FOREWORD

The National Report prepared for the Mid-term Review of the IDNDR and the 1994 World Conference on Natural Disaster Reduction to be held in Yokohama, Japan, in May 1994, which comes soon after the "birth" of the New South Africa, has provided a suitable opportunity for taking a careful look at disaster reduction measures in South Africa.

We in South Africa are glad that we can participate in, benefit from and contribute to the programmes of the decade as we share with the rest of Southern Africa the risks of natural disaster which are of an essentially climatic origin.

Droughts, floods and to a lesser extent other hazards have caused loss of life, severe damage to property and degradation of the environment through the years. Little has been done to reduce such disasters and to prevent them from happening.

Our entry into participation in the decade now, as it passes its halfway mark, signals the desire and the intention of the South African Government to exert itself to develop proactive programmes aimed at reducing all forms of disaster.

We may not be able to control our climate, but we shall strive to minimise the negative effects that it can have on our population, environment and infrastructure. Our neighbouring countries will be our partners in this task.

(This report was compiled from contributions from Government departments and from Non-Government Organisations who have grouped themselves into the newly formed South African IDNDR Committee.
The final draft of the report was discussed and approved at meetings of these organisations.)

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CHAPTER 1

Executive summary

1.1 International Decade for Natural Disaster Reduction

The International Decade for Natural Disaster Reduction (IDNDR) was launched by the General Assembly of the United Nations in Resolution 44/236 of 22 December 1989 with the objective of reducing through concerted international action, especially in developing countries, the loss of life, damage to property, and economic and social disruption caused by natural disasters. The resolution declared the 1990s as the decade in which the international community should devote special attention to achieving international co-operation on combating natural disasters.

The objectives of this resolution are, *inter alia*:

- ☞ To improve the ability of every country to combat the consequences of natural disasters quickly and efficiently.
- ☞ To launch scientific and engineering projects which address important shortcomings in existing information in order to reduce the loss of lives and the destruction of property.
- ☞ To expand existing information and gather new information on measures to predict, evaluate, prevent and combat disasters.

1.2 World Conference on Natural Disaster Reduction

The World Conference on Natural Disaster Reduction, convened by the General Assembly of the United Nations for the IDNDR and hosted by the Government of Japan, will be held in Yokohama from 23 to 27 May 1994.

The theme of the conference is:

A SAFER WORLD FOR THE 21st CENTURY

It is expected that the World Conference will increase awareness of the importance of integrating disaster reduction policies in development planning and humanitarian assistance.

The results of the conference will contribute to the mid-term review of the Decade in 1994 by the United Nations Economic and Social Council, as required by the General Assembly of the United Nations.

1.3 Major natural hazards

Most of South Africa lies within a region of Southern Africa which has a semi-arid to arid climate. This region is subject to climatic extremes, including droughts, floods and other meteorological phenomena. There are indications that climate variability over South Africa is on the increase.

The widespread floods and droughts of the past decade affected many countries of Southern Africa. The floods of the late 1980s were the worst on record in many places. Four years later the 1991/92 drought was the most severe, widespread drought on record in South Africa. The results were great loss of life during floods, and large economic losses and severe human distress during both droughts and floods.

Other natural hazards include tropical cyclones, tornadoes, severe thunderstorms, veld and forest fires, and locust infestations. Life threatening earthquakes occur rarely. Damaging landslides occur during prolonged heavy rainfall.

1.4 Vulnerability to natural hazards

As in many other areas in Africa, the vulnerability to these climatic extremes has increased over the years owing to poverty, population growth and the consequent increasing degree of exploitation of the natural resources. A higher degree of exploitation of the natural grazing and the surface and groundwater resources has made farmers and rural communities

more vulnerable to the effects of long periods of below average rainfall.

Particularly in rural areas, a lack of suitable infrastructure, services and development greatly increases the vulnerability to hazards.

The migration of the rural poor to the urban areas in search of employment has resulted in unplanned settlement in areas vulnerable to floods, as these areas are often the only vacant land close to employment opportunities. These communities are also vulnerable to other disasters, such as fires, health hazards and the occurrence of sinkholes in dolomitic areas.

A large portion of the South African population does not have access to clean water or adequate sanitation facilities, which makes them so much more vulnerable to droughts and health risks.

There are indications that the ability of the natural resources to recover from the effects of droughts and floods is decreasing.

