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

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IMPACTS OF THE 1997-98 EL NIÑO EVENT IN MOZAMBIQUE

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Maputo, Mozambique
26 May 2000

TABLE OF CONTENTS

EXECUTIVE SUMMARY

A. Setting

1. Socio-economic setting

Mozambique, located in southeast Africa, has three main landscapes: the southern coastal plains rising to 200 meters above sea level and covering about 44 per cent of the country; the central and northern plateaux, between 200 and 1,000 meters above sea level covering about 43 per cent of the territory; and the interior large plateaux and mountain ranges over 1,000 meters and covering about 13 per cent of the territory. Most agricultural production takes place in the center and north of the country, where most of the population is also located (apart from the major cities), mainly because the low-lying southern coastal plans are prone to drought and floods. The latter come mainly from rivers rising in neighboring countries. Rains in the center and north tend to be produced by westerly winds generated by the ITCZ, bringing depressions and occasional tropical cyclones.

The population has grown considerably since 1950, despite a series of wars, from 6.5 million to 16.9 million in 1998, at the time of the last El Niño event. The infrastructure and agricultural profile of the country remain profoundly influenced by its colonial heritage, even though much of the infrastructure has been destroyed in the wars. The other effect of its colonial past, apart from a low level of literacy at independence in 1975, was the widespread use of monocultural crops, particularly cotton. This reduced

food security in Mozambique, and encouraged labor migration both within the country and to neighboring countries. The most important labor migrations were from the south of the country into South Africa. The combination of monoculture and labor migration rendered the country (especially the south which has long been prone to drought and flood) highly vulnerable to the impact of natural disasters. The lack of investment has meant that there are comparatively few resources to mitigate the effects of such events.

Mozambican independence more or less coincided with the change that took place in 1976 in the frequency and timing of warm and cold ENSO events. Emergency coping institutions were developed rapidly to deal with the effects of serious floods in 1978. These soon developed into a more permanent arrangement in 1980, but the nature of disaster management changed with the intensification of South African backed destabilization and the developing conflict that became much more intense from 1982 until the Peace Accord of 1992. This conflation of war and the effects of the El Niño events of 1982-1983, 1987-1988, 1991-1992 and 1994-1995 (after the war) meant that Mozambican disaster management did not distinguish very clearly between natural and war-related disasters. The 1991-1992 drought lasted into 1993 in the center of the country, and this meant that the immediate post-war period leading up to the 1994 elections created a huge field for emergency activities, which included massive efforts by the UN peace keeping mission ONUMOZ, and its humanitarian office, UNOHAC.

In 1995, the institutional setting changed with the departure of ONUMOZ and the emphasis shifted to the idea of a coordinating rather than an implementing body, as the DPCCN (Department for the Prevention and Combat of Natural Calamities) had been. This discussion developed further during the 1997-1998 El Niño event, as the Mozambican government developed its Multisectoral Action Plan in consultation with SADC (Southern African Development Community) regional agencies such as SARCOF (Southern Africa Regional Climate Outlook Forum), with meteorologists from the US, with the UN and the major international donors. The result was the creation in June 1999 of INGC (*Instituto Nacional de Gestão de Calamidades*), the body that was soon to be tested by the floods of early 2000.

Within this developing institutional framework, the SNAPSA (*Sistema Nacional de Aviso Previo de Seguranca Alimentar*) early warning system has had the lead role among Mozambican government agencies for advising on impending extreme weather events. This is composed of staff from INAM (*Instituto Nacional de Meteorologia*) and INIA (*Instituto Nacional de Investigacão Agronomica*) with input from the UN FAO, and with a technical commission including key personnel from other ministries.

2. Climate-related and other natural hazards in Mozambique

Apart from drought and floods, the other climate-related hazards are tropical cyclones, malaria, cholera, pest infestations (particularly red locusts) and famine. The impact of pest infestations has been controlled with considerable success since the mid-1990s, but the use of adequate sanitation facilities to reduce the impact of disease remains a high priority issue.

3. Scientific research on El Niño in Mozambique

The main centers for research on recent and contemporary ENSO events is INAM, together with INIA. However, there is also research work being conducted at Eduardo Mondlane University (UEM), where there is an undergraduate degree in Meteorology and Physics, and at the *Universidade Pedagogica*. In addition, there is ongoing work on past ENSO events in the Institute of Geology, and by staff now at the department of Archaeology and Anthropology at UEM. International contacts include the University of Zululand, the SARCOF network, which notably includes the Drought Monitoring Center at Harare and the South African Weather Bureau, the University of Oklahoma, and NOAA (National Oceanographic and Atmospheric Administration). It is not clear whether links have been maintained with the International Institute for Climate Prediction at Columbia University, but such links were certainly there during the 1997-1998 El Niño event.

4. Historical in El Niño before the 1997-1998 event

There was some research, most notably in 1996, but there seems to have been little on current ENSO phenomena before then. The press coverage, indicating public awareness and interest, shows little mention of it before 1992.

B. 1997-98 Event

5. Information on the 1997 El Niño in Mozambique

The 1997-1998 was noted in a special SNAPSA bulletin in March 1997, but the first serious Mozambican report on it took place in July 1997, and was the result of papers sent from the Drought Monitoring Center and the FAO Regional Headquarters in Harare, Zimbabwe. This led to a series of meetings, most notably a SARCOF meeting in Kodoma on September 8th, a MICOA/INAM/IRI meeting on September 15th and 16th and a full national planning meeting from October 1st to 5th, hosted by MAP. This presented the first draft of a Multisectoral Action Plan to deal with El Niño, the first such an initiative undertaken by the Mozambican government.

The UN agencies, especially the FAO and the WFP, were involved in the development of this plan, and the major donors USAID and the EU was also active from August. The revised Multisectoral Action Plan was considered by a wider group of donors early in December, and changes were required before they would support an international appeal for aid by the Government of Mozambique. This was a little unfortunate since some of the aspects that were objected to be in fact quite sensible, although other criticisms were perfectly valid. The criticism that was most misplaced was of the plan to clear the irrigation and drainage canals of the Limpopo irrigation complex near Chokwe. This had already been suggested by FAO in 1993 and enthusiastically supported by the leadership of ONUMOZ, but had not been taken up. This is a measure that is equally sensible for drought or flood, and its implementation would undoubtedly have saved lives in the Limpopo floods of 2000.

The response to the 1997-1998 El Niño was in general a very positive experience, as the MICOA/INAM follow up meeting concluded in February 1998. However, the rains continued at normal or above normal levels, even including some flooding. This had an unfortunate impact in terms of credibility of seasonal forecasting and the integration of such information into the national decision-making process. This negative effect was partly overcome by the subsequent forecast on the effects of La Niña, but it meant that it was only really in late 1999/early 2000 that the government reacted seriously to flood warnings. INAM continues to suffer from lack of equipment that would enable it to give forecasts in sufficient detail to warn government of incoming extreme weather events.

6. El Niño in the media

There was excellent coverage in the media during the 1997-1998 event, although the media tended to be blamed for simplifying the message. This may have been true for radio and TV, whose archives were too poorly organized to be worth accessing, but in general it was not true of the press. Despite this, there was some vitriolic editorial comment when the ‘drought forecast’ did not turn our as expected.

There was very little coverage of El Niño before the 1997-1998 event, the first mention being in 1992.

C. Teleconnections

7. Scientific views on the existence and strength of El Niño teleconnections to Mozambique

The most notable work on this has been conducted in INAM and INIA. The 1996 paper by Lucio and Amade, and the subsequent more detailed study by Lucio, is the most detailed analyses on El Niño in Mozambique. Relying as they do on both Mozambican historical data and satellite data, they are probably the most authoritative. The SNAPSA paper of December 1997 is another important piece of work on teleconnections, indicating that since 1950 some two-thirds of El Niño events have been associated with drought in Mozambique, and not simply in the south as conventional wisdom had it. The most extensive an intense drought of this period, and possibly of the 20th Century, was that of 1991-1992, clearly related to the El Niño of that time.

While not based on scientific data, historical records of drought in southern Mozambique also suggest that about two-thirds of El Niño events are correlated with drought, especially for the [period 1850-1912.

The issue then is the nature of the processes in the Indian Ocean and possibly even the Atlantic Ocean, which mediate the probable teleconnections. This is clearly a priority for future research, and the extension of the TAO array into the Indian Ocean is strongly recommended, as is the upgrading of facilities at INAM, and the fostering of still wider links with southern African and Lusophone climate researchers.

8. Climate-related anomalies and impacts in Mozambique of the 1983-1983 event

The 1982-1983 event clearly produced a very serious drought, possibly the most serious one of the century until then. (The drought of 1912 was also very serious, and its full extent may not be recorded.) Because of the drought began before the El Niño, and was prolonged and intensified by it, and then continued after it, famine was widespread in the south of Mozambique. The war meant that food aid could not be delivered to the affected populations. The official estimate of 100,000 deaths from starvation, while not contested by international agencies, does not seem to have found its way into estimates of the deaths caused by this El Niño, which are put at around 1,500 worldwide.

9. Climate-related impacts of the 1997-1998 El Niño

There were only minor floods in the south of the country, and the damage was more than offset by the increased agricultural production elsewhere. Overall agricultural production grew by around 5 per cent, contributing to a pattern of growth of around 10 per cent per annum for the calendar years 1996, 1997 and 1998. Growth in 1999 was around 14 per cent, partly because of the stable climate conditions for that whole four-year period.

10. Reliability of attribution

The attribution was high, based on a southern African international consensus, which broadly matched that of the WMO. The main issue for attribution now is the improvement of understanding of Indian Ocean processes, which clearly outweighed the El Niño impacts in this case, largely because the Indian Ocean was so warm. The possibility of Rossby waves generated from the Gulf of Guinea in the Atlantic has not been ruled out, and should be a priority for the TAO array currently being installed in the Atlantic.

D. Responses

11. Government reports and statements issued before the impacts of the 1997-1998 El Niño became apparent.

The main reports were the July 1997 SNAPSA forecast, deriving at least partly from the earlier SARCOF statements, the report on the MICOA/INAM/IRI meeting of mid-September, the Multisectoral Action Plan produced in first draft by early October, and the December update produced in relation to the mid- December SARCOF update meeting.

12. Reports issued after the impacts appeared

After it became clear that rains had been sufficient to avoid serious drought, the main government report was the follow up meeting of MICOA/INAM in February 1998. In addition the WFP produced a much longer bound report covering the impact of the event on the whole of southern Africa.

13. The major responses to the event

These were the preparations that took place in the period July – December 1997, which have been described above.

14. Mozambican research on El Niño

If one ignores geological and archaeological research on past El Niño events, there has been very little research on contemporary El Niño events before 1996. This has been mentioned above.

15. A government plan to respond to El Niño

There exists no standing plan to respond to El Niño. The government is currently fully occupied in coping with the floods of early 2000 and their aftermath, which is still considerable. However, the 1997 Multisectoral Action Plan, together with the lessons from the floods of 2000, should help in the formulation of such a plan, and should raise awareness as to its necessity.

16. El Niño as a disaster

While El Niño may not be seen as a disaster because the connection was not widely perceived until 1997, when the expected probable teleconnection did not take place, the current floods have been related to La Niña, and this may raise awareness of the importance of ENSO events in general for policy making in Mozambique.

17. International research on El Niño in Mozambique

While there is ongoing historical research conducted by S.J. Young in Oregon, USA, meteorological and climatological research is concentrated in the USA and South Africa. In the USA, the main centers for research on Mozambique are NOAA, the University of Oklahoma, and the University of West Lafayette. In South Africa, the most notable links are with the University of Natal. However, there is also important research being conducted at the University of Cape Town. The latter is about to establish links with INAM as a result of this project on the 1997-1998 El Niño.

E. Forecasting by Analogy

18. What could have been done differently?

Very little, in the current state of knowledge, could have been done differently. While plans could always be improved, the main issue was the seasonal forecast itself. This has rightly been identified as a major challenge to climatologists and seasonal forecasters, and can only come about by a combination of improved monitoring and forecasting within Mozambique itself, and international research on the processes in and over the Indian and Atlantic Oceans, preferably through an extended TAO array and the development of better regional climate models.

The information flow, in terms of regular monitoring of meteorological, water, health and agricultural developments, could be improved, as could public education on the interpretation of such forecasts.

In addition, long-term investment in Mozambican infrastructure, especially roads, food security warehouses and health clinics would make the country better able to withstand the impacts of climate variability and extreme weather events.

19. Realistic obstacles to perfect forecasting followed by perfect action

The current limitations on INAM both in terms of staff development and equipment, are the main obstacle to better forecasting, which can never be perfect in a situation of climate change. This is followed by the need to strengthen the capacity of INGC to coordinate government and international agencies and NGOs in a disaster management scenario. Some of this could be achieved by the integration of GIS and other information

into a common format for use by the whole range of agencies likely to be involved in disaster response activities.

20. El Niño considerations in Mozambique's national disaster plans

It is perhaps now the main element in disaster planning, especially if one includes the impact of cold ENO events, such as the one associated with the floods of early 2000.

21. Strengths and weaknesses in the national response to the forecast

The weaknesses consist of the still fragile national meteorological service, and in the flows of information across agencies, which affect coordination between them. Response would also be strengthened if the processes mediating the teleconnections from the Pacific to east Africa were better understood.

22. Influence of the 1997-98 El Niño on the response to the following La Niña

There seems t have been no contingency plan for the following La Niña, and the 'failure' of the earlier forecast of drought doubtless played a major role in this.

Lessons from Mozambique: 1997-1998 El Niño

The main lessons are for the Mozambican government regarding longer-term policy formation. There are also lessons for the international donor community, regarding both dialogues with the recipient government over aid priorities and long-term measures to enhance the resilience of the Mozambican economy in the face of climate variability, which will never disappear. The more specific lessons concern the functioning of INAM and of INGC.

F. Mozambican Government Policy Formation

There is a grave danger that Mozambican government decision-making will continue to show the same old attributes of *ad hoc* gathering together of people with relevant expertise as a response to events, rather than a sustained process of policy development, with investment in the long-term development of expertise. It is symptomatic of the political culture that the agricultural season is still described as a campaign.

The reasons for this have long been clear because of the following:

- Policy formation has long suffered from being in 'response mode' rather than proactive. Some attempts at longer-term policy development, such as the Indicative Perspective Plan of the early 1980s, were not seriously debated, and depended on intellectual inputs from donor countries with their own unrealistic agenda. The 1997-1998 El Niño Action Plan was a notable exception to this tendency. However, it suffered from the sometimes-poor process of dialogue with the aid donors.
- There has been a constant process of a loss of expertise to international agencies and NGOs, or abroad. A country that began in 1975 with 95 per cent illiteracy and a very small group of people with higher education has long found that a policy of training staff suffered from high rates of 'brain drain'.
- The dependence on donor aid, induced by drought and war, has given some donors a *de facto* institutional interest in weakening Mozambican government structures, to minimize debate over their preferred policy prescriptions. Other aid agencies have tried to strengthen decision-making processes with Technical Assistance programs, but these have usually depended on a few key personnel who are often enticed away by better career opportunities elsewhere.
- Policy formation without the resources for implementation is inherently problematic. The difficulties in raising taxes in an economy, which was in decline from 1981 to 1994, have seriously depleted the capacity of the Mozambican government to act on its own account. The main exception to this has been the delivery of food and other emergency aid. Yet international donors who understandably wanted a say in its distribution, as well as transparency in decision-making have financed this. The result has been a silent struggle over aid distribution, which is typical of the politics of emergency aid, especially in situations that were perceived as linked to the Cold War.

The issue now is how to foster a change in the political culture in favor of a longer-term view of economic development and management that is not hidebound by issues of debt repayment. The South African backed Maputo Corridor has contributed to the long-term development of Mozambique, but it is not clear whether this success can be repeated in the cases of the Beira and Nacala Corridors. The question of investment to increase resilience to drought and flood in the South and Center is now on the political agenda, with the 'award' of US $500 million to Mozambique at the recent Rome donors' conference. However, the link between emergency rehabilitation aid and long-term development is apparently not yet being made, either within the Mozambican government or the donor community.

The other main lesson is that monitoring within Mozambique needs to be improved. This is not only a matter of increasing the number of weather stations, but of improved communication with provincial governments and NGOs, to increase coverage of the whole country with its different sub-climates.

G. International Donor Community

(i) Emergency aid versus development aid

The donor community has, for budgetary accounting reasons, set up an artificial distinction between emergency aid and development aid. It then poses the question of how the transfer from one to another can be made. Part of the answer lies in the simple fact that a little judicious foresight can mean that emergency aid can have long-term benefits, and that some long-term aid can increase capacity to deal with disasters. Thus for example, design and construction of decent flood resistant roads in southern and central Mozambique could be implemented as a disaster recovery project, but would have long-term economic benefits. A recent search of current UK patents shows that appropriate technology exists to build flood-resistant roads that would be much less likely to be washed away. One wonders if this has been taken into account in planning the reconstruction on EN1, the main road north from Maputo to Xai-Xai and Inhambane.

Similarly reed bed construction would reduce vulnerability to malaria and cholera, but is unlikely to be financed as part of a disaster recovery strategy. It could however, conceivably be funded under Kyoto Carbon Credit measures. The point is that the budgetary distinction between emergency and development aid, which seems to make sense, can at times get in the way. There is little sign of the international donor community interweaving aid in an intelligent way to reduce future vulnerability to climate-related disaster, which remains a serious long-term threat in Mozambique.

(ii) Dialogue between donors and recipients

More important than this 'eternal dilemma' (between spending on emergency and on development aid) is the need to enhance dialogue within the donor community, and between it and the Mozambican government. There is no doubt that events such as the recent Rome donors' conference do enhance donor coordination. However, in the period before El Niño, despite the good job done by various UN agencies, and by USAID and

the EU Delegation in Maputo, there was still a problem of dialogue in response to the Mozambican government's plan to mitigate the effects of the predicted drought. The EU's private response document was a mixture of perfectly reasonable and quite mistaken points. Rather than dialogue on this to clarify the issues, there was an attempt at imposition of *all* the EU points as a condition of making an international appeal for aid. Such a paternalistic attitude, which *inter alia* undermined the advice being given by UN Technical Assistance personnel, was not conducive to good coordination in what was expected to be a serious emergency.

A similar attitude was evident in the UK government's approach before the recent Rome conference. The Minister for International Development, Clare Short, publicly criticized the Mozambican government's capacity to respond to the Cyclone Eline disaster, implying that there was little point in devoting too many resources to disaster recovery in these circumstances. This comment had considerable validity, but took no account of the major restructuring that INGC had been undertaking, as a response to a consultancy report from a UK University. As such, a short-term ministerial view was in danger of undermining the long-term perspective of work that was probably instigated by UK funded aid.

In any case, the UK Department for International Development had had a serious disagreement over emergency aid with the UK Ministry of Defense. The House of Commons for its stance, which delayed the delivery of helicopters to Mozambique after Cyclone Eline, publicly criticized the latter. The US government was also slow in its response. While these are not El Niño events, they do illustrate the point that it is not just the governments of developing countries that have problems with policy coordination and implementation.

While transparency, speed and effectiveness are very important for disaster preparedness, and while dialogue cannot eschew criticism of the recipient government's performance, the objective should surely be to enhance the future performance of the aid-receiving government in terms of disaster prevention, mitigation and recovery.

(iii) **Long-term investment**

Donor governments and agencies need to get away from the so-called 'stick children syndrome', where TV pictures of starving children or other stricken people are used to evoke the political response required to justify the emergency aid. To reduce the vulnerability to drought and flood that can be expected with ENSO events, investment in vulnerable areas is necessary. A simple way to illustrate this is to compare the 1997-98 warm events with that of 1877-78. In the earlier event, tens of millions of people died in India and China. In the later, stronger event comparatively few died. This difference is largely a result of the stronger condition of both economies 120 years later, despite the far greater populations.

Hence the issue is how to identify the vulnerable areas. In the case of Mozambique this is comparatively easy. NVDI and CCD images linked to weather station and udometric

data with the results feeding into GIS make it comparatively simple to identify the drought-prone areas on the basis of historical evidence. This could be modified by the use of dynamic climate models of the southern African region, of the type being developed by Professor Bruce Hewitson of Environmental Sciences, University of Cape Town. The reason for such models is that global warming means that the past is now less useful as a guide to the future.

Such climatic data could then be linked to soil type data (again, readily available in Mozambique in GIS format) and to population data such as the recent census. Even voting data could be used to give an up-to-date picture of how the still mobile population is distributed. Mozambique has had a recent comprehensive survey of poverty, which facilitates the identification of economically vulnerable groups. The levels of poverty are even greater than previously thought, which probably means that Mozambique should again be considered one of the poorest, if not the poorest country. Such evidence should inform disaster planning. Hence the role of INGC could be enhanced to facilitate the integration of such data in dialogue with the international donor community.

(iv) Improved Forecasting

However expensive it is, it is still a rational use of resources from the viewpoint of a country as poor as Mozambique to complete the TAO array of buoys by adding the Indian Ocean to the global network, now that the Atlantic network is under construction. This would enhance the dynamic climate models, and improve short-term prediction, thereby enhancing the credibility of ENSO disaster planning. The improved understanding of Indian Ocean dynamics would benefit the whole of eastern Africa, as well as the more densely populated Pakistan, India and Bangladesh.

H. INAM

INAM, the National Institute for Meteorology, has lost key personnel to Portugal in the last few years. This has doubtless been because of the lack of up-to-date equipment and prospects for serious research in INAM, and has adversely affected its prospects for serious international research collaboration. To some degree, this has been overcome by contacts that have been established by the current Director, Filipe Lucio, to conduct international collaborative research and sustain the research program of INAM. However, prior to Cyclone Eline, it was evident that INAM did not really register as an important part of Mozambican government policy making.

As an illustration of this point, it is worth mentioning that the former Director of INAM returned from Portugal with some colleagues, one whom were also a former INAM staff member, just after Cyclone Eline, on a longstanding engagement to lecture on the latest developments in meteorology and climate monitoring. While this was an imaginative and stimulating evening of lectures, and much it was new material to most of the staff of INAM, in reality there was little that would have been new to anyone reading WMO

material and surfing the Web regularly. This would include the Director of INAM and a few others present.[1]

While the number of weather and udometric stations remains so low compared to colonial times, and compared to real needs in a topographically and climatically diverse country, INAM will struggle to take its proper place in the international research community, as this evening of lectures indirectly indicated. The fact that it was taking place showed that the current Director is doing everything that he can to maintain international links and to upgrade the qualifications of his staff (there is a program to send staff abroad for further training). It also showed how much remains to be done, in that what should have been material that could be accessed from within Mozambique was being introduced as news from the developed world. It was gratifying that the new Minister was present, and one hopes that this was an indication that Cyclone Eline had prompted the senior levels of the Mozambican government to take meteorology and climatology seriously as an integral part of its decision-making process.

Nevertheless, it is worth stating that INAM did well in terms of issuing good weather forecasts, both during the 1997-98 El Niño and during the later floods. The performance could have been improved with Doppler radar and more weather stations, however. Thus, just prior to Cyclone Eline, there had been more rain in three days than during the previous major cyclone, Domoina in 1984. Although rain had been forecast, the intensity had not, and thus the floods of mid-February prior to Eline were not expected to be so severe. Hence it is not special pleading to say that the deterioration of the weather station network needs to be reversed, and that equipment needs to be updated, if not to the levels evident in Macau, at least to give the basic minimum of modern equipment, including the ability to receive data from the new ESA satellite.

I. INGC

This, the National Disaster Management Institute, is a fairly recent creation in its present form, having started its coordinating role in mid-1999. The national Action Plan for responding to the 1997-98 El Niño was drawn up by its predecessor (DPCCN) in conjunction with other relevant Mozambican Ministries. It was unfortunate that the donors did not better receive this plan, either in late 1997 or by the media in 1998 when the forecast was thought to have been 'wrong'. It forms a reasonable basis on which to build a standing contingency plan for disasters, since many of the measures would be the same for flood or drought. It would help if it were in English.

Its role of coordinating Ministries means that it has to have the political backing to be heard when necessary, an issue which seems also to have affected the new ISDR in the UN. Further work is necessary on improving the coherence and financial aspects of the planning process, but the experience of the recent floods should facilitate this

[1] This lecture was part of a program of establishing a Lusophone network of meteorological services, and coincided with the Portuguese Presidency of the European Union in the first six months of 2000. There had been a meeting of all Lusophone meteorology services, except Macau (where flight difficulties had prevented the new Director there from attending) in São Tome a few weeks earlier.

improvement. The issue of resources to implement any plan remains a critical one, as the floods showed, and this means that investment in infrastructure to mitigate the effects of droughts should be an ongoing process. It has to be built into donor priorities until such time as the Mozambican government is able to raise sufficient taxes to finance its own activities. Thus skill at the politics of international aid will be a continuing pre-requisite for the leadership of INGC and for Ministries.

MOZAMBIQUE
SETTING

1. Socio-economic setting

a. Country Introduction

Mozambique is located in the eastern end of southern Africa between parallel 10 degrees 27' South and 26 degrees 52' South, and between 30 degrees 12' East and 40 degrees 51' East. It has an area of 799,380 square kilometres. It has a 2,515-kilometre coastline on the Indian Ocean to the east, and 4,330 kilometres of land borders with Tanzania to the north, Malawi, Zambia, Zimbabwe, and South Africa to the west, and Swaziland and South Africa to the southwest and south.

Within the country, there are three major landscape types: the southern coastal plains rising about 200 metres above the sea level and covering about 44 per cent of the territory; the central and northern plateaux, between 200 and 1,000 metres above sea level and covering about 43 per cent of the territory; and the interior great plateaux and mountain ranges, over 1,000 metres above the sea level and covering about 13 percent of the territory.[2]

Mozambique has two seasons: a dry winter season from April to September and a rainy summer season from October to March. Most of the rain that falls in the southern African region is brought by the Intertropical Convergence Zone (ITCZ), which occurs between a dry, warm air mass and a moist, cool air mass. The ITCZ is a zone of intense rain-cloud development created when the Southeast Trade Winds (from the southern part of the region) collide with the Northeast Monsoons (winds from the north). The movement of the ITCZ southward away from the equator marks the start of the main rainy season in the Southern Hemisphere. The ITCZ migrates seasonally over Africa, in response to the position of the sun, and its arrival over an area generates substantial rain. The ITCZ, which in a normal year can fluctuate between mid-Tanzania and southern Zimbabwe, bringing good rains to most of southern Africa, dominates the weather north of Inhambane, and seldom penetrates south of this province.[3]

Rain in the northern and central parts of Mozambique[4] thus tends to be produced by westward winds generated by the ITCZ, bringing depressions and occasional tropical cyclones. Many of these hit Madagascar rather than Mozambique, which is one of the

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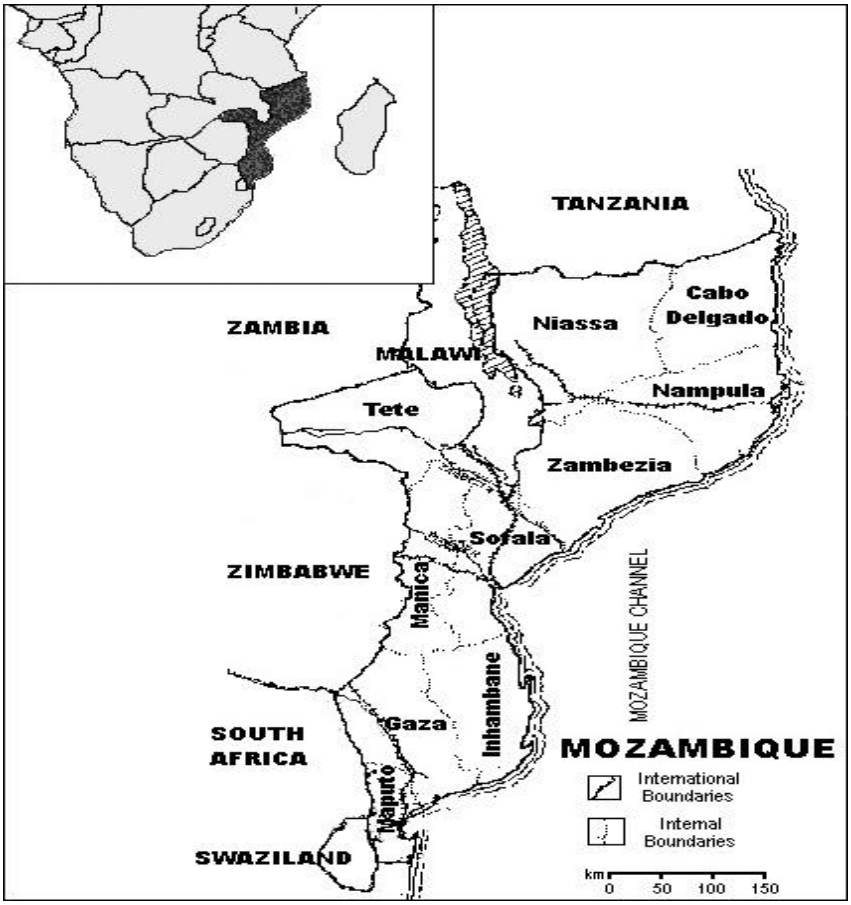
[2] UNDP 1998: 15.

[3] See Chenje and Johnson (eds) 1996: 25

[4] The conventional division of Mozambican provinces is as follows: the North consists of Niassa, Cabo Delgado, and Nampula; the Center is composed of Zambezia, Tete, Manica and Sofala; and Inhambane, Gaza and Maputo comprise the South.

reasons why the South tends to be dry. Those depressions and cyclones that do reach Mozambique tend to be heading from northwest to southeast, along the Mozambican coast, and frequently terminate in the city of Beira and at times Inhambane.

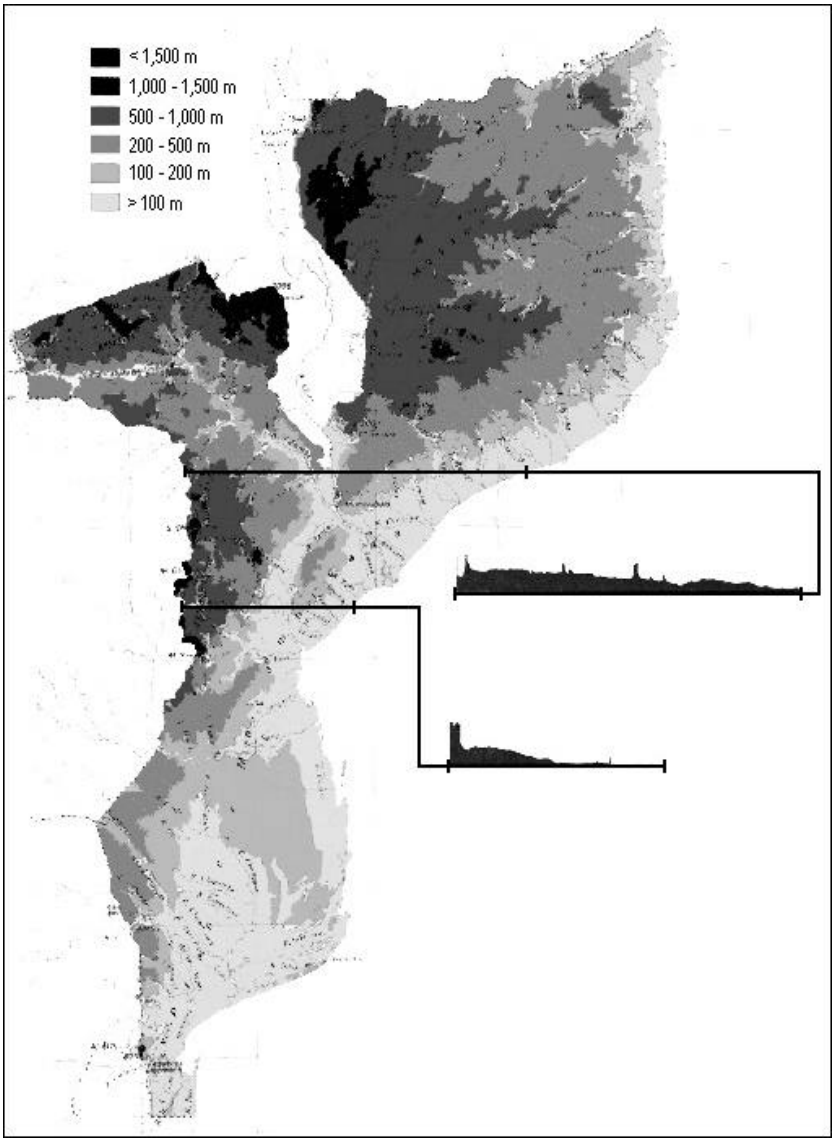
Map 1. Mozambique in Southern Africa



The southern climate tends to be dominated by dry weather. Such rainfall as does reach southern Mozambique tends to come from cold fronts crossing South Africa from the southwest. These can also terminate in Beira. Hence the Sofala Province has a very high index of precipitation owing to the confluence of all the factors, which cause rain in the country.

Mozambique's climate is predominantly tropical with three main sub-climates: humid tropical in the north, centre and southern coastal areas; dry tropical in the south and the Zambezi valley; and high altitude tropical in the interior mountains. The flora is mainly

Map 2. Mozambique's Topography



of dense, open forest and savannah types.[5] Mozambique is crossed by 13 major rivers, some of which have fertile flood plains, and has 15 million hectares of arable land, of which only about one fifth is cultivated.

Mozambique has experienced an accelerated population growth, from its 6.5 million in 1950 to more than twice that in the late 1980s. Being the third most populous country in southern Africa, after South Africa and Tanzania, it is estimated that it currently has over

[5] INE, 1997.

17 million inhabitants,[6] of whom 40% live in the provinces of Zambezia and Nampula, and 9% in the cities of Maputo and Beira. The recent war provoked major population movements across the territory. In the mid-1980s, 3.5 million people, who abandoned their rural homes because of the war, resettled in coastal cities such as Maputo and Beira, and at one stage, 75 percent of Mozambicans lived along the 50-km wide, fragile, coastal zone, which had an average density of 120 people per sq km. Unplanned settlement of people unfamiliar with the coastal environments was then a major cause of degradation of the fragile ecosystem.[7] However, the overall distribution of population is still broadly the same as it was before the war. Thus most of the rural population is still concentrated in Nampula and Zambezia, and the urban population in the two major cities.[8]

Population by province, 1998

	Number (000)			Per Cent			Gender Ratio
Province	All	Male	Female	All	Male	Female	
Niassa	822	398	424	100.0	48.4	51.6	93.9
Cabo Delgado	1374	660	713	100.0	48.1	51.9	92.6
Nampula	3280	1616	1664	100.0	49.3	50.7	97.1
Zambezia	3452	1654	1798	100.0	47.9	52.1	92.0
Tete	1294	613	681	100.0	47.4	52.6	90.0
Manica	1094	517	578	100.0	47.2	52.8	89.4
Sofala	1479	665	813	100.0	45.0	55.0	81.8
Inhambane	1156	501	656	100.0	43.3	56.7	76.4
Gaza	1082	459	623	100.0	42.4	57.6	73.7
Maputo Prov.	843	391	452	100.0	46.4	53.6	86.6
Maputo City	1040	504	535	100.0	48.5	51.5	94.3
TOTAL	16.917	7.979	8.937	100.0	47.2	52.8	89.3

Source: INE 1999: 9

Mozambique was a Portuguese colony until its independence in 1975. The colonial period brought widespread monoculture, particularly of cotton, as well as massive male labor migration to the neighboring territories. By inhibiting the production of food stocks, both labor migration (mostly from the south of the river Save) and the monocultural plantations of the center were powerful factors in rendering the country (especially in the south) highly vulnerable to the impact of natural disasters, particularly droughts.[9]

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[6] The 1997 census produced a total figure in the order of 15.7 million, but if the rate of census omission is taken into consideration, estimated at 5.1 per cent, the adjusted population for 1996, 1997 and 1998 is 16.2, 16.5 and 16.9 million, respectively. See UNDP 1998: 16.

[7] Chenje and Johnson (eds), 1996: 15.

[8] Beira is in Sofala Province.

[9] Mozambique has been vulnerable to drought since at least the 18th century. See Appendix 1.

The apparent paradox that the country is also vulnerable to floods is mainly due to the fact that the center and south are low lying,[10] whereas the neighboring countries to the west are on fairly high plateaux. So the rivers coming off them through the center and south can carry huge amounts of water from a very large catchment area. The construction of dams both in neighboring countries and in Mozambique has mitigated this problem only to a limited degree, since the dams tend to be kept at full capacity as a drought prevention measure. Hence they tend to discharge when rains are heavy, increasing the risk of floods in Mozambique.[11]

b. Brief History of the Development of Emergency Coping Institutions

According to Raikes (1988: 90-1), "Mozambique has been almost uniquely unlucky with the weather for most of the past decade, those years without drought having usually been blasted by torrential rains or high winds". This judgement about bad luck must be interpreted as a comparison with other African countries, since the climate in Mozambique has long been unstable (Appendix 1). However, the period since independence in 1975 does coincide with the apparent intensification of both warm and cold ENSO events, which started in 1976.

To this was added, for most of the period after independence, a fierce internal war which provoked at least 1.5 million refugees and 4.5 internally displaced people, rendering the country one of the most vulnerable in Africa and one of the poorest in the world. The war was at its most intense from 1982 to 1992.[12]

These two factors – extreme climate events and war – have always exerted their negative impact in a closely intertwined manner. Consequently, the Mozambican institutions' approach to dealing with emergency situations has always combined the efforts to react against both threats, which are somewhat indistinctly seen as producing the same effects, i.e. human loss and suffering, economic damage and famines.

As a result of the prevalence of such harsh conditions, those institutions coping with emergencies have always deserved great attention from the post-independence authorities, as witnessed by their impressive development and considerable capacity to respond, even if under the limiting circumstances dictated by Mozambique's peripheral context. Such peripheral conditions exerted a strong influence, imbuing them with specific characteristics.

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[10] Because of its low-lying southern coastal plain, Mozambique is about the tenth most vulnerable country in the world to sea level rises as a result of global warming: See Map 2.

[11] Despite already tangible efforts by SADC, there is still a long way to go regarding the integrated management of water resources in the southern African region.

[12] The most acute phase of the war occurred when the 1982-1983 El Niño was at its peak.

Both such conditions and characteristics will be briefly examined below. The extreme conditions resulted in a severe lack of material, technological and human resources. The institutional characteristics, as a consequence, could be described as deep dependence on external aid – and thus on complex aid politics and policies – and as fostering the development of responsive capabilities, much more than forecasting or preventive ones.

As Raikes indicates, extreme climate events have been recurrent in post-independence Mozambique. However, given the institutional break that occurred at independence, with the sudden flight of most of the skilled settler population and the consequent dismantling of the colonial state, institutions to deal with such events had to be established completely from scratch. In a new context in which other priorities looked like deserving the new authorities' primary attention, the first institutions of the kind to be created followed the impact of these events, rather than preceding them.

In early 1978, in the aftermath of a disaster caused by severe floods, which hit the Zambezi River in particular, the Government empowered an Inter-Provincial Commission of Natural Disasters and Communal Villages (*Comissão Inter-Provincial das Calamidades Naturais e Aldeias Comunais*). This was formed by officials coming from the central areas' provincial governments and became the first post-independence institution to co-ordinate emergency relief operations in Mozambique. Besides providing emergency assistance, it also fostered resettlement schemes that had long been planned, transferring the populations from the riverbanks to higher locations.

