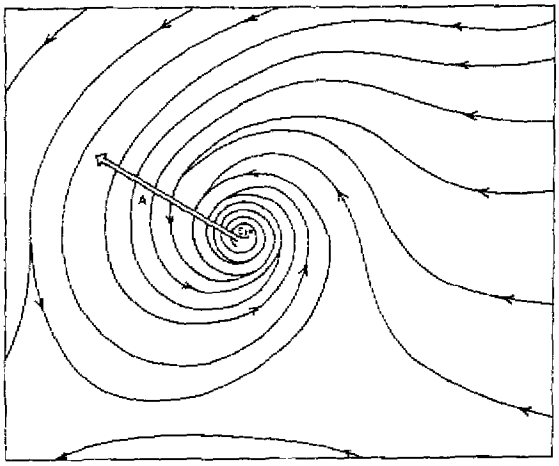

Figure 4 — The surface wind direction and the eye in a northern hemisphere tropical cyclone. The direction of the motion of the cyclone is also shown, by an arrow (A). In the southern hemisphere the wind blows in a clockwise direction.

be expected to be followed by periods with increased numbers of cyclones and seasonal forecasts are being issued on a regional basis in the western hemisphere. However, trends in the frequency of occurrence, tracks and intensity of tropical cyclones have not been definitively identified.

Detection, monitoring, forecasting and warning

Effective early warnings are major factors in tropical cyclone disaster preparedness. Establishment of warning services worldwide is a realistic goal. Indeed, there is now a warning service covering all areas directly affected by tropical cyclones. The responsibility for provision of the warning service for each country and its coastal waters rests in principle with the national Meteorological Service of that country. In a relatively small number of instances where the national service is not able to meet these responsibilities, then by agreement warnings are provided by another Meteorological Service in the region. Primary responsibility for warnings for those on the high seas and for civil aviation is selected by Meteorological Services, each for a specified area until complete coverage has been achieved.

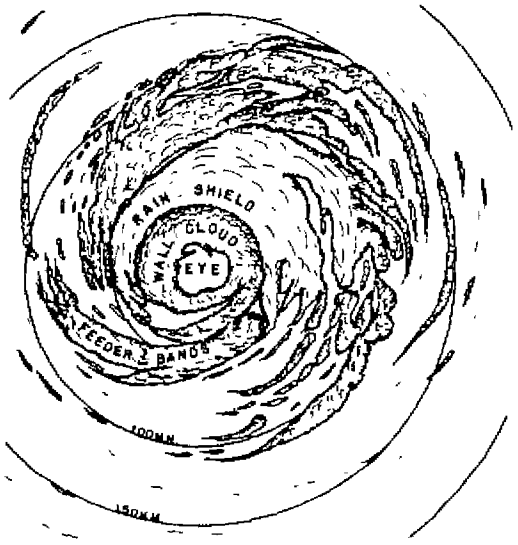

Figure 5 — Schematic diagram of the cloud structure of a northern hemisphere tropical cyclone — looking down from above and as it would appear on a radar picture.

Because of the complexity of atmospheric processes, lack of complete scientific knowledge of the structure, dynamics and behaviour of cyclones or inadequacies in the data available in real time, there are obviously limitations in the forecasting of cyclones. These shortcomings lead to a level of uncertainty in the forecast and the need for a degree of over-warning, which usually increases when a longer warning lead time is to be provided.