1.5 National initiatives

South Africa has a modern and efficient water resource development programme for urban and industrial use, but much has still to be done to provide adequate water supplies for the dispersed rural communities that rely on local streams, springs and groundwater.

The sequence of severe floods and the drought of the past decade has given rise to two major national initiatives. These are the development of national drought and flood management strategies, respectively. These are nearing completion and should be implemented within the next year or two.

There has been a reassessment of the role and functions of the Civil Protection Service to bring it into line with the needs of the broad population. This process is continuing.

1.6 International co-operation

There is as yet no formal international co-operation on natural disaster reduction measures between South Africa and other countries in Southern Africa and further afield, although this is expected to change in the near future. However, assistance is provided on an *ad hoc* basis during crises such as the recent drought which affected the whole of Southern Africa. There is also an exchange of information on locust outbreaks.

A pool of experience and expertise has been developed in South Africa in many fields associated with natural disaster reduction, such as meteorological warnings, flood warning systems and drought management, which is available to the other countries in Southern Africa that have the same problems.

1.7 Shortcomings

The principal shortcomings are deficiencies in high level co-ordination of activities during sudden crises such as during widespread floods, and the short memories of policy makers which inhibit the maintenance of essential preparedness measures during intervals between the occurrence of these disasters, when long intervening periods lead to a breakdown of clear levels of authority and responsibility through disuse.

These are characterised by the cycle:

DROUGHTS
AWARENESS
CONCERN
PANIC
INVESTIGATIONS
REPORTS
APATHY
RAIN
FLOODS
PANIC
INVESTIGATIONS
REPORTS
APATHY
DROUGHTS

There is as yet no comprehensive national and regional disaster management policy in South Africa. Actions are reactive rather than proactive. However, some local authorities do have contingency plans which could be activated when a disaster occurs.

CHAPTER 2

Risk assessment

In order to direct attention and resources to the range of natural disasters that confront the various areas in South Africa, it is essential that the nature and character of these hazards be understood. Similarly, the vulnerability of the population, the infrastructure and facilities, and the short and long-term economic and social consequences of these events are also assessed.

2.1 Explanation of terms used

2.1.1 Disaster

A disaster is characterised by its scale. It is an event which can result in large-scale loss of life, loss of possessions, damage to property and disruption of communications and services, such as occur during severe floods, or large-scale crop losses, stock losses and failure of water supplies such as occur during droughts, which lead to general impoverishment and exposure to disease. These in turn contribute to social, economic, cultural and political disruption, particularly in the case of disadvantaged communities.

Disasters can be natural or can result from human activities. Examples of the latter are the failure of mine tailings dams, aircraft and train accidents, or the accidental release of toxic materials into the atmosphere or river systems. Disasters can result from a combination of natural and human activities such as the sinking of a large passenger vessel with faulty equipment during a storm.

The term disaster also has legal connotations. The responsible minister may declare a state of disaster in terms of the Civil Protection Act (Act 67 of 1977), or the Fund Raising Act (Act 107 of 1978) which defines a disaster as a sudden or disastrous event whereby serious material damage, loss or distress occurs or is likely to occur in a particular geographical area. Several actions can be activated in terms of these two acts. For example, the Civil Protection activities are mobilised under the Civil Protection Act, and the Fund Raising Act allows the release of State funds and the control of the collection and distribution of private fund-raising actions.

During droughts, a magisterial district may be declared drought stricken. This makes facilities such as reduced rail tariffs available to farmers. This aid is administered by the Department of Agriculture.

Similarly if a flood disaster is declared, flood damage restoration costs can be subsidised by the State through the Department of Water Affairs.

2.1.2 Hazard

Hazards are present in all aspects of daily life, from a banana peel through to a continental drought. Only those hazards which could give rise to a disaster are of concern here. The principal large-scale hazards in South Africa are droughts and floods. Other lesser hazards are detailed in this chapter.

2.1.3 Risk and vulnerability

The risks associated with a disaster require the occurrence or presence of a hazard, on the one hand, and the vulnerability of the persons, structures, crops or water supplies, on the other. For example, the risk of damage to a dwelling during a flood will depend on the size of the flood, the distance of the dwelling from the river and the materials used in its construction.

The risk of loss of life during a flood will depend on the awareness of the individuals of the dangers, effective flood warning systems, and the presence of safe escape routes. The risks associated with droughts are primarily related to the financial resilience of the individuals, consequently poverty is the major factor which exposes a community to drought-related risks.

