short	Old variety	
			Wueip	Sweet/cooking	Old variety	
Nasturtium officinale	Watercress	*Hambo*	na	na	na	
Nicotiana tabacum	Tobacco	*Apai*	na	na	Old variety	
Nothofagus sp.	Beech	*Yau/mamo*	na	na	Old variety	
Oenanthe javanica	Water dropwart	*Husalu*	na	na	na	

Continued on next page

Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
Pandanus conoideus	Fruit pandanus	*Ogol*	*Atema*	Yellow fruit	Old variety	
			Mapiima	Red fruit	Old variety	
			Mapu	Rare	Old variety	
			Opaa	Red fruit	Old variety	
Pandanus julianettii	Nut pandanus	*Akoi*	na	na	Old variety	
Pangium edule	*Pangi*	*Kuka*	na	na	na	
Persea americana	Avocado	*Mbata*	na	na	na	
Phaseolus vulgaris	Common bean	*Kum/matano*	na	na	na	
Psophocarpus tetragonolobus	Winged bean	*Tomai/wuntua*	na	na	na	
Rorippa sp	Crucifer spinach	*Lita*	na	na	na	
Rungia klossii	Acanth spinach	*Ketepa/pandala*	na	na	na	
Saccharum edule	Lowland *pitpit*	*Nakh*	na	na	Old variety	
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapeima*	Thick, red skin	Old variety	
			Pasim	Thick, white/green skin	Old variety	
			Pisam	Thick, yellow/red skin	Old variety	
			Yefei	Very thick green skin	Old variety	
Sechium edule	Choko	*Sokop/saiko*	na	na	na	
Setaria palmifolia	Highlands *pitpit*	*Paina/isao*	*Isao*	Large, white	Old variety	
			Kalu	Red	Oksapmin pre-1934	
Trichosanthes pulleana	Climbing cucurbit	*Kusi*	na	Red melon-like fruit	na	
Xanthosoma sagittifolium	Singapore taro	*Panei/sau*	*Singapo*	na	Kopiago 1980	
		Sakukun	*Singapo*	na	Kopiago 1980	
Zea mays	Corn	*Kona*	na	Yellow kernel	PNG Government.1970	
Zea mays	Corn	*Kona*	*Senia*	Red kernel	PNG Government 1970	
Zingiber officinale	Ginger	*Wais/palena*	na	na	Old variety	

Continued on next page

Table 1 (cont'd). Hewa garden crop varieties.

Scientific Name	Common name	Local name	Variety	Description	Origins	Date if lost
na	Edible fungus	*Mikia/tele*	na	na	Many varieties	
na	Edible fruit	*Wuak*	na	na	Old variety	
na	Wild breadfruit	*Yetu*	na	na	na	

na = not available

Table 2. Garden surveys.

Rama Alolu's garden alongside the Wanika River, Wanakipa area, South Hewa, cleared from secondary forest after a five-year fallow, August 1997.

Scientific Name	Common name	Local name	Variety	Origin
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Artocarpus camansi	Breadfruit	*Anua*	na	Old variety
Carica papaya	Pawpaw	*Popo*	na	na
Colocasia esculenta	Taro	*Pane*	na	na
Cucurbita moschata	Pumpkin	*Pumpkin*	*Sepik*	Kopiage (pre-1965)
Cyrtosperma chamissonis	Swamp taro	*Tal*	na	Old variety
Ipomoea batatas	Sweet potato	*Akoi*	*Kakalia*	Old variety
			Pisam	Goroka
			Walmin	Old variety
			Wiski	Wiski (1991)
Manihot esculenta	Cassava	*Paikuwa/togapu*	*Epalu*	Kopiago
			Tokolapia	Old variety
Musa sp.	Banana	*Kan*	na	na
Nicotiana tabacum	Tobacco	*Ai*	na	Old variety
Pandanus conoideus	*Marita*	*Ogol*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	na	Old variety
Zea mays	Corn	*Kona*	na	PNG Government (1970)
na	Bean	*Kum/matano*	na	na

Isao Martin's dryland garden, Waiki area, South Hewa, cleared from secondary forest after a 25-year fallow, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Allium cepa	Spring onion	*Aniami*	na	Kopiago
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Carica papaya	Pawpaw	*Popo*	na	na
Colocasia esculenta	Taro	*Pane/sau*	*Sinai*	Old variety
Cucurbita moschata	Pumpkin	*Pumpkin*	*Mbisel*	Kopiage (1970)
Ipomoea batatas	Sweet potato	*Akoi*	*Andakap*	Galaga (1992)
			Apiam	Old variety
			Madang	Sisimin (1991)
			Metipan	Old variety
			Paiapua	Old variety
			Tuomn	Old variety
			Walumin	Old variety
			Wiski	Wiski (1993)
Laportea interrupta	Bog iris	*Wap*	na	Old variety
Manihot esculenta	Cassava	*Paikuwa/togapu*	*Lobal*	North Hewa
			Tokolapia	Old variety

Continued on next page

Table 2 (cont'd)**.** Garden surveys.

Scientific Name	Common name	Local name	Variety	Origin
Musa sp.	Banana	*Kan*	*Lelekeno*	Sepik
			Tsakal	Old variety
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapiema*	Old variety

Isao Martin and Lupet Naliap's dryland garden, Waiki area, South Hewa, cleared from secondary regrowth after a 5-year fallow, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Abelmoschus manihot	*Aibika*	*Taiyu*	na	na
Allium cepa	Spring onion	*Aniami*	na	Kopiago
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Arachis hypogaea	Peanut	*Pinut/galipa*	*Mopiima*	PNG Government
Carica papaya	Pawpaw	*Popo*	na	na
Citrullus lanatus	Watermelon	*Wataplen*	na	na
Colocasia esculenta	Taro	*Pane/sau*	*Sinai*	Old variety
Cucurbita moschata	Pumpkin	*Pumpkin*	*Mbisel*	Kopiage (1970)
Ipomoea batatas	Sweet potato	*Akoi*	*Andakap*	Galaga (1992)
			Apiam	Old variety
			Madang	Sisimin (1991)
			Metipan	Old variety
			Paiapua	Old variety
			Pati	Arini (1995)
			Tuomn	Old variety
			Walumin	Old variety
			Wiski	Wiski (1993)
Laportea interrupta	Bog iris	*Wap*	na	Old variety
Manihot esculenta	Cassava	*Paikuwa/togapu*	*Tokolapia*	Old variety
Musa sp.	Banana	*Kan*	*Atuwano*	PNG Government
			Lelekeno	Sepik
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapiema*	Old variety
Zea mays	Corn	*Kona*	na	PNG Government
			Senia	PNG Government

Continued on next page

Table 2 (cont'd)**.** Garden surveys.

Phillip and Mattius Tipiyao's dryland garden, Wusai Area, East Hewa, cleared from secondary forest after a 15-year fallow, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Alocasia sp.	Taro	*Pane*	*Kenal*	Old variety
Colocasia esculenta	Taro	*Pane*	*Eleleyan*	Old variety
			Lan	Oksapmin (pre-1934)
			Miyan	Old variety
			Sinai	Paiella Hewa (pre-1934)
			Singapo	Kopiago (1980)
Cucumis sativus	Cucumber	*Pene*	*Fimalu*	Old variety
			na	North Hewa
Cucurbita moschata	Pumpkin	*Pumpkin*	*Flipambo*	Papaki (1996)
			Mis	Kopiago (1967)
			Sepik	Kopiago (pre-1965)
Ipomoea batatas	Sweet potato	*Akoi*	*Apiam*	Hagen (1984)
			Kambin	Kopiage (1983)
			Nalu	Hagen (1984)
			Pan	Hagen (1984)
			Patu	Paiella Hewa (1990)
			Walumin	Oksampmin (1967)
			Wiski	Wiski (1984)
Lycopersion esculentum	Tomato	*Tamato*	na	PNG Government
Manihot esculenta	Cassava	*Oaikuwa/togapu*	*Lobal*	North Hewa
			Tokolapia	Old variety
Musa sp.	Banana	*Kan*	*Kota*	Kopiago (1972)
			Liyao	Old variety
			Mam	Old variety
			Pakai	Old variety
			Pisokol	Old variety
			Silao	Old variety
			Sugu	Wanakipa (1945)
			Telemap	Old variety
			Ungolo	Paiella (1982)
			Wanuf	Wuoane (1967)
			Wifam	Old variety
			Wuakapa	Old variety
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	Mapiema	Old variety
			Pasim	Old variety
			Yefei	Old variety
Setaria palmifolia	Highlands *pitpit*	*Paina*	Isao	Old variety
			Kalu	Oksapmin (pre-1934)
Zea mays	Corn	*Kona*	na	PNG Government (1970)

Continued on next page

Table 2 (cont'd)**.** Garden surveys.

Mark and Joseph Tipiyao's garden alongside the Urei River, Wusai area, East Hewa, cleared from primary forest, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Allium cepa	Spring onion	*Aniami*	na	Kopiago
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Carica papaya	Pawpaw	*Popo*	na	na
Colocasia esculenta	Taro	*Pane/sau*	*Sinai*	Old variety
Cucurbita moschata	Pumpkin	*Pumpkin*	*Mbisel*	Kopiage (1970)
Ipomoea batatas	Sweet potato	*Akoi*	*Andakap*	Galaga (1992)
			Apiam	Old variety
			Madang	Sisimin (1991)
			Metipan	Old variety
			Paiapua	Old variety
			Tuomn	Old variety
			Walumin	Old variety
			Wiski	Wiski (1993)
Laportea interrupta	Bog iris	*Wap*	na	Old variety
Manihot esculenta	Cassava	*Paikuwa/togapu*	*Lobal*	North Hewa
			Tokolapia	Old variety
Musa sp.	Banana	*Kan*	*Lelekeno*	Sepik
			Tsakal	Old variety
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapiema*	Old variety

Isao Martin and Lupet Naliap's dryland garden, Waiki area, South Hewa, cleared from secondary regrowth after a 5-year fallow, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Allium cepa	Spring onion	*Aniami*	na	Kopiago
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Arachis hypogea	Peanut	*Pinut/galipa*	*Mopiima*	PNG Government
Carica papaya	Pawpaw	*Popo*	na	na
Citrullus lanatus	Watermelon	*Wataplen*	na	na
Colocasia esculenta	Taro	*Pane/sau*	*Sinai*	Old variety
Cucurbita moschata	Pumpkin	*Pumpkin*	*Mbisel*	Kopiage (1970)
Abelmoschus manihot	*Aibika*	*Taiyu*	na	na

Continued on next page

Table 2 (cont'd)**.** Garden surveys.

Scientific Name	Common name	Local name	Variety	Origin
Ipomoea batatas	Sweet potato	*Akoi*	*Andakap*	Galaga (1992)
			Apiam	Old variety
			Madang	Sisimin (1991)
			Metipan	Old variety
			Paiapua	Old variety
			Pati	Arini (1995)
			Tuomn	Old variety
			Walumin	Old variety
			Wiski	Wiski (1993)
Laportea interrupta	Bog iris	*Wap*	na	Old variety
Manihot esculenta	Cassava	*Paikuwa/togapu*	*Tokolapia*	Old variety
Musa sp.	Banana	*Kan*	*Atuwano*	PNG Government
			Lelekeno	Sepik
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapiema*	Old variety
Zea mays	Corn	*Kona*	na	PNG Government
			Senia	PNG Government

Phillip and Mattius Tipiyao's dryland garden, Wusai Area, East Hewa, cleared from secondary forest after a 15-year fallow, September 1997.

Scientific Name	Common name	Local name	Variety	Origin
Abelmoschus manihot	*Aibika*	*Taiyu*	na	na
Alocasia sp.	Taro	*Pane*	*Kenal*	Old variety
Amaranthus tricolor	Amaranth spinach	*Lupalupa*	na	na
Colocasia esculenta	Taro	*Pane*	*Lan*	Oksapmin (pre-1934)
			Miyan	Old variety
			Sinai	Paiella Hewa (pre-1934)
Cucumis sativus	Cucumber	*Pene*	*Fimalu*	Old variety
Cucurbita moschata	Pumpkin	*Pumpkin*	*Sepik*	Kopiago (pre-1965)
Ipomoea batatas	Sweet potato	*Akoi*	*Apiam*	Hagen (1984)
			Kambin	Kopiage (1983)
			Nalu	Hagen (1984)
			Pan	Hagen (1984)
			Walumin	Oksampmin (1967)
			Wiski	Wiski (1984)
Lycopersion esculentum	Tomato	*Tamato*	na	PNG Government
Manihot esculenta	Cassava	*Oaikuwa/togapu*	*Epalu*	Kopiago (pre-1934)
			Toi	Old variety

Continued on next page

Table 2 (cont'd)**.** Garden surveys.

Scientific Name	Common name	Local name	Variety	Origin
Musa sp.	Banana	*Kan*	*Mam*	Old variety
			Pisokol	Old variety
			Silao	Old variety
			Telemap	Old variety
			Ungolo	Paiella (1982)
			Wanuf	Wuoane (1967)
			Wifam	Old variety
			Wuakapa	PNG Government (1970)
Nasturtium officinale	Watercress	*Hambo*	na	na
Nicotiana tabacum	Tobacco	*Apai*	na	Old variety
Rungia klossii	Acanth spinach	*Korepa*	na	na
Rorippa sp.	Crucifer spinach	*Lita*	na	na
Saccharum officinarum	Sugarcane	*Mbisam/alia*	*Mapiema*	Old variety
			Pasim	Old variety
			Pisam	Old variety
			Yefei	Old variety
Sechium edule	Choko	*Sokop*	na	na
Setaria palmifolia	Highlands *pitpit*	*Paina*	*Isao*	Old variety
			Kalu	Oksapmin (pre-1934)
Zea mays	Corn	*Kona*	na	PNG Government (1970)

na = not available

In 1991, a health study conducted amongst the Hewa revealed that 45% of children were suffering some degree of malnutrition and 17% were severely malnourished, malaria was endemic and 90% of children under the age of 10 years demonstrated some degree of splenic enlargement (Dyke et al. 1991). The situation of 1997–98 suggested little improvement. In every Hewa settlement visited, we treated a range of complaints and found malaria, chronic ulcers, fire burns, malnutrition and tinea imbricata to be prevalent. We also saw evidence of filariasis and thyroid complaints and treated numerous people suffering from 'flesh-eating' complaints such as yaws.

Another problem specific to Hewa women is persistent or unusual bleeding resulting from pregnancy and miscarriage. Genealogies collected revealed that many Hewa women, especially young girls, die in childbirth and this no doubt contributes to the unusual disparity in the ratio of men to women. In South Hewa we recorded a male to female ratio of 1.2:1, and in North Hewa an even more significant gender imbalance, where men outnumbered women by 1.34:1 (Haley and Robinson 1998). This ratio rises to an alarming 2:1 if prepubescent girls and postmenopausal women are excluded. Another factor contributing to this disparity is the practice of so-called 'witch killing'. The Hewa have a strong belief in witches and a long history of killing people, usually women, thought to be witches. Steadman (1971) calculated the rate of witch killing amongst the Hewa during the late 1960s to be 8 per 1000 per year. This rate is thought to be lower today, but we have recorded numerous instances during the last decade where women held to be witches have been killed. In one instance the victim was only 10 years old.

Together these factors have contributed to a situation where there is a shortage of child-bearing women and this has encouraged the retention of marriage practices where older, well-established men marry very young girls. This increases the likelihood that young Hewa women will continue to die prematurely. The existing gender imbalance means that there are fewer able-bodied women to make gardens and hence provide for their respective households. It is possible that Hewa women are required to work harder than their counterparts elsewhere in PNG, in order to maintain food security, and this may contribute adversely to their overall state of health and the ability to cope in times of environmental hardship.

The Hewa Response to the 1997 Drought

When crops fail, for whatever reason, hunting and gathering activities acquire greater significance than usual. Household fission is a strategy Hewa typically employ during times of drought. They temporarily abandon their homes and frequent forest areas alongside riverbanks, where they can hunt, gather vegetable foods, harvest breadfruit and process sago and *pangi* (if it is in season). During the initial part of the 1997 drought these crops were utilised extensively; later they were replaced with a variety of famine foods.

When we started fieldwork in the Hewa area in mid-July 1997, the drought conditions were already well established. The previous six months had seen unusually lengthy periods without rain and this had already contributed to the failure of gardens in some areas. In late June, Hewa families from Ambi gathered at Galaga, a small Duna settlement, to process *pangi* fruit. There was very little sweet potato about and, apart from *pangi*, cassava was the predominant food crop being consumed at that time. After spending three weeks at Galaga, the visitors left, taking with them large quantities of the processed pulp. Galaga also had extensive sago groves, but water shortages meant that the sago could not be processed. These groves were later destroyed by fire.

The Hewa survived the drought by subsisting on the famine foods available to them. In all areas visited, pumpkins and *tulip* (*Gnetum gnemon*) leaves proved to be drought staples. When we visited Wiski and Arini in September 1997, people were spending the majority of their time foraging and hunting in the bush in small family groups. They no longer had any sweet potato in their gardens, their banana trees were sun- and fire-damaged and they had recently killed or released their remaining pigs. Leaving their homes, they had sought refuge alongside the Pori River, where they were able to hunt, find self-sown tubers of *Pueraria lobata*, harvest a kind of wild breadfruit known locally as *yetu* and gather bush greens such as *tulip* leaves and treefern fronds.

Had it not been for the huge fires that blazed between August and October 1997, the Hewa may well have survived in the bush quite adequately for many months, without the need for food aid. But the fires were so extensive and destroyed the forest so completely that the Hewa were forced to return to their settlements where they camped in the open. Before the fires they had been relying exclusively on bush and famine foods for many weeks.

When we arrived at Usai in September 1997, the people were camped in the open near their homes. During the next week, they ate little—only bush greens and *marita* fruit, which had been salvaged by soaking. These were cooked and consumed communally. It was said that this was to keep the local witches happy, because to hoard or consume food privately during such hardship would surely incite their wrath. Before our visit, many of the Usai residents had camped in a bush garden by the Urei River but had been forced back to their homes after a fire destroyed the area. At the river, they had watered a garden established for the express purpose of maintaining planting stock. Having been forced to return to the main settlement, the adults were foraging for food by day and hunting at night. Elsewhere in the Hewa area, at Tali for instance, similar attempts were made to keep planting stock alive through watering but, as in Usai, their efforts were thwarted by fires.

Losses Resulting from the 1997 Drought

Some Hewa died as a result of the 1997 drought. By September 1997, only nine months into the year, and with the drought still worsening, the South Hewa death rate was already at 2.5%, or 25 deaths per 1000, which was higher than at any point in the previous 10 years. In the decade preceding the drought, South Hewa had died at an average rate of 15 per 1000 per year. Although we did not revisit all the South Hewa settlements in 1998, our inquiries at the settlements we did visit suggested that the death rate for 1998 was as high as, if not higher than, the rate in 1997. For example, at Waiki (which had a resident population of 114 in September 1997) three people (two babies and an adult woman) died within weeks of the food aid being distributed; that alone represents a local death rate of 2.6% per year. At Usai, Maliaeli and Arini, there were also a significant number of deaths in the postdrought recovery period. The few months either side of the food aid distribution were especially hard on young babies. Seven of the nine babies born at those settlements between January and May 1998 died within months of birth. Even in an area where infant mortality is high, this seems to be an exceptionally high death rate.

There were also instances where previously healthy adult men died during the drought. At Maliaeli, for example, a 20-year-old died as a result of a fall whilst searching for *marita* pandanus in the burnt out bush.

At Tali two adult men died. The first, aged approximately 65 years, drank water from the Lagaip river and suffered from vomiting and diarrhoea. He had been watering sweet potato runners planted in a riverside garden. Another man, aged 35 years, died after his legs swelled up. He had been in the bush searching for famine food. At around the same time, there were another two deaths at Iyali, a small North Hewa settlement a day's walk from Tali. The Iyali deaths were attributed not to the drought, but to witchcraft, which in turn resulted in further deaths in retaliation.

The 1997 drought also resulted in substantial losses of other kinds. The drought and fires destroyed gardens throughout the region. As soon as the rains came, people busily replanted new gardens. In most cases, greens and pumpkins recovered well but at many Hewa sites planting stock of the usual staples did not survive the drought. In almost every settlement numerous sweet potato and taro varieties were lost. Take Tali as an example: postdrought, in April 1998, there was not a single variety of taro and only the *tulien* variety of sweet potato. That single variety provided the only source of planting material when gardens were replanted in December 1997. Before the drought, the Tali people, like Hewa elsewhere, had cultivated numerous varieties of sweet potato. During the drought, they lost eight sweet potato varieties (*bespele, bone, bumtek, metene, pisam, tei, wanmun,* and *wome*). Other Hewa areas suffered similar losses.

The people of Usai went to great lengths to preserve planting material during the 1997 drought. They had suffered badly during both the 1972 and 1982 droughts, and had hoped to fare better this time. In 1972 they had lost seven varieties of sweet potato—*sakala, pom, mendi, tau, tataka, kapanau* and *tatawi* and retained only one (*walmin*). Gardens were replanted with *walmin* and runners were brought in from Papaki, Oksapmin and Sisimin. Ten years later, *walmin* was the only variety to survive the 1982 drought. Following that drought, the Usai people again went in search of planting material. On that occasion they obtained planting material from the North Hewa, Paiela Hewa, Sisimin and Papaki areas. In both the 1972 and 1982 droughts, the Usai people had relied significantly upon swamp taro (*Cyrtosperma chamissonis*) and treeferns (*Cyathea* sp.), but in the latter part of the 1997 drought these were not available. The severity of the 1997 drought rendered useless the Hewa survival strategies that they had employed in the past.

Our garden surveys revealed that predrought there were at least 31 varieties of sweet potato cultivated in the Hewa region, and that people at each of the major settlements used, on average, nine different sweet potato varieties.

It was not only gardens that were destroyed by the fires, but also houses, cane bridges and the bush resources needed to rebuild houses and bridges. Kanua and Liripu (1997) reported that when they visited Sisimin in December 1997 only six houses were left standing. Fires were equally destructive at Waiki, where 13 of the 19 houses were destroyed, along with the Lutheran church and the aidpost. These same fires severely depleted the local bush resources, as did fires elsewhere. At Waiki people lost numerous mature *pangi*, *marita*, sago, *tulip*, fig, chestnut and oak trees, and their hunting grounds sustained severe damage. They also reported that their domesticated pigs either died or were killed as the drought progressed and that wild pigs had all but disappeared. Because the Hewa rely on their sows mating with wild boars, it may well take them a very long time to replenish their domestic pig herds.

Drought Aftermath

In the immediate postdrought period there was little intersettlement travel. When replanting their gardens, the Hewa did not seek out additional planting stock from neighbouring areas, as they had done in the past, nor had they done so by April/May 1998 when they began harvesting their first postdrought crop. This was somewhat surprising given the accounts of past drought events, where they had searched far and wide for planting material. Destruction of cane bridges was not the only factor constraining travel; another was the threat of witchcraft or being accused of witchcraft.

The 1997 drought resulted in higher than usual mortality rates. Weakened by a reduced food intake and being of poor health in any event, the Hewa succumbed to illnesses they might otherwise have survived. By leaving their homes, and taking refuge in small groups in the lower altitude forest areas alongside the major rivers, the Hewa exposed themselves not only to illness but to accusations of witchcraft. Steadman (1971) observed that Hewa men and women accused of witchcraft are most often those who lack the protection and support of strong and influential men. During the drought, when people were 'alone' in the bush, so to speak, they lacked such

support. Hence it was not surprising that witchcraft accusations and concerns became more prevalent as the drought worsened.

The previously mentioned deaths of two men at Iyali during the drought led directly to the murder of a young couple at Tali in January 1998. The Iyali people determined that the two men had been killed by witches, and murdered the suspects in a retaliatory raid. The young girl killed in retaliation was 15 years old and had only recently married into the area. Hearing of the murder, her kin, led by two local councillors, reported the matter to village police at Lake Kopiago, the subdistrict headquarters. Subsequently, seven reserve police were sent to Tali to 'investigate' the matter. On the way, they gathered another 30 or so men from Wiski, Arini, Maliaeli, Usai and Tapinam.

Only some of the 30 or so Hewa men who accompanied the Kopiago reserve police were related to the young murder victim. The others were Talikai clan men who took the opportunity to revive an unresolved feud dating back to 1975. The first patrols into the North Hewa area had been to investigate and apprehend the men responsible for a series of raids (witch killings and murders) associated with this fight (see Pascoe 1975ab). Seven men were eventually arrested, and served time for the murders, but because of this administrative intervention the matter was never properly resolved.

The 1998 murder 'investigation' took the form of a violent raid. Elderly men and women were assaulted and two young men forced at gunpoint to make confessions. The group robbed the Tali people of their possessions and razed all six houses in the village. As they left they kidnapped a recently married 13-year-old girl, who was then taken to Yagatone where she was held for some six weeks. During that time she was repeatedly raped. Three elderly men pursued the group and tried to rescue the girl, but all three received serious knife wounds.

These events were not the only ones of their kind. Witchcraft accusations also resulted in a particularly violent display at Wanakipa, where a woman suspected of witchcraft and sexual impropriety was violently raped at the behest of the reserve police. What these examples illustrate is that the stresses caused by the drought resulted in witchcraft accusations, witch killings, violent retaliatory acts and the revival of old enmities in the Hewa case (see also Stewart and Strathern 1998 for a Duna case). It is not surprising then that the Hewa chose to stay put, even after the rains came, for fear of becoming unwittingly embroiled in the attribution of blame for deaths elsewhere.

Food Aid

Apart from the people at Wanakipa, who received some assistance from the Lutheran Church, the Hewa did not receive food aid until late March 1998. However, they had been identified as needing food aid in the initial Australian Agency for International Development (AusAID) report of October 1997 (Allen and Bourke 1997a). Even after it was decided that they would receive aid, there were long delays. Indeed, despite being assessed as category 5 (i.e. the most severely affected by drought), and accessible only by air (Allen and Bourke 1997b), the Hewa were not included in the food delivery operation conducted by AusAID and the Australian Defence Force. For some inexplicable reason, AusAID officials held firm to the view that the Hewa were accessible by road, even after Rebecca Robinson and I furnished them with maps, geographical positioning systems coordinates, up-to-date census figures and notes on how best to access the Hewa area. This same information was supplied to Paul Abbott of World Vision, who subsequently managed the PJV-funded Hewa distribution.

When the food aid was finally distributed, it was delivered to only six of the 22 major settlement locations. That people could not or would not move about was ignored. It was assumed that people from more remote settlements would collect their food aid but this was not the case. With the bridges impassable and concerns about witchcraft rife, the North Hewa could not collect the food supplies. Had the bridges been serviceable, they would still have needed to walk for up to three or four days to reach the nearest delivery point.

The only North Hewa location to receive rice was Waialima, but because of confusion regarding provincial boundaries it in fact received two deliveries, one from the Enga Province and one from the World Vision—Southern Highlands Province distribution. At every North Hewa and East Hewa settlement that we visited between May and July 1998, we were asked if we could collect their share of the rice from Waialima. No one from these villages received food aid. The people from Waialima were left with an equally pressing problem: what to do with all the rice. Having been told that it was to be shared, they were reluctant to use any of it. In May 1998, we were shown through the local aidpost, which was serving as a rice, flour and oil storehouse, as were other nearby houses.

Had the aid effort been managed by people with local knowledge, and the time and/or ability to talk to people and assess the social stresses flowing on from the environmental ones, they might well have noted

the increased concerns about witchcraft and the revival of old enmities. They might also have ensured that the aid was distributed in a more appropriate manner so that it reached its intended targets.

Conclusion

Like people elsewhere in PNG, the Hewa employed traditional coping mechanisms to alleviate the worst effects of the drought, and by and large these were sufficient to maintain them for the many months when they had no food in their gardens. Their often very large households (up to 42 people) split into smaller groups, which temporarily migrated into the more forested areas where bush and famine foods are generally abundant. In the last 30 years, gardening has increased in importance at the expense of hunting and foraging. This may have meant that the Hewa experienced the effects of this drought somewhat sooner than they may have in the past. Even so, the effects of the drought should, in the initial stages at least, have been ameliorated by the use of drought-hardy crops such as cassava and pumpkin, which have been included in gardens in recent times. Drawing on past experience, the Hewa in some areas sought to keep planting stock alive through watering gardens but had very limited success due to fires. These same fires destroyed huge tracts of forest, depleting substantially the bush and famine foods available. The devastation caused by these fires was not foreseen because they were far more extensive than any fires in living memory.

In many ways, this drought extended people beyond their normal capacity for coping with environmental disasters. Deaths in both 1997 and 1998 were significantly higher than in the previous 10 years and this led to exacerbated and unprecedented (at least in recent times) concerns about witchcraft. Fear of witches and fear of being involved in troubles elsewhere meant that people were less inclined to move about after the drought. This meant that their gardens recovered less effectively than they otherwise might have. Because of the distribution delays, the Hewa received food aid not when it was needed most but when their gardens were once again starting to meet their needs. This should not be read as proof that food aid was not needed but that, had the Hewa received aid in a more timely manner, they would have coped far better.

The full extent to which the Hewa have been compromised by the drought remains to be seen. That concerns about witchcraft have been inflamed and increase the likelihood that witch killing rates will again rise. However, the Hewa population today is not as it was 30 years ago. There is in increasing disparity in the ratio of men to women. Any further reduction in the number of child-bearing women would place some, if not all, of the Hewa communities at real risk. The long-term impact of the 1997 drought may be the disappearance of some Hewa groups.

References

Allen, B.J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Australian Agency for International Development, Port Moresby.

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. Poienou, J. Risimeri, R. Shelton, J. Sowei, K. Ukegawa, N. Willson, D. Wissink and M. Woruba. 1997b. 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.

Brutti, L. 1998a. Exploiting natives. The Independent, 13 February, 14–15.

Brutti, L. 1998b. Who's lost? An anthropologist says the author owes one Papua New Guinea village a profound apology. Worldview, Spring 1998, 69–72.

Dyke, T., Ballard, C., Flew, S., Mai, M., Crocker, J. and Lutz, S. 1991. The Health of the Hewa. A collaborative report prepared by PNG Health Services, the Tari Research Unit and the PNG Institute of Medical Research.

Haley, N.C. and Robinson, R.P. 1998. Lagaip River Land and Genealogical Study. Report prepared for the Porgera Joint Venture.

Hatanaka, S. and Bragge, L.W. 1973. Habitat, isolation and subsistence economy in the Central Range of New Guinea. Oceania, 44(1), 38–57.

Kanua, M.B. and Liripu, G.K. 1997. The Impact of Drought and Frost in the Southern Highlands Province: Phase II. Asessment, 1–8 December 1997. Unpublished report.

Lehmann, D., Vail, J., Riley, I.D. and Crocker, D.R. 1993. Demographic trends in Tari, Southern Highlands Province, Papua New Guinea. In: Taufa, T. and Bass, C., eds, Population, Family Health and Development. Port Moresby, University of Papua New Guinea Press, 94–103.

Pascoe, N. 1975a. Justice? Death by axe or arrow. Post-Courier, 12 February, p. 5.

Pascoe, N. 1975b. These people are totally honest. Post-Courier, 13 February, p. 5.

Robinson, R.P. 1999. Big wet, big dry: the role of extreme periodic environmental stress in the development of the Kopiago agricultural system, Southern Highlands Province, Papua New Guinea. Unpublished MA thesis. Canberra, The Australian National University.

Robinson, R.P. and Haley, N.C. 1998a. Hewa Census: Ambi to Papaki. Report for the Progera Joint Venture.

Robinson, R.P. and Haley, N.C. 1998b. Hewa Census: Iyali to Eyaka. Report for the Progera Joint Venture.

Steadman, L.B. 1971. Neighbours and killers: residence and dominance among the Hewa of New Guinea. Unpublished PhD thesis. Canberra, Australian National University.

Stewart, P.J. and Strathern, A. 1998. Witchcraft, Murder, and Ecological Stress: A Duna (Papua New Guinea) case study. Centre for Pacific Studies, James Cook University, Australia.

Subsistence at Lake Kopiago, Southern Highlands Province, During and Following the 1997–98 Drought

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Abstract

At Kopiago in the Southern Highlands Province of PNG, the massive drought of 1997–98 drastically affected subsistence agriculture. The drought followed a particularly wet period and garden production was greatly reduced. Large numbers of pigs died. Fires ravaged forests, depleting famine resources and destroying gardens and houses. People relied heavily on traditional 'famine foods' but some introduced crops were also significant 'famine' crops. The drought and the recovery marked a time of innovation and intensification: people experimented with new methods in order to maintain food and fodder supplies during the drought, and later intensified production in order to rebuild their pig herds. The wetlands of Kopiago played a key role in people's survival strategies, some areas providing a small supply of sweet potato during the drought and many areas providing planting stock for drylands during the recovery period.

THE highlands of PNG do not bring to mind scenes of drought and fire—the western portion of the highlands does not even experience a significant regular wet or dry season. When drought occurs it can have major impacts upon people's subsistence livelihoods—upon their ability to maintain gardens to feed themselves and their herds of pigs for the duration of the drought. It is likely that periodic climatic fluctuations, which result in excessive wet or dry periods, have affected the development and processes of traditional agriculture in the highlands (see also Golson 1997 for a considerable period of prehistory).

This paper discusses the impacts of the 1997 drought in the area around Lake Kopiago gardened by Duna-speaking people. It begins by describing the onset of the drought, then goes on to discuss its immediate effects—the fires, the dying gardens, the loss of livestock, disease and so on, and lastly goes on to discuss the recovery period.[1]

The vast majority of production at Kopiago is for household use (including fodder for large numbers of pigs)[2], with a little for the local market. Gardens, mainly made up of sweet potato, are located both within the wetlands, where extensive drainage ditches are made, and within the drylands, usually cleared from old secondary or younger woody regrowth. During and following the drought, wetlands were a key resource not only for families who were resident within the basin but also for people from other valleys who needed to find planting material when the rains finally recommenced.

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1. Most of the material here is based on research conducted between 1995 and 1998 (Robinson 1999).
2. The pig to person ratio in the Kopiago basin is between 1.78 and 2.15 (Robinson 1999).

Onset of Drought

The impacts of the 1997–98 El Niño drought upon the subsistence activities of Kopiago people were immense. At Kopiago, periodic droughts like that experienced during 1997–98 are often preceded by a series of destructive floods—a pattern apparently common to El Niño Southern Oscillation (ENSO) events—and frequently followed by food shortages (Brookfield and Allen 1989; Bourke 1988; 1989). In the region, the preceding years had seen reliable pandanus harvests, normally triggered by dry spells (Rose 1982 cited in Haberle 1993), become irregular and unpredictable. Floods destroyed many cultivated crops in the wetland gardens and so, as the weather became increasingly dry, people took the opportunity to clear new bush gardens. As the drought took hold, these dryland gardens withered and died or were burnt out by fire. People tried various strategies to buffer themselves against the worst effects of the drought. Their subsistence actions before, during and after the drought demonstrate how they intensified their activities because of extreme and unusual, though not wholly unprecedented, environmental stress. The period illustrates the potential that the high value placed upon pigs still has for agricultural intensification in parts of PNG, despite certain environmental extremes.

In the past, regional environmental crises, particularly drought, coincided with ritual activities that occurred across a large area well beyond the Kopiago Valley (Haley 1995; Strathern 1998; Robinson 1999; Sturzenhofecker 1995). These events were infrequent but periodic. Intensification and innovation, mainly to quickly renew pig stocks (lost directly to drought and, in the past, killed as ritual offerings), followed. Duna horticulture is now based upon sweet potato that, by genealogical reckoning, people have cultivated in the drylands for more than 300 years, and in the wetlands for approximately 250 years. The connections between periodic agricultural changes and pig foddering, as were witnessed during and following the 1997 drought, are likely to be a reflection of processes that have recurred repeatedly in the past, perhaps for the last 300 years.

