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# RURAL WATER SUPPLY IN THE 1980's

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ABSTRACT

Eighty percent of the population of India live in villages and seventy percent of these people do not have assured potable drinking water supply. Hundreds of people die every year because they had inadequate water or sanitation facilities. Thousands of people spend half their day walking in the hot sun to carry polluted water which will poison them and their families. Future rural water supplies have to project for a fifty year period, and a second thirty year period. This plan has to take into consideration the rapidly increasing water demands, quantitative and qualitative modification of the present water resources. The planning comprised (1) valuation of the competitions and gathering useable solutions, (2) analysis of solution variations and the possibility of combining part solutions and (3) economic evaluation and election of optimal project variations.

A model of linear programming was prepared for each independent district, which were considered as basic models. These models contained continuous decisive variables, possible water supply solutions or their variables. Investment variables and quantity of water supplied to the users, operation variables, (dimensions cubic metres per day) were also considered. The cost sensibility of the solution was worked out along with the result of variation of the 12% discount factor, the effects of the modifications of resource demand structure, and the inter-relation between the districts considered as independent. The sum of the investment costs together with the maintenance and 12% discount factor was kept minimal.

## 1. INTRODUCTION

A fifty year plan for providing drinking water supply to Utta Pradesh was programmed. This took into account requirements for communal, household, institutional, local industrial, drinking and production purposes. The peak water consumption in the first 20 years and the later thirty year periods were calculated.

It is required that a large scale water supply network should bring harmony between water resources and water demands relating space and times as well as quantity and quality.

The area of the country may be divided into easily separable consumption districts on the basis of their geographical and economical structure (Ref.1).

## 2. VILLAGE NEEDS

The size of water project that will serve a village should at least meet basic water requirements. An average Indian village has 160 farm families, each of which has 6 persons, 3 heads of animal, 2 hectares of land holding for rice cultivation and 2 hectares for wheat. On the basis of 35 litres per day per capita, and 50 litres per day per head of animal, 180 days of the dry season require 1000m$^3$ for domestic use and animals. Since the onset of the wet season, monsoon is often late for nursery beds it is preferred to allocate a certain amount of water for this activity; the nursery beds for a village of 100 hectares require 30000 m$^3$ of water. (Ref.2).

### 2.1 POPULATION

The Indian rural population lives near available river supplies. Much of the country's fresh water lies in large slow moving rivers, in lakes, or as ground water. In each case the water must be pumped to higher ground before it can be used for culinary, industrial or agricultural purposes. (Ref.3). The pumping of water, even in small quantities may be costly compared to the financial resources of the user. (Ref.4). This solution is particularly true in India where subsistence diet are the horon and a family's welfare is dependent upon their ability to work out a living on a small plot of ground.

### 2.2 ENERGY SHORTAGE

Pumping water in India is compounded by the shortage of available energy to operate pumps. Many people of the country are so short of fuel that they use animal dung for their source of fuel to cook food; with rising fuel costs, there is little possibility that a large capital investment for pumping equipment plus the sustained and rising cost of fossil fuel can be afforded.

The result is that small farm agricultural communities are dependent upon the rainy season for growing crops. During the dry season, water may be nearby, perhaps a few metres beneath the surface of the earth, but without a cost effective means of lifting it on to the land, the water lies wasted and fertile lands are idle. (Ref.3).

2.3 WATER DEMANDS

Water supplied for rural purposes is used in a great variety of activities. The total water use within a community is the aggregation of many individual uses, each such use being determined by a different set of variables. Therefore, the quantities of water used vary widely among different communities and sometimes unexpected changes occur over time. In order to develop a practical capability for describing, estimating and forecasting water use, it is necessary to introduce at least some generalisation and aggregation, since neither suitable models nor data are available for all individual water uses. (Ref.4).

2.4 HOMOGENOUS SECTORS

A contrasting set of assumptions would treat water use separately for each of a number of user classes defined to separate all water uses into a number of relatively homogenous sectors. Water use in each user class is assumed to be explained by a number of factors including price. Since a possible relationship between price and quantity is thereby included, this flexible approach permitted the definitions and numbers of user classes, as well as the explanatory variables to be considered.