However, this kind of *ad hoc* institution was bound to have had extreme difficulties in assembling the means needed to respond to emergency situations. Two years later, in September 1980, the Government announced the creation of a more stable and institutionalised Co-ordinating Council for Prevention and Combat of Natural Disasters (CCPCCN), headed by the Prime Minister and including several Ministers. In its turn, the Council would soon create a Department for Prevention and Combat of Natural Disasters (DPCCN), which was to have an operational role under its command. The DPCCN was headed by a National Director under the direct authority of the Minister for Co-operation.[13]

The severe drought that started in 1982 was undoubtedly a major factor behind the need, which was felt to reinforce the above structure. In addition to the drought, several other factors contributed to provoke a structural and highly negative change. Mozambique's terms of trade deteriorated heavily,[14] but above all the war began to exert its destructive presence countrywide. As a result, Mozambique became a net food importer for the first time from 1983, as well as an important recipient of external food aid.[15]

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[12]Early linkage of national emergency apparatuses with the sector of cooperation is, in our view, a good indicator that, in the lack of local means, all forms of intervention were deeply based on foreign assistance.

[13]According to Hanlon (1991: 23-4), "the unit value (or price per tonne) of exports fell by 20% in just two years (…). Thus export earnings fell from a peak of $281 mn in 1981 to $132 mn in 1983".

[15] Hanlon (1991: 50, 61), considering the years between 1981 and 1985 as crucial in the degeneration of Mozambique's food security, writes that Mozambique's rank as aid recipient mounted from 51st in 1981 to 27th in 1985 (it would be 12th in 1988). According to Raikes (1988: 189) Mozambique received 7.6 percent

The government was now taking very seriously not just the threat of the drought but also others, which combine to produce serious vulnerability in the rural areas, particularly the war. Not eligible for benefiting from tangible aid from the socialist countries, Mozambique sought the support of the western powers, the United States in particular. This was accompanied by required signs that the country's politics were really changing, namely the first steps towards a market economy (and the request to join the World Bank and the International Monetary Fund) and, at the political level, the first contacts for peace negotiations with South Africa.

The United States eventually answered positively to requests for food aid, though enveloping such aid with specific demands.[16] One of those demands was that food aid deliveries should reach the beneficiaries without going through "suspect" state channels, namely the state commerce network and DPCCN. Mozambique reacted, arguing that preventing and combating natural disasters was a matter of national interest. Agreement was eventually reached that though DPCCN should take care of food aid distribution, an American non-governmental organisation, CARE (Concerned Americans for the Reconstruction of Europe) should be involved. And in fact CARE International came to Mozambique with a central and wide executive role, ranging from "technical assistance", staff training and organising DPCCN, as well as intervening in the system of food aid transportation.[17]

CARE International helped to create, within DPCCN, a Logistic Support Unit (LSU). While the DPCCN defined the policies, the LSU operated as a technical unit provided with radio communications and a truck fleet for aid delivery.[18] It was responsible for the fields of technical co-ordination and statistics, goods transportation, training and storage.[19]

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of the total cereal food aid to tropical Africa in 1976, a percentage that would rise to 10 percent in 1983, and to nearly 13 percent in 1986.

[16] As a US State Department official in Washington explained to Hanlon (1991: 43) several years later, "we made it clear to the government of Mozambique that our food aid is political. There are always conditions on aid, although they are often not explicit… To get better relations with us, Mozambique had to demonstrate a willingness to change its economic policies".

[17] See Abrahamsson and Nilsson 1993: 92-93 and *passim.* According to the authors, upon the arrival of CARE in Mozambique rumours circulated that the organisation had close links with the US Central Intelligence Agency. CARE would soon be in a privileged position to gather detailed information on the war situation in the country, at district level, and on the planning of emergency operations, population movements on the territory, etc. This agreement was behind serious debates within the US Congress since it went against the usual procedures of food aid distribution through non-governmental organizations.

[18] According to Macaringue (Interview, 10 January 2000), the LSU started with a fleet of 6 trucks and ended, at its peak in 1992, with a fleet of 410 trucks, by far the largest transportation entity in the country.

[19] The strong US influence on the national food delivery structure created some tensions with other donors, particularly the Nordic countries as well as UN agencies.

The combined negative impacts of drought and war forced the DPCCN to widen the scope of its assistance. While at the start it had targeted Inhambane only, by 1984 it was already operating in three provinces and by the end of 1987 it was reaching all the ten provinces of the country. By this time it created provincial delegations to co-ordinate assistance at the provincial level. Yet the Government felt that this was a very cumbersome structure and in May 1987 it created CENE (National Executive Commission for the Emergency) a lighter structure, which, headed by the Vice-Minister of Commerce, was to replace the CCPCCN.[20] Following the creation of CENE, CPEs (Provincial Commissions for the Emergency) were established in every province, in what was intended to be a more decentralised scheme: while CENE had its list of priority provinces, the CPEs at the provincial level would establish their own priorities and co-ordinate the emergency work.

From this period, there were two main structures taking care of coordination. The first was the Technical Council for the Emergency (CTE), chaired by the Coordinator of CENE and attended by the sectoral emergency units of the ministries involved, namely health, education, agriculture, construction and water, and transport and commerce. CTE was concerned with the identification, design, implementation and follow-up of emergency projects. The other major coordinating structure was the Emergency Operations Committee (EOC), also coordinated by the head of CENE and aimed at assuring articulation with international actors. Representatives attended EOC from bilateral donors, NGOs, UN agencies and government structures.[21]

At the end of 1988, when Mozambique had already signed an agreement with the World Bank and was showing the first signs of liberalisation of the economy, the government invited several partners to reflect on the efficiency of the state-based emergency logistics. At this time USAID strongly pressed for the involvement of private transport operators while other partners such as Canada, Holland and the Nordic countries considered this a very risky move, because private transport operators might not carry supplies into difficult areas.

From the end of the 1980s the government became concerned to prevent the development of parallel emergency structures. An effort was to be made to integrate the existing ones into other permanent state structures such as the Ministries of Agriculture, Commerce and Transport. At the same time, the pressing situation created by the war led the government to appeal to increased NGO participation in the emergency efforts. From this date, several tripartite operational agreements were established between government, NGOs and UN agencies, particularly the World Food Programme.

The 1991-92 drought, associated with the war-induced difficulties in delivering food aid to the victims, created what was perhaps the most difficult situation in the post-independence period. DPCCN was requesting internationally an average of 450 thousand tonnes per year, a volume it was incapable of handling. It was then that the WFP created

[20] However, the CCPCCN seems to have been revived subsequently, and met in April 1997: see Section B.

[21] Ratilal 1989: 77-79; 110-122.

UNILOG, its own local logistics unit. At the same time, in the talks preceding the 1992 peace accord, UNOHAC[22] was established as the humanitarian component of ONUMOZ, the United Nations Peace Keeping Operation in Mozambique.

For several authors the severe early 1990s' drought was a very important factor behind the strong pressure exerted by external partners (particularly NGOs) towards the reaching of a settlement between the government and the rebels. Only a cease-fire could make possible the opening of corridors so that emergency aid could reach the millions of starving victims. If so, it can be considered that this extreme climate event played an indirect but decisive role in putting an end to the long and fierce internal strife.

The implementation of the 1992 peace accord, which unfolded until 1994, still provided a huge field for emergency activities. Besides the need to support the repatriation of 1.5 million refugees in neighbouring countries and the resettlement of more than 4.5 million internally displaced, the emergency structures were also involved in supporting the victims of the 1991-92 and 1994-95 droughts, and of the 1996 floods.

However, with the end of the war, undoubtedly the major cause of the emergency situations in the country, it was felt that mere emergency aid operations had to be replaced by operations of another nature, more focussed on prevention. At the end of 1994 CENE ceased to operate and a series of discussions took place, internally and with foreign counterparts, aiming at defining the strategy to follow. In early 1995 there took place the first internal consultation and all departments maintained that there was a need for a coordination body. In the following year, after discussions with UN agencies, donors and SADC countries, a new institutional model began to emerge: it had to be an institution much smaller than DPCCN but highly capable of assuring coordination.[23] In 1997-98 several versions of the project were circulated and discussed before being submitted to the Ministry of Foreign Affairs and Cooperation, and the Council of Ministers. Finally, in June 1999, the new organ, the National Institute for the Management of Disasters (INGC) was created, replacing DPCCN.

INGC's challenges, besides the one of assuring effective emergency coordination, consist of establishing a new perspective based on prevention, on integrating banks and insurance companies as partners, and on the mobilisation of companies and the society at large. The INGC, under the Ministry of Foreign Affairs and Cooperation, provides regular information to the Council of Ministers.[24]

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[22] UN Humanitarian Assistance Coordination

[23] The role played by the University of Cranfield (UK) was important in the discussions towards the design of the new coordinating institution.

[24] Interview, Silvano Langa (INGC), Maputo, 11 January 2000.

c. Government mechanisms for dealing with climate-related impacts

Within the country, the emergency body dealing with the impact of extreme climate events is coordinated by the National Institute for the Management of Disasters (*Instituto Nacional de Gestão das Calamidades*) INGC, created in 1999 to replace formerly existing structures, particularly the DPCCN. The INGC is under the Ministry of Foreign Affairs and Cooperation.

At the preventive level, the most important entity is the National Early Warning System for Food Security (*Sistema Nacional de Aviso Prévio para a Segurança Alimentar*), integrating the National Directorate of Agriculture and the National Institute for Agronomic Research (INIA), both from the Ministry of Agriculture and Fisheries, and the National Meteorological Institute (INAM). SNAPSA has two main components, namely agricultural statistics and agrometeorological information. The National Directorate of Agriculture, in its role as SNAPSA coordinator, is a member of INGC's technical committee.

Other bodies participate in both the emergency and prevention activities, namely the ministries of Coordination of Environmental Action, Health, Finance, Commerce and Transport.

At the level of forecast, INAM, despite its still serious limitations of staff, equipment and meteorological stations,[25] is acquiring growing visibility. INAM participates not only in the action within the country but also in regional fora, within the context of SADC's strategy aimed at integrating regional forecasting capabilities. Of particular relevance, in this respect, is SARCOF, the Southern African Regional Climate Outlook Forum. Mozambique also participates in another important SADC sector, the Regional Association 1, which is concerned with cyclone monitoring. It also has links with the Regional Tropical Cyclone Centre on the island of Reunion, and with the Drought Monitoring Centre (DMC) based in Harare, which seeks to contribute to the reduction of negative impacts of drought and other adverse weather conditions upon agricultural production. DMC "has devised regional rainfall forecasting schemes that are largely driven by the El Niño Southern Oscillation (ENSO) phenomenon, the Indian and Atlantic SST, the regional pressure and wind anomaly fields. An operational regional ENSO

[25] INAM's staff includes 12 officials in the Weather Forecasting Department with Bachelor degrees from Eduardo Mondlane University. The INAM Director and the Head of the Monitoring Network have MSc. Degrees, and the Heads of the Informatics and Training departments also have Bachelor degrees. The service has five main departments, namely: Department of Weather Forecasting; Department of Monitoring Network (including the agrometeorological sector); Department of Informatics; Department of Studies and Applications (still being created) and Department of Professional Training. It also had two technical departments: Technical Support and Administrative Services. Interviews, Mussa Mustafa (INAM), Maputo, 15 December 1999 and 27 March 2000.

signal interpretation scheme that has been successful in predicting the 1994-95 drought and the nature of the 1995-96 rainy season in southern Africa has been developed".[26]

At the level of research and within the country, activity is centred at the National Institute of Agronomic Research (INIA) and at Eduardo Mondlane University (Faculty of Agronomy and Department of Geography). There are also other research associations such as the Group of Environmental Works (GTA), and the Universidade Pedagogica has links with INAM.

International agencies also play important roles as partners in the field of food security, the most important being the World Food Program, the Food and Agriculture Organisation, with its Global Information and Early Warning System (GIEWS), and USAID's Famine Early Warning System (FEWS).

Finally, and particularly since 1993, there are a multitude of NGOs and civil society associations participating in activities concerning climate-related impacts.

2. Climate-related and other natural hazards in Mozambique

a. Health problems associated to extreme climate events

Mozambique has been particularly plagued by natural disasters throughout its recorded history, and particularly since independence. In order of concern, they are drought and flood (Appendix 1) followed by periodic tropical cyclones, which can be devastating. Drought can be accompanied by plagues of red locust and other species, as well as malaria in standing water. Apart from the real threat of famine, the droughts are often associated with outbreaks of epidemics, historically, for both humans and livestock, and with infestations of pests, particularly locusts.

Cholera tends to be associated with heavy rain and floods, although if drought reduces river levels to the point where there is an incursion of the sea upriver, it is possible that salt water-borne transmission may take place. The ports of Beira, Nacala and Maputo, in that order, are susceptible to cholera[27] when precipitation is high or rivers flood, or when there is a sea incursion into low lying areas. Malaria is endemic in Mozambique, but the incidence can grow when rainfall is high.

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[26] Chenje and Johnson (eds) 1996: 152. Other SADC sectors relevant to combating weather impacts are the Environment and Land Management Sector (ELMS) based in Maseru, Lesotho; the Food Security Sector based in Harare, Zimbabwe; the Energy Sector based in Luanda, Angola; the Inland Fisheries, Forestry and Wildlife Sector, based in Lilongwe, Malawi; the Marine Fisheries Sector based in Windhoek, Namibia; and the Transport and Communications Sector, based in Maputo, Mozambique.

[27] Personal Communication from Marcelino Lucas, 20 December 1999.

With drought, which is what was forecast in 1997 with a probability of around 50 per cent for the centre and south of Mozambique,[28] it is not only the incidence of cholera which can increase: dysentery, conjunctivitis, trachoma, dermatitis and bubonic plague are also likely to do so.[29] In addition, because of food insecurity, malnutrition and other conditions resulting from a scarcity of micronutrients, as well as poisoning from eating unripe bitter cassava, can occur.[30] The floods can be linked at times to sudden increases in malaria.

While some of the epidemics and pest infestations either cannot recur (for example, smallpox has been completely eradicated) or are less likely to recur, others do remain likely to break out with population movements induced by extreme weather events or associated conflicts. On occasion this can include typhoid and bubonic plague. Cholera is also likely even for static populations with floods or even with regular rainfall.

Part of the reason for the prevalence of cholera is the relatively high proportion of the population living near the sea with poor sanitation facilities. Since marine phytoplankton can probably provide a refuge for the cholera vibrio,[31] this is a particular hazard in major ports such as Beira where the land is low lying and subject to sea incursions at times.

b. Post independence weather events

In 1976, less than one year after independence, the country was hit by cyclone Claudette. In that same year and in the following, the southern rivers of Umbeluzi and Limpopo were flooded.

In 1977/78 severe floods occurred in three main rivers damaging large areas of farmland and causing serious loss of human life, crops, cattle and infrastructure. The river Zambezi was one of the most affected, from March 1978. Considered the biggest floods in the region in the 20th century, they affected four out of the ten Mozambican provinces. Caused by pouring rains in Zambia, they were aggravated by sudden discharges of the up-stream Kariba dam, which in its turn obliged the Cahora Bassa dam to open eight of its ten floodgates.[32]

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[28] Governo de Moçambique 1997c: 2-3. For the South, it was 55 percent, for the Center, 50 percent, and for the North, between 20 and 35 per cent.

[29] *Ibid*. 17.

[30] *Ibid*.17 The path-breaking Mozambican research on the issue of cassava poisoning is cited in McMichael *et al.* 1996.

[31] McMichael *et al*., 1996: 99

[32] This possibility, theoretically expected to occur only every 100 years, came true three years after the dam was operative. See Borges Coelho 1993: 379.

Losses caused by the 1978 Zambezi River floods

Losses/Provinces	Tete	Manica	Zambézia	Sofala	Total
Dead	31	3	2	9	45
Displaced	89,568	22,000	30,000	77,420	218,988
Crops Lost (Ha)	25,114	9,500	9,000	17,880	61,494
Schools Destroyed	53	14	20	68	155
Shops Destroyed	-	3	5	-	8

Source: Borges Coelho 1993: 380.

Tete was undoubtedly the most affected province. The provincial capital city Tete had its vital bridge over the Zambezi seriously damaged, and its water supply motor and the broadcasting transmitter submerged, amongst other major losses. Mutarara was the most affected district in the province with, officially, 31 dead, 89,568 displaced, 25,114 hectares of crops lost and more than 50 schools destroyed or damaged.

In the following year of 1979 a cyclone hit the north of the country, damaging crops and, in Cabo Delgado, the fishing fleet and a power station.

Between 1981 and 1984, southern Africa was hit by a prolonged drought. In Mozambique, as a consequence, there was famine mainly in Inhambane, Gaza, Maputo and Tete, affecting 4.5 million people or about a third of the population. It was the worst drought in the recorded history of the region until then.[33] Eight of the ten provinces were affected, particularly Inhambane, Gaza and Maputo, in the south. It was estimated that 100,000 people died between 1982 and 1984 as a result of the drought and because relief efforts were hindered by the war.

In 1984, cyclone Domoina hit southern Mozambique and floodwaters following in its wake left 50,000 homeless, 350,000 with their crops destroyed and 50,000 cattle drowned. Road and railway bridges were damaged as well as small irrigation dams. The trees of important export crops (citrus, cashew nut and coconut) were blown down.

In 1985 floods occurred again in southern and central Mozambique following heavy rains. Thousand of hectares of crops were destroyed. Meanwhile droughts occurred in other parts of the country.

In 1987, there was drought and famine in the south.

In 1988 floods occurred on the Incomati, Limpopo, Buzi, Pungue and Zambezi rivers, in the south and centre of the country. Zambezia province was struck by a cyclone.

[33] Ratilal 1989: 40-41.

In 1989 late rains took place in the southern provinces, damaging crops. Floods occurred on the Pungue, Zambezi, Licungo and Incomati rivers, washing out thousands of hectares of farmland.

In 1991-92 southern Africa, including Mozambique experienced the worst drought in living memory.

In 1994-95, again the SADC countries were hit by worst drought in memory, surpassing the effects of the 1991-92 drought, although for Mozambique itself the drought of 1991-1992 remained the worst.[34]

In 1997-98 localised floods occurred in some areas.

In February 2000, the southern Mozambique provinces of Gaza and Maputo (and particularly the city of Maputo) were hit by the worst floods in 50 years. The main roads were cut; rivers burst their banks and washed out dozens of bridges. In some areas, flooding pushed land mines left over from the civil war into areas that had been cleared.[35] The floods were followed by cyclone Elina, which hit the central areas and the provinces of Inhambane and Gaza. The latter province, already suffering heavily from the floods, had its situation aggravated and lost thousands of hectares of crops. Preliminary results of the combined effects of floods and the cyclone point to more than 450 deaths in Gaza Province alone, thousands of cattle lost and huge tracts of crops ruined. The expected outbreaks of dysentery, cholera and malaria were already giving their first signs by March 2000.

However, recent history has shown that while both having profound negative impacts on the economy and society, droughts and floods represent rather different threats, the former being much more severe in their effects than the latter. In fact, it is much easier and quicker in terms of agriculture and food supply to recover from floods than from drought, although the damage to infrastructure and fruit trees may have longer lasting effects. Floods always cover much smaller areas than droughts and rain-fed agriculture, which is overwhelming in Mozambique, tends to be less affected by them. The unexpected floods of 1997-98 provide a good example: although covering 34,350 hectares belonging to 40,450 rural families, this only represented 0.86% of the total cultivated area in the country, which is insignificant, particularly if compared with the benefits brought by rains to the rest of the cultivated areas. [36] In contrast, droughts usually cover extensive areas, which are terribly slow to recover.

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[34] Chenje and Johnson (eds) 1996: 35.

[35] According to one account, the floods in Matola, on the outskirts of Maputo city, caused a leak in a deposit of toxic waste with effects still to be determined.

[36] Governo de Moçambique [1997a].

3. Scientific research on El Niño in Mozambique

The institutional settings for meteorological and climate research are INAM, INIA and the Eduardo Mondlane University. One of the main problems faced by researchers is that they are very few in number, and tend also to carry burdensome administrative responsibilities as a result of their expertise. This seriously limits the time that can be devoted to research. In the case of INAM, the lines of communication with senior levels of government can be very short when extreme weather events occur. Responding to such political pressures can also reduce the time available for research.

The other important issue faced by such researchers is the lack of equipment, especially up-to-date equipment. This also hampers the daily weather forecasting, where maps are still drawn by hand. In addition, administrative support is not very strong, which implies raising skill levels rather than increasing the number of personnel.

Despite such difficulties, INAM and INIA maintain a series of international contacts as well as working with UN agencies such as FAO, which have their own satellite image processing facilities serving GIEWS in Rome. Among the international academic contacts are those with the University of Natal,[37] the University of West Lafayette, and the University of Oklahoma. The institutional contacts include those with NOAA, with the UK Meteorological Office in Bracknell, with Nairobi, with the WMO Drought Monitoring Centre in Harare, and with the WFP whose southern African regional headquarters are in Maputo.

Applied research at the regional level, within the context of SADC, is a very important one. Here, the World Meteorological Organisation (WMO) and the United Nations Food and Agricultural Organisation (FAO) assist the region in a project on "Drought monitoring for eastern and southern Africa" which as two drought-monitoring centres in Nairobi (Kenya) and Harare (Zimbabwe), aimed at weather monitoring in the region.

There is FAO involvement mostly through a Regional Early Warning Unit (REWU) based in Harare and connected to National Early Warning Unites (NEWUs) in each country within the region.

According to the Drought Monitoring Centre, "member countries send raw weather data to the centres. The centres in turn prepare bulletin such as the *Ten-Day Drought Watch for Southern Africa* and the monthly *Drought Monitoring Bulletin*. Meteorological data is exchanged among member countries and the drought monitoring centres through WMO's Global Telecommunications system, by fax and telephone, but the performance of some models of communication has not been satisfactory. Poor communication remains one of the major constraints to effective exchange of meteorological data in southern Africa".[38]

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[37] Surprisingly, there seems to be no contact with the University of Cape Town, which has a southern African climate model.

[38] Chenje and Johnson (eds) 1994: 95.

The research also includes interesting work on historical rainfall data, showing the areas affected by drought in the El Niño events of 1982-1983, 1991-1992, and the warm event of 1994-1995 (see Section C: Teleconnections).

4. Historical interest in El Niño before the 1997-98 event

A survey of the press for 1982-83 reveals no mention of El Niño at that time. Indeed press coverage of the drought was sporadic, probably because everyone was so well aware of its extent and severity (Appendix 3).

Interest in Mozambique in El Niño was widespread from the 1997-1998 event (Appendix 4). Prior to that, although in a limited scale, the 1991-92 and the 1994-95 started to spread the idea to the general public that ENSO-related weather anomalies in other parts of the world could be having an impact in southern Africa.[39]

[39] Data from the media on the 1991-92 and the 1994-95 droughts is still being researched.

B. 1997-98 EVENT

5. Information on the 1997-98 El Niño in Mozambique

Oceanographers noticed as early as March 1997 the unusual warming of sea surface waters in the eastern equatorial Pacific. This warming process intensified "leading to levels of Sea Surface Temperatures (SSTs) in July, which had not been observed over the past 50 years".[40] It was then forecast that an ENSO global weather anomaly was in the making, one that could lead, in extensive parts of Southern Africa, to a "dry spell with substantial moisture lost and resulting crop production failure during the second half of the growing season (December to February)".[41]

The Mozambican analysis of the event in July 1997 came in a special bulletin from the *Sistema Nacional de Aviso Prévio de Segurança Alimentar* (SNAPSA).[42] This consisted of two pages of text and 5 pages of figures and maps. The maps showed the geographical distribution of the main droughts in Mozambique since 1969/1970.

The first figure showed the worldwide distribution of ENSO-related impacts. The second and third, using TOGA[43] as the source, showed the thermocline under normal and El Niño conditions in the Central Pacific along the equator. The fourth showed the 1997/98 Southern Oscillation Index (SOI) in comparison with those of 1982/83, 1991/92 and 1996/97. That of 1997/98 at this stage looked similar to those of 1982/83 and 1991/92. The fifth figure showed the positive SOI pattern linked with humid conditions (in Mozambique) and the negative SOI linked with dry conditions. Superimposed on this was the SOI pattern from January to May 1997. This clearly showed a marked decline into a negative SOI from February to March with a further decline till May, below the normal dry conditions (implying a greater drought than normal). The sixth figure showed the SOI for 15 drought years since 1963.

The text also introduced the concept of La Niña, which usually had the opposite impact to El Niño in a given region. The southern African droughts of 1982/83, 1991/92 and 1994/95 were clearly related to El Niño episodes. The SOI was then explained and the negative relation to El Niño pointed out. The link to probable drought in southern Africa was explained referring to Figures 4 and 5. The SOI was then examined in relation to

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[40] Government of Mozambique 1998a. The government of Mozambique refers to being aware of the strong probability of the occurrence of an El Niño event only from July. The nature of this 4 months information gap (between March and July) is still not clear. Governo de Moçambique, 1997c: 1.

[41] World Food Program 1997a: 3.

[42] Sistema Nacional de Aviso Prévio para a Segurança Alimentar,1997a. The SNAPSA project was financed by the EU and executed by FAO.

[43] Tropical Oceans Global Atmosphere system, linking a network of buoys along the tropics in the Pacific Ocean with satellites.

Mozambique for 13 drought events from 1951/52. Five of these were highly correlated with a negative SOI, four were moderately correlated and five were not correlated.[44]

The years 1982/83 and 1991/92 were highly correlated with warm ENSO events. The year 1977/78 was a warm ENSO event that was not correlated with drought in Mozambique. The 'arbitrary' definition of zones affected by drought was precipitation of less than 600mm, since the water requirement for maize (corn) is around 800mm. This forms the basis of the maps at the end of this document. The sources cited for this analysis, which indicate scientific links, were INAM, the Drought Monitoring Center, Harare, the South African Weather Bureau, the Oceanography Department of the University of Cape Town, and the SADC Remote Sensing Project.

Based on the July SNAPSA forecast of the possible negative effects of ENSO, the Government of Mozambique (GOM) began to take steps in July 1997. These measures were at both central and provincial level, and involved donors and UN agencies. The aim was to identify the zones most at risk, and to evaluate the logistical capacity to place goods rapidly in the critical zones. A draft national Action Plan was drawn up by October and the final version was completed by December 1st.

a. Initial Reaction

Going into more detail on the months July-December 1997, the GOM reaction to the forecast of a possible drought was noted by FAO Mozambique. On August 5th FAO Mozambique informed FAO Southern African Regional Headquarters in Harare that the GOM had established an El Niño monitoring committee composed of MAP (Ministry of Agriculture and Fisheries), MICOA (Ministry for Coordination of Environmental Affairs) and the Ministry of Transport. The MAP was preparing a workshop for the end of August with provincial and district agricultural officers to discuss drought mitigation measures. Donors were already requesting more information, especially the FAO forecast and its recommended measures. SNAPSA (the National Food Security Early Warning System), which received Technical Assistance from FAO, had already provided information with its July bulletin. USAID had also convened a meeting to explain the phenomenon of El Niño. The FAO representative was at this time in discussions with USAID, the European Union (EU) Food Security Unit (FSU), and other donors, to assist MAP in preparing an agricultural strategy, and to provide information to donors in a specific meeting about drought mitigation measures.

At the same time, August 5th, FAO informed the UNDP of the contents of the USAID meeting: drought-proofing the economy, agricultural production strategies, food security, vulnerability assessment and targeting, as well as other specific initiatives such as disaster preparedness. The EU FSU had co-initiated this proposal to provide donors with more information at a specific meeting. USAID had initiated the process of consultation with donors, including NGOs, and was prepared to participate in such a meeting. Thus

[44] The Table giving dates of the 13 droughts is reproduced in Section C: Teleconnections.

both the major donors in Mozambique (USAID and EU) were active quite soon after the Mozambican government had received an El Niño forecast.

As part of the process of preparing for the donors' information meeting, DINA (National Directorate of Agriculture) at MAP prepared (in conjunction with the WFP and the USAID FEWS - Famine Early Warning System) an Explanatory Note on the Possibility of Drought during the 1997-1998 Crop Season and Preliminary Measures to Minimize its Effects. This five-page document, issued on August 15th, used NVDI maps and seasonal rain averages as well as charts on ENSO to explain the situation in clear terms. In the meantime, the normal Mozambican process of retrospective evaluation of actions continued, with a meeting called on August 18th by the CCPCCN (Coordinating Council for the Prevention and Combat of Natural Calamities) on the floods of April 1997.

At the same time, FAO Regional Headquarters in Harare was becoming more anxious about the developing El Niño event, and on August 20th warned FAO Mozambique that concern was being expressed from Brazil to Ethiopia to the Philippines.

After this initial reaction phase from the GOM and international agencies, FAO followed up with an FAO El Niño-Southern Oscillation Primer, [45] a seven-page document that was sent to the Minister at MAP, to DINA, INIA and INAM, as well as to the UNDP Representative, inter alia. This was in English with a good analysis of the SOI from 1961 to 1996, and figures taken from NOAA web pages. It was written in Harare and not circulated widely in Mozambique, except to those agencies most involved in preparations for the event. It also described the position of FAO in terms of response mechanisms and the development of a strategy covering extreme atmospheric factors in general and involving several institutional partners. The recommendations were couched in regional terms.

The UNDP had been asked by FAO to co-ordinate the UN agencies' response in Mozambique to El Niño, and on August 22nd the UNDP agreed to discuss this proposal at the next Heads of Agency meeting. The UNDP subsequently proposed to call a meeting in September, which suggests that it did indeed take on this Coordination role. However, at this stage, the Special Relief Operations Service of FAO Rome was not willing to commit FAO to any assistance (August 24th). [46]

b. Developing Response

By early September, the response process had moved on to the issue of financing the major national meeting at which the contingency plan was to be discussed, and at which the donors were to receive further information on the GOM proposals. The FAO was

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[45] Gomes *et al.*1997. This paper attributed the introduction of El Niño as an issue to southern Africa to the SADC Regional Early Warning Unit and the WMO Drought Monitoring Center. Both are based in Harare. These institutions were also credited with introducing operational warnings in the Region.

[46] This seems to have changed later, but the time of the change is not documented in the sources available to the Mozambican El Niño team.

invited to an urgent meeting on September 2nd with the Vice-Minister of Agriculture to discuss such financing, and informed the WFP Regional Manager for Southern Africa of this. This indicates that FAO and WFP were coordinating closely in Maputo, which was important not just for Mozambique, but at a southern African regional level.[47]

The Mozambican Government also continued its preparations in within a regional perspective. Thus a regional meeting was held on September 8th in Kodoma, Zimbabwe, which took place with the participation of the national meteorological services in southern Africa and international climate research institutes. The meeting's objective was to discuss and articulate a consensus forecast for the region. Next, the regional forecast was translated into national forecasts that were to form the basis for appropriate national plans and strategies "to guide crop production, health services and water resources management such that the worst impacts of potential drought are avoided".[48]

Prior to the September 8th Kodoma meeting, on September 3rd, the EU FSU agreed to contribute USD 40,000 to the proposed MICOA seminar/workshop (as distinct from the national meeting). It faxed FAO to ask if FAO could contribute USD 5,000-10,000, and stated that WFP had agreed to cover any shortfall. Shortly thereafter, on the 6th, invitations went out from the Ministry for Coordination of Environmental Affairs (MICOA) for the seminar (as it was by now called). Its title was *Action Planning in Response to the Seasonal Climate Forecast for Mozambique*, and it was coordinated by the National Meteorological Institute (INAM) and the International Research Institute for Climate Prediction (University of Columbia, New York). It took place with the participation of representatives from INAM, the SADC Drought Monitoring Center, the ministries of Environment, Agriculture, Health and Public Works, Eduardo Mondlane University, the Pedagogical University and several international organizations, including the NASA Goddard Institute for Space Studies.[49] The aim was "to review and discuss the forecasts in the context of implications for food, health and water resources security".[50] The meeting took place on September 15th and September 16th.

Meanwhile, as the GOM developed its action plan by means of this seminar and other meetings, the WFP issued a letter on September 9th to a wide list of donors on *Drought Contingency Monitoring Planning for Southern Africa*.[51] It informed donors that it was

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[47] The WFP had established its Regional office in Maputo because of the fact that southern Mozambique was well known to be especially drought-prone. On the other hand, the FAO had established its Regional headquarters in Harare in order to make use of the capacity there to receive satellite meteorology images, and to transmit them by telephone to SADC countries if no other means was available. Both FAO and WFP have their world headquarters in Rome.

[48] Government of Mozambique 1997b: 1.

[49] The Goddard Institute was mentioned in the letter of invitation, but not in other available documents. No attempt was made to access USAID sources.

[50]. Government of Mozambique 1997b: 1.

[51] This kind of exercise was usually undertaken in conjunction with the FAO.

proposed to deploy two interdependent teams on this issue. The first would focus on the economic impact of the potential drought, from a food security and needs assessment perspective, and would examine areas and populations likely to be affected. VAM (Vulnerability Analysis and Mapping) would also be in this team, and would work closely with FEWS.[52] The second team would cover logistics analysis, and would interface with the first team, taking the socio-economic and food resources analysis into account in view of regional logistics structures and possible supply routes. Extensive reference would be made to the experience of the droughts of 1991/2 and 1994/5.[53]

The meeting *Action Planning in Response to the Seasonal Climate Forecast for Mozambique* took place on September 15th and 16th. The summary of the forecast included spatial and temporal implications, including the fact that the lack of signs of drought in the period October-December might make the public less convinced by the forecast and less willing to take steps against eventual drought conditions. Efforts to educate the public regarding the forecast were therefore especially important.[54]

The recommendations for the response strategy were interesting, since they may not have been fully taken on board. It was emphasized that structures and institutions created in response to the current climate forecast should be conceived as permanent and very effort should be made to move away from an 'emergency response' planning mode towards routine incorporation of climate forecast information into the environmental planning process.[55] Near-term recommendations were made for agriculture, health, water resources, drought relief, and communications and coordination. Long-term recommendations were made on planning capacity, monitoring, research and education.

The near-term measures were compatible with the subsequent Multisectoral Action Plan, and reference was made to that document as being under development. Suggestions as to its dissemination in different formats to suit different parts of the country were made, although it is not clear whether this suggestion was taken up. Nevertheless, this shows that the various meetings were part of a fairly well integrated planning process, and other suggestions, including future follow-up and monitoring meetings, were certainly taken up.

The long-term measures still make a lot of sense, and are still worth pursuing, including the expansion of the observational network for Mozambique with respect to climate, hydrological and vegetation monitoring. The need for research to build expertise in

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[52] VAM appears to be a section within WFP Rome, and FEWS is part of USAID.

[53] Both of these were warm events in ENSO terms, although this was not mentioned by the WFP.

[54] As will be seen later, this aspect did not go too well, and the media were not entirely to blame.

[55] To some degree this has since happened with the inauguration of the INGC, but the routine monitoring of climate and weather does not seem to have been taken on board as important by the government at the time. The recent floods may bring about a change in attitude, and the presence of the new Minister of Transport and Communications at the inaugural meeting in Mozambique of a climate research network of Lusophone countries and territories on 22 March 2000 may be seen as a hopeful sign.

climatology and seasonal climate forecasting, as well as agronomic applications and social sciences, stressing the interdisciplinary nature of the subject, is well taken. The International Research Institute for Climate Prediction as Columbia University, New York offered training programs in forecasting and applications that were recommended for the enhancement of in-country expertise.[56] Finally, it was advocated that capacity be developed in educational aspects of climate forecasts, targeted at educating both policy makers and the public in making full use of climate forecasts in decision-making.[57]

The GOM response moved into top gear by mid-September, with an invitation to international agencies to attend the national meeting planned for October 1st to 5th 1997: *The National Preparatory Meeting for the Crop Season 1997/98*. This was where the first draft of the Action Plan was presented for discussion.[58] Participants were informed of the possible drought, especially south of the river Save (that is, in the Provinces of Inhambane, Gaza and Maputo).

The October bulletin from the SNAPSA was presumably prepared for the *National Preparatory Meeting*. It contained nothing new on El Niño itself, but did estimate the likely crop reduction by comparing the relatively good year of 1989/90 with the drought year of 1991/92. Cereal production had been 691,000 tons in the former year, but had dropped to only 227,000 tons in the latter. For Mozambique, 1991/92 was probably the worst drought of the century, and hence the best basis on which to judge the likely effects of this, the biggest El Niño.

In the opinion of FAO Mozambique, expressed in a fax to Rome on November 6th, the *National Preparatory Meeting* of early October had been very wide in its scope. The *FAO Special Programme for Food Security* was also presented on that occasion. All of the National directors from MAP had been present, as well as all 10 Provincial Directors, the District Directors of the most important agricultural districts, and the officials in charge of key projects and programs within MAP. The UN agencies, major donors and NGOs were also invited for some of the sessions. On the basis of information collected for this Meeting and some discussions held during the event, MAP submitted its *Multisectoral Action Plan for the Mitigation of the Effects of Drought (1997-1998 Crop Season)*, containing an overall assessment of the situation. It also assessed the requirements for seeds (by province and by crop), for agro-chemicals, equipment and tools.[59]

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[56] This does not seem to have been followed up on.

[57] This remains an important task, which should be pursued actively while the floods are a recent memory.

[58] The international agencies were not present for the whole meeting, since much of the meeting was concerned with Coordination planning internal to the GOM.

[59] This is discussed in detail in Appendix 2, together with the commentary on it by the Food Security Unit of the EC Delegation in Mozambique (EU FSU).

c. Growing International Concern

Just prior to this National Meeting, which took place at the Pequenos Libombos dam, there was an indication of the growing concern about El Niño within FAO, with the news that the Livestock Section was also planning a drought response mission.

This was followed immediately after the National Meeting by a letter from FAO on October 6th to the National Director of DINA. It stated that the FAO GIEWS (Global Information and Early Warning Service, based in Rome) had contacted FAO's southern African offices to alert them that this year's El Niño was being predicted by various experts as one of the most severe of the century. The letter asked the National Director for all available information on weather and crop conditions to be relayed to FAO on a regular basis over the coming months. Perhaps because of this concern, which may have made preparations for a crop and food assessment mission more protracted than in normal years, the mission, which had been brought forward to January 1998, was postponed until February/March.

Regular monitoring for southern Africa as a whole was initiated by WFP with a series of fortnightly reports, which began on October 14th. These went under the general title of Contingency Planning for El Niño, and were usually referred to as the 'fortnightly update'. The first was 11 pages long. The last was circulated on June 11th 1998.

By 16th October, the Inter-Ministerial Technical Group met, apparently for the first time. It included the Ministry of Health (MISAU), MAP, MICOA, around seven other Ministries, and various National Institutes such as INAM, the DPCCN and INDER (The National Institute for Rural Development). The main UN agencies were also present, namely the UNDP, WFP, FAO, WHO, and UNICEF. The main bilateral donors present were USA, the Netherlands, and the UK, along with USAID and the EU FSU, which had initiated the process leading to this meeting.[60] Together with the Inter-Ministerial Technical Group, the donors were known as Task Force El Niño.

The first revision of the Action Plan[61] appeared in late October, taking account of comments made prior to and during the National Meeting. It was sent by FAO Mozambique to FAO Special Relief Operations Service, Rome, on November 6th together with the Executive Summary in English and the budget for the Action Plan. A translation of the full Action Plan was not possible. The fax stated that so far the government did not seem to require a national consultant for in-depth assessment of damages. (Presumably this implied that FAO was willing to fund such a post.)

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[60] The press was also present, and the Mozambican Information Agency (AIM) had already carried a report on the drought on October 8th.

[61] Governo de Moçambique 1997c.

In November, the WFP published a report covering seven SADC countries, including Mozambique.[62] Among the more interesting points made was that in terms of food security Mozambique was in a much better position than in 1991-92, when cereal production had only been 17 per cent of the figure for 1996-97, just prior to the current El Niño. Despite this, donors were reluctant to fund a physical food reserve stock, preferring a cash reserve on the grounds that a grain reserve would incur additional costs such as storage losses and warehouse costs.[63] The report also advocated measures for early warning monitoring, policy review and actions and response options of two types: mitigation/preparedness and relief/rehabilitation.

