INTERDISCIPLINARY DISASTER RESEARCH

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Disaster research is asking scientific questions about Acts of God. During the last ten years efforts have been made to understand the causes of natural and man-made disasters, to determine how people are affected, and how material and mental relief can aid recovery. Such research as has so far been carried out in isolation, has followed the old academic tradition of investigating separate disciplinary problems. Yet to come, and urgently needed, is the interdisciplinary investigation of disasters, where for example seismologists, social scientists and civil engineers work together as a team to study earthquakes in general and together make an in-depth hindsight review of a particular seismological event. This paper will attempt to point the way to more interdisciplinary disaster research.

DEFINITIONS OF DISASTER

Asking scientific questions about Acts of God is hardly an adequate definition of the subject. I have defined interdisciplinary work elsewhere as originating from the joint and continuously integrated effort of two or more specialists of different disciplinary background and training. Research is easy to define and it appears as: "a course of critical or scientific inquiry" in the Shorter Oxford English Dictionary, Third Edition, 1977. It is only when we come to Disasters that our difficulties begin as there is no agreed definition, nor is there a scale of magnitude. In a previous paper I gave on this subject (Disasters Past and Future, 1972) I suggested the following definitions :

ACCIDENTS	1 - 1000 people dead or in immediate danger of death.
DISASTERS	1000 - 1 million people dead or in immediate danger of death.
CATASTROPHES	More than 1 million people dead or in immediate danger of death.

These definitions are by no means adequate. Consider for example the destruction of the City of Darwin by Cyclone Tracy in December 1974. Only 65 people died and there was no imminent danger of death to the population of 45,000; this danger would only have occurred if a lethal epidemic had broken out. Yet it was undoubtedly a real disaster in terms of the total destruction of a city and the suffering it caused to its inhabitants.

Harold D. Foster of the University of Victoria, BC, has so far given the most comprehensive definition of disasters and their magnitude. (Professional Geographer 28, No 3, 241, 1976). His scale is built around a social stress rating, derived from an individual's loss, or change subsequent to being involved in a disaster. He derived a number of formulae, allowing for the differences between developed and under-developed countries, to arrive at the total stress caused during a disaster. The terms in his formulae included the number of fatalities, of seriously injured, the stress values and the number of the total population affected. He derived a logarithmic magnitude scale for a number of famous disaster events, for example: Black Hole of Calcutta of 1756, magnitude 5.0; Titanic sunk 1912, magnitude 6.1; World War I, 10.5; World War II, 11.1; Atomic Bomb, Hiroshima 1945, 8.2; Earthquake, Managua 1972, 7.9; Cyclone Tracy, Darwin 1974, 6.6. These magnitudes on Foster's logarithmic scale, as derived from his formulae, are directly correlated with the total number of stress units, in the hundreds of millions.

I am not aware that the Foster scale of disasters has found universal acceptance as it neglects the difficult-to-assess damage to structures and environment. Yet a universal scale of disaster magnitude would be most valuable both for researchers in this field and for those in charge of relief operations. It might well become as universal as the logarithmic Richter scale for earthquakes.

In this paper, having inadequately defined disasters, I shall attempt to review such systematic disaster research as has occurred and mention some of the results. Again this can by no means be definitive and can only point others in the right direction. After that I want to talk about two types of natural disasters, before coming to man-made disasters and what I would call nuclear accidents. Finally I shall arrive at some conclusions about disaster research by suggesting the need for an International Disaster Research Laboratory.

WHY NO RESEARCH

Disasters, both natural and man-made, are unpredictable but inevitable. We might now know where they could occur but

not when. Each disaster appears to differ from its predecessor, and hence a lack of incentive to carry out research may appear understandable. And who is to fund such research? There is no industrial and profitable infrastructure to encourage it, nor are the academic and scientific communities keen to consider disaster research a subject of pure knowledge, worthy of investigation per se. Would insurance companies not make larger profits if they had to pay smaller indemnities to those who had applied the results of disaster research? For example, adherence to building codes for earthquake-proof buildings is rewarded by lower insurance premiums in California.

