1. INTRODUCTION

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CHAPTER 1

INTRODUCTION

Water is the most precious gift of nature to mankind. It is the principal resource connected with the progress of civilisation. Apart from drinking, the other principal uses include irrigation, power generation, industrial consumption, fishing, recreational, transportation, etc. Although a renewable resource, the availability of water with proper quality and quantity at appropriate time & space are of great importance. The Water management is very essential to maintain quality, quantity and availability of water. The problem assumes great magnitude due to increase in population, rapid urbanisation and industrial growth. Water management becomes very complex due to conflicting requirements and pollution consideration. Though its availability is limited, yet demand for water is ever increasing. It has direct impact on human wellbeing and socio-economic development. Hence, the need of judicious planning and proper management of this precious resource has become the matter of utmost urgency.

Groundwater, unlike other natural resources, is replenishable. Its distribution and occurrence varies in
time and space. The unused groundwater potential is one of the national assets. When properly used, this water will help to assure adequate municipal water supplies to provide growing industrial needs and to ensure constant irrigational use even in adverse climatic conditions. According to Sinha (1983), groundwater claims 50 percent of India's total irrigational requirement. Phenomenal rise in agricultural production in the country, making it self-sufficient in food, is due to the emergence of high yielding varieties of seeds and utilisation of groundwater as an assured source of irrigation. While making provision for irrigation water, it is essential to channelise groundwater reservoir in the irrigation system. Currently, groundwater development is being restricted within average annual recharge for fear of overdraft condition.

Precise assessment of the availability of groundwater resources is very essential before launching any action plan for their development. The need for assessment of the potentiality of both surface and groundwater has become particularly precarious because of the accelerated rise in the investment cost of the irrigation projects for utilisation of the scarce water resources. Any error in the assessment would result in unavoidable wastage of construction of canal network or blocking of huge investments, ultimately resulting in huge recurring financial losses. Similarly, over estimate of groundwater resources is likely to result in blocking of Institutional
funds through highly overdue position of farmers with lending banks. The precise and systematic assessment of available surface and groundwater resource was, therefore, considered as *Sine-qua-non* for planning and development of water resources of India. Its first stage of planning began systematically in 1951 and was reviewed periodically thereafter.

Assessment of groundwater resources in the subsurface reservoir includes assessment of both static and dynamic components of the available water in storage. The assessment of static storage is, however, not normally required for consideration of resource use. What is more needed is the dynamic or replenishable component of the resource, the assessment of which over any space and time is best done by the water balance techniques.

According to *Rao* (1975), the average annual rainfall of our country is 114 centimeters. Based on this, he has estimated that the total annual rainfall over the entire country is of the order of 370 million hectare-metres and one third of this is lost in evaporation. Of the remaining 247 million hectare-metres of water, 167 million hectare metres goes as run off and the rest of 80 million hectare metres goes as subsoil water. Out of this 80 million hectare metres of subsoil water that seeps down annually into the soil, about 43 million hectare metres
gets absorbed in the top layer, thereby contributing to the soil moisture, the balance of 37 million hectare metres is the contribution to groundwater from rainfall. The average annual groundwater recharge from rainfall and seepage from canals and irrigation system is of the order of 67 million hectare metres, of which 40 percent i.e. 27 million hectare metres is extractable economically. The present utilisation of groundwater is roughly half of this (13 million hectare metres) and about 14 million hectare metres is available for further exploitation and utilisation.

According to the figures published by the Central Groundwater Board in 1986, the "ultimate potential" of groundwater is far bigger than the 40 million hectare metres mentioned in the 7th plan document. According to these figures, the annual utilisable groundwater resources of the country are 42 million hectare metres of which only 10 million hectare metres are being abstracted today to create "Utilized Potential" of 26.1 million hectare metres. If these figures are correct, a little calculation will show that the total potential of groundwater is very nearly 110 million hectare metres. Although at first sight this figure looks too good to be true and the Central Groundwater Board is currently engaged in making a fresh assessment on the basis of well observations. It is relevant to point out that groundwater accounts for more
than 95 percent of all the liquid fresh water available on the earth at any given moment and therefore, exists in much larger quantities than may be popularly imagined. There is accordingly no reason whatsoever to doubt that groundwater can take care of the additional potential which will need to be created if the "major" and "medium" route is abandoned.

