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Research Needs for Ground Water Management

By

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Abstract : *Ground water is looked upon too long a free commodity which could be abused, wasted and ignored. Recent critical trends of hydrological events made us to learn to live with limited resources following several managerial practices. Hence an improvised ground water management should comprise of a comprehensive plan giving due consideration for optimum social and economic benefits. The basic research components for such an effective ground water management are classified within the frame work of economic, legal, environmental and institutional aspects. Specific recommendations borne out of the present study are codified.*

1. Introduction

India, as one of the foremost developing countries, has set itself the task of mobilization and utilization of its vast natural resources for establishing a welfare society. This in turn necessiated to explore and make supplies of adequate quantity of water to meet the needs of domestic consumption and developmental purposes. Though the country is bestowed with vast surface water resources by way of perennial rivers, rivulets, springs, lakes and tanks it has been long realised that it is not possible to divert these waters for utilization to remote areas and to areas of higher elevations at reasonable costs. Systematic efforts are, therefore, being made to utilize the alternative resources of ground water in areas where surface water is not available or is inadequate.

Ground Water has several advantages over surface water. At first, ground water is available at large number of places when compared to surface water. Secondly, ground water is less prone to vagaries of monsoon, evaporation losses and pollution and thus it is more dependable than the surface waters. Further, while utilisation of surface water requires construction of big dams, barrages, transportation systems and other structures requiring high capital outlays and very long gestation periods, ground water can be tapped and exploited advantageously even by individuals with very little effort close to their place of utilisation. However, ground water occurrence being highly variable in nature, their judicious exploitation necessarily requires systematic exploration and management in a scientific manner.

Unlike several other countries, India is geologically covered by vast tracts of hard rocks. Ground Water investigations in these hard rocks are complex (Briz-Kishore, et. al. 1981, b, 1982 b) when compared to soft rock regions. The problem of Ground Water exploitation in Indian hard rock terrains is observed to be more complex in view of the highly differential nature weathering and fracturing conditions (Briz-Kishore, et. al. 1982 a). Thus it calls for an integrated strategy using all scientific disciplines that are available for exploitation to solve the problem of location of adequate, usable ground water resources in various parts of this country. All the well known disciplines such as geological, hydrogeological, geophysical and other engineering investigations, therefore, play a

prominent role in the location of water resources in our country. Once the reserves (Briz-Kishore et. al. 1983) are established, management of their planned exploitation then assumes importance.

2. Classification of Research Needs

Compared to investigations for Ground Water in soft rock regions the hard rocks are little investigated. Though Scientists have discussed (Singhal 1971, Briz-Kishore et, al. 1981, Ca) general and specific problems during development of ground water, they are mostly isolated dealing with one or two aspects only. Systems and multidisciplinary approach involving large number of parametric relations have got to be attempted.

The most important geological problem is to determine the number of aquifers, their extent, thickness and depth of occurrences, more particularly in hard rock systems to evaluate their ability for sustained hydraulic flows. The amount of water and its properties as a function of depth, porosity, permeability have to be be extracted by application of various geophysical logs. There is a need to study basic meteorological process to formulate long term forecast in weather behaviour. Various research measures for ecological balance in the areas susceptable to droughts will have to be identified. Also policies for intensive rainfed cultivation may have to be evolved, giving due weightage to the scarcity of rainfall.

Geochemical investigations should be carried out to study and evaluate the past and present hydrological conditions. The hydrochemical zoning in various ground water reservoirs will also have to be studied along with pollution problems (Briz-Kishore, 1985 a, b).

To identify and estimate recharge potentials environmental and injected tritium studies of different aquifer and soil samples during various stages of operations will have to be carried out in addition to conventional methods. Ground Water dating velocities are to be estimated through radio-carbon studies, sources of salinity and estimation of evaporation constants for surface water bodies by measurement of Deuterium and Hydrogen isotopes,

Indigenous instruments satisfying local hydrological condition is another area where there is an immediate need.

