

## **GROUND WATER STUDIES IN RAJASTHAN & GUJARAT (1967-71, 1971-74)**

**Location :** Rajasthan and Gujarat

**Area Covered :** 1,00,000 Sq.Km.

**Region:** Arid and Semi-arid regions

**Collaboration:** UNDP, Indigenous

### **Objectives:-**

The Project objective was to evaluate the ground water development potential of arid and semi arid Western Rajasthan and semi-arid Gujarat.

### **Findings:-**

- The Project was executed in two Phases.
- Phase I covered an area of 60,000 Sq.km. in parts of Rajasthan covering the districts of Jaisalmer, Barmer, Jodhpur and Jalore. The studies brought out the existence of prolific sources of water in the scarcity hit Lathi area of Jaisalmer, and Doli and Borunda areas of Jodhpur. Annual replenishable resource of 77.5 million cubic metres capable of supporting over 100 heavy duty tubewells was proved in this desert belt.
- Phase II covered 40,852 Sq .. km. in Rajasthan and 11,500 sq.km. in Gujarat. In Rajasthan area, a total additional annual replenishable ground water potential of 607 million cubic metres (of T.D.S content less than 5,000 milligrams per litre) was proved. However, if water of only less than 3,000 milligrams per litre of Total dissolved solids content was considered, the additional ground water development potential was of the order of 497.18 million cubic metres capable of supporting more than 1400 heavy duty tubewells.
- Prospective areas in Jodhpur, Jhunjhunu, Nagaur, Sikar and Bikaner districts were delineated for further development of the resources.
- In the Gujarat Project area, total ground water development potential proved was of the order of 193 million cubic metres per year of which the usable resources was of the order of 135 million cubic metres per year.

## **SIDA ASSISTED COASTAL KERALA GROUND WATER PROJECT (1983-88)**

**Location:** Kerala

**Area covered :** 23,300 Sq.km.

**Basin:** West flowing rivers from Vamanpuram in the south to Kadalundi river basin in the North

**Collaboration:** SIDA

### **Objectives:-**

- To evaluate ground water resources of various lithounits and their development prospects
- To evolve the methodology of ground water recharge and discharge parameters for evaluation of resources in sedimentary basins.
- Developments of new methods of storage and retrievals of hydrogeological data.
- Optimum development of ground water development in coastal areas to control the salinity ingress and suitable design of ground water well.

### **Findings:-**

- Deep seated fractures extending over long distances have been observed all along the project area.
- The major fractures direction identified are N-S, NNW-SSE, NW-SE, WNW-ESE, E-W, ENE-WSW and NE-SW.
- In the crystalline rocks two types of aquifers have been identified based on exploratory drilling down upto 300 depth, viz low to moderately permeable aquifers with thickness less than 25 m, moderate to high permeable aquifers with total thickness ranges from 7-130m.
- Warkali and Vaikom beds of tertiary sediments forms potential aquifers with total 5-40m thick granular zones.
- Quality of water in shallow aquifers are generally fresh with EC < 1000 microohms/cm at 25 °C except pockets close to back water or coast. Quality of water in deep fractured rock aquifers is good with low TDS and fluoride contents (0.1-1.0mg/l).
- The calibrated model gave a fair degree of agreement between simulated heads and observed heads within permissible limits.
- Three different types of relational data base management systems were studied and DATA FLEX systems has been found most suitable one.

