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Conference Report

Geohazards: natural and man-made

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Report of a meeting of the Joint Association for Geologists in Development Specialist Group in association with the Joint Association for Geophysics and the Engineering Specialist Groups of the Society, at Burlington House, 18 October 1989. The convenor was G. J. H. McCall.

This meeting was designed to present accounts of a wide variety of Earth science related hazards, both natural and man-made. The theme was particularly topical in view of the commencement of the UN International Decade for Natural Disaster Reduction in 1990. The fact that the San Francisco Earthquake occurred on the night before the meeting added to the topicality of the theme to no small degree! The programme was designed to bring together a number of experts, drawn from both the geological and other related fields such as soil science and geophysics, to cover the scientific investigation of the nature of various hazards and the response to such hazards, both after the event and in the form of prior planning to mitigate the effects of likely future events. The meeting was targeted on the Third World Countries, the Special Interest of the JAGID Specialist Group, but papers of a general nature were included, because of the fact that there is much to be learnt from the experience of developed countries.

G. J. H. McCall introduced the theme by saying that hazard incidence and scale were increasing because of increased population concentrations (especially the mushrooming and sprawling of some Third World cities); increased technological development; over-intensive agriculture and pastoral activities; increased industrialization; excessive use of the internal combustion engine and industrial noxious fume emitters; unwise land development and construction; increased scientific tinkering with Nature without considering long term effects. Geoscientists were only just beginning to comprehend the risks of natural radon emanation; of man-made acid rain; and of highly controversial processes (combined natural and man-made?) such as global warming. The line between natural and man-made hazards was blurred and there was no hazard unless Man and his activities were involved—hazards involve an interaction between Man and Nature. Sudden geohazards such as volcanic eruption, earthquake, tsunami, storm and flooding were particularly devastating in developing countries, but there were also slow-incidence hazards equally harmful such as soil loss and rising groundwater. He emphasized the importance of the new man-made hazards epitomized by Chernobyl, mentioned the unwisdom of destroying agricultural land because of a short term glut in agricultural products, and concluded by suggesting that the global hazard posed by the escalating World population was the central and most critical geohazard of all, and one that politicians and others tended to 'sweep under the carpet'. He asked 'Is not the Earth even now in a sense being overgrazed by Man?'

M. R. Degg (Chester College) demonstrated that tall buildings founded on clays of a former lake were the most vulnerable to destruction in the 1985 Mexico City Earthquake, although the epicentre was 370 km distant. Proper design and construction of buildings to resist earthquake shocks are essential: otherwise the tall buildings rising in the new cities of the Third World would suffer disastrous collapse in earthquake-prone regions. Mexico City has a population of 18 million and is predicted to grow to 30 million by 2000 AD. By the year 2025 AD it is predicted that 93 cities, mostly in the Third World, will exceed 5 million people. The speaker emphasized the importance of the historical approach; study of earthquake history, noting where they have occurred in the past and where crustal tension may be building up, so that in general terms prediction can be made of when and where earthquakes are likely to happen. An improved, up-to-date earthquake Atlas is at present being produced, and its production is a matter of urgency: however, the most interested sponsors of such a product are insurance companies rather than governments and international agencies.

J. M. Reynolds (Polytechnic South West) described glacial hazards from Peru, where there are no volcanic hazards but glacial hazards are equally destructive of life and property, if not more so. He showed how such short term phenomena can be mapped and used to predict future hazard zones and sequences of events, and the zones cleared to reduce disastrous effects. He described the Huascaran disaster of 1970, where the toe of a mountain fell onto a glacier after several earthquakes, producing a debris slide in which airborne boulders travelled at 1000 km per hour, accompanied by a massive air blast which disembowelled people on its path. A collapsing mass the size of an eight storey building leaped over a ridge at 150 km per hour. About 20 000 people were buried by mud. It is not difficult to predict the course of a mud flow, as was done at Armero, Colombia, but the warnings there went unheeded. The exact moment when the population have to be triggered to evacuate is important (if evacuated too early, people return to their homes and disbelieve future warnings: sociological studies may be as important in this context as scientific studies).

D. A. Rothery (Open University) covered the topic of

volcano monitoring by remote sensing. Satellite imagery of volcanoes in the Andes (Northern Chile), in particular that from lower-orbit satellites such as LANDSAT 'infra-red mapper', showed hot-spots months before eruption. Another case illustrated was that of Mt Erebus (Antarctica) in 1986. The method could be operated without even visiting the countries threatened by volcanic hazards, though an initial visit to the volcanoes to be monitored was necessary to initiate the system. To set up a global volcano-watch satellite monitoring system was an ultimate aim, but such a system would require far more financial and other resources than were forthcoming at present.

D. K. C. Jones (London School of Economics) discussed assessment of landslide hazards in a development context. This hazard rarely is of sufficient magnitude to qualify as a natural disaster, yet it is the source of destruction, damage and delay, involving great cost and innumerable small-scale failures. There was need to heighten the awareness of developmental planners to the nature, scale and distribution of landsliding, and to the range of adjustments (structural and otherwise) that can be adopted to ameliorate or avoid the problem. There was also a need to develop rapid and meaningful landslide evaluation practices for areas which lack the benefit of geological and geomorphological base-line information. He illustrated his presentation with examples from China, Nepal, Turkey and Southern Italy.

