OPTIMAL UTILIZATION OF WATER-RESOURCES AT MANGLA RESERVOIR

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ABSTRACT

Pakistan has an agro-based economy, but most parts of the country are arid or semi-arid. As such, a large part of the agricultural activity depends on irrigation water, which mostly comes from two main reservoirs, namely, Tarbela and Mangla. Optimal utilization of the available capacities of these reservoirs, therefore, becomes an important issue.

In this article, optimal utilization of water-resources at Mangla reservoir has been discussed, with possible options. At the time of the dam-design, the Probable Maximum Flood (PMF) value calculated for the dam was 26 lac cusecs. Now, Pakistan Meteorological Department (PMD) has eighty years of data, analysis of which suggests that the present PMF value of 26 lac cusecs is much on the higher side and should be revised downward to around 16 lac cusecs. This revision can allow raising of the present Maximum Conservation Level (MCL) of Mangla by 15-20 ft, which can be accomplished at a fraction of the cost. The storage capacity of the dam would be increased by about 1 million acre ft.

INTRODUCTION

Mangla Dam was built on the river Jhelum in 1960 mainly to replace waters of the three eastern rivers allocated to India under the Indus Water Treaty.

The catchment area of the Jhelum river is about 12,870 sq. miles. Of this, 3,605 sq. miles area (about 28%) is located at an elevation higher than 10,000 ft above Mean Sea Level (MCL). The area above 4,000 ft constitutes about 82% of the total area. The basin is bounded in the north by the great Himalayan Mountains and contains whole of the Kashmir valley.

The climate of the Jhelum basin can be divided into four seasons. These are winter (December-February), the hot weather (March-May), the summer monsoon (June-September) and the transition (October-November). During winter season, precipitation over major porition of the basin is in the form of snow. In April, May and June, the snowmelt gives to hgih sustained river flows at Mangla which normally reach their maximum in June. During the summer monsoon season, preicpitation is concentrated int eh southern and western portions fo the basin and featres intense rainstorms. It is these rainstorms, which usually gives rise to majro floods.

Any proposal to carry out the structural raising of Mangla dam deserves special attention because it could boost the dam's irrigation and power potential. Besides socio-economic and geotechnological considerations, the two major issues involved in the decision-making process relate to: (i) the availability of water in the system, and (ii) the magnitude and volume of the highest possible flood or the probable maximum flood (PMF).

A correct assessment of these two factors will determine whether the structural raising of the dam is at all needed and, if so, then exactly how much. Hydrologists appear divided on the issue of water-availability. Some believe a 40-ft raising of the dam is not commensurate with the water-potential of the dam. They argue that, during quite a few seasons, the Dam's filling even up to the present conservation-level of 1,202ft had not been possible. They fear that an increase in the dam's capacity could increase the number of water-deficient years, as well, and thus make the project uneconomical.

WATER AVAILABILITY & RE-EVALUATION OF PMF

The inflow at Mangla constitutes around 70% of snow-melt water and spring water, plus around 30% rainfall. Dam filling under the increased capacity shall necessitate more than normal snowfall during winter, followed by more than normal rainfall during summer. Such occasions would be relatively few. Thus, the water-availability for the increased capacity (built at such high cost) remains doubtful.

The second most important factor to be considered in the context of raising the capacity of Mangla dam is the accurate assessment of the magnitude and volume of the highest possible flood, called the PMF. It is

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customary to express the PMF in terms of its peak (discharge) value, even though its volume is equally important. Essentially, it is on the PMF-value that the Maximum conservation-level of the reservoir is fixed and the detailed dam-operating procedure is formulated.

In the case of Mangla reservoir, a great deal has gone wrong with regard to the PMF. As it exists today, Mangla PMF is grossly over-estimated and we have under-utilized the dam's capacity right from the beginning. PMF study of the Mangla dam was carried out by two international companies. The first study was done in 1959 by M/S Binnie[1] and its UK Partners, in association with M/S Harza of USA, while second study was carried out alone by M/S Harza[2], in 1992.