"The problem of water management in our country arises basically from the circumstance that although the total annual rainfall is large enough to place the entire land surface under water to a depth of over one meter, it is not spread evenly either in terms of space or time. This makes it necessary to conserve as much water as possible during the brief monsoon season so that it may be available for use during the long dry season, not only locally but if possible also in arid areas situated at a distance". (Vohra, 1987)

Since the inception of planning, shortly after independance, the full extent of the potential possessed by underground aquifers, not only for the storage of vast quantities of water but also for its movement over long distances was not known. The availability of pumping equipments and the energy needed to operate them was also restricted. On the other hand, the success of big canal systems served by river diversion projects was already well
established. In the circumstances it was only natural that our planners should have decided to take advantage of recent advances in construction technology to build big storage dams at suitable sites in the upper reaches of rivers to provide large scale irrigation facilities. The fact that many such projects are called "Major" and "Medium" projects in irrigation terminology also offered substantial side benefits like hydel-power and flood control proved to be an added attraction. This is how big projects became a craze during the fifties and sixties, and State Governments vied with one another to get as many of them built in their territories as possible.

In the Scramble which followed, the planning process became a major casualty. A very large number of "major" and "medium" projects were taken up without adequate studies and without even making sure that there would be enough financial resources to finish them in time. At the same time experience with projects which irrigation departments considered to be complete in all respects showed that they contained no provision for taking water from the outlet in the last distributary to the farmer's field. While designing almost all the irrigation projects, the effects of irrigation on the total environment of the command have not been given a serious thought. The effect of introduction of artificial impounding of waters on the soil, groundwater and vegetative environment has
generally been neglected. Such a planning has created imbalances in parts of the command areas of the existing irrigation systems (Vyas, 1984). Apart from this, an embarrassing gap emerged between the irrigation potential which was claimed to have been "created" and the potential which was actually utilized. In undulating terrains, the failure to arrange for the proper levelling and shaping of farmer's field on the basis of entire outlet command as a unit for planning, made things even more difficult, and contributed significantly to low productivity levels. The absence of drainage facilities coupled with seepage from unlined canals and distributaries aggravated problems of water logging, soil salinity and alkalinity in large areas and converted what should have been a blessing into a curse. It is a great pity that although irrigation establishments were repeatedly warned in the clearest possible terms of the dangers of ignoring problems of water utilization as far back as the early seventies, they merrily went ahead with their plans to create "additional potential". As a result, 25.10 - 5.2 million hectare metres out of 20.8 million hectare metres of the potential created by "major" and "medium" projects from 1951 to 1985 remained unutilized at the end of the sixth plan (Vohra, 1982).

Although the seventh plan document stresses the need for making further "massive investments" in the "major"
and "medium" irrigation sector till its remaining untapped potential of 33.2 million hectares has been fully harnessed. It is clear that such a programme will need to be redesigned on various grounds. In the first place, it is doubtful whether the kind of investment which will be required for such a venture will be at all forthcoming or not. Cost of creating fresh potential have soared from ₹1200/- per hectare in the first plan to an unbelievable ₹27,000 in the seventh plan. However, if the additional investment necessary for converting "potential created" into "potential utilised" is also taken into account, the final cost per hectare is not likely to be less than ₹40,000 at current prices or ₹1,32,800 crores for 33.2 million hectares (Vohra, Op. cit).

Even if investment is no constraint which is unlikely, would it be wise, to continue along the "major" and "medium" route when an definitely cheaper, quicker and more efficient alternative is available in the form of groundwater? It is necessary to remember in this connection that groundwater requires no expenditure for storage and transport, and can be harnessed by the farmer with his own efforts with the help of short term loan within a matter of weeks if not actually days, and can, therefore, be developed through the efforts of millions of private individuals on an infinitely wider front and practically in all parts of the country within a far
shorter period of time than surface water. It also involves no environmental problem such as the submergence of good lands under storage and canals, and no evaporation and seepage losses which take away more than 50% of the waters released from reservoirs before they reach the farmer's fields. It does not create any problem of water logging. Above all, it is a resource entirely under the farmer's control and requires no huge bureaucracies before it can be put to work. It can thus be applied exactly when and to the extent required of the crop on lands which the farmer can level and shape with his own unaided efforts.