## **GROUND WATER STUDIES IN UPPER YAMUNA RIVER BASIN (1973-77)**

**Location :** Haryana, Uttar Pradesh, Himachal Pradesh & Union territory of Delhi.

**Area Covered :** 25,000 Sq.km.

**Basin:** Upper Yamuna

**Collaboration:-** Indigenous

### **Objectives:-**

- To evaluate ground water resource potential in the basin to determine whether the development of deeper aquifers in Haryana would have any large scale effect on ground water availability in U.P
- To evolve the methodology and empirical norms for evaluation of resources in sedimentary basins
- To identify area suitable for development through various ground water structures

### **Findings:-**

- Three aquifer groups along with their aquifer parameters and chemical quality were determined.
- Surface Hydrology and hydrometeorology were analysed.
- Well design and cost of well construction and economics of tubewell irrigation were worked out.
- Ground Water draft was assessed and water balance study of aquifer-I was undertaken.
- Mathematical model studies indicates that River Yamuna has a distinct silt layer under its bed downstream of Kalanaur which gradually increases in thickness in lower reaches. The presence of such layer considerably reduces the stream aquifers interaction in the downstream reaches.
- The presence of gradually increasing silt layers below Kalanaur acts as a separating blanket between the river and underlying aquifers and the base flow generated in the upper reaches of river is preserved because of the diminishing stream aquifers interaction.

## **NARMADA RIVER BASIN PROJECT (1971-75)**

**Location:** M.P. & Gujarat

**River basin:** Narmada

**Area covered:** 29,085 Sq.km. ( 25,900 sq.km. in Madhya Pradesh & 3,185 Sq.km. in Gujarat).

**Collaboration:-** Indigenous

### **Objective:-**

- To establish the surface and ground water systems of closed basin with an outfall area close to the sea and possibilities of assessing the advancement of salt water front as a sequel to the development of the coastal fresh water aquifers.

### **Findings:-**

- Specific photogeological techniques, chemical monitoring of the salt water front and identification of areas for experimental study of artificial recharge were applied as part of the programme.
- The work proved the availability of 1027 million cubic metres of replenishable resource available for further development through construction of 1640 shallow and 1177 deep tubewells.
- In the outfall area of Gujarat, it was seen that the development of resources has reached near optimum limit and any further strain on the system is likely to result in the landward movement of saline water wedge near the coast.

## **PROJECT FOR GROUND WATER EXPLORATION IN BIHAR (1968-71)**

**Location:** Gaya District, Bihar

**River basin:** The Ganga

**Area covered:** 3,900 Sq. km.

**Collaboration:-** The Netherland Government

### **Objectives:-**

- To study the hydrogeology related to water well design in a small well-field area,
- construction of production wells for agricultural purposes,
- Study of suitable well designs for well economics as well as to arrange on the spot training programme for drillers/ operators on water well drilling techniques and use of water lift appliances in alluvial areas.

### **Findings:-**

- Under this programme, about 500 production wells were constructed.

## **WATER BALANCE STUDIES IN VEDAVATI RIVER BASIN (1974-79)**

**Location :** Andhra Pradesh & Karnataka

**Basin :** Vedavati

**Area covered :** 24.000 Sq.km.

**Collaboration:-** Indigenous

### **Objectives:-**

- To develop methodology of assessing ground water potential of hard rocks in economically backward drought prone areas and to estimate the quantity of ground water that could be developed on sustained basis.

### **Findings:-**

- The work has revealed that the area holds potential for additional development of ground water of the order of 530 million cubic metres annually.

## **GROUND WATER STUDIES IN SINA AND MAN RIVER BASINS, SOUTH MAHARASHTRA (1975-80)**

**Location** : Maharashtra  
**Basin** : Sina and Man  
**Area covered** : 16,680 Sq. km.  
**Collaboration:-** Indigenous

### **Objectives:-**

- Evaluation of ground water resources.
- To formulate methodology for ground water exploration in the hard rock areas, and in the Basaltic areas in particular.
- To integrate ground water and surface water data needed to plan optimum use of water and to find out suitable methodology for artificial recharge etc.