The quantification of risk is often difficult as it can range from tangible values such as the economic

consequences through to intangible consequences such as emotional stress.

2.1.4 Probability

Probability is the mathematical quantification of risk. It is the product of the probability of occurrence of the hazard and the consequences should the event occur.

2.2 Hazard assessment

The major natural hazards in South Africa and their geographical extent are given in the following table.

Africa are often underestimated. Earthquakes are rare occurrences, and there is no volcanic activity.

The failure of man-made structures or procedures often plays a significant role in turning a natural hazard into a national disaster.

Man-made disasters also occur in South Africa as a result of political violence, epidemics, pollution, releases of hazardous materials into the air or water courses, the failure of man-made structures and train, aircraft, bus and shipping accidents. Apart from political violence, these disasters are often also associated with and increased by natural hazards.

NATURAL HAZARDS		
Type	**Location**	**Areal extent per event**
Droughts	regional to widespread	entire country (indirectly)
Floods	local to widespread	local to regional
Tropical cyclones	north-eastern coastal areas and adjacent interior	regional
Tornadoes	interior	local
Severe thunderstorms	mainly eastern half	local
Gales and high seas	coastal regions	regional
Temperature extremes - hot	entire country	regional
Temperature extremes - cold	entire country	regional
Veld and forest fires	eastern, southern, and south-western areas	local
Locust outbreaks	Karoo and western areas	local
Landslides	humid regions	local
Earthquakes (rare)	entire country	local

Natural hazards in South Africa include droughts, floods, wind storms, veld fires, locust outbreaks and cold spells as well as severe thunderstorms, hail, wind squalls and tornadoes. Of these, droughts and floods are the main natural hazards with severe consequences. The effects of lightning in South

2.3 Vulnerability assessment

The root causes of vulnerability to disaster in South Africa are poverty and inequitable development. Rapid population growth and urbanisation, inequitable patterns of land ownership, lack of education

and subsistence agriculture on marginal land lead to vulnerable conditions such as the unsafe siting of settlements, unsafe homes, deforestation and environmental degradation, malnutrition and unemployment.

The combination of these vulnerable conditions and natural or technological hazards, has resulted in many people being adversely affected in South Africa.

2.3.1 Population

The total population of South Africa is estimated to be 37 600 000 persons. The rate of population growth is directly related to the degree of poverty. In South Africa as a whole the proportion of the total population living below subsistence level was estimated to be 44,8% in 1989, of whom approximately two thirds lived in the rural areas.

Degradation of the environment including soil erosion and the removal of trees for firewood, are two of the consequences of rural population growth. These increase the vulnerability of the rural poor to natural hazards.

The migration of the rural poor to the urban areas has accelerated in recent years. The magnitude of the influx suggests that many of the extremely poor in the rural areas have swelled the ranks of the poor in urban areas.

2.3.2 Social/Cultural

Poverty is a key factor in making communities vulnerable to the effects of natural disasters. The poor and the socially disadvantaged communities suffer most from natural disasters and are the least equipped to cope with them.

Disasters contribute to social, economic, cultural and political disruption in both rural and urban areas. The rural poor are unable to free themselves from the vicious circle of poverty - drought - environmental degradation - desertification. - increased poverty. People living in unplanned settlements in urban areas are at risk owing to the absence of adequate infrastructures and facilities (services and equipment) that can be put into use during disasters.

The influx of refugees from Mozambique has placed an additional burden on primary health care and relief services in parts of the Transvaal over a number of years

Vulnerability associated with poverty will be reduced as upliftment measures are implemented, but this will take time.

2.3.3 Technical assessment

The probabilities of occurrence of floods and droughts of various magnitudes can be determined with an adequate degree of accuracy. The vulnerability of communities to these hazards can be quantified in many, but not all, cases.

2.4 Droughts

The 1982/83 and 1991/92 droughts were the most severe meteorological droughts this century over Southern Africa. In the 1991/92 drought 70% of the crops failed. It was estimated that half of the population in the affected area was at risk of malnutrition, other related health problems and even starvation.

Drought is a menace of growing significance because, more than any other hazard, drought threatens the sustainability of our most important natural resources. The population growth compounds the effects of droughts on food production. For example, South Africa is rapidly approaching the internationally accepted minimum tillable area of 0,4 ha per capita.

There is ever-growing demand for water by industry and the fast-growing population in this semi-arid area. It is estimated that the demand for water in South Africa will increase by 40% from 1980 to 2000.

