Jal Vigyan Sameeksha–a publication of
High Level Technical Committee on Hydrology
Vol. IV No. 1, December 1989

Hydrological Data Acquisition, Processing and Data Base Management Systems

B. H. Briz-Kishore
Dean

Jawaharlal Nehru Technological University
Mahaveer Marg, Hyderabad-500 028

Abstract : *Because of the ever increasing problems, man has begun to realize that he can no longer follow a "use and discard" philosophy - either with water resource or any other natural resource. Hydrological planning and management must, therefore, be as high as possible. This can be provided only through having a sufficiency of hydrologists well trained in the application of latest of hydrological data processing methods. In the last few years, new methods for assessment of water resources have been developed and more sophisticated tools for data processing have been made available for studies on optimal water use. Application of these specialized methods requires a codification that is more specialized than what is normally available.*

1 0 Introduction

Wide range of technical inputs are required for an effective system of hydrological data processing since the management of the water resource acts as a catalyst for a more extensive form of socio-economic development and administrative policy modernization. The chain reaction of the modernization process depends upon the stimulating impact of the data processing itself, and in this sense hydrological data processing becomes one of the most crucial building blocks of public administration. In fact, a prime factor in the comparative study of national water policy is the close relationship that exists between water administration and national development.

In the recent past in many areas of the country, water is used in excess of actual needs or wastes. Effective steps should be formulated to promote its efficient and equitable use. Protection of water and water related ecosystems are the basic needs of the hour. Hence, there is an imperative need to apply the best available measures to improve the existing system and evolve the best possible techniques for planning and design of conservation and distribution systems in the most efficient way. In many states, no adequate measures are being taken for planning the use and consumption of water by different sectors of economy. Where projects have been proposed, they have not been based on uniform norms or comparable methodologies, the absence of which has hampered the use of more sophisticated methods of estimating future requirements.

Hence, there is an imperative need to develop an effective hydrological data processing method for meaningful utilization of this vital resource, the major areas where data processing can be effectively applied may be classified broadly under Community Water supply, Agricultural Water use, Industrial Water use, Power generation and Fisheries. The data related to the use of water for Agricultural products and Productivity should be aimed at achieving optimum yield in food production by a definite date and at a significant improvement in total agricultural products as early as possible. Particular attention should also be given to land and water management data (Briz-Kishore, 1989) both under irrigated and rainfed cultivation with due regard to long term as well as short term productivity. Necessary steps should also be taken so that the State and National policies should provide for the proper integrated information on land and water resources of the country as a whole.

It is also noticed that in many states problems associated with the use of water in industry need to be studied in greater depth and in a more systematic and comprehensive manner, hitherto in bother their quantitative and qualitative aspects, including question of input and output quality, level of treatment required and recycling of water. Data pertaining to these; matters may be of crucial importance to the attainment of industralization targets in the developing regions of the states, as well as sustaining already industrially developed regions of the country.

Further, in the formation of plans for the development of the power sector, it is also necessary to collect the data of multipurpose hydroelectric projects including pumped storage that ensure the continued enjoyment of this renewable resource without serious damage to health.

Plans for the use of water resources for territorial development should also take into account the water requirement data of fisheries the development of which is considered essential to increase the supply of protiens to the national population. These plans should also take into account the use of water for inland navigation consistent with other objectives of multipurpose development and with a special regard to the needs of less developed countries.

2.0 Components of Hydrological Data

2.1 Community Water Supply and Waste Disposal

(i) Collect Data of related community water supply and sanitation.

(ii) Collect Data of the construction facilities involving the subsidies or low interest loans to communities and to other entities concerned with water.

(iii) Collect Data on long term plans and specific projects with detailed financial information.

(iv) Collect Data of inventory and protection of water supply sources.

2.2 Agricultural Water Use

(i) Identify and compute data with regard to irrigation and drainage projects currently under construction.

(ii) Give due attention to the soil and water conservation data for effective management of watershed areas taking into account data on prevailing economic soil conditions and

- Rational crop distribution
- Improvement of pastures
- Reforostation
- Appropriate soil conservation practices

(iii) Take related health and environmental parameters into account in the planning and management of agricultural water use.

(iv) In the strategy for the development of new irrigation facilities, a judicious combination of data pertaining to major medium and minor schemes would be desirable.