Another reason for the lack of disaster research is the impossibility of creating artificial disasters for experimental purposes. Yet model experiments are undertaken routinely where macro-engineering projects are involved. For example, elaborate hydrodynamic flow tests were carried out before the Thames Barrage was built. Mathematical computer models should prove of great value in disaster research, but so far few have apparently been carried out and reported in the literature. Other scientific disciplines are also difficult to study by experiment, as for instance astronomy. Yet great knowledge of the planets and the stars has been obtained by observation, hypothesis, and renewed observation, refining the instruments for each successive examination.

INTERNATIONAL LABORATORY

There appears to be no theoretical reason why an International Disaster Research Laboratory should not be set up and supported by rich insurance companies. There interdisciplinary research on earthquakes, floods, fires, volcanic eruptions, tsunamis, drought, hurricanes, frost and other meteorological phenomena, landslides and erosion, could be studied in depth by all the many scientific disciplines which must contribute to progress in this field. I shall outline a research programme for such a laboratory a little later on.

INTERDISCIPLINARY PLANNING

Pre-disaster planning is so far the best example of interdisciplinary work in this field, and a considerable literature on disaster planning has accumulated. Advanced Planning for Disaster Relief (Pergamon 1979) a small book by Barbara J. Brown, was a detailed project undertaken for the United Nations Institute for Training and Research, UNITAR. It contained much sound advice for planning before disaster

strikes, particularly for the Third World and also for Donor Countries. For the richer and more developed disaster-prone areas in the US and in Canada Professor H.D. Foster of the University of Victoria, BC, has contributed an excellent research effort in his book Disaster Planning, The Preservation of Life and Property (Springer Verlag, 1980). Each of his chapters contains extensive lists of references and the work is highly recommended to all concerned with pre-planning, be it safer design of structures, the prediction and prevention of disasters, and disaster warning systems. Both Brown and Foster have done much research for their surveys. If their advice were only half followed, innumerable lives would be saved in the next disaster. At present, on an average, there are each year 250,000 deaths and $ 15 thousand million damage due to disasters.

INTERDISCIPLINARY SOCIAL SCIENCES

A very wide-ranging, large-scale survey of natural disasters, in their interdisciplinary relation to human populations and demography, was begun in 1981, and still continues, by J.F. Coates Inc., a consulting firm in Washington; they received a grant from the National Science Foundation for this work. A massive literature search of the social sciences in relation to disasters accompanied the survey; it can only briefly be summarised here. A total of 17 hazards was considered, ranging from earthquakes to bush fires, from tsunamis to drought and snow avalanches. It was found that Disaster Research at various levels was now being carried out at Ohio State, Clark, Toronto, Chicago and Colorado Universities. The well-known newsletter, Unscheduled Events, founded in 1963, will in future be published by the Research Committee on Disasters; other publications in this field include the International Journal of Mass Emergencies, the Hazard Monthly, in its third year in 1981 and the Natural Hazard Observer then in its seventh year.

Coates found that overall migration of the US population affected the likely future of disasters. With people moving into the Sunbelt of Texas, California and Florida, well known high hazard areas, future disasters may have much higher mortality figures. On the other hand, deaths from snow, lightning, frost and tornadoes in the North Central States would diminish, simply because people had moved away from these areas.

In more general terms, Coates stated that man ignores, forgets and discounts hazards from natural disasters. Without any real experience of them, the risks from hurricanes and earthquakes seem uncertain, indefinite and even unlikely. Compared to our many other pressing concerns, of immediate

attention demand, natural hazards receive low priority.