DISCUSSION OF VARIOUS STUDIES

Before commenting on the two studies, it is necessary that a few basic and simple elements regarding the concept of the PMF are brought out. PMF occurs as a result of the heaviest possible precipitation, technically called the probable Maximum precipitation (PMP). The PMP is caused by the extremely rare combination of the most rain-producing meteorological factors, which may act together to produce such an imaginably high rainfall, the equal of which has never occurred before. Thus, the starting point in computing PMF is the estimation of the PMP, which, in turn, calls for an in-depth understanding of those meteorological factors that are necessary to cause PMP. In Pakistan, the essential causes of the heaviest rainfall are the low-pressure weather-systems, which originate in the Bay of Bengal during monsoon season and then move across India, to arrive in the vicinity of the Mangla catchment. Turning of these monsoon depressions (towards the catchment) and their intensification, etc, is caused by another weather-system called the westerly waves. Cause of the extremely heavy rainfall in Mangla catchment develops when, on an extremely rare occasion, the position of the arriving intense monsoon-depression (to the south) and that of the intense westerly waves (to the north) get mutually juxtaposed along a North – South axis. The first step in computing PMP is to look for a past event in which the "heaviest-ever" recorded rainfall and thus the run-off had occurred. Then the actual rainfall is further enhanced (theoretically) by assuming the situation of saturated atmospheric condition to release more (additional) rain. Such precipitation (rain) is then converted into run-off, to compute the PMF, using any standard rainfall / run-off model like, for example, HEC Model.

Now, turning to the Mangla PMF study, it appears that the foreign consultants did not possess full understanding of the local rain-producing meteorological factors. The British and American Meteorologists live and deal with the temperate region and its atmospheric environment, while Pakistan is located in the region which becomes meteorologically tropical during summer and temperate during winter. This regional characteristic causes much more complex weather-systems, which are not easily comprehended by the visiting meteorologists of European or American origin. It further appears that this lack of knowledge of the foreign consultants forced them to play safe by aiming at a very high value of the PMF, with safety margin comparable to the one normally adopted in USA for Hurricane-related rainfall.

In achieving such a high value of PMF, they violated the very basic procedure of PMF computation. As indicated earlier, the first step in the PMP/PMF computational procedure is to select the past event of the heaviest rainfall, which in case of Mangla, up till that time, was the event of the year 1929. The consultants of the study, however, selected an event, which was relatively insignificant in terms of rainfall and flood intensity. This was the flood of 1956. However, strangely enough, despite selecting one of the lowest storms, they produced the highest PMF value. This was done by multiplying the actual storm rainfall with an additional multiplication factor called the Wind Maximization Factor, which was actually not applicable to Mangla storms (since the wind-factor is applicable to the coastal belt only and not as far inland as Mangla).

PMF value of 26 lac cusecs was computed by M/S Binnie[1] and Partners and M/S Harza. Against this, the highest flood actually experienced at Mangla over a period of more then 80 years is less than 11 lac cusecs, which occurred in 1992. The figure of 26 lac cusecs for PMF resulted in fixing the maximum conservation level of the dam at 1,202ft. (Crest level of the dam is around 1,232ft and the level in case of PMF could be taken to 1,228ft). Thus, around 26ft of the useable space was kept empty for the PMF situation. A feeling that 26 lacs of the PMF (as against 11 lacs

actually experienced so far) was on the higher side prompted WAPDA to revise the study. However, strangely enough, the revision was again awarded to none but M/s Harza (which was already co-author of the first study). This was done early in 1992. No wonder that, in this revised study also, the PMF of Mangla again reached close to the previous value of 26 lac cusecs. On the face of it, the previous PMF value got confirmed through the revised study and thus the situation with regard to the water-conservation in the reservoir remained unchanged. Flaw in the entire exercise stemmed from the decision to award the revised study to M/S Harza, which was in no position to prove its (own) earlier study wrong. Indeed, Harza is a good international firm having long-standing association with WAPDA, but this did not deny WAPDA the right to an independent check of its work through some other national / international firm, since quite a few companies of equally good repute are available at the international level.

In 1995, Pakistan Met. Deptt., in one of its detailed studies conducted by its Director, Mr. Abdul Majid, strongly pointed out flaws in this overestimated Mangla PMF value of 26 lac cusecs. Some conservative estimates suggest that this under-utilization of Mangla Dam has caused a loss of about Rs. 20 billion[3] to the national exchequer so far.

CONCLUSION

The gist of what has been stated above is that an independent study of the Mangla PMF needs to be done, through a firm not involved in the earlier studies. Involvement of Pakistan Meteorological Department must be ensured in the study, since the subject of PMF is a hydro-meteorological subject directly related to the technical function of Pakistan Meteorological Department.

On the basis of the various studies[4,5], the present author is of the firm view that the PMF value is most likely to range between 15 lac and 17 lac cusecs. This shall allow a raising of Mangla's present maximum conservation level to 15ft above the present level of 1,202 ft. The first 6 ft can be raised without any structural change, while the remaining raising can be achieved either by raising the emergency spillway (present level 1208 ft) or just by putting gates on it. This can be done at a fraction of the cost of rupees 50 billion needed for raising the Dam upto 40 ft. In view of the water-availability constraint, the option of raising the level, on the basis of revised PMF, should be exercised first. It shall be much more beneficial to use the available funds in the construction of some new dams, rather than raising the Mangla dam too much, without first utilizing the dam's available potential.

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