3. DEMAND MODEL

The use of disaggregate approach was coupled with selective use of demand models. One operational use of water forecasting procedure applied demand models to the residential sector only, including user classes, employing unit use coefficients. Still, price was retained as an explanatory variable wherever feasible. Many current forecasts assume, implicitly or explicitly, that the price elasticity is zero. This is often justified by two types of assertions that the estimates of price elasticity are useless and that in the long run people revert to their old habits anyway. Both assertions are false. The wide variations in the published estimates of the price elasticity result in many cases from the different definitions of price.

3.1 PLANNING NEEDS

In projects for water supply four parameters have to be well defined:

1. The difficulties of measuring the supply.
2. Identification of a base period for supply estimates.
3. Forecasting changes in water supply and conservation.
4. Selection of an equitable base for allocating the available supply, the river gains and losses including water evaporating from storages and conveyance losses.

For purposes of identifying suitable forecasting methodology, a useful distinction was made among water conservation measures. Some measures consisted of changes in the marginal price of water, change in rate level or rate structure. The remainder related to other kinds of behaviour at changes, and to technological change.

3.2 SYSTEM FAILURE

Annual reservoir failures were determined for several different forecasting methods. Two series of simulations were concluded with average demands. This indicated that for the supplies from reservoir systems, forecasting and conservation had more impact on reducing failures when the probability of failure was high when it is low. However, it was seen that forecasting a drought on the average of once every three years was too frequent for public needs and economic stability. The forecasting by model studies aided by computer provided that the conservation mode was stored for years in which subsequent inflows provided the projected shortage. More pessimistic six months forecast resulted in an increase of only 8 years of drought forecast, when no drought occurred and a decrease of 12 in the number of years of failure.

3.3 FORECAST PERIOD

It was observed that increasing the forecast period beyond four months increased the number of failures with the optimistic forecast but decreased the number of failures in the more pessimistic forecost. For those years when there was no reduction in supply the public got full use and supplies. The longer forecasting period had a better chance of including months with high average flows than the shorter forecasting period. The pessimistic forecasts reduced inflows for the months with higher average flows. Any attempt to ensure provision of minimum stream flows for environmental purposes explicitly confronted the state system and either complied with or superseded it.

### 3.4 THE RE-USE SYSTEMS

The most important perspective for saving water and energy was to have re-use systems, convert siphon tube and gated pipe systems to automatic gated pipe systems so that they would change their set times from their normal 12 or 24 hours set to 3 hours or less were used. A technology transfer programme to propagate re-cycling use was taken up. It was found cheaper and easier to substitute water for labour, the latter being expensive and in many cases unavailable. The 12 to 24 hour time on each set fitted their labour schedule and they used water for this length of time whether they required it or not.

### 3.5 INTEGRATED PLANNING

Attempts were made to prepare an economic framework for integrating municipal water supply and waste water systems to create situations for better living conditions. The many economic problems facing municipal and regional planning are source capacity, expansion policy, treatment level requirements and disposal. Water re-use is envisaged to bring a significant improvement of the current quality of living standards. The traditional adhoc planning approach was discounted. Hasty decisions on rural water supply schemes without much attention to disposal of waste water eventually created situations whereby the source of supply got threatened by pollution problems to an extent that its cure necessitated termination of further use of source.

### 3.6 DEMONSTRATION PLANT

Potable re-use was resorted to by treating the secondary effluent to a quality which could without reservation or restriction be supplied through the existing potable distribution system to the rural areas. The implications of this programme are resounding. The programme was demonstrated on a large enough scale to provide adequate and accurate data for a fair and complete evaluation of potable water re-use technology. The design, operation and re-use of demonstration plants have been taken up. These plants are designed to link various unit processes together, which will provide consistent and reliable treatment of a secondary effluent and produce a potable quality water.

### 4.0 EXCHANGE

Water re-use by exchange was found to be the simplest form of successive use. It involves no treatment, had relatively low cost and was thus most attractive.