2.3 Industrial Use

(i) Take into account the water requirement data of industries in the planning and formulation of water development projects, including the needs of small scale and rural industries.

(ii) Collect data related to R & D technologies that promote the use of little water and produce no waste, and technical processes for the recovery of usable substances from waste water.

(iii) Identify the data items relating to the quality and quantity of industrial wastes to form an important criteria in decision making and land use planning.

2.4 Hydroelectric Power

(i) Evaluate the data on multiple and integrated development of the Water Resources in watersheds with hydroelectrical potential.

(ii) Evaluate the involvement of parametric data of non consumptive use of water for power generation on other consumptive uses in order to harmonize the two aspects of water use.

(iii) Collect power generation data for the existing hydro-power projects for optimising power generation.

2.5 Inland Navigation

Ensure in collection of data for the programmes of comprehensive and integrated multipurpose river basin development and for improvement of navigation system.

2.6 Fisheries

Evaluate data to regulate, restrict or prohibit the use of certain polluting substances especially toxic and organdeptic substances to prevent their entry into water.

The six major components mentioned above are to be effectively integrated for purposeful implementation of any water resource development plan involving information and simulation systems (Fig. 1).

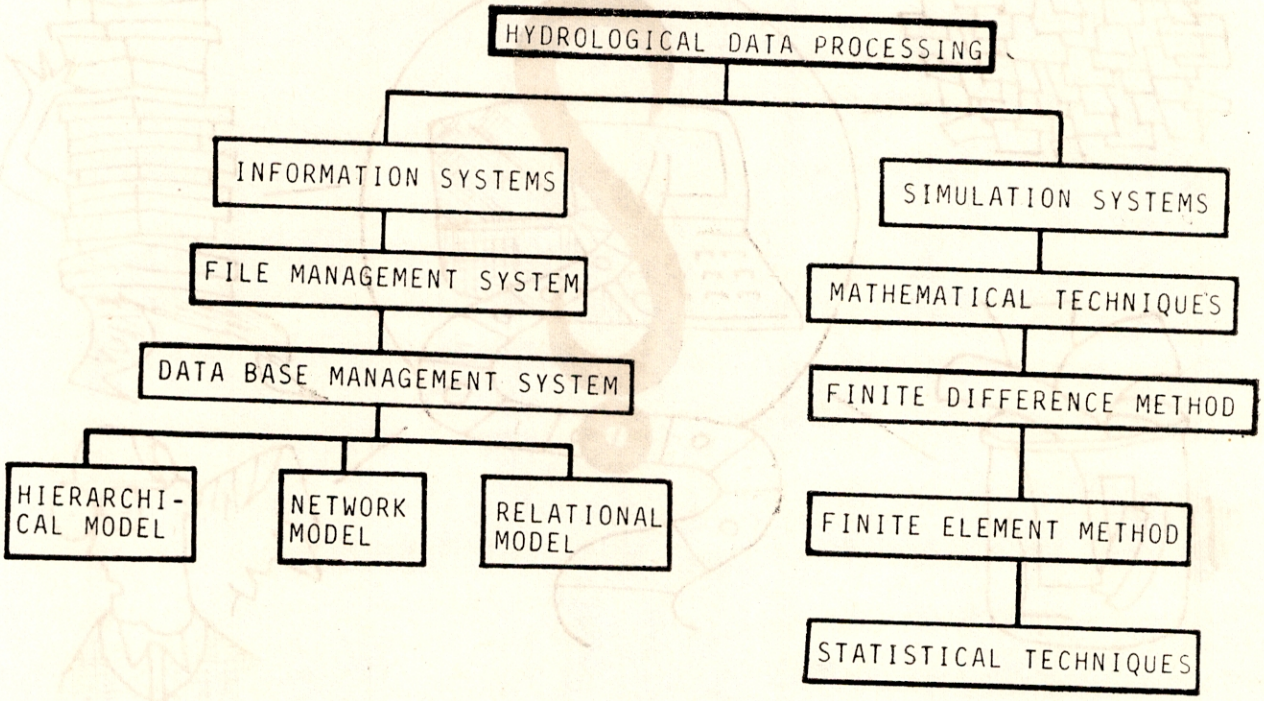

Fig. 1 : Classification of Hydrological Data Proceesing Systems

3.0 Hydrological Information Systems

The present hydrological data collection is designed in a way that each of the above components are dealt with separately by each individual organisation. The intention to retain their independent identity and the consequent rig separation developed between each of these organisations has made the entire hydrological system incoherent which in a lighter vein may be depicted as in Fig. 2.