On November 12th, FAO Regional headquarters in Harare informed the WFP in Maputo that the FAO mission planned for February/March 1998 was now mainly to be concerned with longer-term developmental issues in support of drought mitigation, rather than addressing the immediate short-term concerns associated with El Niño. FAO did not wish to end up in crisis every time that there was an El Niño, so the longer-term issues were important. The SADC[64] Regional Drought Prevention Seminar was due to be held in Gaborone during the following week. FAO expected to receive a formal mandate from within the SADC Region to proceed with this consultancy mission.[65]

Within FAO Mozambique, the strategy was also evolving, with an internal note written on November 17th to the FAO Representative by a FAO consultant working with MAP, explaining the measures being taken by the GOM at national level to diminish the effects of drought. This Coordination within the country was complemented by a report on November 21st, doubtless written for the SADC Regional Drought Prevention Seminar.[66] Within a few days, an updated version of this document was distributed to MAP and to the Ministry of Foreign Affairs (presumably in support of SADC Coordination).

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[62] World Food Program 1997a

[63] This had also been the reaction in to a similar WFP/FAO proposal in 1993, but the consequence is to increase the response time of the international community to any situation of food insecurity. While donors may fear theft or corruption in addition to losses to pests, a system of strategic grain reserve warehouses could be run by the WFP itself, and storage costs could be very low with the correct storage techniques. Training in such techniques was taking place in the port of Maputo in 1993, with technical assistance from the UK government. Such techniques are used in a range of African countries.

[64] Southern African Development Community, an intergovernmental body composed of the fourteen countries in southern Africa, including Mozambique. Its headquarters are in Gaborone, Botswana.

[65] This more measured response by FAO constituted a move towards a more strategic, proactive approach to El Niño and drought in general.

[66] *FAO Special Report on the Impact of El Niño and Other Weather Anomalies on Crop Production in Southern Africa*, 4 pages.

d. Donors Coordination Meeting

At this point, the GOM revised Action Plan was circulated to donors and international agencies on November 26th 1997, at which time FAO received an invitation from MAP to attend a seminar on the revised Action Plan. By December 3rd, FAO issued an invitation to a Donors Coordination Meeting on the Action Plan on December 5th.[67] The meeting included a document updating the long-term weather forecast by the FAO technical consultant in MAP and by the agrometeorologist at INIA. The general background was that for the FAO the three priority areas were to be southern Africa, Bangladesh and Latin America.

For the EU, the initiatives proposed were to include preventative measures, humanitarian aid and post-drought agricultural recovery. On food aid, the EU proposed to make provision on the basis of a well-organized program. Funds had already been made available through *EuroAid* (a European NGO specializing in agriculture). These were for the distribution of seeds, tools, fertilizers, and the constitution of a seed bank. The actions on these aspects of the response would be implemented by NGOs. The EU was also considering buying maize (corn) on the future options market. In addition, the EU had allocated substantial funds to the WFP for the International Emergency Food Reserve under its 1998 budget exercise. Other EU interventions included a global amount of USD 650,000 from the EU Counterpart Funds (CPF)[68] allocated to the 1997 Mozambican government budget. This was earmarked for unexpected emergency situations, to give the GOM an immediate response capacity for crises. A further USD 1.2 million from EU CPF was available at the Central Bank. A program was being prepared by the Ministry of Industry, Tourism and Commerce to use these funds to put together small stocks in the countryside. This would be carried out under the normal activities of the Ministry.

The FAO technical assistance consultant at this Ministry referred to the need to establish a maize import facility, to encourage the private sector to undertake commercial maize imports, owing to the shortage of liquidity in the economy.

The reaction of some of the donors to the Action Plan was very interesting. Most of the participants at this Donors' Coordination Meeting had been unaware of the MAP

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[67] The agencies represented at this meeting were: FAO, UNDP, UNICEF, World Bank, IMF, EU, and the embassies of Denmark, The Netherlands, Sweden, and the UK.

[68] Counterpart Funds represent the amount in national currency, in the case of Mozambique the *Metical* (plural *Meticais*), of funds donated via aid programs. For example, if the USAID or the EU finances food aid in USD, and the food is then sold on the Mozambican market, the funds, which are generated in Meticais, are Counterpart Funds. Most donors, especially the EU and USAID, insist on specifying how such funds are spent by the beneficiary government, since the sums involved are often large enough to have a macroeconomic effect, usually an inflationary one, if the CPF are not spent wisely, or are not deposited in an official central bank account. Such CPF are a major component of government expenditure in the case of countries, such as Mozambique, which have difficulties in levying sufficient taxes to cover their basic activities.

Multisectoral Action Plan, a fact that indicates that the meeting certainly served its purpose. They had not participated in any discussions during its preparation and in some cases did not receive it. The FAO Representative said that the FAO had assisted MAP in the preparation of the agricultural component of the document. This exchange suggests that the process of preparation of the Action Plan, which had evidently involved various Ministries, some at several levels (national, provincial and local), as well as National Directorates and National Institutions, had not brought at least some of the donors on board. However, it is clear that the process had involved major international agencies where appropriate, whom the Mozambican government might have expected to keep individual donors informed. Some had been, and this meeting was clearly designed to do so for the others, as soon as the plan had been finalized for 'public' presentation.

Some donors rather cynically suggested that the Action Plan was a shopping list to increase the donors' contributions. Others felt that drought prevention plans should be treated as a normal part of the development process, a view that echoed some aspects of the FAO response in terms of its planned February/March visit. While one can sympathize with such a viewpoint, this Action Plan was the first time that the Mozambican government had been able to take a proactive approach to drought planning, having been forced to be reactive in the past because of war, destabilization and, in 1994-1995, the national elections and formation of a new government with a parliamentary opposition.[69]

The participants agreed to avoid a food aid program because of the market distortions that it would probably bring, which could undermine government efforts to develop a market economy. Apart from the EU measures described above, no donors were in a position to give any information on commitments to mitigate the effects of El Niño.[70] It was stated that the Action Plan needed an economic component to look at possible effects of a drought on macroeconomic strategy indicators.

[69] In any case, such a point indicates that donors had forgotten that proposals for longer-term drought mitigation measures had been made at the end of the 1993 FAO Crop and Food Assessment Mission, just after the 1991-1992 drought. Measures proposed, but not supported by donors, included the establishment of four grain storage warehouses, one at each of the ports of Maputo, Beira and Nacala, and one in the cooler interior at Chimoio, not too far from the port of Beira. This was to be complemented by a training program to ensure that pest control kept losses to a minimum. These proposals have still not been implemented, and would make even more sense in a situation where Mozambique is a net maize exporter.

[70] This may have been what was driving the slightly critical comments on the Action Plan noted above.

It was agreed that each of the EU Member States would look at the Mozambican government's Action Plan, especially at its agricultural component, and would give an indication of the support to be provided. FAO suggested that the EU FSU provide comments on the Action Plan and circulate them among participants.[71]

The EU FSU comments appeared within five days, on December 10th.

e. Continuing Coordination

Just prior to the circulation of the EU FSU comments on the MAP Action Plan, on December 9th, an invitation was issued by the DPCCN to FAO for a meeting on El Niño to take place on the 18th. This covered a report by INAM on the current situation, the MAP Action Plan, and the DPCCN Plan. This was almost certainly linked to an urgent official request from MAP to FAO for assistance on action against the effects of El Niño. FAO Rome sought details of this request. As anticipated earlier by FAO Mozambique, there were by now, December 17th, a request for a consultant to assess and help co-ordinate the needs for an eventual drought. FAO Rome, which doubtless had many other countries to contend with, asked for the MAP Action Plan, to be told that it had already been sent to Rome.

By this time, WFP Rome had established a Global Task Force on El Niño, which had held a meeting on December 4th. One outcome of this was that there would be a WFP team in Mozambique in January 1998 to assess the situation.

At DINA, the National Food Security Early Warning System (SNAPSA) continued to circulate updates on the current situation, with the one on December 23rd describing the critical situation in some parts of the country.[72] In addition, the developments in the 1997-1998 crop season were described for the Provinces of Maputo, Gaza, Inhambane, Manica, Tete and Zambezia. Apart from Zambezia, these were the provinces most likely to be affected by a drought, whereas Zambezia was a probable food surplus province.

However, the SNAPSA Technical Note of December 1997 did highlight the fact that rains had been above normal in the South and Center of the country. This was attributed to the influence of the Atlantic Anticyclone that had provoked rains favorable to agriculture on the coastal plain of the South, most notably in the Province of Maputo. Nevertheless, the climatic indicators still showed that the probability of drought persisted in Mozambique, and that the El Niño event was expected to have an impact in the following months, notably January and February.[73]

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[71] The last two points suggest that the meeting had in effect achieved its purpose, despite some donors' misgivings, and that the promise of EU FSU comments on the Action Plan allayed fears that donors might be bounced into extra aid on the basis of a plan which they had not had a chance to evaluate. It also showed that donors were nevertheless aware that drought could have extremely serious effects on Mozambican agriculture. The EU FSU comments are discussed in detail in Appendix 2.

[72] This is described in Section C Teleconnections.

[73] Sistema Nacional de Aviso Prévio de Seguranca Alimentar, 1997c.

By January 1998, the WFP/FAO mid-season assessment mission (as it was now called) was drawing nearer, provoking the usual flurry of activity in both agencies. Although there was no sign of drought in Mozambique as yet, there was a strong sense coming from Rome as to how serious the El Niño event was. Thus on January 14th, FAO Rome sent out a general message to country offices in Mozambique and elsewhere stressing the importance and urgency of what it called the El Niño and Food Supply Assessment Missions. The ongoing WFP southern African fortnightly updates continued, and were complemented by updates of the earlier Rome FAO GIEWS Special Report on El Niño, for example in mid-January. The FAO circulated one such report at the end of January to the WFP, UNDP, GTZ[74], ADB[75], USAID, the World Bank, the EU, and the embassies of Denmark, Italy, Sweden and Holland, as well as the Minister of Agriculture and Fisheries and the National Director of Agriculture.

The media were by now contacting FAO Mozambique about the El Niño,[76] but basically by mid-February the worries about a possible drought seem to have disappeared as it became clear that at least first season crops would survive.

The retrospective account from GOM explained later why there had been rain rather than drought, and how little economic damage had been done by the floods.[77] The final WFP fortnightly update, on June 11th, rounded off the Mozambican agencies' coverage of the event.

The occasion for this was a follow-up meeting on the Action Planning Meeting that had been convened in September 1997 by MICOA, INAM and IRI (New York). Although not hosting it, the latter was also present at this later meeting, held on February 18th and 19th 1998. The introduction mentioned the meeting, held on February 18th and 19th in Windhoek, of the SADC meteorological services (Southern Africa Regional Climate Outlook Forum: SARCOF) to update the consensus forecast made at Kodoma on September 8th. This February 1998 meeting was based on the outcome of the Windhoek meeting. Such a sequence clearly shows that the Mozambican Government (GOM) was integrating its actions within a well-defined regional context. The follow-up meeting was to clarify the causes of the differences between the Kodoma forecast and the rainfall pattern observed on the ground. Particular emphasis was given to the feedback from the user community as to the content, usefulness and timeliness of the forecast.

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[74] The German Technical Co-operation Agency.

[75] The African Development Bank.

[76] There was a *Radio Mocambique* program about El Niño on February 7th and Radio Australia faxed to ask if the floods in Mozambique were linked to El Niño, to which the answer was negative.

[77] Governo de Moçambique [1998a].

It is noteworthy that the December Windhoek meeting had continued to forecast normal to below-normal rainfall for central and southern Mozambique. Nevertheless the Windhoek meeting had already pointed to a shift to the west of the areas with the highest likelihood of a drought. This was because of a number of highly unusual signals not accounted for in the models. These differences between the model outputs and the actual observation posed a challenge to all climate scientists to improve the status of understanding of the processes in the Indian Ocean and to incorporate this information to improve seasonal predictions for the region.

After updates from agriculture, water and health, the report on the February follow-up meeting discussed concerns regarding forecast dissemination, monitoring and preparedness. The press did not present the range of possible outcomes mentioned in the SARCOF forecast. The SADC Remote Sensing Project was currently developing maps that showed the cumulative rainfall difference from the long-term mean along with SARCOF predictions. A similar map for Mozambique might be developed to distribute to the press to help explain where the errors occurred and to help demonstrate the spatial variability in both the forecast and the outcome. IRI might also help develop expertise in communications to assist in dealing with the concept of probabilities in forecasts.

The initial, early forecast tended to remain lodged in the public's mind and subsequent updates passed unnoticed. Despite September being the most important threshold for predicting the rainy season in southern Africa, the media took hold of the information in July and reinforced the idea of drought in southern Africa. The FAO/WFP approach of developing contingency plan based on a range of scenarios was worth further investigation and development in the applications community at large.[78] Finally, there was the problem that to some at this February meeting, it appeared as if the international community was controlling the forecast process.[79]

With regard to monitoring, it was argued that a strong monitoring network across a number of sectors would contribute greatly to the process of planning and response to forecasts given the proposed framework of probability distributions and outcome scenarios in contingency planning. A list of monitoring activities in climate, agriculture, health, water resources and economic indicators was proposed.

It was agreed that improvements in the networks of both automated weather stations and rainfall-observing networks across Mozambique be the first priority on the list. There were questions as to the accuracy and quality of measurements on the fairly large number of manually monitored sites. There was general agreement among the climate forecasters that increasing the observing network of the full suite of standard meteorological

[78] Any economic forecaster could have made this point. This is a clear example of different disciplines re-inventing the wheel.

[79] This is a perennial problem in Mozambique, given the lack of national resources compared to those of the international donors and South Africa. Despite being a constant if latent source of friction, in the case of meteorology, there is obvious benefits inn international collaboration, and the best remedy for all concerned is to improve the resources and expertise within Mozambique itself with regard to meteorological and hydrological monitoring.

instruments (temperature, pressure, wind speed and direction, etc.) would greatly assist in downscaling the regional climate forecast for Mozambique. The same was true for the quality and quantity of rainfall data.

The second and third priorities were monitoring of water quality (and proximity and availability of potable water) and monitoring of crop yield and production. It was argued that although the latter is much more advanced in Mozambique than monitoring health or climate, there is a paucity of historical data on which to build predictive models, and current techniques for estimation included a great deal of uncertainty.

For planning and preparedness, it was stated that data from a monitoring network needed to be coordinated maintained and analyzed before it became useful in the planning process. The data also needed to be consistent with respect to spatial and temporal coverage, format and accessibility.[80] In addition to establishing a common framework, the issues that were felt important were the following:

- Cost of data collection/access to data

- "Globalization" of data, or constructing and maintaining a database in a common framework

- Linkages (data-information-action) across three categories:

    1. Program development
    2. Policy development
    3. Pure research

Participants were unanimous that the awareness and preparedness exercise carried out by the GOM, the media and the NGOs was very useful and should be pursued in the future, even though the impacts of the current El Ni o had not been as severe as expected.[81]

f. Media Coverage

In marked contrast to the coverage of El Niño in 1982-1983, there was extensive, detailed and sophisticated coverage in 1997-1998. This was mainly in the excellent international

[80] This has still not fully taken place. For example, only in February 2000 was a working group established to integrate the various GIS data sources in Mozambique, and it was not entirely clear how the results of this would be fed into the INGC for disaster planning. Document lists and archivists still do not have a high enough status in Mozambique for the serious development of institutional memory across a series of ministries and national directorates. (See lecture given by Dr. C. Darcy, Director of Cape Area Library Cooperative, South Africa, at the Center of African Studies, Eduardo Mundane University, Maputo, in February 2000).

[81] Compare this to some of the criticisms from the EC delegation the previous December: See Appendix 2.

page of *Noticias* for theoretical[82] and international aspects of the phenomenon, but the Mozambican implications were well covered in the rest of that paper, and also in the other main press titles.

The coverage also shows the efforts of the Mozambican government to coordinate its response both among its own agencies and with international agencies. Here it was doubtless building on its long experience of coping with the effects of drought and war in the 1980s and early 1990s. What is not clear from this coverage is how much use, if any, was made, not only of INAM, but also of other specialized research institutions such as INIA (*Instituto Nacional de Investigacão Agronomica*).[83]

6. El Niño in the media before the 1997-1998 event

There appears to have been very little coverage of El Niño in the Mozambican media before the 1997-1998 event. However, the press coverage of the drought years 1991-1992 and 1994-1995 is currently being checked to confirm this.

[82] *Notices* also solicited explanations from Mozambican environmental writers and from government agencies.

[83] See Appendix 4 for a detailed account of Mozambican press coverage of the 1997-1998 event.

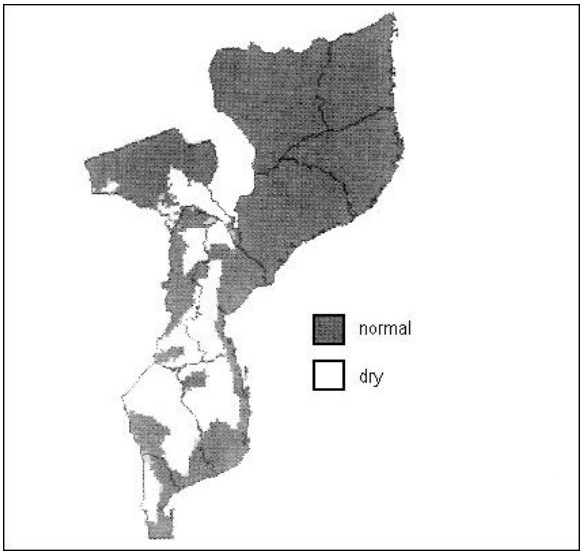
C. TELECONNECTIONS

7. Scientific views about the existence and strength of El Niño teleconnections to Mozambique

In 1996, a study of drought-affected zones was conducted by INAM and INIA.[84] This used NVDI[85] data from the NOAA polar satellite[86] and CCD[87] from METEOSAT.[88] The NVDI and CCD data was supplemented by historical precipitation data from 15 Mozambican meteorological stations, the data sets for each ranging from 27 to 45 years.[89]

The NVDI data was displayed via a GIS to give maps of the droughts and likely precipitation in Mozambique for each month of the eight-month crop seasons in each of the years 1982/83, 1991/92 and 1994/95. It also gave a map of drought prone areas, based on the average of the NVDI data for these same three years. The latter is reproduced here.

Map 3: Drought-prone areas in Mozambique



[84] Lúcio and Amade 1996.

[85] Normalized Vegetation Difference Index.

[86] Data from the AVHRR – the Advanced Very High Resolution Radiometer.

[87] Cold Cloud Duration sometimes called Cold Cloud Cover. The data was for the 9 years 1988-1996 inclusive.

[88] A European geostationary satellite situated at 0 degrees longitude and latitude, that is on the Greenwich Meridian and the Equator, which gives excellent coverage of Africa. This satellite is used on a daily basis in INAM, but is now in the process of being replaced by a new European satellite that has already been launched. This implies that current INAM satellite imaging equipment will be obsolete within about three years at the most.

[89] See Appendix 5 for a list of the years in which stations in all provinces were active.

In addition to showing the drought-prone areas, which clearly include Tete, Manica and Sofala, this map also indirectly shows that there ought to be an extension to the current system of meteorological stations, since there is no coverage of the drought-prone areas in the center of the country.[90] The three droughts covered are evidently ENSO related, a view confirmed by the subsequent analysis in the July 1997 SNAPSA special bulletin.[91] Of the 13 droughts studied over the years from 1951/52 to 1994/95, 5 were highly correlated with El Niño, included those of 1982/83 and 1991/92, 4 were moderately correlated, including that of 1994/95, and 5 were not correlated. This gives a ratio of around two-thirds.[92]

Crop Seasons correlated with Warm ENSO Episodes

Highly Correlated	Moderately Correlated	Not Correlated
1963/64	1953/54	1951/52
1972/73	1969/70	1957/58
1982/83	1976/77	1965/66
1986/87	1994/95	1977/78
1991/92		1983/84

Source: Sistema Nacional de Aviso Prévio para a Segurança Alimentar, 1997a

The Director of INAM has conducted a more detailed study of El Niño and Mozambique, but this has not yet been obtained.

8. Climate-related anomalies and impacts in Mozambique of the 1982-1983 event

Among the results presented in the 1996 study are comparisons of the areas affected by drought in 1982, 1991 and 1994, all of which are El Niño related droughts. The GIS maps resulting from this exercise cover each month from October to June for each of the three years (1982-1983; 1991-1992; 1994-1995).

From this, it can be seen that in 1982-1983, the most affected provinces were Maputo, Gaza, Inhambane, Tete and Niassa. This was probably the second worst drought of the century, since that of 1991-1992 is considered the worst.[93] In terms of human loss of life,

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[90] The closest ones are in Chimoio, Sussedenga, and Beira.

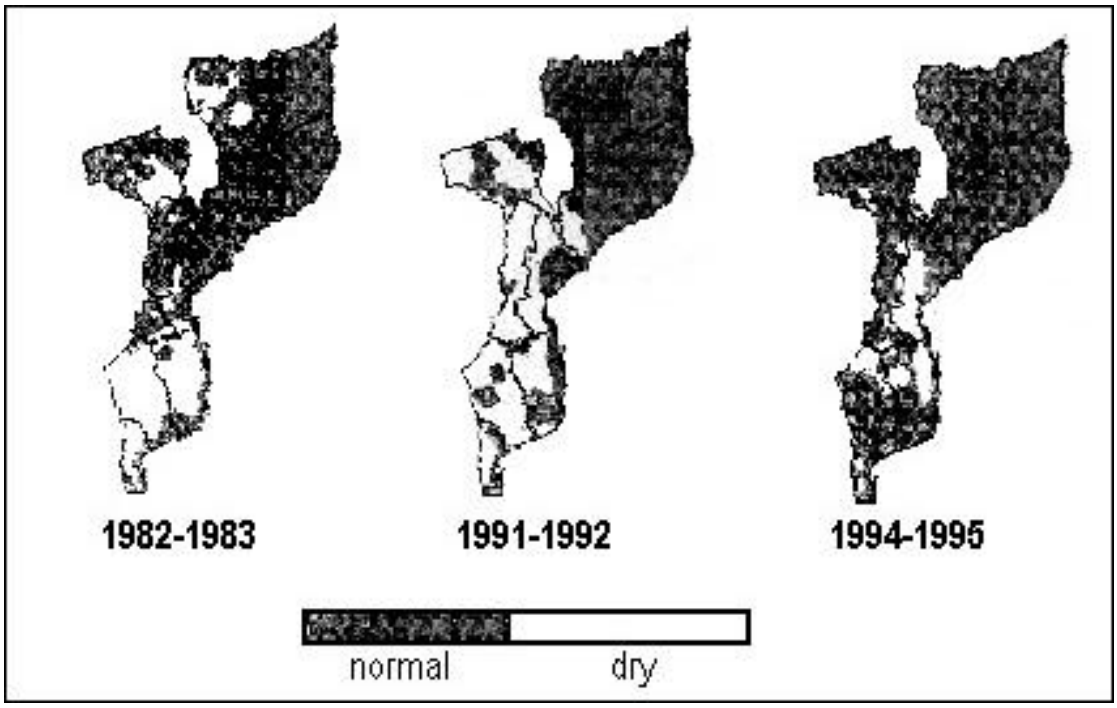
[91] Sistema Nacional de Aviso Prévio para a Segurança Alimentar, 1997a, Table 1.

[92] This ratio roughly corresponds to that produced by the historical analysis by S. J. Young for the years 1850-1912. However, the latter analysis was based on official reports rather than actual weather data. See Appendix 1.

[93] This is not only in meteorological terms of geographical extension, duration and drought intensity, but also in terms of the number of human lives lost, damage to production and population affected, according to the authors (page 8). The study points out that these latter criteria could also be seen as measures of drought magnitude, and claims that they were each worse in 1991/92 than 1982/83. However, the authors

the 1982/1983 drought was probably the worst, since the official estimate was 100,000 deaths, but this was largely because the war prevented food aid from reaching those affected by drought. For similar reasons (the combination of drought and war) it is difficult to estimate what production losses were directly attributable to the drought. Large state farms were particular targets of the rebels, especially in July 1982.

Map 4: Drought-affected Areas



a. The monthly evolution of the 1982-83 drought

In October1982, most of Gaza and a small part of Inhambane were affected, together with a fairly large part of Niassa, and a small part of Cabo Delgado, both of which are sparsely populated. By November, the areas in the South had grown, with Maputo also seriously affected, while in the North a substantial part of Tete and Niassa were affected, and a small part of Nampula, but almost none of Cabo Delgado. By December the drought was heavily concentrated in the South, with really only the most vulnerable part of Tete (near the capital city of Tete) also affected.

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give no figures for any of the latter three criteria, and no reports suggest a loss of life in 1994/95 as great as that in 1983. In fact the FAO/WFP crop and food assessment mission of 1993 showed that people in Gaza were being fed quite effectively in the town of Chokwe.

By January 1983, it had spread into the central provinces of Manica and Sofala, and had widened its scope in Tete, while remaining as widespread in the south. By February it was still more widespread in these areas while adding almost all of Niassa, large parts of Nampula, and small parts of Zambezia and Cabo Delgado. Thus by February, it was seriously affecting not only the drought-prone South, and the food surplus province of Manica, but also the most fertile provinces which normally benefit at this time of year from substantial rain produced from ITCZ[94] activity.

While reducing slightly, the picture remained more or less the same for March, with serious implications for food production throughout the country, and the areas covered actually increased again in April, with Zambezia, the most densely populated and fertile province, being seriously affected. Apart from the two central provinces, the area covered by drought was actually greater in April than in February 1983. In May, Nampula and Zambezia were less affected, but the drought had returned to the central provinces and extended in Maputo, Tete, Niassa and Cabo Delgado. The social impact in the latter two provinces was less because of the sparse population there, but in May it was certainly affecting crops in the food surplus plateau of Mueda.[95]

It should be pointed out that, as the July 1997 SNAPSA bulletin makes clear[96] the drought in Mozambique continued until the crop season 1983-1984.[97] This extension of the El Niño related drought into a time that was not affected by El Niño indicates that the issue of teleconnections needs to be kept in proportion. It seems probable that most of the deaths occurred at this time, after the El Niño event, when crops in the South failed for the third time.

9. Climate-related Impacts of the 1997-1998 El Niño

Briefly these can be summed up as excellent harvests, continuing the growth trend of the previous years, with minor losses due to floods and drought being more than offset by increased production in the parts of the country not affected by floods.

Although there was no serious drought in Mozambique, up to the middle of January a few districts in the southern provinces were affected, as well as the south of Zimbabwe, Lesotho, the west of South Africa, parts of Botswana and Namibia. The situation improved during February. [98]

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[94] Intertropical Convergence Zone. This is clear from the CCD maps for January and February.

[95] NVDI map. However, this lack of rainfall, which had also hit this district in October 1982, did not affect harvests, which remained good in 1983.

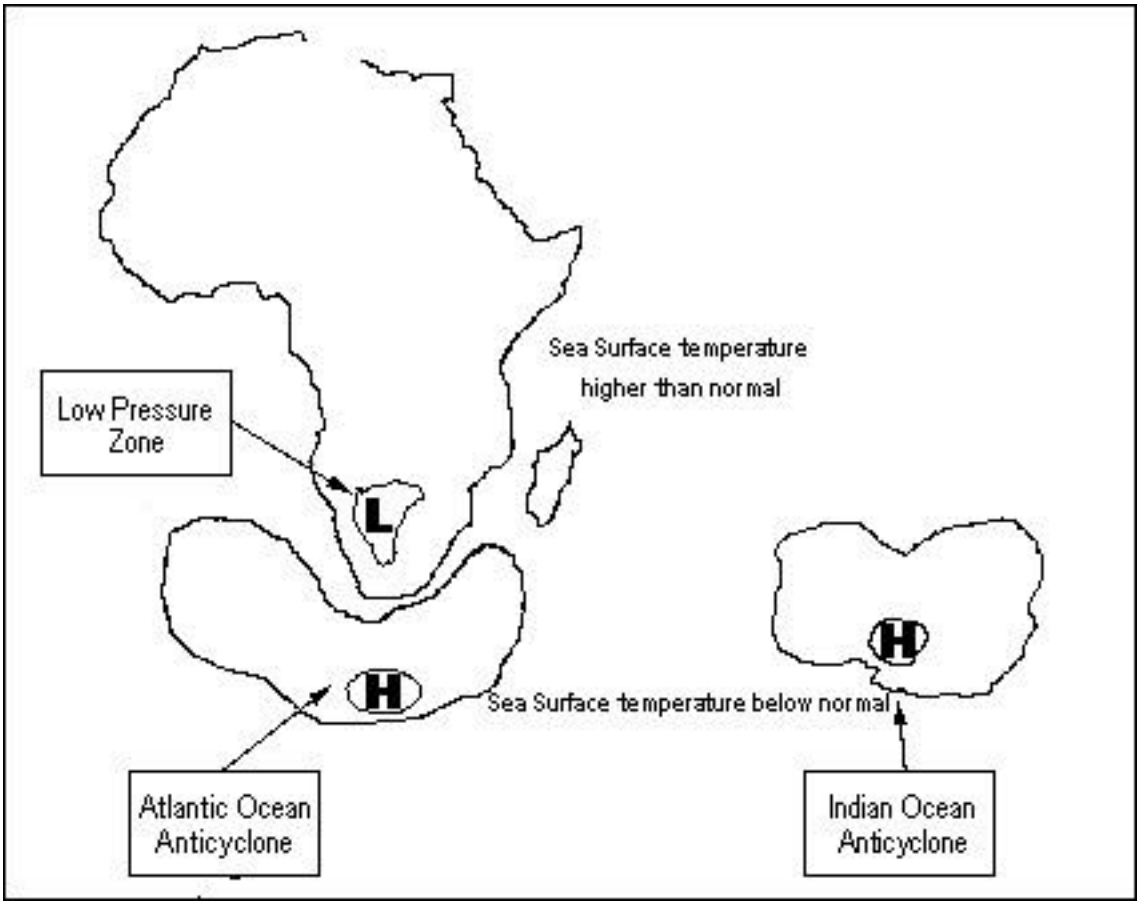
[96] Sistema Nacional de Aviso Prévio de Segurança Alimentar 1997a.

[97] It had also begun to some degree in 1981.

[98] Governo de Moçambique [1997a].

The actual impact of El Niño was influenced by three factors: the above average temperatures in the Indian Ocean, the eastern position of the Atlantic Anticyclone, and the influence of the ITCZ. These factors created conditions for good rain.[99] This view of the reasons why there was no real drought is identical to that of the December 1997 NEWS bulletin, but the latter goes into more detail on the three factors. It pinpoints the warmer Indian Ocean as being to the north of Madagascar,[100] and also points out that a low-pressure zone over the African continent was further south than usual. The latter was causing rain in coastal areas. These unusual circumstances were themselves presented as probably being the result of the size of the El Niño.

Map 5: The 1997-98 El Ni? o



The rains had permitted crops to be sown in September rather than October as normal, which was a positive benefit. There had been losses due to floods, however. These

[99] *Idem.* 5.

[100] This would presumably mean that the ITCZ winds would pick up more rain than usual.

covered about 34,000 ha, and were a good deal less than in the previous two years.[101] The minor drought in the South only led to the loss of some 17,000 hectares. These losses represented only 0.86 per cent of the total cultivated area of the country, which was insignificant in comparison with the benefit from the abundant rain. However, an attempt was made to help those affected by the losses with the sowing of their second season crops.[102] Overall there had been a growth in cultivated area of 2.6 per cent compared with the previous year.[103] Yields also went up, continuing a trend, since maize (corn) yields had gone up by 43 per cent over the previous 5 years. This combination of increased sown area and increased yields meant that production went up by around 4.6 compared to the previous year.

10. Reliability of Attribution

The reliability was as high as could be expected in the circumstances, since the attributions came from MAP, and from the SNAPSA agrometeorological service (which had FAO technical assistance). Results on the meteorological data would probably have been confirmed with the FAO regional service in Harare and other sources. However, all attributions are currently limited by the fact that the TOGA/TAO array has not yet been extended into the Indian Ocean, although work financed by a consortium of countries has now started on its extension into the Atlantic.

In addition to this data-collection limitation on the understanding of weather events in the Indian Ocean, understanding of the weather in Mozambique is limited by the lack of a process model of the climate.[104] Given that weather patterns have changed since 1976, the usefulness of empirical analysis based on past statistical data as a basis for attribution is thereby reduced. The major difficulties in constructing an adequate model of the southern African climate are the following:

- Firstly, that the mechanisms producing fairly stable inversions over the African continent are not fully understood, with the data not yet being well-replicated by the model.

- Secondly, the sources of convection and precipitation are not fully understood, both in the Indian Ocean and the south Atlantic.

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[101] One third of the area lost in 1996/97 and one fifth of the area lost in 1995/96. Governo de Moçambique [1997a].

[102] *Idem*. 6.

[103] This was 8.2 per cent above the area sown in 1995/96.

[104] Professor Bruce Hewitson, of the University of Cape Town, has constructed such a model. The rest of this section is based on an interview with him on 17 March 2000. [*Add to sources*.]

Research on these areas is ongoing. Models of the 1972 El Niño and the 1973 La Niña give results that are close to what one would expect, although they still contain some data errors that will be corrected. However, the changes in the climate since then really imply that national weather services should be running their own process climate models, and having consultations with the services of neighboring countries.

D. RESPONSES

11. Government reports and statements issued before the impacts of the 1997-1998 El Niño became apparent

The reports issued are covered in the account of the 1997-1998 event itself.[105] The public statements issued are described in Appendix 4 on the press coverage of the event.

12.Reports issued after the impacts appeared

This also covered in Section B, and to some degree in Section C on teleconnections. In addition, the WFP also issued a retrospective analysis for the southern African region as a whole.

13. The major responses to the event

Since there was not really an El Niño impact in the sense of a drought (although the rain should be considered a beneficial impact) we have described the responses to the event in section B, on the event itself.

14. Mozambican research on El Niño

The main research on El Niño, apart from that already cited, is that conducted by the present Director of INAM. We have not yet been able to access it, not judging it suitable to attempt to do so at a time when INAM was so busy coping with floods and a cyclone. On other climate-related hazards for example, concerning floods, we have not yet accessed research. Nor have we accessed research on the health effects of climate related hazards, apart from that on cassava poisoning. This may be possible in March.

In addition, there is important Mozambican research on climate change and El Niño over the last 18,000 years or so, which has been conducted in the Institute of Geology in Mozambique. It consists of work on lake sediments, on fossil corals and on the snows of Kilimanjaro in Tanzania. In the Ministry of Agriculture and Fisheries (MAP), there has been research on coral bleaching by extreme weather events. A Mozambican has conducted further work on long-term climate change in a recently completed lengthy PhD at Rutgers University, USA. In the Faculty of Agronomy at Eduardo Mondlane University, there has been work on mangroves in the south of the country. In Archaeology, there has been work on El Niño in the Middle Stone Age, Late Stone Age,

[105] Section B above.

and Iron Age. There has also been work on climate change at the *Universidade Pedagogica*.

The most important work that has been done is probably that of Lucio and Matonse, which uses monthly rainfall data from weather stations covering the period 1951 to 1981.[106] This study investigates the modulation of rainfall over Mozambique by ENSO phenomena. The methods involve the computation of monthly values, and annual and seasonal totals for rainfall. The annual totals of rainfall for each year in the time series were then categorised as above normal, normal and below normal, in an attempt to identify dry, normal and wet seasons. For this purpose the following were defined:

Above Normal (AN) => 125% of median;
Normal (N)=75% <=median <= 125%;
Below Normal (BN) = < 75% median

The annual totals were also used to derive homogenous rainfall regions. On this basis, annual and seasonal rainfall totals were normalised with respect to the standard deviation to ensure a zero mean and a unit variance. Correlation analysis was then used to investigate relationships between the Southern Oscillation Index (SOI) and rainfall before linear regression models were fitted. The significance of the correlation and linear regression models were determined using the student T-Test.

Following a discussion of the climate of Mozambique and summer rainfall interannual variability, the paper discusses ENSO and rainfall over Mozambique. The paper reviews relevant research, including a 1992 paper that analyses 23 ENSO warm events that can be identified since 1880 over southern Africa, and argues that of these 23 events, 22 coincided with below average precipitation during the summer months of November to March. In 25 per cent of these cases, the precipitation was slightly below normal, but in 75 per cent of the cases severe droughts were observed.[107]

For Mozambique, despite the fact that the homogenous rainfall regions were derived from data for 1951 to 1981, the paper reports that for the period from 1951 to 1995, in the southern region of Mozambique, 90 per cent of the 12 ENSO warm events coincided with below normal rainfall. And of the 8 cold events recorded during the same period 75 per cent of the cases coincided with normal to above normal rainfall. While the paper rightly notes that localised droughts have occurred in years other than those with ENSO events, this is apparently clear evidence of teleconnections. However, the paper concludes that the SOI only accounts for 23% of the rainfall variance. The paper discusses the mechanisms by which this rainfall variance could take place, and suggests that the

[106] Lucio, and Matonse, unpublished, no date

[107] This evidence for southern Africa is clearly somewhat higher than the evidence for Mozambique in the second half the nineteenth century presented in Appendix 1, but given the methods used for that estimate, it is certainly in the same ballpark.

model's outputs should be treated with caution. Further explanation of the physical mechanisms behind the processes was required.

15. A government plan to respond to El Niño

There exists no standing national plan to respond to disasters that is regularly scrutinized and updated as new information comes in. This partly because of the fact that the Multisectoral Action Plan developed to cope with the 1997-1998 El Niño event did not have to be implemented, since there was no drought. While the credibility of SNAPSA was to some degree restored by the successful prediction of rains linked to the subsequent La Niña event,[108] the impact of floods can be overcome more rapidly in agricultural terms. Hence despite the longer-term damage to infrastructure (evident in the floods of 1978 and of February 2000) flooding has not been seen as something that could be planned for. This view may well be changing in the light of the current floods, and may well provide the basis for escaping from the crisis-management response mode that is evident at present.

An additional reason for the non-existence of a standing national plan is the fact that the former DPCCN changed its role in becoming the INGC. Its function is now more that of coordination, rather than implementation. While it could be seen as a legitimate part of its activities to maintain and update a national disaster management plan, it has undergone a huge reduction in staff numbers, as well as a change of role, and has doubtless had its hands full in responding to events since its status changed in 1999.

The best starting point for a national plan would probably be the Multisectoral Action Plan drawn up by December 1997.[109] Some elements of that plan, together with the experience of working with a network of Mozambican and international agencies, could form the basis of a plan that could be updated as information came in, and as organisational capacity improved. The latter implies continuing effort at capacity building, including in INAM, whose resources need modernizing.

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[108] Interview with Jorge Amade, Maputo, 9 January 2000.

[109] The actual Multisectoral Action Plan is discussed in detail in Appendix 2. The context and process of developing this plan are discussed in Section B The 1997-1998 Event. Here the main agricultural aspects of the Plan are outlined, since they are relevant to some extent to prioritisation in situations of both drought and flood. The high-risk zones overlap to a great degree for both types of emergency event. The agricultural and water management policy towards them would thus form part of any robust national disaster management plan.

a. Brief review of elements of the Action Plan

The 1997-98 El Niño was the first one that the Mozambican Government was aware of in advance.[110] It represented a high probability that drought would hit the country, particularly its drought-prone central and southern areas. Considering the probability of such an event, the government undertook preventative measures to fight a drought event, because there had already been signs of drought in the southern provinces from January 1997.

The first step of the government strategy consisted of identifying zones of differentiated risk. High-risk zones were the central and southern ones, including the provinces of Maputo, Gaza, Inhambane, Sofala, Manica and Tete. These 6 provinces have a cultivated area of 1.57 million hectares, corresponding to 39.5% of the total cultivated area in the country.

The northern provinces of Cabo Delgado, Niassa, Nampula and Zambézia, with a cultivated area of 2.41 million hectares (60.5% of total) were identified as low-risk zones.

Within the high-risk zones, in their turn, more vulnerable sub-zones were considered, namely the ones where agriculture was entirely rain-fed. These represented 85 to 90% of total, the remaining areas being low well-watered areas.