Coates and his team of researchers maintained that, at least in the US, people did not panic after a disaster and that looting was only a minor problem, although such behaviour was widely believed to occur. Rich and poor had widely different reactions to disasters and saved themselves in totally opposite manner. People always converged on disaster sites, either to watch or to help, and hindering rescue workers. Most disasters have no long term effects, either social or economic, on communities; elderly people do not always agree to be evacuated, and if they remain, they can have a major effect on the morale of disaster victims. Coates pleaded for three kinds of social science research on natural disasters: long-term studies, lasting years and decades, of the same topic and of the same region; more-cross-cultural and international studies, and particularly a vastly increased amount of field research after disasters.

INTERDISCIPLINARY TECHNOLOGY

If the Coates Survey confined itself to the interdisciplinary aspects of human behaviour before and after disasters, then another Washington investigation in March 1977 considered The Role of Technology in International Disaster Assistance from an equally broad and interdisciplinary point of view. This workshop created by the US National Academy of Sciences, which also published its Proceedings, underlined the fact that no technology related to disasters is an economically profitable field, and if it is funded, then only erratically, if at all. It is well known that, whatever the disaster, any rescue equipment brought to the scene is of standard manufacture and must be adapted at the site to the special needs of the occasion. Some of the conclusions and recommendations of the workshop may not be well enough known and should be repeated here.

For immediate disaster rescue, heavy gear is essential, be it helicopters, boats or simply gin poles to lift heavy rubble, or parts of destroyed buildings. In pre-planning operations for disaster-prone areas, it should be borne in mind that military surplus is ideal, as it can be bought at a fraction of the normal cost from commercial sources. Care and maintenance of tractors, assault boats, power-shovels and other items so acquired, can be arranged with nearby military establishments. Training in its use should have top priority for the community, as after a disaster there will always be unaffected volunteers anxious to help. Furthermore, official aid can thus be saved for major aspects of rescue.

Many other ingenious adaptations of readily available goods were suggested; for example large plastic garbage bags can give an instant shelter for people to protect them from wind and rain. Torches, and audible distress signals can be distributed or airdropped before or during floods, and particularly valuable are small radio receivers; these proved essential during the Darwin disaster.

DISASTER COMMUNICATIONS

Communication equipment puts control into the hands of the decision makers. General Alan Stretton's The Furious Days (Collins, Sydney 1976) should be read by any disaster planner as it is the best available account of dealing with a disaster situation - the case of Darwin destroyed by cyclone in 1974 - that has yet to come to my notice. Over 3,000 radio receivers were air-lifted into Darwin and proved vital to keep up morale; Stretton broadcast regularly twice daily after their arrival. Equally important are communicative facilities for the press and the media, who will inevitably flock to the site of any disaster; nothing can be more frustrating for the press than to be unable to transmit their reports back to their home base. During large scale disasters, foreign Governments and International Aid Organisations often send aid for prestige purposes, and their prestige as well as further aid will vanish if media reports do not describe in glowing terms what their help has achieved.

SATELLITES

If satellite systems are available they will of course be most valuable for international traffic. The plan much discussed by the International Telecommunication Union, the United Nations Agency responsible for all telecommunications, to have small portable antennae for underdeveloped countries for disaster communications via satellites, has apparently not yet been used. A booklet on this subject, entitled Space Radiocommunications System for Aid Following Disasters was published by the I T U in 1975.

The first Satellite for Emergencies, SAFE, was proposed by H S Wolff in September 1964. From a hand-held and hand-cranked transponder an interrogation signal from a satellite in polar orbit would be re-transmitted to a ground station. This would give knowledge of the existence of an emergency, and if two such satellites were available, also its location. In his pioneering publication on the subject, Wolff called it a "Technologically feasible pipe dream".

NASA's first Applications Technology Satellite, ATS-1, launched in 1966, transmitted 800 to 900 emergency medical calls per year during its 10 year life, linking doctors with remote villages. A natural technological development from "Flying Doctor" to "Space Doctor"!