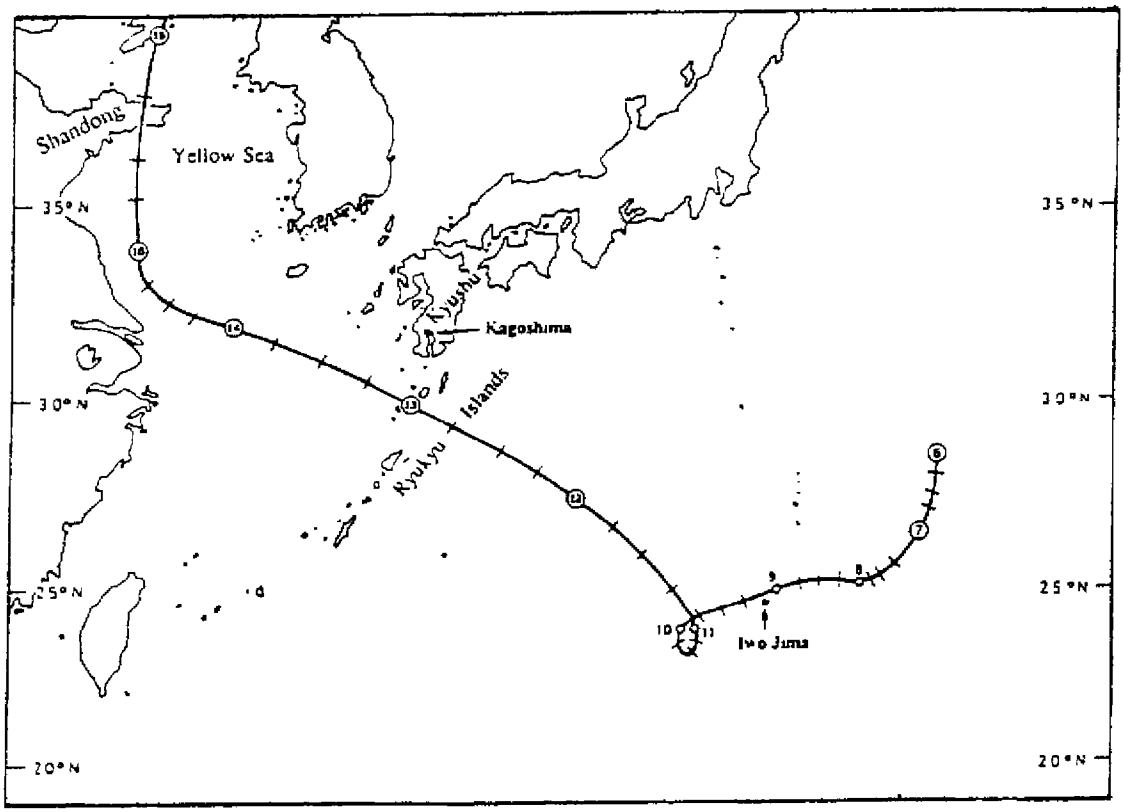

Figure 6 — Tracks of two tropical cyclones showing erratic motion (numbers are dates, starting from formation on 16 and 18 August 1986).

Nevertheless, there will always be users who could benefit from more lead time than is currently given. Thus there will be a continuing value in further improving even the state-of-the-art forecasting and warning systems. The requirement for increased facilities and application of modern technology is strongest in those countries where most deaths from cyclones occur.

The progress already made must be kept in mind. To take an extreme case, it has been reported that early this century hurricane warnings were displayed along the US coast from Charleston, South Carolina to Brownsville, Texas for a hurricane that eventually made landfall in Bermuda. Today the average error in the 24-hour forecast position is of the order of 200 kilometres. With the advent of meteorological satellites and their present complete coverage of tropical ocean areas, cyclones no longer go undetected and all are regularly monitored. The statistics indicate a death toll decreasing with time, despite population increases in vulnerable areas (see Figure 9). This can be attributed in large part to the improvements in warnings and response to warnings. At the same time, both the damage statistics, and certainly the amount and value of property at risk, have been rising, in some places at alarming rates (see Sheets, 1994). It is a complex and difficult task to estimate the reduction in damage attributable to response to warnings. However, the damage caused by tropical cyclones is now certainly much less than it would be without the combined warnings, response to warnings and preventive measures.

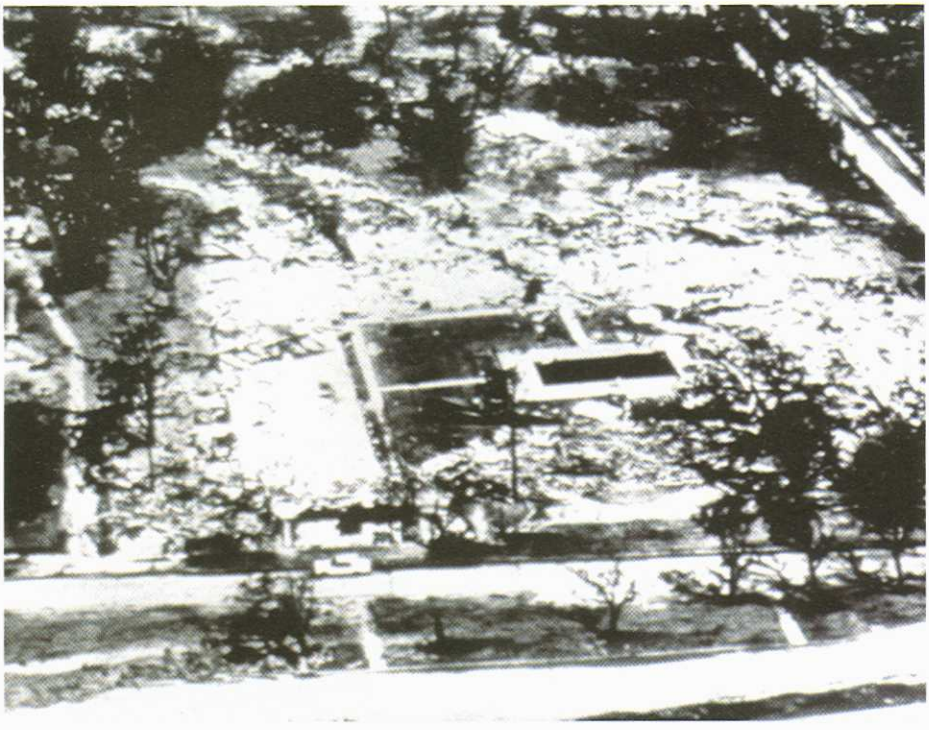

Figure 7(a) — Demolition of a building by a storm tide: Twenty-five people decided to ignore the warnings and have a "hurricane party" in this apartment building...