The importance of availability of data and its economic collection for any information system need not be overemphasized. Though data collected by one organization can be utilized by others, unfortunately in the present system, the same data is collected by different agencies independently. Besides, even the collected data by these agencies observed to suffer from the following two major drawbacks :

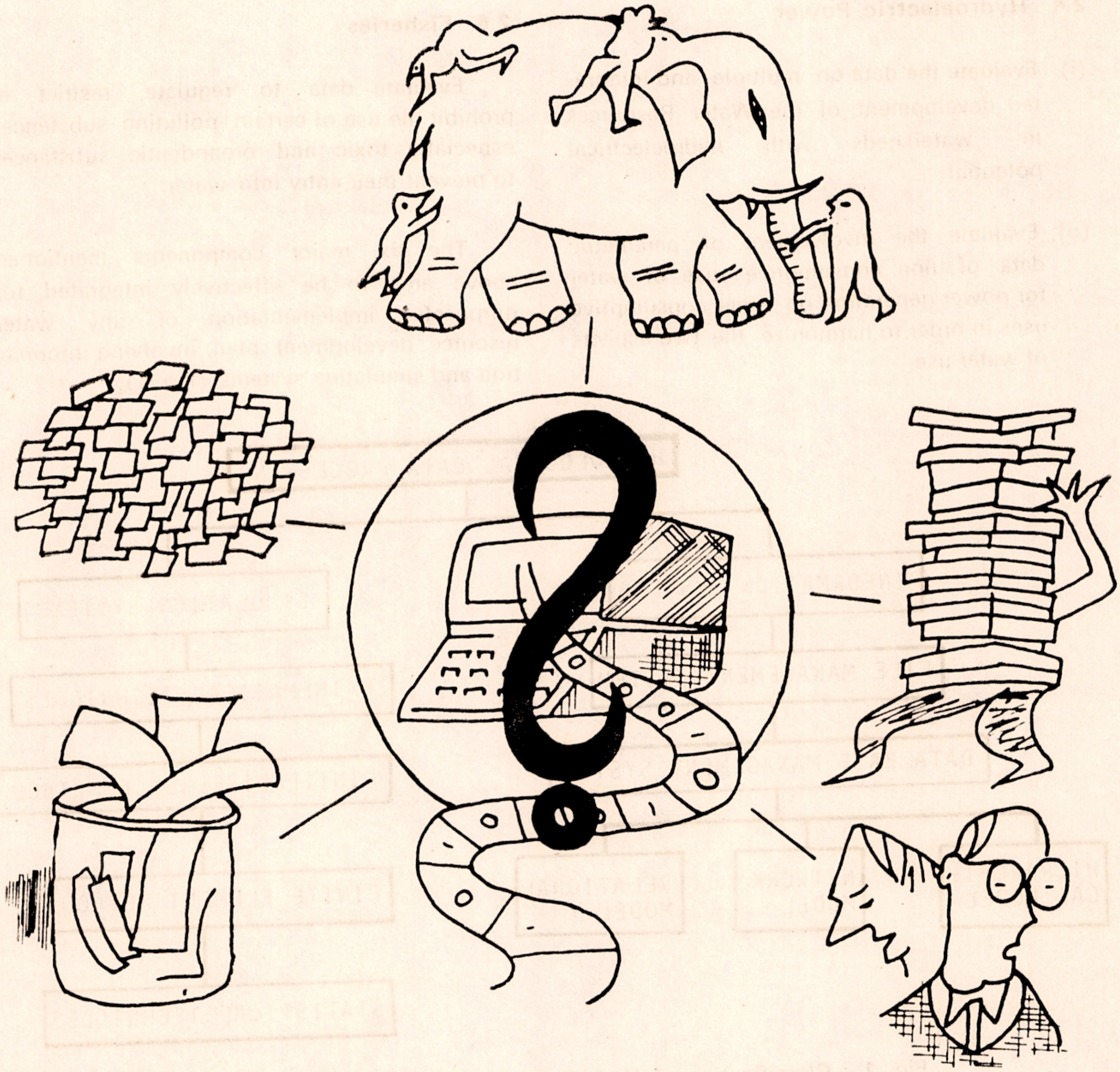

Fig. 2 A pictorial presentation (in lighter vein) of existing hydrological data processing by different organisations

(a) The data collected by any single organisation independently is observed to be inadequate to define the entire water system.