In a number of major river basins the demand for water already exceeds the maximum exploitable yield and increasing volumes of water have to be imported from neighbouring catchments. Bipartite agreements have been entered into between South Africa and neighbouring countries on the joint exploitation and management of the water resources of common river basins.

2.4.1 Nature and character of droughts

South Africa has long been recognised as a country subject to recurring droughts of varying geographical location, area of influence and duration. The 1923 Final Report of the Drought Investigation Commission remains a classic publication on the subject, and the great drought of the 1930s which coincided with world-wide droughts and the Great Depression has been a benchmark for decades, both from an agricultural and a water supply point of view.

The 1991/92 drought once again brought local drought management policy under scrutiny and revealed significant weaknesses in the ability of government structures to respond timeously and effectively to the disaster and to reduce its impact. These weaknesses were in no small measure due to the absence of a comprehensive drought management strategy, including an early warning system.

The effect of the 1991/92 drought in South Africa was seen mainly in crop yields with a grain output 70% lower than average, making it necessary to import nearly five million metric tons of grain in order to satisfy local needs. In neighbouring countries the situation was even worse with an import requirement of 6,1 million tons. These neighbouring countries launched an international appeal for 2,5 million tons of programme food aid, 1,6 million tons of targeted food aid and non-food aid to assure availability of water supplies, health care and agricultural and livestock inputs. The total amount requested was US$854 million which, did not include the value of the 2,5 million tons of programme aid. In the case of South Africa its own resources were used with only relatively small grants to NGOs coming from overseas organisations.

During the drought the natural grazing deteriorated to such an extent that more than 829 000 large stock units and in excess of 107 000 small stock units died.

The South African rail network and rolling stock played an indispensable role in the transport of imported grain from our harbours to our neighbouring countries.

South Africa was spared the more serious health consequences that were experienced by some of our neighbouring countries during the drought. Cholera pandemics were reported from Angola, Malawi, Swaziland, Mozambique, Tanzania, Zimbabwe and Zambia. Outbreaks of other diseases with high fatality rates were recorded. These included dysentery, gastro-enteritis, diarrhoea and typhoid fever.

The impact of drought and political instability in neighbouring countries led to increased movement of refugees into South Africa. These refugees, largely indigent, also had to be accommodated in the national drought relief measures.

The extent of the disaster and its occurrence at the end of a Decade of three lesser crop failures and six years of below average yields, escalating input costs and interest rates, and record accumulation of carry-over debt, threatened the economic survival of many thousands of farmers and the collapse of the rural economy directly and indirectly dependent on agriculture, and the jobs and livelihood of millions of farm workers and their dependants.

A particular shortcoming in the drought strategy was the lack of an information system allowing continuous assessment of the effect of the drought on these rural communities and the employment levels of various categories of farm workers, a group particularly vulnerable owing to the fact that housing on the farms is often linked to employment. Retrenchment meant loss of shelter as well as income.

2.4.2 Vulnerability to droughts (population, infrastructure and facilities)

It is estimated that more than a million subsistence farmers are dependent on their household food supplies from subsistence farming, making these farmers and their dependants vulnerable to natural disasters, particularly droughts and floods.

It is also estimated that a large portion of the rural population in South Africa does not have access to clean water or adequate sanitation facilities, which makes them even more vulnerable during drought periods.

Some of the socio/economic consequences of severe drought are:

- ☞ Loss of means of livelihood and normal sources of food.

- Lack of shelter, fuel for cooking, potable water and household necessities.

- Communities becoming separated from services and facilities previously available.

2.4.3 Vulnerability to droughts (agriculture)

Irrigation

In a particular area the area under irrigation is known and towards the end of the rainy season the availability of water for irrigation can be fairly accurately assessed Owing to the gradual and calculable decrease in the water supply this provides an early warning mechanism which can be used for the allocation of water for cash crops

Perennial crops and orchards are, however, very exposed to water shortages which can in severe cases necessitate the expensive re-establishment of plantations.

Rain-dependent crops

Rain-dependent crops can be devastated by a short spell of drought if this occurs in the growing season. These crops must therefore always be considered to be at high risk.

Natural pastures

In the case of natural pastures, which cover more than 80% of all agricultural land in South Africa, the effect of the advent of a drought is not as sudden as with cash crops. The effects of a drought on pasture develop over an extended period.