One of the first uses of satellite communications during a disaster occurred in July 1977 when Johnstown, Pennsylvania, was flooded. A portable 4-foot (1.2m) antenna was set up at a local school and allowed Red Cross officials to communicate with their headquarters in Washington; the satellite used was NASA's Communications Technology Satellite, CTS, launched in January 1976 into a synchronous orbit and stationed just west of South America over the equator.

Today there are many communication systems available in developed countries and some even in less fortunate areas, be they troposcatter links, cable systems when telephones have been restored, microwave radio, VHF and UHF frequency modulated radio. Small portable intercom-radio equipment will allow those in charge of operations to keep in constant touch with headquarters. All communication in a disaster area should be tied together to establish a total emergency communication system.

But to return to the Washington Workshop on Disaster Technology and one of its final recommendations when considering Search and Rescue: after a disaster, a physical point of orientation is a vital necessity for people who have lost their normal orientation, for receiving of services and advice, for them to be counted and identified, for collecting families and possessions, and as a staging point. This would be necessary for any evacuation, as was the case in the Darwin disaster when in five days 25,000 people were airlifted to the Southern Capitals of Australia.

DISASTER RESEARCH HISTORY

Disaster research, often highly interdisciplinary, has of course also been carried out in other countries, although I am only aware of such work in England and in Australia. It was undoubtedly stimulated, if not started, by one of the greatest disasters in modern history, the cyclone and tidal waves in East Pakistan during November 1970. It was also the worst example of disaster relief. An estimated 500,000 people died as a direct consequence of the event, but had the relief been organised and co-ordinated, thousands would have been spared. The Archdeacon of Westminster, the Venerable Edward Carpenter voiced the thoughts of many who had followed the incredible bungling, the corruption and delays, the deficiencies and scandals, which attended the events in East Pakistan: "The feeling of guilt of the affluent West that in our highly technological age, capable of putting a man on the Moon, forces, so age-old and elemental, could bring about such a disaster". Yet, 14 years later, it appears that half a million Pakistanis did not die in vain.

Two years after Pakistan, in October 1972, the Royal Army Medical Corps held Exercise Helping Hand in Hampshire, England, to which representatives of all the Army Medical Corps of the West had been invited to consider in what manner their Medical Corps might contribute to disaster relief, more efficiently and more cost-effectively, than had been the case in East Pakistan. I was greatly honoured on that occasion by an invitation to give the key-note address Disasters Past and Future in which I pleaded for the establishment of an International Rescue Organisation - it still does not exist.

A few months earlier, in March 1972, the United Nations set up in Geneva an Office for its Disaster Relief Coordinator, generally referred to as UNDRO. It has a communication room

in the United Nations in Geneva with telephones and telexes. The funds allocated to fulfil its true function of co-ordination have been woefully inadequate and its own review report in 1980 was generally considered a disaster itself. (London Times, 11 November 1980).

It was also in 1972, though probably not as a consequence of the Pakistan disaster, that the Civil Defence Directorate of the Commonwealth of Australia was relocated and that its function changed from Civil Defence to Counter-Disaster activities; these activities were formalised on 1 January 1975 and the College received its present name, the Australian Counter Disaster College on 1 January 1978.

Perhaps more directly traceable to the Pakistan disaster is the British Disaster Unit set up in 1974 as part of the Ministry of Overseas Development. Regrettably, like UNDRO, the funds and organisation at its disposal are quite insufficient to make a major impact on relief, although small sums are regularly dispatched to overseas governments when disasters occur.

In England it was the Disaster Research Unit of the University of Bradford which started in December 1973 in order to increase awareness of pre-disaster planning, including research on precautions to be taken before the event. Their team went to the Bahama Islands for field research to study pre-planning and, after two years' existence in 1975 seven occasional papers had been published. Parallel to the Bradford Group, the London Technical Group started work in 1972 on disaster research as a direct consequence of the Pakistan cyclone and in 1978, the International Disaster Institute developed from the London Group. It had extreme financial difficulties in starting its work, as it was attacked by the voluntary disaster relief agencies who feared that some of their work might be critically analysed. The prime aim of the Institute is to make disaster relief more effective through research.