Various activities of national Meteorological Services are coordinated by WMO. Forecasts and warnings are prepared within the framework of WMO's World Weather Watch programme (WWW). Under this programme, meteorological observational data provided nationally, data from satellites, and products provided by designated centres are exchanged around the globe. In the past decade or two, regional cooperation and coordination have contributed to the upgrading of tropical cyclone warning services, with specialised products being provided by centres designated under the WWW and the associated Tropical Cyclone Programme. The flow of data and products is illustrated in Figure 10. Progress is also being made in other activities, such as training of personnel, transfer of technology and installation of modern facilities.

Reduction of tropical cyclone disasters

Overview

The main components of a comprehensive and integrated approach to reducing tropical cyclone disasters are generally considered to be:

(a) Risk assessment, including hazard and vulnerability evaluations;
(b) Disaster prevention, both structural and non-structural measures; and
(c) Disaster preparedness, including emergency planning and response to warnings, with actions taken in an interrelated and coordinated manner.

Figure 7(b) — ...the next day, following a hurricane and storm tide, 23 of them were dead.

Tropical cyclone disaster reduction in tourist areas relates not only to tourists but also to the country's and local area's social and economic development and its sustainability, as well as to its environment. Many of the basic disaster reduction activities are taken at national and local levels.

The tourism industry should cooperate and participate in such activities. Particular attention should be given to disaster prevention (e.g. in tourist accommodation construction and awareness programmes for tourists) and in preparedness planning (such as training of personnel, dissemination of warnings, response to warnings and testing of plans).

In many developing countries funds are limited and decisions are based on the relative priorities of the many requirements. In practical terms disaster reduction often does not obtain a sufficiently high priority; hence it does not command the needed resources. This is because the benefits, although substantial, will only be derived in the future, at some uncertain date. Disaster reduction is compared, to its disadvantage, with other needs which promise immediate and often quantifiable benefits. In such cases the tourism industry should use its influence to promote greater recognition of the importance of disaster reduction, and of the need to accord it a higher priority, for the good of local communities and the industry. Special emphasis should be placed on meeting the requirements for provision of risk evaluation, upgrading the tropical cyclone warning services and obtaining the full benefits of response to warnings.

Figure 8 — Damage to dwellings and domestic plantation by a severe tropical cyclone. (Photo: J. S. Tyndale-Biscoe)

The main concerns for tourism are protecting tourists, avoiding loss of life, and safeguarding tourism plant and infrastructures. Generally, protection of infrastructures is a national responsibility but it should still be of concern to the industry.

Hazard, vulnerability and risk evaluation

Risk evaluation should be the first step in cyclone disaster reduction. The occurrence of a tropical cyclone represents a hazard but does not by itself cause a disaster for tourism. Tourism development is a necessary prerequisite. The impact of the cyclone and its consequences depends on the vulnerability of the location. The combination of assessments of both the cyclone hazard and locational vulnerability leads to risk evaluation, which is ideally displayed on risk maps (details are given in Plate [1994] and UNDRO [1991]).

Risk evaluation should take all risks into account and should, for example, involve combined analyses of storm surge and river flood. Risk evaluations often serve as the bases for assessing the consequences in monetary terms or in terms of potential loss of life, consideration of the options that are available, and hence decisions on disaster reduction actions.

Risk evaluation can play an important role not only as a basis for decisions on disaster prevention and preparedness actions by tourism interests, but also for economic and physical planning and in the equitable design of insurance schemes.

Provision of risk evaluation should, it is contended, be the responsibility of the local authorities and involve interdisciplinary input, including information from tourism planners on present and planned tourism plant and tourist populations. Risk evaluations should be updated as more data become available. Where they are not yet available, the tourism industry should press for the evaluations to be made. In the meantime, decisions on disaster reduction should still be made — actions based on qualitative assessments are better