Allen and Bourke (1997) observed that the 1997–98 El Niño drought was 'at least as severe as the major droughts of the late 1890s, mid-1910s and early 1940s' and, although El Niño may occur every 8 to 13 years 'severe drought events such as 1997 possibly occur only once in a century'. Certainly, the impacts of the drought at Kopiago were said by locals to be the worst in living memory and worse than extensive Duna oral history had recorded. The drought placed immense pressures upon the subsistence strategies of the resident population, for whom outside support was very late in coming.

Rainfall records[3] of the period 1985–95 (and the first nine months of 1996) show the Kopiago basin to be relatively aseasonal—but with great variation in the amount of rainfall in any given month or year (see Figures 1 and 2). Rainfall records are not available for Kopiago for the whole of the 1997 and 1998. Instead, I rely upon my own observations and the observations and impressions Duna people recounted to me of the worsening situation.

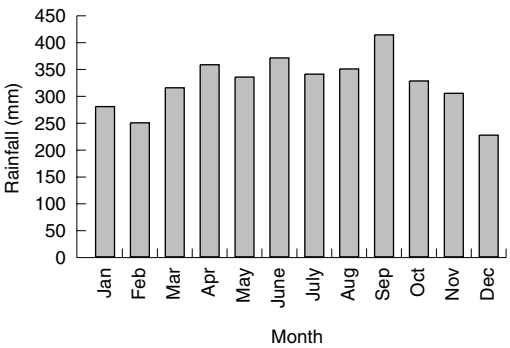

Figure 1. Average monthly rainfall, Kopiago, Eastern Highlands Province, 1985–96.

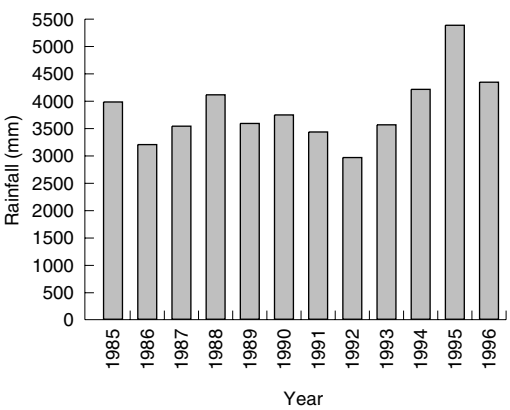

Figure 2. Total annual rainfall, Kopiago, Eastern Highlands Province, 1985–96.

3. Records kept at the Kopiago Catholic Mission.

Drought at Kopiago

Drought began at Kopiago with relatively lengthy periods without rain between April and July of 1997. Between July and November virtually no rain fell at all. At Kopiago, for the first time in oral historical records, the lake bed could be traversed on foot. As the lake levels fell, people fished intensively. While the lake was full, people were free to fish from any part of the lake. However, once the water receded and fish resources became scarce and localised in small remnant ponds,[4] boundary and access disputes arose, to the extent that people erected posts through the middle of the lake bed to mark parish boundaries.

From August onwards, wild fires swept the region. Most fires (*rindi karia kirayea*: 'mountain fire') were accidentally started by people burning off new garden sites or lighting grass fires for hunting in places such as the Strickland Gorge, or from unguarded hearth fires. However, due to the unusually dry conditions, the fires took off unchecked through grasslands and rainforests alike. Massive fires burned through most of the Strickland Gorge, on many of the major mountain ridges and throughout Duna territory further east and beyond.

It is likely that for some time to come the fires will have a significant impact on the entire Kopiago catchment area, as well as on surrounding regions. Forest cover was destroyed and even the roots binding the soil together were burned so completely that, once rains recommenced, landslides became more common and even more forest cover was lost. The basin floods that also followed the drought were probably worsened by increased quantities of water reaching catchment creeks and rivers without being absorbed by the usual cover of vegetation.

The fires threatened, damaged and destroyed not only places of subsistence value (hunting grounds, forest crops and gardens) but also places of immense traditional sacred value (past ritual sites, secondary burials in caves and overhangs, the upper primary forest).[5] During the peak period of the fires, between September and October 1997, the landscape was obscured by smoke, and mountains, invisible by day, were only indicated at night by the lines of fire along the fire fronts. The sun was an eerie pink circle in the haze above, giving everything a strange orange half-light glow.

By early October, the majority of people at Kopiago had come to rely upon bush or famine foods to augment and sometimes to wholly replace their remaining garden produce of small weevil-infested sweet potato (see Table 1). In dryland gardens and in many wetland gardens, sweet potato vines shrivelled up or were burned away by fire. In some areas of the wetlands, grass fires continued to burn slowly in the peaty soil, and in dryland gardens it was common to see burnt-out gardens where the composted sweet potato mounds continued to smoulder for days. Other important crops such as banana stopped producing edible fruit—some banana plants died, taro plants dried up and garden greens died away. For a time, people were able to salvage some *marita* pandanus by soaking the fruit before cooking—but soon the *marita* also ceased producing, and many of the trees were also killed by fires.[6]

In gardens everywhere pumpkin vines dried up but, when even minimal rains returned, they were quick to recover and bear fruit. The importance of the introduced crops, cassava and pumpkin, cannot be overstated; without the drought-hardy introduced crops, the effects of the drought upon the survival of people and their pigs would have been even greater.

From October, some people began making gardens in the deep swamp—near the main swamp river and around the southeastern edges of the dry lake. Those who could called upon kin ties with people who still had some sweet potato to spare to give them meals. Those living and gardening in the wetland margins around the parish of Tsuwaka on the northeastern side of the lake[7] had more productive gardens than any other area, and provided food for a wide network of relations.

4. The introduction of carp, in conjunction with dichlorodiphenyltrichloroethane (DDT) sprayed to eradicate mosquitoes carrying malaria parasites, during the 1960s, and the postcontact use of canoes (increasing the use of the lake), are said to have dramatically altered the ecology of the lake. In the past people commonly caught small native fish, tadpoles, dragonfly nymphs, and waterbirds in the lake.
5. Compensation claims arising from fire damage led to a number of court cases in 1998.
6. Around Yokona, at the edge of the Strickland Gorge, fires that swept up from the grasslands are said to have burned most of the *marita* pandanus trees as well as tree crops such as pawpaw, highlands *kapiak* (*Ficus dammaropsis*) and *liki* (*Pangium edule*). Many of the gardens feeding close to 200 people (see Haley and Robinson 1998) were also destroyed as the fires continued on to burn the forests on Mount Komua at Yokona.
7. Significantly, the population of Tsuwaka is primarily Seventh Day Adventist (SDA), and therefore they do not keep pigs themselves. SDA members there still grow sweet potato, and even in normal times are able to profit from the sale of the smaller tubers to people who do keep pigs. People at Tsuwaka had fewer pigs to feed, and more productive gardens than many other residents.

Table 1. Principal Duna drought bush and famine foods utilised in 1997.

Local name	Common name	Scientific name
Kao-ere	Wild yam	*Dioscorea* sp.
Anokua	Wild yam (sour)	*Dioscorea* sp.
Pema	Taro	*Colocasia esculenta*
Mbatia(*tsiri la*)	Swamp taro	*Cyrtosperma chamissonis*
Hii la	Bush taro	*Colocasia esculenta*
Waliwali	Taro	*Colocasia esculenta*
Hukia	Kudzu	*Pueraria lobata*
Kuango	Ferns	na
Yaki	Ferns	na
Kaiyuku	Tree ferns	*Cyathea angiensis*, *Cyathea contaminans, Cyclosorus* sp.
Poke	*Kumu musong*	*Ficus copiosa*
Riki	Fig leaves	*Ficus pungens*
Kane	*Tulip* leaves	*Gnentum gnemon*
Kutsi	Climbing curcurbit	*Trichosanthes pulleana*
Irapuya[a]	Cassava	*Manihot esculenta*
Mbawali[b]	Pumpkin	*Cucurbita moschata*
Riki	Fig leaves	*Ficus pungens*

na = not available

[a]Introduced in the postcontact period

[b]Two of three varieties now cultivated were introduced in the last 40–50 years, and one, said to be an old variety, was adopted at a time prior to colonial administration in the region.

A number of Hewa people migrated from the north, to a parish named Dilini in the Kopiago basin, to live temporarily with distant Duna kin, relying upon their clan and historical connections.[8] Hewa lands, if anything, were even more badly affected by the fires and drought than Duna lands. Duna people, on the other hand, did not migrate, as it was known that the situation was not any better anywhere else.

Women whose own gardens failed helped other more fortunate gardeners with their work in the hope that they would be given sweet potato at night to take back for their families and pigs. The women who did this felt a great sense of shame at their own inability to feed their families from their own gardens. During the height of the drought, on a number of occasions, different women were caught stealing sweet potato, and the garden owners sought compensation in the village courts.[9] The fact that the women stole sweet potato was a mark of the scale of the disaster. Under normal conditions, families suffering hardship (for example, if their crops are destroyed by flood or pigs) could call upon the hospitality of friends and relations with productive gardens to give them enough food to tide them over. To keep their crops alive, people experimented with various techniques, demonstrating that, in the face of the crisis, people were innovative rather than conservative. These techniques included:

- burning off *pitpit*, then putting out peat fires using containers of water;
- excavating ditches in deep swamp;
- planting some *mondo* in areas of the swamp without complete ditches;

8. Dilini has land extending far north into Hewa lands, having been given the land when some of them fled their own territory and married women from the Wanakipa area of Hewa some generations before (Robinson and Haley 1998).

9. The wider community felt so sorry for these women that the community, rather than just immediate kin, contributed to their compensation fines—recognising the terrible situation that had led them to steal food from other people's gardens.

Table 2. Pig fodder used during drought.

Local name of plant	Common name	Scientific name
Kuango (cooked)	Variety of fern	Not known
Poke (cooked)	Variety of fig leaves	*Ficus copiosa*
Mbatia (leaves cooked)	Swamp taro	*Cyrtosperma* sp.
Hii la (leaves cooked)	Bush taro	Not known
Hinia rako, hinia kuapu (cooked)	Sweet potato roots (not tubers)	*Ipomoea batatas*
Hinia kei hini (cooked)	Sweet potato leaves	*Ipomoea batatas*
Ra tsapu (cooked)	Wild *pitpit*	*Setaria* sp.
Hii tsapu (cooked)	Bush *pitpit*	*Setaria* sp.
Tsola (tips cooked)	Swamp *pitpit*	*Phragmites karka* and *Saccharum robustum*

- using a mulch cover of fern roots and grass (to maintain moisture) over newly planted sweet potato runners;
- watering casuarina trees and cordyline along ditch lines (to keep ditch walls from crumbling);
- watering sweet potato;
- watering banana plants; and
- irrigating sweet potato plots using bamboo feeder pipes from creek lines.

If they could afford to, people purchased rice from the small Kopiago trade stores, but the price of rice doubled as trade-store owners themselves tried to raise money for sweet potato, and as prices of rice in the towns rose.[10] Biweekly markets began at first light, so that people who had enough money could buy sweet potato to feed their pigs as usual in the mornings in order to prevent them from becoming feral. Customers would rush to market to buy what they needed before it all sold out even though the price for a pile of sweet potato rose from 2 to 10 PGK.[11] More people than usual sold pig meat at market to raise money.[12] People did not sell live pigs, which would normally sell for a higher price than pork, because people would not buy new pigs that they could not feed.

Pigs were fed progressively less and less sweet potato. Instead they were fed cooked cassava, boiled wild taro leaves, and sweet potato rootlets and leaves, sometimes mixed with the chopped and cooked tips of swamp grasses (Table 2). Later they were also fed pumpkins grown in the recovering gardens. Great efforts were made to keep pigs alive, but still many pigs died from heat exhaustion and starvation (Table 3). With little prospect of a good feed of sweet potato from their owners in the mornings or evenings, some pigs went missing as they foraged for food without returning to pig-houses in the evenings. Owners were forced to kill some of their own valuable pigs, firstly, to raise money by selling pork (to buy food) and, secondly, because they could not feed all the pigs that they had. People had to kill their own pigs that were starving in case they should die first and be considered inedible. Occasionally people ate the pigs that had already died. Many people were unable to maintain their pig herds.

People had to travel further and further to collect drinking water. In some parishes, people spent up to six hours each day fetching water for their households (a task made more difficult for some after houses burned down and the water containers that were inside were destroyed). In November 1997 some rain began to fall again. The lake filled, and was quickly restocked with fish from small fishspawn ponds that people had maintained at the headwaters of tributary creeks.[13] Drinking-water sources were renewed but, although green vegetables quickly became plentiful, reasonable quantities of sweet potato could not be har-

10. The nearest town used to resupply trade stores at Kopiago is Tari, more than 80 kilometres away in Huli territory.
11. In 1997, 1 PGK = approx. US$0.70 (A$0.94).
12. They were usually able to sell only a small portion of the meat even at lower than predrought prices. This was because there was so much pork available for sale, because people had little money to spare on such a luxury item, and also because people had their own pork from animals that they too had been forced to kill (lest the animal starve to death).
13. Fishspawn ponds—a postcontact technique—are stocked with introduced carp.

Table 3. Examples of pig losses during the 1997–98 drought, Kopiago, Eastern Highlands Province, PNG.

Informant(s)	Residence	Comments	Pigs lost	Reasons
Kipu Piero (female); Kenny Yuwi (male)	Hirane	Wetland garden at Kalitsanda (Hirane parish) dried up but kept runners alive. Dryland garden on Mbatuku dried up and runners died.	35 (of 42)	Died from starvation and disease; killed and eaten
Pariame Pora (female)	Aiyuguni	New gardens made at Konapia Kana beside Lake Kopiago (Yalia parish) during drought. Abandoned March 1998.	0	No pigs lost
Pokole Pora (female)	Aiyuguni	Wetland gardens at Auwi-Tsola (Mbara parish) continued producing some sweet potato.	0	No pigs lost
Hoiya Pora (female)	Mbara	Wetland gardens at Auwi-Tsola (Mbara parish) continued producing some sweet potato.	0	No pigs lost
Yemili Karali (female)	Yalia (Ndolowa)	Worked in other people's gardens to earn sweet potato for her family and pigs. Mainly fed her pigs famine foods.	0	No pigs lost
Urupu and Yapa Kareke (both male)	Yalia (Ndolowa)	New ditches made plus reuse of an area abandoned in 1960s at Kale Kana (Yalia parish). Abandoned in mid-1998.	6 *kurini*	Payment for sweet potato runners; killed and eaten before pigs starved; died from heat exhaustion
Goiya Yowe (male)	Yalia (Ndolowa)	Maintained one new wetland garden near Kale Kana (Yalia parish) throughout drought to feed his family and their five pigs. Thinking of abandoning garden in August 1998 (becoming too wet).	0	No pigs lost
Tsiwi Barako (male)	Mbatane	Attempted to make new wetland margin gardens during the drought because he thought he would run out of sweet potato, but the fences caught fire and the garden was ruined.	3 *kurini;* 2 *range;* 1 *rana*	Payment for land, food, sweet potato runners; killed and eaten before pigs starved; starvation; missing (found dead)
Kariape Pakalu (male)	Mbatane (councillor)	Had a dryland and a wetland margin garden at the beginning of the drought but both were burnt.	1 *warepu;* 1 *range;* 1 *rana;* *5 kurini;* 3 *kipa tsiki*	Payment for land; missing (not found or found dead); sold; died

Continued on next page

Table 3 (cont'd). Examples of pig losses during the 1997–98 drought, Kopiago, Eastern Highlands Province, PNG.

Informant(s)	Residence	Comments	Pigs lost[a]	Reasons
Kepo Angora (female)	Mbatane	Worked in other women's gardens to earn sweet potato. Had three dryland gardens that all withered. Has since planted two wetland gardens.	Some *kipa tsiki;* 3 *kurini*	Payment for food; died from starvation
Kilimbi (male)	Hagini	Lives outside the Kopiago Basin.	4 *kipa tsiki;* 2 *range;* 2 *warepu;* 4 *kurini*	Died; killed and eaten before pigs starved

[a] *kurini* = medium-sized pig (either sex); *range* = sow; *rana* = young piglet (either sex); *warepu* = boar; *kipa tsiki* = young pig (either sex)—the terms *rana* and *kipa tsiki* are often used interchangeably

vested until March 1998 (about two weeks after food relief reached Kopiago). And, although there was plenty of food overall, even by August 1998 sweet potato production levels had not returned to normal.

The return of rains brought new problems; dried-up water sources had become contaminated and now became sources of disease. The rate of typhoid increased tragically. In September 1997, three people were diagnosed with typhoid (two of whom died) compared with a usual rate of one or two a year. In March and April 1998, the typhoid outbreak became an epidemic. The health centre recorded more than 40 typhoid deaths over the two months of March and April, including both adults and children—and including people from more distant valleys such as Aluni (Senator J. Galo, pers. comm. 1998). This did not reflect the true rate, however. During the same period, according to a Lutheran missionary who is a trained nurse based at Dilini on the northern side of the basin, an additional 36 people on the northeastern side of the basin alone died of typhoid but were not taken to the health centre or were misdiagnosed with illnesses such as malaria. Mourning cries did not cease for two months and the usual more extensive funeral rites did not occur as people went from one funeral to another.

Impacts Upon Agricultural Practices

To understand why the drought had such a deep impact on agriculture it must be placed within a wider time frame. In the years leading up to the 1997 drought, there had been a series of serious floods. Floods in 1993 had been so widespread and lengthy (June, July and September all received more than 500 millimetres of rain each) that all the Kopiago wetland gardens except those on the very outer margins were completely inundated, and the sweet potato crops were largely destroyed.[14] People used canoes to salvage their sweet potato crops from beneath the water. Repeated floods affected the pattern of wetland and dryland gardening activities of Kopiago residents. Some people had already started to make their new gardens in the drylands rather than the wetlands, and as the weather remained dry, as the drought began, people took the opportunity to clear and burn more new dryland gardens, thereby increasing the likelihood of fires. By acting upon recent experience and taking the rational step of concentrating their activities in the drylands, many people acted at the expense of their investment in the wetlands. By the time the drought took hold, people say that they had fewer wetland gardens than for many years.

At the height of the drought some people began to make drained-field gardens in the deep swamp areas around the margins of Lake Kopiago and near watercourses through the swamp. These areas are normally considered to be too wet and too floodprone to be worth the investment of labour needed to make the deep ditches required, or to take the risk of planting. The new gardens beside the dry lake were only partially ditched. The ground was dry enough not to require added drainage; the gardens were far enough into the swamp and away from habitation to risk the chance of pig damage and were made in the expectation that the water levels would rise again and so destroy the garden. These gardens were created expressly for short-term goals of feeding families and pigs during the drought. People realised that, even if complete ditches were excavated, the ground chosen would be inundated frequently under normal conditions. Within four months, these novel gardens began to produce much-needed sweet potato to feed people and pigs, but in March 1999 much of the basin was flooded once more and the gardens had to be abandoned. However, the families who cultivated these lake-bed gardens did not lose any pigs to the drought. For them the investment was worthwhile and there were no real alternatives if they were to maintain their herds.

Recovery

A rainfall pattern of unusually wet periods followed by dry periods (and sometimes another wet period) is consistent with the effects of the ENSO index. Allen and Bourke (1997) have noted that 'these wet periods often create additional food supply problems in sweet potato based agricultural systems in the PNG highlands'.[15] At Kopiago, as well as elsewhere in the highlands, people reported that, although the sweet potato vines and leaves were now growing in abundance, tuberisation was poor (R.M. Bourke, Research School of Pacific and Asian Studies, The Australian National University, pers. comm. 1998). Gardens that looked lush and abundant during my final visit to Kopiago in August of 1998 were actually producing poor sweet potato crops (see Postdrought Agricultural Rehabilitation: the 1997–98 El Niño Drought in PNG by Matthew'Wela B. Kanua and Sergie Bang, in these proceedings).

14. I did not witness events before 1995, but was told about them by local informants, and was also provided with aerial photographs of the 1993 flood taken by Fritz Robinson as part of a reconnaissance flight over the area for Porgera Joint Venture before providing food relief.

Once the drought ended and was followed by another flood, people once again invested more of their energies into cutting new dryland bush gardens. This had a number of repercussions because people made new gardens and replanted in tandem with each other, beginning with the first regular rains. So, instead of the optimum pattern of gardens being at various stages from clearance through to final harvest and fallow, an unusual proportion were at the same point in the cycle—increasing the community's vulnerability if there were to be another drought, or indeed another prolonged wet. In March and April of 1999, a period of rain and extensive flooding did result in a shortage of food from loss of crops in the basin and poor production in the dryland gardens, a consequence of both the wet period and a shadow famine effect (Bourke 1988) from the previous drought.

Before the drought, sweet potato runners used as planting stock were freely available. In the drought, the sweet potato vines in the dryland gardens, and in many of the wetland gardens too, withered and could no longer be used as planting stock.[16] Following the rains, some people were given new planting stock by their kin and close friends who had gardens in those areas of the wetlands that had remained productive, or at least just wet enough to keep the vines from a state of dormancy. During the drought some people planted sweet potato runners in wetland areas which remained moist, not to produce a crop but only so that planting stock could be maintained. The places that provided most of the runners to restock the gardens in the basin and the valleys beyond were the areas with a history of intensive gardening, where the soils are peaty and less likely to dry into a hard crust. These places remained productive for longer and all maintained planting stock even when tubers were no longer produced. Many people were forced to replant using stock bought for anything from 6 to 20 PGK per *bilum*. People came from distant valleys of up to two days' walk away to collect runners from Kopiago.

In contrast to people in the Hewa region to the north, the people that I asked in the area around Kopiago did not know of any sweet potato varieties that had become extinct due to the drought.[17] It is unlikely that the drought itself eradicated many varieties of sweet potato in the Duna territory, but the sweet potato dormancy period following the drought and the collection of runners from a limited area will, for a time, reduce the range of varieties commonly propagated. After a time, the variety range would be renewed from new varieties that appear in old gardens (probably new phenotypes resulting from sexual reproduction and seed propagation) (Yen 1991).

When people replanted gardens or made new gardens, their choices of planting stock were governed primarily by the need to provide food for pigs in order to renew pig herds that had been depleted during the drought. People chose from varieties of sweet potato that tend to produce numerous small tubers, since the smaller tubers are usually used as pig fodder, while the larger tubers are for human consumption. Another change that occurred was that some women chose to plant greater numbers of sweet potato runners into each mound than they had before. The stated reason was not just to increase total production per mound but to produce the smaller tubers suitable for feeding pigs.

Thus, a kind of agricultural intensification, driven by the socially-prescribed need for pigs, occurred at Kopiago in the wake of the drought. Before the drought, people did not explicitly plant sweet potato gardens for their pigs but incidentally produced enough surplus in the form of lesser quality or smaller tubers to feed their pigs. During the drought, people explicitly made deep-swamp gardens in order to keep their pigs alive. Afterwards they deliberately planted more sweet potato runners per mound, either to feed more pigs to quickly replenish their herds or to make up for a short-

15. Here they do not refer specifically to the effects of flood but more generally to the way that sweet potato production reacts to excessively dry and wet periods. The combined effect of a long wet period during the tuber initiation phase and a drought during the tuber-bulking phase depresses yields (Bourke 1989). The return of excessive rains following the drought also added to sweet potato production problems throughout the highlands as a result of a 'nitrogen flush' inhibiting growth of the tubers in the recovering plants (R.M. Bourke, Research School of Pacific and Asian Studies, The Australian National University, pers. comm. 1998; Kanua and Muntwiler 1998). This effect is one of the main reasons that researchers have concluded that wet periods often precede food shortages (Bourke 1988).

16. Sweet potato plants grown under such conditions may remain dormant for up to four months before sprouting again (Allen and Bourke 1997).

17. At Wusai, in Hewa, people noted that some varieties of sweet potato were lost during the drought of 1972 and at Wanakipa people said that local stocks of the *wanumin* variety had died out in the 1997–98 drought—although the same named variety elsewhere has been successful as a postdrought recovery variety. *Wanumin* had been a common variety in Wanakipa gardens and postdrought gardens were largely restocked using unknown new varieties that emerged in old gardens. (*Wanumin* means one month.)

fall of fodder due to having fewer gardens than 'normal' (since many gardens had fallen out of production during the drought). A consequence of the decline in pig numbers was that some compensation payments, at the insistence of the claimants, were made with live pigs. Not since the early 1970s had it been common for compensations to be paid with live pigs.[18]

Conclusion

The floods that preceded the drought motivated people to reduce their reliance upon wetland gardening and increase their dryland gardening activities. During the drought, parts of the wetlands remained as a refuge for human food production and pig fodder and as a source of vital replacement planting stock with people extending their gardening activities into the deep swamp. Finally, many wetland gardens were destroyed by floods following the drought and people began once again to shift their efforts to the drylands, often into old secondary or primary forest.

Use and abandonment of the wetlands at Kopiago can and does occur within a short time span, facilitated by a traditional system of land tenure and the availability of relatively abundant arable drylands. However, the pattern of use and abandonment does not occur evenly.

Some people continue to garden in the wetlands even after the floods. They do so because they live there, because their wetland gardens are better off in drought than the dryland gardens and because they have invested energy in the drainage ditches around the gardens. Provided people are willing to take the risk, the wetlands can provide better quality and greater quantities of sweet potato for potentially longer periods of time, at a slower rate of soil fertility decline.

Subsistence sits at the nexus between the physical and social environments. The changes in subsistence activities during and following the drought at Kopiago were environmentally driven but were socially prescribed. They would not have occurred as they did had there not been a drought or floods. The changes in subsistence activity are associated with socially conceived notions of the importance of the pig as 'social capital', as Modjeska (1991) has put it. It has been suggested that it is 'necessary to understand who benefits from change and why and when'. The people who benefited from change at Kopiago included those who wanted to ensure survival during and after the drought; those who wanted to ensure that they could continue to eat; and those who wanted to continue to maintain herds of pigs and thus remain active members of society. That is, the majority of people benefited. It is only by adaptation to social and environmental changes that people can survive severe environmental crises.

References

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.

Bourke, R.M. 1988. *Taim Hangre*: variation in subsistence food supply in the Papua New Guinea highlands. PhD thesis, Department of Human Geography, Australian National University, Canberra.

Bourke, R.M. 1989. The influence of soil moisture on sweet potato yield in the Papua New Guinea highlands. Mountain Research and Development, 9, 322–328.

Brookfield, H. and Allen, B. 1989. High altitude occupation and environment. Mountain Research and Development, 9(3), 201–209.

Golson, J. 1997. From horticulture to agriculture in the New Guinea highlands: a case study of people and their environments. In: Kirch, P.V. and Hunt, T.L., eds, Historical Ecology in the Pacific Islands: Prehistoric Environmental and Landscape Change. New Haven, Yale University Press, 39–50.

Haberle, S.G. 1993. Late quaternary environment history of the Tari Basin, Papua New Guinea. PhD thesis, Department of Biogeography and Geomorphology, Australian National University, Canberra.

Haley, N.C. 1995. Where ritual roads converge: exploring some of the myths associated with ritual performance at Gelote. Unpublished paper presented at the conference on Importing Cultures: Regional Transformations in Myth and Ritual in the Western Highlands of Papua New

18. The proximal causes for each of the compensation claims were unrelated to the drought. However, the reason behind the switch in these cases from payments as pork to payments as live pigs was a direct result of diminished pig herds. For the past 30 years, compensation payments have been made with pork while bride price payments have been made with live pigs. Any compensation payment led to a diminution of total pig numbers. In the months following the drought it may have been that, in addition to people making claims for payments in live pigs, the people paying also did not want to see a 'waste' of livestock at such a time. The change to payments in live pigs marked a return to traditional patterns of compensation payment, and also a shift closer to the form still practiced by their Huli neighbours.

Guinea, Brisbane, University of Queensland, September 1995.

Haley, N.C. and Robinson, R.P. 1998. Bogaia, Yeru and Duna Census: Mbulago to Galaga. Unpublished report prepared for Community Affairs, Porgera Joint Venture, October 1998.

Kanua, M.B. and Muntwiler, M. 1998. A survey report of the impact of drought on availability of planting materials in Simbu Province, 20–23 February 1998. Port Moresby, The Salvation Army.

Modjeska, C.J.N. 1991. Post-Ipomoean modernism: the Duna example. In: Godelier, M. and Strathern, A., eds, Big Men, Great Men: Personifications of Power in Melanesia. Cambridge, Cambridge University Press and Editions de la Maison des Sciences de L'Homme.

Robinson, R.P. 1999. Big wet, big dry: the role of extreme periodic environmental stress in the development of the Kopiago agricultural system, SHP, Papua New Guinea. MPhil thesis, Department of Archaeology and Anthropology, The Australian National University, Canberra.

Robinson, R.P. and Haley, N.C. 1998. A social and genealogical study of the Bogaia, Yeru, Duna and Hewa people of the Lagaip and Upper Strickland Rivers. Unpublished report prepared for Community Affairs, Porgera Joint Venture, February 1998.

Strathern, A. 1998. Sacrifice and sociality: a Duna ritual track. In: Goldman, L.R. and Ballard, C., eds, Fluid Ontologies: Myth, Ritual and Philosophy in the Highlands of Papua New Guinea. Westport, Bergin and Garvey, 31–42.

Sturzenhofecker, G. 1995. Sacrificial bodies and the cyclicity of substance. Journal of Polynesian Studies, 104(1), 89–109.

Yen, D.E. 1991. Domestication: the lessons from New Guinea. In: Pawley, A., ed., Man and a Half: Essays in Pacific Anthropology and Ethnobiology in Honour of Ralph Bulmer. Auckland, The Polynesian Society, Memoir, 48, 558–569.

Food Aid and Traditional Strategies for Coping with Drought: Observations of Responses by Villagers to the 1997 Drought in Milne Bay Province

Jane Mogina*

Abstract

A prolonged annual dry season and unpredictable rainfall are common to both the Goodenough Island and Cape Vogel areas in Milne Bay Province, PNG. The challenge for these areas is ensure that food is available throughout the year. During normal times, food security is ensured by the management of staple crops. In a drought, normal management of crops is not sufficient to sustain food availability and there is a change in both gardening practice and food procurement strategies. Experiences from Bogaboga village on Cape Vogel and Utalo village on Goodenough Island during the severe 1997 drought illustrate the changes in gardening strategies and in food procurement behaviour that occurred in these areas in response to the drought.

Both communities have traditional strategies for coping with food shortages. However, in 1997, food aid and money altered the traditional strategies in Bogaboga as villagers relied on government assistance and outside help. Planting materials and gardens were not widely maintained, ultimately hindering a quick recovery from the drought. In contrast, the more isolated and self-sufficient villagers of Utalo received very little aid rice or government assistance. They used yam and a drought-resistant taro cultivar, and then survived on wild cassava, yams and figs. Planting materials were maintained in Utalo, so gardens recovered quickly when rains arrived. This illustrates that management of crops at cultivar level and preservation of diversity are essential for long-term food security while food aid and money can alter customary strategies for coping with drought.

THIS paper explores traditional means of coping with drought in PNG, and considers what happens today in respect of government aid and the ability to buy food. The focus is on food production systems and food security. The two areas of interest are Bogaboga village on Cape Vogel and Utalo village on Goodenough Island in Milne Bay Province, PNG. Bogaboga is on the coast of mainland Milne Bay whilst Utalo is about 5 kilometres inland from Diodio, on the west coast of Goodenough Island (Fig. 1).

Food security is achieved 'when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (FAO 1996). This concept of food security has to be differentiated from that of food self-sufficiency, which is when a household or a community produces enough food for its own consumption. A high degree of food self-sufficiency is not necessarily a precondition for food security—many wealthy urban regions can buy food security, though they produce little food.

The two main factors that affect food security in these areas are access to government services and climatic conditions. Government services influence food availability, directly or indirectly, because they determine services such as transport and access to cash income. Bogaboga has greater access to government services because it has an active local government council and has access to Alotau, the administrative centre of Milne Bay Province, by boat and air. Both Cape Vogel and Goodenough Island are classified as having unproductive environments with low cash incomes; Goodenough is also categorised as having poor access to services (Hanson et al. 2000).

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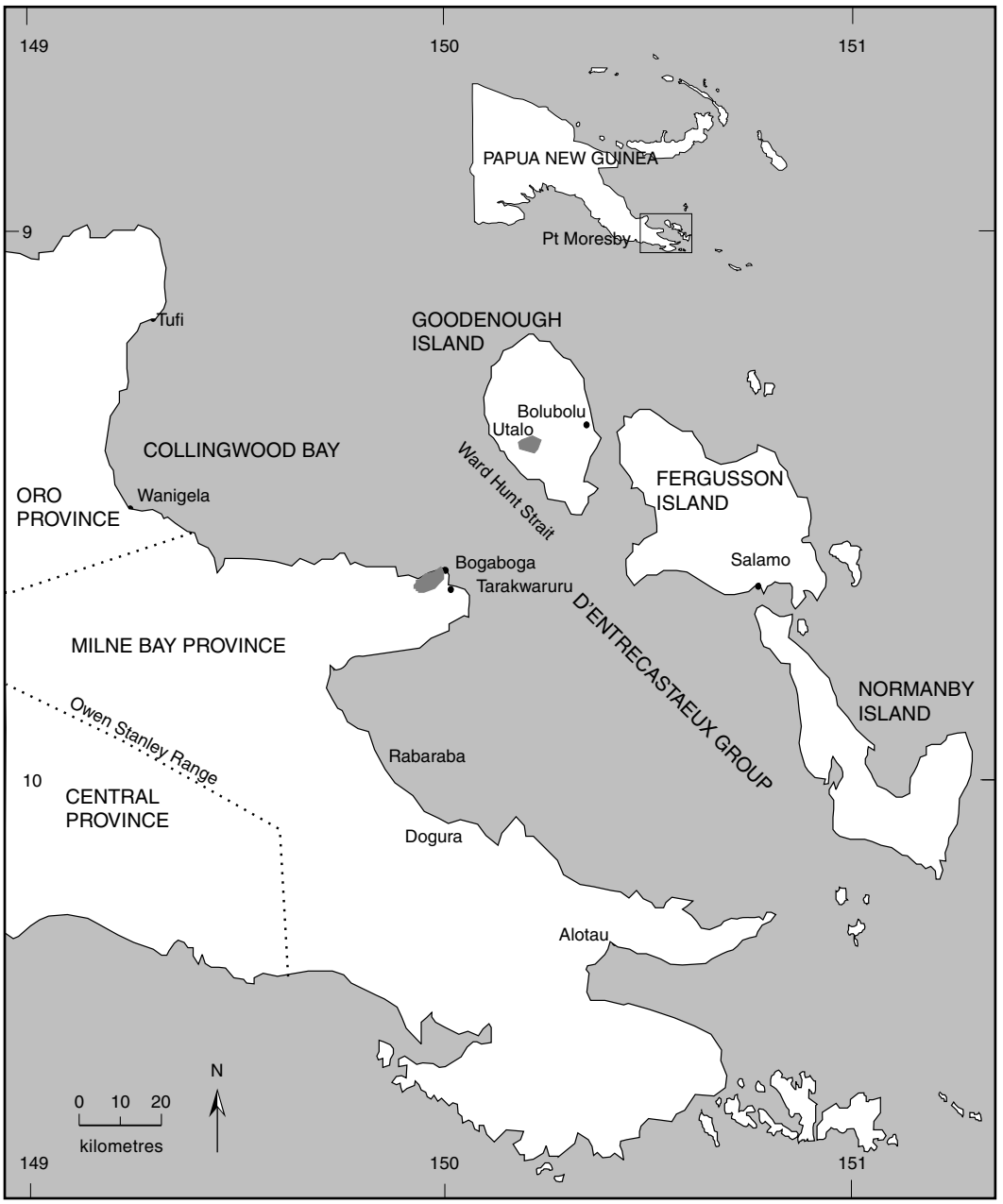

Figure 1. Milne Bay and adjacent provinces showing study sites.

Climatic factors are a critical factor influencing food security. Climatically, Cape Vogel and Goodenough Island have very marked wet and dry seasons. There is a long dry season dominated by southeasterly winds from late May to September. Most rain falls from December to May. The general rainfall pattern on Goodenough Island is similar to that on Cape Vogel (Fig. 2), although rainfall is higher there because of orographic effects.