An outstanding example was their investigation of the effectiveness of large scale vaccination in developing countries following a breakdown of normal life after a disaster. In the past it had never proved possible to vaccinate a complete population at risk, and if a small proportion only can be vaccinated at random, the epidemic cannot be contained. Much better, LTG concluded, to conserve the available supply, watch for outbreaks, then vaccinate and thus contain the epidemic; this of course depends on local conditions and the particular disease. Similarly the distribution of vitamin supplements was found to be a waste, as deficiency diseases appear only after long periods of deprivation.

END OF METHODOLOGY

So far I have reviewed what might be called the methodology of disaster research, I have pointed to the inadequacy of

interdisciplinary research and the preponderance of pre-disaster planning advice. The need for an International Disaster Research Laboratory appears to me overwhelming. And this is particularly so as disasters are on the increase world wide. The reasons are not only the population explosion in the underdeveloped countries, but also the steady movement of populations into cities, increasing living standard and hence greater loss during a disaster, and in the last decade the location of industries in disaster areas. For example off-shore oil platforms in the North Sea, exposed to the dreaded winter storms, and in the Gulf of Mexico, exposed to cyclones; also the erection of high-rise hotels along hurricane exposed coasts.

Similarly it appears that after the relative quiet of 1950-1980, earthquakes are again becoming more frequent; however, there is a lack of historical research, only in China and in Italy are records available extending over 2,000 years. We need to know the 'repetition period', the 10, 100, 1000 year event, as present accurate knowledge extends at most over a 30-50 year period.

HISTORICAL EARTHQUAKES

I would now like to turn to a more detailed consideration of earthquakes. Here there is one splendid example of historical disaster research, the in-depth hindsight review which is so much needed for all types of disasters. It was Professor N.N. Ambraseys of Imperial College, London, who made a profound study of the history of earthquakes and reported some of his results in 1976 (UNESCO Courier vol. 29, May p. 24). Using all possible human documentation during the last 2,000 years, he found for example that after the earthquake in 25AD which destroyed the town of Taxila in Northern Pakistan, stronger houses were built with special foundations, going down to as much as 5m. Elsewhere, builders learnt after destructive earthquakes to reduce the heights of new houses from three and four stories to only one or two. Grids of wooden beams were also used to strengthen foundations.

On a more historical basis, he found that areas free from earthquakes at present were previously the centres of such events, and conversely. He also found that single large earthquakes during the last 25 centuries had little or no effect on a stable and developed community. Personal, political, religious and particularly economic interests seemed to over-shadow the lessons to be learnt from earthquakes. As an example, Ambraseys mentioned Antiochia in Turkey: in 115 AD, the city was almost totally destroyed but was rebuilt on the same site, to be destroyed again in 458 AD, but was again rebuilt on the same spot. A generation later a further earthquake led to the death of 200,000 lives, yet the city was once again rebuilt in the same place, finally to be destroyed in 540 AD by the Persians. However, should the affected community be poor and politically unstable, earthquakes may bring about great social

changes, such as population movements, emigration and conquests by enemies.
Earthquake prediction also has a venerable history, Ambraseys discovered; soothsayers, astrologers and various prophets all tried their hand. There was for example the Cadi (judge) in Eastern Persia who in 1549 predicted an earthquake in his city. In vain did he try to persuade his friends to spend the night in the open, away from their houses. His pleading was fruitless and for a time he was alone in the open during the bitterly cold night. Eventually, not being too sure of his own prediction, he returned to his house, only to be engulfed together with the 3,000 people who perished in the earthquake.