### **Findings:-**

- Deccan traps is the dominant rock type in the project area.
- 32 basaltic flows have been demarcated in the area which do not show any major structural disturbance.
- Weathering is the main factor which controls the movement and storage of ground water in the impervious basaltic rocks. Fractures and joints also have developed secondary porosity but it is restricted only upto the depth of 40 m.
- Three distinct aquifer systems have been identified, namely shallow aquifers( upto 20 m depth)yielding water under unconfined condition, the semi-confined aquifers( upto 40 m depth), and the confined aquifers comprising intraflow weathered material between the depth of 40-175 m.
- The yield of well tapping shallow and semi-confined aquifers vary from 2-14 LPS, while deeper aquifers have limited yields of 0.25-2 LPS.
- The work done on the Project proved availability of 1170 million cubic metres additional ground water resources which can be developed by 97,500 additional ground water structures which will bring additional 1,95,000 hectare of land under irrigation.

## **GROUND WATER STUDIES IN NOYIL AMRAVATI AND PONNANI RIVER BASINS (1975-79)**

**Location** : Tamil Nadu and Kerala States.

**Area covered** : 8150 Sq.km.

**Basin** : Noyil, Ponnani , Vattamalai Karai,(tributary of Amravathi)

**Collaboration:-** SIDA

### **Objectives:-**

- To determine the water budget for the basins with due respect to quality as well as quantity, using hydrometeorological, hydrological, photogeological, geophysical and hydrochemical surveys and nuclear techniques.
- To optimize ground water extraction structures through study and critical analysis of results from existing wells.
- To study the ground water development and agriculture use on different soil and crop.
- To establish the overall water resources with emphasis on ground water of the hard rock basins
- To impart training to the staff of the central and state organizations and to the post graduate students.

### **Findings:-**

- Exploratory drilling in hard rock area was done upto 300 m for the first time by CGWB
- The study has revealed that the water bearing fractures could occur beyond 200 m depth in hard rock also.
- Ground water prospecting methods adopted in the project have yielded promising results and well failure have been minimized.
- Construction of sub-surface dykes in Kerala for storing sub-surface runoff, "Underground" has been done successfully for utilization to raise second and third crops
- The studies have revealed that additional ground water resources are available in Noyil basin is about 45 MCM, in Ponnani basin about 300 MCM and in Vattamalai basin about 44 MCM, for further development.
- The training was imparted to Tamil Nadu & Kerala state govt, CGWB officers and post graduate students of universities.

## **INDO BRITISH BETWA GROUND WATER PROJECT (1975-79)**

**Location :** Madhya Pradesh & Uttar Pradesh.

**Basin :** Upper Betwa River

**Area covered :** 20,600 Sq.k.m

**Collaboration:** U.K

### **Objectives:-**

- To evaluate the ground water resources of the upper catchments of the Betwa river basin.
- To refine and apply appropriate technique for assessment of ground water resources of the basin and to extend its applicability over other areas of similar hydrogeological conditions.
- To develop methodology for achievement of optimum abstraction regime for the project area, with a view to its applicability in other areas with comparable hydrological conditions.

### **Findings:-**

- In Deccan Traps formation, three aquifer systems i.e shallow(<30m) , deeper(30-60m) and Deep(> 60 m) were identified.
- Ground Water quality of shallow aquifers was good to excellent for irrigation purposes with few exceptions. Higher Fluoride (>1 mg/l) was observed in some deep aquifers.
- Annual dynamic ground water reserves were estimated as 811 MCM, with safe yield of 690 MCM. Static ground water reserves in shallow aquifer were estimated as 751 MCM.

## **GROUND WATER STUDIES IN GHAGGAR RIVER BASIN (1974-78)**

**Location :** Parts of Punjab, Haryana, Rajasthan, Himachal Pradesh and the UT of Chandigarh

**Area covered:** 42,200 sq.km.

**Basin:** Ghaggar River

**Collaboration:-** UNDP

### **Objectives:-**

- The main objectives was to establish a basis for planning the use of water resources in the Ghaggar river basin in support of agriculture.
- Quantification of Ground water resources of the basin
- Identification of the areas of over exploitation.
- Establishing the feasibility of artificial recharge of the aquifer
- Investigate the areas of water-logging problems
- Studies of the chemical regime
- conducting digital model studies for management of the ground water in conjunction with surface water.
- To train personnel for such work in future