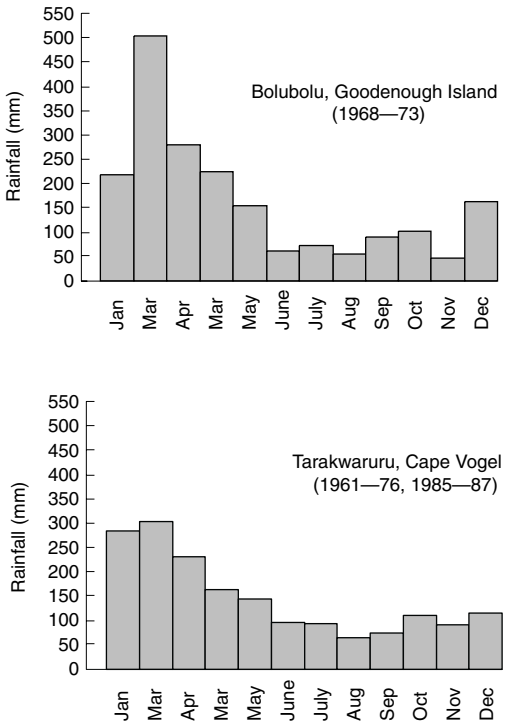

Figure 2. Rainfall patterns on Goodenough Island and Cape Vogel (PNG Bureau of Meteorology).

Over the past 100 years, five major droughts have been recorded in 1899–1901, 1911–12, 1946–47 (Young 1971), 1957–58 (McBarron 1958) and 1997. Of these, the 1946–47 drought is considered to have been the most severe, and the 1997 drought was of comparable severity (Allen and Bourke 1997). Given this history of severe droughts and long dry seasons, food security is an important issue on Cape Vogel and Goodenough Island, both at normal times and during unpredicted prolonged drought conditions.

This paper argues that food security can be ensured in drought-prone areas by maintaining crop diversity, cultivar diversity and food distribution systems. These factors are complementary in enabling food security in such areas.

Methods

During 1997–1999, I studied crop use on Cape Vogel and Goodenough Island and was able to observe the impact of the drought on village communities in these areas. My study focused on two villages: (i) Utalo village on Goodenough Island (a traditional subsistence community); and (ii) Bogaboga village on Cape Vogel (a community with a stronger association with the urban and national economy).

Qualitative information was obtained through observation and informal interviews of individuals and groups. This information was validated with formal interviews with individuals, survey of gardens for cultivar diversity and abundance, and household surveys of food consumption.

Crop Diversity

Very high crop diversity occurs in many of the gardens at both Bogaboga and Utalo. In any one garden, up to 40 different crop species may be grown for consumption. However, the following discussion focuses on basic starch or staple foods. The staple foods on Cape Vogel and Goodenough depend on the time of the year and type of garden visited. Both areas have four or five major food crops as staples that contribute most to daily consumption and are most highly valued culturally. At Cape Vogel, these staples include two species of yam, *Dioscorea alata* and *D. esculenta*, banana and sweet potato. In periods of low food availability, sago is also important. On Goodenough Island, taro, yam and banana are most important culturally. Cassava is not of cultural importance, but it forms a significant part of the diet.

Diversity of cultivars

A high diversity of cultivars was observed in some species (Table 1). Although each crop may show many cultivars, within taro and banana gardens the most productive cultivars are most common. Small numbers of other cultivars are maintained in moderate numbers as an insurance against adverse conditions, while the rest of the cultivars are maintained for 'sentimental' reasons. Yam, which can be stored, has many

Table 1. Numbers of different cultivars of important food crops grown in gardens at Utalo and Bogaboga and proportion that are drought tolerant.

Region	Taro	Yam (*Dioscorea alata*)	Yam (*Dioscorea esculenta*)	Banana
Utalo	42	24	12	22
Drought-tolerant varieties	1	6 (25%)	3 (25%)	2 (9%)
Bogaboga	10	26	23	15
Drought-tolerant varieties	0	5 (19%)	3 (13%)	3 (20%)

cultivars. New crops such as cassava have been integrated into the local crop management system. Taro at Utalo and *D. alata* at Bogaboga illustrate the diversity and management of traditional crops, while cassava at Utalo illustrates management of an introduced crop.

At Utalo villagers identify 42 cultivars of taro. Three cultivars dominate, with a further cultivar (Kwadogana) also present in moderate numbers. The remaining cultivars are present in very small numbers. Normally, people do not eat Kwadogana but this variety can survive drought and is available even in severe dry periods. Such varieties are planted year after year as an insurance against drought, even if they are not eaten every year.

Bogaboga people identify 25 cultivars of *D. alata*. Half of these yam cultivars are planted in large numbers while the other half cover a small area. Yam cultivars vary in time of maturity and storability. While some cultivars are consumed as soon as they are harvested, others go into storage. Overall, yams are managed such that their availability for consumption is prolonged.

In Utalo, seven known cultivars of cassava that mature at different times are grown. Most cultivars are planted in about equal numbers but one or two cultivars are planted in lower numbers. Cassava can be eaten all year round if constancy of planting is maintained. Although cassava is available in Bogaboga, it is not a status food as are yams and banana, and not everyone grows or eats it.

Crop Management Systems

Different crops have different ecological requirements. For example, yam needs good drainage and has a high nutrient requirement. Therefore new forest plots are cleared each year on hill slopes to cultivate it. Cassava, on the other hand, grows in nutrient-poor soils and is therefore used in the second or third planting in old yam gardens, or cultivated in poor grassland soils or water-logged floodplain soils.

In Utalo, yam gardens are cleared annually on forested hill slopes and are planted in September and October. The first taro is also planted during this period. Taro is planted in pure taro plots or intercropped with yam. Yam harvest starts in April and ends in July. A mixture of sweet potato, banana and cassava is planted in the harvested yam mounds. When the sweet potato and cassava from the second planting are harvested some 6–9 months later, cassava and *pitpit* (*Saccharum edule*) are planted but no further weeding occurs. The variety of cassava in the last planting is called *fiti* and will serve as food for wild pigs and people if food becomes scarce during the next year**.** The average fallow period in these areas is 15 years or more.

At Bogaboga, yam gardens are usually planted in October and early November on hill slopes cleared from secondary forest. Yams mainly occupy the top part of the slope, while some bananas mixed with sweet potato are planted on the lower part of the slope. Gardens are fenced to keep out wild pigs and wallabies. Yam is harvested from May to August. Some of the yam is left unharvested while sweet potato and bananas are planted in the mounds where yam had been harvested. The unharvested yam produces the first crop of yam in the following year. Little taro is grown at Bogaboga. The garden is abandoned after the third year and left fallow for 20–30 years.

'Banana gardens' are made annually at both Utalo and Bogaboga in low woody regrowth on areas of flat or gently sloping land. These gardens are made close to the village and, while dominated by bananas, they also grow cassava and sweet potato. Although the gardens are abandoned after two years, the bananas remain productive for the next 3–5 years. The fallow period is 5 years.

'Cassava and sweet potato gardens' are made in grasslands along streams. The gardens are abandoned once the cassava and sweet potato are harvested, usually within nine months, and are left fallow for two years. These gardens serve as a convenient source of food close to houses.

All three types of gardens are essential for managing the necessary staple crops and their cultivars. The most important source of food is from the yam and banana gardens. Food is harvested from each garden at different times of the year. During periods when yam is not available, banana from floodplain gardens and cassava from old yam gardens are harvested. All three gardens have to be managed to ensure yearlong food availability.

Food Availability

Because of the different types of gardens cultivated and the large number of cultivars maintained, food is generally available throughout the year at Utalo and Bogaboga (Fig. 3). Different types of food are eaten at different times of the year. In Utalo, banana, sweet potato, cassava and taro are all available all year round in varying quantities. Sweet potato, cassava and bananas mainly come from floodplain gardens or old yam gardens. Between December and April, food is harvested from the floodplain gardens, grassland gardens and old yam gardens. From April, yam forms a large component of daily meals, continuing through to October when yam is again planted. Different yam cultivars mature at different times and have different storage properties. Hence, the availability of yam can

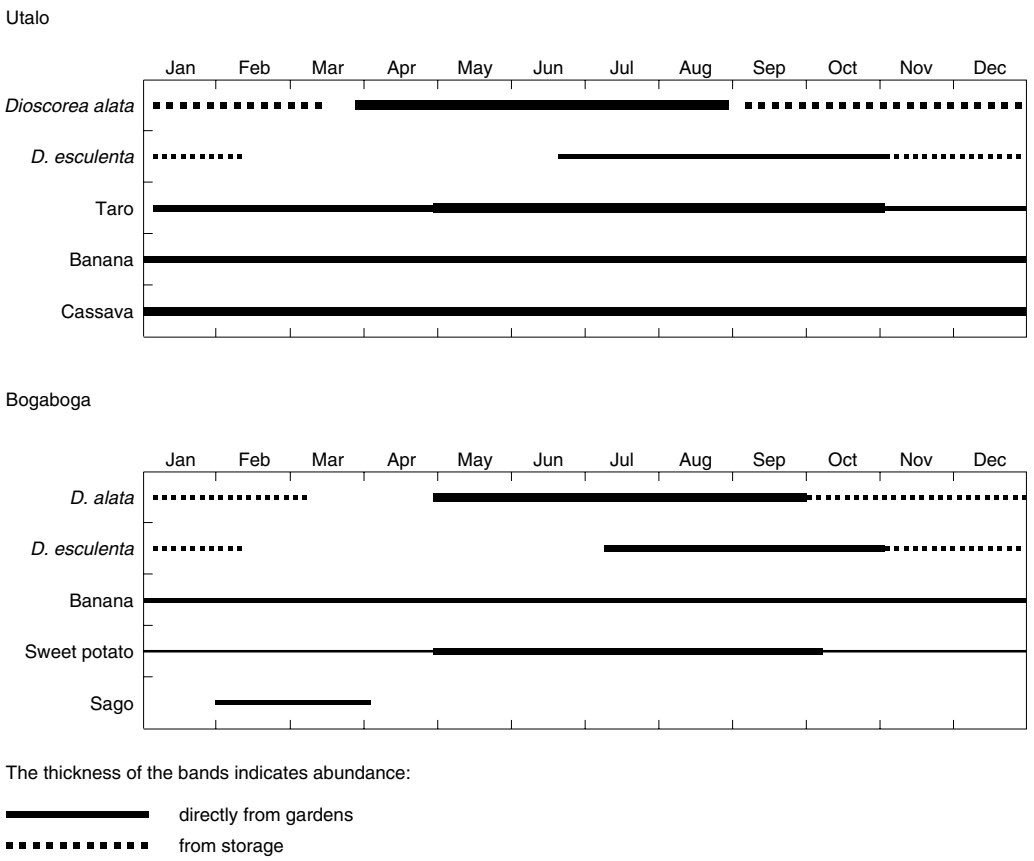

Figure 3. Food availability at Utalo and Bogaboga in non-drought years.

be managed, making it available in small amounts beyond the immediate yam harvest period.

Taro and banana are very dependent on high water availability. During prolonged dry periods, taro is the first to die and bananas become unproductive. During droughts, yams, sweet potato and cassava become the most important foods. Cassava is not a highly valued food: people in Cape Vogel will not eat cassava unless they are really desperate. At times of food scarcity, however, cassava becomes the main source of food at Utalo. For reasons not currently understood, very little sweet potato is eaten in Utalo.

Social Networks in Food Production and Redistribution

Social networks are critical for food production, maintenance of crop diversity and food redistribution in PNG, and serve to enhance food security. Members of a clan garden together, or help each other with garden work, and share the food produced. Clans have alliances to exchange food and reciprocity is common. Important occasions such as feasts are held to release and redistribute food. This sharing and reciprocity ensures general food security for all at all times, good or bad.

The 1997 Drought

In both areas, the drought started toward the end of March 1997 and the first rains came in December 1997, although heavy rain did not occur until late January 1998. The national assessment of food and water supply in October 1997 classified both areas as having no food available from gardens (Allen and Bourke 1997).

Utalo

Within two months of the onset of the drought, most of the taro plants at Utalo had died but small amounts of the drought-resistant cultivar Kwadogana remained available for a short time. In April, the yam harvest was much reduced and very little was stored. Yam was eaten as it was harvested from the gardens until July; stored yam was available until September. Until September, cassava served as a major food source and remained available for a long period. Further cassava was collected from fallow hillside gardens, and served as a major food source. Wild yams and figs (*Ficus capiosa*) were also eaten. In early January 1998, breadfruit became available (Fig. 4).

In September 1997, the community made copra, which they sold in Alotau. The money earned enabled people to buy rice (about 20–30 kilograms per family), which helped to sustain them until January 1998. People were only able to purchase this large quantity of rice once during the drought in Alotau, and they received very little food aid rice because of their isolation.

People continued to plant yam gardens on the hill slopes during the drought. In addition, they cleared gardens on river banks where they planted taro, cassava, sweet potato and pumpkin. All gardens recovered quickly when the rains arrived, although the first food harvested came from the gardens closer to the river, which produced food within two months of the rain arriving. By the end of March 1998, food was plentiful in those gardens, with people feeding sweet potato and pumpkins to pigs. Yams then recovered and the April–May harvest of 1998 appeared to be normal. Taro was slow to recover and material had to be taken from the river gardens to plant in the hillside gardens. By July 1998, the taro harvest was back to normal.

Feasting was limited during the drought but people engaged in *kweli*, which is a tradition of moving around, from one village to the next, singing. Singers received food as gifts. Rice that was bought with the money raised from the sale of copra and the small amount of aid rice often appeared as gifts in *kweli* events. Coastal people sang in inland villages to receive wild yams and wildfowl eggs, while inland people received fish from coastal villages.

Bogaboga

At Bogaboga, yams and bananas failed in most gardens as soon as the drought set in. A few of the gardens that were further inland in wetter areas had yams and bananas until September 1997. Most people ate sweet potato, which was available until June. From June to August, wild yams were harvested from remnant forest. From November, sago was made (Fig. 4).

Around October 1997, people were told that food was available from the government. They left their gardens and moved back to the main village. Many of the gardens were not planted again until late 1998. This was partly because people had eaten their planting material and partly because they did not have food to feed other people helping with clearing and fencing of gardens. In the latter part of 1997, mangos became plentiful and breadfruit became available in early 1998. People did not eat cassava during the drought, although they planted and ate it during the

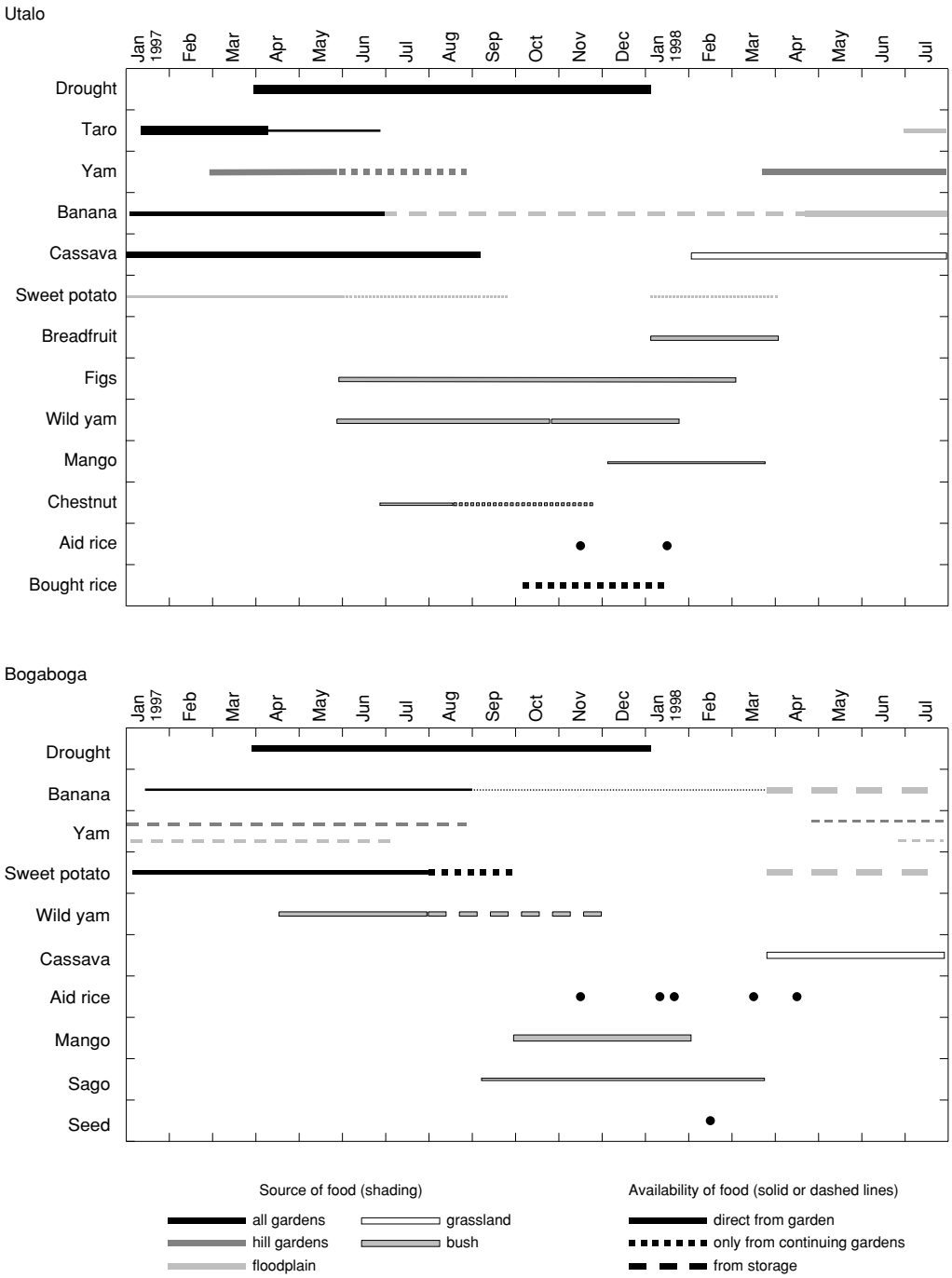

Figure 4. Food availability during the 1997 drought and recovery period in Utalo and Bogaboga.

recovery period from January 1998. Fish and shellfish were abundant and supplemented rice. Many families also received money from relatives living elsewhere and they used this to buy rice and other foods from trade stores.

The first aid rice arrived in early November 1997. From this time until April 1998 Bogaboga people received five shipments of aid rice: a total of about 100–150 kilograms of rice per household for a period of six months. Even by early 1998 many people had not made new gardens, mainly because they were confident that aid rice and remittance money would continue to flow in.

Discussion

In Utalo, people recognised that a drought had set in. They changed their garden behaviour by moving closer to wet areas to cultivate crops that were likely to tolerate dry conditions. At the same time they turned to food which in normal circumstances would not be eaten. They foraged for wild foods. When they realised that their natural sources of food were not sufficient they turned towards commercial food. However, they did not become reliant on it. Instead they treated it as luxury food by giving it away as they would with yam and taro in normal conditions. While foraging and living on wild foods, they continued to plant yam and other gardens in anticipation of rain. This anticipation paid off as those gardens recovered within two months of the rains returning. The social practices for redistributing food continued under a different guise. At no point did people depend on the government for food. The people's perception was that the government had no interest in their wellbeing and that they would have to be self-reliant.

In Bogaboga, reaction to the 1997 drought was very different from previous drought years. Traditionally, as soon as drought conditions prevail, people move closer to water sources and swampy areas and plant banana, sweet potato and pumpkin. The yam planting material is stored away and planted as soon as the rains arrive. People forage in the forest for wild yam and berries and in the grasslands they harvest wild *Pueraria* tubers. Their main traditional source of food during droughts is the underground stem of bananas called *bagana*. These are harvested when the swamp gardens are being planted. The stems are cleaned, baked and stored above the fireplace. *Bagana* can be stored for six months. When needed, it is peeled, soaked, sliced or grated, and cooked again before being eaten. A diet of wild yam, *Pueraria* and *bagana* is always supplemented with fish and shellfish, which are plentiful.

During the 1997–98 drought, however, only 12 households established swamp gardens and eventually returned to normal gardening practice when the rains arrived. For those who maintained their planting material and gardens, food was harvested by May 1998. Food was so plentiful that one clan from among this group challenged another clan to a competitive food exchange (a way of distributing excess food that would otherwise spoil).

Purchased rice and food aid rice replaced the need for *bagana* or *Pueraria* tubers. Prolonged availability of rice removed the need to establish grassland and floodplain gardens. Recovery of gardens was difficult because people lost planting material. Most of the people started returning to grassland and floodplain gardens around mid-1998. They had to wait another year to establish yam gardens when planting material again became available.

Recovery would have been much quicker but people in Bogaboga not only lost a lot of planting materials but also stopped making their gardens, particularly the most important yam and banana gardens. The people of Bogaboga relied on cash and government assistance, which ultimately hindered their recovery.

References

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.

FAO (Food and Agriculture Organization of the United Nations) 1996. Synthesis of the Technical Background Documents. World Food Summit, 13–17 November 1996. Rome, FAO.

Hanson, L.W., Bourke, M. and Allen, B.J. 2000. Priority Areas for Rural Development in Papua New Guinea. Canberra, Department of Human Geography, Research School of Pacific and Asian Studies, The Australian National University.

McBarron, B.A. 1958. Patrol Report Goodenough Island, August–November 1958, File No. 3-3-29. Unpublished report for the Department of Agriculture, Stock and Fisheries.

Young, M.W. 1971. Fighting with Food. Leadership, Values and Social Control in a Massim Society. Cambridge, Cambridge University Press, 282 p.

The El Niño Drought: an Overview of the Milne Bay Experience

Allen Jonathon*

Abstract

The El Niño drought struck PNG between April 1997 and March 1998 with an impact that had not been experienced by the present population of Milne Bay Province. Food gardens, water supplies and livelihoods were all but destroyed on a wide scale. As a result, the national government, provincial governments and aid donors were obliged to provide relief supplies to those who had been severely affected.

Milne Bay Province had its share of the devastating effect of the drought. The distribution of relief supplies was daunting because of the fragmented nature of the province, with more than 80% of its population physically located in the three island districts, and the complex logistics needed to overcome this. This paper highlights the Milne Bay experience.

THIS paper discusses the effects of the 1997–98 El Niño drought and the efforts involved to mitigate its effects, especially in the Milne Bay Province. While this paper will attempt to highlight the Milne Bay experience, the views expressed are the writer's and not necessarily those of the Milne Bay Provincial Government nor its implementing agency, the Milne Bay Administration.

Geography of Milne Bay

Milne Bay Province comprises the southeastern portion of PNG and takes its name from the deeply indented Milne Bay. It is the most fragmented province in the entire country with its geographic boundaries encompassing some 16,200 square kilometres of land and more than 100,000 square kilometres of sea.

Approximately 25% of the total land mass comprises 10 relatively large islands and 150 smaller islands and atolls. The most dominant feature of the province's mainland is the Owen Stanley Ranges, rising in height to three mountain peaks of more than 3000 metres above sea level.

Extending eastwards over the higher sections of the submerged extremities of the range are the Engineer and Conflict groups of islands and the islands of the Louisiade Archipelago, covering the Misima, Sudest and Rossel Islands in particular. Directly north of the mainland is the D'Entrecasteaux group of Normanby, Fergusson and Goodenough Islands. Goodenough Island is one of the most mountainous islands in the world with its central peak rising to a height of 2536 metres above sea level, flanked by numerous sharp ridges falling suddenly to the narrow coastal alluvial plains. The D'Entrecasteaux Islands are mostly metamorphic rock and volcanoes surrounded by coral and raised limestone formations.

Further to the north of the D'Entrecasteaux group are the Trobriand Islands. The largest island is Kiriwina which is only just above the sea level at its highest point. To the east of the Trobriand Islands are the Lachlan group of Iwa, Gawa and Kweiwatta Islands and, further east, the Woodlark Islands of which Budibudi Island is the most easterly inhabited island.

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Vegetation

The most common natural vegetation found in Milne Bay Province is forest that covers most of the mainland and the higher parts of the D'Entrecasteaux, Misima and Woodlark Islands. Grasslands are very extensive on the north coast and in the Sagarai valley, southwest of Alotau on the mainland. Smaller grasslands can be found on Goodenough and Fergusson Islands. A wide variety of mangroves are also common on the mainland coastline and on the major islands.

Climate

Climatic conditions vary throughout the province and are related to topography. A general climatic description would be: wet from November to March; and dry from April to October. However, in parts of the province, the seasonal rainfall patterns are quite reversed, and in other locations rainfall is high throughout the year. As well, the seasonal northwesterly and southeasterly winds can make seas quite treacherous for coastal vessels.

Population Statistics

The 1990 National Population Census showed a total of 157,288 residents in Milne Bay Province, an increase of 18.7% over the 10 years from 1980–90. District populations are as listed in Table 1. Approximately 94% of the total population live in the rural areas compared to a national average of 85%.

Table 1. Increases in Milne Bay Province district populations between 1980 and 1990.

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There are three main cultural groupings in Milne Bay Province—island, coastal and mountain people—with distinct differences in customs, language, behaviour and general lifestyles. Clan groupings are ancestral and are mixed patrilineal and matrilineal. There are 22 different ethnic groupings with 10 predominant languages spoken in the province.

The El Niño Drought

Milne Bay Province is prone to natural disasters and in 1997 we experienced two.

First, cyclone Justin hovered near Sudest and Rossel Islands in the Misima area of the Samarai–Murua district for 13 days from 6–20 March 1997. Windspeeds of 80 km per hour at its centre and from 140 to 160 km per hour on the outer perimeter caused damage estimated at 1.3 million PGK (PNG kina).[1] Damage was recorded as far west as Rabaraba on mainland Milne Bay. In all, an estimated 22,000 people in all four districts of the province were affected by cyclone Justin.

Second, and soon after, the El Niño drought followed, affecting 15 of the 29 census divisions (CDs) in the province, with eight CDs declared as category 5 (the most serious category) and seven as category 4 (the second most serious category) during the December 1997 Phase 2 Drought Assessment. This amounted to 79,882 people, involving approximately 11,000 households and accounting for about 50% of the 1990 population.

With regard to these figures, however, we suggest that:

- another three CDs should have been assigned a category 5 listing and the affected population should have been reduced in two other CDs; and
- it would have been more realistic to take into account the 18–20% increase in population since 1990 for purposes of distribution of relief supplies.

Overall effect of the drought

The most notable consequences of the drought in Milne Bay Province were:

- food gardens were completely destroyed by lack of rain;
- food sources became restricted on the coast and island areas to coconut, fish, breadfruit, wild yams, roots and nuts and on the mainland to wild yams, nuts, berries, breadfruit, banana corm, immature banana, cassava, sweet potato and some sago;
- gardening activities were abandoned because of the lack of rain;
- infestations of hawkmouth caterpillar and fruit piercing moth appeared in some parts of the province (Rabaraba and Alotau);

1. In 1997, 1 PGK = approx. US$0.70 (A$0.94).

- water sources near villages dried up requiring villagers to walk considerable distances to collect water from creeks and rivers;
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Major tasks to alleviate the effects of the drought

- The distribution of relief supplies (of basic food and water) to the worst affected areas of the province.
- The purchase and collection of seed and planting materials from the least-affected areas for distribution to the worst-affected areas.
- The planting of four seed multiplication gardens at Bubuleta Agricultural Station with quick-growing crops, such as sweet potato, cassava, *aibika* (*Abelmoschus manihot*), corn, giant swamp taro and high-yielding coconuts, for continued distribution even after the effects of the drought had abated.
- The formulation of short- and long-term fishing and agricultural rehabilitation programs in the light of this experience.

Funding

The Milne Bay Provincial Government had appropriated 100,000 PGK in its 1997 budget for disaster and emergencies within the province. However, this funding was exhausted by April 1997 in the aftermath of cyclone Justin in the Sudest and Rossel Island areas of the Samarai–Murua District.

An additional 100,000 PGK was secured from the Milne Bay Provincial Government and, together with only 40,000 PGK of a 100,000 PGK commitment from the National Disaster and Emergency Services (NDES), the Provincial Disaster Office continued to deal with the aftermath of cyclone Justin. In all, 240,000 PGK was spent on the cyclone relief exercise. Almost 60% of this funding was spent on sea transportation between Alotau and the Sudest–Rossel Island area.

After cyclone Justin, there was no funding available to address the effects of the El Niño drought.

Because of the enormity of the drought, the Milne Bay Provincial Government released another 113,300 PGK in August–September 1997 from savings identified in the normal budgetary review process. The national government assisted with another 30,000 PGK and donations from private enterprise and the general public amounted to 5000 PGK.

For the second half of 1997, a total of approximately 150,000 PGK was available for the El Niño drought relief exercise and, given the maritime nature of the province, and the extent of the drought, this funding was insufficient to say the least. However, the funding formed the basis for our Phase 1 operations (see below).

While an urgent request to the Milne Bay Provincial Government for an additional 250,000 PGK had been approved, funds could not be released owing to the end of the year closure of accounts.

The national government, through the Department of Finance, had also released to the chairpersons of the province's four district planning committees, a combined amount of 105,000 PGK which was allocated tor districts as follows:

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Because of the Department of Finance's instructions that these funds only be used under the authority of the respective district chairpersons, it was difficult to access the funds. In some cases, it was necessary to commit funds in the respective districts without the chairperson's approval and this resulted in some problems for provincial government staff.

For 1998, the Milne Bay Provincial Government appropriated 225,000 PGK in its budget to address all disaster and emergency occurrences throughout the year, including the El Niño drought.

Two local level governments (LLGs), Kiriwina and Goodenough, had assisted the Provincial Disaster Committee with 20,000 PGK each, which was tied to cover only the costs for the transportation of relief supplies to their respective areas.

The national government, through the then Minister for Provincial and LLGs under whom NDES fell, committed 620,000 PGK to assist Milne Bay in this exercise with an initial amount of 120,000 PGK in mid-January and another 500,000 PGK by the third week of January 1998. Only 75,000 PGK was released under this commitment, with instructions for it to be divided equally to cover transportation and expenses incurred.

A local politician had managed to secure approximately 68,000 PGK directly from NDES for relief supplies, which he forwarded directly to his electorate for

distribution. We were informed that this would come out of our provincial funds allocation. For obvious reasons, we had flatly rejected this situation and, as well, we had refused to be accountable for the distribution of these supplies.

Phase 1 Operations

Initial reports of the effects of the El Niño drought were received from rural-based government officers in July 1997. These reports indicated that although this was the dry season (April to October), which is the normal harvesting season, villagers had reported that the harvest had not been good and that most root crops were 'burnt and/or shrivelled' prior to the harvest. Most reports indicated an acute shortage of food within the community.

The Phase 1 operation commenced in early October 1997 with a total funding of approximately 150,000 PGK. This involved the purchase of relief supplies for distribution to the drought affected areas and initially included items such as rice, flour, margarine, dried peas, sugar, tea and powdered milk. However, when the extent of the drought and the limited funds available were realised, we quickly reduced the items to rice, flour and dried peas.

Phase 1 operations covered Cape Vogel, Goodenough Bay Coastal, Maramatana and parts of Suau; CDs in the Alotau District; areas in the Kiriwina and Goodenough Islands in the Kiriwina–Goodenough District; the smaller island communities of the Samarai Island; the Rossel, Sudest and Calvados Chain in the Misima area; the smaller islands of the Woodlark Island Census Divisions in the Samarai–Murua District; and parts of the West Fergusson and Dobu LLG areas in the Esa'ala District. In all, 50 tonnes (2500 bales) of rice, 30 tonnes (600 bales) of flour and 600 cartons of dried peas were distributed to about 39,000 people.

Phase 2 Operations

Phase 2 of operation commenced in January and was completed by March 1998. It involved the distribution of 319 tonnes of rice donated by the Australian Agency for International Development (AusAID) in December 1997 and another 20 tonnes donated by the Republic of China.

Despite the lack of funding, during the first 17 days of the operation in January 1998 we moved 165 tonnes of rice to 13 CDs for approximately 50,000 people using 13 local vessels and 9 vehicles (whose owners had agreed to be paid at a later date once funds were made available).

At the start of the new school year, we distributed some rice to all educational institutions that were taking in boarding students, as well as rural health centres with inpatient ward facilities. By the end of March, a total 319 tonnes of rice had been effectively distributed into all category 5 and category 4 areas within the province.

Problems encountered during this phase of the operation included:

- political interference and influence in the quantifying and distribution of relief supplies;
- unnecessary demands for relief supplies from areas which are not affected by the drought;
- nonreceipt of relief supplies;
- air transport costs; and
- release of funding.

Phase 3 Operations

Phase 3 commenced in April 1998. It had two parts—the distribution of 890 tonnes of rice donated by the government of Japan and the start of an agricultural rehabilitation exercise in the affected areas of the province.

While the distribution of the Japanese government's donated relief supply of rice continued in the same manner as in the phase 2 operation, the emphasis was now on the agricultural rehabilitation process in all the affected areas.

One of the major agricultural areas in the province, the Rabaraba area on the north coast mainland, had been severely affected by the drought. Other areas such as Duau, the eastern half of Normanby Island and the east Fergusson Island area had not been affected as much, and the Huhu and Sagarai areas of Alotau fared relatively well. It was from these areas that we collected local planting material, donated free of charge for the rehabilitation program, for distribution. Material included, banana suckers, cassava sticks, yam setts, sweet potato runners, *aibika*, Chinese taro (*Xanthosoma*), *pitpit* (*Saccharum edule*), sugarcane, corn, pumpkin and coconuts.

The first rains began in late December 1997. AusAID, through the Fresh Produce Marketing Corporation, provided funding assistance of 10,000 PGK and 600 kilograms of seedlings. These were distributed, together with the local planting materials, in the Cape Vogel, Goodenough Bay Coastal and Inland, Maramatana and Suau CDs of the Alotau district; the Amphlett–Sanaroa and South Normanby CDs of the

Esa'ala district; the Lusancay, Kilivila and Kitava CDs of the Kiriwina–Goodenough District, and Woodlark Island CD in the Samarai–Murua District.

The next phase of the agriculture rehabilitation program covered the distribution of seedlings and planting materials to the West Calvados, East Calvados and Deboyne–Reynard CDs in the Misima area of the Samarai–Murua District.

A seed multiplication garden with planting materials purchased from the Lowlands Agricultural Experiment Station at Keravat had been planted at Bubuleta Research Station and were ready by June or July 1998 for distribution.

The investigating entomologist on the fruit piercing moth and sweet potato and taro hawkmoth infestations recommended letting these run their natural cycle. Although certain cultural practices and control measures could have lessened the damage, their impact would not have been significant: thus economic losses were high.

Public Health

All 154 health institutions throughout the province (including 14 health centres, 16 subhealth centres and 124 aidposts) were sufficiently stocked with drugs during the drought. The major concern was the movement of health personnel in the event of an outbreak of any diseases.

In February 1998, two major outbreaks of a complication of malaria, pneumonia and influenza had been reported at Aragip in the (lower) Daga CD of the mainland and on the outer islands of Egum, Iwa and Gawa in the Woodlark CD. Health teams despatched to these areas had brought both situations under control.

Aragip reported 13 deaths, of which two were children. On Egum, Iwa and Gawa islands, eight deaths were recorded (four adults and four children) and one death was reported in the Suau CD in the Alotau district.

Water Supply

We had only succeeded in transporting water from Alotau to Samarai town on Samarai Island using Australian navy barges. Our attempts to deliver water using the same vessels to the outer islands (Egum, Yanaba, Iwa and Gawa) were not successful due to navigational constraints.

The Geological Survey Division of the then Department of Minerals and Energy had despatched its officers to Milne Bay Province with a proposal to drill for water on the more isolated islands of the province; we are not aware of the results of this activity. The nongovernment organisation Adventist Disaster and Relief Agency (ADRA) of the Seventh Day Adventist Church had been successfully finding underground water sources and digging them out in the Rabaraba area using divining rods.