Efforts were directed primarily to such vulnerable sub-zones, which received the following guidelines: to plant drought resistant crops, namely cassava, sorghum and *nyemba* beans;[111] to cultivate quick maturing varieties of maize and beans; to favour agriculture in low areas; to avoid forest fires; to keep seeds for next season; to plant a second season; and to avoid selling the entire harvests, keeping good food reserves.

b. Lessons[112]

These agricultural measures could be seen as a kind of template for agricultural preventative measures in drought conditions. The use of the 1991/1992-drought experience in a non-mechanical way[113] can be seen as a good example of forecasting by analogy.[114]

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[110] Unless otherwise stated, the following points on the Action Plan are based on Governo de Moçambique [1997a].

[111] A local variety of beans.

[112] The lessons in terms of dealing with international aid agencies are implicit in the discussion of the process of developing the plan, and in the Appendix 2 discussion of the plan itself. The latter also indicated weaknesses in plan construction methods and co-ordination between Ministries, which it could be the legitimate task of the INGC to resolve. However, in Mozambique co-ordinating bodies have a history of being marginalised by implementing agencies, both government and international, and institutional capacity building would have to be one of the measures to combat this.

[113] Notwithstanding the EU FSU comments.

With regard to floods, the hydrological conditions and soil types of Mozambique are well mapped.[115] Heavy rains and floods lead to serious erosion because the soils tend to be of a sandy or sandy loam type. This is partly because southern Africa is one of the oldest geological regions of the world, and consequently the soils have been broken down into very fine sand, which is easily transported by suspension in water.[116] It is the ease with which soils are eroded which makes heavy rainfall so damaging in Mozambique, in addition to the fact that much infrastructure was not well built in the first place, or was destroyed in war.

Flood planning, however, would require greater international co-operation than exists at the moment in practice, although matters have improved since 1994. The problems endemic in most regions where large rivers cross international boundaries are present in southern Africa, and SADC has so far made only limited progress in dealing with them.

To sum up, there is no national plan to respond to disasters at the moment, although it is doubtless part of the remit if INGC to develop one. Such a plan could probably begin by building on the fairly positive experience of the 1997 Action Plan, while taking account of some of the criticisms that were made of it.

16. El Niño as a Disaster

The sense of El Niño being a disaster was doubtless lessened by the fact that the weather was beneficial during the last event of 1997-1998. However, it is now understood (and to be confirmed later) that media coverage of the drought in 1992 did refer to El Niño. In addition, the research in INAM has doubtless led to a slightly increased awareness among decision-makers of the possibility of El Niño producing drought. The July 1997 SNAPSA bulletin (see table in Section C Teleconnections) suggested that El Niño does seem to have been strongly or moderately correlated with drought in about two-thirds of the cases during the second half of the 20th century.

How far the general public is aware of the connection is doubtful, since there is a widespread perception that the last forecast was 'wrong', even in well-educated circles. This is partly because the complex nature of the forecast was simplified by the media and to some degree by foreign NGOs seeking to justify additional activities in the North of Mozambique where the prediction of the probability of drought was only between 20 and

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[114] Glantz 1995.

[115] These maps are available at INIA and are held in GIS format.

[116] While the geology of Mozambique is somewhat different from that of the rest of southern Africa, this does not affect the nature of the surface soils, partly because rivers from the neighboring plateaus have already washed them down.

35 per cent. It is also partly because provincial authorities also gave out a simple message.

17. International research on El Niño in Mozambique

Links between INAM and the USA have already been mentioned. These include links with NOAA, and with the University of Oklahoma and the University of West Lafayette. Despite the presence of the NASA Goddard Space Research Institute and of the International Research Institute, New York, at the MICOA seminar in September 1997, these do not appear to be involved in current research on El Niño in Mozambique. This is to be confirmed when the research conducted by the Director of INAM is accessed, hopefully in March, as has been agreed.

There is extensive work on climate modelling conducted at the University of Cape Town. There has also been work on the island of Bazaruto, using thermal imaging to check for traces of past changes in weather. The Council for Geophysics in Kwazulu-Natal South Africa has conducted this. There has also been research on tree rings as an indicator of climate oscillations, including some work by P. D. Tyson. At the University of Oxford, UK, there was a PhD in the early 1990s on the climate in Africa, covering climate, water and plant diversity.

E. FORECASTING BY ANALOGY

18. What could have been done differently?

a. Forecast

Since the expected drought provoked by the 1997-98 El Niño did not occur in Mozambique, the plan mounted to combat it was not actually put to the test. In this sense, a perfect forecast would perhaps have eliminated the need to take preventive measures. However, the way forecast was made and linked to preparatory action, and how the latter unfolded, deserved some post facto reviews and analysis.[117]

The limitations in predictability by forecasting and in the nature of what was forecast and what was understood deserve some attention.

In real terms, a very early forecast cannot be sufficiently accurate and detailed to be of concrete use. Forecast has to be, therefore, a continuous process closely associated with permanent monitoring and communication/dissemination.

The Mozambique lesson from the 1997-98 El Niño shows that the initial forecast, though methodologically and scientifically well constructed, tended to develop into a rather different scenario than what had been expected at the onset. This showed that other regional climate factors can interact in a powerful manner with ENSO to produce different and unexpected phenomena and, therefore, there is still a lot to be researched in this field.

Furthering such research cannot rely only on global approaches, even if scientific and technological advances in this area have permitted significant and impressive advances in forecasting accuracy. International and regional forecasts have to be adequately complemented by weather monitoring within the country, particularly through networks of weather stations and good communications with regional and international centers.

b. Information Flow

Forecast findings and warnings seem to have been disseminated through both official and unofficial channels with a good level of efficiency. However, the forecast message that was disseminated, based on temporal and spatial variables, seemed too complex. The message, which was apprehended by the media and the society at large, was the first and strongest one, which was that southern Africa as a whole, and Mozambique in particular,

[117] Unless otherwise referred, the discussion in the present and following sections is based on Government of Mozambique 1997b and Government of Mozambique 1998a.

would endure an unprecedented drought.[118] This had contradictory effects: on the positive side, it helped to step up preparedness, even if the expected outcome did not occur; on the negative side, it contributed to casting doubts on the accuracy of the forecast, with the possible perverse long term effect of undermining acceptance of the importance of forecasts and preparedness.

On the other hand, the process of constructing an effective and coordinated action plan is rather complex, particularly in a case such as the Mozambican one, where there are several "strong" actors involved, resulting in equally complex problems of coordination and information exchange. Roughly, we could consider here at least five instances. Firstly, the state, with its politico-administrative structures, articulating the central level of the relevant ministries (particularly environment, agriculture, health, transport and commerce) amongst themselves and with the provincial structures,[119] including also more operational services such as the then DPCCN, the coordinating system created to establish and implement the action plan (SNAPSA - the National Early Warning System for Food Security), the National Meteorological Institute (INAM), state universities, and so forth; secondly, the several international agencies operating in Mozambique, especially the World Food Program (WFP), the Food and Agriculture Organization (FAO) and USAID, each one with their own plans and objectives; thirdly, the several foreign NGOs, here distinguished from the domestic ones because of their own agendas and greater financial capacity to act; fourthly, the local civil society, including associations increasingly capable of intervening in events, and the media; and finally, the international organizations operating outside the country and the regional fora, an important source of information (primary, in fact, at the level of forecasting).

The flow of information was fairly intense among the international agencies, as can be seen from Section B. There was also a reasonable flow of information between the SNAPSA team and the FAO/WFP. Both the major donors, the EU and USAID, also reacted quickly, with the latter presumably being responsible for the US presence at the MICOA seminar in September. There also seems to have been reasonable co-ordination between the EU and USAID, which is important for any effective action in Mozambique, given the current dependency on foreign aid for any emergency activity. All of this seems to have included good regional contacts on the possible drought.

Where the flow of information may have been less good was between the central government of Mozambique and provincial and district authorities. To some degree information flows within the central government may also have been deficient. The MAP National Preparation Meeting at Pequenos Libombos Dam in early October 1997 does seem to have been wide-ranging, with a good flow of information. However,

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[118] According to Government of Mozambique 1998a: 5-6, "regarding the forecast dissemination process (…) the initial, early forecast tends to remain lodged in the public's mind and subsequent updates pass by unnoticed (…). It was noted that the media took hold of the information available as early as July this past year [1997] and began to reinforce the idea in the mind of the public of drought in southern Africa".

[119] Provincial governments have their own provincial directorates of agriculture, health, etc., accountable both to the provincial governments and to the ministries at the central level.

thereafter there does not seem to have been a process of regular updating, and insofar as it was performed, it seems to have been conducted more by the WFP than the GOM. However, the fortnightly WFP updates covered the whole region, which meant that Mozambique would get a few paragraphs within a two or three page document. Admittedly these were informative,[120] but this was hardly a detailed monitoring exercise within Mozambique, although possibly all that could be done in the circumstances, and more than some neighboring countries were able to report to the WFP.

Individual Ministries continued to act on their part of the Action Plan, it seems. For example, the Ministry of Industry, Commerce and Tourism (MICTUR) kept in touch with grain traders, and passed on information to the WFP for wider dissemination.

What seems important is the reinforcement of coordination and strength of the actors involved, both at the level of forecasting and at the level of planning and concrete action. While the first aspect regards the strengthening of INAM and SNAPSA, the second concerns the need to render the national plan more visible, both at the government level and for the general public, which has to be done mainly through the media. The third aspect, besides involving the means to implement what is planned, also concerns the reinforcement of the emergency mechanisms, still very much needed as the current flood situation shows. It is important to achieve this is by reinforcing the coordinating capacity of INGC and bringing new relevant actors to participate in the emergency procedures. Of special importance in this respect is the potential role to be performed by the armed forces.

The best way to improve the flow of information would have been for NGOs to report to provincial authorities on their activities, as well as to their own headquarters in Maputo. There has been a longstanding tendency in Mozambique for NGOs to be a law unto them, attracting the best-qualified Mozambicans and having greater resources at their disposal than the government in their areas of activity. Given the limitations on their own management skills and the variability in the quality of their performance, both over time and geographically within their area of Mozambique, monitoring of NGO activity would be highly desirable.

19. Realistic Obstacles to Perfect Forecasting Followed by Perfect Action

a. Forecasting

At this level, it is vital to reinforce INAM's capacity to provide data on weather monitoring, both for research and to feed continuous forecasting. Lack of staff and resources, and particularly the war, contributed greatly to the deep crisis in which the INAM monitoring network is immersed.

[120] See for example, World Food Program 1997b.

INAM Weather Monitoring Network[121]

	Synoptic Stations	Agro-meteorological Posts	Climatology Posts	Udometric Posts	Total
In 1975	21	21	125	669	836
In 2000	13	12	27	8	60

Source: Patrício 1999: 5; Interview with Mussa Mustafa.

Besides, the services involved in forecasting will have to pay special attention to their relationship with the media, seeking appropriate strategies to translate complex forecasts into simple and effective messages with an impact on the public opinion.

Although the INAM network of stations is just adequate to the purpose of monitoring rainfall, an important way of improving information flow would have been to improve INAM facilities. Firstly, an extended network of meteorological stations, especially in the central provinces of Manica and Sofala, would have helped to monitor the areas most vulnerable to drought. Secondly, the communications between the stations and INAM in Maputo could have been much improved, with direct telephone data links in all cases, rather than relying on radio links, telex and the postal service for communication of summaries. Thirdly, manual drawing of daily weather maps could be replaced by automatic map production, thereby freeing up staff to concentrate on the interpretation of content of the weather data. Fourthly, automatic 10-day weather forecasting, making use of the latest ESA satellite (EOSAT) for more detailed information than METEOSAT provides, could be introduced to facilitate national monitoring of developing drought or heavy rainfall situations. This would avoid or reduce the element of surprise with regard to rainfall, and freeing up staff to consult more with neighboring countries' weather services and water authorities. This would also facilitate the production of more detailed local forecasts within Mozambique, to help local farmers adjust their activities. Coupled with improved document handling and storage capacity, this would greatly facilitate the more regular and detailed circulation of SNAPSA bulletins.

[121] Udometric posts, usually scattered throughout the territory, were almost entirely wiped out by the guerrillas, who looked at it as a symbol of state presence. As to the other posts, they were also heavily affected and the ones considered as operational work under enormous difficulties of staff, equipment and communications (some send the results by post on a monthly basis). As a result, even the data available has a lot of problems. For example, results presented as from one entire province (thus results that should come from a series of provincial posts) usually come from just one observation point.

b. Preparing for the forecast impacts

The preparation for the forecast impacts could have been far greater, had there been no resource constraints. In the long run, simply building better roads and a national system of four warehouses (as the senior staff in ONUMOZ would have wished in 1993) would be the best preparation for droughts and floods. The proposal to improve roads in Sofala to create better links with Tete is one example. This would cost some USD 400 million, and is currently under study by USAID. With no resource constraints at all, the most important road construction projects would be a major flood-proof suspension bridge over the Zambezi at Caia, the completion of the road into Angonia within Tete, the completion of the road into Mueda within Cabo Delgado, and the rehabilitation of the rail connection to Lichinga in Niassa.[122] Rural road upgrading in Niassa, Nampula and Zambezia would also stimulate food production and marketing, and reduce dependence on food aid imports.

Roads would stimulate further growth in agricultural production, which in turn would encourage local traders to engage in local warehouse construction, to complement the proposed system of four state food reserve warehouses, one each in the three main ports of Nacala, Beira and Maputo, and one in Chimoio. In addition to the above, improved roads in the South and Center of the country, built on embankments, would be an important part of a more general national disaster plan, since they would serve as both a short-term refuge for local populations when rivers rose rapidly, and as a means of delivery of food aid and rescue vehicles in a disaster scenario.

The role of the army in national disaster planning should be written in to its formal remit, with a fleet of helicopters and inshore rescue craft made available for flood rescue. In addition, given that the INGC has more of a co-ordination than an implementation role, and that prior to 1997-1998 the WFP delivered over 80 per cent of food aid, and the then DPCCN only some 20 per cent,[123] the army should have a civil defense role in terms of logistics of food aid, rather than relying so much on the WFP within the country. This implies a fleet of trucks, with adequate maintenance facilities, which could complement the remaining INGC fleet. The latter should be rehabilitated as an intermediate measure.

With regard to health, the network of clinics, of which around one-third was destroyed, is being rehabilitated, especially in the Beira Corridor. The use of reed beds for sewerage treatment would reduce the health risk from septic tanks, both in cities and wherever new health posts are being constructed. Septic tanks pollute ground water sources and contribute to the spread of disease, especially in time of flood when their contents are more rapidly distributed.

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[122] The Angonia road and the Niassa rail connection were recently under active consideration. The exact state of play on these projects is not known, but the Angonia road may well be financed by Japan.

[123] FAO/WFP 1997: 15.

In addition, preparations for impacts could be better planned if there were an integrated GIS system making full use not only of automatic 10 day weather forecasting, but of the GIS data on soil types,[124] of remote sensing using EOSAT and/or NOAA data, the 1997 census data in GIS format, updated by the 1999 electoral results to keep track of what is still a highly mobile population. The targeting of vulnerable groups might well be facilitated by the data from the first ever-comprehensive study of poverty in Mozambique, which indicates its extent, levels and geographical distribution.[125] The existence of all this additional data, most of it in GIS format already, should greatly facilitate disaster impact mitigation planning in Mozambique in the future, provided that the capacity building is there to facilitate its full use, especially by INGC.

A full decision support system based on regular reports from districts and provinces could be established utilizing integrated GIS provincial subsets of the proposed national GIS system. This implies a provincial government capacity-building program. The updating would be possible by radio, with the situation in the remoter parts of Gaza and Inhambane having improved communication by wrapping fiber optic cable round the electricity supply lines running from Cahora Bassa dam in Tete to South Africa, and around the power lines supplying Beira from the dam in Manica. This would not only improve communications generally in the Center and South of the country, but also would cover the remoter weather stations in the more drought-prone areas and facilitate communications with the new ones proposed for the very drought-prone areas not yet covered by the current network of stations.

c. Planning

Planning, though existing and being improved, is still marginal, hardly corresponding to an instrument capable of mobilizing and giving an overall perspective to the several sectors involved. Means should be sought not only to reinforce integration but also to translate the plan into something simple and visible in which all sectors of society can have a role.

d. Action

The INGC is still a young body, and the recent floods have shown its limitations in terms of mobilizing the existing resources to cope with emergencies (if not of coordinating them). To avoid the tendency of centralization, which would result in something like what DPCCN was in the past, means of coordination should be reinforced, while new resources will have to be allocated to the several participating sectors. One of special

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[124] For a good example of the use of soil classification to target ENSO flood mitigation measures, see Vos *et al.* 1999. An indication of the important work on soil fertility at INIA in Mozambique can be gained from Folmer 1998:159-167.

[125] Government of Mozambique 1998b.

relevance is the armed force. Also new,[126] the armed forces are still working with the parliament on the definition of their role. It is important to ensure, at this particularly favorable moment, that emergency operations in response to natural disasters are made part of their mission. For this, it is necessary to provide them with equipment for rescuing operations; such has helicopters and light planes, rubber boats, equipment for installing temporary bridges, and so forth.[127]

20. El Niño Considerations in Mozambique's National Disaster Plans

El Niño is already part of the considerations of Mozambique's National Disaster Plans. However, it is so in an indirect manner. In this respect, it is necessary to pursue scientific work to strengthen the ability to monitor extreme weather events, especially ENSO ones, to feed into improved disaster mitigation planning.

21. Strengths and Weaknesses in the National Response to Forecast

As was said elsewhere, Mozambique has been submitted to recurrent extreme climate events and has recently experienced a long and fierce civil strife, these two factors having combined to provoke, in the state apparatus, a relatively high "sensitivity to emergency situations" associated with an effort to build up an increased capacity to respond to them. This is already a strength. To be added to this, the 1997-98 El Niño was the first in which the government was fully "involved", from forecast to following appropriate planning and action. Although things had gone differently from what was predicted, there is a clear indication that there is sensitivity and an organizational basis upon which to react to such phenomena, both at the state and societal levels, by forecasting and taking appropriate action.

However, several weaknesses still prevail in this respect, ones that can be located at least at three levels. First, the still very fragile national meteorological service, where lack of appropriate equipment and staff prevent it from being much more proactive in the whole process of forecasting[128] has definitely hindered predictions and precautions. As a result, the national response still does not derive from national forecasting but rather from the regional network or international agencies' forecasting. Although recognizing the

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[126] The new Mozambican armed forces were established during the implementation of the peace accord, after 1994, integrating part of the former opposed armies, which were dismantled.

[127] The current floods, such as the ones in early 1998 in Inhambane, showed the limitations of the armed forces in this domain. On the contrary, the South African army played an important role in the rescue operations.

[128] Currently, INAM is still living on very marginal conditions, in which the state only pays for the salaries of its staff (of whom only a few are properly qualified for the job), the obsolescent equipment being acquired and maintained on the basis of external financial contributions.

transboundary nature of the entire process, the fact is that such a situation highlights Mozambique's dependency in this field.

Secondly, there is still a lot of room for improving coordination and information flows amongst the several actors in forecasting and building-up a coordinated response. While forecasting is almost entirely "imported", effective coordinated response will remain hampered by the diverse nature of the actors involved, with their own fields of action and definition of objectives.

Thirdly, there is still a lot to be done in the establishment of scientifically sound teleconnections. One hidden lesson of the 1997-98 event was that it created a process, which constitutes an "inversion" of the usual one. Effectively, what should be expected, in normal conditions, would be an appropriate forecast followed by the development of a national plan and by a minimized impact as a result of the success of that plan's implementation. The 1997-98 event showed a different sequence, in which an appropriate forecast and the development of a national plan in accordance with that forecast were not followed by the event. The result was that the national plan could not be tested. In a country where, historically, disasters have had several and diversified origins, this could have the perverse effect of rendering El Niño less visible as a cause of natural disasters provoked by climate-related anomalies. The only way to by-pass such a hazard is furthering research related to teleconnections, reinforcing monitoring, explaining why the 1997-98 event did not occur as expected and making it clear, countrywide, that similar circumstances can produce very serious disasters. The extension of the TOGA/TAO array into the Indian Ocean would greatly facilitate the monitoring process.

22. Influence of the 1997-98 El Niño on Response to a Forthcoming La Niña

As was already said, the absence of drought due to the 1997-98 El Niño affected adversely the credibility of the meteorological forecasting. Hence, a contingency plan for the following La Niña seems to have been non-existent. However, the fact that the La Niña forecast proved correct did greatly help to re-establish the credibility of SNAPSA. In the current flood situation, SNAPSA are in great demand by both senior levels of government and by the media.

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Appendix 1

Historical Investigations on Drought and Famine: El Niño in Mozambique

Introduction

With regard to Mozambican history, there has been little work on El Niño as such, but there is some very interesting work on drought and famine,[129] linking it to important historical changes, as well as to epidemics and plagues of locusts, usually Red Locusts. The more difficult task, given that Mozambique, especially southern Mozambique, is prone to drought, is to 'separate the signal from the noise'. Research conducted by S. J. Young on this problem is discussed below, in relation to other historical investigations, particularly those of Liesegang and Newitt. .

El Niño can be considered an extreme climate event, which at times gives rise to extreme weather events, such as floods and drought. Fossil coral evidence[130] suggests that El Niño is at least 125,000 years old, and the 65 years covered by the fossil evidence has a similar periodicity to now, if one ignores the apparent changes in El Niño's pattern since 1976,[131] which may be related to global warming.[132]

While such climate events as El Niño (warming of the eastern Pacific ocean off the coast of south America) and La Niña (the corresponding cool event) can be extreme by recent historical standards, they pale by comparison with previous climate changes such as ice ages, or the even more extreme 'snowball earth'. The latter event is postulated by some scientists as having occurred some 700 million years ago, and as having been the basis for the development of complex life on earth.[133] However, current global warming may be a climate change of similar importance to the global warming which appears to have

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[129] The author is very grateful to Dr. David Hedges, of the *Departamento de Historia* at *Universidade Eduardo Mondlane,* for his insights on this material, and for his help in obtaining access to it. He is also very grateful to Dr. Gerhard Liesegang for allowing access to his unpublished research.

[130] Pearce 1999: 36-39.

[131] Kininmonth 1999. Hereafter this will be referred to as SATR. Figure II.18 on page 35 shows the time series departure for the standardized Multivariate ENSO Index (MEI) from 1950 to 1998, and shows a clear difference between the pattern for 1950 and 1976 on one hand, and 1976 to 1998 on the other.

[132] Pearce 1999, also discusses the change in the El Niño periodicity since 1976. Both meteorological and modern coral evidence show a dominant return period for El Niño of around six years, prior to 1976. Since then the peak return period is 3-5 years, implying a fundamental change in the last quarter-century. The Pacific Ocean thermocline (boundary between warmer surface water and cooler deep water) has deepened by about 10 meters since 1976. Minimum sea temperatures have gone up by 1C since 1976. In the Indian Ocean Chagos Archipelago, average air temperatures have risen abruptly by 1C since the mid-1970s, while cloud cover has declined by 50 per cent.

[133] 'Snowball Earth', *New Scientist*, 6 November 1999: 29-33

led to the extinction of 90 per cent of life on earth some 350 million years ago, or the meteor-induced cooling and extinction of life forms associated with the disappearance of the dinosaurs some 65 million years ago.[134]

Such geologically related evidence should be borne in mind as a broader context within which to evaluate current climate change and extreme weather events, including those recorded over the last 250 years or so.

Historical work on drought in Mozambique

An unpublished typescript for a book by G. Liesegang contains detailed descriptions of droughts, famines, epidemics and locust infestations from the mid-18th century.[135] It also contains material going back beyond the 18th century, but this Appendix will confine itself to the period beginning with the El Niño of 1791,[136] and what seems to be the associated drought in Mozambique.

Richard Grove of Cambridge University, UK, has analyzed the big El Niño event 1791 in terms of southern Africa and attempts are being made to gain access to this analysis. Liesegang notes a source recording famines from 1791 overlapping in Inhambane and Lourenço Marques (present-day Maputo, capital of Mozambique) as well as in the Zambezi valley in the center of the country. In Tete, much of which has a generally dry climate despite straddling the river Zambezi, hunger started in 1792 and continued until 1796, with loss of numerous herds of livestock, including total extinction of pigs. The loss of crops and livestock led to large numbers of Africans dying, and others deserting the area for other lands. Downstream on the Zambezi, at Sena, the land conserved some moisture, which enabled them to supply food at great cost to the city of Tete. Otherwise the city of Tete would have been completely deserted.[137]

Additional sources are available to cover the period from 1800. The work of P. D. Tyson[138] is cited in various sources on the environment in southern Africa.[139] [140] The

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[134] Tickell, Sir C., comments on BBC Radio 4, November 1999. Sir Crispin Tickell is a former UK Ambassador to the UN, and is currently working on environmental affairs, particularly climate change.

[135] Liesegang, 1993. Unless otherwise specified, references are to draft Chapter 7, entitled *Droughts and Famines to 1890*.

[136] A. Zapata, Personal communication, January 2000. This consists of a table of major El Niño events from 1701 to 1891, and a list of the historical sources. The authors are very grateful for this help.

[137] *Ibid*. 4-5.

[138] Tyson 1987.

[139] Chenje and Johnson 1994: 91. This was produced in collaboration with IUCN – The World Conservation Union, and SADC, the Southern African Development Community.

[140] Chenje and Johnson 1996: 35.

table based on this work is reproduced here (with minor presentational changes), as Table A1, but it does not explicitly relate drought and rainfall to El Niño.

Table A1
Climatic Change 1800-1992: A historical overview of drought and rainfall patterns in Southern Africa since 1800

1800-1830	Southern African rivers, swamps and other water sources dried up. Some well-watered plains turned to semi-karoo (dry area).
1820-1830	This was a decade of severe drought throughout Africa
1844-1849	Southern Africa experienced five consecutive drought years.
1870-1890	This period was humid in some areas and former Lake Ngami filled in the northwest of Botswana. (despite generally decreased rainfall – see below)
1875-1910	There was a marked decrease rainfall in southern Africa, and 1910 experienced a severe drought.
1920-1930	Severe droughts in the region.
1930-1950	Southern Africa experienced dry periods alternating with wet ones, and in some years the rains were very good. The 1946-47 season experienced a severe drought.
1950s	There was abnormally high rainfall in some parts of the region. East Africa experienced flooding, and Lake Victoria rose by several meters. Elsewhere, the equatorial region experienced below normal rainfall.
1967-1973	This six-year period was dry across the southern African region. The equatorial region experienced above average rainfall.
1974-1980	This period of six years was relatively moist over much of southern Africa. In 1974, the average annual rainfall was 100 per cent above normal throughout the region.
1981-1982	Most of southern Africa experienced drought.
1982	Most of sub-tropical Africa experienced drought.
1983	This was a particularly bad drought year for the entire African continent.
1985	Conditions improved
1986-1987	Drought conditions returned
1991-1992	Southern Africa, excluding Namibia, experienced the worst drought in living memory

Although not explicitly related to El Niño, Table A1 suggests impacts of El Niño, and La Niña. The period since 1950 also conforms well to the pattern suggested by SATR[141] in terms of warm and cold El Niño/ Southern Oscillation (ENSO) events.

According to Chenje and Johnson[142] scientists first recorded theories about the cyclic nature of the rainfall in the southern African region in 1888. By 1908, a South African scientist based in Natal (next door to southern Mozambique) had found evidence of an 18-year cycle of wet and dry years. P. D. Tyson is again cited as providing research

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[141] See footnote 3 above.

[142] *Op. cit.*, 1996: 31.

evidence that seems to support this theory.[143] Exactly how this might relate to the dominant 6-year return period of El Niño is unclear without access to the original work.

The extent to which this is confirmed by other sources is discussed below, as are the impacts in Mozambique. Tyson appears to attribute about one-third of the droughts in southern Africa to El Niño[144] but in the case of drought-prone southern Mozambique, the connection may be closer than that, as discussed below.

One reason for believing that rainfall in Mozambique may be more affected by ENSO events is evident in Chenje and Johnson:[145]

'The region's drier ecozones are particularly affected by rainfall patterns, and the frequency and intensity of drought cycles. Scientists studying these ecozones think that areas receiving less than 300-400mm rainfall annually are controlled more by the short-term changes in rainfall than the long-term average. This is particularly so where the amount of rainfall differs on a yearly basis from the average by more than a third.

Areas receiving an average of 400-600mm of rainfall per year can expect six droughts of two years or more in every 50 years. Few areas in southern Africa receive rainfall in excess of 1,600mm.' If such droughts were all related to El Niño, then at a crude level it would imply a periodicity of about 8 years, rather than six. However, the basis of this judgment is not clear from Chenje and Johnson.

A fairly large proportion of southern Mozambique (Gaza Province mainly) receives 400-600mm of rainfall or less per year on average, and most of the rest (Inhambane Province and parts of southern Sofala Province) has rainfall of between 600 and 800mm per annum.[146] Consequently, one would expect that southern Mozambique would be more vulnerable to relatively short-term climate changes, such as are induced by ENSO. The same is true in the case of Tete, where average annual rainfall is also around 600-800mm per annum, with a small pocket around 400-600mm. If central and northern Mozambique is affected by drought, then it is reasonable to presume that this could be related to quite strong El Niño events. Here the effect would be more likely to be connected to the tendency of El Niño to induce a shift to the north of rain emanating from the Intertropical Convergence Zone (ITCZ).

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[143] *Ibid*. 31. Their footnote refers to the work of Tyson cited earlier, but the chapter references also include Tyson 1981.

[144] Cited in Chenje and Johnson 1996: 33.

[145] *Ibid*. 27.

[146] Moyo *et al.* 1993: 141. The map shown on page 141, as Fig. 5.3 is more detailed than that given in Chenje and Johnson 1996: 26, but the two maps correspond very closely with regard to Mozambique.

Research Explicitly Linking Drought and El Niño in Southern Mozambique

S. J. Young[147] argues that, for the analysis of southern Mozambican societies in the period 1850-1950, climate is the central factor in defining and delimiting potential life. For her, the occurrence of severe droughts defines the success or failure not only of rural food production strategies, but also of the social forms of organization defining interdependence and redistribution of resources among people.[148] The paper has a table comparing El Niño events of varying strengths with official reports of rainfall in southern Mozambique in the 19th and 20th centuries.[149] This is reproduced below (with minor presentational changes).

[147] Young, S. J., *Climate in southern Mozambique: identifying and quantifying extent and periodicity of nineteenth and twentieth century drought*, 1996. Paper presented to the Environmental History Workshop, University of Natal, Pietermaritzburg, South Africa, 8-10 July 1996.

[148] This is not linked to A. Sen's work on entitlements in theorising famine, but appears to be a similar kind of conceptualisation. The concept of household or village coping strategies might also be compatible with her approach.

[149] These reports appeared in the *Boletim Oficial de Moçambique*, and are not based on actual weather station data.

Table A2. ENSO Warm Events and Southern Mozambique Droughts 1850-1912

Key:
Proper names indicate location of weather stations
Blanks indicate absence of drought or warm event

ENSO Strengths -

M	Moderate
M+	Moderate Plus
S	Strong
S+	Strong Plus
VS	Very Strong

YES	Drought Present
Q1…	Quarter of year in which drought recorded
ND	No Data
SST	Sea Surface Temperatures
L	Mentioned in Liesegang (1993)
S	Mentioned in SATR (1999)

YEAR	INHAMBANE	GAZA	LOURENÇO MARQUES	ENSO Strength
1850	1850	ND	YES	S
1854-55		ND		S
1857-59	1858 Q1, Q2, Q4	ND		M+
1860		1860 Q1,Q2		
1861	1861 Q1			
1862	1862 Q3, Q4	1862 Q4	1862 Q4	(M-)
1863		1863 Q1,Q2	1863 Q1	S+ (Single
		1864 Q1, Q2	1864 Q1, Q2, Q4	Event)
1865-66				M+
1867-69 L				S+
1876-78 LS	1876 Q1, Q2, Q4		1876 Q1, Q2, Q4	VS (Single
			1878 Q4	Event)
1880-81				M+
1882			1882 Q1,Q2,Q4	
1884-85	(1885 Q1)		(1885 Q1)	M+
1887-89 L			1887 Q4	S+ (Single
			1888 Q4	
	1889 Q1,Q4	1889 Q4	1889 Q1,Q4	Event)
1892			1892 Q1, Q2	VS (1891)
1895	1895 Q2	1895 Q1,Q2	1895 Q1,Q2,Q4	
1896-1897	1896 Q4		1896 Q2,Q3,Q4	M+ (Single
		1897 Q1, Q2	1897 Q1, Q2	Event)
1899-1900	1899 Q4		1899 Q4	VS (Single
			1900 Q1	Event)
1901-02	1902Q1,Q2, Q4		1902 Q1,Q2,Q4	S+
1903			1903 Q1,Q2,Q4	
1904-05	1905 Q1,Q2	1905 Q1		S
1907				Cold SSTs
1908	1908 Q4		1908 Q4	
1911-12	1911 Q4		1911 Q1, Q2	M+ (Single
	1912 Q1,Q2,Q4		1912 Q1,Q2,Q4	Event)

This analysis is more specific than that of Tyson as shown in Table A1 above, both in temporal and spatial terms. It is nevertheless worth comparing the two tables, and linking these analyses with those of Liesegang (1993) and Newitt,[150] in order to assess the social impacts of different droughts in relation to El Niño events. Young cannot be compared directly with SATR, except where the latter explicitly mentions earlier El Niño events, such as the one in 1877-78.[151]

Of the 16 cases of events shown as M+ to VS, 11 correspond to evidence of drought. A twelfth case of drought corresponds to an M- case, which is shown in brackets. This gives 12 out of 17 events, a strong relationship. In one of the ENSO events, which she classifies as not showing drought in southern Mozambican, Liesegang (to whose typescript she also had access) notes that there was evidence of famine in South Africa, Mozambique and eastern Zambia. Young does not have access to specific references to the south for this year.[152] In addition, for the events of 1881 and 1891, there were droughts in Mozambique in 1882 and 1892 respectively. Since many ENSO warm events seem to last for more than one year, this suggests that the relationship is possibly even stronger than is claimed by Young, who it seems is being deliberately cautious. Given the SATR analysis of ENSO[153] events, this connection between El Niño and drought in southern Africa, especially southern Mozambique, makes sense. In evaluating this evidence of teleconnections, it should be noted that while Gaza and Inhambane tend to be dry anyway, Inhambane city is in a small area that normally tends to have somewhat higher rainfall, of over 1000mm per annum. Consequently, if that city was recording drought, it is likely to be the case that rainfall would be worse in the surrounding areas. However, the official reports used by Young are probably referring to areas outside the city.

Whatever the strength of the teleconnection, it is enlightening to compare the work of Tyson, Young, Liesegang, and where appropriate Newitt. This enables one to evaluate the social impacts of El Niño related droughts.[154]

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[150] Newitt 1988.

[151] SATR 1999: 35.

[152] Young 1996: 10.

[153] SATR 1999: 22, Figure 1.8. The 1997-98 El Niño seems to have been unusual in bringing more rain than usual to Africa, because of *inter alia* unusually warm temperatures in the Indian Ocean. See SATR for further details.

[154] Little attention will be paid to heavy rains and floods, which may be associated with La Niña. This is partly because there is less discussion of them in the available sources.

Social Impacts of Droughts and Famines

Tyson's Table A1 starts in 1800. The effects of the 1791 El Niño drought seem to have been over by 1797,[155] and consequently droughts mentioned after that year are not related to it. Liesegang cites a source mentioning drought in Lesotho in 1800-1803, and a corresponding famine in 1802-1804, but there is no mention in available sources for southern Mozambique, despite the fact that such droughts and famines in Lesotho often correspond to ones in southern Mozambique.[156] In 1807-1808 there was again a famine in Tete, and many slaves died, with cereal price doubling or tripling. In 1812 and 1816-1818 droughts are again recorded for Lesotho. After 1818 the Mozambican evidence is much fuller, and the droughts are often treated as related to the well-known major social changes, known as the *mfecane*, which affected large parts of southern Africa.[157]

In 1818 Maganja on the river Shire north of Sena on the Zambezi was said to be unable to trade because of hunger. This was normally a cereal surplus area, relying partly on rain fed and partly on flood recess agriculture.[158] There were also unfavorable conditions for agriculture in 1822-1823 on the lower Zambezi near Sena, but more interesting for present purposes are the problems beginning in 1825. Liesegang notes that there seems to have been a famine in 1825, and people were given permission to cultivate on the Zambezi islands (a classic tactic for coping with drought) at the end of 1825, because of the lack of rain. In 1828 there was a major El Niño.[159] In 1827-1829 hunger induced most inhabitants of the small town of Sena to abandon the town. There was also drought in southeastern Zambia and in Zimbabwe from 1827 to 1829, possibly extending in some areas until 1830-1831.[160] In Inhambane in 1827 many were falling dead on the beaches looking while looking for shellfish (another classic drought response tactic). There were also food shortages in Lourenço Marques in 1827, until around February-March 1829. An Nguni military expedition in 1828 also fell victim to starvation.[161]

Other historians, including Newitt, and Vail and White, mention the droughts and famines of the 1820s in the area around Sena.[162] Newitt's 1988 article is the most detailed on the social, economic, political and environmental impact of the droughts,

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[155] Liesegang, 1993: 5.

[156] *Ibid*. 5.

[157] *Ibid*. 5 Note that the Tyson Table A1 treats the whole decade as being one of drought throughout Africa.

[158] *Ibid*. 5.

[159] Zapata Personal communication, 1999.

[160] Liesegang, 1993: 5.

[161] *Ibid*. 6.

[162] Newitt 1988: 18; Vail and White 1980: 28.

especially for the late 1820s, that is around the time of the major El Niño of 1828. Among the environment related impacts are smallpox and plagues of locusts, which seem quite often to occur with drought until preventative measures were taken in the twentieth century.[163]

Newitt states that 1824 was a better year,[164] implying a distinction between the drought of 1822-1823 and that beginning in 1825, which was evidently much bigger and longer lasting. From a historical point of view, the earlier droughts of around 1818 and 1822 are important because they had already made the population more vulnerable, and normal coping strategies were less likely to work because e.g. food stocks had already been depleted. Consequently, the very serious drought beginning in 1825 hit an already vulnerable population, and the social changes were thus much more profound than even such a serious drought might have led one to expect. This was a period of major change in southern Africa. The Portuguese response was to try and sustain existing trading conditions, but this proved impossible, according to Newitt, and the result, apart from widespread violence and looting, was that many Africans voluntarily sold themselves or their children into slavery. Coming as it did at a time when Brazil was known to be about to cease importing slaves as of 1830, the drought led to a rush of slave exports from Mozambique in the late 1820s.

From an ENSO climate event viewpoint, it is interesting that the drought and associated famine continued into 1830 and 1831.[165] For example, from February to December 1831 there was no rain at all in Inhambane. Some 2,000 slaves died. Nearby, there were reports of almost universal mortality in the hinterland, with emergency measures to bury the dead being necessary in both Inhambane city and the hinterland. Similar stories are recorded for the far north of Mozambique, in Cabo Delgado,[166] normally an area with over 1400mm of rainfall per annum nowadays.[167] Liesegang also cites the example of Mozambique Island, also to the north, where the public granary (another tactic for coping with drought and famine) was empty by July 1831.[168] The drought broke in 1832 and despite the rains failing again in 1833 (an indication of 'normal' rather than ENSO related drought, one assumes) and in 1836 a slow recovery had begun. Newitt states that contemporary observers 'were well aware of the magnitude of the ecological catastrophe

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[163] While smallpox has been eradicated, continued vigilance on locusts may well be necessary for future El Niño related droughts. For example, locusts appeared in 1947/48, at a time of major drought, again in 1972, and again in 1996/97, each time in central Mozambique. Liesegang discusses locusts and the measures taken against them in 1993, *op. cit.*, Chapter 6: 12-16. The locusts were controlled in 1996-97.

[164] Newitt 1988: 20.

[165] *Ibid*. 21.