G. J. Hearn (Scott Wilson Kirkpatrick, Consulting Engineers) covered the case of environmental hazards in the Himalayan region, where flooding, mass movement, erosion and sediment transport (including debris flow) have resulted in loss of agricultural land and disruption of communications including mountain road loss. An inventory of selected Himalayan roads had been prepared as a first attempt to quantify these hazards in terms of topographical, geological and geographical setting and also road impact and engineering response. Particularly important were hindsight reviews of previous roads which had suffered disastrous failure to identify poor engineering practices. Also important was a study of the impact of road construction on the operation of the hazardous processes. He mentioned the problems of education of the local people, an essential to improving practices.

T. I. Longworth (Buildings Research Establishment, Watford) gave an account of the La Butte slow-moving landslide in Port Louis, Mauritius, affecting an area of 600 m by 400 m in colluvium on the slopes of Signal Mountain. Some 1500 buildings were affected, also four trunk water mains (95% of the city supply) and high voltage power lines (65% of the city supply) were cut. The site of slippage was located during the investigation in smectic clay seams, parallel to and 20 m below the ground surface. The cause was long term leakage of the water mains and a former tank reservoir, aggravated by torrential cyclonic rainfall, deforestation, cut and fill, and poor maintenance and drainage. Emergency works were put in hand including rerouting of water and power lines, sealing of tension cracks, and provision of drainage to carry off the surface water.

P. Gregory & S. Nortcliff (Reading University, Department of Soil Science) gave an account of factors affecting the loss of soil and agricultural land in tropical countries. Particular reference was made to the Amazon Basin where the soils have a low cation-exchange capacity, are deficient in some plant nutrients and have low pH with consequent high levels in aluminium. Clearance of forests may result in undesirable soil physical conditions which place additional constraints on food production. The problem here was not simple, because of the pressures by a population otherwise unable to support itself on taking up new land for short-term cultivation, and the solution lay in introducing better practices in relation to land clearance and cropping rather than complete prevention of clearance.

In arid regions, the problem is that crops can be produced only by irrigation, with salinization of the land an inevitable consequence, unless there are periods during which salts can be leached from the soil. There is great scope for improving irrigation practices to mitigate the consequent destruction of agricultural soils. In rain-fed areas, despite integrated systems of production involving crops and livestock, overgrazing is an inevitable result of increased population and again there is growing loss of agricultural soil and thus of potentially productive land. This problem of soil loss is a major one on a global scale.

D. George (Dames and Moore, Consultants) gave an account of the problem of rising groundwater in the Middle East, where seven Saudi Arabian cities as well as Cairo, Doha and Kuwait were affected. Principal causes are infiltration of imported water from wellfields and desalination plants; and recovery of aquifer systems following reduction or abandonment of wells and wellfields (rates of rise may be as much as 2.0 m per year). In Qatar (Doha) and Kuwait irrigation returns, leaks from septic tanks and sewers were responsible: in Jeddah, lack of centralized waste disposal combined with low permeability soils: in Riyadh leaks from potable systems and septic tanks, irrigation leaks, together with natural rainfall infiltration and subsurface flow.

The geotechnical problems caused include heave and swelling of cohesive and granular soils, settlement and collapse of the same, consolidation of soils on dewatering, poorly consolidated backfill suffering heave and settlement, solution of rock matrix, washing out of fines by flowing water, and loss of pile- or foundation-bearing capacity. In addition there are public health problems such as surface flows of polluted groundwater, insect and parasite breeding, use of polluted water on crop irrigation, polluted water entering the potable system, gas generation (H_2S) in polluted groundwater and general nuisance problems, such as odour. The material problems include attack and corrosion of concrete and reinforcement, damage to pipes and services, degradation of road pavements by salt build up, and solution of concrete components by flowing water. The hydrostatic pressure can build up to crack floors and cause wall failure, and flood basements. Stormwater sewers lose capacity and sewerage generally becomes overloaded. Soils become waterlogged and salted.

A large number of measures, mainly regulatory, were suggested to mitigate this effect, but remedial action is expensive, disruptive and not always fully effective. Measures adopted have included control of water levels using wells or drains; drainage to lower aquifers, groundwater abstraction or reuse; grouting and cut-off structures. The speaker concluded that almost all developments involving use of imported water will result in some rise in the water table and that good planning, permitting and water conservation policies can reduce the problem, but a real understanding is first needed of the water budget, hydrogeology and geotechnical conditions.

The final presentation was by **D. Brook** (Department of the Environment) who spoke on a personal basis of government policy with regard to geohazards. The typical response was unfortunately reaction after the event. While this has saved many lives during disaster relief operations, it is no substitute for a proactive response and positive hazard risk assessment before the event. Although the geoscientist can warn of dangers and even quantify the risk, it is the planners and decision makers who have to act. The function of proactive response is really tied up with land use planning. There is a problem of public education and also of education of the governmental authorities themselves, presenting the issues to them in a way that will evoke a positive response. The planning procedures adopted in relation to hazards have to be fitted into the legal, cultural and political framework of the region at risk. The speaker again emphasized the difficulties of education of the population at risk, something repeatedly raised by other speakers and one that is particularly applicable to the Third World countries. He illustrated his presentation with cases from New Zealand, the United Kingdom and the USA.

S. Scott (Polytechnic South West) summed up the meeting and mentioned the newly established Natural Hazards Assessment, Mitigation and Information Unit at Plymouth, at the Polytechnic.

The papers presented at this meeting are to be incorporated in a Special Publication of AGID which will also include additional papers, mainly from overseas contributors (Editors, G. J. H. McCall, D. J. C. Laming, S. Scott).