Despite the severe shortage of drinking water in all the drought-affected areas, most people had reverted to traditional water sources, previously been abandoned because of difficult access, in favour of the more accessible water tanks and bore waterpumps.

With the exception of Samarai, there had not been any reported major need for drinking water.

Conclusion

Following the drought, agriculturalists from the Milne Bay Administration who had been part of the Milne Bay Province drought relief team drew up food security proposals for Milne Bay Province covering subsistence and semicommercial food production, rice and grain development, atoll farming, fisheries and marine resources and seed distribution projects as short-, medium- and long-term proposals. It now remains for the government to approve funding for these proposals.

We were very well able to address most of the health problems that arose during this drought. However, we were not successful in addressing the need for water in all the affected communities. We can only pray that someone will solve this problem before the next El Niño-type drought appears and that, when it does, the need for water does not become a pressing issue.

In all, the people of Milne Bay Province were able to withstand the effects of the El Niño drought very well, given the severity of its effect on their livelihoods.

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distribution. We were informed that this would come out of our provincial funds allocation. For obvious reasons, we had flatly rejected this situation and, as well, we had refused to be accountable for the distribution of these supplies.

Phase 1 Operations

Initial reports of the effects of the El Niño drought were received from rural-based government officers in July 1997. These reports indicated that although this was the dry season (April to October), which is the normal harvesting season, villagers had reported that the harvest had not been good and that most root crops were 'burnt and/or shrivelled' prior to the harvest. Most reports indicated an acute shortage of food within the community.

The Phase 1 operation commenced in early October 1997 with a total funding of approximately 150,000 PGK. This involved the purchase of relief supplies for distribution to the drought affected areas and initially included items such as rice, flour, margarine, dried peas, sugar, tea and powdered milk. However, when the extent of the drought and the limited funds available were realised, we quickly reduced the items to rice, flour and dried peas.

Phase 1 operations covered Cape Vogel, Goodenough Bay Coastal, Maramatana and parts of Suau; CDs in the Alotau District; areas in the Kiriwina and Goodenough Islands in the Kiriwina–Goodenough District; the smaller island communities of the Samarai Island; the Rossel, Sudest and Calvados Chain in the Misima area; the smaller islands of the Woodlark Island Census Divisions in the Samarai–Murua District; and parts of the West Fergusson and Dobu LLG areas in the Esa'ala District. In all, 50 tonnes (2500 bales) of rice, 30 tonnes (600 bales) of flour and 600 cartons of dried peas were distributed to about 39,000 people.

Phase 2 Operations

Phase 2 of operation commenced in January and was completed by March 1998. It involved the distribution of 319 tonnes of rice donated by the Australian Agency for International Development (AusAID) in December 1997 and another 20 tonnes donated by the Republic of China.

Despite the lack of funding, during the first 17 days of the operation in January 1998 we moved 165 tonnes of rice to 13 CDs for approximately 50,000 people using 13 local vessels and 9 vehicles (whose owners had agreed to be paid at a later date once funds were made available).

At the start of the new school year, we distributed some rice to all educational institutions that were taking in boarding students, as well as rural health centres with inpatient ward facilities. By the end of March, a total 319 tonnes of rice had been effectively distributed into all category 5 and category 4 areas within the province.

Problems encountered during this phase of the operation included:

- political interference and influence in the quantifying and distribution of relief supplies;
- unnecessary demands for relief supplies from areas which are not affected by the drought;
- nonreceipt of relief supplies;
- air transport costs; and
- release of funding.

Phase 3 Operations

Phase 3 commenced in April 1998. It had two parts—the distribution of 890 tonnes of rice donated by the government of Japan and the start of an agricultural rehabilitation exercise in the affected areas of the province.

While the distribution of the Japanese government's donated relief supply of rice continued in the same manner as in the phase 2 operation, the emphasis was now on the agricultural rehabilitation process in all the affected areas.

One of the major agricultural areas in the province, the Rabaraba area on the north coast mainland, had been severely affected by the drought. Other areas such as Duau, the eastern half of Normanby Island and the east Fergusson Island area had not been affected as much, and the Huhu and Sagarai areas of Alotau fared relatively well. It was from these areas that we collected local planting material, donated free of charge for the rehabilitation program, for distribution. Material included, banana suckers, cassava sticks, yam setts, sweet potato runners, *aibika*, Chinese taro (*Xanthosoma*), *pitpit* (*Saccharum edule*), sugarcane, corn, pumpkin and coconuts.

The first rains began in late December 1997. AusAID, through the Fresh Produce Marketing Corporation, provided funding assistance of 10,000 PGK and 600 kilograms of seedlings. These were distributed, together with the local planting materials, in the Cape Vogel, Goodenough Bay Coastal and Inland, Maramatana and Suau CDs of the Alotau district; the Amphlett–Sanaroa and South Normanby CDs of the

Esa'ala district; the Lusancay, Kilivila and Kitava CDs of the Kiriwina–Goodenough District, and Woodlark Island CD in the Samarai–Murua District.

The next phase of the agriculture rehabilitation program covered the distribution of seedlings and planting materials to the West Calvados, East Calvados and Deboyne–Reynard CDs in the Misima area of the Samarai–Murua District.

A seed multiplication garden with planting materials purchased from the Lowlands Agricultural Experiment Station at Keravat had been planted at Bubuleta Research Station and were ready by June or July 1998 for distribution.

The investigating entomologist on the fruit piercing moth and sweet potato and taro hawkmoth infestations recommended letting these run their natural cycle. Although certain cultural practices and control measures could have lessened the damage, their impact would not have been significant: thus economic losses were high.

Public Health

All 154 health institutions throughout the province (including 14 health centres, 16 subhealth centres and 124 aidposts) were sufficiently stocked with drugs during the drought. The major concern was the movement of health personnel in the event of an outbreak of any diseases.

In February 1998, two major outbreaks of a complication of malaria, pneumonia and influenza had been reported at Aragip in the (lower) Daga CD of the mainland and on the outer islands of Egum, Iwa and Gawa in the Woodlark CD. Health teams despatched to these areas had brought both situations under control.

Aragip reported 13 deaths, of which two were children. On Egum, Iwa and Gawa islands, eight deaths were recorded (four adults and four children) and one death was reported in the Suau CD in the Alotau district.

Water Supply

We had only succeeded in transporting water from Alotau to Samarai town on Samarai Island using Australian navy barges. Our attempts to deliver water using the same vessels to the outer islands (Egum, Yanaba, Iwa and Gawa) were not successful due to navigational constraints.

The Geological Survey Division of the then Department of Minerals and Energy had despatched its officers to Milne Bay Province with a proposal to drill for water on the more isolated islands of the province; we are not aware of the results of this activity. The nongovernment organisation Adventist Disaster and Relief Agency (ADRA) of the Seventh Day Adventist Church had been successfully finding underground water sources and digging them out in the Rabaraba area using divining rods.

Despite the severe shortage of drinking water in all the drought-affected areas, most people had reverted to traditional water sources, previously been abandoned because of difficult access, in favour of the more accessible water tanks and bore waterpumps.

With the exception of Samarai, there had not been any reported major need for drinking water.

Conclusion

Following the drought, agriculturalists from the Milne Bay Administration who had been part of the Milne Bay Province drought relief team drew up food security proposals for Milne Bay Province covering subsistence and semicommercial food production, rice and grain development, atoll farming, fisheries and marine resources and seed distribution projects as short-, medium- and long-term proposals. It now remains for the government to approve funding for these proposals.

We were very well able to address most of the health problems that arose during this drought. However, we were not successful in addressing the need for water in all the affected communities. We can only pray that someone will solve this problem before the next El Niño-type drought appears and that, when it does, the need for water does not become a pressing issue.

In all, the people of Milne Bay Province were able to withstand the effects of the El Niño drought very well, given the severity of its effect on their livelihoods.

The Experience of the 1997–98 Drought in Simbu Province: Lessons Learnt

Edward Kiza* **and Mathias Kin***

Abstract

The worst drought in PNG in recorded history occurred in 1997, and it had a major impact on the 184,000 people of Simbu Province. The problem was recognised by the government only after major environmental and social changes had commenced. These included food shortages and the associated problems of law and order and environmental changes. Field assessments were conducted to assess the need for relief supplies. Villagers responded by using cash savings to purchase food, traded possessions for cash and food, and many sought financial assistance from friends and relatives. The provincial administration coped with the major challenge fairly well, but there were some problems. These were brought about by poor communications, poor road access, inadequate preparation, insufficient trained personnel and political attempts to influence distribution of resources. There was a lack of cooperation by villagers in some localities. With the return of the rains in late 1997, fast-growing crops started to produce. By April 1998, staple foods were being eaten again in most locations and life had almost returned to normal. A number of recommendations are made that, if followed, will reduce the vulnerability of food shortage in the future.

SIMBU Province is situated in the central highlands of PNG and shares borders with five other provinces. The province has a land area of 6181 square kilometres and a population of 183,849 (1990 census) with a growth rate of 0.5%.

The 1997–98 drought affected all provinces of the highlands and PNG to an extent never felt in the history of this land. Simbu Province was one of the worst-affected provinces with much of the province being placed in the most severe food shortage classes by the mid-October 1997 assessment.

This paper describes the early signs of drought, how people responded as the drought developed, the responses and reactions of governments and problems that were confronted and successes that were achieved.

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Early Signs

Early signs that things were not normal included a change in the colour of the sun, which became blood red in the afternoons, a very hazy daytime sky, greater extremes in temperatures with very cold nights and hot days, and frosts which occurred as night time temperatures fell below freezing in the high altitude parts of the province, and of course a lack of rain.

In Simbu Province, the dry weather started earlier than normal in April 1997, and continued after the normal dry period at the end of July right through to the end of 1997. There were sporadic periods of rain in October and November in the northern parts of the province but in the south, it was dry for at least ten months before the first rain in December 1997. In most parts of the province there was little further rain after this until late February 1998, when heavy rain was received all over the province. Local sources of water began to dry up, forcing people to walk further to

collect drinking water, the ground began to crack and there was an increased incidence of bush fires. Small animals began to behave differently: earthworms came out of ground in large numbers and died and small wild animals began to move away from their natural habitat towards water sources. Vegetation started to change colour, wilt, defoliate and die. As the drought proceeded, there was a noticeable increase in sickness among children, women and older people.

The Food Situation

As early as August 1997, shortages of sweet potato became evident. By the mid-October assessment most of the province was found to either only have left a supply of food for two to four weeks in gardens or to have no edible food left at all. In the latter places, people were eating famine foods, and many children and other people were becoming sick.

People started to sell pigs for money to buy food from the stores or to exchange them for food. From about August, food sold at the markets decreased in volume and much of the sweet potato that was on sale was weevil-damaged. Bush leaves appeared in the markets to be sold as green vegetables. By October there were no sweet potato or green vegetables of any kind in the markets. An increase in demand for store-bought food occurred and a general increase in the prices of store food items was also noticed. By November, the food supply situation was critical.

In November 1997, the first relief food distribution took place (provided by the national government giving money to all politicians in the country), but the food supplied was not sufficient for families' needs. In most cases, the food distributed was enough for only two meals and people had to make do with whatever they could survive on for more than two months before the next relief food was distributed. Many families missed out totally in the first distribution. However, the *wantok* system (sharing between relatives and friends) was operating at its best throughout this time and helped many families and communities to withstand this crisis.

A sudden increase in gardening activities was observed in January 1998 at the end of the drought. By February 1998, green vegetables and cucumbers were being eaten in most villages and the immediate danger of starvation was over. By March 1998, Irish potatoes were being eaten in most of the northern part of Simbu. By April 1998, after some problems with the formation of tubers, sweet potato and most other root crops were being eaten in most parts of the province and normal life had almost resumed in most villages. Only a few localities in higher altitude areas were waiting to harvest sweet potato.

Water

The drought brought about a serious shortage of drinking water. By October 1997, in many localities of the province most of the traditional waterholes, streams and creeks had dried up and people were drinking from main rivers and had to walk many hours, often down mountains, to collect water and then carry it back up to their homes. By mid October, more than half of all localities in Simbu were in a situation where water was in very short supply but was available at longer distances. Even the large rivers in the province shrunk to very small flows. It became possible to walk across the Waghi River in the Gumine area, where the river is usually swift, deep and very dangerous to cross.

People's Reactions

People reacted to these impacts of the drought in a number of ways. There was an increase in stealing and a breakdown in law and order. Family disputes over land, crops and animals increased noticeably. There was a general increase in demand for store-bought food with people using savings, cash from the sale of stored coffee, or pigs and money from relatives working in towns.

Many families moved to be closer to reliable sources of water. Partly as a result, there was a sharp drop in school attendance. Other children stopped attending because they were too hungry and found it hard to concentrate on schoolwork. They spent their days looking for food. A number of schools in the province closed and a drop in academic performance occurred throughout the province, reflected in the Grade 10 examination results at the end of the year.

Village people began to place increasing demands upon those family members who were working and earning a wage. Communities also put pressure on government authorities for relief assistance. There was also a marked change in the attitude of people about their general way of life and much greater numbers sought forgiveness and repentance in the local churches.

Reactions of Government and Aid Organisations

On 7 August 1997, the Simbu Provincial Government recognised the drought as a national disaster and established a Provincial Disaster Working Committee and a number of District Disaster Working Committees. The provincial government organised a number of field assessments in early September 1997, and were assisted by the Australian Agency for International Development (AusAID) in late September. By October, the provincial government suspended all other government activities and diverted all resources to assist in the relief efforts. A public awareness campaign was carried out throughout the province in partnership with nongovernment organisations (NGOs). The churches were the first NGOs to assist their own followers. The national government gave grants of 224,000 PNG kina (PGK)[1] through national Members of Parliament, followed in November by international assistance when relief food and material assistance of 2077 tonnes of rice, 188 tonnes of flour, 94,572 litres of oil, 5830 water containers, 267 water purification kits and medical supplies were provided.

Later rehabilitation started with the supply of sweet potato vines, potato seeds, corn and other seeds.

Problems

A major problem was the difficulty of communication that occurred between local-level governments (LLGs) and district headquarters, including the Provincial Disaster Working Committee. Councillors had no means of communicating other than walking long distances, and when food became short they were reluctant to leave their homes. A second problem was the totally inadequate resources (mainly materials) and finances that were available to meet the demands of the crisis. Both these difficulties were compounded by the very poor condition of infrastructure that increased the problems of accessibility. Roads and bridges were impassable to vehicles. The only way to travel quickly to many places was by helicopter. Helicopters were not readily available and were very expensive to charter.

The water supply problems were made worse by poor rural water collection and storage facilities. The roofs, guttering and tanks of government and mission schools, health centres and churches were in a poor state of repair and many tanks were empty when the drought began.

Within the province, at all levels of government, there was a lack of preparedness for the disaster and a lack of expertise to manage a government response to it. Within village communities there was often a reluctance to cooperate with the government, which compounded the problems in some areas.

When the demand for store-bought food rose, many stores ran out of supplies and there were no local stocks available. Food had to be brought in by truck from Lae, which made the commercial response slower than if local stocks had been available.

The same problem affected medical supplies, which quickly ran out in almost all health institutions.

Finally, attempts by leaders to use political influences to unfairly distribute relief supplies was an initial problem, which lessened as the seriousness of the situation was realised and as outside independent assessments were used as the basis for making food distribution decisions.

Among village communities, a general decline in interest in subsistence agriculture that can be attributed to people wanting to adopt a contemporary and more westernised lifestyle meant that gardens were not as large or as productive as they could have been. The fact that irrigation is not practised in Simbu Province also reduced the opportunity to grow food during the drought.

Successes

Despite these problems, a clear spirit of community cooperation developed throughout the province as a result of the food and water problems caused by the drought. The *wantok* system proved very effective and beneficial and members of families in waged jobs contributed food and money to their less fortunate rural relatives. The coping capacity of communities were very much evident. An excellent cooperative spirit developed between government agencies, aid organisations, NGOs and the business community and between the government and the people.

Valuable lessons were learnt from the disaster and also almost forgotten traditional ties and Melanesian values were revived.

Recommendations

The following recommendations are derived from those developed by the Provincial Disaster Working Committee in consultation with the regional and

1. In 1997, 1 PGK = approx. US$0.70 (A$0.94).

national disaster management services. They are directed at the three levels of government: national, provincial and local.

The national government should:

- establish a permanent provincial disaster management service, fully resourced that should report to the national disaster management services;
- establish an early warning system and communication systems at all levels of government for the reporting, recording and compilation of more accurate weather and social and economic indicators of any impending food and water supply problems;
- improve the training of people at all levels of disaster and emergency management;
- promote the processing, preservation and storage of locally produced foods so that stocks of food are available when needed; and
- trial and promote drought-resistant food crops, through the National Agricultural Research Institute.

The provincial government should:

- develop a disaster management plan which must be reviewed annually in consultation with the national disaster management office's plans;
- ensure adequate funds are set aside from annual budgets and are rolled over yearly for disaster relief operations;
- ensure that communication facilities are maintained to enable monitoring and carrying out of relief operations;
- ensure that the necessary arrangements are in place for the collection of up-to-date data on social status, health status, weather trends and other factors that will assist in planning and management of disasters;
- include other stakeholders, such as churches and the business community, in the development of plans and in meetings of the provincial disaster working committees;
- pass laws that will ban all forms of gambling, liquor sales and enforce penalties on people who cause tribal fights;
- promote the diversification of village farming to improve food security and reduce dependency on traditional staples;
- promote improved gardening techniques such as irrigation, selection of gardening sites and soil conservation methods;
- increase funding for effective extension work in health and agriculture sectors; and
- promote and strengthen economic management practices for increased savings and investments by individuals and at the village level.

LLGs should:

- establish ward and community centres in all LLG areas that will be suitable for storage and emergency accommodation in time of need and also to serve as training and meeting centres;
- conduct immediate identification and assessments of all drinking water sources;
- establish and maintain water supply systems in identified localities;
- promote agricultural practices that promote/enable soil conservation; and
- pass and enforce laws that address environmental and sanitation problems.

Summary

The 1997–98 drought and frost in Simbu Province was the worst in the recorded history of the province. Local food supply became critical and water was in very short supply. Imported foods were mostly expensive and, in many cases, unavailable in many rural areas. There was an increase in health problems and a break-down in traditional norms and rules and a general increase in law and order problems. Governments lacked the ability to recognise early signs of a problem and to respond. The provision of adequate relief food to large rural populations required large amounts of money that was never readily available. However, the event brought together people and organisations from all over the country and from the international aid and relief communities and good, supportive relationships were established. Traditional Melanesian values (including the *wantok* system) were revived and strengthened.

Australia's Response to the 1997 PNG Drought

Allison Sudradjat*

Abstract

Through the Australian Agency for International Development (AusAID), the Australian Government responded to what was probably the worst drought to hit PNG this century. The aim was to ease the suffering of isolated communities. Between October 1997 and April 1998, in a joint program between the governments of PNG and Australia, a total of approximately 100,000 people in areas accessible only by air were assisted with basic food rations consisting of rice, flour and cooking oil for between one and six months. In early 1998, AusAID also worked with the government of PNG to distribute vegetable seeds and/or seed potato to each of PNG's provinces to ensure that those worst affected by the drought would have planting material when the drought broke.

The drought that hit PNG in 1997 was the third 'big event' of the year; the first being the 'Sandline affair' and the second the national elections. At least two books have already been written about Sandline, and at least a dozen doctorates will come from analysis of the Skate and Morauta governments. Reams could equally be written about the drought—arguably the worst to hit PNG this century. Thus, it is clearly difficult to describe the role of the Australian Agency for International Development (AusAID) in the drought relief operation in a short paper. With apologies for what is unsaid, particularly for the tendency to understate the critical and much-appreciated role our many partners played, this paper outlines the major landmarks and features of Australia's relief effort in PNG, and concludes with some lessons for the future. Though we hope and pray the 1997 drought was the last to hit PNG, the old farmers' adage of 'expect the best but prepare for the worst' is prudently applied to such matters.

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Australia's Initial Response

Around mid-1997, PNG's national newspapers carried articles describing communities affected by food and/or water shortages as a result of extreme frosts and drought. These types of articles, highlighting the impact of natural events and seeking government assistance, are not uncommon in PNG and there was little to suggest that anything out of the ordinary was taking place. Initial inquiries by AusAID met with reassurances that seasonal drought and frosts were common, and that people's coping mechanisms were robust.

AusAID became aware that the situation was potentially quite a bit more serious than originally thought in late August 1997 through the coincidence of two events.

Firstly, we were contacted by the Rumginae Health Centre outside Kiunga to provide transport for medical supplies and food urgently required to keep the health centre operational. The Fly River, by that time, was so low that barges were not able to bring these supplies to Kiunga. A visit to the area confirmed that a number of church-run health and education facilities in the Kiunga area were in urgent need of assistance to transport essential supplies.

At almost the same time, we were contacted by the PNG Government seeking funding for Dr Michael Bourke and Dr Bryant Allen of The Australian National University to undertake an assessment of the extent and severity of the drought and frosts and the impact on communities.

AusAID's response was rapid: with the assistance of the Australian Defence Force, we transported essential supplies to Kiunga in September and we provided funding for the first drought assessment in September/October.

The First Drought Assessment: Australia's Contribution to the Response

Drs Bourke and Allen and their team concluded that there were at least 150,000 people in communities across PNG whose normal resilience to shortages of food and/or water had been exceeded by the drought gripping the country, and a further 170,000 people who were close to the point of no longer being able to cope.

The Australian Government's reaction to these sobering findings was an offer to deliver food rations to the worst-affected communities in locations only accessible by air. This offer was made on the basis that the PNG Government could then channel its resources to purchasing food supplies and delivering these to badly affected communities accessible by either road or water. It was also made on the basis of comparative advantage: PNG's air capacity is limited and at the time was heavily utilised for normal functions.

The offer of assistance was accepted. Between October 1997 and April 1998, AusAID and the Australian Defence Force worked in close cooperation with the PNG National Disaster and Emergency Services and the PNG Defence Force on the largest and most complex emergency humanitarian aid activity that AusAID has ever managed as a lead agency.

During the drought operation, more than 100,000 people in remote locations in Sandaun (West Sepik), Western, Gulf, Enga, Southern Highlands, Central, Morobe, Oro (Northern) and Milne Bay provinces were assisted. Food rations—set by the National Disasters Committee and comprising 8 kilograms of rice, 2 kilograms of flour and 1 litre of cooking oil per person per month—were delivered to central locations for distribution to each individual. Some communities received food supplies for just one month, while others were supported for up to six months.

At the same time, AusAID funded complementary activities, including a nutrition assessment, purchase and delivery of essential pharmaceuticals to combat drought-related sickness and water supply advice. In addition, AusAID provided substantial funding for drought relief projects undertaken by nongovernment organisations.

Emerging from the Drought

AusAID and the PNG Government monitors constantly reassessed the requirement of individual communities for food relief. This was formalised through two follow-up drought assessments in November/December 1997 and March 1998.

A critical issue, identified very early in the drought response, was the need to ensure that affected communities had adequate planting material once the rains started again. It was considered that Australia could make a contribution to this area by providing seed potato and vegetable seeds to areas badly affected by the drought, and by delivering this planting material into areas only accessible by air. In the end, nearly 22,000 kilograms of vegetable seeds and 350 tonnes of seed potatoes were delivered to almost all of PNG's 19 provinces. This seed distribution was never intended to fully address the needs of most people for planting material—particularly those whose staple diet is sweet potato. The generosity and cooperation of fellow Papua New Guineans in providing sweet potato runners, in particular, to needy communities should not go unmentioned in this regard.

Did Australia's Aid Effort Make a Difference?

It was alleged at the time, and these arguments have since been repeated, that Australia had mixed and largely self-interested reasons for providing approximately A$30 million worth of assistance to PNG as part of the drought-relief operation. The answer to this allegation is an unequivocal 'no': Australia sought only to relieve the suffering of ordinary people in PNG.

In respect of the food rations, our assessment was, and remains, that we stood to 'add the greatest value' in areas only accessible by air, and that the PNG Government had the resources to address the other badly-affected but more accessible areas.

Whether or not anyone had already died in the areas where food relief was eventually provided, or whether

or not the assistance Australia provided saved any lives, are not helpful questions. Measuring the extent to which Australian food deliveries relieved hunger and reduced sickness and longer-term health impacts is an almost impossible exercise. Most of the areas where the food supplies were delivered are under-serviced, population figures are sketchy and health statistics are questionable. Like the international effort to combat the Y2K computer problem, the question of how bad things might have been is likely to remain moot.

Planting material was provided to help people get back on their feet. Seed potato, in particular, is not readily accessible in the Asia–Pacific region. By sourcing and supplying seed potato, Australia was again assisting in an area where it had a comparative advantage and where its efforts could complement those of PNG and other donors.

In a bid to counteract the increased incidence of diet-related infection and illness imposed by the drought, AusAID distributed pharmaceuticals to the value of 1.2 million PNG kina (PGK),[1] as requested by the Department of Health.

During November 1997, the Australian Government invited Australian nongovernment organisations to submit proposals for activities that would supplement relief efforts already under way in PNG. Australia funded six proposals covering water supply, agricultural recovery, health and the supply and distribution of food.

Lessons for the Future

AusAID commissioned an evaluation of its involvement in the drought relief operation in April 1998 before memories faded.

The evaluation drew many conclusions, but possibly the most important one is that intended beneficiaries received between one-half and three-quarters of their intended food rations. By international measures, this is an outcome to be proud of and signals the success of the cooperation between AusAID, PNG National Disaster and Emergency Services, the Australian Defence Force, the PNG Defence Force, targeted villages, the people in these villages who assumed responsibility for distribution, and PNG's private sector suppliers.

The evaluation highlighted things that could have been done differently to produce a better outcome.

Key recommendations included the following.

- Inclusion of professional relief assessors as part of the assessment teams and continuing reassessment by these experts to ensure that relief is delivered only to those areas and people who cannot meet their own needs.
- Deployment of monitors to focal areas. These monitors would be required to check that relief supplies are being passed down the chain to the most remote villages in each location. They would also reaffirm population estimates.
- Strengthening of PNG's National Disaster and Emergency Services and provincial and district disaster networks. This assistance is to be delivered under a major AusAID-funded project commencing shortly.
- Support for rural health services so that populations are more resilient to future droughts. AusAID is providing assistance in this area through a series of major health projects being implemented with the PNG Government.
- Earlier attention to agricultural rehabilitation, including the earlier delivery of planting material.
- Provision of safe and permanent water to communities in rural PNG.
- Assistance for rural development programs that include crop diversification, processing and storage.

Conclusion

Collectively, we learnt many lessons from the joint drought relief operation, though several factors conspired against us acting on all of those lessons straight away.

The rains came to most places by about December 1997 and within weeks or, at worst, months people had resumed their normal diets. Hunger and thirst quickly became a distant memory for many.

Those most closely involved with the drought operation were tired. The drought demanded more than six months of sustained effort, and the work had been, at times, demoralising as even our collective best efforts were not enough to provide relief to all who needed it.

And then just as we had gathered enough energy to focus on post-drought development requirements, the horrific tsunami struck Aitape.

Though the people of Aitape could never be described as fortunate, they did benefit from a relief operation that was somewhat more effective and efficient than it might otherwise have been. The people of PNG, who had just come through the drought together, expressed a sense of nationhood and poured contribu-

1. In 1997, 1 PGK = approx. US$0.7 (A$0.95).

tions into Aitape. PNG government officials, non-government organisations, donors, the PNG and Australian Defence Forces and the community were well-practised at working together and settled quickly into complementary roles. The National Disaster and Emergency Services, under the late Ludwig Kembu, was better equipped to fulfil its mandate and provided essential coordination of the relief and rehabilitation phases.

Now, however, it is time to turn our thoughts back to the drought and what needs to be done to ensure that future droughts do not cause the level of suffering and hardship of the 1997 drought. This conference is timely and critical, and AusAID applauds the organisers for the opportunity to participate and contribute in ever so modest a way.

Some Methodological Problems with the Nutritional Assessment of the 1997–98 El Niño Drought in PNG

Robin Hide*

Abstract

Assessment of the impact of the 1997–98 drought on the rural population of PNG was primarily based on a sequence of three, rapid, national evaluations of food and water availability in local areas. Direct nutritional assessment played a minor, and late, role. An ambitious sample nutrition survey was conducted in early 1998, but the worst of the crisis was over by April when the survey report was completed.

This paper describes three methodological problems associated with the 1998 survey that may have limited its value to emergency administrators. Firstly, comparisons between the children's nutritional status of 1998 with those obtained from the 1982–83 PNG National Nutrition Survey (NNS) were not valid. This is because the age groups measured were different, with very young infants (0–6 months) not included in the 1998 survey. Since the nutritional status of PNG infants in this age group is relatively better than for older children, exclusion of this age group may have biased the 1998 results to appear worse than the 1982–83 ones. Secondly, comparisons of the results of the 1998 and 1982–83 surveys were invalid because of differences in the population sampling methods. Unless adjustment for geographical location is made, significant bias can occur. Finally, there were problems with making accurate anthropometric measurements of adult women, as indicated by those from some locations showing unusually high or low bodymass indices. Comparison of the results from one area with those of an earlier survey shows that measurement error is likely.

These findings emphasise both the need for appropriate sample selection if future anthropometric surveys are to take advantage of the 1982–83 NNS as baseline information, and the value of previous baseline data for evaluating results. It is suggested that the NNS still provides an invaluable baseline for children's nutritional status.

DURING 1997, as a result of the El Niño Southern Oscillation, large areas of PNG experienced a major drought. Frosts also occurred at higher altitudes. Food production was seriously threatened. Official assessment of the impacts of the drought and frosts largely centred on the rapid evaluation of both food availability and water viability in local agricultural systems (Barr 1999). Major relief programs were initiated following national assessments of food production and water supply in October and December 1997, which categorised drought effects at the level of census divisions. By comparison with emergency food situations elsewhere in the world, there was little emphasis on assessing or monitoring the nutritional effects of the food shortages using anthropometry and indices of nutritional status. There were a few local-level surveys, but at the national level there was only a single nutrition and food security assessment survey in Feb-

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ruary 1998, in sample areas of nine severely affected districts (as identified by the December 1997 food and water assessment).

This ambitious survey was undertaken by nine teams of provincial health staff under the leadership of a consultant nutritionist (Monsef et al. 1998) and funded by the Australian Agency for International Development (AusAID). Besides assessing nutritional status, the study aimed to assess the adequacy of the emergency drought rations and to identify problems, both immediate and long term, related to the use of drought and other emergency foods. By the time the nutrition survey report was completed in April, however, the worst of the crisis was over.

Two years after the 1997–98 drought, it is appropriate to evaluate some of the problems encountered by this survey. The purpose of this paper is to examine some of the methodological problems that limited the value of the survey results for emergency decision makers and aid administrators. While there are other wider strategic issues relating to the use, and especially timing, of nutrition investigations during periods of major food shortage in PNG that warrant discussion, these are not covered here. Thus, my intention is to highlight problems that, in future emergencies, can be avoided.

I will focus on two main features: firstly, to identify major problems concerned with comparing the 1998 children's results with those of the 1982–83 PNG National Nutrition Survey (NNS), which are the only national-level baseline data available; and secondly, to highlight problems with the measurement of adult women. These problems can be summarised in the form of three questions: who to measure; where to measure; and how to measure?

The 1998 Nutrition Survey

The 1998 nutrition survey was intended as a rapid nutrition assessment in some of the worst drought-affected areas of PNG. Using the rankings of the second national drought assessment (Allen and Bourke 1997b), the worst-affected district of each of the nine worst-affected provinces were selected (Monsef et al. 1998). Within each district, one census division was chosen randomly, and the populations of all census units within that census division were surveyed (Table 1).

The survey aimed to collect anthropometric measurements of the heights and weights of some 2123 children and over 1500 women. Such measurements, converted to indices of nutritional status (that is, weight-for-age and similar indices for children and bodymass index (BMI) for adults) would then allow comparison either with international reference standards or, and more significantly, with previous local PNG survey results, in order to evaluate the relative nutritional status of children and adults.

Table 1. Sample census divisions surveyed in the 1998 nutrition survey, with numbers of children and women measured.

Province	District	Census division	No. of children measured	No. of women measured	No. of women BMI calculated
Milne Bay	Rabaraba	Daga	382	307	284
Madang	Rai Coast	Warup	165	72	66
West New Britain	Kimbe	Bali–Witu	562	437	324
Simbu	Gumine	Nomane	155	184	57
Central	Goilala	Ivane–Auga	64	80	76
Enga	Kandep	Marient	137	202	185
Western Highlands	Tambul	Tambul	244	231	215
Gulf	Kaintiba	Mienta	272	291	228
Western	Nomad	Pare	142	74	72
Totals			2123	1878	1507

BMI = bodymass index
Source: Monsef et al. (1998, p. 11, 17, 31, Tables 1, 2, 11)

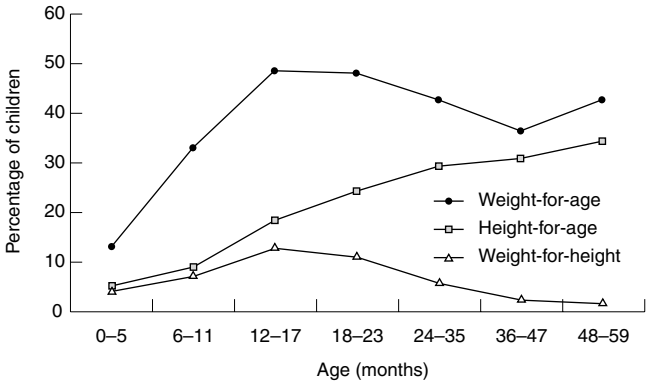

Figure 1. Percentage of PNG children less than 5 years of age below specific levels of median weight-for-age (< 80%), height-for-age (< 90%) and weight-for-height (< 80%) (NNS 1982–83).

The survey measured children aged between 6 and 59 months and their mothers (or other women attending). Every fifth woman was interviewed using a questionnaire to gather information about food security, consumption and food-relief distribution.

In order to evaluate nutritional status, the report presented its anthropometric results in two ways:

- as proportions of children below cut-off levels of median nutritional status indices, and
- as comparisons of the rates observed with both the earlier findings of the 1982–83 NNS and more recent data from maternal and child health clinics (for a variety of reasons, the health clinic data have limited use, and are not considered further here).

Comparison with the 1982–83 National Nutrition Survey

Comparison between the results of the 1998 survey and those of the 1982–83 NNS (Monsef et al. 1998) has two major problems: the age classes of the surveyed children; and, most significantly, the validity of grouping the 1998 samples by census division.

The problem of children's ages

The 1998 survey results on the nutritional status of children aged 6–59 months were directly compared with those reported by the 1982–83 NNS (Monsef et al. 1998). The NNS, however, measured children aged 0–59 months (Heywood et al. 1988) but the figures were not recalculated or adjusted for the 1998 comparison.[1]

Would adjusted figures (i.e. recalculation of the NNS data to include only children aged 6–59 months) make any difference to the comparisons? The answer is, in general, yes. This is because, in PNG, children's weights and lengths/heights are relatively greater for their age during the first few months following birth than they are subsequently (as shown in Fig. 1).

Thus, inclusion of children aged 0–6 months reduced the proportion of children below cut-off levels of median weight-for-age and height-for-age in the 1982–83 NNS figures. For instance, the example from Rabaraba District (Milne Bay Province) in Table 2 shows that the recalculated NNS figures for the age group 6–59 months for both weight-for-age, and height-for-age, are about 4–5% greater than the original figures based on all children aged 0–59 months. The difference for weight-for-height is minimal.

1. For instance, Tables 8, 9 and 10 in Monsef et al. (1998), which presented weight-for-height, weight-for-age and height-for-age comparisons, respectively, all used the 1982–83 NNS percentage figures below cut-off figures for children aged less than 5 years, which were taken from the published table in Heywood et al. (1988). However, there are a number of unresolved discrepancies between the NNS figures, as given in the 1998 report, and those appearing in Heywood et al. (1988). It is worth pointing out that institutional memory is poor in Port Moresby: there were undoubtedly real practical problems of poor access to the relevant reports and publications, let alone the 16-year-old computer files of the NNS data.