Therefore, on consideration of enormously beneficial nature of this resource, the author has taken to study the problem of "PLANNING AND MONITORING OF GROUNDWATER AVAILABILITY, UTILISATION, QUALITY AND ITS IMPACT ON ENVIRONMENT IN TAIL REACHES OF MATATILA COMMAND AREA (M.P.)."

1.1 BRIEF DESCRIPTION OF THE MATATILA COMMAND AREA:

Matatila dam is built across the river Betwa near Jhansi town in Uttar Pradesh. Its command area forms a small part of the Yamuna drainage basin and is bounded by Sind and Pahuj river. The Pahuj river is a tributary of the river Sind which, in turn, is a tributary of the Yamuna river. Matatila reservoir is the source of water for the
Photograph No. 1

A View of the Matatila reservoir
near Jhansi District (U.P.)
FIG. 1.1
LOCATION INDEX MAP OF TAIL REACHES OF THE MATATILA COMMAND AREA (M.R.).

SCALE

3 6 Kms.
command area and is a joint venture of Madhya Pradesh and (Photograph No.1). Uttar Pradesh States. The total cultivated area of the Matatila command in Madhya Pradesh is 1,09,621 hectares, whereas the gross command area is 1,21,152 hectares. The main canal known as the Bhandar main canal, irrigates parts of the Bhandar tehsil of Gwalior district, Seondha Tahsil Datia district and Lahar tehsil of Bhind district. The Bhandar canal has three major distributaries known as Daboh distributary, Akhdeva distributary and Lahar branch canal. The Bhandar Canal System is shown in the Fig. 1.1.

The cultivated area coming under the Bhandar canal in the Datia district is about 26,923 hectares, while in the Gwalior district it is 17,800 hectares. The gross command area, available for irrigation is about 27,076 hectares in the Datia district and 20,882 hectares in the Gwalior district.

The length of the main Bhandar Canal is 57.6 kms and the length of its branches and minors amounts to 389.05 kms. The depth in the middle of the canal is 6.36 metres and is 0.56%. The full supply depth of the canal is 3.33 meters. The head discharge from the main canal is 985 cusecs, whereas in the Daboh distributary, it is 292 cusecs. The Lahar branch canal has a discharge of 610 cusecs.

The main Bhandar Canal is a Contour Canal bank, irrigating the farmlands on the right of the Canal.
The distributaries of this canal irrigate on either side.

1.2 **SELECTION OF THE STUDY AREA:**

The selection of the present study area has been made on the following grounds:

1. The entire Matatila command area is yet unstudied with no detailed literature available as far as hydrogeological and geoenvironmental studies are concerned.

2. The study area is faced with various geoenvironmental problems like water logging, soil erosion, headward erosion, formation of ravines, soil salinity, soil alkalinity and deterioration in the quality of ground water. Most of the productive agricultural land existing in the area is barren because of waterlogging and soil salinity. The productivity of such soils can be restored by adopting specific scientific soil management and reclamation techniques. At present, adequate information is not available about the geographic distribution and extent of the area facing such problems. Therefore, this study has been carried out for delineating the accurate geographic distribution and extent of the areas facing the aforesaid problems.
3. Ground water has gained top priority due to its ever increasing demand for irrigation and domestic uses. In order to maintain balance in the ground water recharge and draft monitoring of groundwater is most essential.

In addition to this, the author has taken up study of these problems in the lower reaches of Matatila command (Lahar Tahsil of Bhind District and Seondha Tahsil of Datia District), with a view to find out solutions of these problems which may be beneficial to the State of Madhya Pradesh and the cultivators of the area.

