Minimizing costs in a drought situation - Malawi

19th WEDC Conference ACCRA, Ghana 1993

WATER, SANITATION, ENVIRONMENT and DEVELOPMENT

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Abstract

The current drought experiences of Southern Africa including Malawi has shown that the failure of the existing water supply systems to meet demands when water resources are receding can be reasonably described in terms of the clear and definite monetary expenditures and economic losses related to the emergency actions. Malawi through Ministry of Works' Water Department operates over 53 urban and semi-urban water schemes and 56 rural piped water schemes. It is known that frameworks have previously been presented which can allow Water Department's designers of the stated range of water systems and the utility management to formulate least cost drought emergency plans, and to systematically examine the trade-off between the expected value of the long-term cost of coping with water deficits and the cost of the long-term water supply/conservation projects. This paper examines the suitability of such framework which has been used once in some places as an analytical tool for deficit planning. The analysis of that scheme in Spring Field, Illinois had indicated that the optional short-term programs for the mitigation of potential shortages of water during droughts consist of a combination of moderate demand and loss reduction measures coupled with intensive utilization of emergency water supply systems. To this it is therefore important to note that the choice of demand reduction measures should involve a certain degree of discrimination among various consumer categories in order to avoid substantial losses to the local economy.

Introduction

Planning for drought has been recognised to be an area to give high priority in research by the water utilities in Malawi following the worst drought period in Southern Africa. The drought also affected Malawi the previous rainy season November, 1991 to October, 1992. The Malawi government through Ministry of Work's Water Department operates over 53 urban and semi-urban water schemes and 56 rural piped water schemes in addition to nearly 9,000 boreholes.

Last drought monitoring and assessment revealed that water shortage situation had worsened in most parts of Malawi. It highlighted water supply situations in areas served by piped water schemes, boreholes, shallow wells and traditional sources such as streams rivers, lakes and springs which also outlined drought relief water supply programme, its funding and implementation. From this last experience the water authorities in Malawi have concluded that there is a critical gap in existing knowledge concerning the explicit consideration of the benefits of providing increased reliability of water supply sources. In addition to this there is the decision criteria and incentives for implementing emergency measures during such previous severe drought which are lacking within the existing management.

It is learnt that many researchers attempted to define the criteria and procedures for developing an optimum strategy for investing in water supply capacity that would protect the existing systems from adverse impacts during drought (Benedyt Dziegielewski et al, 1986). Most of these are believed to be dealing with long-term planning criteria, and offering very little guidance to the water management in Malawi while operating existing systems threatened with supply shortages.

However, it has to be mentioned further that three authors Russell, Young et al and Russel et al integrated some concepts, decision criteria, and measurement techniques that would assist Malawian managers the production of their own comprehensive planning method for determining the best strategies for dealing with the past deficits which is further elaborated by Dziegielewkski, et al (1986).

Development of 'Drought Optimization Procedures' model (DROPS)

According to Dziegielewski, et al (1986) a model known as "Drought Optimization Procedures" (DROPS) could be used to assist and this approaches planning for water deficits from the perspective of the cost minimization of short-term deficit management programmes. It is stated that from this model the minimum cost drought emergency programme would be deficit by trading off the expenditures and monetary losses reducing demand with expenditures on acquiring additional water.

For consideration of all specific aspects of water deficit planning, the general model for the development and implementation of optimal shortage mitigation plans is composed of the following five elements (Dziegielewski, et al, 1986).

1 Determination of the magnitude and probability of possible water supply deficits for an existing system capacity.

2 Formulation of alternative deficit management measures, including emergency water supplies.

3 Selection of the best packages of shortage mitigation measures for water deficits varying in magnitude and probability.

4 Assessment of the effectiveness of alternative capacity expansion and non-emergency conservation plans in terms of investment costs needed to reduce the expected cost of coping with supply deficits.

5 Implementation of appropriate management plans during a water shortage.

Model application to Zomba water supply

The Malawi government apart from other existing sources experienced the worst drought in Zomba town with a population of over 40, 000 people. Zomba town gets water from a shallow dam on Mulunguzi River. There have been plans for expansion of the scheme to meet the increased demand but availability of funds has been a major set back. The alternatives recommended in engineering reports (Lahmeyer International, 1989) include the construction of a new dam, expansion of treatment works and extension of distribution system. However, during the time of previous studies no drought emergency plan was formulated resulting in serious consequences. This paper therefore examines possible drought measures that can minimise costs if the town faces another situation of the same as in 1992.

Possible supply deficits

The magnitude and probability of potential water supply deficits that could face Zomba in the long run could have been determined by comparing current and future rates of withdrawal to historical drought records.

The magnitude and probability of potential water supply deficits could have been determined by comparing the probability distribution of system yields in each future year with corresponding long-term unrestricted water use projections.

Setting of drought emergency measures

Figure 1 shows some of the measures which management could have used for judgement to be applicable, feasible technically and socially acceptable by the general public. The effectiveness of each measure could have been calculated separately for each affected sector. The effectiveness of a combination of measures could have been calculated, taking into account possible interactions between measures. Determination of the effectiveness of the water bill surcharge required the knowledge of price-elasticity of demand for water in all the user sectors.