The used water at the sewage treatment plant outfall was exchanged for less polluted water at the treatment plant intakes upstream. Unfortunately the amount of relatively unpolluted water available in the river is limited; therefore, exchange could not utilize all of the return flow resource available. The re-used water made additional water supplies available to the continued growing demand. Responsibility was assumed for monitoring the programme. The efforts to re-use and progress towards achieving the goals set forth were constantly re-valuated. The goals for subsequent targets were recommended. Future diversions required elaborate and length up transmission systems.

### 4.1 BASIN TRANSFER

The available surface water is sufficient to meet the requirements in the plain areas. But the water is not available in the desired quantities in all plains. There is no national planning system, and a surplus or saving in one region has little use in another region far removed. But basin transfers can be effected in neighbouring regions. With the growth of population, water use will rapidly increase and difficult areas will suffer from further shortages. In order to remove the widening imbalance of the geographic imbalance between water supply and water demand, it became necessary to transfer the water from surplus sources to deficit areas.

### 4.2 INTER STATE WATER LINES

Ganga river carries 65 to 70% of the total water during the monsoon months while Godavari and Krishna carry out 90 to 95% during the 4 monsoon months. The technique of transferring water from one basin to another has been practised in our country and many more are contemplated for construction. These schemes are necessary to meet local problems of deficiency. It is imperative that a more detailed study to evolve a more accurate picture of the imbalance of water supply, and water supply on national levels, will have to be worked out. Approximate routes for necessary inter-state and inter-regional water lines and volume of water to be transferred after meeting fully the requirements of the basin states have to be determined.

### 4.3 CO-OPERATION

It is necessary to have co-operation of basin states for undertaking further investigations after identification of the projects and their vital components. With the availability of more data it would be possible to re-define and finalise the schemes envisaged.

The basin plan would bring about an equitable distribution of water resources and remove the imbalances and provide increased safety of water supply and water demands in different areas. This has an added advantage of effecting a reduction in overall costs as compared to a multitude of smaller schemes to derive limited localised benefits.

5.0 WIND MILLS

A wind assisted pumping system has been designed for use, in areas which are short of diesel, with an existing well and electric turbine pump to supply water in rural areas. The system has operated satisfactorily and has effectively utilized the unsteady output of a wind turbine. Wind assisted power systems are proposed to be utilized in rural and remote locations where a second power source is applicable.

5.1 TURBINE PUMP

A 200 mm vertical turbine pump, installed in the well was used without modification to the pumping system. The well produces approximately 90 $m^3$/hour and the total dynamic head on the pump is about 100m. The induction motor used to power the pump is a three phase vertical, hollow shaft type normally used with vertical turbine pumps. The 56 kw motor has a full load operating speed of 1500 r.p.m. the same as the pump. In addition to being the primary power source, the electric motor controls the speed of the wind turbine. Since the wind turbine provides less power than the motor, the motor speed varies between 1780 r.p.m. and 1800 r.p.m., the synchronous speed of the motor. This maintains the rotor speed of 90 r.p.m. or slightly more.

5.2 PUMPING SYSTEM

The wind assisted pumping system effectively utilized the unsteady power output of the wind turbine. The system has operated satisfactorily and the concept has proven to be sound. All components are available and proven and the mechanical drive is simple. The over-running clutch has proved to be a simple and a reliable method of synchronising the two power systems. Any correctly sized wind turbine can be mechanically connected to the system and operated at constant speed.

5.3 POWER

Where the wind turbine power exceeded the total load on the system the induction motor was driven above the synchronous speed and became an induction generator.

6.0 CONCLUSION

Increased awareness of the rural water supply problem has to be propagated. Top priority has to be provided to the poor and the less privileged and to water scarcity areas. Larger allocations have to be made to the water supply sector from local resources available for general economic and social development. Manpower planning has to be provided at the intermediate and lower levels. Instruction in appropriate and low cost technology has to be provided in engineering institutions. All water projects should be managed in such a way that the rural folk can fully benefit from the project.

7.0 REFERENCES

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