(b) The data which is not really required or data pertaining to unrelated elements are frequently observed and collected.

To overcome the above limitations it is highly essential to have a common formatted approach (Briz-Kishore, 1986, 1988) to retrieve the essential data, fill the data gaps with appropriate interpolation and extrapolation and finally arrive at a meaningful and efficient response within the minimum possible time. A new concept of distributed data-base (Briz-Kishore, 1989) approach can be utilised for this purpose which allows the individual organisations to retain their identity and still provides unilateral, bilateral and multi lateral linkages among them. Such an approach helps the water resource administration to a great extent since it provides procedural approach without affecting presently existing habit-oriented methodology.

The distributed data-base is also a data-base with a unique facility to store, update and retrieve information through specially designed models. The nature and applicability of each of these models (namely hierarchical model, network model and relational model) are briefly described as follows :

The hierarchical model can be explained very easily from the term "hierarchy". The hierachy in the model (Fig. 3) lies with the overall control of the functions through a single defined element and its relation may be explained as "one to many correspondence". It can be clearly seen from Fig. 3 that the regional hydrological data is dependent on basin data which is in turn dependent on well-wise data, basin characteristics and rain gauge station characteristics. Any required information pertaining to these elements has to be referred through regional data only, thus maintaining the hierarchical status of the model.

When different elements in the existing system are not accepting any hierarchy and require to retain their identity and at the same time require to maintain co-existence with other elements in several combinations, the network model is highly applicable (Fig. 4). It can be seen from this figure that the data pertaining to water levels, recharge and discharge in any basin are inter-related and the pertinent information regarding any one of the elements or their relations among them can easily be retrieved from any of the presented elements.

The outcome of the analysis of hierarchical or network models are represented in the form of charts and tables which is known as relational model (Table 1). The figure is self-explanatory depicting the well water level observations.

The design and development of distributed data-base can be easily implemented on any 16 bit medium range machines of recent generation. The necessary software for designing these models are often provided by the manufacturers and these packages can be easily improved or modified depending on specific requirements and conditions.

4.0 Hydrological Simulation Systems

Simulation systems are useful to identify the behaviour of the integrated hydrological system under varied conditions and are necessary tools for policy makers for crucial decision making in the process of water resource management. These models are also essential for people at the tactical decision making level for analysing the resources and their utilisation (Briz-Kishore, 1983).

