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# INTEGRATED WATER MANAGEMENT IN URBAN AREAS - BENEFITS

K ACHUTHAN*

ABSTRACT

Water has quantitative, qualitative, spatial temporal, and state dimensions. The hydrologist is a major contributor to financial, social and engineering decisions by efficiency of water networks and which translate directly into development works. Integrated water management, cannot be considered an end. It is, after all, only a beginning, a beginning that starts some where in the middle of man's adventure with nature.

## INTRODUCTION

The provision of a reliable and plentiful supply of potable water is necessary for the existence and growth of urban communities. For this reason water producing and distributing facilities occupy an important position in urban development and planning. Almost every activity of the metropolitan region directly or indirectly affects the design and operation of the water system, in turn, water supply helps shape the direction and spatial patterns of urban growth.

### Public View

Because water is essential and non-substitutable communities treat it as a monopolistic social utility to be distributed by regulated private or publicly operated agencies. It is therefore surprising that shortage-induced crises, water has never generated as much interest or controversy as the provision of other utility services such as power, transport, communication, and education. The public's widespread attitude of euphoria over water resources in humid areas undoubtedly stems from its historic abundance and supply accessibility.

Water is cheap relative to its socio-economic value in urban uses. Consequently, its marginal value has remained low. The pricing of water has not been governed by the incremental cost of supply. The result of a policy of making water equally available to all users independent to its marginal value has been to foster an environment of placid contentment among potentially firece competitions for a scarce resource, that not only includes residential, commercial, industrial, and public consumers but also sets community against community.

Water planners of the future may not have the luxury of exercising the option of reaching out to distant sources because suitable sites will no longer be available or because the cost will be prohibitive. Like the resources of the forest the grasslands,

*Prof. Dept. Civil Engg. Annamalai Univ. Annamalainagar - 608 002

the mines, and the soil before it, water too has become a limited resource even in humid climates.

In short, it is time to examine closely the efficiency with which urban water is managed in an environment of growing scarcity and rising marginal costs.

## APPROACHES TO WATER EFFICIENCY ANALYSIS

There are at least three paths by which the efficiency of water networks may be examined. They are the (1) engineering hydrologic. (2) economic, and (3) systemic. Efficiency is defined intutively in the sense of the following query how well does the water network do its job with the structural facilities and water resources at its command?

### Engineering Path

The engineering path emphasizes the hydrologic performance of the water network. How effectively does it harvest, treat,and reliably deliver to places of demand receipts of ground or surface water. Is water lost enroute from the point of entry into the network to the place of delivery. The leakage coefficient is a good measure of engineering efficiency. Peak hour average day, peak hour - maximum day and maximum day - average day consumption ratios are values needed to design distribution nets with maximum operational effectiveness.

The locations and capacities of storage reservoirs depend on the daily water requirement and minimum stream flows. When the former exceeds the latter impoundments are needed. There is a relation between the required storage and the maximum amount of water that can be obtained from the watershed without emptying the reservoir. The maximum amount of water that can be depended on from a watershed is set by the drought of record. During a drought the entire capacity of the reservoir may be needed to meet demand. From these hydrologic relations and network objectives the most fundamental parameter of the metropolitan water agency is derived dependable supply. It is the maximum supply of water that can be drawn from a reservoir through a drought period. When the minimum streamflow of record exceeds the daily demand volume, reservoirs are not needed and the streamflow is equal to the dependable yield. For agencies dependent on ground water sources a corresponding safe yield estimate is made.

### Economic Path

The economic path to efficiency follows another route. Its objectives, questions, and answers are different. In an economic analysis of a resource, as water, efficiency can be reduced to the allocation of the resource to a set of possible end uses and a comparison made of their marginal values. Inefficiency results when a high productivity service is cut back in favour of a low value use. Consideration of the relative productivities of alternative uses provides the guidelines for allocating and rationing urban water optimally. Price is the allocating mechanism. The price system allocates resources most effectively when demands are responsive to prices. But with water service regarded as an essntial community social utility, agencies, publicly or privately owned, have not employed price to regulate demand. In addition, within the range of regulated prices water demand tends to be inelastic.