[166] *Ibid*. 22.

[167] Moyo *et al*. 1993: 141, Figure 5.3.

[168] Liesegang, 1993: 6.

that had taken place and attributed to it the far-reaching changes that were affecting every aspect of life in east-central Africa'.[169]

The next major period of drought mentioned in the Tyson Table A1 (before being comparable with the Young Table A2) is that of 1844-1849, with five consecutive drought years in southern Africa. Liesegang cites the year 1845 in a short 1982 paper[170] as exhibiting drought and famine in the south, center and north of Mozambique. His description of it in his 1993 work is more detailed, and food shortages seem to have begun in some parts of Mozambique in mid-1844.[171] It was certainly widespread by 1845, with no rice available for European soldiers by December. Food problems are reported in 1847, 1849 and 1850. For example, one source cited for 1850 refers to 'wars and hunger without remedy which have been general in this unhappy country'.[172] There is no easy way to link this drought to El Niño, but its generality throughout southern Africa over five years, mentioned by Tyson, is suggestive.

From 1850, we are able to link the historical descriptions of social impact to Young Table A2. While Tyson Table A1 makes no mention of the period from 1850 to 1870, Young explicitly relates droughts to El Niño from 1850. Table A2 shows Strong El Niño events in 1850 and in 1854-1855, and a Medium Plus event in 1857-59.[173] The first and last of these three events are associated with her official-report based evidence of drought in southern Mozambique. Liesegang discusses 1850 as a continuation of the previous five-year drought, but notes drought in Lesotho for 1851-1852. For January 1854, hunger is recorded in Sena, but the source does not indicate its cause. However, in 1855 6,000 to 7,000 Africans died in Quelimane because the harvest had failed.[174] This was reputedly associated with an increase in the slave trade.

Quelimane, in what is now Zambezia Province, has an average annual rainfall nowadays of more than 1400mm. Zambezia as a whole has over 1000mm annually, with large parts receiving over 1200mm and over 1400mm.[175] It is one of the main parts of Mozambique to benefit from depressions and cyclones that are generated by the Intertropical Convergence Zone (ITCZ), and is today an area of dense population. Hence harvest failure there suggests a serious drought. Liesegang's sources state that further south in Inhambane the harvest was abundant. This corroborates Young's weather station data

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[169] Newitt 1988: 22.

[170] Liesegang, 1982: 3.

[171] Liesegang, 1993 (Chapter 7): 8.

[172] *Ibid*. 9.

[173] While SATR 1999: 16, discusses problems of defining El Niño events, Young partly circumvents such problems by her classification of events in Table A2.

[174] Liesegang, 1993: 9.

[175] Moyo *et al.* 1993: 141 References to rainfall patterns are based upon this source unless otherwise stated.

from Inhambane. Taken together, this suggests that the El Niño simply moved the ITCZ north, as often happens, and so northern Sofala (at Sena) and Zambezia, rather than southern Mozambique, were the areas to suffer drought. If this argument holds, then again the historical teleconnection seems perhaps stronger than Young argues.

For 1857-1859, a Medium Plus El Niño event according to Young, Liesegang again corroborates Young's data for Inhambane, in the sense that in March 1858 (Q1 in Young's data) the drought led to a public order canceling the right to export grain.[176] He also points out that in November 1858 (Q4 in Young A2) the drought 'forced entire families to feed on sea food and wild fruits near Inhambane'. In the Limpopo valley, in what is now the nearby Province of Gaza, the Gaza king Soshangane died in October 1858. This is an evident indication of very serious drought in an area that is normally drier than Inhambane and with a shorter coastline for access to seafood. Apparently it did not rain very much during the season 1858-1859, and in December there was continuing hunger in Chicualacuala north of the Limpopo in Gaza. The drought also extended to Lesotho. There was even less rain in 1859-1860. This corresponds very well to Young's 1859 Q4 for Inhambane, and 1860 Q1, Q2 for Gaza, and probably contributed to the overthrow of Soshangane's successor in 1861, following further insufficient rainfall in Gaza in 1860-1861. The insufficient rainfall for that period does not show up as drought in Young Table A2, but it shows that, as at other times in Mozambican history, the cumulative effect of drought and insufficient rainfall continued to have serious social and political consequences.

For Liesegang, this is part of another period of major famines extending from 1858 to about 1863. His description of the various associated historical events seems to fit very well with Young Table A2 from 1858 to 1864. Young treats 1862 as a Medium Minus event in Table A2,[177] and 1863-1864 as a single Strong Plus event. However, she also records droughts for 1860 and 1861 that are not related to El Niño.

The drought of the early 1860s extended to Lesotho and South Africa, which generally exhibit average rainfall figures similar to those of southern Mozambique,[178] and like the latter are more influenced in terms of rainfall by cold southern fronts than the ITCZ which dominates the weather in central and northern Mozambique. Owing to the persistent drought, food was imported into South Africa. This did not prevent many from dying in Zululand in 1862-1863.[179] The droughts of 1858 and 1861-1863 were also reported further north by the Livingstones for Tete. Drought was confirmed by other sources in Tete in 1862-1863 and in other parts of the Zambezi valley.[180] A similar

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[176] Liesegang, 1993: 9.

[177] Surprisingly, her text (Young 1996: 10) refers to 1862 as a year where no El Niño was recorded, yet Mozambique was drought stricken. Presumably this has been corrected in subsequent versions of the paper.

[178] Chenje and Johnson, 1996: 26.

[179] Liesegang, 1993: 10.

[180] *Ibid*.: 10.

picture as indicated by crop failures is evident for 1861-1863 for Inhambane, Lourenço Marques, and even in Angonia in the north of Tete. The latter is particularly unusual since it normally has an annual rainfall of between 800mm and 1200mm, and is usually a food surplus area. Since the 1863-1864 event is classified by Young as Strong Plus, perhaps its impact is not too surprising.

Despite the Moderate Plus event of 1865-1866, neither Young nor Liesegang have any evidence of droughts in Mozambique. Nor is there any discussion of drought for the strong El Niño of 1871.[181] For the Strong Plus event of 1867-1869, Young has no official evidence, but Liesegang does provide some evidence of dry years from 1867.[182] For example, traders from Inhambane sent food to Bazaruto and Chiloane, two islands to the north of Inhambane, off the coast of Sofala, that probably normally have a rainfall of over 1000mm a year. Lower Zambezia was also badly off for food, which suggests that again the ITCZ had moved with its rains to the north. The drought may have been widespread, with a report of a famine suffered by the Ngoni at around this time in eastern Zambia, leading to a population movement and subsequent political split.

For the Very Strong event of 1876-1878,[183] Young Table A2 shows clear evidence of drought in Inhambane and Lourenço Marques in 1876, and again for the latter city in 1878. Liesegang reports 'a horrible famine' in 1876 in Inhambane, together with insufficient harvests in Lourenço Marques, causing many local Africans to immigrate to Natal in South Africa. By January 1877 food prices remained very high in Lourenço Marques, and great quantities were imported from Mozambique Island and from Zanzibar. In early 1878 a famine was reported among the Tsonga of the Lowveld near Venda in South Africa, which also seems to have affected eastern Zimbabwe and the northern Transvaal and beyond in South Africa.[184] Tsonga from the Limpopo area on Mozambique fled to a mountainous area in South Africa. This is the El Niño event mentioned in SATR as having been associated with calamitous weather events around the Pacific and Indian oceans in 1877 and 1878.[185]

As indicated earlier, while Young has no data for the Medium Plus event of 1880-1881, she does have drought evidence for 1882 for Lourenço Marques. Liesegang again tends to corroborate this. Apart from Quelimane, which reported some food shortages, rainy seasons after 1878 were irregular but no serious problems are reported until 1882, when there are again references to calamities. In July 1882, Inhambane confirmed 'the scarcity

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[181] Zapata Personal communication 2000.

[182] Liesegang, 1993: 10.

[183] Zapata, (Personal communication 2000) defines this event as being for 1877-1878.

[184] Liesegang 1993: 11.

[185] SATR 1999: 11. This event prompted the research that eventually led to the development of the concept of the Southern Oscillation in atmospheric pressure, which together with El Niño, constitutes the major element in current analysis of what have come to be called ENSO events.

of the harvest in the present year' and recommended the suspension of exports. This fits very well with Young's Lourenço Marques data for Q1 and Q2, and her data also show problems for Q4. This then is one of the cases where the evidence of a teleconnection is weak, and Young does not treat it as one her 12 out of 17 cases. However, she does indicate that in this case that she is not entirely sure of the year of the event.[186]

For the next event, also a Medium Plus,[187] Young has some evidence of drought for 1885 Q1, while Liesegang states that in December 1884 fishermen from Tete had been going down the river from the Lupata gorge to fish, and were exchanging their dried fish for cereals and sweet potatoes. This suggests that very little water was coming down the Zambezi from what are now Zimbabwe and Zambia. In addition, people were begging for food at the Lupata gorge and even organized attacks on boats transporting food. In Tete city, there was no rain from the end of January to the end of December 1885. Overall there was not enough rain in 1884-1885 for the crops to mature, and by June the government council was debating the situation in Tete. The reports of very many deaths are graphic, with many 'real walking skeletons' presenting themselves at the doors of the missionary, Courtois, who reported that by early 1886 two thirds of the population of Tete had died. The drought and famine affected much of eastern Africa and northern Swaziland.

The next event is a Strong Plus for 1887-1889. This implied little respite since the previous one, and by October 1887, when Young's data shows drought in Q4 for Lourenço Marques, Macanga north of Tete was still in a state of disturbance due to the famine, which seems to have been continuous in the Tete-Zimbabwe borderland. There are reports of food shortages in central Mozambique (the Manica-Sofala border) in late 1888 and early 1889.[188] Young's data shows drought for Lourenço Marques for Q4 1888, and for both Lourenço Marques and Inhambane for Q1 1889. She also has drought for both of these stations and for Gaza for Q4 1889, perhaps suggesting cumulative effects of strong El Niño events that last for more than one year.

It is worth recalling that Tyson treats the period 1875-1910 as a period of marked decrease in rainfall in southern Africa. Even at times that do not correspond to El Niño events, Liesegang' evidence tends to support this general picture, but more impressive is the fact that Young's evidence clearly shows a string of Medium Plus to Very Strong events from 1876 through to 1911-1912. The drought of 1887-1889 is only about one third of the way through this period.[189]

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[186] Young 1996: 10.

[187] Zapata (Personal communication 2000) dates this event as 1884.

[188] Liesegang 1993: 13.

[189] Since evidence from records of the magnetosphere indicates that the sun itself has started to become warmer since 1850, which is one of the factors contributing to global warming, one wonders if solar warming is linked to this sequence of El Niño events, which amounts to 10 over the period of 35 years. This is a higher rate than that suggested by other examinations of meteorological records, which may be based more on twentieth century records, and coral evidence. The change in the six-year pattern after 1976

Liesegang has access to a much wider range of sources for the period from 1890.[190] He provides rainfall data from the Lourenço Marques weather station where rainfall data starts from 1892.[191] Following the Very Strong event of 1891,[192] Young shows drought for Q1 and Q2 of 1892. This is not one of the cases that Young treats as indicating a teleconnection. Liesegang's use of the actual rainfall data for Lourenço Marques in 1892 corroborates this, with rainfall of around 400mm for January-September 1892. The present-day annual average for Maputo is 800-1000mm. In 1892, it seems to have been about 1000mm for the whole calendar year,[193] and this is certainly not a case for a teleconnection.

Without any El Niño, Young reports drought in 1895 in Q2 for Inhambane, Q1 and Q2 for Gaza and Q1, Q2 and Q4 for Lourenço Marques. Liesegang's weather station rainfall data also shows drought in Lourenço Marques for 1895-1896. This does not correspond to an El Niño.

There was a Medium Plus event in 1896-1897, and Liesegang's data shows even lower rainfall for 1896-1897. Young's reports show drought for Q2-Q4 for 1896 and for Q1 and Q2 in 1897, in Lourenço Marques. They also show drought for Q4 of 1896 in Inhambane and for Q1 and Q2 of 1897 in Gaza. It seems to have precipitated the killing of the nominal mother of the Gaza king in March 1987. The same drought is reported for Tete, and for South Africa and Zimbabwe.

During the dry 1890s, the Red Locust also made its way south, making food scarcities worse.[194] The year 1897 is also famous as the year in which the previously unknown livestock disease rinderpest made its way south from east Africa and into South Africa.

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comes some 25 years after the contribution of solar warming to total global warming fell below 50 per cent. Most of the remaining 50 per cent nowadays probably comes from human activity.

[190] For this reason he devotes a separate chapter to the period after 1890. Unless otherwise stated, from now on references to Liesegang are to 1993 Chapter 8, *Droughts, Famines and Epidemics 1890-1974*. This takes us rather neatly to the period just before the 1976 change of pattern of El Niño, and includes the El Niño of 1972-1973. (SATR 1999: 12-13).

[191] This weather station in what is now Maputo is the location of the present day *Instituto Nacional de Meteorologia* (INAM). Manuscript records are still available, although they are now transferred to computer.

[192] This is corroborated by Zapata Personal communication 2000.

[193] According to Liesegang 1993: 5, all the years with less than 700mm in Lourenço Marques involve some risk of drought. For 1892, the 8-month period from October 1892 to May 1983 shows 1659mm. That implies an average of 200mm per month, which would actually give an additional 600mm for the last three months of 1892. Although the station started in January 1892, and took measurements from January to September, it became the practice from then on only to take measurements during the agricultural growing season from October to May. This practice lasted from 1892 until 1896, according to Liesegang 1993: 29.

[194] *Ibid*. 5-6.

Famine in South Africa was in part caused by the prohibition on using oxen for transport, as part of the attempt to stop the spread of rinderpest, and the 1897-1898 famine in Tanganyika was probably due to the same combination of drought and rinderpest, as well as Red Locusts.

With little respite, there being a near drought in 1898 in Lourenço Marques, the next El Niño took place in 1899-1900. This is classified as Very Strong, and is certainly associated with drought in Liesegang's rainfall data for Lourenço Marques (414mm) although Young does not appear to have a clear report of it for that city. However, it does appear in Q4 in 1899 for Inhambane. Liesegang reports famines in many parts of Mozambique for 1899, 1901 and 1903. This fits quite closely with the two El Niño events, namely the Very Strong one of 1899-1900 and the Strong one of 1901-1902. For example, to the north of Magude in what is now Maputo Province, there were reports in September 1899 of large numbers of people deserting the area for the mountains in the Transvaal in South Africa because of hunger and thirst. This fits well with Young's report of drought for 1899 Q4 for Inhambane, which is not too distant from the reported area. In addition, Young has a clear report on rainfall for Lourenço Marques for 1899, Q4 and 1900, Q1. Liesegang's rainfall data also clearly shows drought for 1899-1900 (414mm).

For the year 1900 in southern Mozambique there was drought, as well as in Tanganyika.[195] In Lourenço Marques, however, 1900-1901 was paradoxically quite a good year for rainfall, although concentrated in three months. Elsewhere rainfall was far below average, including in the center and far north of Mozambique. In Zambezia, the period brought starvation and death, with people dying like flies in the Boror area. The Boror famine is reported in Vail and White.[196] There was also major outbreak of smallpox in Zambezia at this time. The exceptional rainfall position in Lourenço Marques for 1900-1901 appears to undermine the teleconnection evidence, but it is clear from Liesegang's evidence that there is indeed a strong indication of a teleconnection, especially for 1899-1900, even for Lourenço Marques. This holds true for 1900-1901 for most of Mozambique.

The Strong event of 1901-1902 must therefore have seemed like a continuation of the existing drought to people in Mozambique, and that is how it is treated by various sources. Liesegang's rainfall data show near-drought conditions for 1901-1902, and a clear drought for 1902-1903, where most of the very low rainfall was concentrated in the month of April. For Young, there are reports of drought for both Lourenço Marques and Inhambane for Q1, Q2 and Q4 of 1902. As for further north, on the Island of Mozambique, the rains for the season 1901-1902 did not start until January 1902, and by December 1901 it was stated that the native population would have died of hunger were it

[195] *Ibid*. 7, In Lindi, the combination of drought and locust plague killed 3,000 people.

[196] Vail and White 1980: 119-120. The photograph on page 119 recalls the 1886 report on Tete by the missionary Courtois, concerning walking skeletons.

not for mangoes and cashew nuts. Rains for February 1902 meant some kind of harvest, but food was scarce.

Although Young has reports for Lourenço Marques indicating drought for Q1, Q2 and Q4 of 1903, this is not fully borne out by Liesegang's rainfall figures, which are above 700mm. There was no El Niño event in 1903, and the drought is probably a continuation of the previous year's difficult food situation combined with low rainfall figures. However, there does seem to have been drought in Inhambane, and in the lower Buzi, in the center of the country. It also extended into well into South Africa (Transkei) and Lesotho,[197] so this does seem to have been a case of drought with no El Niño.

The next event that of 1904-1905 was a Strong one. The Lourenço Marques rainfall data show clear drought. Young has no report for that city, but for Inhambane and for Gaza, there are reports for 1905.

While none of the years from 1905 to 1908 seem to have been very good (the generally low rainfall corroborating Tyson's view of the end of this 35-year period) there were fairly good rains and crops in 1909. The drought of 1911-1912, which is associated with a Medium Plus El Niño event, is corroborated by Young's reports for both Lourenço Marques and Inhambane for 1911 and 1912. The Lourenço Marques rainfall data also shows drought there. It also failed to rain in Vilanculos to the north of Inhambane, and not only were the crops lost, leading to famine, but there was no water even to drink. The famine in Inhambane seems to have lasted all of 1912.

Overall, as well as indicating a higher periodicity for El Niño than other studies suggest,[198] Young's Table A2 can be taken as refining Tyson's view that the period 1875-1910 was one of low rainfall, and 1910 experienced a severe drought. Rather the period seems to be 1876 to 1912. While Young's Table A2 stops at 1912,[199] Liesegang and Tyson can be compared for later years. This forms the basis of the next chronological period, that from 1914.

El Niño and Mozambique from the First World War

The years 1915-1916 seem to have been ones of droughts in southern Mozambique. The year 1917-1918 was a high rainfall year, and floods were experienced.[200] Rainfall was again low in the years 1921 and 1922. The drought and famine covered Lourenço

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[197] Liesegang 1993: 8-9.

[198] This could simply be a matter of definition, which as SATR 1999: 16, indicates, is not yet fully resolved. Young is relying for her definition on Quinn *et al.* 1987: 449-561.

[199] Young has also examined precipitation tables from meteorological stations in what are now the Provinces of Maputo, Gaza and Inhambane from 1910 to 1992. However, these results are not discussed in any detail in the paper.

[200] Liesegang 1993: 13-14.

Marques, Inhambane and Beira in Mozambique, and also extended to Swaziland and Zimbabwe. In some areas it continued into 1923. In November 1925 a bad famine was registered in east Africa, and low rainfall was recorded for Lourenço Marques in 1925-1926, followed by serious drought in 1926-1927. The latter seems associated with a serious drought from 1926-1932 in Kruger National Park, in South Africa on the border with Mozambique, where thousands of animals died. This drought seems to have been confined to southern Mozambique, Swaziland, and the low veld of South Africa. It included the loss of 13,000 head of cattle in Ermelo in South Africa. There were fairly low rains for the next two years, and drought again in 1930-1931. This corroborates Tyson's view on this period.

Tyson treats the years from 1930 to 1950 as exhibiting dry periods alternating with wet ones. Liesegang generally confirms this picture. There was a drought and famine in 1935-1936 in Mozambique and Swaziland. It seems to have continued in Zambezia in 1936-1937.[201] There was further drought-induced famine in Gaza, Sofala and Zambezia in 1941, resulting in the loss of one third of the plantations at Sena Sugar Estates. It seems to have extended into Swaziland and South Africa. The rest of the 1940s were relatively dry, with South Africa, southern and central Mozambique having a disastrous intensive drought in 1946-1947.[202] This again corroborates Tyson. Yet another drought was experienced in 1949-1950, in central Mozambique. It resulted in several thousand deaths in Tete.

From 1950 to 1992, Tyson's description tends to fit reasonably well with the evidence in SATR,[203] as already indicated. Yet while Tyson reports abnormally high rainfall in some parts of the region, especially east Africa, for the 1950s, this does not seem to be the picture for southern Mozambique and South Africa,[204] unless he is referring to the mid-1950s. Liesegang's descriptions fit the SATR pattern rather well for the 1950s. Thus in 1951-1952 and 1953-1954 there was insufficient rain in the Lourenço Marques area, and this corresponds to warm events shown in SATR. The description of a cyclone and unusually cold weather for 1955 through to 1957 seems to correspond to a strong cold event or La Niña. This may also be the time of high rainfall for east Africa reported by Tyson. In 1958-1959, there was fairly good rain in the south of Mozambique, but the center-north seems to have had drought, especially in Nampula, where many died of hunger. This corresponds to a warm event. Yet despite the weak onset of a cold event n 1960, very poor rainfall continued in Mozambique. The cold event strengthened in 1963-1964, yet seems associated with drought in South Africa, but the warm event of 1965-1966 does correspond to poor rainfall in Mozambique. The cold event of 1966-1967 is associated with exceptionally high rainfall in Mozambique, and a huge maize

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[201] *Ibid*. 17-18.

[202] *Ibid*. 20.

[203] SATR 1999: 35.

[204] Liesegang 1993: 22-24.

crop. The year 1969-1970, corresponding to another warm event, is a year of drought in southern Mozambique.

Tyson considers the years 1967-1973 to be a dry period across the southern African region, but the pattern may be slightly more complex than that. Certainly both 1969-1970 and 1970-1971 are years of drought in Mozambique. Yet 1970-1971 sees the beginning of another cold event, which lasts through to the warm event of 1972-1973, according to SATR. This cold event appears to be reflected in maize production in central Mozambique, which rose in Manica from 100,000bags in 1970 to 500,000 in 1972. Yet care should be exercised in interpreting this evidence for one can find dry areas in Mozambique at the same time, also in central Mozambique.

Liesegang does not go beyond 1974, the eve of Independence in Mozambique. Tyson treats the years 1974-1980 as a relatively moist period for southern Africa. However, SATR would suggest that the main moist period was 1974-1976, with a warm event beginning in 1976. This needs to be checked against the rainfall evidence. The year 1976 marks the turning point in the pattern of ENSO events, as discussed in the Introduction.

From 1979 through to about 1981, there is another warm event, followed after a very short break by the major El Niño event of 1982-1983. In southern Mozambique this was experienced as a continuous three/four-year drought. Tyson has 1981-1982 as the years when most of southern Africa experienced drought, but this is because in 1983 the particularly bad drought extended to whole of Africa. In drought-prone southern Mozambique, the drought resulted in around 100,000 deaths in Gaza and Inhambane.[205] There were also small pockets of serious hunger in Swaziland. In Maputo Province, the drought was immediately followed by a devastating cyclone, Demoina, which also caused considerable damage in Swaziland.

Tyson's description of the improvement in 1985 and the return to drought in 1986-1987 is corroborated exactly by SATR. Tyson's judgment that the drought of 1991-1992 was the worst drought in southern Africa in living memory fits extremely well with the time series data from SATR, but both that time series data and the accompanying comparison of the seven strongest El Niño events since 1950 would suggest that 1982-1983 event was a bigger El Niño. The last event, that of 1997-1998 was also bigger than in 1991-1992, but both the 1982-1983 and 1997-1998 events, subsided slightly more quickly than that of 1991-1992. The length of the event may well have a bigger drought-inducing impact than its amplitude, when one is dealing with events of such a magnitude.

The social impact of the 1991-1992 event was considerable, with starvation again in southern Mozambique. This time, with the ending of hostilities in October 1992, it was possible for international agencies to deliver food in time to prevent deaths by starvation.

[205] The UN could have dealt this with, but for the war, since the Renamo rebels denied entry to this area.

The drought continued into 1993 in central Mozambique.[206] While Tyson's comment that Namibia was not affected by this drought is entirely correct,[207] surprisingly Angola was most affected just across from the Namibian border, where around 250,000 people were at risk.[208]

Conclusion

The available evidence over about two centuries suggests a strong teleconnection between an El Niño event and drought in Mozambique. There is evidently a lot more work to be done, especially on the rainfall data already collated by Young.[209] It would help a great deal if the evidence prior to 1850 could be examined in the light of Quinn et al., who are used by Young to define El Niño events. For future disaster mitigation planning, it would also help to link this evidence to coping strategies, as Young has apparently begun to do.

In general, at least from the beginning of the 19th century until 1850, where Tyson and Liesegang can be used to gauge the periodicity of El Niño without any direct evidence of the phenomenon itself, there is a strong *prima facie* case for a periodicity of six years. From 1850, where Liesegang and Young can be used to relate drought to El Niño, there is perhaps even stronger evidence of teleconnections. However, from 1850 to 1912, on Young's account, the periodicity seems to be shorter than the expected 6 years. Rather it appears closer to 4 years, and there is no obvious explanation for this. Even if one excludes Young's Medium events, the interval between events is still only about 5 years. From 1915 to 1950, where there is no evidence on El Niño events to hand, the periodicity appears to remain at 4 years. This would need to be checked against Quinn et al., or some other objective evidence of El Niño events. From 1950 to 1976, it is possible to check Liesegang and Tyson against SATR, and the fit seems very good. However, it still seems to indicate a periodicity of around 4 years. The shift since 1976 seems to show very strong evidence of teleconnections, but rather than showing a major change in the periodicity, it is the amplitude and often the length of events which have changed. The interval still averages out at around 4 years, or less. This raises the issue of apparent

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[206] The author toured south and central Mozambique in March 1993, as part of the joint UN FAO/WFP Food and crop assessment mission for that year.

[207] This conclusion is based on examination in March 1993 of decadal rainfall index figures for all of southern Africa, produced in a GIS by FAO Famine Early Warning System in Rome. This data, which covered the period October 1992 to February 1993, is no longer in the author's possession.

[208] For Angola as a whole, some 900,000 were at risk of starvation that year, as much because of the war as the drought: A. Vines, Paper given at University of Leeds, 1995. The figure of 250,000 comes from an Angolan government survey in Cunene Province in February/March 1993.

[209] There already exists an analysis of drought in Mozambique using historical rainfall data to produce GIS maps of drought prone areas: Lúcio and Amade, 1996. However, it does not analyze the data by historical time period until the selected years 1981-1982, 1991-1992, and 1994-1995.

periodicity of 6 years, apparently based *inter alia*, on coral evidence. Such matters cannot be addressed in this Appendix.

Clearly, the teleconnection between drought and Mozambique can be overstated. Since southern Mozambique and Tete Province in the center are prone to drought anyway, some of the apparent teleconnections may be coincidence. It would be easier to form a judgment on that with harder evidence on El Niño for the period before 1850, and for the period between 1912 and 1950. Nevertheless, Young's 12 cases out of 17 from 1850 till 1912 do seem to be soundly based. This implies that, in Mozambique if not for the rest of southern Africa, two-thirds of droughts are related to El Niño. Tyson's estimate that one third of droughts are explicable in such terms may nevertheless hold true for the rest of southern Africa. In the case of Mozambique, the evidence of teleconnections for the other time periods is sufficiently suggestive to indicate that further work is merited.

Appendix 2

Multisectoral Action Plan

The Action Plan was issued in its final version on December 1st,[210] as indicated in the EU Comments on it,[211] which were circulated on December 10th. Apart from the Executive Summary (3 pages) and the main text (22 pages plus 3 pages on funds sought and committed and the budget) there were five annexes. The Executive Summary gave an overall budget of USD 221.3 million for a strong drought, and USD 204.4 million for a moderate drought. About two thirds of this was for agricultural measures, as befitted an economy such as that of Mozambique.

Main Text of Action Plan

The Introduction went right to the point, introducing the concepts of El Niño and the Southern Oscillation, denominating them jointly as ENSO, and stating that monitoring ENSO was extremely important to forecast precipitation several months ahead. In Mozambique, it stated that ENSO was related to a reduction in precipitation, principally in the Provinces of Tete, Manica, Inhambane, Gaza and Maputo. Maize yields diminished by more than 50 percent of the average yield. The province of Manica in years of strong El Niño events was critical for food security, although it only contributed about 15 per cent of total cereal production.

Data from INAM and from the [National] Early Warning System for Food Security indicated that Mozambique would have weak and irregular rain during the 1997/98 rainy season, with vast regions being affected. The probable impact in the five provinces mentioned would be:

- Reduction in agricultural production levels
- Shortage of water
- Outbreaks of epidemics
- Animal deaths
- Famine
- Loss of human life

Although the effects would be strongest in January and February, they could continue until April, affecting second growing season crops. A strong El Niño could lead to a reduction in cereal production of 600,000 tons, while for a moderate one it would be 450,000 tons, of which 350,000 would be maize. For the South, the probability of rains below normal was 55 per cent, while for the Center it was 50 percent, and for the North, between 20 and 35 per cent.

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[210] Governo de Moçambique 1997c.

[211] Delegation of the European Commission in Maputo [1997].

From July to December, the most important measures taken by the GOM were:

- Regular dissemination by INAM and the National Food Security Forecasting System of information on behavior and development of the phenomenon
- The sending of alerts from different central bodies to their respective provincial subsidiaries, for them to take appropriate measures and to elaborate contingency plans
- A seminar by MICOA (Ministry for the Coordination of Environmental Action) with the help of the University of Columbia, New York, to study forms of combating drought
- A conference at Pietersburg, South Africa on Regional strategies for the mitigation of the effects of drought
- A workshop on meteorology in Harare, Zimbabwe
- The constitution of an inter-ministerial group for the elaboration of a contingency plan
- A national meeting of MAP (Ministry of Agriculture and Fisheries) at the Pequenos Libombos dam, to prepare the 1997-1998 crop season, taking account of the possible occurrence of drought
- The reactivation of the Technical Emergency Council
- Provincial level conferences involving relevant institutions for the elaboration of action plans

After describing the main activities leading up to this Action Plan, the plan itself was presented. Based on the characterization of high and low risk zones, the aim was:

1. Achievement of full potential production in low risk zones
2. Reduction of the risks of production losses in high risk zones, using drought-tolerant crops and making use of low lying areas and irrigation schemes to guarantee food security.

It consisted of eight sections, followed by Recommendations:

1. Agriculture

The current upward trend in agricultural production could be reversed, given that it was almost entirely based on rain fed agriculture. The drought could also compromise the current attempts to rebuild the country's cattle population.[212] The lack of drinking points because of the scarcity of water reserves and the reduction in pasture areas might increase the number of cattle deaths. Wildlife and marine life could also be affected.

[212] Although it was not stated in the Action Plan, the total number of cattle had been seriously reduced by the war. A lot of game had also been hunted, leading to the near extinction of some species within Mozambique. According to the FAO, in 1992 the number of cattle was one tenth that of 1982.

The measures envisaged were the following:

- National and provincial radio campaigns to raise awareness, in November and December, in Portuguese and 14 national languages. These were to warn people of the possibility of drought, to indicate ways of minimizing its effects, to control burning[213] with the involvement of local leaders and to make greater use of low lying areas together with adoption of drought resistant crops.
- Speeding up of the supply of agricultural inputs, given that the crop season had already begun.
- Given the availability of water for the next crop season in the Chokwe irrigation scheme, it was recommended to clean the main irrigation and drainage canals, of 60 and 40km respectively, and to leave the clearing of secondary and tertiary canals to the local producers.
- Making available plant propagation material of drought tolerant crops, such as cassava cuttings and sweet potato roots. The Provincial Directorates of Agriculture and Fisheries were to try to obtain such material by inter-provincial exchange if necessary.
- Dissemination of forms of treating unripe cassava to prevent people from consuming it without proper preparation.[214]
- Acquisition and distribution of seeds of drought tolerant crops.
- Distribution of tools
- Acquisition, making available and distribution of fertilizers and pesticides (linked to a Japanese aid program KRII).
- Prioritization to producers' organizations and co-operatives in the allocation of inputs, to stimulate greater community involvement in the implementation of these measures.

The inputs would be financed by PESU[215] in the case of seeds and tools, and KRII in the case of agro-chemicals. Normal needs in this area were already covered and additional needs were calculated in relation to this (Annex 2). Depending on the severity of the drought, these inputs might be given away or sold for symbolic prices. The detailed budget was in Annex 2.

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[213] Most of Mozambican family agriculture still uses slash and burn techniques. While these are frowned upon in some quarters, they do raise soil fertility in the short term and get rid of rats and other pests. A reduction in fires implies the use of rat poison to reduce the risk of bubonic plague, as is indicated, somewhat implicitly, elsewhere in the Action Plan.

[214] This measure is evidently based on the research conducted in the early 1980s within the Ministry of Health on the effects of cassava poisoning from eating unripe cassava.

[215] *Programa de Emergencia de Sementes e Utensilios*, the Emergency Seeds and Tools Programme, which had been running with FAO technical assistance and some EU funding since at least the early 1990s.

For livestock, it was estimated that of some 316,000 in total, about 120,300 were at risk. A provincial breakdown was given. The measures to be taken by April/May were the following:

- Advising the private sector to produce and keep hay and to increase use of sub-products and residues of national agro-industry, such as use of cottonseed that was not used for oil. Meetings of cattle farmers and industrialists would be held to find ways of implementing these measures.
- Provision of strategic medicines and drugs to kill ticks.
- Expansion of effective water supply by cleaning existing wells and opening new ones
- Purchase from cattle farmers of cows of reproductive age that were at risk, to transfer them to areas where they could be fed. This required the creation of an emergency fund to be allocated to the Fund for Agricultural Development and to be managed by the Provincial Directorates of Agriculture and Fisheries.

The majority of current livestock activities were financed by the ADB (African Development Bank) through the Livestock Service Rehabilitation Program. There were no funding sources for the above emergency measures. About 20 per cent of the cattle whose lives were at risk, that is 24,000, could be acquired. Detailed costs were in Annex 2.

2. Agricultural Marketing and Food Security

As well as increasing food production, marketing was important for food security. The principal marketing problems were linked to the degraded rural marketing infrastructure: roads and bridges, means of transport, insufficient number of shops. There was weak access to credit by merchants, high interest rates and lack of merchants' experience. High internal transport costs meant that Mozambicans operating in the Center and North opted for exports rather then selling agricultural products to the deficit areas in the South. In addition, the openness of the country to external trade meant that merchants from neighboring countries had also purchased large quantities of agricultural products in an uncontrolled fashion, undermining Mozambican merchants, who did not have the finances to compete.

Assuming that the whole southern African Region would feel the effects of drought, this cross-border purchasing would certainly increase, as a comparatively cheap way to overcome their food deficits. Examples were given of prices paid by merchants from Tanzania, Zimbabwe and Malawi, but not quantities purchased. Mozambique was taking measures to prevent uncontrolled exports of large quantities of products, and to dynamize Mozambican merchants, to guarantee necessary stocks if drought were confirmed.

The principal conditions to secure this were the following:

- Rigorous customs control to ensure that legal export procedures were followed. Exceptionally, in this crop season, a 50 per cent tax on maize exports at the estimated CIF price would be imposed (until the El Niño disaster was declared to be under control).
- To dynamize the internal marketing process, it would be necessary to ensure that sacks and chemical products were available, that the ICM[216] had the financial means to purchase agricultural products for the food reserve, and that road rehabilitation work was intensified in the areas with greater agricultural potential. A costed table of the priority roads was given. Most of them already had ongoing work on them.

Food security in current market conditions presupposed that funding was available for sacks and chemicals, that preferential finance was available to the ICM and that a fund was created for the constitution of strategic reserves (physical and financial reserves). The fund for sacks and chemicals was to be run through the ICM and to be reimbursable. Quantitative and financial estimates were given. The practice of the ICM in attempting to stimulate rural trade was to take out rural banking credits at high interest rates (between 35 and 44 per cent annual interest rate)[217] and use this to refinance small and medium rural traders who were not eligible for credit. The preferential finance was for a reimbursable fund charging lower interest rates, in order to expand this support activity during the expected drought period.

3. Monitoring of ENSO

The National Early Warning System for Food Security (NEWS), which involved MAP, MICTUR[218] and MTC[219] had the responsibility for furnishing regular detailed information n the evolution of the ENSO phenomenon. With technical assistance from FAO/WFP it was proposed to monitor the drought on a Regional scale. A close link would be kept with the Regional SADC network to exchange and render compatible drought information. This would enable government agencies to adjust this Action Plan in terms of scale and types of intervention. The following actions were envisaged:

- Meetings to divulge the prognostications for the 1997/98 crop season
- Study of the implications of the El Niño for precipitation during the crop season

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[216] *Instituto de Cereais de Mocambique* – the Mozambique Cereals Institute.

[217] It is not entirely clear why rates of interest remained so high when the rate of inflation in Mozambique had come down by 1997. The most likely explanation is the continuing under-development of rural credit institutions, which is presumably what the ICM was trying to compensate for.

[218] Ministry of Industry Commerce and Tourism.

[219] Ministry of Transport and Communications.

4. Water

It was assumed that where the impact of the drought was worst there would be a tendency for the population to disperse to zones where the situation was more favorable. Such a situation of [population] saturation could create a more general crisis because the water supply would then be insufficient. Manual pumps could have their useful life reduced, compromising the policy of using sustainable sources based on local resources, as defined in the National Water Policy.

To design a strategy to cope with the drought, a way of taking account of sustainability was sought, with immediate actions being defined that recognized that not all [newly installed] infrastructure would be fully used once people returned home. Measures to be taken would take into account local capacity, including the private sector, in the provinces.

It was considered that around 3 million people in the affected provinces, or around 15 per cent of the affected population, could move within the country, and according to the 1992 experience they would concentrate in frontier zones.

Normally three basic situations could be considered:

- Complete lack of water

This referred to places where no underground water supply was available, and in which aid could only be of a temporary character, rather then construction of wells. Such aid could not be sustained for very long, requiring as it did costs of transport, storage, fuel and human resources.

- Water at great depth

This implied construction of mechanical pump wells, on the assumption that drought considerably lowered the water table.

- Population movement

Part of the population could move to the most secure zones, the low-lying ones, which would increase demand for potable water. New sources would need to be created.

It was proposed to build 300 new mechanical pump wells, and a breakdown was given for the six provinces. Tanks with a minimum capacity of 8 cubic meters would be acquired for the most critical zones, assuming that there would be some resistance to

moving.[220] A provincial distribution of 55 tanks was given. This implied a fund to hire tractors and trucks. Tables showing the needs were in Annex 3.

5. Health

The lack of water could have diverse effects on transmissible diseases, namely cholera, dysentery, conjunctivitis, trachoma, *dermatoses/sarna*, and bubonic plague. The lack of food could raise the prevalence of nutritional illnesses and cassava poisoning. The following health measures were envisaged:

- Reinforcement of epidemiological and nutritional vigilance.
- Establishment of norms to control epidemics and for nutritional supplementation and rehabilitation
- Training of health personnel
- Preparation of medicine and reagent stocks
- Reinforcement of the programs of Maternal Infant Health, of PAV (Enlarged Vaccination Program) and others
- Reinforcement of the SIS (Health Information System)
- Strengthening of laboratories

6. Ministry of the Interior

Actions to be carried out over one year included the following:

- Using the water trucks of the fire brigades to aid populations most in need of water. Costs of fuel, engine oil and rations for firemen were given.
- Police activities. Costs were given.
- Training of brigades to raise awareness among the population of the danger of land collapsing where wells were very deep, and of the need to have a water supply for fires, given that during droughts the speed of fire spreading was greater. Costs for TV and radio dissemination were given, as were costs for auxiliary equipment.[221]

7. State Administration

The Ministry of State Administration had already on September 23rd 1997 sent an alert to all provincial governments informing them of the El Niño and advising them to take preventive measures.

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[220] The relation of this to the earlier statement that some 3 million could move to frontier zones, and that some could move to low-lying zones, is not clear.

[221] The need for the latter was not explained, but it appears to be fire-fighting equipment.