Table 2. Comparison of proportions of Rabaraba District children below cut-off levels of median nutritional status indices for two age classes: 0–59 months (n = 225) and 6–59 months (n = 202) (1982–83 National Nutrition Survey data).

Weight-for-height < 80%		Weight-for-age < 80%		Height-for-age < 90%	
0–59 months	6–59 months	0–59 months	6–59 months	0–59 months	6–59 months
14.2	14.4	59.1	64.4	36.9	40.1

Source: PNG Institute of Medical Research (no date; figures recalculated from Table 5 of this source)

This example illustrates that use of the 1982–83 NNS nutritional status rates calculated for children aged 0–59 months as a baseline for comparison with subsequent rates based on children 6–59 months, is likely to be invalid. In the case of the 1998 survey, the unadjusted comparisons of weight-for-age and height-for-age tended to make the 1998 results appear worse than the 1982–83 baseline results, even where there may have been no real difference between them.

In future, where comparisons need to be made using different age groups of children from those used in the original NNS survey, it is essential that the NNS rates should be recalculated, either using the age breakdowns appearing in the provincial NNS reports (e.g. PNG Institute of Medical Research, no date)[2] or, ideally, by accessing the data from the original NNS computer files held at the PNG Institute of Medical Research in Goroka.

The problem of different sampling units

The NNS 1982–83 sampled children by census units (villages) within particular environmental zones in provinces (Heywood et al. 1988; Keig et al. 1992; Smith et al. 1992; PNG Institute of Medical Research, no date). For Department of Health convenience, many of the results were presented at the level of administrative districts. Because the sampled census units within districts were stratified by environmental zones, they were not necessarily representative of the whole district population. For this reason, the provincial reports warned explicitly that valid comparisons between the NNS data and new surveys would require surveying 'children in the same, or comparable, villages' (PNG Institute of Medical Research, no date).

In the 1998 survey, however, children were surveyed only from a single census division chosen randomly within each district: in other words, from only one random part of each district. Unfortunately, because of major environmental variation, some districts contain census divisions that differ radically from the district 'average'. This means that the comparisons made between the 1998 survey and the NNS may not be valid unless the data are further subdivided by location.

For example, in Milne Bay Province, the 1998 report's analysis of the Rabaraba District child anthropometry illustrates the problem of an unrepresentative 1998 sample used for comparison with the NNS baseline. Rabaraba District is divided (see Fig. 2) into four

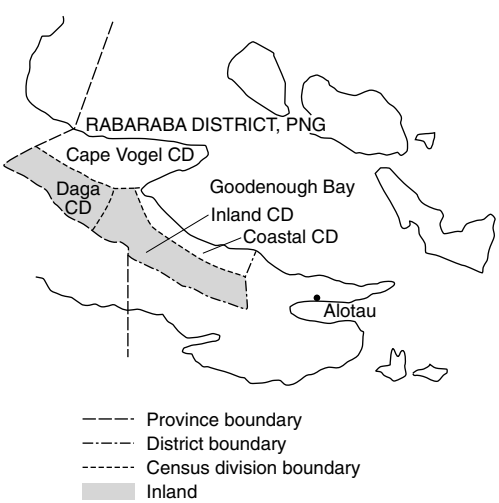

Figure 2. Census divisions of Rabaraba District, Milne Bay Province.

2. The NNS dataset used in the provincial reports differs slightly from that used in the earlier NNS analysis and by Heywood et al. (1998) due to 'cleaning' and checking of the original data. Use of the provincial data may therefore lead to slightly different results from those of Heywood et al. (1988). For example, this is illustrated here by comparing the figures for Rabaraba children aged 0–59 months in Table 2 (taken from the PNG Institute of Medical Research, no date), with those for 1982–83 in Table 3 (from Heywood et al. 1988).

census divisions, two of which are largely coastal/lowland (Cape Vogel and Goodenough Bay Coastal), and two which are inland and at higher altitudes (Daga and Goodenough Bay Inland). The 1998 survey selected the inland Daga Census Division for its sample, and then compared the results from that single division with those for the whole Rabaraba District from the 1982–83 NNS. In the NNS, however, there were more coastal than inland children surveyed (see Table 4 below).

Table 3 shows the comparison that allowed the 1998 report to conclude that nutritional status had severely worsened in Rabaraba. In this comparison, the proportion of low weight-for-age children increased significantly from 60.6% to 82%, and the proportion of low height-for-age children also increased from 41.8% to 47.6% (Monsef et al. 1998).

This comparison, however, is invalid. Children's growth patterns appear to be very different in the inland and coastal parts of Rabaraba. This is illustrated in Table 4 where the 1982–83 NNS data were divided (see Fig. 2) between an inland area (Daga and Goodenough Bay Inland Census Divisions), and a coastal area (Cape Vogel and Goodenough Bay Coastal Census Divisions), and then recalculated. Thus, in 1982–83, the inland children were found to be much shorter and lighter than their coastal counterparts.

Had the 1998 survey results from the Daga Census Division of Rabaraba (Table 3) been compared with the inland results for Rabaraba from 1982–83 (Table 4), rather than with the composite Rabaraba District results, very different conclusions could have been drawn. For instance, weight-for-age showed little or no difference (82.0% in 1998 compared to 79.8% in 1982–83), while height-for-age was worse in 1982–83 (72.6% compared to 47.6% in 1998). In short, instead of nutritional status being worse during the 1997–98 drought in the inland areas of Rabaraba District, it actually appeared to have been better than in 1982–83.

In order to reflect the environmental diversity of PNG, the sampling frame developed for the 1982–83 NNS was complex. Despite this complexity, it is possible to use the NNS as a source of baseline data for comparison with subsequent surveys. What is important, though, is that neither districts nor census divisions be taken as the basic units for such comparisons without a careful examination of the distribution of originally sampled census units. Wherever possible, comparison should be made on the basis of data from the original, or similar, census units.

Table 3. Proportion (%) of Rabaraba District children below cut-off levels of median nutritional status indices: comparison between 1982–83 and 1998.[a]

Weight-for-height < 80%		Weight-for-age < 80%		Height-for-age < 90%	
1982–83	1998	1982–83	1998	1982–83	1998
16.5	15.7	60.6	82.0	41.8	47.6

[a]In 1982 *n* = 249 (Heywood et al. 1988, p. 94); in 1998, *n* = 374–378 (Monsef et al. 1998, p. 21, 23).
Source: Monsef et al. (1998, p. 28)

Table 4. Comparison of proportions (%) of inland and coastal Rabaraba District children aged 6–59 months below cut-off levels of median nutritional status indices in 1982–83.

Area	Sample number	Weight-for-height < 80%	Weight-for-age < 80%	Height-for-age < 90%
Inland[a]	84	13.1	79.8	72.6
Coastal[b]	120	15.0	56.7	17.5

[a]'Inland' includes 70 children from Daga Census Division, and 14 from Goodenough Bay Inland Census Division. Restriction to the Daga children alone gives similar proportions: i.e. 14.3% for weight-for-height, 82.9% for weight-for-age and 72.9% for height-for-age.
[b]Cape Vogel Census Division and Goodenough Bay Coastal Division
Source: recalculated from 1982–83 National Nutrition Survey computer files

The Problem of Accurate Anthropometric Measurement

Achieving accurate anthropometric measurements under emergency field conditions is always problematic. The 1998 nutrition report (Monsef et al. 1998) noted possible weaknesses in some of the measurements of adult women, especially those from Nomad (Kiunga District, Western Province). In Nomad, the BMI (weight/height squared) of women appeared to be very low: about 11% of women had a BMI of less than 16. In contrast, results from the Bali–Witu islands (Kimbe District, West New Britain Province), showed that BMIs tended to be extremely high, with about 50% of women having a BMI over 25, which may have been in part due to unusually small stature. Follow-up surveys to confirm or refute these extreme findings were recommended.

Assessing the reliability of measurements requires careful protocols both in the field and during data checking.[3] Without sound baseline information, the accuracy of unexpected values may remain doubtful. The NNS 1982–83 did not measure adults and, therefore, does not provide such a national set of reference values. However, for some areas there are comparative data from regional or local surveys which can be used to evaluate measurement reliability. The following comparison makes use of data from a 1988 survey in Simbu Province.

In Gumine District (Simbu Province), the 1998 survey sampled the Nomane Census Division, where, as in the Bali–Witu islands, women were reported to have unusually high BMIs. According to the 1998 survey, only 2% of Nomane women had a BMI of less than 20, while more than half had a BMI of over 25 (Table 5). From this, it was concluded that the 'BMI of women in Gumine was healthy …approximately 55% were overweight/obese… Certainly women between the ages of 15–40 did not appear to have lost weight recently' (Monsef et al. 1998).

This evaluation sits awkwardly with the fact that Nomane had been classified as amongst the worst-affected drought areas in both the October and December 1997 assessments (Allen and Bourke 1997ab). Thus, when the women were measured in February 1998, Nomane had been experiencing a prolonged period (4–6 months) of unprecedented food shortage. Most (90%) of the Nomane women interviewed in February 1998 reported that their staple garden crops were exhausted; most households claimed that only a single distribution of relief food had been supplied in January (Monsef et al. 1998).

In this context, then, it is useful to compare the 1998 BMI figures with those collected 10 years earlier from some 286 Nomane women, as part of a large-scale nutrition survey of most of Gumine District (Table 5, Fig. 3). In 1988, the distribution was very different, with only 10% of Nomane women having a BMI over 25 (compared to 53% in 1998), and 13% below 20 (compared to 2%).

3. Alois Ragin (PNG Department of Health, pers. comm.) has pointed out to me that there were problems with some of the equipment, in particular the microtoises for measuring heights.

Table 5. Comparison of the distribution of bodymass index (BMI) in adult women in 1988 and 1998 in Nomane Census Division, Gumine District (Simbu Province).

BMI class	1988 survey[a]		1998 survey[b]	
	No. of women	%	No. of women	%
< 20	38	13.3	1	1.8
20–24.9	219	76.6	26	45.6
≥ 25	29	10.1	30	52.6
Totals	286		57	

[a]1988 survey: Groos and Hide (1989), BMI for this comparison calculated from original computer files.

[b]1998 survey: Monsef et al. (1998, pp. 17–18); BMI figures taken from bar diagram percentages in Figure 1 of source. Note that although a total of 184 Nomane women were measured in 1998, BMI was calculated for only 57 (Monsef et al. 1998, p. 17, 31). Since BMI was not calculated for pregnant women or for women lacking information on their pregnancy status, Nomane presumably had a high proportion of such women (Monsef et al. 1998, p. 16).

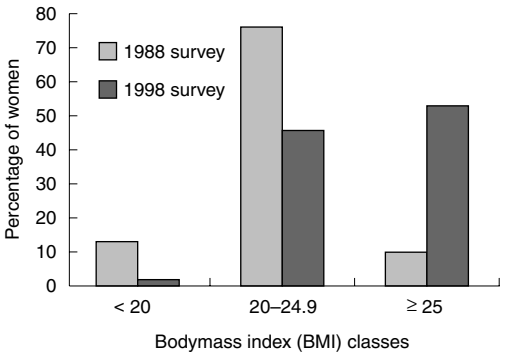

Figure 3. Distribution of adult women by BMI classes in Nomane Census Division, 1988 and 1998.

While a major improvement in the nutritional status of Nomane women is possible over the 10 years between 1988 and 1998, an increase of this magnitude, even under conditions of adequate food supply, seems unlikely. This is especially the case in the light of the very modest rate of change in Nomane women's nutritional status found between 1980 and 1988 (Groos and Hide 1989). Such an increase (particularly to the point of obesity or overweight), seems even less likely if the food availablity assessments of the previous few months are correct. Earlier surveys of short-term adult weight change in Simbu Province, both in Gumine District and elsewhere, have shown regular mean variations of 1–2 kilograms, usually linked to fluctuating food supplies (Bailey and Whiteman 1963; Harvey and Heywood 1983; Wohlt and Goie 1986). Thus weight loss, and hence reduced BMI, is to be expected in such situations. A preponderance of overweight women is not an expected finding in these circumstances.

In this case, then, the availability of comparative data on adult anthropometry raises major questions about the reliability of these Gumine District measurements.

To achieve reliable anthropometry for the purpose of nutritional status assessment requires not only adequate training in measurement under field conditions, but also the means of checking accuracy at various stages of recording and analysis. Regional baseline data can provide a valuable reference point for establishing expected values, as well as for detailed comparisons of changed nutritional status.

Conclusions

The focus of this paper has been on problems associated with the assessment of current nutritional status at the time of a major food crisis by means of comparison with pre-existing baseline information: the 1982–83 NNS in the case of children, and other surveys in the case of adults. The description of three specific problems highlights the ways in which such problems, if not avoided, may severely compromise the value of the results and recommendations of nutritional surveys at times when they are most needed.

Nutritional surveillance or monitoring using anthropometry during food emergencies can undoubtedly play a significant role in the task of determining those most in need, and the effectiveness of relief policies. The 1982–83 NNS, although now nearly 20 years old, still provides the only national level anthropometric baseline information on children (discussed further below). The 1982–83 results are still of considerable value for comparing with new survey data in order to evaluate current nutritional status. Such comparisons must, however, be based on similar age groups of children, and on samples of the same or similar census units. Above all, the basic skills involved in procedures for measuring, checking and recording anthropometry require the most careful cultivation. While good quantification is invaluable, unreliable numbers are often worse than no numbers.

Discussion

Given the significance of the use of comparative data for assessing nutritional status in times of emergency, it is worth asking whether the results of the 1982–83 NNS can still be regarded as providing useful baseline information on the nutritional status of children in PNG. No further national-level nutrition survey has been conducted since 1983. Both the 1998 survey (Monsef et al. 1998) implicitly, and the 1998 Human Development Report (ONP 1999) explicitly, have recommended the need for a new national nutrition survey. At present, this seems unlikely to be considered a major national priority. There is little evidence on which to evaluate the extent of changes in child growth, and hence nutritional status, over the last two decades.

An evaluation in 1992 (Hide et al. 1992), which examined all extant local and regional surveys since 1982, tentatively concluded that: (i) there appeared to have been some improvement in child growth in some areas with initially poor status (such as the Western

Schraders in Madang Province and Karimui in Simbu Province), but not in all such areas (such as the Eastern Schraders); and (ii) that no change occurred in one area that initially had a relatively good status (Gumine, in Simbu Province). Surveys since the early 1990s[4] have not been reviewed. In the absence of a major review, the position taken here is that the 1982–83 NNS still provides a valuable baseline, although its use for comparative purposes should take into account specific local circumstances (such as the effects of major resource developments, etc.) that are likely to have altered nutritional status.

Acknowledgments

My thanks to AusAID for allowing me to see and cite the 1998 survey report (Monsef et al. 1998), to the PNG Institute of Medical Research for providing the opportunity in 1987–89 to examine in detail the National Nutrition Survey of 1982–83, to Anita Groos and others for sharing the Gumine anthropometry in 1988, to Pam Swadling for assistance with Figure 2, to Ivo Mueller for presenting the paper in Lae in my absence, to Alois Ragin for most useful comments, and to the editors for removing ambiguities. The remaining faults are my responsibility.

References

Aaron, L. 1997. Nutrition survey report: Tambul/Nebilyer District, Mt Hagen. Unpublished report. Western Highlands Department of Health.

Allen, B.J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Australian Agency for International Development, Port Moresby.

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. Poienou, J. Risimeri, R. Shelton, J. Sowei, K. Ukegawa, N. Willson, D. Wissink and M. Woruba. 1997b. 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.

Anon. 1998. Medical teams in PNG. Post Courier, 18 February 1998.

Bailey, K.V. and Whiteman, J. 1963. Dietary studies in the Chimbu (New Guinea Highlands). Tropical and Geographical Medicine, 15(4), 377–388.

Barr, J. 1999. Drought assessment: the 1997–98 El Niño drought in Papua New Guinea and the Solomon Islands. Australian Journal of Emergency Management, 14(2), 31–37.

Demerath, E.W. 1997. The impact of economic modernization on adult nutritional status in Manus, Papua New Guinea. Unpublished PhD thesis, University of Pennsylvania, USA.

Flew, S. 1999. Human health, nutrition and heavy metals: report of a survey from the Fly River, Western Province, Papua New Guinea. Unpublished report, Ok Tedi Mining Ltd.

Groos, A. and Hide, R.L. 1989. 1987–88 Nutrition surveys of Karimui and Gumine districts, Simbu Province. Unpublished report. Madang, PNG Institute of Medical Research.

Harvey, P.W.J. and Heywood, P.F. 1983. Nutrition and Growth in Simbu, Report of the Simbu Land Use Project. Port Moresby, Institute of Applied Social and Economic Research.

Heywood, P., Singleton, N. and Ross, J. 1988. Nutritional status of young children—the 1982–83 National Nutrition Survey. Papua New Guinea Medical Journal, 31(2), 91–101.

Hide, R.L., Allen, B.J. and Bourke, R.M. 1992. Agriculture and nutrition in Papua New Guinea: some issues. In: Papua New Guinea National Nutrition Policy Workshop. Port Moresby, Institute of National Affairs, 139–176, 285–313 (refs).

Keig, G., McAlpine, J.R. and Freyne, D. 1992. An environmental framework for nutrition surveys in Papua New Guinea. In: Levett, M.P., Earland, J. and Heywood, P., eds, Proceedings of the First Papua New Guinea Food and Nutrition Conference: Changes in Food and Nutrition in Papua New Guinea. Port Moresby, University of Papua New Guinea Press and Department of Agriculture and Livestock, 321–335.

King, S.E. 1999. A cross-sectional study of socio-economic status, nutritional anthropometry and helminthiasis among the Kamea of Papua New Guinea. Unpublished Ph.D thesis, University of Cambridge.

Makamet, C. 1998. Report of the nutrition assessment survey in the Mieta Census Division, Kaintiba District, Gulf Province. Unpublished report. Port Moresby, Foundation of People for the South Pacific, and Community Development.

4. Nutrition surveys during the 1990s appear to have been restricted to either populations affected by resource developments such as Ok Tedi (Taufa 1998; Flew 1999), Lihir (Taufa et al. 1992), and Porgera (Porgera Joint Venture 1996), to emergency situations such as health assessments during the 1997–98 drought (Aaron 1997; Makamet 1998; Anon. 1998) or to occasional academic research such as in Manus (Demerath 1997) or in Gulf Province (King 1999).

Monsef, E., et al. 1998. Nutrition and food security assessment of 9 'Category 5' districts during 1998–98 drought/frost in Papua New Guinea. Unpublished report. Canberra, Australian Agency for International Development.

ONP (Office of National Planning). 1999. Papua New Guinea Human Development Report 1998. McKay, K., Lepani, K. and Wagner, T. eds. Port Moresby, ONP.

PNG Institute of Medical Research. No date. Papua New Guinea 1982–83 National Nutrition Survey: Provincial Tabulations Milne Bay Province. Goroka and Boroko, PNG Institute of Medical Research and Nutrition Section, Department of Health.

Porgera Joint Venture. 1996. Review of Riverine Impacts. Canberra, Commonwealth Scientific and Industrial Research Organisation, Environmental Projects Office.

Smith, T., Keig, G., Marks, J. and Grau, R. 1992. Summary results by environmental zone from the 1982–83 National Nutrition Survey of Papua New Guinea: implications for future survey design. Unpublished report. Goroka, PNG Institute of Medical Research.

Taufa, T. 1998. Lower Alice River (Lower Ok Tedi) Health and Nutrition Survey (one-page summary only). Ok Tedi Mining Ltd.

Taufa, T., Jones, M., Day, G. and Mea, V. 1992. Baseline Health Survey of Lihir Islanders April 1991. Lihir Joint Venture.

Wohlt, P.B. and Goie, A. 1986. North Simbu Land Use. Research Report of the Simbu Land Use Project, Volume V. Port Moresby, Institute of Applied Social and Economic Research.

PNG Disaster Management: 1997–98 Drought and Frost Impact Assessment—Methods Used and Experiences

S.R. Ivahupa*

Abstract

Between September 1997 and May 1998, I took part in four national assessments of the impact of the 1997–98 drought in PNG, acting as team leader in each assessment. The first assessment (September 1997) was in Oro (Northern) Province, the second (November–December 1997) was in Manus and New Ireland provinces, the third (March 1998) was in Milne Bay Province and the final assessment (May 1998) was in the mountains of Central and Oro provinces. In this paper, I summarise my experiences during the four assessments. Responses by villagers are noted, including their attitude to government officers and vice versa. It is suggested that villagers' experiences during the drought should be recorded to help people in future national disasters.

IN RESPONSE to the prolonged 1997–98 drought and frost, the PNG Government, through the National Disaster and Emergency Office (NDEO) of the Department of Provincial and Local Level Governments Affairs (DPLLGA), engaged staff within the department and from the Department of Agriculture and Livestock (DAL) to conduct assessments on the impact of drought and frost throughout the country. The assessments were carried out in three phases by 13–18 teams of staff from DAL, DPLLGA and the Department of Health. Staff from the provincial offices including those from nongovernment organisations (NGOs) were also involved.

This paper presents the personal reflections of the author, being observations and experiences on the responses to the drought at both provincial and village level.

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Methods and Results

Pre-assessment preparations

Before each assessment, team leaders were identified. The team leaders, other key staff and the drought and frost assessment coordinators met and discussed strategies for assessment. Team leaders were then given funding for assessment of each province.

To prioritise areas for assessment, team leaders, together with key staff from national organisations, met with the provincial staff and administrators to discuss the situation in each province. At these meetings, logistics such as transport and accommodation in the areas to be assessed were discussed. Where the provinces could not assist, team leaders used the limited funding given to them. This was especially useful to hire helicopters or speedboats to access very remote areas.

The types of interviews that the author used were:

- group interviews;
- separate male or female group interviews;

- health worker interviews; and
- food and water source visits.

The author ensured that separate male or female group interviews were used if it was apparent that the men dominated the group interview sessions. If there was more than one interviewer, the group was divided into male and female groups. The author, who is female, interviewed female groups.

Assessment phases and questionnaires

There were three drought and frost impact assessment phases and a separate questionnaire was designed for each phase. The questions were designed to obtain information from the people, and thereby for the province, on the impact of conditions resulting from the drought and frost. Factors contributing to food shortages were also recorded, while interactions between all parties involved were observed and recorded for future reference. The author visited five provinces during this period (Table 1; Fig. 1).

Phase 1

The first phase of assessment of the impact of drought and frost was conducted in September 1997. As this was the initial assessment, an eight-page questionnaire was used to gauge the situation of the people regarding food supply, water, health and local services and communication.

The questions were designed so that the interviewer could obtain an overall view of the situation. At the end of each day, the condition of the area was given a score from 1 to 5 (with 5 indicating the most severely-affected areas) and a summary was written and faxed to the NDEO.

The province visited in Phase 1 was Oro (Northern) Province. The drought situation in this province was fairly severe, especially where fires had destroyed the gardens and bush. The response of most people interviewed was not good—many expected aid in the form of food and gave the interviewers a negative reception once they discovered that food aid was not forthcoming.

Some people were making efforts, though, to overcome drought problems, mainly through gardening on riverside plains and storing planting materials in swamps and shallow oxbow lakes. In some cases, food gardens had to be planted away from villages as good garden areas were either occupied by cash crops or burnt by fires. Hunting and gathering of wild plants and animals was another means of obtaining food for consumption where fires had not destroyed the area.

The status of the food and water supply was summarised and given a score from 1 to 5 for all areas in the country. This data was mapped using the Mapping Agricultural Systems of PNG (MASP) database, combined with the 1997 population estimate for PNG.

Phase 2

The second assessment of the assessment was conducted in December 1997 and was designed to monitor any changes since the first assessment. Maps created from the information gathered in the first phase guided the teams in prioritising areas for assessment in the second phase and to assist people who were distributing food (rice, flour and cooking oil) and water containers to the severely affected areas.

A modified questionnaire was developed, based on the first assessment. Assessment of government services and communication were omitted from the second phase and components were added to determine whether people were replanting and whether there was any migration. Also, the food and water supply in the areas at that time was assessed and categorised from less severe to very severe conditions, and a prediction made

Table 1. Provinces or areas visited and mode of transport used.

Assessment phase	Date	Province or areas assessed	Mode of transport
1	September 1997	Oro (Northern) Province	Air (aeroplane or helicopter); road (vehicle and foot)
2	December 1997	Manus and New Ireland provinces	Road (vehicle); sea (speedboat); air (helicopter)
3	March 1998	Milne Bay Province	Road (vehicle); sea (speedboat); air (helicopter)
	May 1998	The mountains of Oro and Central provinces	Air (helicopter)

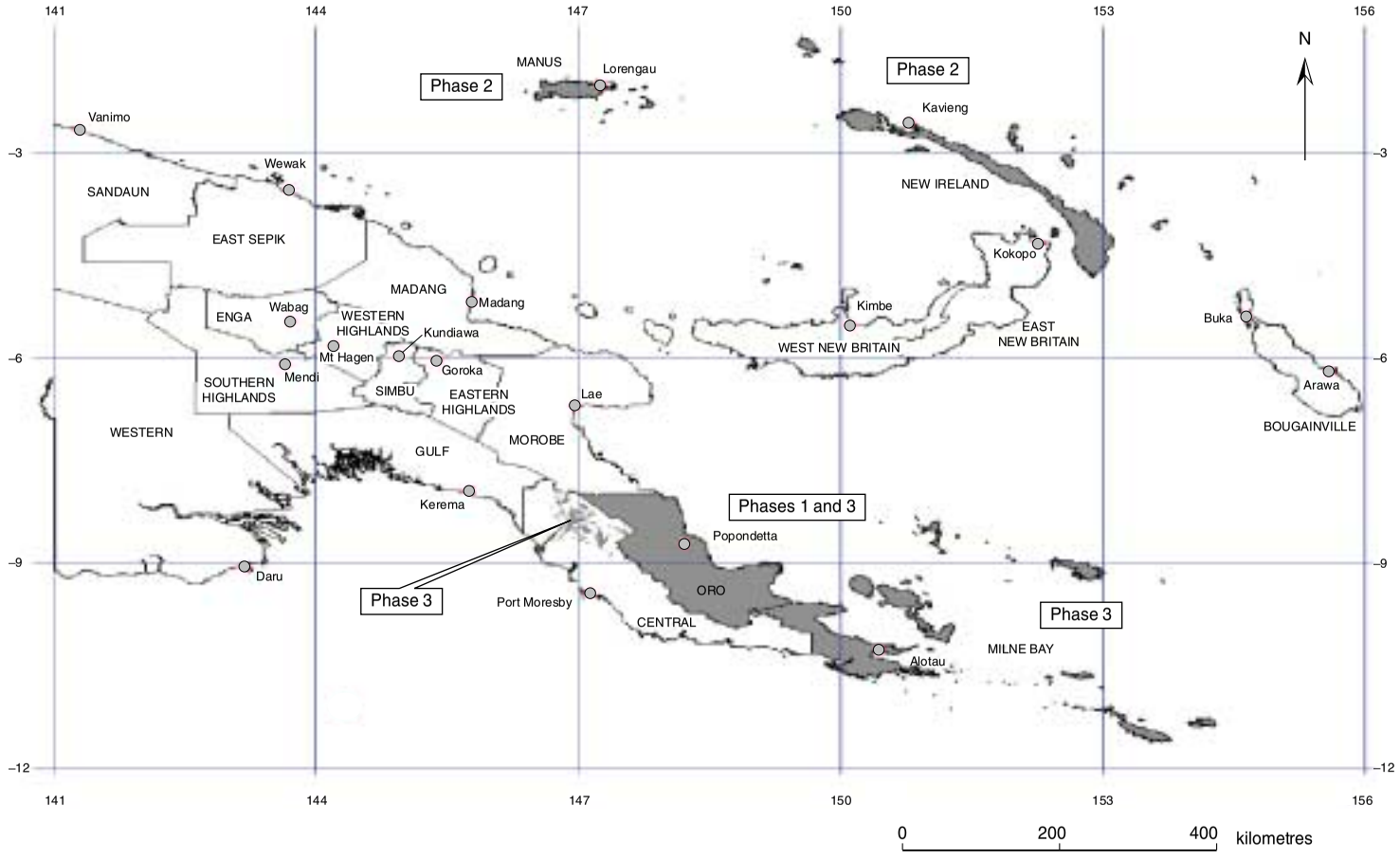

Figure 1. Locations visited and assessed during and after the 1997–98 drought (Phases 1, 2 and 3).
Source: PNG Resource Information System, produced through the National Agricultural Research Institute

of the likely categories that would apply in the next 2–3 months (February–March 1998). As in the first phase, daily summaries were written and faxed to the NDEO.

Manus and New Ireland provinces were visited by the author in this phase of assessment. In Manus Province, water was a major problem. Sago is one of the staple foods there and water is essential to process the sago starch. As water was limited, the supply of sago starch was low. Traditionally, people in Manus Province adapted to the situation by using a barter system, and people reported that exchange of food (sago for fish) occurred during this period.

In New Ireland Province, the smaller outer islands were affected to differing degrees. Some survived on *Cyrtosperma* spp. taro and whatever little they had stored, while others harvested very small tubers of sweet potato and *Xanthosoma* taro for consumption. For those eating *Cyrtosperma* taro, one taro plant (corm) could be consumed over a period of two or even three weeks by removing a certain portion of the corm then replanting it for later harvest and consumption. Water was also a major problem on these islands.

Phase 3

The third phase of assessment was conducted in March 1998. By this time, many areas were recovering from the drought. The questionnaires were similar to the ones used in the first phase. The main focus of this assessment was on movements of people and aid received. Also covered were local services and communication, food and agriculture, water, health and general questions on previous assessments. Access to food and water were gauged and categorised into areas least to worst-affected.

The author visited Milne Bay Province and the mountains of Central and Oro provinces in this phase. Most areas at this time were receiving rain. In Milne Bay Province, villagers were leading normal lives regardless of the situation. In the outer islands, both food and water were a major problem while, on the drier mainland, people were starting to replant food gardens. In the mainland, people were familiar with the weather pattern in their area and had adapted techniques such as cultivation of selected varieties or species of food crops at certain times of the year. Gathering of wild food for consumption was also recorded.

In the mountains of Central and Oro provinces, the situation was quite different. The main problem in both provinces was health. Malnutrition (Oro Province) and respiratory problems (Central Province) were observed. Water was in abundance while food was still a problem in Oro Province, but not in Central Province. Gathering of wild food was only recorded in Milne Bay and Oro provinces. In Central Province, gardens visited were either on sloping land, valleys or backyards that were usually marginal (in terms of soil fertility and erosion). Gardens in the valleys were a long walk away from the houses or villages.

Responses of the people

The responses of all those involved were significant. In terms of alleviation of the conditions resulting from the drought and frost, responses at provincial and village level were, in general, good. In the province, staff divided assessment areas into clear subdivisions such as census divisions, districts and even farming systems. These farming system divisions occurred especially in areas where certain food crops were identified as dominant staples. Based on reports received from district staff or reliable sources (e.g. NGOs), the provincial disaster management offices were distributing food and planting materials either to each household or village or directing the assessment teams sent from the national government.

At the village level, people adapted technologies that had traditionally been passed down through the generations or were from neighbouring areas. These included storage of planting materials in oxbow lakes or swamps, gardening alongside rivers, use of stored food or reserve gardens, hunting and gathering, and cultivation of specific varieties or cultivars of crops better adapted to drought conditions.

The interaction between the interviewers and the people, however, was a different situation. Initially, villagers were reluctant to cooperate with the assessment team. Sometimes this reluctance was even noticeable at the provincial level. Information was either not readily available or few people would participate at group meetings and, sometimes, this made it difficult to collect unbiased data.

Discussion and Conclusions

The drought in 1997–98 in PNG caused a lot of damage to people's livelihood. The destruction of food gardens by fires, coupled with the prolonged drought and frost, affected food and water supplies in many areas of the country. People had to travel longer distances to obtain food and water. Original gardening sites on marginal land gave low yields, and nearby water sources were low or had dried up. Food shortages, malnutrition and other health problems associated with the drought were recorded.

My participation in the drought assessment was personally beneficial and educational. The opportunity to work with people in different fields and professions, including the village people, taught me many new things. People in different areas used different technologies to overcome the drought situation and even had different attitudes and approaches to government officials.

Adaptation technologies, developed either through traditional knowledge or from other people, included gathering and processing of wild food, storage of planting materials and food, use of selected varieties or crop species and use of barter systems.

The interviewers' approach towards the people was very important: the answers to the questions asked and people's willingness to give answers depended on the interviewer's approach and willingness to work together with the people.

In conclusion, these assessments have allowed people's experiences in the drought to be usefully recorded for further analysis. It is recommended that the ideas and technologies observed be used by:

- researching methods for increasing food production in low-yield situations (drought and frost) and on marginal land;
- researching and publishing information on wild or famine foods that are available and the methods used to process them; and
- increasing and improving agricultural or any other form of extension services with the objectives of improving villager–government officer relations.

Personal Reflections on the Effect of the 1997 Drought and Frost in the Highlands of Central Province

Passinghan Igua*

Abstract

In 1997, temporary changes associated with the El Niño climatic disruption caused one of the most prolonged and severe droughts in PNG in over 100 years. An assessment of the impact of the drought and frosts in the highlands of Central Province was carried out from 3 to 7 December 1997. This paper describes the impact on village food and water supplies, health of rural villagers, education and health institutions, as well as cash income and effects on bushfires in the Goilala area. The responses of villagers to the drought and frosts are also noted.

MUCH of PNG was severely affected by a major drought and a series of frosts associated with the El Niño weather pattern in 1997–98. El Niño has become a household word and refers to a number of complex changes that occur in oceanic and atmospheric circulation across the Pacific region. In an El Niño event, the eastern Pacific Ocean becomes warmer than the western (PNG) side, which is the reverse of the normal situation (Allen and Bourke 1997a). In 1997, the El Niño event was particularly severe. Rather than warm, moist air rising over PNG, cool dry air was descending, resulting in lesser cloud cover and lower rainfall (Allen and Bourke 1997a). The 1997–98 drought was more severe than any recorded previously and resulted in extensive bushfires. The drought was much more severe and had wider impacts than others in recent decades. It was comparable in severity with events in 1914 and 1941, and possibly more severe and widespread than those droughts (Bourke 2000). The greatest impact of the 1997 drought and associated frosts was on the subsistence food supply and villagers' health.

The drought commenced as early as March 1997 in some locations and became widespread throughout PNG by July of that year. Frosts were also reported in many highland locations (above 2200 metres above sea level) in parts of Enga, Southern Highlands, Western Highlands and Central provinces (Allen and Bourke 1997ab). As with El Niño events over the past 40 years, intermontane basins and valleys above 2200 metres were most severely affected by repeated frosts (Bourke 2000).

A few areas in the Goilala District received useful rain in late November. One area, Woitape, received 140 millimetres of rain in the weeks before my visit. However, most of the area were still experiencing drought conditions in early December 1997.

Assessments of the Impact

In late November and early December 1997, Heai Hoko and I assessed the situation in inland and coastal Central Province. (Another 18 teams visited other

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parts of the country. Team members came from the Department of Agriculture and Livestock (DAL), provincial governments, Ok Tedi Mining Ltd., the Cocoa and Coconut Extension Agency and nongovernment organisations including CARE Australia. The teams included provincially-based staff and specialists in agriculture, water and health.) After briefing on the appraisal techniques and locations to be visited, fieldwork in the Goilala District was carried out over five days. Here I give a summary of what I observed in the areas visited in the mountainous Goilala District.

Areas visited

Ononge

On my visit to Ononge, I was accompanied by a Goilala man, James Gitai, who works for DAL in Port Moresby. His knowledge of the area proved invaluable. We were informed of food shortages and told how people were living on *karuka* (pandanus nuts). Whole families had been living on *karuka* from the bush since June 1997. Water was available but required half a day to fetch it from the Hamba River as all nearby drinking water from creeks had dried up. It was suggested that water could be pumped from Hamba River to irrigate gardens during the dry season.