Sophisticated computer systems may be put to use by developing necessary software for executing programs for simulation of the complex hydrological systems (Briz-Kishore, et. al. 1981 a) on one side and creation of a data base system (Briz-Kishore, 1986) on the other side to arrive at future requirement. Further these computers are utilised for data integration, evaluation, mass balance and sensitivity studies (Briz-Kishore, et. al. 1982 a and Briz-Kishore, 1984).

The experimental experience for water resource must be imparted as part of advance education and extended through exercises, laboratory and field investigations which facilitate engineering scientists to tackle the problems of any kind.

Management studies is another thrust area comprising of resource planning, utilization and manpower development.

The entire classification is codified in terms of fundamental, applied and management research and is presented in Fig. 1.

3. Evaluation of Research Needs

Any research need is not only evaluated in terms of the economics of operations (benefit cost ratio) but also its viability within the frame work of legal, environmental and institutional aspects to get practical implementation. Various components of evaluation are presented in Fig. 2. There is an immediate need to incorporate and strengthen these areas for evaluating any research component in Ground Water Management.

3.1 Economic Aspects

Lowering of water levels in wells is the most common problem resulting in increased

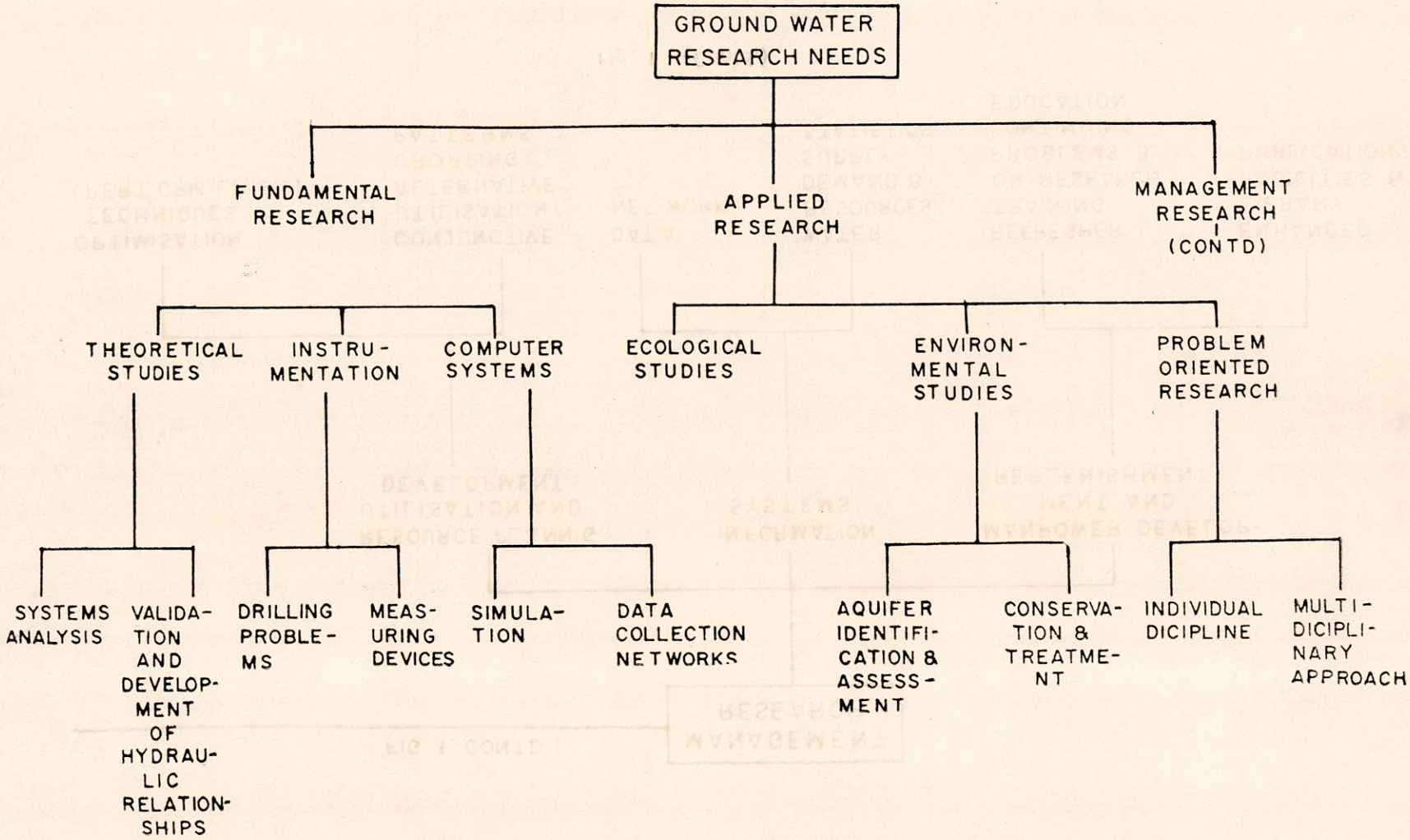

Fig. 1. Classification of Ground Water Research Needs

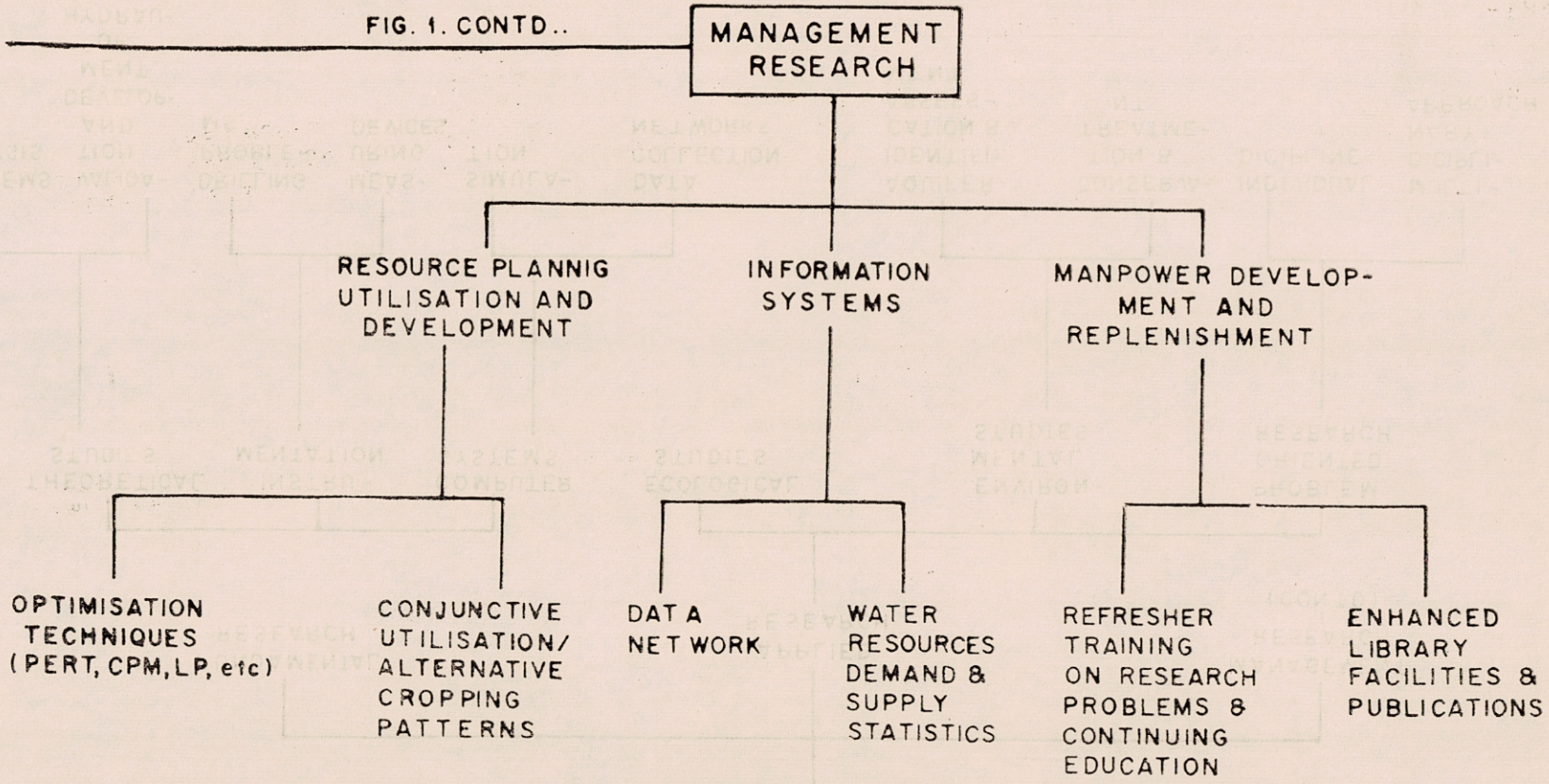
FIG. 1. CONTD..
MANAGEMENT RESEARCH
RESOURCE PLANNIG UTILISATION AND DEVELOPMENT
INFORMATION SYSTEMS
MANPOWER DEVELOPMENT AND REPLENISHMENT
OPTIMISATION TECHNIQUES (PERT, CPM, LP, etc)
CONJUNCTIVE UTILISATION/ ALTERNATIVE CROPPING PATTERNS
DATA NETWORK
WATER RESOURCES DEMAND & SUPPLY STATISTICS
REFRESHER TRAINING ON RESEARCH PROBLEMS & CONTINUING EDUCATION
ENHANCED LIBRARY FACILITIES & PUBLICATIONS