8. DPCCN

The expected food deficit implied that around 600,000 tons of food would be needed, of which around 38 per cent or 228,000 tons would be needed for humanitarian assistance to 3.8 million people potentially at risk at least until the next harvest. The remaining 62 per cent was for normal commercial distribution in zones where the El Niño event affected agricultural yields.

For contingency planning, it was considered that some 30 percent of the above figure, that is 1,140,000 people, should be the basis of estimates for immediate emergency needs whether in food aid or other aid goods. The cost would be USD 23.3 million (Annex 4).

Transport was being planned to try to avoid the need for an expensive air bridge although there would be access problems whose solution had been presented in the agricultural component of the plan. This implied that part of the humanitarian assistance would consist of Food for Work schemes to rehabilitate roads. Both private and DPCCN transport facilities were available, despite the fact that the DPCCN fleet required funds to rehabilitate vehicles, to provide spare parts and other consumables.

In terms of warehousing, the DPCCN had a capacity of 75,000 tons of which 20 per cent were in the North of the country, 45 per cent in the Center and 35 per cent in the South. An additional 128,000 tons' capacity was available through the ICM. This was considered sufficient capacity to cope with the El Niño event. Given that some of this infrastructure had been damaged during the war, financial resources would be necessary for rehabilitation and to manage the operational warehousing costs (Table 1, Annex 4).

There had been a Pre-Project on the National Policy for the Management of Natural Disasters, which had identified that training was necessary in the DPCCN for institutional capacity building. The cost would be USD 1 million. Costs of creating an immediate response capacity were given in Annex 4. The DPCCN would continue to ensure the monitoring of the progress of the El Niño phenomenon, whether through the central and local CTE (Technical Emergency Committees), or work in partnership with specialized UN agencies, donors and NGOs, developing mainly:

- Collection, processing and dissemination of information for prevention and mitigation of drought effects
- Continuous education and awareness raising of all segments of society to develop actions necessary to develop concrete actions to reduce the impact of the drought under different scenarios.
- Creation of prompt response capacity and of volunteer groups keeping in mind the responsibilities of local communities in the prevention of natural disasters (Annex 4).

Recommendations

Considering that the socio-economic impact of the natural disaster could be short or long term and with dramatic effects, anticipatory measures were urged. These are the following:

- Raising the awareness of populations, using among other means radio and television
- Improvement of management of water resources, establishing bases of understanding with neighboring countries for the reciprocal use of waters from international rivers and for use of dams
- Efficient use of low-lying zones and irrigation schemes, including the Chokwe irrigation scheme.
- Acquisition and distribution of agricultural inputs for arable farming and livestock, namely seeds of drought-tolerant and quick-growing crops and varieties; agricultural tools; fertilizers and pesticides; veterinary drugs and medicines; phyto-sanitary equipment for irrigation
- Acquisition and transfer of livestock at risk and rehabilitation of livestock infrastructure
- Guarantee and supply of food and other goods for humanitarian assistance to affected populations
- Creation of operational reserve stocks to a minimum total of 100,000 tons of maize and beans
- Creation of a special financial fund for importation of food and other essential goods. This fund would have to envisage the timely payment of CPF (Counterpart Funds) by those using it.
- The advancing to the ICM of reimbursable funds for the purchase of marketing goods (sacks, chemical products and others).
- The concession of preferential financing to the ICM via the state budget and banks
- Making more flexible the mechanisms of importation and distribution of goods destined to minimize the impact of the drought
- Reorientation as the situation developed of the use of food aid funds to be conceded by the donor community for the acquisition of wheat, targeting them for acquiring other products of higher priority at this time
- Acceleration of the implementation of preventive measures against the uncontrolled exportation of food and the creation of measures to dynamize the marketing by internal economic actors to guarantee the stocks necessary to the country
- Exceptional imposition during the present crop season of an export tax of 50 per cent on the CIF price

Technical Annexes

It is proposed to examine the annexes, since they would be thought to form the technical basis of the Action Plan, which would indicate how feasible it was.

The first annex, of 11 pages, consisted of a logical framework (logframe) analysis of the activities of all the Mozambican government agencies involved in the plan's proposed implementation. However, the timing of some of the actions was left blank, raising the question of how much of an operational plan this was, and also raising the issue of whether the various agencies had decided how to avoid time conflicts in the use of their limited resources. Similarly some of the costs were unspecified, which meant that budgetary totals for some parts of the plan were not filled for the logframe analysis. Nevertheless the overall basic coherence of the plan seemed to be shown by the logframe analysis, allowing for the fact that there were many uncertainties as to the impact of the El Niño event.

The second annex, 12 pages long, consisted of a provincial breakdown of the proposed seed distribution, by crop, in US dollars. It also contained similar proposals for distribution of cassava cuttings, sweet potato roots and other seeds, and for agricultural tools: hoes, machetes and axes. At the end of this part of the second annex there were two observations: one that 40km of irrigation canals, and 60 km of drainage canals would need clearing, and the other that USD 7,000 would be necessary for customs costs of tools already in the country.[222] These observations elicited comment from the EU (see below). This annex also contained uncosted details of agro-chemicals to be distributed: only two pesticides had actual quantities and costs filled in on the table. This also caused comment, as did other unquantified and uncosted items of clothing and equipment in this annex, and other partly unquantified provincial distribution lists of necessities. Provincial infrastructural work was quantified and costed, as were medical and veterinary material, and information dissemination and agricultural extension work, but none of these were justified in the annex (although the reasons were given in the main text). The penultimate table in this annex also mentioned a further 1200 hectares of canal clearing, in addition to the 100km mentioned above. The reason for this appearing in the state budget is not entirely clear, since the main text states that this will be left to local producers. It is assumed that the state proposed to pay for this, but leave the actual work to the family or private farmers using the Chokwe irrigation scheme.

[222] This would raise a continuing problem for many donors. The major donors, namely the EU and USAID, had long argued that since they donated large amounts of aid in kind, which generated large counterpart funds (CPF) that went into the central bank and the state budget, they should not also have to pay the customs costs of importing aid in kind into Mozambique. This had been raised as a major issue during a seminar in April 1992 to train Mozambican government officials I the workings of the Lome Convention, the treaty governing aid and trade relations between the EU and some 70 African, Caribbean and Pacific (ACP) countries.

The third annex of 9 pages consisted of a series of budgetary breakdowns of the National Water Directorate[223] plan, firstly by the 6 Provinces of Maputo, Gaza, Inhambane, Sofala, Manica and Tete, and then by activity within each province. It also included a costed provincial list of water gauges and a small logical framework analysis of this part of the Plan. Strictly, this latter logframe analysis should have been integrated into the overall one in Annex 1. That it was not raises doubts about the degree of inter-Ministry co-operation in the construction of the Action Plan.

The fourth annex was composed of 4 pages, each with a table. This referred to the DPCCN part of the Action Plan. The first table showed a projection of the zones and population to benefit from aid. It covered all ten provinces, and gave a total affected of 1,140,000, of whom 40,000 were expected to be displaced. The first figure corresponds to that given in the main text, while the second does not appear there, so the basis of this estimate is not clear. The second table concerned food aid needs, in terms of maize, beans and oil. It was quantified and costed. The third table showed the needs for free non-food aid for six months in the potential risk areas. This too was quantified and costed by province, for 5 kinds of consumer goods such as soap and blankets. The fourth table covered tables 2 and 3, in summary format, and linked them to warehousing, transport, education and awareness raising, institutional support, and monitoring and supervision. The latter were all costed but not quantified.

The fifth and final annex was a single logical framework analysis table of meteorological work, which was quantified and costed.

Even from this preliminary description, it is evident that in some parts of the background work for the Action Plan, as indicated by the annexes, there were elements that might give rise to concern among donors, since they did not all seem to be fully justified or coherently related to each other. This may have partly reflected the diverse working practices in different government bodies, and the fact that this was the first time that such a multisectoral plan had been drawn up. However, on the whole this plan was reasonable, given the uncertainties surrounding the event, and the limited resources available to the Mozambican government, which seemed intent on using fully the resources available to it, by rehabilitating infrastructure where appropriate.

[223] *Direccão Nacional de Águas* or DNA, which is part of the Ministry of Public Works and Housing (MOPH) and not to be confused with DINA, the *Direcção Nacional de Agricultura* within MAP.

Discussion of the Action Plan

As indicated in the discussion of the flow of information (*see Chronology of Response*) donors expressed some initial concern when informed of this Action Plan. The EU[224] was asked to make a written commentary on it, and did so quite quickly.[225] These comments contain some good points, but others are misplaced. The main objective of the paper was to provide general comments and suggestions in order to advise the Ministry of Agriculture of some adjustments considered necessary before launching the Government appeal. There were five general comments and three specific ones, in terms of the headings of the paper, but some headings in fact cover different sections of the Action Plan.

General Comments
The paper argued that two issues were omitted in the Plan:

- The Government's contribution in terms of financial resources available to mitigate drought effects and how much it would represent in relation to the required donors assistance
- The impact of the prevention measures taken by the Government in rural areas, with additional prevention actions and alert information that would be required.

Both of these points are misplaced. Firstly, the Action Plan stated, at least in some places, that the financial estimates given were estimated on the basis of what was additionally required over normal state budget expenditure. Where known, existing donor programs were mentioned and additional costs indicated or reorientation of funds was suggested. Even if this had not been stated, the EU knew that its own Counterpart Funds at the disposal of the Mozambican government for such contingencies amounted to less than USD 2 million (see Donors Meeting, December 5th). The USAID CPF were presumably of a similar order of magnitude, which came nowhere near the estimated USD 204 –221 million for the Action Plan. In this sense the Mozambican government contribution could not have amounted to more than a few percent of the total cost.

Secondly, the impact of measures could hardly be known given the uncertainties of the El Niño event itself, and uncertainties about implementation given the meager resources available and the difficulties of evaluating public awareness-raising campaigns. Expected results were defined in the logframe analysis. Finer impact analysis was probably impossible given the quality of information available.[226]

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[224] Strictly speaking, it was the Delegation of the European Commission in Mozambique that was asked to do so. For this reason some documents refer to it as the EC rather than the EU.

[225] Delegation of the European Commission in Maputo [1997].

[226] This could be improved in future with the 1997 census, more detailed evidence on the economy, and the results of the 1997 poverty study (Government of Mozambique 1998b) as well as GIS data on soil types and hydrology.

The paper then argued that there was no reference to the influence of the possible Regional drought in Mozambique, in particular to the demand in the domestic cereal market by traders from neighboring countries. This is either an astonishing inconsistency within the EC document itself, or it is a demand for more information than the Mozambican Government could possibly supply. Later in the paper, under the second specific comment, the EC paper itself points out that the Action Plan is very critical of 'uncontrolled exports of maize.' This was clearly a reference to demand on the domestic cereal market by merchants from neighboring countries. So this general comment is best understood as requiring further information on the topic. However, the very fact that traders were entering the country and leaving without paying excise duties implied that the Mozambican government had no way of collecting statistics on this phenomenon. Hence it was unreasonable of the EC to expect further comment in the Plan.

The third general point was that that the expected affected population (3.8 million) was based on the information from the 1992/93 drought. It was argued that this was not applicable to current conditions prevalent in Mozambique, for three reasons.

Firstly, because the 1991/92 drought occurred when the country was affected by more than 15 years of a civil war. This point is quite reasonable in that many of the displaced people at that time had already been encouraged to move into priority districts which were more productive and easier to defend. However, the drought itself did lead to further unanticipated population movements, for example out of Renamo areas and into the Beira Corridor. In addition, the actual estimate of affected population is explicitly put at 30 per cent of this 3.8 million in the Plan, that is 1,140,000 of whom only 40,000 were expected to be displaced. While the basis of the estimate of 40,000 displaced is unclear, this is hardly a simple process of lifting the 1991/92 experience and applying it to a post-war situation.

Secondly, the estimate of the beneficiary population should have taken into account the preliminary results of the recent population census (2 million less than expected). This is a fair point that should be included in future disaster planning, but a proportionate reduction in the less well populated rural areas of the six provinces most likely to have been affected would not have greatly changed the figures, given the margin for error already implicit in them.[227]

Thirdly, the latest information on rainfall between September and December and the planting season for the southern provinces indicated that the crops would be harvested by the end of December with very satisfactory results, which would considerably reduce the expected number of vulnerable people. The point about the good rainfall was entirely correct, and was corroborated by the December NEWS document on El Niño.[228] However, the latter still warned of a possible drought in January and February 1998.

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[227] This argument could be checked out against the final 1997 census results if a GIS were used.

[228] Sistema Nacional de Aviso Previo para a Seguranca Alimentar, 1997c.

Moving on from these sub-arguments within the third general point, to the fourth general point, the paper stated that the Action Plan did not indicate which body would undertake the overall co-ordination of the Plan. What would be the role of the DPCCN in relation to the other government institutions involved? Would the MAP continue with the co-ordination role? This is a very good point. It presumably was already a concern within the Mozambican Government, and underlay the pre-project on the DPCCN, which had indicated that institutional strengthening was required. While the DPCCN has since been reorganized and reoriented as the INGC, the relation between government agencies in disaster management still does not seem to have been fully resolved and may only become clearer as the INGC does actually receive further institutional support.

The fifth point was that the 1998 budget that was then being finalized should identify the necessary financial resources to react to a possible drought. This was considered essential to create within the Government a response capacity in disaster management. While such a point is superficially reasonable, it ignores the fact that the Action Plan does broadly identify what would come from existing Ministry budgets for 1997 and 1998, and points to the shortfalls that would require donor support. The fifth general point then adds that an economic component should be included to review the effects of a drought on the Government's economic and financial benchmarks. Again, this is an entirely reasonable point, and should be part of future disaster planning, but it would have had to include estimates for moderate and extreme scenarios.

Specific Comments

1. Agriculture

The required seeds were identified, but no timing was given for the seed distribution.[229] Would the seeds be utilized in the second crop season starting in April/May 1998 or in the next agricultural year (starting in October 1998)? However, Annex 1 (page 4, section 2.4) did in fact give the time for the distribution of the maize seeds as the first quarter of the 1997-1998 agricultural year, so the timing of bulk of the seed distribution *was* covered despite the EC paper's comments. The second crop season is also covered (page 8, section 1). So this comment seems largely unfounded. A more pertinent point was that there was no information on whether the seeds would be sold or distributed freely to farmers. However, the MAP position was almost certainly the same, as for other inputs,

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[229] One of the purposes of logframe analysis is to identify such omissions, and for that reason the rigorous completion of the entire logical framework should be seen as part of the process. The methodology is designed to identify weaknesses in a plan, so that they can be addressed in a realistic fashion. Failure to complete the entire logical framework vitiates the exercise and leaves the planning body open to such criticisms.

namely that this would depend on how bad the drought was. In view of the devastating impact of the 1991-1992 drought, this seems an entirely reasonable position, if only implicit in the Action Plan.

The EC paper rightly says that the distribution of hand tools was only calculated for Gaza and Manica, with no clear information as to why other provinces, especially those most at risk, were excluded. However, the table in Annex 2 does give the quantities and costs for all provinces. It gives the *additional* quantities and costs only for Gaza and Manica. While no rationale is given for this, one can guess that the reason is that Gaza is the province most vulnerable to drought, while Manica is the one, which is most crucial in terms of food security if the drought is bad, as the Plan says in the Introduction. Hence these do seem to be the top priority provinces. If the other four provinces at risk had also been included, then the charge of just producing a shopping list (made at the donors meeting on December 5th 1997) would have been more justified.

A more pertinent point was that the funding requirement included USD 7,000 for customs duties, which was not acceptable. This was doubtless related to the continuing difference between the GOM and donors over customs duties on aid in kind, where the GOM position does seem difficult to defend. The EC paper was equally scathing about the use of the word 'flexibility' to refer to efforts by the GOM to facilitate imports.[230]

The proposal to save cattle by purchasing them and transferring them to areas where they could be fed also elicited adverse comment. The EC paper rightly asked how the cattle were to be managed and who would take charge of the related management costs. It also asked who would benefit from this operation.[231]

The EC paper also asked what the criteria were for concentrating irrigation construction works in Chokwe. While no reasons were given, they were easy to guess, namely that Chokwe is in Gaza, the most vulnerable province,[232] and irrigation there, if it led to an increase in production, would reduce the costs of food aid transport. It would also reduce rice imports for the major cities, freeing up food import funds to concentrate on the more important maize. The irrigation scheme in Chokwe had been damaged by salinization resulting from the incursion of the sea during the 1992-1993 drought, and was only slowly recovering. Clearing the canals, allowing the Limpopo River water to irrigate

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[230] This was certainly a great deal less than waiving customs duties, as the donors would have wished. In any case, the GCPI (*Gabinete do Coordenação do Programa de Importação*) had in the past shown little sign of flexibility in harmonising EU and USAID importation procedures into a single system, so promises of flexibility would carry little weight with donors.

[231] Indeed there was no indication of proposals to sell the cattle back to the private sector and at what cost. If they were not to be resold to the original owners, then either the state would become a cattle farmer or would sell to unspecified private owners – surely a recipe for illicit influence to be exerted.

[232] The weather station at Chokwe is the one with the highest probability of drought in Mozambique: Lúcio and Armade 1996:10.

more effectively, would have been a sensible way to speed up the desalination and rapidly improve output in this food-deficit province.

2. Agricultural Marketing and Food Security

The EC paper pointed out that the proposed exceptional tax of 50 per cent on food imports was already in force. It rightly argued that this decision should be reviewed in terms of its impact in fostering agricultural production and stimulating local food crops marketing. However, it is hard to see how the scale of the problem of traders from neighboring countries could be assessed without some sort of customs duty as a means of collecting statistics on the traffic. The rate of 50 per cent might be disputable, but any review would have had to be based on information that would have been difficult to collect by other means. In any case, if the Plan's measures to stimulate local marketing were successful, the tax in itself probably would not have had a strong disincentive effect on Mozambican food production in food surplus provinces.

The rural roads rehabilitation proposal was criticized for having no schedule of works, and it was stated that it could only be implemented after the rainy season (April 1998). The latter claim overlooks the basic premise of the Plan, that a drought would probably be taking place, so that road rehabilitation would be feasible in the affected provinces. The EC paper also asked why these roads were not included within the priorities of the ongoing rehabilitation program. One answer to that could have been that most of the roads mentioned did have work going on, so they probably were part of the ongoing priority rehabilitation program. An alternative answer could have been that a drought contingency plan could quite reasonably introduce new priorities that would not be applicable in a normal situation.[233] Either way this EC comment does not seem a very intelligent one.

The comments on the ICM were interesting. The EC paper pointed out that agricultural marketing measures were concentrated in the ICM. What was its role? Did the government intend to give the latter a monopoly of importation of marketing inputs? However, it seems that a near monopoly already existed. The ICM had already been providing agricultural inputs by way of an agreement with *the* importer. [234] It was argued that this arrangement was not applicable in the presumed drought situation, because of the need to constitute reserve stocks. In effect, this does seem to be an argument to establish a monopoly for importing and distributing agricultural inputs. The EC paper asked if the ICM had suitable facilities to constitute the 100,000 tons of operational food reserve stocks. This was a good question. The DPCCN part of the Action Plan answered it by stating that the ICM had a warehouse capacity of 128,000 tons, and that funds would be necessary to rehabilitate the warehouses of both DPCCN and the ICM. The cost of this was put at USD 350,000 (Anne 4, Table 4).

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[233] The roads listed were all in the food surplus provinces of Zambezia, Niassa and Cabo Delgado, which would mean that such surpluses would not be lost because of difficulties of getting them to market.

[234] Governo de Moçambique 1997c: 11.

The real issue then was whether a monopoly was acceptable. That could have been argued both ways. On the one hand, a monopoly could help overall plan co-ordination by the state in the emergency scenario envisaged, especially since the private sector was so weak in this area. On the other hand, a state monopoly of imports could be open to abuse, as some donors believed had happened in the early 1990s. Instead of evaluating the merits of such arguments, the EC paper confined itself to a rhetorical question: what would be the role of the private sector in the proposed program? The honest answer would have been very little.[235] In that case, measures to ensure that the state monopoly was not abused could have been emphasized by the donors. The valid point that it was not clear what the relation was between the 100,000 tons of reserve food stocks and the 550,000 tons of food imports could have been used to support a donors' stance of vigilance against potential abuse. The lack of clarity on the relation between this food reserve and the DPCCN food distribution program could also have been set in such a context.

The paper also makes the very good point that the relation between the DPCCN component of the Action Plan and the WFP Contingency Plan was not specified, although the DPCCN had sat in on all the meetings. The two ought indeed to have been integrated.

3. **The Remaining Components of the Action Plan**

The EC paper considered that some adjustments were necessary on the water supply and meteorology components, but did not think that they raised major questions. It did not specify what the adjustments were, but did state that assistance to meteorology had to be considered a priority in view of the importance of this institution within a disaster management information system.[236]

The only comment on the health component was that no specific fund requirement was presented.[237]

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[235] This section of the EC paper echoes an earlier difference between USAID and the DPCCN. The weakness of the private sector could not be overcome within the short timeframes of the drought and other emergencies of the late 1980s and early 1990s, and the state's logistical capacity supplemented by that of NGOs and international agencies was the only realistic option. The role of the private sector will have to await further development of the Mozambican economy.

[236] Unfortunately, to date there is no sign of this view being acted upon, although the current adverse weather has raised the profile of meteorology in the media and on the Mozambican political agenda.

[237] However, some funding was specified in the logframe analysis in Annex 1. The fact that these did not appear in the general budget at the end of the main text is another indication that more work was needed on the overall coherence of the Action Plan.

The DPCCN component was said to have been elaborated on the basis of the operational activities carried out by it in the1991/92 drought. This appears to be an implicit criticism, in view of the earlier general comment about the interaction of drought and war affecting population movements in 1991/92. Yet it is hard to see what alternative experience could have been used as a basis for action. The 1997-1998 El Niño event was forecast to be the biggest of the century, and although the 1982-1983 event had been bigger than that of 1991-1992, the drought in Mozambique had been larger and more intense in the latter event, which may have been the biggest of the century for Mozambique. Hence it was the closest scenario on which to base any plan, and as indicated earlier was not used mechanically to produce identical estimates of the number of people likely to be affected. In that sense, the Action Plan seems to have attempted to subtract the number of people displaced by war in its use of the 1991/92 figures, and to have estimated drought displacements alone.

The EC paper then stated inaccurately that USD 1.9 million was requested for institutional support. In fact the figure was USD 1million, and had come from the above-mentioned pre-project, which had been conducted with technical assistance from a consultant. (*Check this against interview with Silvano Langa: J-P has notes*.) Thus it was not a matter of empire building (as implied by the "No comments!" of the EC paper) but of responding to perceived weaknesses in the DPCCN. In view of the above EC comments about the need to build a disaster management information system, this response from the EC to a Mozambican attempt to move in that direction was rather unhelpful. Constructive criticism would have been more appropriate.

The EC paper saw no justification for the Ministry of the Interior component. However, since fire brigades would probably have been located in major cities such as Beira and Maputo, then they would most likely have been deployed in rural areas of the Center and South. This is where the danger of uncontrolled burning would have been greatest. Given that all other available water tanks would have been used to supply drinking water, and then this use of fire brigades would seem eminently sensible, in the event that education to reduce uncontrolled burning was not completely effective.

Conclusion

Although the EC commentary makes some very good points, it also has an element of cynical carping at the attempts by the GOM to build its own disaster response capacity. The fact is that, in conjunction with international agencies, particularly the then ONUMOZ,[238] WFP and FAO (both of which received substantial EU funding), and with NGOs, the GOM in general and the DPCCN in particular had developed a considerable logistical capacity and was able to cope with both a major drought and a war in 1991-1992. This capacity had been greatly reduced in the intervening period to 1997, but the infrastructure in terms of buildings and vehicles was still there, although in need of

[238] The UN Special Mission to Mozambique, which concluded its activities in December 1994, after the October 1994 elections, which it monitored.

repair. Rebuilding that capacity and strengthening it institutionally would seem a cost-effective approach to disaster management, and would not preclude private sector involvement when the later was sufficiently well developed.

Despite some methodological weaknesses, the 1997-1998 Action Plan seems to have been generally sound and robust in the face of different possible scenarios. It would be worth updating this plan for future El Niño events, as well as developing a comparable one for La Niña (cold ENSO) events. The latter could make use of the experience of the floods and cyclones of 1999-2000.

Rather than castigating the GOM for what might seem like an attempt to revive institutions of the past, the use of the DPCCN (now the INGC) and the ICM should have been seen as probably the cheapest and most effective way of dealing with the possible drought in the lead time available since the forecast. It is somewhat disturbing that the EC commentary which contained an undifferentiated mixture of good and poorly supported points should have been presented to other donors by the EC Delegation as advice that was *necessary* prior to making a Government appeal in support of the Action Plan.

Appendix 3

Press Coverage of the Weather 1982-1983

Domingo

The press at that time contains no mention of the El Niño phenomenon. It does, however, contain a little material on the weather, particularly the drought, and the rare occasions when it rained heavily during this period.[239] Examples of news related to the drought include a 1983 story in *Domingo* giving a meteorological analysis of the drought, with detailed rainfall figures, both normal and for 1982, for 19 weather stations in Mozambique.[240] Another report[241] gives an account of how drought and hunger are killing people and animals, and indicates measures being taken to reduce the impact of the drought.

World Food Program aid is the basis of a short piece in September 1983, by which time the drought has become really serious in terms of famine.[242] By the second of October the headline seems somewhat desperate.[243] The 9th October carries a story on drought in Mauritius, but also has a report on rain to the south of the river Zambezi.[244] There is a plaintive story on the need for rain to sow crops.[245] Finally for *Domingo* in 1983, there are reports of a violent cyclone and an article wondering if the rains would begin in November.[246]

Tempo

The coverage in the magazine *Tempo* is limited to a single article, in 1982. This concerns some 4,000 tons of international food aid channeled through the UN World Food Program to the victims of the drought.[247]

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[239] *Domingo*, 21 February 1982: 1 This is a weekly newspaper, published on a Sunday, and this report concerns a cold current that was the source of some bad weather.

[240] *Domingo*, 5 July 1983: 22-23.

[241] *Domingo*, 10 July 1983: 8-9.

[242] *Domingo*, 4 September 1983: 2 the same page carries a story on EEC food aid of 15,000 tonnes of maize.

[243] *Domingo*, 2 October 1983:8-9 the headline is 'Will rain come this month?' October is normally the start of the rainy season. Rainfall patterns for the previous 41 years are shown in a photographed chart, along with a picture of the emaciated body of a cow.

[244] *Domingo*, 9 October 1983 The report on rain is careful to point out that this does not signify that the rainy season has started. It also reports people storing rainwater in the capital, Maputo.

[245] *Domingo*, 6 November 1983.

[246] *Domingo*, 13 November 1983: 8.

[247] *Tempo*, 28 February 1982.

Noticias

The other main newspaper in Mozambique at this time was the daily *Noticias*.[248] For 1982, there are only three reports of relevance. The first refers to a depression and resultant floods in Quelimane, Zambezia.[249] The second covers another depression in the same area.[250] The third concerns how SADCC was planning to deal with the drought in the southern African region.[251]

The 1983 coverage is equally thin, and covers only the drought. Thus the first report for that year covers the high temperatures of around 40C in Maputo, attributing it to air coming from the 'semi-desert' zone of Chicualacuala in Gaza. However, the temperature *per se* was not unusual for January, judging by the records from 1960 to 1979. What was unusual was the fact that more than 1,000 chickens per day were dying in each unit of a large chicken farm, because of the heat.[252]

The impact of the drought on the center of Mozambique, and the threat to rice production, form the focus of the next report. Rainfall in Beira for late October to early January was down from the normal 500mm to between 80mm and 110mm, depending on the area. The effect was seen as potentially catastrophic.[253] By April the drought was imposing large restrictions on the use of water in the capital Maputo, owing to the low level of water in the river Umbeluzi, in those days the main source of the city's water supply.[254] The general picture was abundantly clear by May, where the drought is treated as a catastrophe for the whole of Africa. A report published by UN ECA (Economic Commission for Africa, located in Addis Ababa) is cited as saying that the drought threatened thousands of lives in the Sahel, Central Africa, and eastern and southern Africa. The report also mentions a team working in Mali, seeding clouds in an attempt to induce rain. As with citations of meteorological sources, this reference to scientific work contains no mention of El Niño.[255]

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[248] This ignores *Diario de Moçambique*, which was published in Beira at the time. The other two were published in Maputo, and were accessible in the *Arquivo Historico de Moçambique* (hereafter AHM).

[249] *Noticias*, 5 January 1982.

[250] *Noticias*, 2 April 1982 this is where any depressions generated by the Intertropical Convergence Zone (ITCZ) would tend to come ashore in Mozambique.

[251] *Noticias*, 6 November 1982 SADCC stands for the Southern African Development Co-ordination Conference, founded in 1980. This intergovernmental body has now evolved into the SADC, the Southern African Development Community.

[252] *Noticias*, 6 January 1983.

[253] *Noticias*, 8 January 1983.

[254] *Noticias*, 20 April 1983.

[255] *Noticias*, 10 May 1983.

Appendix 4

J. Press Coverage of Weather and Climate in 1997-1998[256]

Domingo

The weekly newspaper *Domingo* has greater coverage of the weather in 1997-1998 than in 1982-1983. January 1997 commences with a story on torrential rain causing damage in the Nampula port of Nacala.[257] Within days there are reports of serious floods in the center of Mozambique, with the south and north experiencing no floods.[258] In this case, seven people died, and 14,000 were affected in an area of 11,000 hectares in Sofala. In Gaza, the rain was not yet a cause for worry, but the Prime Minister ordered coordination of measures across the four Provinces of Sofala, Manica, Tete and Zambezia.

These anticipatory measures would have been necessary, for the following week brought a report of 78 deaths from the floods in Sofala, Manica and Tete. This time the President was going to fly over the affected areas.[259]

In July 1997, just before the beginning of the main growth phase of the El Niño event, a cold front was reported to be affecting Mozambique. This was an anticyclone originating in the Atlantic.[260] A similar event affected the southern Provinces of Maputo and Gaza in October 1997. Although this report includes an interview with a staff member from INAM, there was still no mention of possible El Niño impacts.[261]

First *Domingo* report mentioning El Niño:

The first mention of El Niño in *Domingo* appears a week later, in a report concerning a forecast of rising temperatures over the whole country.[262] It explicitly states that the recent rains could cease by the end of the month because of the El Niño phenomenon, and that a period of drought could ensue.

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[256] This survey does not cover such smaller circulation newspapers as *Diario de Moçambique* and *Savana*, which would in any case probably devote less attention to the weather than, say, *Noticias*.

[257] *Domingo*, 12 January 1997.

[258] *Domingo*, 16 February 1997: 16-17 This was a period of a mild cold event preceding the 1997-1998 El Niño, and the center of Mozambique is the area most likely to receive rains emanating from the ITCZ.

[259] *Domingo*, 23 February 1997: 1 These floods were covered in detail by *Noticias*: see below.

[260] *Domingo*, 7 July 1997: 1.

[261] *Domingo*, 12 October 1997.

[262] *Domingo*, 19 October 1997: 1 This forecast and the accompanying remarks are attributed to Mussa Mustafa, who is currently head of the weather forecasting department of INAM.

Within a week, there is a report advising people in Vilankulo, Inhambane Province, to increase their cultivated areas to withstand the effects of the drought forecast to 'assault the country' as a result of the influence of the El Niño/Southern Oscillation phenomenon.[263] The El Niño is reported as having begun in March 1997, and the article in effect predicts this as directly leading to large reductions in precipitation, starting in the following month of November. Vilankulo is picked out for special attention because of the poor agricultural results in the preceding season. This left the area with only about 57 per cent of its food requirements. To avoid peasants being taken by surprise by the negative effects of El Niño, the Agricultural and Fisheries district authorities in Vilankulo were running a program in local languages to raise awareness and to counsel people. Part of the advice included cultivating drought resistant crops, and moving to lower zones. Implicitly, the latter is a traditional tactic for coping with drought, since access to water by various means is easier in low-lying districts.

The phrase 'El Niño' first appears in the headlines in the following week:[264] 'Drought in Inhambane: has "El Niño" arrived?' This quite lengthy article reports drought as causing coconut trees to dry up or yield small coconuts, and river levels to be falling. In some regions people were traveling up to 50 km in search of water. A shift from normal commercial to drought-resistant crops was envisaged. Around two-thirds of the Province's population was reported to be confronting the effects of a long period of lack of rain. The other one-third was surviving confined to the only area currently fertile, namely the area from the coast to 30 km inland. Hunger was already reported in some areas without access to fishing.

There is also a box devoted to the national government's worries expressed during this week about a possible coming drought related to El Niño, thought most likely to affect the south and center of the country. The government was ready to take measures to minimize eventual problems, particularly food security ones. It notes drought in Gaza, as well as the more developed drought in Inhambane. A District Administrator in Gaza is reported as saying that the agricultural season is threatened. In the far north of the country, in Cabo Delgado Province, Mueda District (normally a food surplus area, even during the 1982-1983 event[265]) was showing signs of drought.

The box stresses that up to the present an absolute drought had not been confirmed for Mozambique. The probability of an El Niño drought was estimated at 33 per cent. Nevertheless, the Provincial Directorate of Agriculture considered that national cereal production could rise by 11 per cent, because of an effective campaign to distribute seeds and tools to some 200,000 families.

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[263] *Domingo*, 26 October 1997 Vilankulo is by no means a low rainfall area, in terms of Inhambane Province, with an annual rainfall of between 800mm and 1000mm normally: Moyo et al., op.cit.:141.

[264] *Domingo*, 2 November 1997: 12.

[265] G. Littlejohn was part of a team conducting extensive research in Mueda in 1983, and again in 1984. The District still had 1983 food stocks available for sale in August 1984.

The box then has a succinct and clear section explaining El Niño/Southern Oscillation, using INAM as its source. The predicted effects of ENSO are then detailed as follows:

'**October, November and December**
A. Center and South of Mozambique – normal to below-normal precipitation. Yet during October and November it could be above normal at times.
B. North of Mozambique – normal precipitation

J. December, January and February
A. Center and South of Mozambique – below normal precipitation
B. North of Mozambique – normal precipitation'

An editorial note then adds factors of desertification not mentioned by INAM as causing climate change. These are said to include forest fires, both deliberate and accidental, which are changing precipitation patterns, and globally the entire world is said to be suffering from ozone layer depletion of about 2 per cent 'because of this phenomenon'. The warming, which is talked about, is a product of the 'greenhouse effect', associated with ozone depletion. One assumes that INAM would not have wished to be associated with this slightly confused account.

The next weather related article, in December 1997, concerns a gale leaving sorrow and poverty.[266] This affected Gaza, and shows that agriculture there had not been suffering as feared in November. However, crops were destroyed by the gale, and some 30,000 chickens were killed. The following week, there is a report of a district in Gaza, Manjacaze, needing 20,000 tons of seeds, because of the gale.[267] Interestingly, the District Administrator links this gale, which also destroyed 75 thousand fruit trees, with El Niño. It was said that El Niño could have various forms of effect, and if this were one of them, it was the only explanation that he had given to the local population.

The final report on weather events from *Domingo* in 1997 was one about rain in the capital city, Maputo.[268] It was mainly about the inadequate drainage system in the city, rendering it vulnerable to rain, and about the limited resources at the City Council's disposal to deal with the problem. Such articles have been appearing for years, but this one is the first indication of above average rain in the south of Mozambique, the opposite of what was expected for an El Niño event.

[266] *Domingo*, 7 December 1997: 2.

[267] *Domingo*, 14 December 1997: 14.

[268] *Domingo*, 21 December 1997: 16.

In 1998, *Domingo* begins in the second week of January with editorial comment on the heavy rains in a single night of the previous week in Maputo.[269] The costs were literally incalculable. The editorial asks why environmentalists, including the Minister for the Environment, were silent. Did they have no idea of what was happening? Was this just to be one more excuse for an appeal for aid to the international community? The truth was that the situation was extremely grave.[270] These rains in Maputo and elsewhere in the country were beginning to throw doubt on the truth of the supposedly scientific theses according to which the effects of El Niño in Mozambique would be a prolonged drought. The rains which were falling in different African countries, and the recent floods in Somalia led the scientists to admit that El Niño was a phenomenon with unforeseeable consequences, and that it was not known where it would provoke drought and where floods. 'We should be prepared to deal with all eventualities. And we should pray that our meteorologists would know how to interpret correctly the satellite images to which they, like many of us, had access. We should pray, above all, that they are more scientists and less like politicians.'

This seems like a classic case of shooting the messenger, although admittedly in this case the messenger got it wrong. However, the editor seems to have forgotten that the forecast of an El Niño induced drought was of 33 per cent probability. Still, this reaction corresponds to interview evidence that the fact that it rained did to a certain extent discredit the disaster mitigation authorities. This may have implications for future disaster reduction measures in Mozambique.

The bad weather continued, with reports of a major storm in Beira, capital of Sofala Province, the following week.[271] This strong storm, a tropical depression with winds of 64km/h, according to INAM, had the previous weekend left 4 dead and hundreds of families homeless. By the Monday, precipitation had been almost 70mm, as against 7.4mm during the same period the previous year. Surprisingly, the fire brigade had not been called out, and took no initiative of its own.

There were no other weather reports in *Domingo* until after May, when the El Niño was over. Thus the first report was in July, and dealt with the familiar issue of droughts in Gaza.[272] Interestingly, the affected area (Manjacaze again) had had no rain for the previous 8 months.

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[269] *Domingo*, 11 January 1998 The issue of January 11 1998 also has an article with photographs showing the extent of damage to Maputo from these rains. The headline is 'Is Maputo sinking?' and one can see why it was indeed a disaster.

[270] In terms of Maputo this was true. One of the major roads had subsidence near the Eduardo Mondlane University, and this remains closed to this day. This crater was mentioned in the article of 11 January, and together with housing built nearby on slopes that had previously suffered subsidence, formed the subject of the editorial on 18 January. One recent estimate of the cost of repair was USD $10 million. While this is probably an exaggeration, it gives an indication of the scale of the problem.

[271] *Domingo*, 25 January 1998: 7.

[272] *Domingo*, 26 July 1998.

By August 30, the headline for the north of Inhambane only is that 'Drought affects more than 60,000 people.' People were reduced to eating roots and wild fruits.[273] Despite the headline, this report covered Gaza as well, and indicated widespread food shortages. This drought is once again linked to El Niño, whose effects had been projected for the first months of the current agricultural year,[274] in certain regions of the south and center of Mozambique. Fortunately, El Niño had passed the margin of Mozambique.[275] The article notes that six provinces were suffering drought at this time, that is in August 1998: Maputo, Gaza, Inhambane, Manica, Sofala and Tete. Such a pattern is like a belated effect of a strong El Niño. This report may not seem too easy to reconcile with the pattern shown in SATR,[276] but the latter covers the period from I July 1997-31 March 1998, so it appears that with some exceptions the drought developed between March and August.

The last two weather-related articles appear in November and December 1998. The first concerns rain being provoked by a warm front.[277] The comment is attributed to Mussa Mustafa, head of forecasting at INAM. This was said to be typical for this time of year. Gaza and Inhambane had almost no rain. Neither had the central and north of the country, where normally rains began in November.

The final report predicted possible floods for the next three months of January, February and March 1999.[278] This is explicitly linked to La Niña, and emanates from the Department for the Prevention and Combat of Natural Calamities (DPCCN).[279] This body changed its name to the National Institute for the Management of Natural Calamities (INGCN). The prediction that La Niña was about to predominate in the southern region was attributed to INAM. The southern part of the country was predicted to suffer strong effects of La Niña. For central and northern parts of the country, normal

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[273] *Domingo*, 30 August 1998: 2.

[274] i.e. for October 1997 onwards.

[275] This sentence suggests that understanding of El Niño remained somewhat vague in this newspaper, despite the excellent succinct account given earlier when in contact with INAM.

