3. Design preferences affecting probabilities of rates of downstream flooding under hypothetical failures.

Possibly one of the next important design considerations will be the rate of change of factors leading to a critical condition and failure, rate of mobilization of defences, and the rate of failure itself. As is being fully recognized, some embankment dam materials and design cross-sections are vulnerable to much more rapid release of reservoir volume, than others. Tradition would place compacted clay materials as very suspect; but we must recognize that part of such historical evaluation is associated with early poorer than average compaction, and the better abutment-to-embankment comparative conditions. Recent trends are in favour of well compacted « fat-clay » and angular rockfill as the slowest eroding embankment section materials.

If sweet are to be the uses of adversity, important lessons should be drawn from the overtopping failures of the two compacted-clay « homogeneous » dams in São Paulo, Jan. 1977. After some hours of being overtopped by a 1.5 m thickness of water over the crest, the upstream dam started its failure at the right abutment ; in both dams the start of failure was in the abutment residual soil erodibility. The point of interest, moreover, is that the erosions of the breaches were sufficiently slow so that right downstream the river channel floodplains were not flooded either destructively, or to depths of more than a meter or two.

Concrete-face compacted rockfill dams and inclined core earthrock compacted sections have definite advantages with regard to not being subject to catastrophic breaching and rapid reservoir-volume releasing.

Just as an example of minimum adjustment to proper concept within simplified probabilistic procedures, note that the design flood inflow is frequently quoted as a 1 : 10 000 year recurrence (or 0.01 % probability) based on the extended extrapolation of the central value of the linear regression of the flood data. Obviously we must employ a composite probability including not only the median value extrapolation, but also the confidence bands of dispersion of single values around the mean : thus for instance, the upper 98 % confidence band at the 1 : 100 year recurrence would reflect a (1 %) (1 %) value for which the probability of being exceeded incorporates the erratic dispersions of hydrological behavior at the site.

It continues to be a fact, however, that the fitting of a mathematical best-fit extreme value distribution to data constitutes theorization, therefore « averaging », and the individual project faced by the engineer faces a risk of failure on the basis of the probability of dispersion of single events around the equation (confidence limits of individual data), and even somewhat beyond, insofar as an accidental event does not have to respect a mathematical best-fit formulation of past events. Do we consider the breach of an upstream dam?

2. Design criteria regarding flood discharges and risks to downstream.

In the light of the inevitable trend towards ever higher estimates of flood inflows, for increasing guarantee by each Designer against catastrophic overtopping failure of his specific dam, two questions arise : (a) have we really accounted for what can happen upstream, including consideration of Man as one dominant conditioner? (b) what design outflow values should be aimed at?

As a member of scores of Boards of Consultants I have signed the consensus reports approving decisions of large-outflow gated spillway capacities, that I should philosophically wish to oppose : therefore I feel compelled at this International forum to vent my views, with due respect to our priority allegiance to humanity and our fellow-citizens.

I fully agree with the General Reporter in advocating, wherever possible, spillway discharges limited to the order of the 1 : 100 probability flood. Since in many projects such an aim may be very difficult and/or expensive to attain, the downstream riverside developments should be guarded and insured compatibly. It is strange to note how much campaigning went into changing hurricane names from feminine to masculine (!)... and then there was David, Ernest and Frederick! How much publicity are we willing to pay for, to generate public awareness (among people of the valleys that we help develop) that engineering is not really an « exact science » and that once in a while they may suddenly find themselves with the river 5 or 10 m higher than Nature would have done even for Noah's legendary preparedness? As we engineers honestly recognize that there are inevitable probabilities of our failing in our attempt to act as local gods, the important thing is for us to share with the rest of Society the difficult decision-making on costs, benefits, risks and insurances.

78.3

13th ICOLD. Q.50: discussions. New Delhi, 1979. v.5, p. 544-546

20 - Victor F. B. DE MELLO (Brazil)

Mr. Chairman, fellow Delegates. There are three points that I should like to make, one concerning design flood inflows, the other concerning design criteria affecting risks to downstream, and the third regarding our obligations as citizens to maintain Society adequately informed of the risk decisions it is asked to accept tacitly. I hate to appear as the Cassandra wailing over the anticipated fate of Troy, but I strongly feel that we are responsible for having repeatedly brought the wooden horses into our walled cities, and that there is tragic destruction ahead in many a case.

In having sought the « zero-probability » maximum « possible » flood, which I have named the once-never flood (Rankine Lecture 1977), we have been illuded into foolish and highly uneconomical decisions, which are far from the optimized minimum risk-consequence solution, especially to everything downstream of the project. Moreover, I have ventured emphasizing that the game of numbers, of probabilistic risk assessment for extreme conditions within given statistical universes (specific, subjectively adopted, project designs), is another lure that we embrace rapidly because it is work-generating rather than thought-generating: why should it be safety-improving for the really crucial accidental condition? The computation is reminiscent of the delusion of multiplying $1/\infty$ (very low probability) by ∞ (very high estimated damage). The engineering solution calls for a choice of change of « physical universe », change of type of design, so as to preclude being conditioned by the feared extreme-value condition. In short, regarding spillways, appropriate combinations of gated operational facilities plus emergency free-overflow, upstream meteorological monitoring and anticipations, and so on.., are solutions to be optimized.

1. Estimated maximum flood inflow probabilities and design decisions.

Firstly I take the liberty to deplore the fact that current practice has retrogressed into estimates of the so-called PMP and PMF, which are truly misnomers with regard to the term « Probable », being generally quite devoid of anything either statistical or probabilistic. It is comprehensible and even inexorable that early applications of statistical and probabilistic methods in flood estimation should have led to many frustrations and failures. But surely it is the blind non-critical applications of few statistical methods (analytically derived under certain hypotheses) that have harmed applications of extreme-order statistics to hydrology, principally because the physical realities are generally neglected in order not to delve into the hypotheses underlying those methods; and if statistical and probabilistic concepts are a definite development in all scientific and technological thinking over the past decades, we should not have dropped them totally, but should painstakingly tread the right road of seeking the errors and pruning them. I might just recommend referring to special papers of the 3rd ICASP Conference, Sydney, Jan. 1979 (cf. for instance, Hasofer, Yevjevich, etc.).