The incidence of diarrhoea, dysentery, pneumonia and other respiratory problems had increased due to lack of water (Table 1). Deaths were also reported from anaemia, dysentery and typhoid since the drought commenced in June 1997 (Table 2). Lactating mothers were not breastfeeding well due to low production of milk, resulting in malnourishment of children. One death was also reported after a man fell from a pandanus tree while looking for food. There was an urgent need for planting materials such as cabbage, carrots, lettuce, broccoli, beans and peas, and English potato.

Woitape

The food situation was poor at Woitape. A few crops such the vegetable *pitpit* (*Setaria palmifolia*) and sugarcane were available; however, staples such as sweet potato were not. Delays in relief supplies resulted in people resorting to *karuka* and other famine foods.

Woitape received 140 millimetres of rainfall in the weeks before the visit. Planting materials were needed to capitalise on the recent rain; sweet potato, corn, pumpkin, beans, lettuces and carrots were among crop planting materials requested. Water supply was satisfactory, provided it was boiled.

Table 1. Incidence of diseases at Ononge, Central Province, PNG, during the 1997–98 drought.

Disease	Reported cases
Cold and influenza	74
Pneumonia (< 5 years of age)	95
Pneumonia (> 5 years of age)	83
Other respiratory diseases (e.g. asthma)	36
Diarrhoea (< 5 years of age)	11
Diarrhoea (> 5 years of age)	12
Simple malaria	145
Severe malaria	1
Anaemia	1
Malnutrition	1

Source: Ononge Catholic Health Centre

Table 2. Number of deaths reported at Ononge, Central Province, PNG, July–December 1997.

Month	No. of deaths	Child/adult	Cause of death				
			Anaemia	Dysentery	Typhoid	Pneumonia	Other causes
July	1	Adult	1				
September	2	Adults	1	1			
October	2	1 Adult, 1 Child			2		
November	13	Not recorded		6	6	1	
December	1	Adult					1
Total	19		2	7	8	1	1

Source: Ononge Catholic Health Centre

Fane/Auga

In Fane/Auga, a community of 7000 people was living on *karuka* and other famine foods as gardens dried up in the drought. People were reported to be camping at a site where food and water was present. The school was closed due to the high incidence of diarrhoea resulting from water shortages and possible contamination of water. People migrated to the Tolukuma gold mine from the areas around Fane (a walk of 3–4 days) in the hope of obtaining food and cash from *wantoks* (friends and relatives) at the mine site. There were complaints about the mine's failure to offer assistance during the drought.

Water was readily available but transport of water to homes was difficult. The United Nations Children's Fund (UNICEF) was reported to have brought materials for a water supply; however the local villagers had not been able to assist in building it. Information from the local clinic showed that diarrhoea and other gastric disorders were increasing (Table 3).

The local priest expressed concerns that men were buying beer while women and children had no food. The people were in urgent need of food aid, medical assistance and planting materials.

Large tracts of forests and a lot of homes around the communities of Garima and Kalaipe were burnt as a result of the drought. Several of the villagers requested government compensation for their losses. One villager reported that his loss amounted to 500 PNG kina (PGK)[1] and inquired about government compensation. It was explained that the assessment team was there to report on the effects of the drought and frost, not to pay compensation claims. Local priests had earlier reported on the situation in the area to the disaster relief officers in Port Moresby.

Table 3. Incidence of diseases at Fane, Central Province, PNG, October–November 1997.

Disease	Reported cases
Cold and influenza	0
Pneumonia (< 5years of age)	0
Pneumonia (> 5years of age)	0
Other respiratory diseases (e.g. asthma)	0
Diarrhoea (< 5years of age)	42
Diarrhoea (> 5years of age)	18
Malaria	166
Dysentery	5
Anaemia	0
Malnutrition	16

Source: Fane Catholic Health Centre

Kosipe

Kosipe experienced continuous frosts from April to October 1997, causing the vegetation to dry up. With the onset of the drought, the whole area became a fire hazard zone. People were living on *karuka* as the frosts and drought destroyed gardens.

In late October to early November 1997, the situation in Kosipe worsened when a bush fire destroyed a total of 19 villages including the Catholic Station. People had to deal with the issue of shelter as well as food shortages.

Of all the places visited, Kosipe was in the most desperate situation. People could not build houses or shelters because building materials (pandanus) were destroyed in the fire. Days were hot and dry, nights very cold. People began migrating to Woitape, Tolukuma, Port Moresby and other places where food and shelter was thought to be available.

Since the fire, people had lived on relief supplies. The final food relief supply was dropped on 14 November 1997 and its impact was quickly felt in the community. Health conditions of starving children improved significantly. Urgent medical assistance was required to address the high incidence of stomach disorders, influenza and pneumonia. People expressed the need to rebuild the aidpost and waterpump to help with irrigation of food crops. Other urgent needs included cooking utensils, clothes, blankets, tents, farming implements, water containers, fencing materials, and planting materials (seeds, cuttings, suckers, etc.).

Social problems were caused by distribution of relief supplies. The first relief supply was dropped at Kosipe, the second at Woitape. Concerns were raised by villagers that other villagers would steal the supplies.

Kerau

The situation at Kerau was similar to that at Kosipe. People were living on *karuka* as gardens had failed. The gathered *karuka* nut kernels were becoming smaller and smaller. In the first week of November 1997, 1500 kilograms (kg) of rice (60 × 25-kg bags) was given to the people of Kerau; however, this was not sufficient. Concerns were also raised when 50 bags of rice were sold after they were

1. In 1997, 1 PGK = approx. US$0.70 (A$0.94).

given as relief food. People were not happy that further relief supplies were dropped at Tapini, a six-hour walk away.

The water supply was low and was reducing fast. All nearby creeks had dried up and drinking water had to be fetched from another source, an hour's walk away. Poor water quality and a diet of *karuka* also increased the incidence of diarrhoea and other stomach disorders. Major diseases could not be treated as the aidpost was not staffed.

The villages of Elava, Kirivi, Ilai, Gane, Malava and Lamanaipi were burnt by bushfires, causing an exodus of people to Port Moresby via Tapini. Tents, water containers, cooking utensils, clothes, blankets, planting materials and medical assistance were urgently needed.

Koiloa

When we arrived, Koiloa, a village of 200 people, had been living on relief supplies, delivered six weeks earlier. When these ran out, people survived on *karuka* and breadfruit, resulting in a high frequency of diarrhoea and stomach problems. Gardens were destroyed in the drought, resulting in migration to Port Moresby.

Water was available but was at least an hour's walk from the village. The younger children and elderly people from each household were often too weak to carry water home from the rivers and creeks. Fire also destroyed three houses in Koiloa, leaving people homeless and very vulnerable to colds, influenza and pneumonia. The incidence of other diseases also increased (Table 4).

Upper Kunimaipa

In the Upper Kunimaipa area, assessments were made at the villages of Hoeta (Olivi) and Gagave.

Table 4. Incidence of diseases at Koiloa, Central Province, PNG, during the 1997–98 drought.

Disease	Reported cases
Diarrhoea	25
Pneumonia	40
Malaria	20
Influenza	53

Source: figures supplied by a village leader

Hoeta village. In Hoeta village, all food gardens were destroyed in the drought resulting in people turning to *karuka* as the source of food. When this was exhausted, people had to live on wild yam, despite its bitter taste and difficult preparation. People also depended to a lesser degree on ferns, breadfruit and the leaves of *kumu mosong* (*Ficus copiosa*). Villagers predicted that, within two months, all food supplies would run out. Betel nut trees, a main source of income, were also lost in the drought.

All nearby streams were dried up in the drought and the nearest water source (Makorak River) was a three-hour walk away. The stronger members of the family collected an average of five litres of water per household daily. Bigger families needed more water than smaller families. With the prolonged drought, the water level dropped drastically, so that it took up to an hour to collect two litres of water. Children were assisting less and less with household chores due to weakness from lack of food.

The general decline and deterioration in the health of children and the elderly was obvious. Seven cases of malaria and one case of tuberculosis were reported by the villagers, although the true figure may be much higher.

Many people from Hoeta village moved to Port Moresby via Tapini in search of food. Six families were reported to have migrated to Port Moresby. Bigger families were finding it difficult to travel to Tapini and Port Moresby due to lack of food to feed relatives along the way and slow movement. Concerns were expressed that the government had offered no assistance since the drought started. Villagers indicated that relief supplies should be dropped at a central location like Hoeta for distribution to nearby areas. People were in urgent need of medical and food assistance. Planting materials requested included sweet potato, potato, corn, cucumber, pumpkin, bean, cabbage, carrot, peanut, *aibika*, banana, sugarcane, taro and yam.

Gagave village. Gagave village, with a population of approximately 200 people, had received no food aid since the drought started. For almost a year people had been surviving on breadfruit, ferns, and *karuka*, after gardens were destroyed. The size of mature pandanus nuts was becoming smaller as the drought continued. Villagers lost their entire income source when livestock (mainly pigs) died through starvation.

People were walking long distances looking for food. A total of 25 people had left for Port Moresby via Tapini (a two-day walk) in search of food and many more planned to leave should relief supplies fail to

arrive. The villagers wanted their relief supplies to be dropped at a central point for easy distribution rather than at Tapini, where risk of theft was high.

Water collection had become a hard but essential daily chore for survival. All nearby creeks had dried up. The nearest source of water was Ngotngot River, about 2–3 hours' walk away. The diet of *karuka* gave rise to a high incidence of diarrhoea and other stomach complaints. Other diseases were also increasing and, since June, five deaths were reported from starvation. The general status of health was deteriorating rapidly, particularly in malnourished children and the elderly. Urgent medical and food assistance was needed. The drought also had a spiritual effect on the people, who said the recent blessing of four days of rain was God answering their prayers. They claimed that to have survived so far was a miracle in itself. In a nearby village of Gumizi, the whole village was burnt, including Division of Primary Industry houses. Urgent relief supplies, including tents, food, water, medical supplies, clothes and cooking utensils, were needed.

Lower Kunimaipa

Kamulai Catholic Mission. At Kamulai Catholic Mission, a Belgian priest reported that in 40 years at Kamulai he had not seen such a devastating drought. There had only been four days of rain, amounting to 24 millimetres, since the start of the drought. Food was in short supply from May and people were surviving on *karuka*, of which very little was left, and that was very dry. Although no actual figures were given, the incidence of diarrhoea, gastroenteritis and other stomach disorders increased significantly. A lot people have migrated to Port Moresby in search of food. All food markets were closed, as there was nothing to sell. Most of the pigs died of starvation and cash crops of coffee were neglected.

Relief supplies were dropped at Tapini, but were claimed to be insufficient. Two 100-kg rice bags were delivered to Tapini but most was then stolen. The Guari people were alleged to have stolen most of the food supplies after threatening the officials with guns; the police were investigating the matter. Concerns were raised that new supplies had been delivered to Tapini but had not been distributed, while people were starving in nearby areas. Urgent relief assistance was needed including medicine, food, clothes, blankets and planting materials.

Conclusion

The drought and associated frosts had a major impact in the Goilala area and much of PNG. The most severe effect was on the subsistence food supply. All the villages visited in Goilala District were surviving on either relief food supplies or famine food. The impact of the drought and frosts was greatest in the most remote locations where the effects were compounded by poverty and lack of access to government assistance.

The drought resulted in significant water problems. Water collection was a hard but essential daily chore for survival. The majority of villagers in Goilala District were obtaining their drinking water from sources other than their usual ones.

At first glance, the general decline and deterioration in the health of villagers was evident, particularly in the younger children and the elderly. In some places, nursing mothers reported a decline in the quality and quantity of breastmilk. Incidence of illness and death increased.

The drought resulted in extensive bush fires causing loss of homes, for example, 19 villages were burnt in Kosipe. Income was lost through neglect of coffee trees and loss of betel nut trees and pigs. All community schools were closed. Students lacked stamina and needed to spend time looking for food. Health institutions closed because of water shortage and lack of staff and medicine. Due to loss of gardens and livestock, many people camped at sites where famine food was available, or migrated to Port Moresby and the Tolukuma gold mine.

Concerns over delays in distribution of relief supplies were reported. Other social problems caused by the drought included the selling of relief supplies to villagers, the stealing of relief supplies at Tapini, and men buying beer while children and women were starving. The drought also brought renewed faith among Christians in some of these rural communities.

The 1997 drought had a major impact in the mountainous part of Central Province. The food supply was limited and people survived on emergency foods, especially *karuka*. Water supplies dried up and many people had to walk long distances to obtain water. There were many reports of increased health problems and some of an increased death rate. Some people responded by migrating to Port Moresby and to other locations. Some problems with the effective delivery of food relief occurred, often because of social factors.

References

Allen, B. J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Port Moresby, Australian Agency for International Development (AusAID).

Allen, B. and Bourke, R.M. 1997b. Report of an Assessment of the Impacts of Frosts and Drought in Papua New Guinea—Phase 2. Port Moresby, Department of Provincial and Local Level Government Affairs.

Bourke, R.M. 2000. Impact of the 1997 drought and frosts in Papua New Guinea. In: Grove, R.H. and Chappell, J., eds, El Niño—history and crisis. Cambridge, UK, White Horse Press, 149–170.

The Influence of Available Water in 1997 on Yield of Arabica Coffee in 1998 at Aiyura, Eastern Highlands Province[1]

P.H. Hombunaka[*] and J. von Enden[†]

Abstract

At Aiyura, Eastern Highlands Province, PNG, a wetter season usually occurs between September and March, and a drier season between May and August. However, in 1997, very little rain fell from February to November. It was feared that the 1998 coffee crop would be significantly reduced and that this would result in severe financial problems throughout the coffee industry from producers to exporters. This fear proved to be unfounded. The relationship between the 1997 rainfall and the resulting crop yield in 1998 at Aiyura is examined. The findings contribute to a better understanding of the behaviour of Arabica coffee under varying soil moisture conditions.

RESEARCH carried out in PNG to investigate the growth cycle, crop development and nutrient demands of Arabica coffee (*Coffea arabica* L.), to optimise the time and quantity of fertiliser application, has identified a considerable variation in nutrient demands during crop development. A fluctuating nutrient demand implies that varying amounts of water are needed by the plant for optimal growth (Harding 1994). Hombunaka (1998) refined Harding's findings, and showed that even slight climate differences lead to modified crop development cycles, and that the climate of the PNG highlands is an important influence in coffee production there. In particular, in the PNG highlands:

- contrary to most other-coffee-producing countries of the world, the wet and dry seasons are not clearly defined;
- due to the equable year-round climate, coffee ripens during most months of the year; and
- a rainfall stimulus can influence yields 8–9 months later.

Wrigley (1988) refers to research work in Kenya that examined the influence of water deficiency on coffee growth. It was found that a lack of plant-available water can lead directly to water stress or indirectly to nutrient deficiencies in plants that limit crop development. As a result, coffee development is reported to be limited when available soil water is depleted by about 50%. However, low water availability at different times in the crop development cycle can lead to different outcomes. For example, a period of lowered water availability in the soil that results in water stress to the plant, followed by strong rainfall that raises the available soil water, results in a larger number of flowers and higher subsequent yields. But at other times, for example during cherry development, lowered water availability strongly hinders crop development.

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1. This paper has previously been published in the Proceedings of the 18th International Conference on Coffee Science, ASIC '99, August 2–6 1999, Helsinki, Finland.

von Enden (1998) outlined the 1997–98 crop development at Aiyura, Eastern Highlands Province, using a semiquantitative approach. The sources of information was a quantitative assessment of the 1997 water balance, combined with a qualitative assessment of farmers' perceptions of crop development. This assessment gives insights into the influence of drought (and frost) on crop development, and provides information for management strategies for smallholder coffee production.

These data were collected from the Coffee Research Institute plantation at Aiyura, where controlled conditions make the collection of reliable data possible. These conditions do not necessarily reflect village smallholdings, where different management techniques will result in different outcomes. However, the inclusion of smallholders in research and the use of PNG-wide export data strongly suggest that the findings are generally applicable to smallholdings.

Normal Weather and Cropping Pattern

Aiyura receives an average annual rainfall of 2074 millimetres (mm) (Trangmar et al. 1995). Under average weather conditions, this rainfall is divided into two periods: a slightly wetter period between September and March and a slightly drier period between May and August. The soil moisture regime is closely associated with this annual rainfall pattern. The soil moisture model on which the analysis is based assumes a maximum water-holding capacity of the soil of 85 mm, reflecting average soil characteristics in the Aiyura area. Under this assumption, soil moisture is slightly depleted between June and September (Fig. 1). During this period, evapotranspiration exceeds rainfall, so that plants must draw on soil moisture reserves. This situation, however, does not put coffee growth in danger. Rather, it provides a situation in which a rainfall event acts as a stimulus for the onset of flowering. Figure 1 illustrates the central variables of the average weather pattern and soil water regime at Aiyura.

The variables acting upon the soil water balance are:

- rainfall, which provides the water input into the system;
- soil moisture, which represents the ability of the system to store moisture; and
- evapotranspiration, which withdraws water from the system.

The 1997–98 Weather and Cropping Pattern

The 1997 and 1998 weather data have been examined on a 10-day basis, which allows a detailed analysis of the climate and crop. The weather in 1997 was characterised by exceptionally low rainfall that resulted in low soil moisture levels for extended periods. In total, evapotranspiration exceeded precipitation for five months in 1997, and at times this led to fully depleted

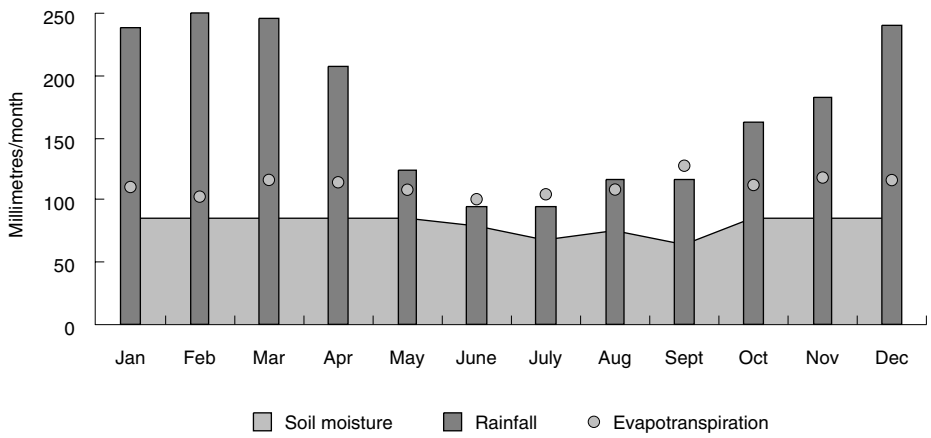

Figure 1. Monthly rainfall, soil moisture and evapotranspiration at the Coffee Research Institute, Aiyura, Eastern Highlands Province, PNG, 1997.

soil water resources. Water demands could not be met by rainfall inputs, consequently water deficits were experienced, a rare event in the PNG highlands (McAlpine 1970). In addition, low temperatures were experienced during the dry periods, especially at night. Clear night skies led to longwave radiation, and hence to heat lost to the atmosphere.

The pattern of 1997 and 1998 soil moisture, and its influencing variables, at Aiyura are shown in Figure 2. Four periods can be identified: in the first period from March to May 1997, a fall in soil moisture during late March and April is followed by a recovery in May; in the second period from May 1997 to July 1997, there is a larger fall in soil moisture from May to June, followed by a smaller recovery in July; in the third period from July to October 1997, soil moisture is very low to zero and there is a water deficit, but there is also rain and a consequent minor recovery in soil moisture during October; and in the last period from October to November 1997, the water deficit continues, but soil moisture again falls to zero and then has a minor recovery. In each of these periods, soil moisture falls sharply but then, to a limited degree, recovers again. Each partial recovery of soil moisture favours the onset of flowering of the coffee tree and the start of a new crop cycle.

During the third period, in addition to the low rainfall, unusual low minimum temperatures were experienced. Minimum temperatures below 10°C, together with dry conditions, were likely to have acted as an added stimulus for flowering.

If it is assumed that an increase in soil moisture that exceeds 20% of the total water storage capacity of the soil is likely to have stimulated the onset of flowering, then flowering stimuli occurred four times during 1997: in May, July, late October and late November.

Coffee Yields in 1998

The 1998 cropping pattern should reflect these four flowering periods; production peaks can be predicted for around eight months after each such stimulus. The 1998 coffee production data shows a clear peak yield across May, June and July (Fig. 3). The marked variation in coffee yields in 1998 can be explained by the pattern of water availability during 1997. Each increase of rainfall and soil moisture was the starting point of a new plant development cycle.

Dry weather and reduced soil moisture levels occurred from March to April 1997, which were very unusual for that time of the year, and were followed by a clear flowering stimulus in May. This flowering was reflected in a production peak eight months later in January 1998. The peak was small because water supply during the cherry development phase, between July and October 1997, was insufficient.

Dry conditions and the lack of a rainfall stimulus in the beginning of the second period in June 1997 suppressed flowering. In addition, a lack of soil moisture after any flowering that occurred probably led to high proportion of cherries not going on to reach maturity. The resulting outcome in 1998 was yields in February, March and April that were 92% lower than the corresponding yields in 1997.

The yield peak in May 1998 is more difficult to explain because it is not possible to identify a rainfall stimulus eight months earlier. The crop is likely to have originated from a flowering caused by low temperatures in September. Low temperatures were observed during September, but temperature records are not available for Aiyura (an inexcusable situation for a research station). A reasonable yield occurred because of adequate soil moisture from October onwards, which is the period of rapid expansion, endosperm formation and weight gain in cherries. If there had not been adequate soil moisture from late October, then most of the cherries would have been aborted.

The strongest water deficits during 1997 occurred from August to November. A strong flowering stimulus was received in October and November 1997, that led to a marked increase in coffee yields in June and July 1998 (slightly more than double the yields for the same period in 1997). The extreme dry spell before the strong stimulus increased the level of flowering. The good availability of water from the end of October 1997 onwards was also important for optimal cherry development.

The flowering stimuli in April, May, July and August were countered by insufficient water availability during cherry development. Wrigley (1988) states that coffee yields are negatively associated with soil water deficits 8–17 weeks after flowering, which is the time of the most rapid weight gain in cherry development.

At Aiyura, the changing water availability in 1997 led to multiple flowering, resulting in three yield peaks in 1998. The El Niño weather patterns appear to have brought about higher coffee yields rather than have put the crop in danger. The increased yields in peak months more than compensated for the reductions of yield caused by soil water deficits at other times.

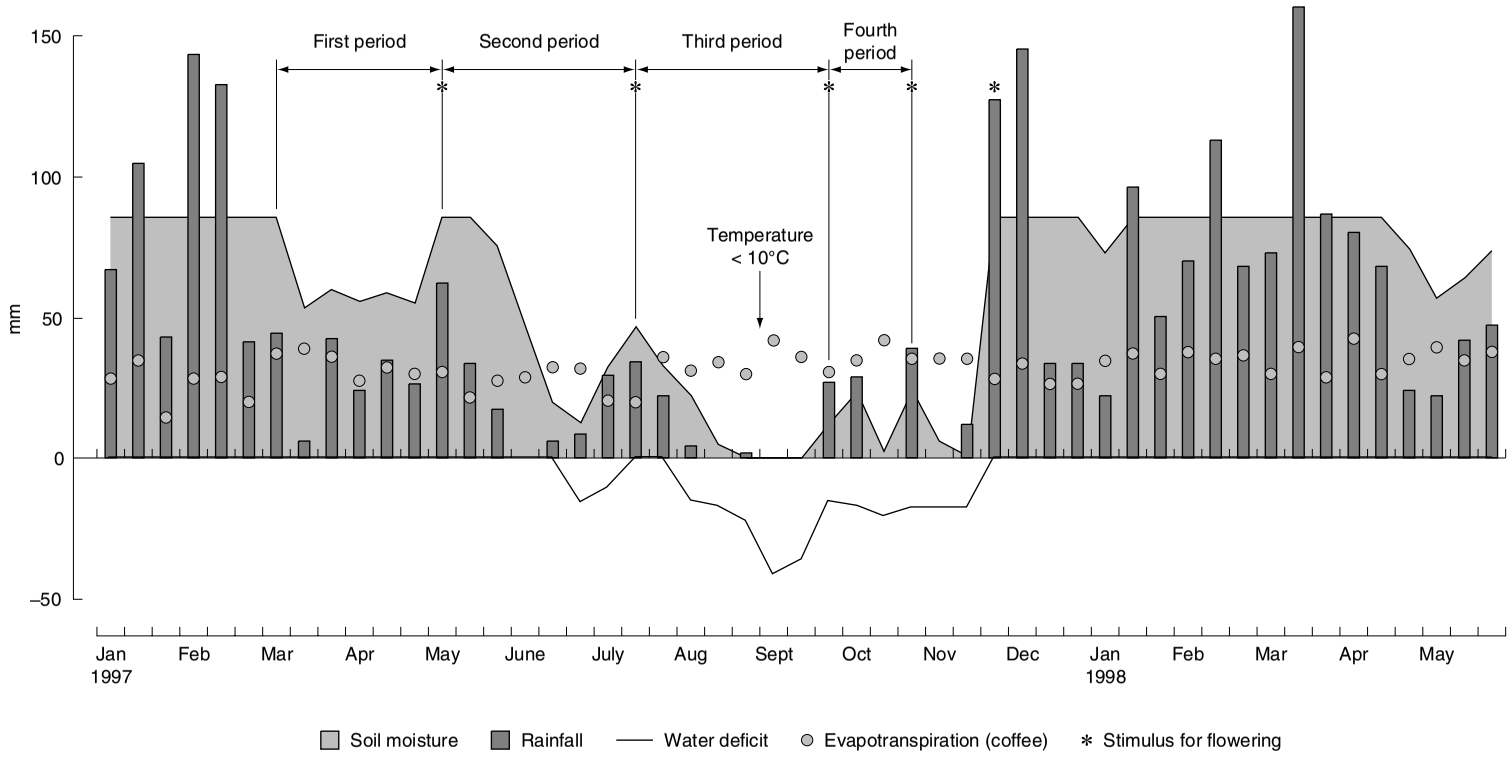

Figure 2. Soil moisture and its influencing variables between January 1997 and May 1998.

PNG Coffee Exports in 1998

Coffee exports from PNG in 1998 are shown in Figure 4. It is assumed that about two months passes from the time of picking of ripe cherries to the time that the green beans are exported. The January and February 1998 exports of green beans were largely the harvest of November and December 1997. The exports from March to December 1998 were the harvest of January to October 1998. Between March and December 1998, more than 1.2 million 60-kilogram (green bean equivalent) bags of Arabica coffee were exported from PNG.

The increase in exports that began in June 1998 was related to harvesting that began in April 1998. The most severe water deficits were experienced from July to September 1997 (Fig. 2), implying that the massive flowering that occurred in October 1997 resulted in the harvest of June 1998, as recorded in the export statistics in August 1998.

Conclusion

The rainfall conditions of 1997, a year in which one of the most severe droughts this century occurred in PNG, did not lead to an Arabica coffee crop failure in 1998. On the contrary, it almost certainly resulted in increased production. After severe soil water stress, sharp rises in soil water as a result of rainfall brought on massive flowering. This occurred even in coffee trees under heavy shade, which under normal weather

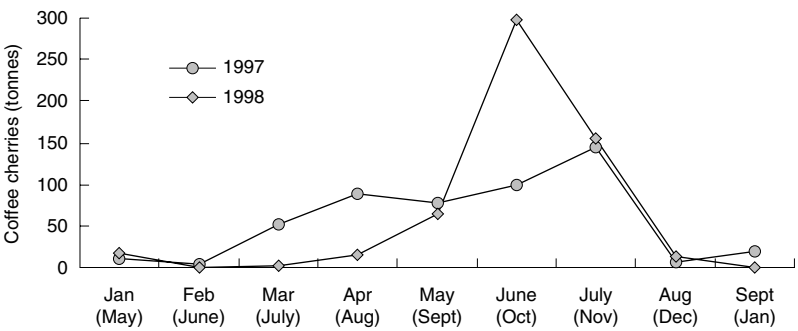

Figure 3. Coffee production at the Coffee Research Institute, Aiyura, Eastern Highlands Province, PNG, 1997–98. Months in brackets indicate the month of stimulus eight months earlier.

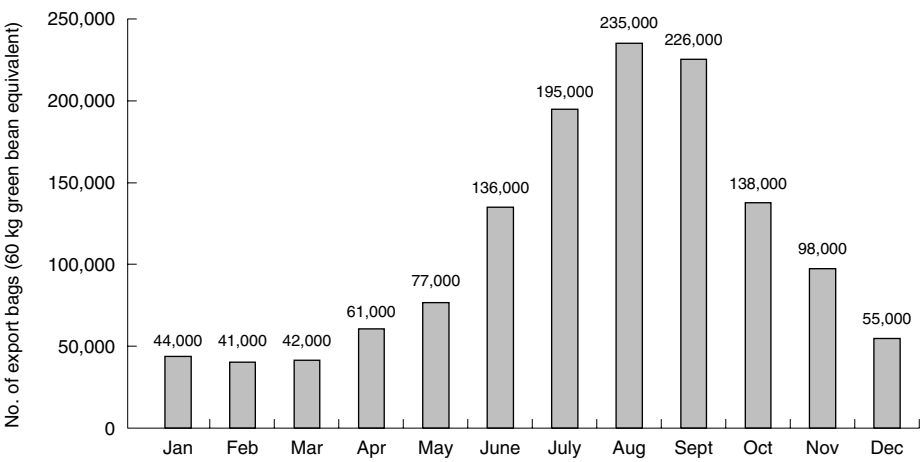

Figure 4. PNG coffee exports, 1998. (Stapelton et al. 1998).

conditions do not flower heavily. Coffee growing above 1800 metres above sea level, which does not normally yield as well as coffee at lower altitudes due to lower ambient temperature, also had massive flowerings in 1997 that resulted in exceptionally high yields in 1998.

The 1997–98 green bean coffee exports from PNG were more than 1.2 million 60 kilogram bags. This is the highest level of exports on record, apart from 1988–89 (Stapleton et al. 1998). While some of this increase may have been due to people selling coffee from village stores in order to release cash to buy food, the major part of the increase was caused by the excellent drought tolerance of Arabica coffee and its ability to survive low soil moisture regimes and to respond quickly when soil moisture recovers again.

Acknowledgments

The PNG Coffee Research Institute provided coffee yield figures and rainfall data.

References

Harding, P.E. 1994. Seasonal fluctuations in leaf nutrient contents of fertilised and unfertilised Arabica coffee in Papua New Guinea. PNG Coffee, 10(1), 1–5.

Hombunaka, P.H. 1998. General fertiliser recommendations for Arabica coffee in Papua New Guinea. Technical Advisory Circular No. 3 (third edition), Coffee Industry Corporation Ltd. Aiyura, Coffee Research Institute.

McAlpine, J.R. 1970. Climate in the Goroka–Mt Hagen area. In: Haantjens, H.A., McAlpine, J.R., Reiner, E., Robbins, R.G. and Saunders, J.C., eds, Lands of Goroka–Mount Hagen Area, Territory of Papua and New Guinea. Land Research Series No. 27. Melbourne, Commonwealth Scientific and Industrial Research Organization, 66–79.

Stapleton, G., Umetrifo, B., Alu, M. and Wheeler, M. 1998. Coffee Report No. 44. Goroka, Papua New Guinea Coffee Industry Corporation Ltd, Industry Affairs Division.

Trangmar, B.B., Basher, L.R., Rijkse, W.C. and Jackson, R.J. 1995. Land Resource Survey, Upper Ramu Catchment, PNG. Papua New Guinea Resource Information System Publication No. 3. Canberra, Australian International Development Assistance Bureau.

von Enden, J.C. 1998. El Niño and PNG: weather induced dynamics in a highland agroecosystem. Unpublished MSc thesis. University of East Anglia, Norwich, UK.

Wrigley, G. 1988. Coffee. New York, Tropical Agricultural Series.

The Role of Humanitarian Organisations in the PNG Drought Response

Royden Howie*

Abstract

Humanitarian organisations played an important role in the PNG drought response of 1997. During the drought, humanitarian organisations implemented traditional disaster response activities and also trialled a range of nontraditional responses that were more oriented towards community development. Churches, international organisations and local humanitarian organisations involved in PNG often have unique knowledge and experience that can determine the effectiveness of disaster response strategies in particular communities. This paper provides an overview of the response of humanitarian organisations to the PNG drought. It concentrates on nontraditional activities and lessons learned through the experience of nongovernment humanitarian organisations.

Definitions

For the purpose of this paper, church organisations, humanitarian nongovernment organisations (NGOs)—national and international—and community-based organisations (CBOs) are collectively referred to as humanitarian organisations (HOs). Most of the information in this paper was obtained from Adventist Development Relief Agency (ADRA) PNG files relating to the drought response and from discussions with other HOs. Information on involvement of other organisations was provided by the respective organisations. I have attempted to make information on organisations as complete as possible in the time available, but some organisations were not able to be contacted or were not able to provide information.

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Position of Humanitarian Organisations in Communities

The long-term relationships that HOs have with communities in which they operate, and their unique local knowledge can be invaluable when planning or implementing disaster response or mitigation programs. HOs have a range of strengths and weaknesses in relation to disaster response (Table 1), which were clearly illustrated throughout the 1997–98 PNG drought response. They gathered valuable information during assessment visits to communities and through reports from communities or field workers. This information was often able to alert provincial authorities and the drought committee to serious community needs. In addition, HOs have a knowledge of community dynamics that affect efforts to distribute aid in communities.

However, while there are significant strengths of HOs in large-scale disaster situations (such as drought) in PNG, there are also some serious weaknesses that sometimes limit their effectiveness. The most serious of these is the limited communication between organisations and their unwillingness at

Table 1. Strengths and weaknesses of humanitarian organisations in disaster response.

Strengths	Weaknesses
Good communication with communities	Lack of communication between organisations
Knowledge of practices of communities	Lack of systems to collect information in a useful form
Knowledge of power structures and leadership in communities	Lack of knowledge of what useful organisations exist
Knowledge of needs in communities	Lack of knowledge of what organisations have a presence in particular areas
Knowledge of history of communities	Lack of interest in disaster response and mitigation
	Lack of knowledge of how their systems and presence could be used to mitigate a disaster or assist in disaster response at very limited cost
	Sometimes unwilling to assist outside of their immediate constituency
	Dependency of many on external funding

times to work outside their own constituencies or project areas. It was pleasing that, during the PNG drought, there were much greater levels of cooperation between HOs than there had previously been. The effectiveness of HOs during the 1997–98 drought provides a model for cooperation and communication between HOs.

Humanitarian Organisation Networking During the PNG Drought

HOs have been criticised for failure to coordinate their activities during a disaster such as the 1997–98 PNG drought. Lack of coordination has led to duplication of activities in some areas while other areas receive no assistance from HOs. A further criticism is lack of coordination between national disaster coordinating bodies and HO activities on the ground. PNG's national disaster plan establishes coordination mechanisms to reduce this problem, but the effectiveness of those mechanisms is dependent on the cooperation of individual HOs and government departments involved in the disaster response. In some previous disaster situations there has been a reluctance by some HOs to coordinate activities through the PNG Red Cross (PNGRC) which, in the national disaster response plan, provides HO representation to the national disaster committee. This has been the case particularly where international organisations have established a presence in PNG specifically in response to a disaster, without any ongoing commitment to the country or any knowledge of national coordination methods.

There are few NGOs in PNG with the capacity for rapid disaster response. During the onset of the drought, PNGRC and leading HOs communicated very closely and were determined that coordination would occur effectively between HOs and government bodies. Accordingly, contact was initiated with organisations likely to be involved in the disaster response to encourage their involvement on the national HO coordinating committees hosted by PNGRC. These committees held meetings throughout the drought and most organisations involved in the disaster response participated in them. This proved invaluable to HOs in coordinating activities, setting standardised operational guidelines and communicating HO activities to the national drought committee and the various sectoral subcommittees. This coordination meant that there was little duplication of effort or lack of communication between HOs. This drought-response mechanism demonstrates that the provisions of the National Disaster Plan can work and indicates that it could form an effective model for future disaster response and mitigation activities. However, it remains dependent on the willingness of individual organisations to be involved in this kind of coordination.