Among several complicating variables involved only those parameters which are

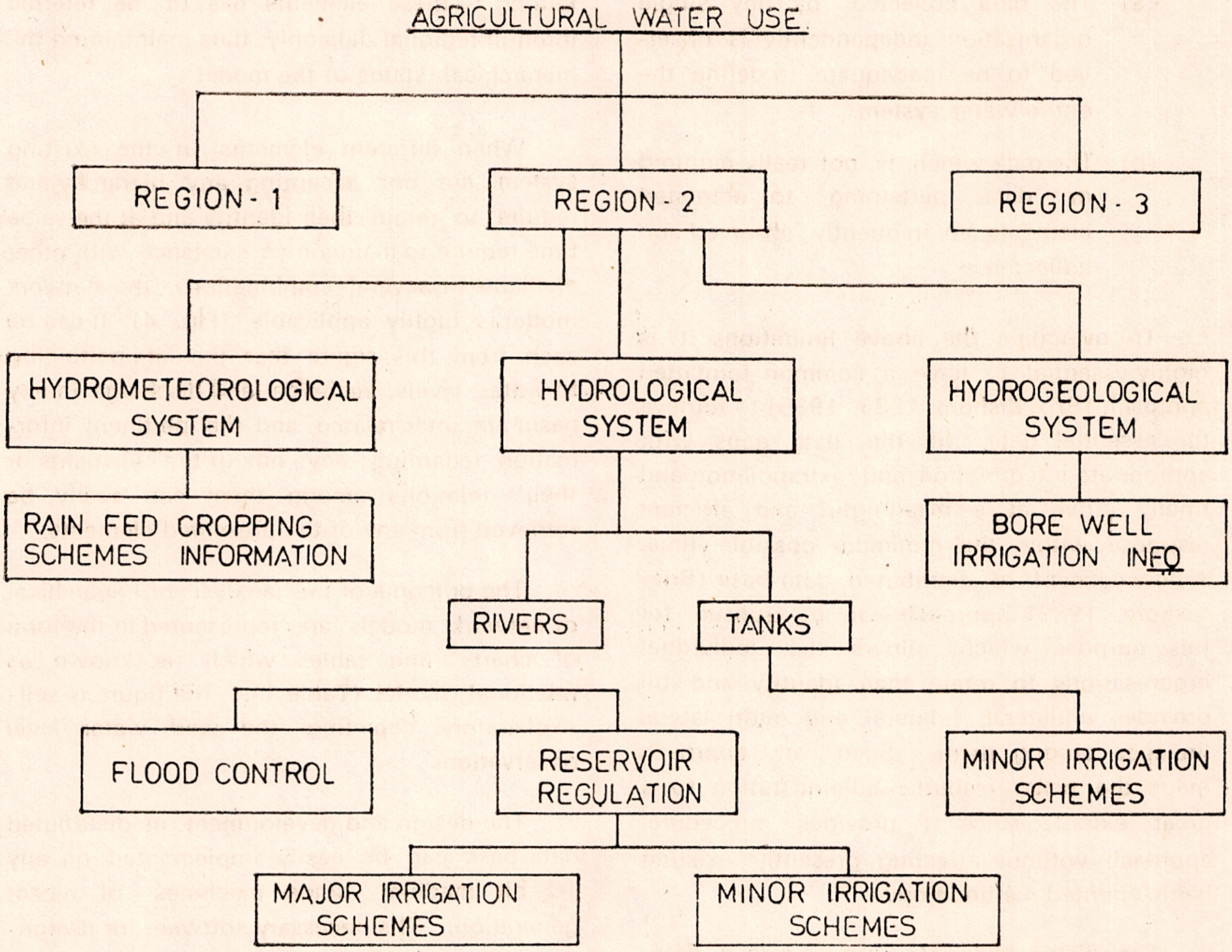

Fig. 3 A typical hierarchical model

related to the present and future conditions are to be incorporated in designing these models. Towards development of these models, the data from different subsystems of hydrological environment are to be identified and their inter-relationships are established for all constraints through statistical and mathematical techniques. The models so developed help in quantitative and qualitative estimate of water resources and their allocation for different components of integrated system. (Briz-Kishore, 1981 & 1982).

The computer models can also be used for prediction of future water levels under different recharge and discharge conditions, reservoir regulation conditions, command area development status, flood monitoring and conjunctive water exploitation method.

5.0 Conclusion

The importance of hierarchial, network and relational models for hydrological data processing and data base management is demonstrated. Broad classification for different sectors of economy is provided where data processing can be effectively applied for planning the use and comsumption of water. Distributed data base approach enables to overcome the

TABLE 1 : A view of relational model for well location and water levels

WELL LOCATION-WELL NUMBER RELATION

Well Location	Well Number
A	1
B	2
	3
	4
	5

WELL NUMBER-WATER LEVEL RELATION

Well Number	Serial Number of observation	Date	Observed water level (in metres below ground level)	Observer's Name
1	1	1-1-82	10.0	X
1	2	7-1-82	10.2	X
1	3	15-1-82	10.1	Y
5	1	1-1-82	8.5	Y
5	2	10-1-82	8.6	Y
5	3	20-1-82	8.4	X