Overgrazing and mismanagement can aggravate the effects of droughts on pastures, depending on the different types of grassland. Repeated droughts can promote desertification, bush densification and harvester termite infestation.

Protracted droughts cause severe stock losses, which in turn lead to decreased incomes, or can endanger the livelihood of subsistence farming communities.

2.4.4 Short and long-term economic and social consequences of droughts

In South Africa, as elsewhere in the world, drought alleviation strategies have traditionally been aimed at helping agriculturists to retain productive capacity and resume production when conditions improve.

Previous experience in the alleviation of agricultural crises facilitated the introduction and deployment of aid schemes designed to stabilise the commercial agricultural sector and to buffer the effects of the drought on subsistence farmers and small commercial farmers who constitute a large section of the rural community.

It is clear that South Africa has a unique juxtaposition of first and third world economies; a developed commercial farming sector and a large subsistence farming sector; affluence and poverty; assured national food security but no household food security; sophisticated urban water supply but vulnerable rural water supplies. There is therefore the need for a more comprehensive policy to protect the rural communities against the ravages of drought.

2.5 Floods

Of all the natural phenomena capable of producing disaster, flooding is by far the most significant in causing loss of life. The severity of such disasters is often increased several fold by the after effects - disease and starvation. (United Nations report on *"Disaster prevention and mitigation - a compendium of current knowledge"*, 1976)

2.5.1 Nature and character of floods

Laingsburg floods of January 1981

Laingsburg is located in the arid Karoo 250 km north-east of Cape Town on the main road and rail routes to the interior. The Buffels River overtopped its banks at 10:00 on a Sunday morning and reached its peak eight hours later, during which time it traversed five street blocks. This would normally have been more than enough time to warn and evacuate most of the people in this small community, but nevertheless 104 persons drowned. The Floriskraal Dam 20 km downstream of Laingsburg did not fail despite the water level, which was well

above the non-overspill crest of the dam. A search for evidence of palaeoflood levels downstream of the dam was successful, but these were **lower** than those of the 1981 flood. Elsewhere in South Africa palaeoflood levels are appreciably higher than recent flood levels.

Floods caused by the tropical cyclone Domoina in January 1984

The cyclone crossed the mainland coast near Maputo in Mozambique, followed a curved path and moved out to sea in northern Natal three days later. The path of the cyclone in Natal followed the rivers in a downstream direction, which increased the magnitude of the floods. The loss of life and damage to structures would have been even more severe if the path had been across the more densely populated area further to the south. This was one of the few recorded tropical cyclones to have crossed into South Africa, although a number of previous tropical cyclones approached close enough to cause widespread rainfall and floods.

Natal floods of September 1987

In many catchments these floods were the highest on record, exceeded only by the 1856 floods where this information was available. Not only did these floods cause severe damage and loss of life, they also destroyed the main water pipelines to Durban, where water had to be rationed until repairs were completed.

An encouraging feature was the accuracy of the forecasts issued four days in advance of the rainfall and five days before the occurrence of the floods.

The first warning of the possibility of unusual rainfall over the south-eastern region of South Africa was the British Meteorological Office's Bracknell numerical weather prediction centre forecast issued on Wednesday 23 September, in which it predicted widespread rainfall for the forthcoming Saturday. On Thursday the Weather Bureau (Department of Environment Affairs) issued special warnings of heavy rainfall which were repeated in the days that followed. The heavy rainfall began at midday on Saturday as forecast. A subsequent analysis showed that the forecast positions of the 850-hPa level low pressure over the interior and the Indian Ocean high pressure were remarkably good. The actual rainfall was much higher than the predicted rainfall, however. This was ascribed to an underestimate of the role that the steep topography plays. This rises from sea level to an elevation of more than 3 000 m over a distance of less than 200 km.

Floods over the interior in February 1988

The floods in many catchments in the interior of South Africa were the highest on record. Two large dams failed, but there were no lives lost from this cause. This was because by the time the dams breached the downstream areas and bridges were already under water. These floods occurred five months after the earlier floods in Natal and were followed a month later with further floods. Prolonged seasonal rainfall is a characteristic of severe flood events.

Floods in urban areas

Smaller-scale severe storms have also occurred in urban areas. Details of three of these are given below.