Fig. 1 (Contd.)

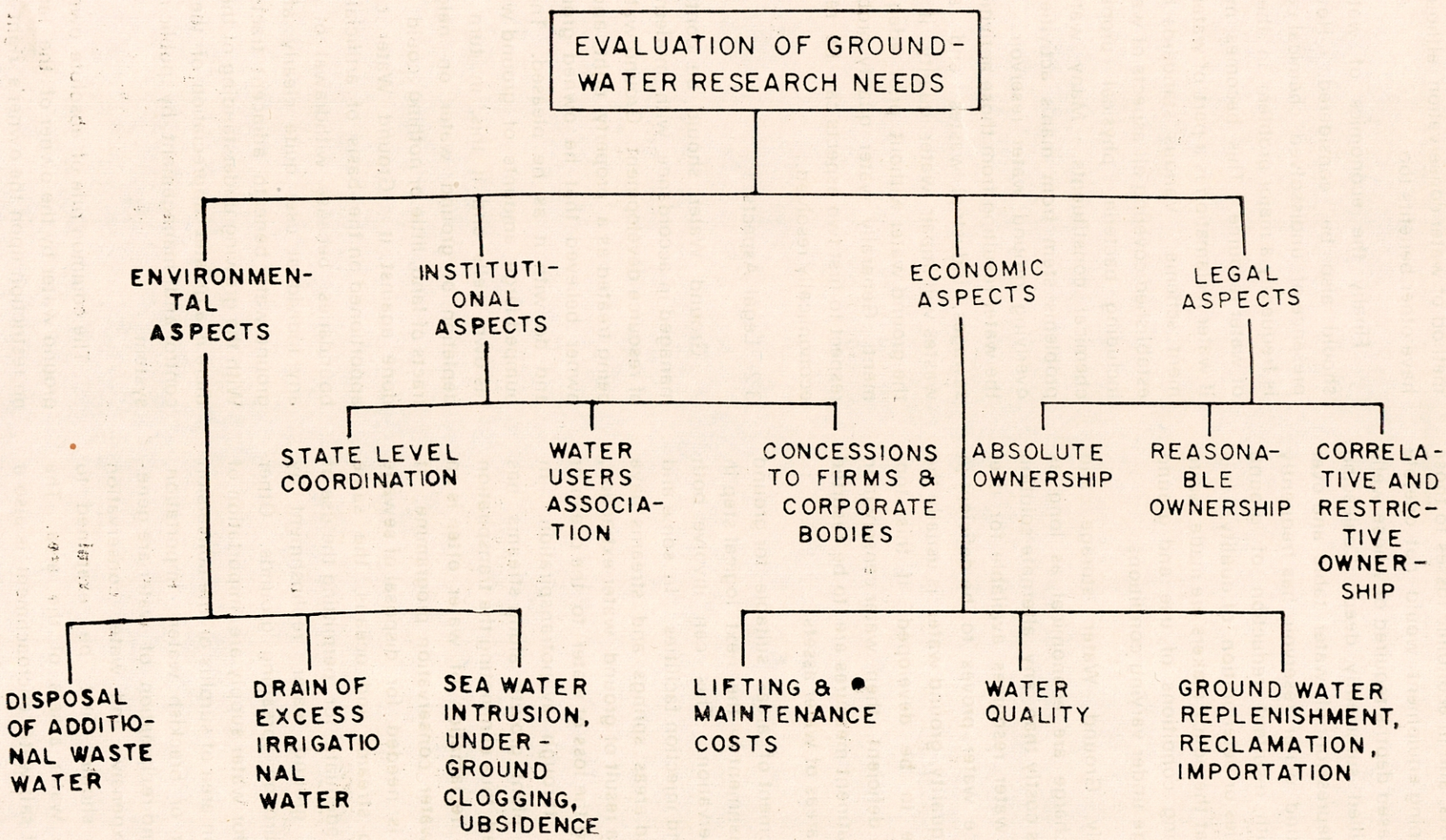

Fig. 2 Components for Evaluation of Ground Water Research Needs

pumping costs, and in economic losses to those whose pumping equipment would not operate at the increased depths required or whose wells were not drilled sufficiently deep. Coalescing cones of depression of water table and over draft of ground water reservoir has frequently occured with resultant reduction of ground water supplies or deterioration of quality. It is essential that the policy makers are made aware of the limiting conditions of use and ground water storage under varying conditions.

Secondly, Ground Water storage and artificial recharge are economical as long as they are less costly than any alternate solution for making water resources available for use. When surface water proves to be deficient in quantity or quality, ground water is usually the next source to be developed. If this, too, proves to be deficient, then water conservation or water treatment measures are to be resorted to enhance areas of water assets.

Development of areas suitable for ground water replenshment is the next logical step in water conservation. This can involve both spreading and injection facilities. In some arid and semi-arid areas springs and streams have dried up as a result of ground water extraction, thus avoiding the loss of water to the ocean or inland seas through evapotranspiration. In other areas plant growth along streams has been removed, thus eliminating the transpiration losses. The reclamation of water often is an alternative water conservation programme. If a treatment is needed for disposal of sewage effluent into streams and oceans, the same treatment is adequate for permitting the use of effluent for ground water replinshment by infiltration through spreading grounds. Other alternatives for water supply are importation of water from an area of surplus or the conversion of sea water or brackish