1.3 **LOCATION AND EXTENT OF THE STUDY AREA:**

The area of the tail reaches of Matatila command falls on the Survey of India toposheet Nos. 54 K/9, 54 K/10, 54 K/11, and 54 J/12, 54 J/13, 54 J/15 and 54 J/15. The area mapped geologically falls between (Longitude E 78°35' and E 79°) and (Latitude N 26° and N 26°25'). The region under investigation, covers a total area of about 2001 Sq.Kms. The area under study falls between Sind River (West) and Pahuj River (East). To the south-west lies the boundary of Bhandar tehsil of Gwalior district. To the East lies the boundary of U.P. state. To the North, the area is bounded by Bhind town.
1.4 ACCESSIBILITY:

The area is approachable by train as well as by bus (Fig. 1.2). The Seondha and Lahar tahsil of Datia and Bhind district respectively are the important towns which fall in the Command area. The Datia town is situated on the Jhansi-Gwalior National Highway. It is the district place and from this town the Matatila Command is approachable by the buses. No railway lines run across the area under study. The entire area, except during the rainy season, is approachable by the bullock carts. Some of the tracks, for example along the main Bhandar Canal and its distributaries are motorable during the dry season.

1.5 PERIOD OF STUDY:

The field and laboratory studies were carried out from the month of March-April, 1988 to the end of March, 1989. In all, the total five calender months were spent in the command area for field work. Rest of the time has been devoted for the analytical work. In addition, the research work has been done for nine months at the "Remote Sensing Applications Centre" Bhopal. During this period a geological map of the area has been prepared on a scale 1:250,000 using Landsat-5, thematic mapper (FCC) which is later verified by field visits, to show the various geological units in the area. In order to demarcate groundwater potential zones, geomorphological and
hydrogeomorphological maps of the study area are also prepared from the Landsat-5-Thematic mapper, false colour composit during this period.

1.6 PREVIOUS WORK:

The Directorate of Groundwater Surveys, Govt. of M.P. had carried out a preliminary groundwater survey in parts of the study area. Chourasia et al. (1979) had done "Studies on the conjunctive Use of Water in Lower Reaches of the Bhandar Command, under M.P. Groundwater Development Project, University of Sagar. Chourasia, et al. (1976, 1978) had also carried out studies on Conjunctive Use of Waters in the Chambal Command area. No scientifically systematic work has been carried out so far, in the area as far as its Geoenvironmental problems are concerned. Therefore, the area is adequately attractive for this type of study.

1.7 METHODS OF STUDY:

The investigation was initially directed to carry out reconnaissance survey for groundwater investigation through technology development for the time and cost effective methodology. Landsat-5 TM, False-colour-composit on 1:250,000 scale has been visually interpreted for regional reconnaissance survey which is required to zonalise the groundwater potential areas. The use of
Remote Sensing data as a primary step helps in specifying the target areas for further detailed study. This greatly reduces the cost and time in investigation of groundwater. Based on the data obtained from the above studies the important methods selected for study are as follows:

(1) Preparation of a regional geological map and interpretation of various geological aspects with the help of remote sensing techniques (Fig. 2.11).

(2) Preparation of geomorphological and groundwater potential maps using remote sensing techniques (Fig. 2.4 and 2.15).

(3) Assessment of the various geoenvironmental hazards, viz. water logging, soil salinity, etc., with the help of remote sensing techniques (Fig. 2.7 and 2.8).

(4) Preparation of the vegetation map and delineation of regional geological structures present in the study area (Fig. 5.10 and Figs. 2.5 and 2.6).

(5) Collection and interpretation of hydrometeorological data pertaining to the area under investigation.

(6) Collection of the borehole data and its interpretation with the help of correlation sections and fence diagram in order to delineate subsurface geology of the study area.

(7) Study of physiographic features of the Sind drainage basin.
(8) Preparation of average slope map and relative relief map of the study area.

(9) Morphometric analysis of the Sind Pahuj drainage basin.

(10) Preparation and interpretation of groundwater level maps. viz premonsoon, post monsoon, water level fluctuation maps.

(11) Interpretation of vertical electrical soundings data conducted in the study area.

(12) Determination of coefficients of transmissibility and storage of the aquifer using Papadupulus-Cooper's & Theis Non-equilibrium Method.

(13) Collection of water samples from surface & groundwater, their analysis and interpretation.

(14) Determination of the suitability of water for its utilisation.

(15) Preparation and interpretation of isopach map of the first aquifer and determination of water yielding and holding capacity of it.

(16) Determination of groundwater balance of the basin using the norms suggested by groundwater estimation committee, Govt. of India.
(17) Planning for future groundwater development.

(18) Demarcation of suitable areas for groundwater exploitation by various methods.

(19) Collection of soil samples and their analysis.

(20) Study of the various geoenvironmental aspects of the area under investigation.