[276] SATR, op. cit.: 61, Fig. 11.60 This shows extra rainfall for the whole of southern Africa, except Tanzania, which is presumably seen as east Africa in climatological terms. In the case of Mozambique, the extra rainfall is particularly evident from Beira northwards. Southern Manica and Sofala still only have between 400mm and 600mm, which is indicated as well above normal. However, such levels would be drought type levels, and are *not* above normal according to Moyo et al., op. cit.: 141. (See Appendix 1 for details of such references cited here.) On this interpretation, the drought could have been developing before March, as a previous *Domingo* report suggested for Gaza: see footnote 16.

[277] *Domingo*, 22 November 1998.

[278] *Domingo*, 20 December 1998.

[279] The DPCCN (*Direcção Nacional de Prevenção e Combate às Calamidades Naturais*) was the forerunner of INGCN (*Instituto Nacional de Gestão* de *Calamidades Naturais*).

precipitation was forecast. Given that floods were possible in the majority of low-lying parts of the country (i.e. the south) the DPCCN, the Red Cross and the Ministry of Public Works and Housing were going to send joint forces to forewarn populations living in river bank zones.

The latter report shows that credibility in terms of disaster warning and mitigation had been restored to some extent, at least in the eyes of *Domingo*.

Tempo

There was no report on the weather in the weekly magazine *Tempo* during 1997, which might be thought ironic since its title could mean 'weather' as well as 'time'. However, in April 1998, there is an article on El Niño.[280] The title of this lengthy article is 'El Niño created problems'. It covers the coastal District of Govuro, especially its capital Mambone. This District, with a population of some 40,000, is in Inhambane Province.

The article is interesting because it gives an idea of the economic costs of flooding at local level. These are considerable, and should be borne in mind when planning for cyclones induced by La Niña. In this case of course, it refers to the rains associated with the 1997-1998 El Niño event, and explicitly links this outcome to the warnings of drought delivered earlier by both central and local government.

The District authorities for Agriculture and Fisheries had had meetings with the population and explained what El Niño implied for the region. They foresaw a drought for Govuro, and explained to the population that in the first part of the agricultural season it would be better to use the low-lying areas (*baixas*). Some accepted this advice. When the time came for the expected drought, Govuro was affected by a cyclone followed by torrential rain. The farming plots (*machambas*) in the *baixas* were flooding, with the loss of crops affecting the food reserves of the region. The *baixas* were those of both the river Save and the river Govuro. In Mambone, many people had also lost their houses, cattle and goats, as well as their crops.[281]

Some government aid had arrived, but it did not cover all those affected. Fortunately there had been no cholera. Malaria had increased because of the (new) swamps. The roads were another major problem, after the floods. They were all graded dirt roads, with one exception. After the war, the government had made a great effort to rehabilitate the 50-km road linking the District capital of Mambone to the National Highway 1 (which is tarmac). This had been completed by 1996. However, within a year problems had begun. The company contracted to repair the road had used inappropriate soils, which

[280] *Tempo*, 5 April 1998: 13-16.

[281] It should be noted (because it is not mentioned in the report) that at the end of the war in 1992, the national herd of cattle was only one tenth of what it had been ten years earlier. So loss of livestock was especially serious in an area that is often too dry to be conducive to successful arable farming. That is why, as the report does state, fishing is the main form of economic activity. There is also salt production, but there are marketing difficulties caused by the fact that it often not in good condition when being sold.

were ruined during the rains. It took the reporting team 3 hours to cover this 50-km road in a four-wheel drive vehicle. The result of the crop losses and transport difficulties was that the price of maize was rising. The crop had been growing well until the floods, which meant the loss of almost 5,000 hectares. In addition, the poor road seemed to be causing accidents, thereby further worsening transport problems.

The next report on an extreme weather event was in November 1998, well after the El Niño had finished.[282] The headline was 'Beira under water'. This was said by the meteorological services to be due to a depression that had formed off the coast of Sofala Province. This had led to an outbreak of cholera, 'which in Beira has pretty fertile ground' owing to the weak sewerage system, and the garbage.[283] The health sector had already indicated that it did not have sufficient funds to take preventive measures for the inhabitants of Beira. Some local people blamed a recent Italian project to improve the water supply to the city for its worsening health problems, saying that the company had, presumably inadvertently, tapped into old drainage areas (rather than clean water sources).

The same issue also has a report[284] from the far south of Mozambique, in the District of Matutuine where the flooding river Maputo had destroyed 876 hectares of crops, thereby ending hopes of food self-sufficiency for that area, at least for this year. The rise in the river level had occurred between the 19th and 26th of October. It was the result of the South Africans opening the gates on their dam. This showed the need for coordinated management of the river resources of both countries. In the current situation, either Mozambique had rivers that were completely dry, or overflowing to the point of calamity. Both were damaging to the economy of the affected areas.

Noticias

The first report is a short piece on a cyclone that did incalculable damage to Chókwè.[285] This strong cyclone had struck on January 1st, and had affected the Districts of Chókwè and Guijá. An emergency commission had been created to take an inventory of the damage caused. No human loss life was mentioned. The source of the report was *Radio Moçambique*. This was followed two days later by a fuller account, accompanied by

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[282] *Tempo*, 15 November 1998: 26-28.

[283] There are almost certainly additional reasons for cholera to be almost endemic in Beira, given that the view is gaining ground that marine phytoplankton provide a refuge for the dormant spore-like vibrio: McMichael, A. J. et al., op. cit.: 99.

[284] *Tempo*, op. cit.: 28.

[285] *Noticias*, 4 January 1997 Chókwè is an important town in Gaza Province that is adjacent to the large Limpopo valley irrigation scheme. This had suffered from salinisation owing to sea incursion of around 100km. during the drought of 1991-1992, when the river Limpopo had been completely dry in Mozambique. It had probably not fully recovered by the end of 1999.

photographs.[286] The damage had been done in 30 minutes, injuring at least 16 people and destroying 85 hectares of cotton at LOMACO.[287]

By mid-January, normal rainfall is noted for most of the country, but damage to roads, rail and housing is mentioned for the Provinces of Tete, Nampula, Gaza and Maputo.[288] Within two days, the rain is said to have interrupted traffic on National Highway 1 (EN-1) in Sofala Province.[289] Chimoio, the capital of Manica, was also said to be paralyzed by the rain. The following day brought the announcement that EN-1 had been closed.[290]

K. Floods in the center of Mozambique

These floods are worth covering in detail, since they imply lessons for disaster mitigation, and show how well the Mozambican authorities coped with a weather-related emergency.

A tropical depression[291] affected the south of the country in late January, and a gale made families homeless in Nampula. The two events were not connected. Rain in Zimbabwe had caused the river Pungue to rise, making people in Sofala homeless. Despite this rain in the south and center, in Cabo Delgado the lack of rain was threatening crops.[292] By the following day the floods in the Pungue valley were serious, the river having risen 7.34 meters in six hours.[293] The Zambezi was also rising, forcing the Cahora Bassa dam authorities to discharge water. The riverbank population had been warned to move. (Monitoring of river levels is the responsibility of the *Direcção Nacional de Aguas*: the National Water Directorate.)

By February 4th, Beira hit the headlines with intense rain.[294] The following day brought another report of the floods in the Pungue valley.[295] Since the Pungue enters the sea at

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[286] *Noticias*, 6 January 1997.

[287] A large joint venture of the Mozambican government and the multinational company Lonrho, operating among other places in the Limpopo valley irrigation scheme.

[288] *Noticias*, 18 January 1997.

[289] *Noticias*, 20 January 1997.

[290] *Noticias*, 21 January 1997.

[291] *Noticias*, 28 January 1997 Cyclone Gredelle had earlier killed 10 people in Madagascar.

[292] *Noticias*, 31 January 1997.

[293] *Noticias*, 1 February 1997 This shows the vulnerability to both floods and droughts of a country which is downstream of rivers crossing international borders. Few major rivers originate in Mozambique: see *Mapa Hidrometeorologica de Moçambique*, Banco Mundial e PNUD, 1990.

[294] *Noticias*, 4 February 1997: 7.

Beira, that city may also have been feeling some effects in its low-lying areas, but the report concerns the population outside Beira being forced to move to high ground and to trees. Roads were reported cut, and there were 14 dead in Manica and Sofala.[296] Despite the fact that the subsiding river rose again,[297] the situation was easing somewhat by February 10.[298]

Not surprisingly, this flood isolated Beira from the rest of the country.[299] The river level rose again, this time to 8.1 meters above normal and at least 5 people had died by this time.[300] The situation in southern rivers was reported to be stable, but in Niassa Province in the north, the rising river had dislodged a bridge, affecting transport to the capital, Lichinga. By the following day the Pungue had risen again, to 8.9 meters, and the nearby river Buzi was also flooding, allowing crocodiles to attack people.[301] Not surprisingly, the Prime Minister flew over the Pungue and Buzi rivers at this time. Meanwhile, the rising Zambezi had isolated the District capital of Mutarara.[302]

By the 18th, the South African army had been called in, saving hundreds of lives.[303] Zimbabwean transport had also been used. Despite the improvement in the Pungue and Buzi valleys, there was alarm in the Zambezi valley.[304] The Pungue, having risen to 8.2 meters, had subsided slightly, and the Buzi had gone down from 8.49 meters above normal to 7.3 meters. There were 12,832 homeless people, and 5,907 hectares of crops lost in the Pungue and Buzi valleys. Not surprisingly, food prices in Beira rose. Cahora Bassa was still having to discharge water into the Zambezi. The headlines were soon warning that the situation in the Zambezi valley could worsen in the next few days.[305] This was partly because other smaller rivers were rising, offsetting the reduction in the discharges from the Cahora Bassa dam. The preliminary count was 25 dead. South

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[295] *Noticias*, 5 February 1997.

[296] *Noticias*, 6 February 1997 On the same day, there is a report of winds making people homeless on the Island of Moçambique.

[297] *Noticias*, 8 February 1997 They had begun to fall on the 6th, but were still some 7.55 metres above normal: *Noticias*, 7 February 1997.

[298] *Noticias*, 10 February 1997.

[299] *Noticias*, 11 February 1997.

[300] *Noticias*, 12 February 1997.

[301] *Noticias*, 13 February 1997.

[302] *Noticias*, 14 February 1997.

[303] *Noticias*, 18 February 1997 This raises policy questions about the future role of the Mozambican armed forces (FAM) in the context of extreme weather events.

[304] *Noticias*, 19 February 1997.

[305] *Noticias*, 20 February 1997.

Africa and Zimbabwe were still helping with air, water and land transport. South Africans in the lower Zambezi had rescued some 350 people the previous day. The total number of affected people in Tete Province alone was 132,500. In Manica, 30,000 were homeless, of which 5,000 had seen their houses destroyed, and 1,200 hectares of crops had been practically lost. Food and other goods were being distributed to homeless families, with help from the Zimbabwean air force.

By the following day, the South African and Zimbabwean air rescue teams, in the four Provinces of Sofala, Manica, Tete and Zambezia had saved a total of some 1,500 people. The South Africans had also supplied goods to the Caia area, and had also supplied hospitals and educational centers in the District capitals. They were expected to cease operations on this day. NGOs were also getting organized, providing food, spare parts and clothing among other basic consumer goods.[306] The Buzi and Pungue rivers were going down, although the Cahora Bassa dam was still having to discharge water.

Despite this situation in the center of the country, and even in Niassa, in the north, the other northern Province of Cabo Delgado was still suffering drought.[307] The roads were also in a poor way, which cannot have helped the Provincial DPCCN[308] to cope. Some 15,000 people were starving. A multidisciplinary government team was already there, composed mainly of DPCCN and Agriculture personnel. Food for work programs was being considered.

President Chissano toured the center of the country on February 23rd having already declared an emergency, and launched an appeal to the international community.[309] He also wished to stimulate mutual aid among populations affected by catastrophes of this type, and offered a month of is salary to aid victims. A separate report on the same day gave an overview of the whole period. Some 400,000 people had been affected. The city of Beira, the second city in the land, had been totally isolated from the rest of the country, except by air. Prompt help had avoided even bigger problems, although on the first day of their aid mission, people had fled the South African helicopters.

The international community responded quickly to the appeal from the President.[310] By now the total number of dead was known to be 78, and there were 25,000 internally displaced people. Representatives of the international donor community attended a meeting to hear these facts, and to listen to an appeal for almost US $30 million. Road traffic had restarted at the Pungue, and the Zimbabwean air force was continuing to

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[306] *Noticias*, 21 February 1997.

[307] *Noticias*, 22 February 1997 This was in Mueda District.

[308] The *Departamento de Prevenção e Combate às Calamidades Naturais* is the Provincial office of the national DPCCN.

[309] *Noticias*, 24 February 1997.

[310] *Noticias*, 25 February 1997.

rescue people from islands, the total now reaching some 1,500. Gifts were coming in from social, religious and humanitarian organizations.

The final note on these floods was struck at the end of February, with a report on an air bridge lifting goods into Mutarara, Tete Province.[311] Road transport via Malawi was also being used. Some 150,000 people were affected in this District alone. A Technical Commission of the Emergency was coordinating the work, with the food aid being stored by the DPCCN in Tete city. Damage included 812 houses destroyed, and a further 342 partly so. The Malawi Congress Party had also offered aid. The postscript in terms of weather was provided by another cyclone, Lisette, causing further flood damage in Sofala Province. There were also floods in Cabo Delgado, but well away from the area, which had previously suffered drought. That problem had been completely overshadowed by the floods.

External aid started to arrive by March, reaching one million US dollars, a great deal less than the $30 million requested.[312] However, an evaluation mission composed of DPCCN, FAO and WFP[313] had visited the affected areas.

In general, this event shows that Mozambique and its neighbors were able to respond quite well to a major problem. The lack of military capacity in Mozambique itself reflects the demobilization after the war ended in October 1992 and the impact of reductions in state expenditure resulting from Mozambique's adherence to a Structural Adjustment program. As the economy grows, and tax receipts perhaps grow with that, then it may be worth considering augmenting domestic military capacity to deal with such emergencies.

L. Other weather events: the beginning of El Niño

Floods further to the north more or less coincided with the March westerly winds that induced the Kelvin waves, which helped, produce the 1997-1998 El Niño event.[314] It is not clear whether or not there was a connection, that is, whether the westerlies were also crossing the Indian Ocean and bringing additional rain to Mozambique.

Nampula soon suffered a similar fate to the Provinces to its south. Floods affecting this Province made more than 20,000 people homeless, and destroyed thousands of hectares

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[311] *Noticias*, 28 February 1997

[312] *Noticias*, 14 March 1997.

[313] These are UN organizations, both headquartered in Rome and with offices in Maputo: FAO is the Food and Agricultural Organization, and WFP is the World Food Program. The former both researches factors affecting agriculture and monitors crop development, providing a famine early warning system (FEWS), while the latter concentrates mainly on delivering food aid. When it is considered appropriate, they send joint Food and Crop Assessment Missions to countries considered at risk, and issue warnings to the international donor community.

[314] SATR 1999: 28.

of crops.[315] In addition, aid to Manica was delayed because of further floods there. By late March, it was reported that at least six people had lost their lives, and the number affected had risen to 50,000.[316] Silvano Langa, National Director of DPCCN, who had been to both Nampula and Cabo Delgado, was quoted as saying that people faced serious health problems without medicines, as well as food shortages. Hydrometeorological services in both Provinces were functioning very poorly, which affected medical work near rivers, and led to people living on river banks being surprised by rising water levels.

Despite all this, in Cabo Delgado northern Districts such as Mueda and Moçimboa da Praia were still suffering drought, and needed additional seeds to sow their crops for the second half of the year. The evidence on the center of Mozambique showed that the problems had by no means disappeared. It was now clear that more than 500,000 had been affected, of whom 125,000 needed emergency aid.[317]

The following day, attention focused on Cabo Delgado[318], near the capital city of Pemba. It was not clear what the exact nature of aid from the DPCCN would be, but the regional representative of the WFP had also been present and would present his report in Maputo.

The next weather report concerned the damage done by a gale in the city of Tete.[319] It had only lasted 15 minutes, and had had a speed of over 100km/h. The report states that it is not known how to classify this event, but one could speculate that it could have been a tornado. The same issue carried another report on the effects of the earlier floods in Nampula. The response by various institutions to the appeal launched by the government had been slow, although 50,000 people had been affected. The situation in terms of transport was bad, with 22 roads impassible.

In April, the floods in Mutarara, Tete are discussed in an article stating that aid to those affected was proceeding satisfactorily,[320] according to the Provincial DPCCN.

The scene shifts to Chókwè in Gaza for the next report, which fortunately does not appear until May 1997. The weather itself had not been catastrophic, but poor drainage meant that the intense rain since the beginning of the year had submerged a lot of rice at a time

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[315] *Noticias*, 15 March 1997.

[316] *Noticias*, 25 March 1997.

[317] *Ibid.* This was higher than the figure given at the international appeal, and the request made then was a long way from being met, although the amount received had risen to $2 million. The Mozambican authorities seemed determined to view this in a positive light.

[318] *Noticias*, 26 March 1997.

[319] *Noticias*, 31 March 1997.

[320] *Noticias*, 1 April 1997.

when it should have been ripening.[321] Interestingly, on the same day there is a report on summer coming early to the Arctic, suggesting that the cause might be the greenhouse effect.

On August 21, the earlier floods of February are discussed in an article reporting that the government, WFP and FAO had met to evaluate the impact of the floods.[322] This meeting had begun on the previous Monday, and was due to finish the following Saturday. A major concern was to avoid food aid interfering with normal market exchange of food. One recommendation would be for aid teams to submit a report at the end of their activities. People were once again being advised to move from lower to higher ground.[323] The report goes on to mention the possibility, already announced, of a drought in the south of the country (clearly a reference to El Niño). Provincial technical teams had already received recommendations to start preventative measures, and multi-disciplinary teams were being prepared, and would soon be seen in the provinces. Thus evidently the public was being informed of contingency planning. 'We are working to guarantee that, if the drought is confirmed in September, we can put into action all the plans drawn up in this period of preparation' said João Zamissa. Such plans envisaged, among other things, the provision of seeds of drought-resistant varieties and the identification of water-shortage zones.

M. El Niño and the forecast of drought

If the previous report had only implicitly referred to El Niño, this was very explicit in the headline for September 1: 'El Niño and drought in southern Africa'.[324] This lengthy factual article is worth citing at length, since it shows that the most widely read newspaper in Mozambique gave a detailed and generally accurate account of what was taking place, based on a conference that had just finished in Geneva. This story doubtless set the tone for subsequent reporting on the weather for the rest of 1997, probably for the media in general.

The article suggests that the profound climatic changes currently being provoked by the El Niño phenomenon could induce a serious drought in southern Africa, probably worse

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[321] *Noticias*, 3 May 1997. These drainage problems should be seen in the context of the drought of 1991-1993, related to the El Niño of 1991-1992. Although maintenance had by no means been perfect on the Limpopo valley rice irrigation scheme before then, it is clear that the drought and sea incursion at that time had done lasting damage, still being reflected in this report.

[322] *Noticias*, 21 August 1997. The report relies on an interview with João Zamissa, Head of the Department of Planning, Information and Projects (DPIP) in the DPCCN.

[323] *Ibid*. It was stressed that this was not a matter of forcing people. This seems to be an implicit reference to the government's response to floods in 1977, when the danger was linked to a policy of forcible removal of some people from riverbanks into what were termed 'communal villages' on higher ground. This had been a highly controversial policy, at least for international commentators, and may have fostered political opposition to the government within Mozambique.

[324] *Noticias*, 1 September 1997.

than the one in 1982-1983, according to more than 300 scientists and experts who had just taken part in a world conference on the climate in Geneva. Meteorological studies in July had shown that the eastern tropical region of the Pacific was some 4-5 degrees above normal. Serious storms were predicted for California, and floods for the southern USA, if it did not dissipate. El Niño was a phenomenon, which caused a climate disorder, giving rise to torrential rains in some regions, and prolonged droughts in others. UN organizations such as the FAO were monitoring climate developments in southern Africa, including Mozambique.

Experts following the course of this El Niño said that its effects were already being felt in the serious floods affecting central Europe, especially Poland and Germany.[325] If it continued its development, the worst period would be at the end of this year and the beginning of the next, when it would be at its peak. Apart from the direct threat to human life, it also threatened crops and even the sterilization of soils because of prolonged drought. The health implications mentioned included a possible increase in malaria, and more asthma attacks. If El Niño continued and reached its peak, drought could affect various other parts of the globe, namely Australia, Indonesia, the Philippines, and the north of Brazil.

Some weather analysis centers such as the National Center for the Analysis of Climate and Temperature, directed by the main source for this story, Ants Leetmaa, considered that this El Niño could cause more deaths and injury than the one of 1982-1983. Then the drought, which affected southern Africa, was considered the worst since the one of 1911.[326] At that time countries such as South Africa and Zimbabwe, which were normally self-sufficient in food or exported it, had to ration their food stocks and stop exports of basic foodstuffs, even being forced to import food. Despite the lack of precise data, some experts thought that the grave drought affecting North Korea and central China could already be an effect of El Niño.

Following on from this, reporting on hunger was presumably taken more seriously, for the next day saw a piece on the specter of hunger in the Pungue valley, Sofala.[327] The food shortage was attributed to the previous floods, the low humidity afterwards and a plague of rats. The forecast drought was seen as adding to the problem. The population, especially the 9,000 most likely to be affected, had been alerted to the problem.

This perceived food problem was reflected in a report the following week on the losses in sown area in Tete caused by the earlier floods.[328] Some 137,000 hectares of production had been lost during the 1996-1997 agricultural year with plagues of rats, locusts and other insects.

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[325] *Ibid*.

[326] See Appendix 1.

[327] *Noticias*, 2 September 1997.

[328] *Noticias*, 11 September 1997.

Later in the month, in Gaza, the Provincial Directorate of Agriculture and Fisheries launched an appeal to NGOs to help deal with the drought, which as already a reality in the northern Districts of the Province.[329] These NGOs were apparently willing to help make the peasants aware of the issue, and to encourage them to make use of local knowledge of how to access water. Community seed purchasing schemes were praised. The implications for livestock meant that would need to be move to areas where they could be watered.

However, a few days later, the picture from the center of the country, namely Chimoio, the capital of Manica Province, was very different. Rain and a gale killed and injured people there.[330]

This incident appeared isolated, however, and the next major headline concerned a mission from the WFP to assess the areas and populations at risk from El Niño. This was a mission covering the southern African region.[331] The Director of the DPCCN, Silvano Langa, said that early in October a second mission would arrive to evaluate logistical response capacity. These technical teams were integrated into the Mozambican government's program to reduce to the minimum the possible negative effects of El Niño, should it be confirmed. Contact had also been made with other countries' institutions in the region. Within Mozambique, there were Provincial action plans, which confirmed *inter alia* the zones at risk, alternative areas for production, the numbers of the population to be affected, food and water needs, alternative grazing areas and practical actions to make the population aware of the issue. The same plans defined resources not available locally, and schemes for national mutual support and water saving.

In addition to the Provincial plans, matters being decided centrally included the need to reduce water discharges from dams and food distribution via a system of exchange of services. All Provinces were drawing up plans, but those most at risk at the moment were Zambezia, Gaza, Tete, Maputo and Cabo Delgado. The Technical Emergency Council was currently drawing up a drought disaster mitigation plan to be presented to the government at the beginning of October. The main awareness-raising activities were informing the populations of the need to secure their own food reserves and to be thinking already of cultivating drought-resistant crops. There was already an interest being expressed by international agencies in providing aid to populations that would be affected, and within Mozambique, various social organizations were engaged in awareness raising.

A national-level meeting on drought, opened by the Minister of Agriculture and Fisheries, was held at the Pequenos Libombos dam, Maputo Province, soon thereafter.[332]

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[329] *Noticias*, 24 September 1997.

[330] *Noticias*, late September 1997.

[331] *Noticias*, 29 September 1997.

[332] *Noticias*, 1 October 1997.

This was intended, *inter alia*, to look for alternatives to attenuate the impact of drought, which could affect a large part of the country. The Special Program, as the national action plan was now being called, was to be presented at this meeting. An awareness-raising film entitled 'A Man Prepared is Worth Double' was presented to this meeting.

By the end of October, it looked as if the drought had arrived.[333] The prolonged drought had battered the whole of the interior of the Province of Inhambane, and in addition to having ruined the previous harvest was aggravating the chronic problem of lack of potable water. More than 600 cattle were also close to death. The Provincial Governor declared the province to be in a situation of emergent hunger. This declaration followed the announcement that El Niño could hit the country, and Inhambane was extremely vulnerable to drought. The last rains had fallen in March. However, in the Province of Maputo on the following day, the story was of electricity cuts resulting from bad weather (heavy rain).[334]

On the 3rd November, the main weather story was that Rio de Janeiro in Brazil could lose its famous Copacabana beach because of El Niño.[335] The reason for this attribution is not made clear. The next day the impact of El Niño on Mozambique was covered in a story on the inside pages.[336] The District Director of Agriculture and Fisheries at Nhamatanda, Sofala declared himself worried about low rainfall, said to be effectively the effect of El Niño, and outlined the preparations for it. The months considered most critical for hunger were December and January. On the same day, the back page, which is always devoted to international issues, carried a story on the effects of El Niño in east Africa. More than 100 people were said to have been killed because of floods caused by El Niño. This was attributed to unnamed meteorological sources, although Kenyan sources are cited later, giving a clear account of the current event. One of the countries mentioned is Ethiopia, where 57 people had died, and more then 9,000 cattle had died. Nevertheless there was also drought in Ethiopia. Sudanese authorities had warned people of possible floods on the Blue Nile, coming from Ethiopia. Somalia as also affected by floods from the rising river Juba, according to the WFP. Details of floods in Kenya and Tanzania were also given in this report.

The WFP was reported to have completed its strategic thinking for southern Africa by early November.[337] It was going to evaluate the impact of the El Niño on the world's poorest countries, to coordinate response strategies and mobilize potential donor resources. An exchange of information between the international community and various

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[333] *Noticias*, 29 October 1997.

[334] *Noticias*, 30 October 1997.

[335] *Noticias*, 3 November 1997.

[336] *Noticias*, 4 November 1997: 7.

[337] *Noticias*, 5 November 1997.

Mozambican agencies was intended, to keep up to date on the amount of aid really necessary. For southern Africa, the WFP had a headquarters in Mozambique, which in partnership with other regional organizations was already analyzing the socio-economic impact of the drought, the consequent food needs, and where the populations would be indirectly affected by the drought. Logistical structures, current food stocks, and marketing systems were among the other aspects being analyzed. The countries of the region were mobilizing their disaster reduction institutions, paying particular attention to the movement of reserve stocks and distribution of drought-resistant seeds. Information campaigns were being launched to alert farmers and to encourage populations to improve their food reserves. Some governments had already begun to increase water stocks by constructing dams and improving rainwater harvesting and conservation.

Judging by evidence from Central America, China and New Guinea, the situation could be worse than foreseen. In southern Africa, the situation was foreseen. Areas at risk in the event of scarce rain included South Africa, Lesotho, Swaziland, the center, north, northeast and south of Mozambique, Zimbabwe, large parts of the east and south of Botswana, as well as the south of Malawi and Zambia.

Since 1992-1993, the WFP had been working with SADC[338] in a preliminary preventative program to reduce the impact of El Niño. Using the logistical infrastructure of the WFP, the international community had placed around 11 million tons of imported food at the disposal of affected populations, at a cost of more than USD $4 billion, and benefiting 20 million people. In 1996, the WFP had helped more than 45 million people worldwide. The positive experience of the operation carried out in 1992 led the WFP to think that adequate preparations had already been made to deal with the event threatening this year.

This report was followed up within a day by a large piece on El Niño and southern Africa, with a map of the likely high rainfall areas in east Africa and drought areas in southern Africa, together with a histogram of the numbers of people affected by drought in southern Africa over the years 1981-1996.[339] The latter graph, based on USAID/OFDA figures, showed clear peaks in the years 1981, 1983-1985, and 1992-1993[340]. The numbers for 1995 and 1996 were also high. The article provides an excellent account of El Niño, the Southern Oscillation and La Niña, before going on to discuss forecasting and prevention. The current El Niño is said to be possibly the largest yet observed, with its area, temperature similarity to the 1982 event and speed of development being mentioned. The observation network of ships, satellites and stationary buoys is also described. The article states that an El Niño is followed by drought in southern Africa the following summer, with La Niña bringing extra rain. A drought in the region was expected for the beginning of 1998. Two common drought

[338] Southern African Development Community.

[339] *Noticias*, 6 November 1997.

[340] The year 1992 had the highest number, with some 17 million people affected in southern Africa.

development scenarios are described, with reference to the map. Yet the map itself indicates the probability of drought from November to May as being 77 per cent. The humidity for Kenya, Uganda and northeastern Tanzania is put at 71 per cent. The article then emphasizes that a forecast is not a certainty, but is based on probabilities derived from earlier observations.

The probable crop losses are then estimated. In 1982 such losses had cost more than UD $1billion. The role of meteorologists and climatologists was to reduce the negative effects of such natural phenomena. The phenomenon was repeating itself more frequently. The article stressed in bold type that although the phenomenon of drought had been announced, it was impossible to prove. As well as reducing harmful effects, there was also the risk that decisions would be taken which would be counterproductive if the drought did not happen. El Niño was not the only determinant factor. As yet, it was an unanswered question as to what the other factors were.

Evidently this as an extremely important article, and it was based on an earlier article written by Roxo Leão for the journal *Moçambiente*. It clearly shows that *Noticias* took El Niño very seriously, and that the readership was being well informed.

The point about the drought not happening began to look like a serious one by mid-November. This was a report on flood damage to a district of Maputo city, and the resulting homelessness. [341]

Attention then turned to the international scene with a follow-up story on the floods in Somalia. At least 1,000 people had died, 15,500 houses had been destroyed and over 10,000 head of cattle had been killed, according to CARE International. The WFP confirmed that over 200,000 Somalis needed food aid for about 8 months, as a result of these floods. [342]

A storm in Gaza made hundreds of families homeless.[343] This disaster surprised everyone. There were no resources available to the Provincial DPCCN to deal with this kind of problem. Crops had been destroyed.

The next day brought a long report on the vulnerability of Africa to climatic variations.[344] The Intergovernmental Group on Climate Evaluation based this on a report.[345] Africa

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[341] *Noticias*, 14 November 1997 Rain was still destroying houses in Maputo some days later: *Noticias*, 19 November 1997. By December 1st, the rains affecting Maputo were the subject of another story: *Noticias*, 1 December 1997.

[342] *Noticias*, 15 November 1997 Further details on Somalia appeared a few days later: *Noticias*, 19 November 1997.

[343] *Noticias*, 3 December 1997.

[344] *Noticias*, 4 December 1997.

[345] A UN body whose report preceded the Kyoto conference due to take place this December.

was picked out as the most vulnerable continent, because of the combination of climatic variability and lack of resources, which limited its capacity to adapt. Recurrent drought, uncoordinated land use and extreme dependence on rain fed agriculture exacerbated the problem in Africa. The majority of the 19 countries classed as suffering from 'water stress' were in Africa. Independently of climate changes, this number would probably grow, owing to demographic growth and the degradation of water reserves. Prolonged droughts could have serious consequences in terms of food and deforestation. Because of population pressure and conflicts over land use, some coastal regions of Africa would be victims to the sea level rising. Lakes and lagoons next the sea could disappear in east and central Africa because many countries were building fast-growing cities next to them. Traditional coping methods would help, but would not be sufficient. The article also contained evidence on global warming, and problems in the Amazon rainforest.

Noticias then returned to El Niño.[346] The current El Niño was worse then earlier ones. This was based on a report from the Met Office in London. Southern Africa would remain very warm over the next few months, and the eastern Pacific was having intense rain that would continue to cause flooding. An official from the European Union (EU) expected the floods to continue in North America, Europe and in some African countries, such as Ethiopia and Somalia. The causes of El Niño were not yet understood. Global warming was nevertheless blamed for the intense rains. Global warming was the dominant topic at the Kyoto conference, where 160 countries were debating the emission of harmful gases. There appeared to be an interaction or correspondence between the emission of greenhouse gases and rising temperatures worldwide in the closing years of the century, and both of these were being linked to the frequency of El Niño events. TV pictures showed global warming was causing rising sea levels in oceans such as the Indian, which were eroding sand dunes that prevented the sea from invading areas further inland.

Some two weeks later, Mozambique was said to be one of the SADC countries that would be most affected by El Niño.[347] This view was attributed to the UN High Commissioner for Refugees in Geneva. She indicated that it was not by chance that the WFP had chosen Mozambique as the center from which it would coordinate all its assistance during the crisis. The event was affecting 27 million people, who could count on less food aid, since the amount available to the international community was half of that available in 1982-1983.

The year closed, in terms of weather reporting, with a brief account of torrential rain in the RDCongo. The homeless numbered 5,000.

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[346] *Noticias*, 8 December 1997.

[347] *Noticias*, 20 December 1997.

The return of floods

The year 1998 began badly for citizens of Maputo, with heavy rains once again causing serious damage, partly because of the quality of construction in the *caniso*,[348] the shanty town parts of the city, and partly because of poor drainage in the 'cement city'.[349] The event had been forecast by INAM, but no prior measures had been taken.

El Niño remained high on the agenda, however, and the next day carried a headline on the worries of Frelimo in Guijá, Gaza, concerning El Niño.[350] This was about an awareness-raising campaign on drought, asking peasants to profit as much as possible form the recent rains, to avoid future hunger, as had happened there in the 1980s. Three brigades had been formed for this purpose. Food reserves had been exhausted the previous October, leading inhabitants of vulnerable districts to move to the District capitals.

By the following week, the heavy rains that had affected many parts of southern Africa had diminished the fears that the region could register a grave drought during the current agricultural season. The WFP remained on the alert, but was declaring itself cautiously optimistic, despite the fact that El Niño remained strong and would not disappear for three to six months.[351] The rains were unusual for an El Niño event. Evaluations by the WFP and FAO would be conducted throughout the region during January to see if drought would occur or not, and whether or not any food aid would be necessary. Three preparatory meetings had been held the previous week. The less vulnerable north of Mozambique had not been included in this process. It was still possible that rains could fail, reducing the harvest by 30 per cent, which would require only small-scale food aid.

Within two days, there were two small stories. One was on a depression that was about to affect the center and north of the country. The other was about rain cutting roads in Niassa Province.[352] The areas affected by the depression were Cabo Delgado, Nampula, Zambezia and Sofala. The effects of the depression were evident by the next day, when Beira was reported to have suffered floods since the previous Sunday. Nampula city was also reported to be isolated.[353] The storm was reported to have caused death and destruction in Sofala and Nampula.[354] The latter had been at the center of the

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[348] The 'cane city'.

[349] *Noticias*, 9 January 1998.

[350] *Noticias*, 10 January 1998.

[351] *Noticias*, 17 January 1998.

[352] *Noticias*, 19 January 1998.

[353] *Noticias*, 20 January 1998.

[354] *Noticias*, 21 January 1998.

depression, which was still causing problems. In Zambezia, further details of the destruction soon became known.[355] A Provincial brigade composed of staff from Health, Agriculture and the DPCCN was evaluating the size of the catastrophe, which included 13 dead and 40 missing. Details on Nampula Province were also given.

By January 30, the constant rains were beginning to cause unease in Cuamba District, Niassa Province, where they were becoming a threat to agricultural production.[356] There were also pest infestations in the bean plants. Much more space was devoted to the more densely populated center of the country in early February, where the floods in Sofala were causing continuing damage.[357] The Pungue had again risen to 8,2 meters above normal, and floods were touching major roads, threatening them with closure. The Buzi had risen by 8.5 meters. Dozens of families living on a river island were in danger of drowning. Others were afraid to try to rescue them in canoes, fearing that panic-stricken people would capsize them.

The full extent of the problem throughout the country became clear by February 7, with a report that the floods were tending to happen in all the hydrographic basins.[358] The government was said to be worried. Light vehicles were prohibited from using National Highway 6 (EN-6) near the river Pungue. The National Water Directorate had issued an alert for the Limpopo valley the previous day. This had been caused by rain in Botswana and South Africa. The Massingir dam in South Africa was full and was initiating a program of discharges. This affected the Elephant River, one of the tributaries of the Limpopo. Similarly in Tete, the Cahora Bassa dam was releasing 3,600 cubic meters of water per second into the Zambezi. The Tete Provincial DPCCN had practically no means of aiding those most likely to be affected downstream at Mutarara. Roads had been cut in various quite separate parts of Tete Province. It was also raining in the north of Cabo Delgado. Crops had been washed away.

The center then quietened down a little, while in the south the state of alert grew.[359] The Limpopo was rising, and required measures at Chókwè, Gaza, where the level had risen 4 meters above normal. Nevertheless, the level was falling further up-river. The levels were not yet worrying for the Limpopo, but the Massingir dam was reported to be about to open its gates again because of energy problems.

The Intertropical Convergence Zone (ITCZ) was invoked as an explanation for the fact that the El Niño event had not had the expected effects.[360] An additional cause was said

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[355] *Noticias*, 22 January 1998.

[356] *Noticias*, 30 January 1998.

[357] *Noticias*, 3 February 1998.

[358] *Noticias*, 7 February 1998.

[359] *Noticias*, 10 February 1998.

[360] *Noticias*, 12 February 1998.

to be the movement of the anticyclone from the Atlantic to the Indian Ocean had helped cause the abundance of precipitation, which went against the effects of El Niño. Normally drought would be expected with an El Niño, but in this case there were other factors intervening, such as the ITCZ. This was provoking rains in the north, and to some degree in Sofala, and the Atlantic anticyclone was currently positioned over the Indian Ocean. The latter phenomenon had not been seen for the last ten years, and encouraged rain in the center and south of the country. The reason for its shift was not too clear, and it was difficult to link this with El Niño. The source for this was a technician from the National System of Early Warning for Food Security.

By March, the floods were seen as adversely affecting agriculture in Sofala, specifically in Marromeu on the banks of the Zambezi.[361] This was a new set of floods, but they would not result in hunger, partly because people in that area were used to subsistence hunting. In any case, the district of Gorongosa in Sofala was expecting a good harvest. While noting in passing the damage caused by El Niño in Ecuador,[362] *Noticias* next returned to the topic in mid-March.[363] The present El Niño was the worst of the century. The damage would be about double that of 1982-1983. Specific mention was given to the floods devastating Uganda, Tanzania and Mozambique, as well as Germany and the USA. In Kenya, 900,000 people had been left without food and surviving on external aid. UNICEF described this as 'an extreme situation'. Malaysia, Thailand and Papua New Guinea were also mentioned in this long descriptive report. The drought in Panama merited almost a paragraph, whereas Indonesia had only a passing mention. An FAO official in Rome is quoted as stating that the effects of the latest El Niño are more dispersed and devastating than before. This was true for southern Africa as well. The FAO had stocked large quantities of drought-resistant seeds on the basis of past experience, but this time it was the excessive rainfall that was causing the damage in southern Africa. Evidence suggested that global warming was exacerbating the El Niño phenomenon, according to *The Observer*. Thawing of the poles was leading to sea level rises, which threatened coastal countries such as Mozambique. Rains were appearing in areas such as the desert of Peru, where the rain now seemed endless.

The next report concerned a forecast by INAM that El Niño would bring a late and mild winter to Mozambique, in the months of June, July and August.[364] There was no reason for alarm on this.

By June, the headline was that El Niño was coming to an end.[365] This view was attributed to the WMO. This was followed by another brief summary of its worldwide

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[361] *Noticias*, 3 March 1998.

[362] *Noticias*, 4 March 1998.

[363] *Noticias*, 13 March 1998 This was based on a report in the London Sunday newspaper, *The Observer*.

[364] *Noticias*, 11 May 1998.

[365] *Noticias*, 5 June 1998.

effects and a description of its four main characteristics: warming of the east Pacific Ocean, movement of precipitation to the east Pacific, decrease in wind speeds and alterations in sea level. The precise timing of its end could not be predicted, but it was hoped that it would be over by the end of June. La Niña could replace the phenomenon, but this was not certain.