water. Importation, conversion and reclamation of water are generally very expensive and water conservation programmes should first be examined to enhance the water assets of the area. The prevention of salt-water encroachment is also a method of water conservation although it may have other benefits too.

Finally the economics of water quality should also be considered. However the presence of undissolved chemical constituents is frequently a major problem in the utilization of water resource. This becomes more critical if water reclamation is a part of water management scheme. Various standards have been established covering all aspects of water quality including bacteria, physical properties and chemical constituents. Many water quality problems stem from man's activities on land overlying ground water reservoir. Certainly, the water resulting from those activities such as sewages, industrial wastes and radio-active wastes will impair water quality, if they enter the ground water without prior adequate treatment. Generally water quality problems with respect to first two aspects can be readily and economically resolved.

3 2 Legal Aspects

Ground Water should be controlled and managed in accordance with modern concepts of resource development. Ground water is now being treated as a property right, and the land owner believed that he owned ground water and do with it as he pleased. Thus if man pumped large amounts of ground water from his own wells and if this, in turn caused a depletion of ground water on neighbouring tracts of land, little or nothing could legally be done against it. Ground Water cannot be apportioned on the basis of artificial property boundaries, because withdrawal of water by any individual user quite clearly affects the ground water beneath adjacent tracts of land. With the growing understanding of the science, there is a greater appreciation of the need for control and management by public regulatory system.