TABLE 1
The Saffir Simpson hurricane intensity scale*

One	Winds 74-95 m.p.h. (64-83 kts, 119-153 km h^{-1}, 33-42 ms^{-1}) No real damage to building structures; damage primarily to unanchored mobile homes, shrubbery and trees.
Two	Winds 96-110 m.p.h. (84-96 kts, 154-177 km h^{-1}, 43-49 ms^{-1}) Some roofing, door and window damage to buildings; considerable damage to vegetation, exposed mobile homes and piers. Small craft in unprotected anchorages break moorings.
Three	Winds 111-130 m.p.h.(97-113 kts, 178-209 km h^{-1}, 50-58 ms^{-1}) Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures; mobile homes are destroyed.
Four	Winds 131-155 m.p.h.(114-135 kts, 210-249 km h^{-1}, 59-69 ms^{-1}) More extensive curtainwall failures with some complete roof structure failure on small residences.
Five	Winds greater than 155 m.p.h. (135 kts, 249 km h^{-1}, 69 ms^{-1}) Complete roof failure on many residences and industrial buildings; some complete building failures with small utility buildings blown over or away.

* based on the hurricane's present intensity

than no action at all. Actions may be taken on the basis of hazard assessments derived from long-term meteorological records obtained from the national and other Meteorological Services and available vulnerability data, or at least by taking stock of past experiences of the impacts and consequences of cyclones.

Disaster prevention

The term tropical cyclone disaster prevention is used in practice to describe activities designed to provide protection from the impact of cyclones. These include structural measures — engineering and other physical protective measures for reducing vulnerability of sites — and non-structural measures such as legislation and codes on land use, urban planning and building. It refers to actions that may be taken well in advance of the occurrence of the cyclone and usually also includes public awareness and disaster insurance (see ESCAP/WMO/LRCS, (1977).

Structural measures. The construction or establishment of tourism plants, including tourist accommodation, should be based on risk assessments and touristic appeal. These may be conflicting factors, a commonly encountered example being the attraction of tourists to beaches, some of which may be areas where occurrence of storm tides is likely. The hazard assessment should estimate the probability of occurrence of tropical cyclones and their recurrence intervals, that is the average time interval between occur-

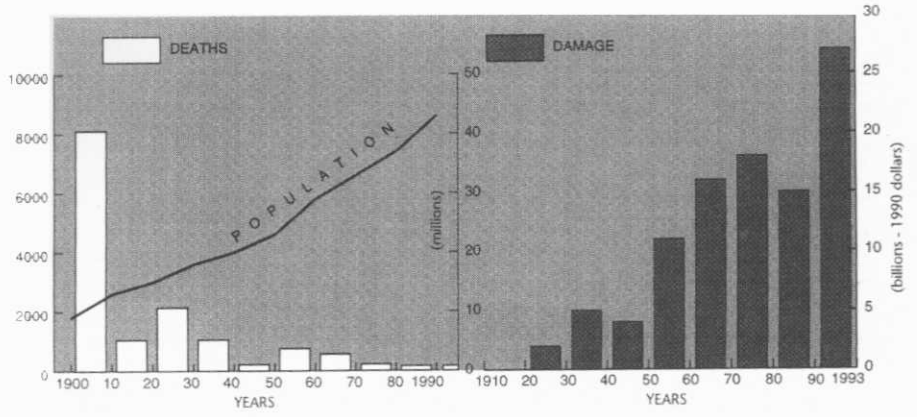

Figure 9 (a) — Decreasing death toll due to hurricanes in the United States...

Figure 9 (b) — ...despite increasing population in hurricane-prone areas such as Florida's coastal counties.

rences, of the parameters (winds, storm tides, etc.) of specified strengths. The risk evaluation takes into account the consequences if the event should occur. These should be factors in taking decisions on location of installations and the design of constructions, including buildings and physical protective barriers. The latter may vary widely, from sea walls and windbreaks to building shutters. Thus, in broad terms, design criteria should be based on the recurrence intervals expected, and should be largely influenced by a reasoned judgment balancing the risk of loss of life and property and the investment required. Risk evaluation is also useful for making decisions on effecting disaster insurance.

As long as the arguments in favour of tourist activity in a vulnerable area are stronger than the arguments against it, tourism development is likely to take place. Disaster reduction must therefore seek to apply technical solutions through structural measures, within the limits of economic viability. Generally, as the protection from risk is increased so is the cost, but safety of people must also be considered. Implicitly, a degree of risk has to be accepted. This may be larger than desirable if the costs are very high. Alternatively, or more usually as additional actions, disaster preparedness must be increased, with the main emphasis on saving lives rather than property.

Non-structural measures. National authorities should have the responsibility for enacting legislation or making regulations on land use, urban planning and construction as well as promulgating building codes. Full compliance by the tourism industry is strongly advocated. It is in the long-term interest of the industry itself as well as of the community. In the absence of such legislation and codes, rational decisions on tourism planning should prevail and developments in risk areas should be preceded by careful study and planning, and accompanied by appropriate prevention and preparedness measures. The authorities and the tourism industry itself must be concerned about individual developers who seek to make a quick profit without regard to long-