### **Findings:-**

- Mathematical model for ground and surface water management was prepared.
- Ground Water potential in the basin were assessed.
- Surface resistivity Surveys(VES ) and profiling were carried out with emphasis on the kandi area and possibility of artificial recharge of aquifers with flood waters was studied.
- Drilling programme for creation of network of observation well was completed.
- A training programme for central staff were carried out in all the phases of the project.
- In water logged areas, overdeveloped areas, areas with special interest, etc reevaluation of ground water condition should be carried out more frequently to enable adjustments in the corrective measurements

## **GROUND WATER STUDIES IN KASAI AND SWARNAREKHA RIVER BASIN (ASSISTED PROJECT 1985-1990)**

**Location:-** Bihar(Now Jharkhand), Orissa & West Bengal,

**Basin:-** Parts of Ganga and Brahmani Basin

**Area :-**29,700 sqkm

**Collaboration:-**UNDP

**Objectives:-**

- The main objective of the project is to assess the ground water potential in the study area and to develop adequate ground water abstraction technology
- To build up in the concerned States and the Central Ground Water Board capabilities in hard rock hydrogeology, modelling of complex hydrogeological conditions and capacity to undertake feasibility studies in related areas to facilitate future investment decisions.
- Improving the economic conditions of the tribal population in the drought prone hard rock areas of Bihar(Now Jharkhand), Orissa and West Bengal.

**Findings:-**

- The area ranges in altitude from 80 - 700 m and is characterised by widely varying geomorphic features like, undulating plains, structural hills, plateau scarp etc.
- The area is underlain predominantly by Singhbhum granites with criss-cross dolerite dykes, Chotanagpur granite, metasedimentaries, limestones and sand stones of Kolhan formation.
- The area is characterised by three major thrust i.e. Singhbhum shear zone, Dalma thrust and Manbazar thrust and different linear structural features.
- Weathered mantle, saprolite zone, shallow and deep fractures have been identified as repository of ground water in the area.
- The weathered mantle has variable thickness in different litho-units, average being 12-16 m. It constitutes the shallow aquifers which contain ground water under phreatic condition.
- The saprolite zone is persistent throughout the area. The thickness of this zone is around 4m but seldom exceeds 8m. The groundwater occurs under semi-confined condition. The discharge varies between less than 1 to less than 3 Ips for draw down between 10 and 18m respectively.
- The bed rock fractures have been identified down to 140 m in Singhbhum granite and meta sediments; 110m in Chotanagpur granite The productive fractures are broadly aligned in NE-SW, NW-SE, E-W direction. The frequency of the fractures decreases with depth. The discharges from bed rock fractures varies between 3 and 8 Ips and drawdown more than 18m with the maximum of 45m.

## **Canadian Assisted Ground Water Project (1967-71, 1971-74)**

**Location :** Andhra Pradesh & Karnataka

**Area Covered :** 11,620 Sq.Km.

**Collaboration:** Canada

### **Objectives:-**

- To develop the methods of ground water resource evaluation in hard rock areas using hydrogeological mapping and water balance techniques.

### **Findings:-**

- Ground Water in granitic terrain occurs in sheet fractures under semi-confined conditions. Ground Water recharge areas comprise approximately 70% of the drainage basins under natural conditions
- In basaltic terrain ground water occurs in laterite-Basalt contact zone, weathered zone, vesicular lenses, sub-trappean alluvium and fractured granite zones underlying shallow basalts. Ground Water recharge areas comprise approximately 90% of the drainage basins under natural conditions
- The long term annual recharge in the area ranges from 2-5 % of average annual rainfall in valley bottoms(discharge areas) and 15-20% in upland(recharge areas)
- Average dynamic ground water reserve in the area approximately 8.3% of average annual rainfall and static ground water reserve in the area approximately 15% of average annual rainfall in valley areas and 50% in upland areas.
- Iron, Floride and Nitrate concentrations are higher than recommended limits in parts of the area.