The common rule of absolute ownership of ground water by the owner of the land places no restriction upon the owner's right of unlimi-

ted use of water. The rule of reasonable use limits the right of use of water as is reasonable with regard to the rights of all other owners of land which overlie the same source of water supply. Correlative rights which stipulates not only the use should be reasonable beneficial to the owner's land but the owner is entitled to his reasonable share. If there is no enough water to supply to the needs of all, restrictive regulations are to be applied where-ever a permit is required to drill a well.

In order to obtain reliable information on the degree of exploitation to apply control measures the water meters must be installed, maintained and periodically monitored by the competent authority. Controls should also be extended to the construction and modification of bore wells, which should be allowed to be drilled only under licence from the competent authority. It is even advantageous to make the driller legally responsible for holding a licence for each well he drills. If the driller contravenes the law, his rig may be temporarily impounded on the spot and illegal work may be stopped at once.

3.3 Environmetal Aspects

Storage and recharge programmes involve the construction of a considerable amount of public works for the purpose of spreading water over vast areas. The operation of these facilities may be detrimental to previously existing environmental conditions. Further, the increase in availability of water resource will generate new environmental problems, such as the disposal of additional waste water and draining of excess irrigation water. If the amount of water involved is in excess, rich agricultural regions may turn into swamps and deep saline ground water may come to the surface level thus destroying crops and soils. Careful attention should be given to the ecological effects of the changes which will occur in the distribution of water resources in space and time. Improper management of ground water, especially the pumping rate greatly exceeding the recharge potential, will result in sea water intrusion, underground clogging of existing wells and land subsidence.

3.4 Institutional Aspects

A clear policy defining the aims of the state Government regarding ground water investigation, development and use within the broader framework of water resource development has to be worked out. What ever may be these purposes, this policy must be supported by corresponding programme of action and by provision for setting up an organisational frame work. The form of organisation is closely related to the structure of Central Government and to local conditions. Variations can there be as wide as the limits of these two controlling factors.

Other institutional aspects to be considered include the creation of association of water users, the education of the public in respect to water use and granting.

4. Organisation of Ground Water Research

At present the research studies on Ground Water are isolated, fragmented and localised in nature. The existing system is beset with redundancy in research effort. Unfortunately, there is no apex body which can clearly codify, maintain, monitor and decipate the research. The logical steps that are involved in the systematic organisation of research are presented in Fig. 3. As can be seen from the figure it is equally essential to assess the strength and weakness of the existing Ground Water Research for further motivation towards development. Care should be taken while implementing the research to avail the enormous funding facilities for the organisation where only the research is meaningful and with highest utilisation value. The published work should be encouraged for implementing the already available solution to other analogous situations for wider applicability, utility and economy.