## Systems Analysis

The water that flows through the urban network of aqueducts, distributaries, reservoirs, sources, and sinks may establish an inefficient pattern because the selection of each agency path is made largely without regard to the effect on other agencies and distributions. As a result shortages may exist in one part of the regional network while surplus water is locked in elsewhere. Such a condition defines an inefficient state.

## Efficiency rating

Consider a system composed of a number of identifiable agencies each with facilities for the distribution of water to service areas of final and/or intermediate demand, for receipts of water directly from sources and/or as transfers from other agencies, and for the storage of water in impoundments and/or as underutilized safe yields. The system is operating suboptimally when it exhibits a state in which a water deficiency exists at any distribution area while a water surplus is available anywhere else in the network. The ratio between the surplus and the deficiency provides a numerical scale for evaluating system efficiency according to the following computational formula :-

$$\text{Efficiency rating} = 100 - \frac{(\text{Total surplus in the system} \times 100)}{\text{Total deficit in the system}}$$

in which, surplus is defined as the sum of excess water over demand for each and every agency, and deficit is defined as the sum of demand minus supply for each and every agency.

## Case study

Consider the set of system states given in Table-I.

Table-I
System States and System Efficiency Ratings

| System State | Water deficit (mld) | Water surplus (mld) | Efficiency rating |
|---|---|---|---|
| (1) | 0 | 0 | 100 |
| (2) | 10 | 0 | 100 |
| (3) | 0 | 10 | 100 |
| (4) | 10 | 10 | 0 |
| (5) | 20 | 10 | 50 |
| (6) | 10 | 20 | 100 |

(mld =million litres per day)

In system state (1) the system is operating with maximum efficiency because water is distributed perfectly, there is no deficit and no surplus. In state (2) the system also is operating efficiently as a network because there is no water surplus. All surpluses have been allocated, but the system is not able to satisfy the total demand on it. Only an exogenous change will enable it to meet demand, such as an increase in water inputs from a source. State (3) is the inverse of state (2), no water deficit exists, but the system has a surplus. The network satisfies demand but suffers from overcapacity because inputs are too large, only an exogeneous reduction of source inputs will bring supply and demand into balance. The surplus must be discharged as spill when storage capacity is exhausted. The efficiency ratings for states (1), (2) and (3) are each 100, the formula is incapable of distinguishing levels of efficiency among these states.

Turning to states (4), (5) and (6) the formula is more sensitive to relative system inefficiency. This is of greater interest. In state (4) deficit is equal to surplus and the rating equals zero. This suggests that total network water supply is adequate to satisfy demand, but the system is not able to transfer water. Water is locked in the system and is immobilized.

In state (5) the deficit exceeds the surplus and the rating is between zero and 100. It appears that the system is partially effective in mitigating shortages but is not able to effect entirely the necessary transfers. State (5) describes a more efficient condition than state (4). However, there is insufficient surplus water to overcome the deficit. The optimal redistribution of the surplus would transform state (5) into state (2), state (6) clearly describes the most inefficient condition. Here the available surplus exceeds the deficit. Optimal redistribution of the surplus would transform state (6) into state (3).

## Conclusion

Water has quantitative, qualitative, spatial, temporal, and state dimensions. The objective of an urban potable water supply system is to satisfy the demands for water delivered in required amounts at times and places desired by users. Stated this way the objective of the system cannot be met acceptably by decreasing demand. Demand is encouraged to fall during periods of shortage, but this is not regarded as an acceptable solution for imbalances.

There are alternative paths to system objective new sources, (traditional and unconventional ones), recycling and reuse, spill capture, increased production from old sources, runoff in the service area, and network redesign.

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