Case study: localised networking

At a more local level, the importance of communication and networking was demonstrated through the effectiveness of the Morobe Province NGO *kibung*[1]. The *kibung* was formed by the HOs of Morobe Province to facilitate communication and coordination between organisations in the province. The *kibung* has been very effective in this role. During the onset of the drought, the *kibung* met to discuss how each organisation could most effectively be involved in the drought response. There was general recognition that not all organisations would have access to additional financial resources—but all organisations demonstrated a willingness to help where they could. Through active dialogue, and with only limited financial resources, the *kibung* was able to find means to establish many small-scale activities that collectively had a significant impact.

Examples of activities coordinated by the *kibung* include the following.

- *Scouts*: they required only bus fares and some lunches to be able to distribute leaflets throughout the province or get them placed on public motor vehicles and in public areas at government stations and around towns. ADRA, Lions and Soroptomists were able to provide financial support.
- *The Appropriate Technology and Community Development Institute (ATCDI)*: the ATCDI was able to very economically put together information leaflets for distribution by the scouts, published by Word Publishing. Financial support for printing of leaflets was provided by ADRA, Lions and Soroptomists.
- *General coordination*: through coordination of NGO activities, a much more accurate understanding of the impact of drought in different areas was gained, which was useful in implementing HO activities. In addition, this information was provided to the provincial government through the provincial coordinating committee.

Table 2 lists a number of NGOs involved in all parts of PNG that networked with the NGO Drought Committee. It gives some idea of the wide range of organisations contributing to the relief efforts and the scope of the activities in which they were involved.

1. *Kibung* means a meeting, or meeting place, in Melanesian Pidgin.

Table 2. Sample of nongovernment organisations (NGOs) involved in drought response and their activities.

Organisation	Areas of activity
Adventist Development Relief Agency	Humanitarian organisation (HO) coordination Food/commodity distribution Funding of community-based organisations (CBOs) Water supply Agricultural training Seed distribution
Anglican Church	Food distribution Seed distribution Water supply Health promotion
Appropriate Technology and Community Development Institute	Development and printing of resource materials
Australian Volunteers International	Volunteers
CARE Australia	Food distribution Seed distribution
CARITAS	Food distribution Medical assistance Seed distribution Water supply projects

Continued on next page

Table 2 (cont'd). Sample of nongovernment organisations (NGOs) involved in drought response and their activities.

Organisation	Areas of activity
Evangelical Brotherhood Church	Seed distribution
Foundation for People and Community Development	Food distribution
Lutheran Development Services	Food/commodity distribution Agricultural training Seed distribution
Lions/Lionesses	Food distribution Funding of CBOs
Morobe Province *kibung* (a nongovernment organisation)	HO coordination
PNG Red Cross	HO coordination Food/commodity distribution Funding of CBOs Disaster response training Water supply
Rotary	Financial support to NGOs
Save the Children Fund	Food distribution/logistics Seed distribution Water supply
Scouts	Information dissemination
Soroptomists	Funding of CBOs and NGOs
Word Publishing	Articles in *Wantok* newspaper
World Vision	Food distribution

Case study: cooperation between church organisations in agricultural aid distribution

Church representatives attending the national coordinating meetings in Port Moresby agreed to try to ensure that distributions of aid covered all church groups. Thus, it was clear in reports to other HOs and to government that a whole area had been covered by a particular distribution, which was not limited to one denominational group. It is difficult to ascertain how effective this was and not all churches participated. However, there are specific examples of where this cooperation did occur and was effective.

ADRA commenced disaster response activities by expanding its water supply program. Subsequently, funding was provided by the Australian Agency for International Development (AusAID) to expand the water supply program and to initiate a distribution of seeds once rainfall began. A number of options for distribution were considered. Ultimately a joint effort between ADRA, Department of Agriculture and Livestock (DAL) and four church organisations was undertaken. ADRA's distribution was implemented by DAL and by the Anglican, Lutheran, Evangelical Brotherhood and Seventh Day Adventist churches.

The example set by this joint effort demonstrated that the churches could work cooperatively to help everybody. Ultimately, with funding from AusAID through one humanitarian organisation, several churches worked together in cooperation to ensure all people in distribution areas received assistance. If churches are able to cooperate in this way, they provide an excellent way to cover almost all parts of PNG. Further consideration needs to be given as to how to establish effective ongoing relationships between churches, so that similar cooperation can occur in the future. It is also important to find ways to extend the involvement of those church groups that remained exclusively focused on their own constituents during the drought response.

Traditional Distributions as Disaster Response

The advantages and disadvantages of traditional relief distributions are listed in Table 3. Typically, in disaster situations, the immediate reaction by HOs is to provide distributions of commodities to solve immediate needs and allow communities to re-establish. During the PNG drought, the major needs were food and water. At times there was also a need for shelter and other household goods due to wildfires that occurred as a result of the very dry conditions. Disaster relief distributions are absolutely necessary in times of critical need but, if provided on an ongoing basis, tend to create dependency. Many parts of PNG already have a culture of dependency on external assistance both in times of disaster and for ongoing development initiatives. It is important that both humanitarian and government organisations seek to overcome this dependency wherever possible. This will only be achieved through ongoing preparedness programs and not by continuing to resort to handouts when disasters occur.

The impact of the PNG drought was unusual in that the lack of water and length of time without rainfall would not necessarily have caused a national disaster in most other parts of the world. Many areas stricken by the drought were affected as much by lack of preparedness, and the social and political environment, as they were by the severe climatic conditions. This is an issue that needs to be addressed directly through national programs implemented by government and NGOs. However, it also needs more indirect approaches that help overcome the culture of dependency and engender an environment where people are more willing to do more for themselves.

Disaster Preparedness and Response Through Development Activities

During the drought response, a number of development programs were commenced or expanded by NGOs, in addition to more traditional means of commodity distribution. These included:

- agricultural training;
- water supply installation;
- nutrition education;
- traditional food-source education; and
- postdisaster training.

The development approach requires significantly more predisaster planning and skills, and programs are more difficult to quantify, plan and implement. However, they can have a much longer term impact and, if implemented prior to natural disasters, could ameliorate the impacts of events such as occurred during the 1997 drought in many areas of PNG. The advantages and disadvantages of a developmental approach to disaster response are listed in Table 4.

Analysis

NGOs are attempting to create programs that can help to address the issue of dependency throughout the country. It is likely that a long-term development program aimed at reducing the impact of disasters such as the drought would ultimately be much more cost-effective than continuing to implement disaster responses. Greater analysis of some of these programs

Table 3. Advantages and disadvantages of traditional relief distributions.

Advantages	Disadvantages
Provide rapid relief to people in need	Encourages dependence on repeat assistance
Easy to standardise	High cost when implemented repeatedly
Immediate results	No training to avert future disasters
Fixed and known costs	Difficult to ensure that people most in need are assisted
Fixed and known timeframe	Can create community conflict about who gets what
Well known methodologies	
Appealing to media and the public	
Good public relations for donors	
High commodity cost, low personnel/administration cost—attractive to donors	

Table 4. Advantages and disadvantages of a developmental approach to disaster response.

Advantages	Disadvantages
Longer-term impact	Rapid implementation during disaster response may reduce long-term impact
Can reduce the impacts of natural events	Requires considerable predisaster planning
Cost effectiveness	Less attractive to donors as they do not have the same fixed timeframes and quantitative results
Significant education components	Difficult to standardise
	Difficult to estimate costs
	Difficult to estimate timeframes
	Generally less appealing to media and the public
	Public relations for donors generally more challenging

may enable a selection of them to be adopted by government in the national development program. While it is not possible to fully analyse these programs in this paper, two case studies are presented below to encourage further discussion and research in this area.

Case study: cost effectiveness—installing a water supply system rather than delivering food

During the 1997 drought, ADRA compared the cost of supplying food to various communities with the cost of implementing a water supply system that could supply sufficient water for irrigation and drinking. In most cases, it was significantly more cost-effective to implement a water supply program than to feed a community for three weeks. This illustrated that if a water supply program could be implemented immediately, it would have been less costly to install a very basic irrigation system for them to continue to grow food in their own gardens during a drought, than to feed people, even if it started raining within three weeks. Furthermore, in many communities the installation costs could be justified by the cost savings in just one disaster situation, which is an outstanding payoff for an infrastructure item that benefits the community in both disaster and nondisaster periods.

There were some villages in Morobe, Madang, Milne Bay and New Ireland provinces where ADRA was able to achieve this and those villages had plenty of food throughout the drought while other surrounding villages were struggling for food.

The tendency to move gardens regularly could reduce the long-term effectiveness of fixed irrigation systems, but creative approaches to this situation that are appropriate to local culture could be effective. For example, where a village has decided to locate permanently in one place and a gravity feed water system is installed, it is possible to design overflows from filters, tanks and pressure breaks so that overflow from the system during off-peak times can be used for agriculture. Even if the community locates gardens elsewhere during normal seasons, they at least have the option of getting water to a particular area for gardening in a drought situation. Pipes with taps could be run some distance from a couple of the overflows, at very little extra cost, for use when the community required them.

One community in Morobe Province relocated gardens to areas within their tank overflow and the runoff from their tap stands, and used their dish and clothes-washing water on their garden plants for pest control. They had an outstanding crop of a wide range of food in a severely drought-affected area, throughout the drought. The total system and training cost less than feeding the community for three weeks with the distribution package developed for drought relief.

Case study: low-cost humanitarian organisation involvement—information dissemination by PNG scouts

Many organisations do not have the funding to get involved in commodity distribution or water supply programs. However, they are still willing to be involved in whatever way they can. During the drought, the scouts demonstrated how effectively a small organisation could be involved. In Morobe Province, they attended every meeting of the Morobe NGO *kibung*, making themselves available to everybody. They never requested significant funding to be

involved in activities, simply enough to cover their modest expenses. They were involved in design of brochures and in distribution of information. They were the key channel for getting information to many remote parts of Morobe Province. Organisations, such as the scouts, given appropriate training and resources from other humanitarian organisations, would be willing to be involved in activities in communities if there was funding available for ongoing disaster prevention and mitigation activities. This is a simple way that organisations with a strong desire to be involved, excellent relationships with communities and teams of volunteers can have a very significant impact on communities at minimal cost. There is immense scope for more effective partnerships between NGOs and CBOs with support from the donor community, in order to achieve the sort of outcomes seen during the drought response.

Concluding Comments—Implications for Nongovernment Organisations

Table 5 lists the factors that affected the severity of the 1997 drought in PNG. Clearly the effectiveness of and the need for disaster response activities depends largely on levels of preparedness prior to disasters. HOs in PNG are at the forefront of disaster preparedness activities in the country and play an important role in disaster response. In Morobe Province, the ADRA water supply program and the Lutheran Development Service (LDS) *Yangpela Didiman* programs had a significant impact on the need for disaster response distributions. The LDS *Putim na Kisim* program and the ADRA Small Enterprise Development program are beginning to have a positive impact on savings levels in participating communities and demonstrate the feasibility of more widespread community banking services for rural areas. Ongoing water supply, agriculture, credit, business, health education and disaster preparation training programs from a wide range of organisations are able to have a significant long-term impact, reducing the need for disaster response. These education and community development-oriented programs are cost-effective when compared with reliance on disaster response strategies and need to be looked at much more closely by the government and donor organisations when considering approaches to disaster response and food and nutrition issues in PNG.

NGOs are beginning to better prepare for disaster reponses. The PNGRC and ADRA are developing national disaster response and mitigation plans for their respective organisations as a result of experience gained from the drought. After the drought, the Lutheran church hosted a workshop on lessons learned and disaster preparedness; the Baptist church and University of Technology were also involved. As disaster response plans are prepared, there is a growing awareness of how disaster mitigation can be tied in with regular development programs.

The collective HO response to the 1997 PNG drought was a very positive experience for NGO involvement in disaster response. Lessons learned from this experience can be applied to future disaster situations—but more importantly, they can form the basis of a more sustained, development-oriented approach to disaster mitigation in PNG. NGO, donor and government organisations involved in development assistance and disaster response need to look at ways to reduce the impact of disasters in communities, rather than simply responding to a disaster as it occurs, if they have a genuine interest in the welfare of the PNG community.

Table 5. Factors affecting the severity of drought.

Direct	Indirect
Lack of water supply for irrigation	Law and order problems—making distribution very difficult where it was needed
Lack of diversification of agriculture	Loss of many traditional food sources, dependency on store goods (affects existing nutritional levels and hence vulnerability to disaster; affects savings levels)
Lack of knowledge of how to use water in agriculture	Lack of access to infrastructure/banking services
Lack of savings	Lack of education on disaster mitigation and need for savings
Loss of knowledge of alternative food sources	Lack of government services in agricultural extension and health and nutrition education
Lack of access to land	
Lack of effective government systems for distribution	

The Role of Rice in the 1997 PNG Drought

Neville Whitecross[*] and Philip Franklin[†]

Abstract

Trukai Industries was the major supplier of emergency rice during food shortages associated with the drought and frosts in 1997. The drought forced big changes on household economies because garden crops failed and sweet potato, a major staple carbohydrate of the PNG diet, was not available. Rice, which normally only provides a portion of the total diet, was one of the only available food sources and people used their cash reserves to supplement food supplies with rice. The increase in the demand for rice posed a major challenge to the supply chain. This was met by sourcing increased supplies from overseas, continuous 24-hour operations at rice mills, extra shipments and increased warehouse and haulage operations.

As the drought took hold, consultation and coordination occurred between Trukai Industries, the PNG National Disaster and Emergency Services, the Australian Defence Force and other private sector interests, but these services were slower to reach villagers because of the government decision-making processes involved. When their cash reserves were low, people raised money to buy food through activities such as the sale of soft drink bottles but there was also an increase in criminal activity. As aid rice began to reach the people, commercial sales fell. Overall, the commercially operated distribution system was able to react faster to the emergency than other government and overseas aid-assisted relief efforts. However, this was made possible because people had some cash reserves. This emphasises the importance to food security of encouraging people to save some money.

RICE played a very significant role during the drought that devastated PNG in 1997. It is not an exaggeration to say that thousands of PNG families survived because rice was available when almost all other food sources failed or had been consumed. Rice was vitally important then, and is likely to be so again for three compelling reasons: it is a long-lasting, nonperishable, easily transported food that people like to eat; there is an efficient, established, commercially maintained and operated supply network in PNG, available full-time through 12 distribution centres; and private enterprise is equipped and attuned to respond to market demand for increased supply and will take decisions when bureaucracy is unable or unwilling to react with necessary speed.

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Trukai Rice Industries' Response to Increased Demand

It was not weather reports that first alerted Trukai Industries to the onset of the drought, but reports from our sales representatives of increased rice sales. Travelling through the country, they began to report stories from their customers of failing food supplies. The cause was not only drought, but in some areas frost as well. Nationwide sales of rice began to exceed those of previous years in July 1997 (Fig. 1) and wholesalers started to exceed credit limits to meet extra demand.

Trukai Industries' logistics and stock management systems responded in a programmed way to the

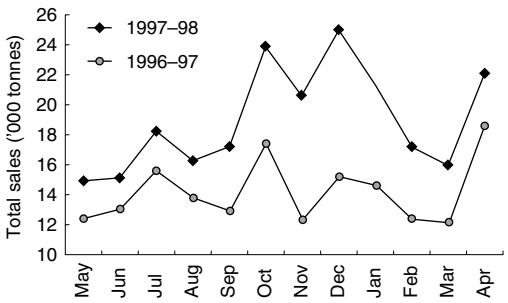

Figure 1. National rice sales, PNG, 1996–98 (Trukai Industries Ltd).

increasing demand. The 1997 budget for all Trukai rice sales in all of PNG was 170,000 tonnes. The forecast sales and therefore the stock orders necessary to meet those sales, rose quickly to 228,000 tonnes. Including 8000 tonnes of aid rice from Japan, the total demand actually reached 236,000 tonnes.

This posed a major challenge to Trukai's supply chain. Could an additional 58,000 tonnes of rice be sourced, paid for, uplifted and landed in PNG in time to meet a food crisis? The urgent situation also called upon Trukai, as a commercial operator, to respond rapidly to the demands of its customers.

Rice Stock Movements and Increased Freight Requirements

How big a challenge was it to find and distribute an additional 58,000 tonnes of rice in a hurry? For a start, the rice had to be sourced. In Australia, the Ricegrowers Co-operative Limited responded to the call by dramatically increasing the allocation of supplies to PNG, including the diversion of 4300 tonnes of rice intended for other countries.

Six rice mills operated seven days a week, three shifts a day—that is, continuous 24-hour production, with no rest days—until the additional 58,000 tonnes of rice had been supplied, on top of the normal budgeted demand.

The rice had to be shipped, and in a hurry. The extra 58,000 tonnes meant nine extra ships, provided by the shipping contractor Central Container Services.

Trukai Industries' rice mill at Lae also worked three shifts, 24 hours a day, seven days a week. Extra staff were employed in the warehouse operation and Pagini Transport, the road haulage contractor, also had to employ an extra 20 staff, right through the period from August 1997 to February 1998, to handle the extra cargo. Pagini had the responsibility of carrying an extra 24,000 tonnes of rice to the highlands, which meant 960 extra truck loads.

So it was a large logistics exercise, requiring the cooperation of many parties. This was a private sector response to market demand. All this extra purchasing and transportation was market-driven and funded.

Coordination with Emergency Services and Subsequent Government Action

The very nature of government emergency resources, which are only used intermittently, meant that there was a very significant difference between the government's ability to respond and the response of the commercial organisations.

Trukai Industries, as the major food supplier, obviously sought consultation with government agencies. As the drought took hold, in August 1997, and increased reports of hardship were coming in, Trukai asked if drought relief supplies were going to be required by the National Disaster and Emergency Service (NDES).

A preliminary assessment of the extent of the need had been carried out by Dr Mike Bourke and Dr Bryant Allen who were engaged by the Australian Agency for International Development (AusAID). Meetings began with them in September 1997.

From rough estimates made at that time, it was calculated that extra rice would be needed for the NDES in November and December and Trukai sent urgent orders to Australia for another 5000 tonnes. This was done 'on spec'; there was no government order placed with Trukai Industries at this time.

Assessment results were made available, unofficially, in October 1997 and in the same month NDES sought quotations for supply. Payment became an issue, with all tenderers calling for payment in advance because of the previous poor payment record of government. Even with advance notice for payment and the urgency of providing relief supplies to starving people, the PNG Finance Department took five weeks to action payment.

In the meantime, people were starving. AusAID personnel volunteered to take control of supply to remote areas highlighted as being critical in the Bourke–Allen report. AusAID personnel negotiated their own supply

contracts and commenced relief distribution on 2 October 1997. NDES drought relief supplies were mobilised two months later, on 5 December 1997.

Without intending to speak too critically of government agencies, this highlights the fact that a well-managed, already active, commercially operated distribution system can react much faster in an emergency. Aid rice was vitally important because, even with sufficient quantities of commercial rice available, not all the people had money to buy it.

There are lessons to be learned, and improvements that could be made, with regard to communication between the disaster headquarters, local disaster committees, Trukai headquarters and regional warehouses. There was some confusion and some duplication. For example, the Trukai Industries' assessment list was different to the ones given to local committees.

Further Increases in Demand

Even with Trukai's resources mobilised, the private sector buying and distributing large extra quantities of rice, AusAID picking up the worst cases at the end of remote supply lines and NDES getting into action, the crisis continued. If anything, it got worse, requiring ships to be diverted with bulk loads of rice to keep the worst-affected areas resupplied.

Such was the demand from PNG consumers, that the level of rice stock in Trukai Industries PNG warehouses was severely depleted before new shiploads arrived. As shown in Table 1, it was not the demand for aid rice from AusAID and NDES that was the greatest challenge (AusAID actually took just 2677 tonnes, and NDES 5484 tonnes), but keeping up with consumer demand.

Keeping Prices Down

At a time when Trukai was making huge efforts to procure and distribute more rice, every tonne sold was costing the company more.

PNG, and Trukai Industries, were on the horns of a nasty dilemma. As the hardships caused by the drought continued to mount, the value of the PNG kina (PGK) continued to slide (Fig. 2). Rice is purchased on the open international market in US dollars. The PNG kina was buying only US$0.62 at that time and, as a consequence, at the height of the drought in December 1997, Trukai Industries was losing 98 PGK per tonne of rice sold.

The Trukai Industries Board decided to support their customers, the rice consumers of PNG, at a time of great national need, and continued to sell at pre-drought, predevaluation prices. During this period, Trukai Industries lost 9 million PGK on sales, which translated as a year-end loss to its shareholders.

Response by Rural Communities to the Drought

The drought forced some very big changes on household economies. Research indicates that 85% of all consumers in PNG supplement their food budgets with garden produce. In some places, garden crops failed altogether and people resorted to forest foods and

Table 1. Extra volumes of rice 1997–98.

Agency	Rice distributed (tonnes)
Trukai Industries:	
– forecast sales	170,000
– actual sales	227,917
– additional sales	57,917
Japanese government aid	8,000
Total rice consumption	235,917
Additional over forecast	65,917
Distribution of additional rice:	
– commercial	49,759
– Australian government aid (AusAID)	2,674
– National disaster relief (NDES)	13,484
– total	65,917

Source: Trukai Industries Ltd

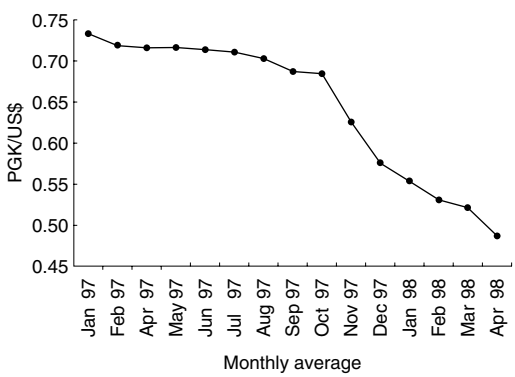

Figure 2. Exchange rate of the PNG kina (PGK), January 1997 to April 1998 (Department of Treasury).

killed their livestock to survive. Large-scale human-ignited bush fires (which traditionally are thought to cause rains) exacerbated the situation and thousands of hectares of forest were burnt out.

With traditional food sources failing, people had no alternative but to purchase all their food requirements. Sweet potato, which is the basic carbohydrate in the PNG diet, was not available, and households purchased more rice than normal to fill the gap in the family diet.

Sales of tinned fish, corned beef and chicken declined dramatically as families with limited resources struggled to fill bellies. Rice normally provides a portion of total nutrition in PNG. In the drought it was, at times, the only food keeping people alive.

Breaking Open the Money Jar

Cash to supplement family expenditure on food had to come from somewhere, and people sold their stores of returnable soft drink bottles and soft drink companies hired space to warehouse the extra bottles.

Local leaders with financial reserves bought large quantities of rice through the commercial system to supply their people.

Other people resorted to 'help-yourself' tactics. With large volumes of food moving along highways, two complete truckloads of stock en route from Lae to Mt Hagen were hijacked and looted, and there were reports of other losses by hold-ups from NDES disbursements in the regions.

In some provinces there was disorder in the distribution of rice. Local disaster committees in some cases were surprised by the large quantities of rice that arrived, and consequently had storage and security problems. Other committees coped well.

As aid rice began to reach the people in need, commercial sales dropped. In fact sales of commercial rice declined by the exact amount of aid rice purchased by NDES. Japanese aid rice arrived in December and was distributed in January, which was well after the worst point of the crisis.

Trends in Rice Consumption

The Trukai Industries Board had made the decision to absorb cost increases incurred during the drought so as not to add further to the hardship of rural people. But economic reality falls upon companies too, not just on hungry families. Trukai was losing money, and sharing the hardship, in a big way.

From May to November 1997, the basic cost of rice rose by 20%. Trukai Industries absorbed those costs during the drought, but as the drought eased and people had other food choices, economic reality forced Trukai to advise the Price Controller of the need to increase the price of rice by 5% per month for four months from December 1997 (Fig. 3).

Sales of rice declined sharply from February 1998 as the higher-priced product reached the shelves.

When the drought broke, Trukai sales representatives reported extensive planting of gardens in the highlands and increasing availability of local produce from markets. This trend continued through 1998 and early 1999. In fact, there have been gluts of sweet potato and other garden crops at times in the highlands markets but, because these are temporary and perishable, they do not constitute a sufficient food reserve to guarantee national food security. Obviously, drought impacts immediately on such garden crops, as do frost, fighting and other disruptions.

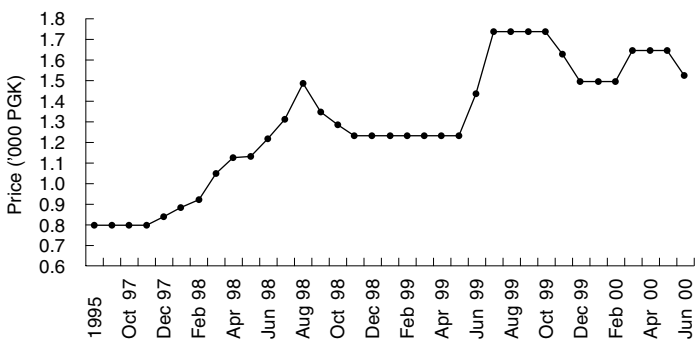

Figure 3. Rice distribution price, PNG 1995–2000 (Trukai Industries Ltd).

For 20 years, from 1972 to 1992, Trukai rice was the best value-for-money carbohydrate food available in PNG. Per capita consumption grew at slightly more than the official population growth rate (Fig. 4). Rice is a very popular food. People buy rice in stable economic times by choice and not necessity.

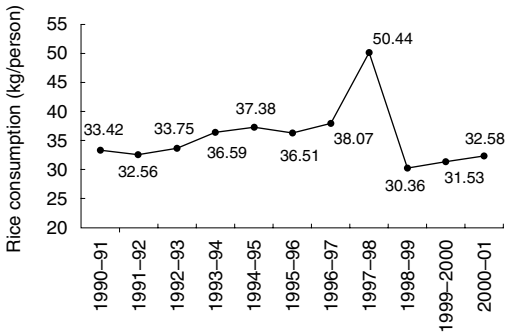

Figure 4. Rice consumption (kg/person), PNG 1990–2000 (Trukai Industries Ltd).

Lessons from the 1997 Drought

Distribution of rice during the drought taught us that the commercial food distribution network is the best equipped to cope with food emergencies. It is responsive, efficient, accountable and always ready to roll.

Government decisions can often be slow due to bureaucratic red tape. Quicker decision-making processes are needed and thus government agencies should be encouraged to use commercial linkages because they are efficient and accountable.

The experience also confirmed that, in guaranteeing food security in PNG, a reliable source from a close neighbour is very valuable.

However, there is an important factor in the 1997 picture that may not be in place in any future food shortage. Papua New Guineans, through prosperous years in the early 1990s, had built up cash reserves. This enabled them to supplement their supplies through the drought. They should be congratulated for this and encouraged to always have some cash in reserve.

In conclusion, consider one image that often haunts the world. How many nights on television do we see piles of food aid dumped on the wharves in miserably drought-affected countries like Ethiopia and Sudan, with no hope of moving it to where it is needed, while thousands of people starve painfully to death? Those countries do not have a commercial food distribution system like the one we have in PNG. PNG is lucky to have such a safety net, made up of ships, warehouses, trucks, bank accounts and people. Trukai Industries is glad to see itself as a major contributor to this national food security safety net.

Responses to the 1997–98 Drought in PNG

Peter Barter*[1]

Abstract

This paper is my personal reflection upon the responses to the 1997–98 drought in PNG. I had various political roles during this time, which have given me a unique overview of the situation in PNG. Initially, as chair of the National Drought Relief Committee, I was party to the first foreign drought relief efforts, and I saw how these overshadowed the PNG responses to the drought, which were further hampered by ineffective governmental administrative processes. In fact, as a result of diplomatic differences and an inability to compromise, the PNG government actually missed out on foreign financial aid that was given instead to various nongovernment organisations. Later, in other positions, I found it frustrating to witness a politically-motivated distribution of donated food in Madang Province that failed to reach those most in need, and also to observe at first hand the effects of administrative disorganisation in the utilisation of resources and supplies. Australia took a leading role in the response to the PNG drought but, whilst we were grateful for their efforts, I feel that if they had not been so forceful, and if we in PNG had been more organised and resourceful, then we ourselves could have prevented the drought from becoming an international crisis. I now feel that we have a lot to learn from our experiences from the drought of 1997–98, and that we should be able to use these lessons to prevent similar crises in the future. Of particular importance is aiming to achieve food security as a nation, with an emphasis on improved, sustainable agronomic practices. Perhaps most importantly, it is essential that we draw up and implement plans to provide a supply of potable water to every community in PNG.

THIS paper is my personal account of the responses to the drought of 1997–98 in PNG, in which I was involved in many different roles. Initially, in October 1997, I accepted an invitation from Bill Skate, then PNG Prime Minister, to chair the National Drought Relief Committee. As I did not keep a written record of events at the time, this account is simply from memory and represents my personal point of view.

My primary question is: whose drought was it? If it had not been for the Australian Government, perhaps we would never have known that we had a drought. Whilst some PNG Government reports indicated that food shortages were occurring, it was Australian 'experts' who told us of the impending magnitude of the drought.

I initially believed that the media exaggerated the drought situation, publishing reports and statements made by politicians hoping for personal advantage. At the time, I was concerned that this exaggeration might lead the public to overreact to the crisis. Without rain, many of the essential root crops would fail and, in areas where there were few alternatives, people would go hungry. In a Western country, this would be a relatively straightforward problem, but PNG is not a Western country. Despite the warnings, the PNG National Disaster Office was not prepared for such widespread drought, and there were consequently major problems with funding and the logistics of food distribution.

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1. The author was a Member of Parliament for the Seat of Madang Regional from 1992 to 1997, and was the Minister for Health for part of this period.

Initial Responses to the Drought

The role of Australia

Whilst we did appreciate the assistance from Australia during the drought in PNG, I have always felt that PNG should have taken the lead in drought relief measures, and that we were overshadowed by Australia, which prevented us from doing so.

In early meetings between relevant organisations, a decision was made to ask two experts on PNG agriculture and food supply systems, from The Australian National University, to quickly put together teams to travel throughout PNG to evaluate the drought. This project was funded by the Australian Agency for International Development (AusAID).

Australia also more or less completely bypassed both the PNG National Disaster Office and the PNG Defence Force, because the PNG Government could not fund a response to the developing drought and because the National Disaster Office was unprepared for the situation. Despite this, Australia took the initiative, with the Australian Defence Force and their aircraft distributing food to the worst-affected, most remote regions of PNG.

The role of the PNG Defence Force

Due to the involvement of the Australian Defence Force, the PNG Defence Force was marginalised—at a time when their involvement would have improved both their image and their morale. The tremendous human resource of the PNG Defence Force continues to be ignored in times of crisis. If it were necessary to have additional logistic support from elsewhere, these requests should have been made by PNG through the appropriate diplomatic channels, and should not have been initiated from outside PNG.

The involvement of the PNG Defence Force was limited to providing some physical facilities and resources, and they had almost no part in the planning and implementation of the drought assessments or the delivery of relief supplies. It must be acknowledged that not one PNG Defence Force aircraft was serviceable—but, had some of the available funds been used to repair these aircraft, many of the supplies could have been carried on PNG aircraft.

Funding

Funding was the greatest concern during the drought. As the results of field assessments began to reach the Australian team leaders at the Department of Provincial and Local Government Affairs in Port Moresby, it became obvious that the drought was more serious and widespread than we had thought at first. It was soon apparent that we would need more money than that allocated by the PNG Government.

At meetings in the Central Government Complex, heated exchanges took place between public servants and diplomats. Foreign governments and international aid organisations refused to release their monetary aid to a general revenue account. They required that a transparent trust account be established for this purpose, so that they could be certain that the money would be used for the intended purpose of drought relief, and not to pay for other things such as governmental administrative costs. Despite this, the government did not set up a trust fund with transparent conditions of audit and accountability. Instead, the Department of Finance representatives attempted to insist that all donations be banked into a government-controlled account.

Eventually, a government trust account was established, but the delay in its establishment resulted in major donors redirecting their funds to the Red Cross, Caritas, Oxfam and other nongovernment organisations (NGOs). The signatories of the government trust account included the Secretary to the Department of Provincial and Local Government Affairs, the Director-General of the National Disaster and Emergency Services and me.

The only funds deposited by the PNG Government into this account were from the Gaming Board, who were directed to deposit 2 million PNG kina (PGK)[2] into this trust account. Various other statutory bodies also contributed funds to this account, including Telikom, the PNG Harbours Board and the PNG Banking Corporation. The only cheque withdrawal from this trust account that I countersigned was to fund aid for an unrelated measles outbreak in the Jimi Valley.

Because I was seriously concerned about the lack of a financial response to the drought in PNG, I travelled to Australia at my own expense to meet various organisations willing to help PNG; this visit raised around 8 million PGK.

Distribution of Aid

On my return from Australia, I found that I had been replaced as Chairman of the National Drought Relief Committee by the Hon. Peti Lafanama, Governor of

2. In 1997, 1 PGK = approx. US$0.70 (A$0.94).

Eastern Highlands Province. I then read in a newspaper that the Prime Minister had appointed me Liaison and Implementation Officer. I was unable to ascertain what duties this position entailed, and in the end I worked to provide any assistance that I could. I also continued to monitor the trust account, watching with great interest the withdrawal of funds, and I wrote letters on behalf of the government thanking donors.

During this time, I took part in field assessments and I was involved in the distribution of food to remote regions. In contrast, in Madang Province, where I live, not one member of the Provincial Disaster Office took part in the assessments within the province, although they had been invited to do so.

Inequity in local distributions of food

When food aid finally arrived in Madang Province for distribution, it was not released to the worst-affected areas. Instead, a political decision was made to fill every available truck and take the food anywhere, provoking a chaotic free-for-all situation. The efforts of the national assessment teams in Madang Province were ignored by the local authorities, who wanted to ensure their own areas would not miss out on the free food. I found this particularly frustrating because, in order to ensure that some of the donated food reached Madang Province, I had made a special request to declare some areas in the province as seriously-affected regions. This request was not based on formal assessments but was largely based on my local knowledge.

I was becoming very concerned that, if the drought was as bad as the assessment teams were predicting, we should ensure what little funds we had available should be used frugally to their best advantage. We should have been avoiding, at all costs, free handouts of food to people who did not really need them. The best use of the funds would have restricted the relief food to rice, flour and oil delivered to only the worst-affected areas identified by the assessment teams. Whilst we were doing this, other donor agencies, NGOs and the Madang Provincial Government were purchasing eggs, powdered milk and other Western foods that were well above the requirements established by the Drought Relief Committee.

Import duty on donated supplies

Another of my roles was in assisting NGOs to get import duty exemptions for supplies. Although such exemptions were approved by the PNG Government, delays in obtaining relief supplies were caused by difficulty in actually getting many of the donated items through Customs, where officials insisted duty was to be paid.

Medical supplies

I was also involved with having the Department of Finance release money to purchase drugs that were said to be urgently required in many locations throughout PNG. This was not just because there was a drought, but because, even before the drought, there had been an acute shortage of medical supplies and drugs throughout the country.

One of the frustrations I suffered was the number of requests for assistance being made to me personally, day and night. Yet when I myself wanted to contact officials in the provinces it proved virtually impossible to do so. The communications equipment was in place but the human element failed; human greed had a lot to do with this situation.

Australian Isolation from the PNG National Drought Relief Committee

It was around this time that AusAID and the Australian Defence Force began to operate in almost total isolation from the Drought Relief Committee and the PNG Government. I do not blame them for this course of action: they had virtually no choice. Initially, we asked the Australians to provide aircraft to deliver the drought relief supplies that PNG would purchase. They responded quickly, but PNG failed to have the supplies ready because the funds had not been released. The Australians released money through AusAID, purchased the food required and carried it in their aircraft. This pattern continued throughout the entire period of the drought.