5. Conclusions

Various Ground Water Research needs

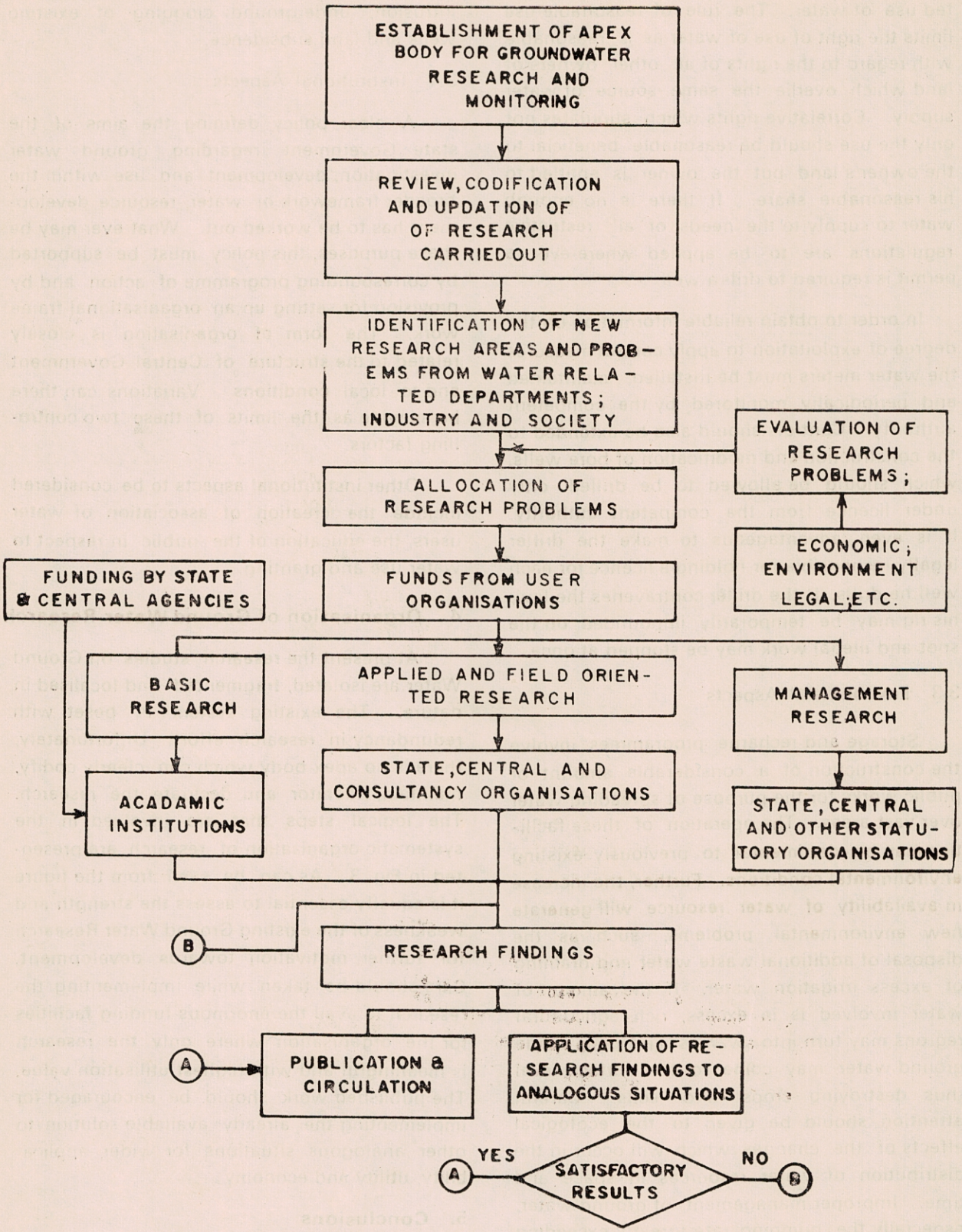

Fig. 3 Schematic presentation of organising Ground Water Research

borne out of the frame work of the present discussion are codified below :

1. Application of integrated and multidisciplinary approach for exploration and management of ground water resources.

2. Evolution of pragmatic and efficient plans for identification and quantitative assessment of ground water potential on a village scale.

3. Evolution of plans for location of suitable well sites, and pumping rates, as long term planning programme for drought prone and over draft areas.

4. Development of techniques for exploration of deeper aquifers for augmentation of water resources in drought prone areas.

5. Co-ordination of activities of different organisations in the State for cost effective returns, to avoid duplication of efforts and to more purposefully utilize the data collected.

6. Identification of origin of flouride/quality hazards for preventive measures and to provide protected water supply to rural masses.

7. Working out schemes for optimal utilization of ground water resources using modern computer modelling techniques.

8. Establishment of data collection network and data storage/retrieval centres at minimal cost for continued updating of programme strategies on rational basis.

9. Assimilation and application of modern technological advancements in the field.

10. Problem oriented specific R & D efforts on continual basis.

11. Establishment of an Apex body for codification, updation, decipation and monitoring of Ground Water Research.

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