However, the arrival of La Niña was virtually confirmed within six weeks.[366] This article contained a reference to the Topex-Poseidon satellite, and was accompanied by a world map showing the likely effects. It carefully stated that meteorologists were awaiting signals indicating the arrival of La Niña. Analysis of the Topex-Poseidon images by NASA's JPL indicated that the Pacific could be in transition, but that it would be premature to declare the death of El Niño and the birth of La Niña. A more precise indication was expected by the beginning of autumn. The report then went on to give more details of the Topex-Poseidon data, and an excellent account of how El Niño and La Niña develop.

By August, it was possible to state that the drought of the 1997-1998 agricultural growing season was the main reason for cereal production not achieving record levels.[367] This may seem surprising, but the drought had been during the second growing season and had been concentrated in Tete, Gaza and Inhambane. Any floods there had been near the major rivers, and later in the growing season. The Minister of Agriculture and Fisheries stated that the indications of drought were still there, and he called for an improvement in the warning systems. The current situation called for a focus on the lower risk areas to mitigate any drought. The major problem for agriculture was access, rather than availability of produce. This refers to the difficulties of getting food out to market, and of delivering food to areas that are not self-sufficient. Clearly the infrastructural weakness of rural transport and storage systems was becoming a constraint on further agricultural growth.

This season marked the beginning of the Program of Agrarian Development (PROAGRI), which was intended to improve the provisioning of seeds, and monitoring of various climate phenomena. Commercial products such as cane sugar, cotton and prawn production had grown (the latter by 25 per cent). In general, fish production had gone up by 13 per cent in value. This year, however, prawn production had decreased by 10 per cent. This possibly reflects the impact of loss of mangroves and evidence of over-fishing.

The incipient drought of August developed into a serious affair by October, when the DPCCN was reported to be planning food aid deliveries to Gaza and Inhambane. This amounted to 400 tons of food and water.[368] Water was the main problem in some southern districts, including in Maputo Province. There would be a further 2,000 tons of

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[366] *Noticias*, 15 July 1998 This piece was based on an article in *Environmental News Network*.

[367] *Noticias*, 20 August 1998.

[368] *Noticias*, 13 October 1998.

rice from the Italian government later. The National Water Directorate (DNA) was coordinating actions with the DPCCN to minimize water problems. The Ministry of Finance and Planning was being consulted on the costs of this operation, and donors were being contacted about this program. The WFP was being approached with a view to getting its food stocks out of the port immediately to send to the affected area. A Food for Work scheme would be instituted, but there would be free distribution for the most vulnerable.

In Sofala, the situation was somewhat different in November, where the rains again provoked localized floods in and near Beira.[369] This was seen as the beginning of the rainy season. The same issue carried a story on Zambezia, where rains were more continuous then normal in Mopeia. Six years after the end of the war, there was still no commercial network in the District. World Vision and the WFP were the main agencies distributing seedlings and seeds. In the next issue, the final one to mention the weather in *Noticias*, it was stated that the floods in Beira had killed people and made others homeless.[370] This shows the continuing vulnerability of this port, the second city of Mozambique.[371]

There was no further press coverage of El Niño in the sources consulted. TV and radio coverage was not undertaken; following advice on the condition of their archive tape catalogues.

[369] *Noticias*, 9 November 1998.

[370] *Noticias*, 9 November 1998.

[371] With possible future coastal erosion and rising sea levels, perhaps future investment should be concentrated further inland, at Dondo. Further sanitation measures are nevertheless required for the poorer areas of Beira.

Appendix 5

Weather Stations in Mozambique

The following tables list the weather stations in Mozambique, together with details of their location, elevation, period in use and station type. The code 9999 under 'End date' indicates that the station is currently in use. Stations have closed down for a variety of reasons, including obsolescence and war.[372] There is at least one functioning weather station in every Province. A list of planned new or rehabilitated stations is provided at the end.

Maputo Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
MP009001	Maputo/Observ.	25D 58M S	032D 36M E	60.0	1910-01-01	9999-12-31	Climatologica
MP009003	Namaacha	25D 59M S	032D 01M E	523.0	1911-01-11	1988-01-31	Climatologica
MP009005	Umbeluzi/Agric	26D 03M S	032D 23M E	12.0	1912-01-01	9999-12-31	AgroClimatol
MP009008	Belavista	26D 20M S	032D 41M E	15.0	1914-01-01	1983-09-30	Climatologica
MP009009	Catuane	25D 50M S	032D 17M E	37.0	1914-01-01	1981-12-31	Climatologica
MP009010	Manhiça	25D 22M S	032D 48M E	35.0	1914-01-01	9999-12-31	Climatologica
MP009011	Marracuene	25D 44M S	032D 41M E	26.0	1914-01-01	1985-07-31	Climatologica
MP009012	Moamba	25D 36M S	032D 14M E	110.0	1914-01-01	1983-12-31	Climatologica
MP009013	Umbeluzi/Partic	26D 04M S	032D 22M E	10.0	1914-01-01	1952-12-31	Climatologica
MP009014	Sabie	25D 19M S	032D 14M E	80.0	1914-01-07	1983-05-31	Climatologica
MP009015	Manhoca	26D 49M S	032D 35M E	40.0	1915-01-01	1915-12-31	Climatologica
MP009016	Magude	25D 02M S	032D 39M E	18.0	1915-08-01	1941-09-30	Climatologica
MP009018	Inhaca	26D 02M S	032D 56M E	27.0	1916-01-01	1973-12-31	Climatologica
MP009018	Inhaca	26D 02M S	032D 56M E	27.0	1981-01-01	9999-12-31	Climatologica
MP009021	Unatze	20D 00M S	030D 00M E	999.9	1919-01-01	9999-12-31	Climatologica
MP009029	Chobela	25D 00M S	032D 44M E	15.0	1941-12-01	1983-06-30	AgroClimatol
MP009040	Tinonganine	26D 29M S	032D 34M E	50.0	1954-07-01	1983-10-31	Climatologica
MP009041	Goba- Fronteira	26D 15M S	032D 06M E	418.0	1954-11-01	1982-04-30	Climatologica
MP009044	Maputo/Maval.	25D 55M S	032D 34M E	39.0	1956-01-01	9999-12-31	Classe 1
MP009045	Ressano Garcia	25D 26M S	031D 59M E	130.0	1956-05-01	1983-07-31	Climatologica
MP009051	Zitundo	26D 45M S	032D 50M E	71.0	1962-07-01	1985-08-31	Climatologica
MP009052	Changalane	26D 18M S	032D 11M E	100.0	1962-12-01	9999-12-31	Classe 2
MP009054	Mazeminhama	26D 27M S	032D 15M E	61.0	1963-11-01	1983-11-30	AgroClimatol.
MP009061	Machava	25D 34M S	032D 34M E	60.0	1969-01-01	9999-12-31	Climatologica
MP009063	Manhiça-Marag	25D 27M S	032D 48M E	100.0	1970-03-01	9999-12-31	AgroClimatol
MP009064	Benfica	25D 55M S	032D 34M E	37.0	1970-07-01	9999-12-31	Climatologica
MP009066	Ponta Dobela	25D 31M S	032D 54M E	999.9	1971-02-01	1976-08-31	Climatologica
MP009067	Mapulanguene	24D 29M S	032D 05M E	418.0	1971-09-01	1981-05-31	Climatologica
MP009070	Ricatla	25D 46M S	032D 38M E	55.0	1973-04-01	9999-12-31	AgroClimatol.
MO009072	Bobole	25D 37M S	032D 40M E	66.0	1974-01-01	1974-12-31	Climatologica
MP009074	Matola	25D 49M S	032D 27M E	30.0	1981-02-01	1986-03-31	Climatologica

[372] The result is a network of stations that is much smaller than was the case in the past, which is unfortunate for a country whose climate and weather vary so much over time and geographically. Logistical problems are currently preventing the installation in Maputo Province of three stations that have been financed by the FAO, plus around another 14 in the rest of the country: see last table in this Appendix.

Gaza Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
GZ008001	Chicomo	24D 23M S	034D 35M E	4.0	1901-01-01	9999-12-31	Climatologica
GZ008003	Barra Limpop.	25D 11M S	033D 30M E	80.0	1911-01-01	1945-12-31	Climatologica
GZ008005	CanicadoGuija	24D 20M S	033D 05M E	33.0	1912-01-01	1960-12-31	Climatologica
GZ008007	Manjacaze	24D 43M S	033D 53M E	65.0	1914-02-01	9999-12-31	Climatologica
GZ008008	Chibuto	24D 41M S	033D 32M E	90.0	1914-03-01	1948-08-31	Climatologica
GZ008010	Macia	25D 02M S	033D 06M E	56.0	1915-01-01	9999-12-31	Climatologica
GZ008011	Massingir	25D 53M S	032D 09M E	100.0	1915-01-01	1964-02-29	Climatologica
GZ008011	Massingir	25D 53M S	032D 09M E	100.0	1970-11-01	9999-12-31	Climatologica
GZ008022	Pafuri	22D 27M S	031D 20M E	215.0	1932-11-01	1976-01-31	Climatologica
GZ008032	Xai-Xai	25D 03M S	033D 38M E	4.0	1948-02-01	9999-12-31	Classe 1
GZ008034	Chongoene	25D 00M S	033D 47M E	67.0	1949-01-01	1962-11-30	Climatologica
GZ008035	Maniquenique	24D 44M S	033D 32M E	13.0	1949-01-01	9999-12-31	AgroClimatol
GZ008042	Mapai	22D 04M S	032D 03M E	254.0	1956-02-01	1976-09-30	Climatologica
GZ008045	Praia Bilene	25D 17M S	033D 15M E	20.0	1958-09-01	1987-06-03	Climatologica
GZ008048	Massangena	21D 33M S	032D 58M E	136.0	1960-09-01	1976-09-30	Classe 2
GZ008050	Chókwè	24D 33M S	030D 00M E	33.0	1961-01-01	9999-12-31	AgroClimatol
GZ008051	Chigubo	22D 50M S	033D 31M E	102.0	1961-08-01	1978-06-03	Climatologica
GZ008052	Chicualacuala	22D 05M S	031D 41M E	452.0	1961-09-01	1976-12-31	Classe 2
GZ008062	Combomune	23D 28M S	032D 27M E	195.0	1971-07-01	1977-05-31	Climatologica
GZ008063	Mabalane	23D 51M S	032D 38M E	999.9	1971-07-01	1979-08-31	Climatologica
GZ008064	Maguco	24D 20M S	032D 49M E	43.0	1971-09-01	1976-10-31	Climatologica
GZ008065	AltoChangane	24D 18M S	033D 38M E	999.9	1971-11-01	9999-12-31	Climatologica

Inhambane Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
IB007001	Cumbana-Jan.	24D 15M S	035D 15M E	30.0	1910-01-01	9999-12-31	Climatologica
IB007002	Homoine	23D 53M S	035D 11M E	130.0	1910-01-01	9999-12-31	Climatologica
IB007003	Inhambane	23D 52M S	035D 23M E	14.0	1910-01-01	9999-12-31	Classe 1
IB007004	Inharrime	24D 29M S	035D 01M E	43.0	1910-01-01	9999-12-31	Climatologica
IB007005	Morrumbene	23D 40M S	035D 22M E	20.0	1910-01-01	1988-07-01	Climatologica
IB007006	Nhacoongo	25D 18M S	035D 11M E	30.0	1910-01-01	9999-12-31	AgroClimatol.
IB007007	Panda	24D 03M S	034D 43M E	150.0	1910-01-01	9999-12-31	Climatologica
IB007008	Panga-Mocod.	23D 40M S	035D 12M E	999.9	1910-01-01	9999-12-31	Climatologica
IB007009	Quissico-Zav.	24D 43M S	034D 45M E	147.0	1910-01-01	9999-12-31	Climatologica
IB007010	Vilanculos	22D 00M S	035D 19M E	20.0	1910-01-01	9999-12-31	Classe 2
IB007011	Massinga	23D 19M S	035D 24M E	109.0	1910-03-01	1982-10-31	Climatologica
IB007014	Inhamuassua	23D 54M S	035D 14M E	37.0	1913-06-01	9999-12-31	Climatologica
IB007015	Mocumbi	24D 32M S	034D 46M E	45.0	1913-08-01	1978-10-31	Climatologica
IB007015	Mocumbi	24D 32M S	034D 46M E	45.0	1982-05-01	9999-12-31	Climatologica
IB007018	Funhalouro	23D 05M S	034D 23M E	116.0	1915-01-01	1981-12-31	Climatologica
IB007019	Mavume	23D 04M S	034D 24M E	999.9	1915-01-01	9999-12-31	Climatologica
IB007021	Bartolomeu D.	20D 00M S	030D 00M E	999.9	1916-01-01	9999-12-31	Climatologica
IB007026	Burra	20D 00M S	030D 00M E	999.9	1921-01-01	9999-12-31	Climatologica
IB007033	Ponto da Barra	23D 47M S	035D 32M E	13.0	1927-01-01	9999-12-31	Climatologica
IB007041	Mabote	22D 03M S	034D 07M E	143.0	1934-05-01	1984-02-29	Climatologica
IB007046	Mambone	20D 59M S	035D 01M E	4.0	1938-01-01	1987-12-31	Climatologica
IB007058	Inhassune	24D 14M S	034D 51M E	48.0	1971-11-05	9999-12-31	Climatologica

Sofala Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
SF006001	Cherinda	26D 17M S	034D 41M E	999.9	1912-01-01	9999-12-31	Climatologica
SF006004	Nhamatanda	19D 16M S	034D 12M E	57.0	1912-01-01	1979-07-31	Climatologica
SF006005	Sena	17D 20M S	035D 03M E	50.0	1912-01-01	1915-12-31	Climatologica
SF006007	Beira/Observ.	19D 50M S	034D 51M E	7.0	1915-01-01	9999-12-31	Climatologica
SF006009	Chingune	20D 00M S	030D 00M E	999.9	1916-01-01	1922-12-31	Climatologica
SF006010	V.PaivaAndr.	18D 41M S	034D 04M E	300.0	1916-01-01	1977-09-30	Climatologica
SF006012	Chupanga	20D 00M S	030D 00M E	999.9	1917-01-01	1918-12-31	Climatologica
SF006018	Chemba	17D 14M S	034D 35M E	100.0	1923-01-01	1956-12-31	AgroClimatol.
SF006029	Caia	17D 50M S	035D 20M E	30.0	1938-01-01	1977-10-31	Classe 2
SF006029	Caia	17D 50M S	035D 20M E	30.0	1981-07-01	1984-06-30	Classe 2
SF006030	Inhaminga	18D 24M S	035D 00M E	316.0	1938-01-01	1980-12-31	Climatologica
SF006031	Marromeu	18D 18M S	035D 56M E	20.0	1938-01-01	1976-09-30	Climatologica
SF006032	V.G.Arriaga	19D 53M S	034D 35M E	10.0	1938-01-01	1977-09-30	Climatologica
SF006043	Chiou	17D 14M S	034D 49M E	100.0	1952-01-01	1982-10-31	AgroClimatol.
SF006053	Beira/Aeroport	19D 48M S	034D 54M E	8.0	1964-04-01	9999-12-31	Classe 1
SF006055	Mucheve	20D 34M S	033D 49M E	145.0	1963-07-15	1974-06-30	Climatologica
SF006058	Chitengo	18D 59M S	034D 21M E	42.0	1966-01-01	1983-12-31	Climatologica
SF006060	Muanza	18D 49M S	034D 50M E	7.0	1967-10-01	1979-12-31	Climatologica
SF006061	Dondo	19D 37M S	034D 45M E	999.9	1967-01-10	1979-10-31	Climatologica
SF006062	Mazuirgue	17D 15M S	034D 11M E	625.0	1967-12-01	1968-09-30	Climatologica
SF006062	Mazuirgue	17D 15M S	034D 11M E	625.0	1970-09-01	1974-06-30	Climatologica
SF006064	Magadade	17D 37M S	035D 07M E	570.0	1968-01-01	1968-12-31	Climatologica
SF006064	Magadade	17D 37M S	035D 07M E	570.0	1971-09-01	1974-03-31	Climatologica
SF006065	Maringue	17D 58M S	034D 23M E	10.0	1968-11-01	1979-08-31	Climatologica
SF006068	Mafambisse	19D 33M S	034D 37M E	999.9	1971-05-01	1979-10-31	Climatologica
SF006072	Beira-Munha.	20D 00M S	030D 00M E	999.9	1979-03-01	1987-08-31	Climatologica
SF006002	Chiloane	20D 37M S	034D 53M E	10.0	1912-01-01	9999-12-31	Climatologica

Manica Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
MN005001	Espungabera	20D 28M S	032D 46M E	824.0	1912-01-01	1978-09-30	Climatologica
MN005001	Espungabera	20D 28M S	032D 46M E	824.0	1982-05-01	1984-06-30	Climatologica
MN005002	Mandigos	19D 00M S	033D 00M E	610.0	1912-01-01	9999-12-31	Climatologica
MN005003	Vila Manica	18D 56M S	033D 28M E	723.0	1912-01-01	9999-12-31	Climatologica
MN005005	Vumba	18D 55M S	033D 40M E	0.1	1914-01-01	9999-12-31	Climatologica
MN005015	Chimoio	19D 07M S	033D 28M E	731.0	1924-01-01	9999-12-31	Classe 1
MN005017	Catandica	18D 04M S	033D 10M E	611.0	1925-08-01	1979-05-31	Climatologica
MN005022	Mavita	19D 18M S	033D 01M E	999.9	1930-10-01	1946-12-31	Climatologica
MN005032	Messambuzi	19D 30M S	032D 55M E	966.0	1947-01-01	9999-12-31	Climatologica
MN005042	Machaze	20D 39M S	033D 22M E	999.9	1967-10-10	1976-12-31	Climatologica
MN005043	Amatongas	19D 11M S	033D 45M E	999.9	1968-10-16	1977-09-30	Climatologica
MN005043	Amatongas	19D 11M S	033D 45M E	999.9	1979-09-01	1980-09-30	Climatologica
MN005043	Amatongas	19D 11M S	033D 45M E	999.9	1983-04-01	1986-12-31	Climatologica
MN005044	Macosse	17D 54M S	033D 56M E	254.0	1967-11-01	1978-07-31	Climatologica
MN005045	Sussudenga	19D 20M S	033D 14M E	620.0	1967-11-01	9999-12-31	Climatologica
MN005049	ChimoioAgric	20D 00M S	030D 00M E	999.9	1970-07-01	1975-10-31	AgroClimatol.
MN005049	ChimoioAgric	20D 00M S	030D 00M E	999.9	1979-07-01	9999-12-31	AgroClimatol.

Tete Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
TT003001	Tete	16D 10M S	033D 28M S	149.0	1910-02-01	1952-08-31	Climatologica
TT003002	Tete	16D 11M S	033D 35M S	149.0	1952-09-01	9999-12-31	Classe 1
TT003005	V.CoutinhoVe	14D 34M S	034D 18M S	0.1	1913-05-01	1960-09-30	Climatologica
TT003005	V.CoutinhoVe	14D 34M S	034D 18M S	0.1	1961-12-01	1973-12-31	Climatologica
TT003005	V.CoutinhoVe	14D 34M S	034D 18M S	0.1	1976-07-01	1985-11-30	Climatologica
TT003007	Muchena	15D 40M S	033D 47M S	500.0	1914-01-01	9999-12-31	Climatologica
TT003010	Furancungo	14D 54M S	033D 36M S	0.1	1916-01-01	1974-06-30	Climatologica
TT003011	V.Albuquerqu	20D 00M S	030D 00M S	999.9	1916-01-01	9999-12-31	Climatologica
TT003015	Zumbo	15D 37M S	030D 26M S	343.0	1920-02-01	1961-10-16	Climatologica
TT003015	Zumbo	15D 37M S	030D 26M S	343.0	1961-10-17	1984-12-31	Classe 2
TT003020	VascodaGama	14D 54M S	032D 16M S	0.1	1925-10-01	1971-02-28	Climatologica
TT003027	Fingoe	15D 10M S	031D 53M S	853.0	1932-11-01	1971-02-28	Climatologica
TT003027	Fingoe	15D 10M S	031D 53M S	853.0	1973-09-01	1984-12-31	Climatologica
TT003029	Mulatsi	14D 10M S	032D 59M S	958.0	1934-02-01	1963-07-31	Climatologica
TT003029	Mulatsi	14D 10M S	032D 59M S	958.0	1967-11-01	1969-06-30	Climatologica
TT003032	Mutarara	17D 23M S	035D 03M S	88.0	1936-10-01	1974-11-30	Climatologica
TT003036	Chicoa	15D 36M S	032D 21M S	274.0	1940-02-01	1965-10-31	Climatologica
TT003036	Chicoa	15D 36M S	032D 21M S	274.0	1967-10-01	1972-07-31	Climatologica
TT003037	Casula	15D 24M S	033D 38M S	597.0	1940-08-01	1969-03-31	Climatologica
TT003037	Casula	15D 24M S	033D 38M S	597.0	1973-01-01	1981-09-30	Climatologica
TT003038	Chiuta	15D 34M S	033D 17M S	0.1	1940-08-01	1973-06-30	Climatologica
TT003040	Mungari	17D 10M S	033D 33M S	535.0	1942-01-01	1965-06-30	Climatologica
TT003043	Maue	14D 55M S	034D 20M S	999.9	1945-01-01	1960-10-31	Climatologica
TT003053	Ulongue	14D 44M S	034D 22M S	0.1	1960-09-22	1985-02-28	Classe 2
TT003055	Tembue	14D 53M S	032D 50M S	500.0	1961-12-01	1971-07-31	Climatologica
TT003060	Moatize	16D 06M S	033D 37M S	535.0	1968-01-01	1974-10-16	Climatologica
TT003062	ChangaraFront	16D 50M S	033D 17M S	999.9	1969-01-01	1976-04-30	Climatologica
TT003063	Chioco	16D 25M S	032D 51M S	999.9	1969-01-01	1975-11-30	Climatologica
TT003064	Cambulatsitsi	15D 59M S	034D 11M S	999.9	1969-01-01	1974-04-30	Climatologica
TT003064	Cambulatsitsi	15D 59M S	034D 11M S	999.9	1980-10-01	1984-07-31	Climatologica
TT003065	Magoe	15D 49M S	031D 46M S	999.9	1969-01-01	1979-07-31	Climatologica
TT003065	Magoe	15D 49M S	031D 46M S	999.9	1984-02-01	1985-03-31	Climatologica
TT003066	Zobue	15D 36M S	034D 26M S	64.0	1969-01-01	1984-07-31	Climatologica
TT003068	Mandie	16D 27M S	033D 31M S	159.0	1971-07-01	1979-09-30	Climatologica
TT003070	Estima	15D 44M S	032D 45M S	300.0	1972-05-01	1974-08-31	Climatologica
TT003070	Estima	15D 44M S	032D 45M S	300.0	1979-12-01	1986-01-31	Climatologica
TT003070	Estima	15D 44M S	032D 45M S	300.0	1988-01-01	9999-12-31	Climatologica
TT003072	Songo	15D 36M S	034D 26M S	966.0	1973-01-01	1984-12-31	Classe 2
TT003073	Caroeira	16D 06M S	033D 40M S	999.9	1973-10-01	1974-09-30	Climatologica
TT003074	MBonaSongo	20D 00M S	030D 00M S	999.9	1973-10-01	1974-09-30	Climatologica

Zambezia Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
ZB004001	Quelimane	17D 53M S	036D 53M E	6.0	1911-03-01	9999-12-31	Classe 1
ZB004003	Mopea	17D 58M S	035D 44M E	51.0	1912-01-01	1913-12-31	Climatologica
ZB004006	Milange	16D 05M S	035D 47M E	745.0	1914-01-01	1919-12-31	Climatologica
ZB004007	Muabaze	17D 10M S	038D 45M E	999.9	1914-01-01	9999-12-31	Climatologica
ZB004008	Lugela	16D 49M S	036D 55M E	293.0	1914-01-01	1918-12-31	Climatologica
ZB004010	Maquival	17D 44M S	037D 50M E	999.9	1915-01-01	9999-12-31	Climatologica
ZB004011	Porto Belo	17D 43M S	037D 13M E	999.9	1915-01-01	9999-12-31	Climatologica
ZB004012	Ragone	15D 44M S	036D 48M E	999.9	1915-01-01	9999-12-31	Climatologica
ZB004013	Vila Bocage	17D 28M S	035D 20M E	21.0	1915-01-01	9999-12-31	Climatologica
ZB004015	Mocubi	16D 12M S	036D 57M E	999.9	1916-01-01	9999-12-31	Climatologica
ZB004016	Muobede	16D 26M S	036D 45M E	293.0	1916-01-01	9999-12-31	Climatologica
ZB004017	Namacurra	17D 30M S	037D 01M E	50.0	1916-01-01	1984-11-31	Climatologica
ZB004018	Namarroi	15D 57M S	036D 52M E	603.0	1916-01-01	1917-12-31	Climatologica
ZB004024	Alto Moloque	15D 38M S	037D 41M E	563.0	1924-01-01	1985-06-30	Climatologica
ZB004028	Chinde	18D 35M S	036D 28M E	4.0	1927-03-01	1983-08-31	Climatologica
ZB004029	Pebane	17D 16M S	038D 09M E	25.0	1927-08-01	9999-12-31	Classe 2
ZB004032	Errego-Ile	16D 02M S	037D 11M E	533.0	1929-05-01	1966-11-30	Climatologica
ZB004032	Errego-Ile	16D 02M S	031D 11M E	533.0	1967-07-02	9999-12-31	Climatologica
ZB004037	Mocuba	16D 50M S	036D 59M E	134.0	1933-02-01	1985-04-30	Climatologica
ZB004038	Maganja Costa	17D 18M S	037D 32M E	70.0	1933-11-01	1986-08-31	Climatologica
ZB004043	Gurue	15D 30M S	036D 59M E	734.0	1937-10-01	1983-04-30	Climatologica
ZB004049	Lugela	16D 26M S	036D 45M E	293.0	1941-09-01	1981-12-31	Climatologica
ZB004050	Namarroi	15D 57M S	036D 52M E	603.0	1941-10-01	1984-07-31	Climatologica
ZB004051	Milange	16D 06M S	035D 47M E	745.0	1941-11-01	1986-07-31	Climatologica
ZB004052	Mopeia	18D 00M S	035D 50M E	51.0	1941-11-01	1959-07-31	Climatologica
ZB004056	Morrumbala	17D 20M S	035D 35M E	417.0	1946-09-01	1954-12-31	Climatologica
ZB004056	Morrumbala	17D 20M S	035D 35M E	417.0	1957-01-01	1965-12-31	Climatologica
ZB004056	Morrumbala	17D 20M S	035D 35M E	417.0	1968-11-01	1981-05-31	Climatologica
ZB004057	Melela	15D 44M S	037D 29M E	650.0	1947-01-01	1964-04-30	Climatologica
ZB004062	Tacuane	16D 21M S	036D 30M E	343.0	1952-01-01	1971-10-31	Climatologica
ZB004063	TacuaneMadal	16D 21M S	036D 22M E	400.0	1952-01-01	1982-09-30	Climatologica
ZB004065	Lioma	15D 09M S	036D 46M E	736.0	1953-09-01	1974-09-30	Climatologica
ZB004067	Mopeia	17D 59M S	035D 42M E	51.0	1959-10-01	1985-04-30	Climatologica
ZB004070	BrigadadaCha	15D 28M S	036D 27M E	534.0	1965-01-01	1981-12-31	Climatologica
ZB004075	I.Inhassambo	18D 43M S	036D 13M E	999.9	1971-07-01	1984-08-31	Climatologica
ZB004076	Mugema	15D 23M S	037D 33M E	736.0	1971-10-01	1983-05-31	Climatologica
ZB004077	Mucelo	17D 42M S	036D 52M E	3.0	1971-11-01	1979-07-31	Climatologica
ZB004079	Gile	16D 09M S	038D 22M E	170.0	1972-09-01	1985-03-31	Climatologica
ZB004080	Mocubela	16D 54M S	037D 49M E	70.0	1972-10-01	1983-04-30	Climatologica

Nampula Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
NP002001	Ilha Moçamb	15D 02M S	040D 44M E	9.0	1914-01-01	9999-12-31	Climatologica
NP002004	EntreRiosM	14D 57M S	037D 25M E	625.0	1916-01-01	1970-05-31	Climatologica
NP002005	Namapa	13D 43M S	039D 50M E	200.0	1916-01-01	9999-12-31	AgroClimatol
NP002006	RibaueAgric	14D 59M S	038D 16M E	535.0	1916-05-01	9999-12-31	AgroClimatol
NP002008	Angoche	16D 13M S	039D 54M E	61.0	1917-01-01	9999-12-31	Classe 2
NP002010	Meconta	14D 59M S	039D 51M E	235.0	1919-10-01	1930-09-30	Climatologica
NP002011	NampulaAgric	15D 09M S	039D 20M E	432.0	1919-10-01	1984-07-31	AgroClimatol
NP002011	NampulaAgric	15D 09M S	039D 20M E	432.0	1987-11-01	9999-12-31	AgroClimatol
NP002013	Nametil	15D 43M S	039D 21M E	171.0	1920-01-01	1986-01-31	AgroClimatol
NP002016	Muecate	14D 54M S	039D 38M E	280.0	1923-10-01	1954-12-31	Climatologica
NP002018	Mossuril	14D 57M S	040D 40M E	15.0	1924-01-01	1974-05-31	Climatologica
NP002018	Mossuril	14D 57M S	040D 40M E	15.0	1980-08-01	1982-10-31	Climatologica
NP002019	Memba	14D 10M S	040D 30M E	999.9	1924-03-01	1956-03-31	Climatologica
NP002020	Moma	16D 46M S	039D 13M E	4.0	1924-11-01	1985-09-30	Climatologica
NP002022	Mongicual	15D 34M S	040D 25M E	35.0	1925-07-01	1976-06-30	Climatologica
NP002022	Mongicual	15D 34M S	040D 25M E	35.0	1980-09-01	1984-11-30	Climatologica
NP002030	Nacala1933-55	14D 33M S	040D 38M E	24.0	1933-02-01	1955-07-31	Climatologica
NP002036	Mecuburi	14D 39M S	038D 45M E	468.0	1939-03-01	1964-12-31	Climatologica
NP002036	Mecuburi	14D 39M S	038D 45M E	468.0	1967-10-01	1980-11-30	Climatologica
NP002036	Mecuburi	14D 39M S	038D 45M E	468.0	1984-09-01	9999-12-31	Climatologica
NP002039	Muite	14D 02M S	039D 02M E	400.0	1941-02-01	1972-05-31	Climatologica
NP002039	Muite	14D 02M S	039D 02M E	400.0	1984-09-01	1988-09-30	Climatologica
NP002040	Mutuali	14D 53M S	037D 03M E	570.0	1941-07-07	1986-09-30	AgroClimatol
NP002045	NacalaAgric	20D 00M S	030D 00M E	999.9	1952 01-01	1957-07-31	AgroClimatol
NP002049	Lumbo	15D 02M S	040D 40M E	10.0	1956-01-01	1987-10-31	Classe 2
NP002050	Ribaue	14D 56M S	038D 16M E	535.0	1956-01-01	1967-01-31	Climatologica
NP002051	Nampula	15D 06M S	039D 17M E	438.0	1956-12-01	9999-12-31	Classe 1
NP002057	F.VelNacala	14D 28M S	040D 41M E	45.0	1962-10-01	1976-11-30	Climatologica
NP0020 57	F.VelNacala	14D 28M S	040D 41M E	45.0	1978-01-01	1979-02-28	Climatologica
NP002063	Nacala1972-78	20D 00M S	030D 00M E	999.9	1972-01-01	1978-02-28	Climatologica

Cabo Delgado Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
CD000001	Ibo	12D 20M S	040D 36M E	999.9	1910-01-01	9999-12-31	Climatologica
CD000011	Macomia	12D 15M S	040D 08M E	343.0	1932-10-01	1970-12-31	Climatologica
CD000011	Macomia	12D 15M S	040D 04M E	343.0	1973-10-01	1977-05-31	Climatologica
CD000012	Maunda	11D 37M S	039D 30M E	860.0	1932-10-01	1939-05-30	Climatologica
CD000013	MoçimboaPrai	11D 21M S	040D 22M E	27.0	1932-10-01	1939-04-30	Classe 2
CD000013	MoçimboaPrai	11D 21M S	040D 22M E	27.0	1943-02-01	9999-12-31	Classe 2
CD000014	Montepuez	13D08 M S	039D 02M E	534.0	1932-10-01	9999-12-31	Classe 2
CD000016	Murrebue	13D 06M S	040D 32M E	60.0	1933-01-01	1947-09-30	Climatologica
CD000020	Quissanga	12D 26M S	040D 24M E	42.0	1937-08-01	1966-01-01	Climatologica
CD000020	Quissanga	12D 26M S	040D 24M E	42.0	1969-01-01	1981-02-28	Climatologica
CD000022	Mecufi	13D 17M S	040D 34M E	10.0	1938-01-01	9999-12-31	Climatologica
CD000024	Mueda	11D 40M S	039D 33M E	847.0	1939-06-01	1974-03-01	Climatologica
CD000028	Palma	10D 46M S	040D 30M E	60.0	1941-10-01	1979-02-28	Climatologica
CD000034	Pemba	12D 59M S	040D 32M E	101.0	1947-10-01	9999-12-31	Classe 1
CD000042	Cuero	12D 33M S	039D 38M E	323.0	1955-01-01	1962-10-31	Climatologica
CD000043	MoçRovuma	11D 25M S	039D 10M E	453.0	1955-01-01	1964-09-30	Climatologica
CD000044	Muidumbe	11D 47M S	039D 55M E	502.0	1955-01-01	1964-11-30	Climatologica
CD000045	NamaraBalam	13D 21M S	038D 34M E	597.0	1955-01-01	1965-12-31	Climatologica
CD000045	NamaraBalam	13D 21M S	038D 34M E	597.0	1970-02-01	9999-12-31	Climatologica
CD000046	Namuno	13D 37M S	038D 49M E	495.0	1955-01-01	1968-12-31	Climatologica
CD000046	Namuno	13D 37M S	038D 49M E	495.0	1970-03-01	1982-08-31	Climatologica
CD000046	Namuno	13D 37M S	038D 49M E	495.0	1984-01-01	1986-03-31	Climatologica
CD000046	Namuno	13D 37M S	038D 49M E	495.0	1988-03-01	9999-12-31	Climatologica
CD000048	Ancuabe	12D 58M S	039D 52M E	349.0	1956-01-01	1981-10-31	Climatologica
CD000048	Ancuabe	12D 58M S	039D 52M E	349.0	1983-01-01	1987-11-30	Climatologica
CD000049	Meloco	13D 29M S	039D 10M E	438.0	1956-01-01	1978-10-31	Climatologica
CD000050	Nairoto	12D 24M S	039D 06M E	311.0	1956-01-01	1966-08-31	Climatologica
CD000050	Nairoto	12D 24M S	039D 06M E	311.0	1968-09-01	1983-04-30	Climatologica
CD000051	Nanripo	14D 07M S	038D 48M E	999.9	1956-01-01	1978-04-30	Climatologica
CD000052	Bilibiza	12D 34M S	040D 17M E	32.0	1957-01-01	1971-01-31	Climatologica
CD000058	Nangade	11D 04M S	039D 40M E	260.0	1971-10-01	1974-07-31	Climatologica
CD000061	Meza	13D 02M S	039D 32M E	999.9	1974-01-01	1981-04-30	Climatologica

Niassa Province

Station ID	Station Name	Latitude	Longitude	Elevation (meters)	Begin Date	End Date	STN-QUAL
NS001001	Maniamba	12D 46M S	034D 59M E	0.1	1932-11-01	1966-06-30	Climatologica
NS001001	Maniamba	12D 46M S	034D 59M E	0.1	1976-03-01	1985-02-08	Climatologica
NS001002	Cuamba	14D 49M S	036D 32M E	606.0	1932-12-01	1974-12-31	Classe 2
NS001002	Cuamba	14D 49M S	036D 32M E	606.0	1977-04-01	9999-12-31	Classe 2
NS001003	Lichinga	13D 18M S	035D 14M E	0.1	1932-12-01	9999-12-31	Classe 1
NS001004	Litunde	13D 19M S	035D 45M E	0.1	1932-12-01	1948-12-31	Climatologica
NS001004	Litunde	13D 19M S	035D 45M E	0.1	1953-10-01	1967-04-30	Climatologica
NS001004	Litunde	13D 19M S	035D 45M E	0.1	1973-03-01	1976-07-31	Climatologica
NS001014	Maua	13D 52M S	037D 10M E	594.0	1941-09-01	1983-11-30	Climatologica
NS001024	Marrupa	13D 44M S	037D 33M E	836.0	1954-06-01	1974-08-31	Classe 2
NS001024	Marrupa	13D 44M S	037D 33M E	836.0	1981-01-01	9999-12-31	Classe 2
NS001025	Mecula	12D 06M S	037D 37M E	0.1	1954-07-01	1966-02-28	Climatologica
NS001025	Mecula	12D 06M S	037D 37M E	0.1	1972-10-01	1986-01-31	Climatologica
NS001026	Cobue	12D 08M S	034D 46M E	502.0	1954-10-01	1964-07-31	Climatologica
NS001028	Massangulo	13D 53M S	035D 26M E	0.1	1955-11-01	1982-12-31	Climatologica
NS001030	Nungo	13D 25M S	037D 46M E	610.0	1956-02-01	1970-06-30	Climatologica
NS001030	Nungo	13D 25M S	037D 46M E	610.0	1973-06-01	1983-09-30	Climatologica
NS001031	Mepanhira	15D 20M S	036D 08M E	681.0	1956-10-01	1976-04-30	Climatologica
NS001035	Meponda	13D 24M S	034D 52M E	520.0	1960-01-01	1963-04-30	Climatologica
NS001035	Meponda	13D 24M S	034D 52M E	520.0	1964-09-01	1984-05-31	Climatologica
NS001040	Majune	13D 28M S	036D 10M E	280.0	1970-01-01	1983-03-31	Climatologica
NS001040	Majune	13D 28M S	036D 10M E	280.0	1985-10-01	1987-03-31	Climatologica
NS001041	MitandeBelem	14D 12M S	035D 56M E	999.9	1970-03-01	1983-06-30	Climatologica
NS001043	Unango	13D 04M S	035D 12M E	0.1	1972-09-01	1985-12-31	Climatologica
NS001045	Mandimba	14D 21M S	035D 39M E	767.0	1973-05-01	1983-04-30	Climatologica
NS001047	Mecanhelas	15D 11M S	035D 52M E	999.9	1973-07-01	1986-12-31	Climatologica
NS001050	Nipepe	14D 02M S	037D 51M E	999.9	1976-11-01	1984-04-30	Climatologica
NS001052	Metarica	14D 19M S	036D 48M E	999.9	1977-05-01	1985-05-30	Climatologica
NS001053	Matama	13D 15M S	035D 23M E	999.9	1977-12-01	1986-06-30	Climatologica

Meteorological Stations: New and Rehabilitated/Upgraded

Province	District	District Capital	Belongs to:
Cabo Delgado	Mueda	Mueda	INAM
Niassa	Marrupa	Marrupa	INAM
Nampula	?	?	INIA
Nampula	Angoche	Angoche	INAM
Zambezia	Alto Molocue	Alto Molocue	INAM
Zambezia	Mocuba	Mocuba	INAM
Zambezia	Morrumbala	Morrumbala	INAM
Tete	Angonia	Ulongue	INAM
Tete	Moatize	Zobue	INAM
Tete	Mutarara	Nhamayabue	INAM
Sofala	Marromeu	Marromeu	INAM
Sofala	Chibabava	Chibabava	INAM
Manica	Barue	Catandica	INAM
Manica	Mossurize	Espungabera	INAM
Gaza	Chicualacuala	Vila E. Mondlane	INAM