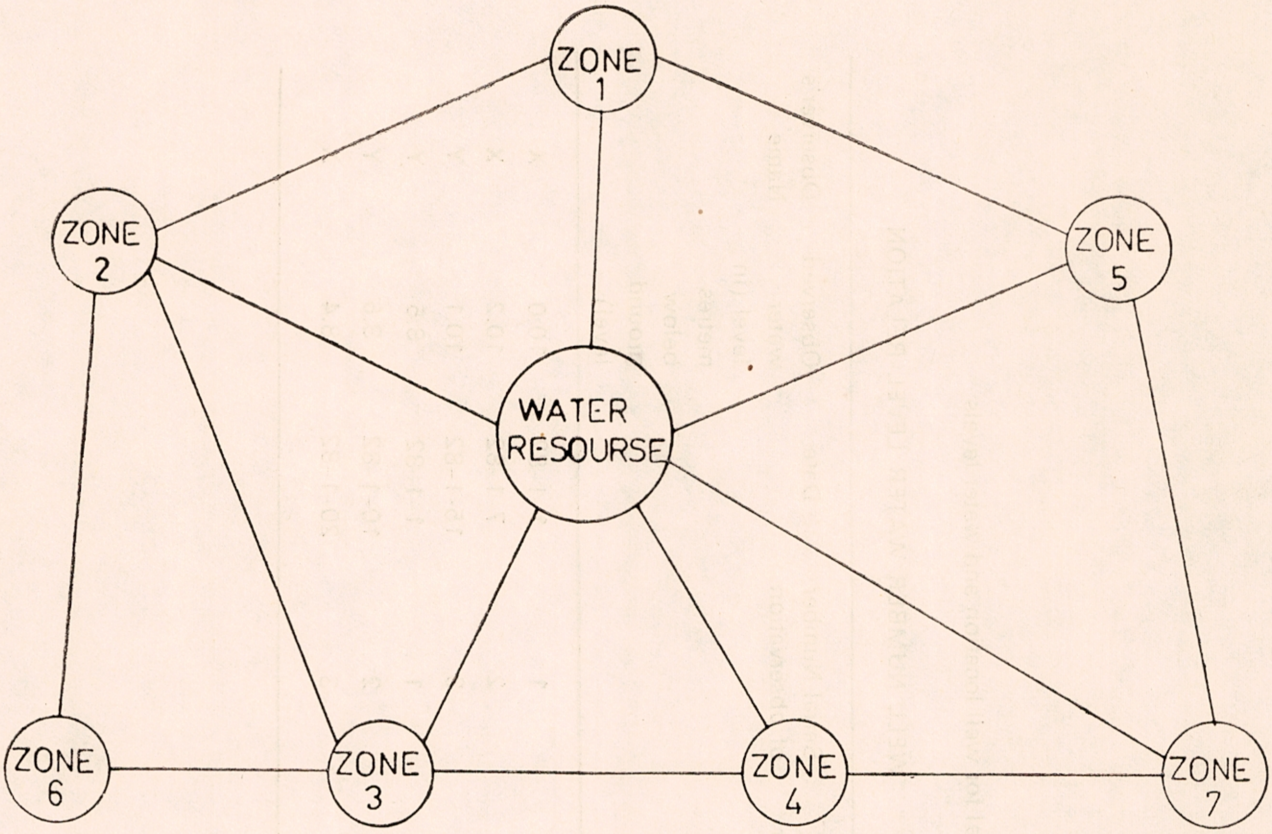

Fig. 4 A network model for water supply

problems in manual methods of data handling and helps fast review and evaluation of various resources through effective information systems.

References

Briz-Kishore, B.H. and Avadhanulu, R.V.S.S., An aquifer simulation program for micro based processors-Ground Water, July-August, 1981

Briz-Kishore, B H. and Avadhanulu, R.V.S.S., A compact modified 3-D aquifer simulation for small computers, Ground Water Journal, Ground Water, May-June, 1982 (a).

Briz-Kishore, B.H., A compact modified 3-D aquifer simulation for small computers Ground Water Journal, Ground Water May-June 1982 (b).

Briz-Kishore, B.H., An efficient procedure in the digital simulation of aquifer systems Journal of Hydrology, Vol. 64, 1983 (a).

Briz-Kishore, B,H., An approach for usage of micro computers In Ground Water Management studies; Journal of Association of Exploration Geophysicists, India, Vol. 3, No. 4, 1983 (b).

Briz-Kishore, B.H., Hydrological data base A modern tool for effective information. Journal of !nstitution of Engineers (India) Vol. 67, Part Cl 3, 1986.

Briz-Kishore, B.H., A compact SOCRATE Program for an Efficient Water Management Information System; Institution of Engineers Vol. 68, 1988.

Briz-Kishore, B.H.. Computers in Quest of Ground Water News, Vol, XI, 1986.