September 1962

Port Elizabeth — *552 mm in four hours*

August 1970

East London — *447 mm in six hours*

January 1978

Pretoria — *245 mm in four hours*

Damage and loss of life were not on the same scale as in the large area floods detailed above, but since then there has been an appreciable increase in residential occupation of flood plains in the major urban areas in South Africa, and a repetition of storms of this magnitude in any major urban area in future could result in a large loss of life.

2.5.2 Vulnerability to floods (population, infrastructure and facilities)

Population

It is estimated that at least 50 000 persons, and possibly more than 100 000 persons, are living along rivers and streams in South Africa below levels reached by previous floods. Most of these live in

unplanned settlements within the jurisdiction of local or regional authorities.

As is the case in many developing countries, there has also been a general migration of the rural poor to urban areas and the surroundings. Often the only vacant land is in flood- prone areas where planned development was prohibited in the past. This is in addition to the many thousands of persons living in planned development which is subject to flooding.

In a recent report issued by the President's Council it was estimated that there would be an influx of an additional 20-million people into the urban areas by the year 2020. This will result in a proportionate increase in the occupation of flood-prone areas.

Damage to structures

Although dams have a much higher potential for causing loss of life and damage, more lives have been lost in South Africa as a result of the structural and functional failure of bridges than as a result of the failure of dams. This is largely because of the more stringent safety requirements for dam construction.

The location of bridge sites is determined more by optimum route location than by optimum foundation conditions, and their higher elevations make them more vulnerable to flood damage when unusually severe floods occur.

There have been an unacceptably high number of failures of bridges owing to floods in recent years, particularly in Natal, but also in the Southern OFS/ Northern Cape region, and in the Southern Karoo. In addition to the direct repair costs, the indirect costs have also been severe.

An even more tragic occurrence was the influence of the bridge over the Buffels River at Laingsburg during the January 1981 floods, when 104 lives were lost in the town. The combination of topography, and the location and design of the bridge resulted in an appreciably higher loss of life and damage to buildings in the town than would otherwise have been the case. Sixteen people were trapped on the bridge itself and lost their lives.

Interruption of communications

Trunk roads are designed for high speed, all-weather transportation which includes heavy haulage vehicles, frequent passenger busses and high densities of private vehicles. The direct and indirect costs of interruption of communication routes owing to floods have increased in proportion to the increased usage.

Interruption of services

Another more recent development is the isolation of communities during floods. Large communities have been cut off from hospitals, health centres and places of work. The present establishment of informal settlement areas in and near cities, and on the flood plains themselves in some instances, is a matter for considerable concern. The socio-political consequences of being unable to reach and assist these communities during severe floods owing to the inundation and destruction of roads and bridges would be grave.

2.5.3 Increase in vulnerability to floods

Despite the increase in experience and knowledge over the years, the risks of loss of lives, damage to structures, interruption of communications, breakdowns in services and general distress to affected persons owing to floods have increased rather than decreased. They will continue to increase as greater numbers of people are exposed to flood risks and as greater utilisation of flood-prone areas occurs.

2.5.4 Short and long-term economic and social consequences of floods

Floods are essentially short-term phenomena which can cause large loss of life and severe economic damage. The rate of economic recovery is relatively short when compared with droughts, but the social consequences may be prolonged.

An analysis of the available information on flood damage over the past 20 years revealed that the average annual flood damage in South Africa amounts to R200 million. Intangible damage such as human suffering caused by social disruption and death can be severe.

2.6 Other meteorological hazards

Mid-latitude storms

Intense mid-latitude storms (extra-tropical cyclones) are often among the major causes of natural disasters in many countries. At sea, gales accompanied by

high waves and high swells disrupt shipping, fishing and offshore operations and also cause damage to coastal regions when the storms move nearer to the land.

For example, the May 1984 storm caused damage to the value of several million Rand over the South-Western Cape. Eleven people drowned near Cape Town during the similar storm on 11 April 1992.

The frequency of intense mid-latitude storms (central pressure less than 980 hPa north of 45° south) with the potential to cause devastation on the south coast is fairly high. In 1991 fifteen of these intense mid-latitude storms were identified. In most cases the country was sufficiently cushioned by a ridge of the subtropical high pressure system so that there was little direct effect over South Africa apart from heavy swells.

However, all these storms posed a serious risk to shipping and especially oil tankers. On average four out of five of these extreme events affect the coastal regions per year.

Tropical cyclones

On average 8,2 tropical cyclones occur per year in the South-West Indian Ocean, of which 2,2 pass through the Mozambique Channel. In the past 35 years only 10 tropical cyclones moved inland over Southern Africa, causing widespread rain and flooding over the Northern and Eastern Transvaal and/or Northern Natal.