Further organisational problems

In November 1997, I travelled throughout the Milne Bay islands providing transport to isolated islands for the Australian assessment team. Before departure, I requested that relief supplies be released to load on the *Melanesian Discoverer*. In the end, I purchased the supplies myself because we could not delay the departure of the vessel. A lack of coordination by the National Drought Relief Committee and the provincial authorities, who knew what I had done, meant that a New Zealand naval vessel undertook a

special trip to the areas we had visited with supplies, delivering food; this was both costly and unnecessary. This is just one example of similar matters that made the work very frustrating.

Adverse Agricultural Practices

On another field trip I travelled into the highlands with a World Bank assessment team interested in providing cash to rural communities through funding employment on public works. I travelled by car from Madang to Kundiawa via Bundi and Keglsugl. What I saw shocked me. The entire western slopes of most mountains were quite bare. This was not just because of the drought, but because of deliberately-lit fires that not only destroyed food gardens, but also destroyed coffee gardens and houses. Thus, the destruction of gardens and houses in the area between Kundiawa and Gumine was the result of an artificial disaster, and not solely a consequence of the drought.

Ironically, despite the drought, there was plenty of water in rivers and creeks. I saw few creeks or rivers that had completely dried up as one would imagine in the midst of a severe drought. It appeared to me that people were not aware that gardens could be watered by hand and that simple irrigation or water pumps could have averted the destruction of many gardens.

After my Milne Bay and highlands experiences, I became very concerned that we would use up all of the money we had raised on merely providing food, in the end finishing up with nothing. I was very keen to see at least half of the money used to fund water supply projects throughout all the areas affected by the drought. Despite the acceptance of this idea in principle, I doubt if very much of the money was ever used to develop good rural water supply projects that could sustain gardens and local drinking and washing supplies at times of low rainfall.

Like many people, I was also concerned that PNG did not appear to have any grain crops, or other crops that would enable us to store food. It is obvious that PNG is a country of abundance, and that severe shortages of food are so rare that it is not necessary to introduce crops especially to prepare for serious droughts. I am not an agronomist, nor do I profess to be an expert in nutrition, but I am a practical person and I have eyes. Even through I saw some very hungry people during my touring around PNG, I never saw people starving to death.

Consequences of the Response to the Drought

I sometimes wonder what the end result would have been had we not been alarmed by the Australians into taking action. To put anything as serious as this to the test would clearly have been folly, but PNG has had serious droughts in previous years and most people have survived them.

Today, with improved global media coverage, everyone knows everything—often before those who are affected. In the case of the drought in PNG, this was true but welcome. Most people who were short of food received some help. Others who needed help went hungry but did not starve, and there were also those who capitalised on the situation and became wealthy. I frequently heard of trade store proprietors getting hold of relief food and selling it over the counter. At other times I received complaints from trade store owners that their business was collapsing because people were getting free rice and not purchasing their rice from the store. As recently as early 2000, I saw relief supplies left over from the drought being distributed at will to anyone who wanted them.

The Future of Water in PNG

Throughout the entire period of the drought, I constantly talked about the need to make PNG a drought-proof country. We have the water; what we need is a national objective to overcome many of the self-made obstacles that restrict the provision of safe drinking water to as many people as possible. What we need are water systems that will work all year, even when it does not rain, in the form of inexpensive gravity-fed systems that do not rely on solar pumps or other mechanical means to pump water. However, amongst the projects that are being considered for this purpose are hi-tech osmosis systems that will not be maintained and will not be economic: most of these systems use as much fuel as the water that they could produce.

I have been encouraged by reading about the Ok Tedi Mining Ltd program to improve food security. Obviously, such an ambitious and worthwhile project will need to address ways in which we can use our natural resources better than we have in the past. It will need to educate people that, when it stops raining, our food still needs water and that in many cases during the drought water could have been provided if there had been a greater awareness. I believe that this conference is able to make a valuable contribution towards alleviating the impact of droughts in PNG by considering

ways in which we could nationally improve the access to potable water by people in rural areas. Water should not be for the privileged few in urban areas; it should be a universal right.

Unfortunately, the decision to privatise the PNG Waterboard and to establish Edu Ranu has reduced the chances that the PNG Waterboard could use its profits to fund rural water schemes. It should be possible to offset the cost of smaller water projects in both urban and rural areas with the profits earned from larger, more economically viable, schemes. I was very sorry when the European Union cancelled its aid-funded rural micro water projects, which were examples of the most worthwhile, forward-thinking projects ever funded by an overseas donor in PNG.

Postdrought Agricultural Rehabilitation: the 1997–98 El Niño Drought in PNG

Matthew'Wela B. Kanua* **and Sergie Bang†**

Abstract

Compared to previous recorded droughts in PNG, the resources used to mitigate the effects of the 1997 drought and associated frosts were unprecedented. However, these are only scientific observations on the postdrought management of agriculture by smallholders. This paper discusses the scientific basis of postdrought agricultural rehabilitation, based on limited survey data and the experiences of the authors.

A study in February 1998 of the yields of postdrought crops of sweet potato in Simbu Province and a follow-up study in Eastern Highlands Province in March 1998 revealed that, in both these provinces, sweet potato yields in the first postdrought harvests were reduced by 70% and 30% respectively. The yield reduction was reported to be associated with lack of tuber formation. The Fresh Produce Development Company (FPDC) investigated the concern between May and July 1998 and concluded that the sweet potato tuberisation problem in the first postdrought plantings was short lived, and did not occur in subsequent plantings. However, the FPDC did not investigate associated effects of the shortfall in supply of the staple. The problem of lack of tuber formation in sweet potato not only prolonged the food shortage unnecessarily by a further six months, from about December 1997 to May/June 1998, but also meant that farmers wasted labour and other limited resources in preparing and planting large areas of crop land to sweet potato crops that subsequently failed.

COMPARED to the 1941, 1956, 1972 and 1982 droughts in PNG, the amount of resources used to mitigate the effects of the 1997 drought was unprecedented. Whilst it is not within the scope of this paper to give a comprehensive account of the 1997 drought, it is important to review the salient features of the event, particularly the management of agriculture just before the onset of the rains in late 1997.

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The 1997 Drought Assessment Reports

The first two nationwide assessments conducted by Australian and PNG scientists (Allen and Bourke 1997a; 1997b) reported that by December 1997 about 1.2 million people in rural areas of PNG, some 40% of an estimated 3.15 million, were suffering a severe and to some extent life-threatening food shortage (see The 1997 Drought and Frost in PNG: Overview and Policy Implications by Bryant J. Allen and R. Michael Bourke, in these proceedings). The December 1997 report showed all provinces were affected to some degree. Simbu Province (54,720 people affected) and Eastern Highlands Province (30,300 affected), were among the most severely affected by shortages of food. Also severely affected were Southern Highlands

Province (28,300 affected) and Western Highlands Province (28,390 affected).

The nationwide drought impact assessment surveys sponsored by the Australian Agency for International Development (AusAID) reported that by far the greatest impact of the drought was on rural life, particularly on food, water, forests and other life-supporting systems. The combined effect of drought, and frost in the very high altitude areas, together with extensive burning, destroyed food plants, depleted food reserves and reduced reserves of planting materials.

In February 1998, The Salvation Army of PNG funded surveys to assess the postdrought shortage of planting materials in two highlands provinces, Simbu Province (Kanua and Muntwiler 1998) and Eastern Highlands Province (Muntwiler and Kanua 1998). An important finding was the widespread problem of lack of tuberisation on sweet potato. The Simbu Province survey reported, among other things, that:

- garden preparation and planting started when rains were received around November and December 1997; more than 50% of the gardens surveyed were between 0.2 hectares (ha) and 0.6 ha; 90% of the gardens were planted in sweet potato only; and
- of the sweet potato gardens surveyed between October and December 1997, 70% did not produce tuberous roots; of the tubers produced, 79% were either fibrous or had other defects.

The survey in the Eastern Highlands Province, reported that, among others things:

- only one-quarter of gardens surveyed in four districts were planted in sweet potato only. Compared to Simbu Province, Eastern Highlands Province farmers had a wider range of crops in their gardens, and depended less on sweet potato; and
- the data collected showed that 33% of the sweet potato mounds examined did not have tubers, 36% had one or two harvestable tubers per mound, and 31% had three or more harvestable tubers—overall, an average of 29% of mounds contained potentially harvestable tubers.

The most important findings of the Simbu and Eastern Highlands provincial surveys were that, between October, November and December 1997, 70% of the sweet potato planted in Simbu Province and 30% of that planted in Eastern Highlands Province, did not produce tuberous roots. That means that the supply of sweet potato to families in Eastern Highlands Province would have been barely adequate throughout 1998, whilst in Simbu Province, food supplies would have been severely limited during the first part of 1998. The findings prompted CARE Australia to fund the Fresh Produce Development Company (FPDC) to conduct a nationwide study of the sweet potato tuberisation problem (Bang et al. 1998).

Within the confines of the available evidence, this paper attempts to provide a scientific explanation for the lack of sweet potato tuberisation. Because no systematic postdrought follow-up research was undertaken, the available evidence is based on field observations made in late 1997 and early 1998, and the literature on sweet potato physiology.

The Fresh Produce Development Company Study

In May 1998, the FPDC commissioned a study into the yields in postdrought sweet potato, in particular the reported problem of sweet potato tuberisation in Simbu Province and Eastern Highlands Province. A report was completed in July 1998 (Bang et al. 1998).

This study used three sources of data:

- yield data from village gardens at three altitude classes—low (0–500 metres above sea level), mid (1600–1800 metres above sea level) and high (1900–2780 metres above sea level);
- the quantity and prices of sweet potato sold in a number of highlands markets; and
- soil analytical data from gardens in Gumine, Simbu Province.

Sweet potato yields

Average yields were 10 tonnes per hectare (t/ha) in Simbu Province and 42 t/ha in Eastern Highlands Province by June 1998. For all gardens sampled, the lowest yield was 5 t/ha and the highest yield was 50 t/ha. When yield was stratified by altitude, the average yield recorded was 9.7 t/ha at low altitude, 26 t/ha at midaltitutde, and 13.3 t/ha at high altitude. These yields are within the range of PNG smallholder yields (2–50 t/ha) reported by Bourke (1985).

The survey results suggested that by June 1998, whilst the level of sweet potato supply was satisfactory in the midaltitutde areas, at high altitudes it had not reached a satisfactory level. This outcome was probably more due to the effects of altitude on sweet potato yield, than any other cause. It was possible that soil compaction impeded tuber enlargement but it is not possible to demonstrate this with the data available.

Market data

Limited data on sweet potato market prices were collected at a roadside market at Dom, in Gumine District from May to June 1998. These data have been supplemented with data from the Goroka market.

At Dom, sweet potato supply increased over the period of the survey but had almost certainly not reached predrought levels by mid-1998. The predrought price of sweet potato at Dom was around 0.15 PNG kina per kilogram (PGK/kg)[1] but in May 1998 it was still 0.35 PGK/kg. In contrast at Goroka market, the lowest price for sweet potato in January 1998 was 0.71 PGK/kg, in April it was 0.32 PGK/kg and by June 1998 it had fallen to 0.22 PGK/kg (FPDC 1998abc). The steady fall in price at Goroka from December 1997 to June 1998 indicates a correspondingly steady increase in supply to near predrought levels by June 1998.

The yield data and the market price trends suggest that the recovery in sweet potato supply was slower in Simbu Province than in Eastern Highlands Province. Gumine and Goroka are within the same altitude class. The slow recovery at higher altitudes is to be expected. This suggests that the retarded recovery in Simbu Province was the result of the lack of tuberisation, as discussed above. This leads us to ask what actually happened in Simbu Province, that did not happen elsewhere? To explain this, we will examine the analytical data from Gumine garden soils. Similar information is not available from Eastern Highlands Province gardens. Nevertheless, we believe the Simbu Province data provide a reasonable explanation of what happened in Simbu Province, and what is likely to happen again, under similar climatic conditions.

Soil analytical data

The Gumine soil samples came from three adjacent sweet potato gardens at Omkolai village (1750 metres above sea level) collected in February 1998 by Kanua and Muntwiler and in July 1998 by Bang et al. A sample from a nondrought year for comparison was collected from a garden at nearby Boromil village (1850 metres above sea level) by Kanua in 1987 (Table 1).

Of all the major nutrients, sweet potato is most tolerant of low soil phosphorus (P) levels (de Geus 1967). Goodbody and Humphreys (1986) obtained highly significant positive linear correlations for first harvest yields on available P in soils in Simbu Province. Those soils contained 0.6–5 mg/kg available P (Olsen's method). The available P level of the Omkalai soil in July 1998 was about half-way in that range, but the ability of sweet potato to take up P can be limited by the high soil pH. It is noteworthy that the Olsen P value of the Boromil soil in a nondrought year is less than half the value from Omkalai in February 1998. Research on similar soils elsewhere in the highlands of PNG shows that the efficiency of a crop of sweet potato in obtaining soil P is positively influenced by local mycorrhiza (Floyd et al. 1988) and is modified by intervarietal differences (Kanua 1998). However, it is unlikely that the level of P observed at Omkalai in 1998 would have adversely affected sweet potato production.

It is more likely that sweet potato production at Omkalai in 1998, and the lack of tuberisation observed there was influenced by soil moisture and the availability of nitrogen and potassium.

A clear negative relationship exists between sweet potato yield and rainfall during the cropping period (Gollifer 1980; Kanua 1995; King 1985). Bourke (1988) has shown that the phenomenon of reduced tuber formation or the complete lack of tuberisation in sweet potato can be caused by high soil moisture at the time of planting, and/or high soil moisture during the critical tuber initiation around eight weeks from planting. Given that the first postdrought crop in Simbu Province was planted with the first significant rainfall for almost six months, high soil moisture would not seem to have been a major cause of the lack of tuberisation and the low yields observed.

Nitrogen influences tuber development, in particular the growth or enlargement of tubers. The exceptionally thin, elongated tubers observed in Simbu Province in February 1998, could have been caused by excess nitrogen, which would have promoted lignification of the roots, rather than bulking of tubers.

Potassium, on the other hand, influences yields in two ways. First, potassium determines the number of tubers that a sweet potato plant produces. The number of tubers is decided during the tuber initiation period that occurs about eight weeks after planting (Bourke 1988). Second, potassium accelerates photosynthesis in the leaves and facilitates the translocation of the products of photosynthesis to the developing tubers (Fujise and Tsuno 1967). Magnesium is required in small amounts by the sweet potato plant, but excessive available magnesium can negate the effects of potassium.

1. In 1998, 1 PGK = approx. US$0.49 (A$0.77).

The experimental evidence suggests that an absolute value for a physiological optimum nitrogen:potassium ratio cannot be given, because the levels of nitrogen and potassium are determined by the individual levels of nitrogen and potassium, leaching (Bourke 1985), and the intensity of land use (Godfrey-Sam-Aggrey 1976). At Omkalai in July 1998, nitrogen and potassium levels were both high, but magnesium was low. This probably would have offset the nitrogen:potassium balance in favour of potassium. The nitrogen:potassium ratio in July (1:0.125) was marginally (20%) lower, in favour of potassium, than in February (1:0.098). Together with the low magnesium levels, and the high carbon:nitrogen ratio, the conditions would have been ideal for tuber initiation and development in July 1998, compared to the less favourable soil conditions in February.

Magnesium levels at Omkalai were almost twice as high in February 1998 than they were in July, in two out of three gardens. The corresponding potassium levels were lower in early 1998. In contrast, in July 1998, the potassium levels were high and the magnesium levels low. Thus, in February the magnesium:potassium balance is in favour of magnesium, which would have resulted in magnesium competing vigorously against potassium at cation exchange sites. A high proportion of potassium would have been displaced and then leached from the soil, despite the high cation-exchange capacity. Furthermore, a relatively lower nitrogen:potassium ratio in July than in February would have increased potassium availability in July, which would have promoted sweet potato growth. At Boromil in 1987, high magnesium was responsible for a potassium deficiency, and the direct application of potassium led to significant sweet potato yield increases. Elsewhere in the highlands, potassium deficiencies have been shown to be responsible for significantly reduced growth and lower yields of sweet potato (D'Souza and Bourke 1986; Goodbody and Humphreys 1986). The other demonstrated requirement of sweet potato in highlands PNG is the micro-nutrient boron (Bourke 1983; O'Sullivan et al. 1997), but there is no information on boron from Omkalai in 1998.

Table 1. Soil analyses from Omkalai and Boromil Villages, Gumine District, Simbu Province, 1987.

Parameter	Unit	Critical value	Boromil 1987		Omkalai February 1998		Omkalai July 1998
			Lower slope	Upper slope	Block 1	Block 2	Block 3
pH (H_2O)		< 5.5	5.2	5.2	5.7	5.4	6.1
Calcium		< 5.0	4.6	4.1	11.4	13.6	11.1
Magnesium	me %	< 1.0	3.7	3.4	4.9	6.3	2.3
Potassium	me %	< 0.3	0.2	0.2	0.3	0.2	1.2
Sodium	me %	> 0.7	0.1	0.1	0.05	0.08	0.02
CEC	me %	< 6.0	16.9	17.9	18.6	17.2	17.8
Base saturation	me %	< 30	51	43	89	117	82
Phosphorus (Olsen)	mg/kg	< 5.0	3.0	1.0	6.1	3.8	3.6
Organic carbon (C)	%	< 3.0	7.3	0.79	1.79	0.9	5.2
Total nitrogen (N)	%	< 0.3	0.52	0.58	0.10	0.08	0.37
C:N ratio		< 10	14	14	18	11	14
Phosphorus retention			96	93	na	na	na

me = milliequivalent; mg/kg = milligrams per kilogram
Source: Kanua (1987)

Conclusions and Recommendations

No other postdrought follow-up research was undertaken. Consequently there is an absence of experimentally proven scientific data on postdrought management of sweet potato. Hence the scope of the paper is limited to a small amount of survey data, existing literature and the observations of the authors in one district in Simbu Province. The observed yield data and the market price information confirm that the problem of lack of tuberisation experienced by the first postdrought crops observed in Simbu Province was short-lived. However it resulted in the wasted efforts of farmers in preparing gardens and planting large areas of sweet potato and, more importantly, extended the period of the food shortages by up to six months. At midelevation areas, there were other starchy foods such as banana, cassava, corn, taro, yam and pumpkin that supplemented sweet potato. But, at higher elevations, this was not the case and people's food supplies remained vulnerable. Where food sources were more diverse, as they were in Eastern Highlands Province, people were better off.

On the basis of these conclusions, the following recommendations are made.

- The first crops planted postdrought should be heavy nitrogen and phosphorus feeders such as maize, brassicas, legumes and Irish potato.
- Monocrop sweet potato as a first postdrought planting should be discouraged. The first postdrought crops of sweet potato should be extensively intercropped with legumes and maize. Mixed cropping will result in a wider capture of available nutrients and will improve the nutrient balances in favour of sweet potato. These other crops would also supplement the diet if the sweet potato yields remained adversely affected.
- Crop diversification research should be undertaken, including an assessment of prospective crops such as Andean yams, avocado, banana, and nut and stone-fruit trees. Suitable plants that can withstand frost should be sought.
- Frost-tolerant sweet potato cultivars should be identified and distributed in the high altitude areas (some breeding may be necessary).
- The very low number of scientists working on sweet potato in PNG should be addressed immediately.
- Experiments should be designed to test the hypotheses put forward in this paper and by Bang et al. (1998) on the phenomenon of the lack of tuberisation and yield decline in the first postdrought sweet potato plantings.
- Plans should be made for a rigorous program of postdrought research on agricultural rehabilitation, ready for the next drought event.
- The reports listed below about the impact of the drought and frost in 1997 and 1998 should be brought together and secured in at least two locations in PNG and one in Australia for future reference.

References

Allen, B.J. and Bourke, R.M. 1997a. Report of an Assessment of the Impacts of Frost and Drought in Papua New Guinea. Australian Agency for International Development, Port Moresby.

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. Poienou, J. Risimeri, R. Shelton, J. Sowei, K. Ukegawa, N. Willson, D. Wissink and M. Woruba. 1997b. 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.

Bang, S.K., Kanua, M.B. and Lutulele, R.A. 1998. A study on the postdrought yield of sweet potato (*Ipomoea batatas.* (L.) Lam) in selected areas of Papua New Guinea.

Bourke, R.M. 1983. Crop micronutrient deficiencies in Papua New Guinea. PNG Department of Primary Industry, Technical Report 83/3.

Bourke, R.M. 1985. Sweet potato (*Ipomoea batatas*) production and research in Papua New Guinea. Papua New Guinea Journal of Agriculture, Forestry and Fisheries, 33, 89–108.

Bourke, R.M. 1988. Taim hangre: variation in subsistence food supply in the Papua New Guinea highlands. PhD thesis. Canberra, Australian National University.

de Deus, J.G. 1967. Fertilizer Guide for Tropical and Subtropical Farming. Zurich, Centre d'Etude de1'Azote.

D'Souza, E. and Bourke, R.M. 1986. Intensification of subsistence agriculture on the Nembi Plateau, Papua New Guinea: general introduction and inorganic fertilizer trials. Papua New Guinea Journal of Agriculture, Forestry and Fisheries, 34(1–4), 19–28.

Floyd, C.N, Lefroy, R.D.B. and D'Souza, E.J. 1988. Soil fertility and sweet potato production on volcanic ash soils in the highlands of Papua New Guinea. Field Crops Research, 19, 1–25.

FPDC (Fresh Produce Development Company). 1998a. Fresh Produce News, January–February. Edition 134. PNG, Mt Hagen, FPDC.

FPDC. 1998b. Fresh Produce News, March–April. Edition 135. PNG, Mt Hagen, FPDC.

FPDC. 1998c. Fresh Produce News, May–June. Edition 136. PNG, Mt Hagen, FPDC.

Fujise, K. and Tsuno, Y. 1967. Effect of potassium on the dry matter production of sweet potato. In: Tai, E.A., Charles, W.B., Haynes, P.H., Iton, E.F. and Leslie, K.A., eds, Proceedings of the International Symposium on Tropical Root Crops, Volume I–II, 20–29.

Godfrey-Sam-Aggrey, W. 1976. Effect of potash fertilizer on sweet potato in Sierra Leone. Experimental Agriculture, 12, 87–94.

Gollifer, D.E. 1980. A time of planting trial with sweet potatoes. Journal of Tropical Agriculture (Trinidad), 57(4), 363–367.

Goodbody, S. and Humpreys, G.S. 1986. Soil chemical status and the prediction of sweet potato yields. Journal of Tropical Agriculture (Trinidad), 63(2), 209–211.

Kanua, M.B. 1995. A review of properties, nutrient supply, cultivation and management of volcanic soils, with particular reference to Papua New Guinea. Papua New Guinea Journal of Agriculture, Forestry and Fisheries, 38(2), 102–123.

Kanua, M.B. 1998. The response of three sweet potato cultivars to inorganic fertilizers on an Ardisol in the highlands of Papua New Guinea, trials. Papua New Guinea Journal of Agriculture, Forestry and Fisheries, 41(1), 79–84.

Kanua, M. B. and Muntwiler, M. 1998. A report of a survey on the impact of drought on the availability of planting materials in Simbu Province, Kainantu. Unpublished report funded by The Salvation Army of Papua New Guinea, 14 p.

King, G.A. 1985. The effect of time of planting on six varieties of sweet potato (*Ipomoea batatas* (L.) Lam.) in the southern coastal lowlands of Papua New Guinea. Journal of Tropical Agriculture (Trinidad), 62(3), 225–228.

Muntwiler, M. and Kanua, M.B. 1998. A survey report on the impact of the drought on the availability of planting materials in the Eastern Highlands Province, 9–11 March 1998. Unpublished report for the PNG Department of Agriculture and Livestock, Aiyura, and The Salvation Army, Kainantu.

O'Sullivan, J.N., Asher, C.J. and Blamey, F.P.D. 1997. Nutrient disorders of sweet potato. Canberra, Australia Centre for International Agricultural Research.

List of Additional Reports on the Impact of the 1997–98 Drought and Frosts in PNG

Allen, B.J. 1997. Report on an assessment of the impacts of frost and drought in Tambul District, WHP, Enga Province and SHP, 9 p.

Kanua, M.B. 1997. The impact of drought and frost in the Eastern Highlands Province: Phase I Assessment.

Kanua, M.B. 1998. An information paper on Murlip Agricultural Research Centre, Kandep, Enga Province, prepared for the PNG National Agricultural Research Institute, Lae.

Kanua, M.B. 1998. Dry Lowlands Research Programme, Laloki, end of year report. PNG National Agricultural Research Institute, Lae.

Kanua, M.B. 1998. Report on The Salvation Army seeds and planting material delivery programme to Simbu Province, Papua New Guinea. Report for The Salvation Army.

Kanua, M.B. and Liripu, G.K. 1997 The impact of drought and frost in the Southern Highlands Province. Phase II Assessment.

Wayi, B.M. et al. 1998. Interim report of the Impact of Frost and Drought in Papua New Guinea—Phase II. Port Moresby, Australian Agency for International Development, 15 p.

The World Bank El Niño Drought and Frost Impact Management Project

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Abstract

The PNG El Niño Emergency Drought Response World Bank Project is an agricultural research project aimed at decreasing the impacts of future El Niño-related weather fluctuations. It originated from a joint proposal by the Department of Agriculture and Livestock and the National Agricultural Research Institute (NARI) following the severe effects of the unusual weather in 1997; it is funded by the World Bank and implemented by NARI. The project aims to identify drought-tolerant crops and cultivars, introduce appropriate irrigation technologies, develop an early-warning system and farm-based contingency plans, and carry out onfarm operational research and demonstration projects. Progress on the drought-related activities is nearly on target. Progress in the frost-related activities has been hampered by our failure to identify practical solutions. The project is about half finished, with ongoing work in all areas.

FOLLOWING the 1997 drought and frosts, the PNG Department of Agriculture and Livestock (DAL) and the National Agricultural Research Institute (NARI) jointly proposed a project to improve PNG's ability to cope with future El Niño-related weather fluctuations. The proposal was accepted in 1998 and was given the name 'PNG El Niño Emergency Drought Response World Bank Project (P7213-PNG) Agriculture Research Component: Development and Adaptation of Technologies to Manage Impacts of Droughts and Frosts in PNG'. NARI was given the responsibility of implementing the project. The project consists of four components:

- selection of drought-tolerant crops and cultivars;
- identification of better soil and water management techniques;
- development of advanced warning and contingency plans; and
- onfarm operational research.

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In October 1998, the project scientist Dr K.P.C. Rao began duties. He was assisted by NARI scientist Anton Varvaliu and experimentalist Timothy Geob of the Highlands Agricultural Experiment Station (HAES) at Aiyura, and later by scientist Peter Gendua and experimentalist Paul Osilis. Anton Varvaliu left NARI in May 1999 and was replaced by John Demerua. Dr Rao lead the project until October 1999, when he returned to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and was replaced by Bill Humphrey as project scientist at Aiyura. At that time, James Ernest was also assigned to the project. Although the World Bank has funded the project under emergency arrangements, NARI sees it as the beginning of long-term work in the area of food security.

Selection of Drought-Tolerant Crops and Cultivars

Initially the project obtained information about the impact of the drought and frosts in the worst-hit provinces of PNG. Table 1 shows the percentage of the population in categories 4 and 5 (severely affected by

the drought) in October 1997 and December 1997. The next step was to compile a database describing existing germplasm collections and collect information from farmers about drought-tolerant crops and cultivars. This information is summarised in Tables 2 and 3, respectively. Project personnel are also producing digital databases describing the national collections of cassava and drought-tolerant sweet potato and yam. The collected cultivars of these crops have been added to the national collections for ongoing evaluation. Finally, screening trials have been conducted at Laloki Research Station, in Central Province, and at HAES. When the evaluations have been completed, the selected materials will be distributed to appropriate agencies and departments.

The 1997 drought survey collected much data about the use of famine foods in the worst-hit areas. The project team will review the survey data and carry out follow-up collection and identification trips. In addition, a trial to evaluate 10 selected cassava cultivars is under way at Laloki. This trial will assess yield, cyanide content and protein in irrigated and unirrigated treatments.

Table 1. Summary of drought and frost impact in the worst-hit provinces.

Province	Percentage of population in drought-affected categories 4 and 5[a]	
	October 1997	December 1997
Western	50	74
Gulf	11	58
Central	24	50
Milne Bay	29	60
Western Highlands	9	21
Simbu	0	100
Eastern Highlands	10	74
Morobe	12	55
Madang	3	42
New Ireland	0	19

[a] The most severe impact categories of food supply at the time of the survey during the 1997 drought/frost period: 4 = severely affected; 5 = critically affected.
Source: Allen and Bourke (1997ab)

Lowlands (Laloki) screening trial

A sweet potato drought-tolerance screening trial was conducted at Laloki Research Station using 20 cultivars selected through predrought screening done at Keravat. The trial relied on the natural dry season to impose drought stress where desired and irrigation was used where stress was not desired. Planting was carried out on 31 July 1999. The stress treatments were:

1. continuous irrigation;
2. irrigation to day 35 followed by no irrigation to day 95; and
3. irrigation to day 95 followed by no irrigation to day 155.

Planting was poorly timed and the seasonal rains began just as the stress period was starting for treatment 3. This effectively made treatment 3 the same as treatment 1. No significant differences were found in the cultivar responses to drought conditions. A second trial will be conducted in 2000 to screen about 30 varieties, including the best 15 from the first trial as well as other recommended varieties not yet tested and one cultivar identified by farmers as having drought tolerance.

Highlands (Aiyura) screening trial

A sweet potato drought-tolerance screening trial was conducted at the HAES using 20 cultivars selected through predrought screening at Aiyura and Tambul. The dry season at Aiyura is less reliable than at Laloki, so the trial employed rain-out shelters to ensure that rain was excluded from the plots when necessary. Irrigation was applied when soil moisture conditions suggested it was necessary. The moisture stress treatments were:

1. continuous irrigation when needed;
2. irrigation when needed to day 45, followed by irrigation and rain excluded to day 107; and
3. irrigation when needed to day 117, followed by irrigation and rain excluded to day 188.

As in Laloki, no significant differences were found in the cultivar responses to drought conditions.

Two more screening trials are scheduled for Aiyura. The first will involve about 60 cultivars originating from the national highlands plant germplasm collection as well as farmer-identified drought-tolerant cultivars. Before the trial, some cultivars will be eliminated if they perform poorly or duplicate the recommended varieties from the national collections of cassava and drought-tolerant sweet potato. The trial will rely on the natural dry season because of practical

Table 2. Overview of PNG's national germplasm collections.

Crop	Number of accessions				
	Keravat	Laloki	Aiyura	Bubia	Tambul
Sweet potato	737	–	1200	–	58
Banana	70	303	–	19	–
Taro	4	–	–	586	–
Cassava	38	78	–	7	–
Yams	13	–	–	63	–
Aibika	43	46	–	–	–

– = not in the collection

Table 3. Summary of farmer-identified drought-tolerant accessions collected following farmer surveys.

Source province	Number of accessions by crop			
	Sweet potato	Cassava	Banana	Yam
Western Highlands	16	11	9	5
Simbu	28	9	9	7
Eastern Highlands	3	12	13	4
Madang	1	12	13	SPYN
Morobe	–	10	6	SPYN
Central	–	2	10	20
Milne Bay	1	2	–	9

– = not in the collection
SPYN = South Pacific Yam Network

problems in evaluating more than 20 cultivars under rain-out shelters. The dry season at Aiyura is not as distinct as at Laloki, so there is a risk that results will only be indicative and further work may be necessary.

A second screening trial under rain-out shelters will also be carried out. This will use mainly farmer-identified drought-tolerant cultivars. Of the 47 collected, 18 will be selected from observations of performance in multiplication plots and after elimination of duplicates. Two cultivars from the first trial will be included as a check.

Soil and Water Management Techniques

The aims of this component of the study are to:

- identify appropriate irrigation systems;
- identify appropriate soil and water conservation technologies;
- test the technologies on farmers' fields; and
- document and disseminate information to extension agencies.

To date, we have identified people with expertise in irrigation in PNG, held a one-day workshop and set up a working group to identify the most appropriate technologies to supply water to farmers' fields during droughts. We have tentatively identified some sites for installation of irrigation equipment.

We are evaluating irrigation equipment. Any pump used must be inexpensive and easy to maintain. After considering ram pumps, pressure coil pumps and shallow-well hand pumps, we believe it will be difficult to find a pump that will be inexpensive, yet have sufficient capacity for a food garden and be topographically appropriate for our target population. We have not yet decided what pumps to use for demonstration sites, but one possibility is a simple lined well from which water would be drawn by hand. Only a limited amount of water could be applied with this method, which would probably be limited to preserving planting materials rather than actually producing food

during drought. However, it would allow much quicker recovery from drought and be within the budget of smallholder farmers.

Work has not yet begun on identifying appropriate soil and water conservation technologies. We will begin by carrying out a literature review and demonstrating contour mounding, mulching and other water conserving practices.

Eventually, we will demonstrate and document chosen technologies by selecting demonstration sites for the construction of pumps, irrigation equipment and agronomic practices. This has not yet been done.

Advanced Warning System and Farm-Based Contingency Plans

This component of the project is aimed at providing a warning period prior to impending drought. This would allow farmers to adopt avoidance or adaptation strategies. The project will also develop contingency plans that will provide practical advice to farmers to increase their awareness of alternative cropping strategies to lessen the impact of drought.

Advanced warning system

The advanced warning system concept is based on using the Southern Oscillation Index (SOI) to predict the onset of El Niño-induced drought. The SOI is a measure of changes in the atmospheric pressure between Darwin and Tahiti. The SOI changes at the start of an El Niño event and the subsequent changes in rainfall patterns take a few months to develop, so the SOI can provide a warning of impending drought. It is the world's most widely used index for seasonal weather predictions.

The challenge in PNG is to determine, from historical rainfall data, the strength of the association between the SOI and subsequent seasonal drought. Historical PNG rainfall data have been collected and a software package has been used to evaluate the association between the data and the historical SOI. The project is currently evaluating the data quality and usefulness on a station-by-station basis. This is a complex task because the network of rainfall observation stations in PNG is less formal than in some other countries. In order to augment the existing network, the project has purchased eight automatic weather stations. These have been commissioned at various locations in PNG, including five NARI sites and three other sites, all in the highlands. As the project proceeds, we will develop a protocol for monitoring the SOI with a view to deciding when drought warnings should be given.

Farm-based contingency plans

This component of the project is intended to provide farmers with information on how they should respond to impending drought or an increased likelihood of frost as indicated by the advance-warning system that is being developed. Ideally, the contingency plans will reflect local conditions and will be linked to the resources necessary to implement them. The work on contingency plans will not begin until the results of the other components of the study are known.

Onfarm Operational Research

The onfarm operational research component of the study will extend the results of agronomic trials to farmer management and further test technologies that seem promising in research trials. Current activities include yam technology demonstrations in three locations. As yam is a drought-adapted crop, and stores well after harvest, it is well-suited for promotion in drought-prone areas. The African yam, *Dioscerea rotundata*, is the test crop in this case. The technologies under evaluation are miniset propagation, continuous planting at two-month intervals, and alternative plant spacings. The test locations are in Central, Morobe and East Sepik provinces.

Acknowledgments

Most of the work was initiated by Dr K.P.C. Rao, who worked for one year in PNG while still maintaining his position at ICRISAT in India. The World Bank and the government of PNG, through NARI, provided funding for the work. The difficult task of implementing the fieldwork has been carried out by many staff within NARI and collaborating organisations, primarily the provincial Divisions of Primary Industry. These people and institutes are gratefully acknowledged.

References

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

Allen, B. J. and Bourke, R. M., with others, 1997b. Report of an assessment of the impacts of frost and drought in Papua New Guinea—Phase 2. Port Moresby, Department of Provincial and Local Government Affairs.