PREDICTIONS AND PATTERNS

After more than 500 years and in spite of some recent scientific research we are still quite unable to predict earthquakes. A Panel on Earthquake prediction set up by the US National Academy of Sciences, Washington DC, concluded in 1976 that "imminent routine prediction of earthquakes is not warranted". A program of reliable, routine prediction may be 10 or more years away, and even then there might be "unavoidable errors and false alarms". Even the Chinese claims for earthquake prediction cannot be fully accepted on a strictly scientific basis and much further research will be required.

Earthquakes appear to follow certain patterns, but so far their analysis has hardly yet begun. Charles Richter who in 1932 originated the Richter Scale of earthquake magnitudes, gave in 1976, a year of great tectonic activity an outline of earthquake patterns. From 1896, when the first accurate measurements were made, to 1906 there was high activity, with 1906 being particularly notable with five earthquakes of magnitude 8, including of course the San Francisco event. In the following years there were on average only one or two events a year of such magnitude, until 1950, when there was again great activity. From 1953 to 1964 there was again a respite, until the great earthquake in 1964 in Alaska. After further years of relative absence, the year 1976 was once again one of great activity with major earthquakes in Mexico, Iceland, Italy and Turkey, China, Bali and Japan, the Philippines and New Guinea. Correlations of these patterns with other geophysical and possibly astronomical events presents a great challenge to disaster research, which may only now be possible by powerful computers.

NAPLES EARTHQUAKE

Let us now turn to a recent earthquake, the one that hit Southern Italy on 23 November 1980 which exemplified the worst possible human behaviour. It struck not far from Naples one of the poorest districts of the country, a mountainous, isolated region where peasants obtained a meagre living from olive trees and a few cattle. The number of dead has never been officially stated, the figures ranged

from 4,000 to 5,000. Like all disaster victims, the local peasants were stricken with terror and at first quite unable to help themselves. It was at that stage that all outside aid was lacking and for four days after the earthquake, hardly any constructive help reached them, except the criminal elements to exploit the situation. Contemporary newspaper accounts (London Times and Frankfurter Allgemeine Zeitung) were full of ghastly stories which one cannot dismiss. Amongst the bus loads of sightseers, eager to photograph the events, were smart cars with well-dressed persons. They did not come for pictures, but left with babies and young children, perhaps only stolen for themselves, but likely to be sold for adoption. Others were satisfied with simply stealing relief goods and selling them on the black market, a type of behaviour not unknown after most disasters in developing countries. There is a saying in Turkey that each earthquake makes one millionaire, the bad ones several.

In Italy, in November 1980, there was a total lack of command structure, locally as well as from central Government in Rome. In fact the disaster had severe political repercussions, as politicians accused each other of mismanagement and corruption leading to resignations. Worst was the opposition to evacuation of the most seriously damaged towns, as local politicians feared that this would lead to the loss of their electorate at the next election. Undoubtedly, as in all disasters, there must have been many acts of heroism and utterly unselfish behaviour; so for example a group of German volunteers with their specially trained dogs flew to the area and the dogs discovered at least some victims under the rubble. It was also reported that 13,000 soldiers were brought to the disaster area, but as they only carried their rifles and had no picks or shovels, they only added to the need for food, housing and transport which should have been reserved for the disaster victims. And all this in spite of strict laws which had been passed by the Italian parliament a few years previously to set up a Disaster Relief and Command Organisation; the laws were simply not implemented.

INSURANCE

Finally a word about earthquake insurance. If there was to be a repeat in Japan of the Kanto earthquake of 1 September 1923 with 143,000 dead, the present total damage would amount to $\$250 \times 10^9$. This has led to a country-wide Japanese insurance scheme but covering only 30 per cent of damage. It is therefore only a minimal help to start rebuilding. However, the Chemical industry can only be insured for 15 per cent. Similar calculations for damage of San Francisco and Los Angeles reach for each city the sums of $\$50 \times 10^9$; Insurance against earthquakes, however, is hardly more than 10 per cent. There are far too few instances of insurance companies demanding earthquake-proof constructions to decrease their premiums.