About 1,5 million people were left homeless by tropical cyclone Nadia, which swept through Nampula province in northern Mozambique in March, 1994. According to newspaper reports, at least 21 people were killed and 80% of the province's agricultural production was affected.

2.6.1 Severe thunderstorms

Lightning

South Africa has one of the highest lightning densities in the world It is therefore not surprising that deaths and damage caused by lightning are significantly high in South Africa, especially in rural areas where people are burned to death in their thatched dwellings. Also, lightning-initiated bush and forest fires cause millions of rands worth of damage to property, crops and stock. The number of lightning ground strikes is in the order of 10 to 12 strikes/km^2 per year over the south eastern Transvaal and the eastern mountainous areas of Natal. In November and December 1993 alone 17 people died as a direct result of lightning strikes.

Cloudbursts and wind squalls

Cloudbursts and wind squalls are associated with damaging thunderstorms. Sixteen serious events have occurred in Transvaal alone in the past 10 years. Rainfall intensities can exceed 50 mm in half an hour. In the Pretoria storm of 1978 eleven people drowned when 245 mm rain fell in four hours.

Wind gusts associated with thunderstorms can reach 150 km/h and structural damage frequently occurs.

Hail

Hail probably has a greater total economic impact than any other thunderstorm-related event. Over the Highveld region of the Transvaal and the Orange Free State the frequency of hailstorms at a point varies from four to eight days per year The frequency of hailstorms over the Pretoria - Johannesburg - Vereeniging area, the most densely populated and urbanised area in South Africa, averages 65 days per year.

Hailstones measuring 230 mm in circumference fell in Pretoria in November 1949. Every building in the western part of Pretoria suffered some damage. In the same city the hailstorm of November 1985 caused an estimated R180 million worth of damage.

Tornadoes

Tornadoes are characterised by their destructive potential and powerful winds which are frequently accompanied by hailstorms often cause tremendous damage to property and loss of life

In March 1990 a tornado swept through part of the town of Welkom, leaving a 700 to 1 700 m wide swathe of destruction along a 14 km long path, resulting in extensive damage and the loss of two lives. Another two lives were lost and 600 families rendered homeless by a tornado in the township of Maatse in the Orange Free State in April 1994.

Cut-off lows

In a 30-year period, 1952 to 1982, 156 cases of heavy rain over extensive areas of Southern Africa were identified. These cases can, with few exceptions, be ascribed to troughs and cut-off lows. Cut-off lows are the most important flood-producing weather system in South Africa. There are on average 5,2 of these potentially flood-producing weather systems per year over South Africa, of which one will cause damaging floods, mainly over the southern and eastern coastal regions.

2.7 Geological hazards

2.7.1 Sinkholes

Sinkholes occur in dolomitic areas, particularly in areas where mining activity has resulted in a lowering of the water table. The stability of the large solution cavities is reduced where these are near the ground surface. Subsequent rainfall or concentration of surface runoff often results in the collapse of the material forming the roofs of these cavities. The development of sinkholes in these areas has caused occasional loss of life and destruction of property

There is a high risk of sinkhole formation in some dolomitic areas where the deliberate lowering of the water table has taken place to reduce the costs of mining. In these areas the affected properties have been bought out and development is severely restricted. In other dolomitic areas where geophysical surveys have indicated the presence of potential sinkholes the local authorities have placed restrictions on residential development. Some of these undeveloped areas have recently been occupied by informal settlement communities. This has exposed them to additional hazards.

2.7.2 Landslides

Landslides in South Africa are associated with prolonged heavy rainfall and not seismic activity, which causes landslides in some other countries.

A national disaster associated with a landslide occurred on 22 February 1994 in the town of Virginia in the Orange Free State and as a result the muddy contents of a mine tailings dam swept through the suburb of Merriespruit. Fourteen people lost their lives under the mud. Some 350 persons were taken to hospital. The structural damage alone is initially estimated at approximately R50 million.

2.8 Wild-fires

Wild-fires frequently occur in the well vegetated regions of South Africa from August to October and during prolonged dry periods. The forestry and agricultural industries are highly vulnerable to these fires.

Wild-fires caused severe damage to commercial forests and pasture towards the end of the 1991/92 drought. Fires broke out throughout the year, at least eight of which could be classified as devastating.