A residential water demand model could have been estimated from a sample of N individual customers of the utility basing on their water use and total bills for M consecutive monthly billing periods for a certain period. Then average price elasticities which can be used have to be assumed to customers to changes in their total water bill. The value of 0.6 of average price elasticity, i.e short-run elasticity is acceptable as the appropriate measure of consumer response to drought surcharge (Dziegielewski, et al 1986).

Secondly, the effectiveness of the surcharge in non-residential sectors could have been estimated by allocating the reduction in water use by each sector in proportion to the reduction in residential sector. An assumption here is that the elasticities of commercial and industrial sectors equal to those of residential sector.

Having estimated the effectiveness of various demand reduction measures in each sector, and the relationships between the reduction in water delivery and the monetary losses in each sector, it was possible to calculate the expenditures and reduction programme. The estimates of these losses accompanying the three most severe demand reduction measures could have been presented.

Emergency water supplies

A detailed evaluation of emergency water supply for Zomba town could have been selected for implementation during the actual crisis which could have been done by the determination of the expected deficit. The search for additional emergency sources could have led management to select an auxiliary system (sources 3) which would be constructed only during a severe drought, with imminent shortage of water in Mulunguzi Dam.

Optimal shortage mitigration plans

Demand and loss reduction programmes could have been undertaken. "Programme" denotes one or more demand reduction measures assembled in 'packages' to achieve a desired reduction in water use when it could have been implemented.In order to compare the effectiveness of individual programmes in terms of the cost of water saved, a total unit cost had to be included also emergency water supplies are the cheapest source of water however, in case of S1 and S2 supplies, if pumping facilities are already in place and no initial investment cost is needed.

Conclusion

From the above presentation it is therefore noted that provision of "adequate" water supply rely on the principle of balancing the cost of supply additions against the

expected damages that may result from recurrent shortages of water caused by droughts. However, for Zomba Town it was felt that the systems safe yield for any design drought would be of limited value to the water managers. The planning procedure presented in this paper will allow managers of water systems to formulate least - cost drought emergency plans as well as to examine systematically the trade - off between the expected value supply of the costs of coping with water supply deficits in the long run, and the cost of the long-term water supply/conservation projects (Dziegielewski, et al, 1986).

The events argued in this paper support the conclusion that formulation of drought management alternatives in terms of their effectiveness and required expenditures allow a water utility managers to make more informed decisions during crisis situations.

References

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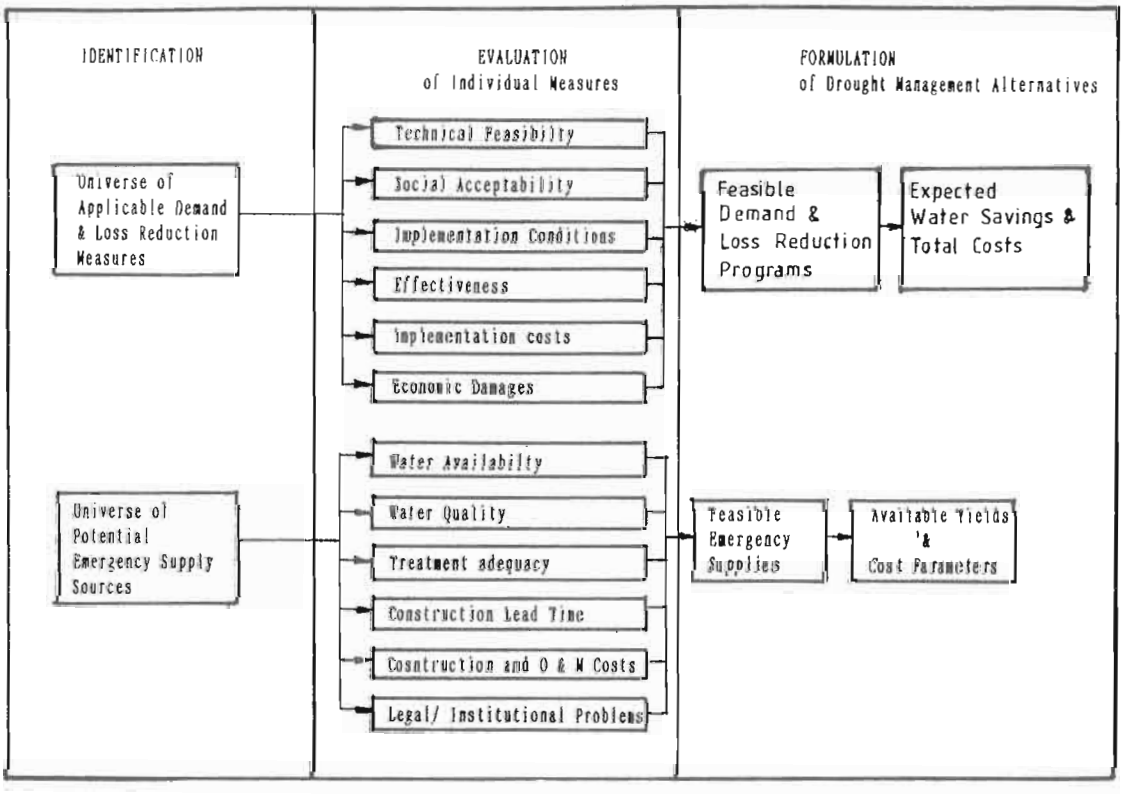

Figure 1 - Formulation of drought management alternatives