# BASIC HANDBOOK OF IWS INDUSTRIAL TRAINING

**Abstract**

This report presents the experience and skills gained during the two weeks of training undertaken at the Institute of Water Studies (IWS), Public Work Department (PWD), Tharamani, Chennai, Tamil Nadu. This trainimng was on the use of hydrogeological studies like Groundwater Exploration Techniques, Groundwater Quality studies and Remote Sensing based studies. During this training period we acquired practical knowledge and skills in Remote Sensing studies by using softwares like ArcGIS to interpret water quality data studies using Kriging methods.Also times were spent in the workshop toget hands on experience in using the geophysical instruments like resistivity meter. We used Integraph software to prepare the mapping of the certain area. This report discusses the skills gained and experience gathered during the period of training. Justifying the relevance of the scheme in equipping students with needed technical competence to thrive in the real world.

**Keywords:** Groundwater, IWS, Water Quality, Remote Sensing, GIS, Water Shed

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## I. INTRODUCTION

This Industrial training have introduced in our M. Sc., curriculum related to geological field. We visited PWD, Tharamani (Institute for Water Studies) for two weeks, which are highly helpful to learn the practical knowledge relevant to our study. With our theoretical study we learned more about Hydrology, Remote Sensing and Geochemical study. What we learned there such as methodology and interpretation have been discussed in this report.

Mans concern with the earth takes many from wanting to prepare a geomorphic map to assess its natural resources, predicting earth quakes volcanic eruptions, Movement of storms etc.

To do this he was developed remote sensing method in which an aircraft Equipped with cameras used and photographs are taken of the earth surface. These photographs are interpreted to extract information required.

The term photo implies that visible light is the energy used in producing the image and the act of examining photographic images for the purpose of identifying objects and judging their significance is called photographic interpretation.

Landsat-1, NASA'S first earth resource technology satellite was launched on July 23 1972 into a near polar orbit at an altitude of 910 km.

The sensor abroad LANSAT-2 launched on January 22 1975 one identical to those of LANSAT-1 and operate the same orbital altitude the LANSAT payload carries three major elements.

## II. RETURN BEAM VIDICON (RBV)

The Consist of 3 cameras each camera is sensitive to a different colour board in the Electromagnet spectrum- green, red and near infrared with smallest feature Identifiable being about 90 meters (300ft). The three cameras simultaneously photograph the area of 185*185 km.

## III. MULTISPECTRAL SCANNER SUB SYSTEM (MSS)

The other sensor sensitive to 4 spectral bands is the line-scanning device. This scans Horizontally along the orbital track and gathers data by imaging the surface of the earth in four spectral bands simultaneously through the same optical system. The spacecraft Scans across an area of about 185*185km. Otherwise the data is stored a tape for trasnsmission later. This data when processed is useful in many studies such as agricultural Forestry, water resource, marine resource and biology, land use, geology and air and water pollution. The four spectral bands are

| | | | | | |
|---|---|---|---|---|---|
| Band | 4 | 0.5 | to | 0.6 | micrometer |
| Band | 5 | 0.6 | to | 0.7 | ,, |
| Band | 6 | 0.7 | to | 0.8 | ,, |
| Band | 7 | 0.8 | to | 1.1 | ,, |

## IV. DATA COLLECTION SYSTEM (DCS)

The DCS is a communication system, which collect information from about 150 remote ground platforms and relays the information to NASA ground station for delivery to the users.

"Remote sensing'' is a new expression for an old practice. Of means we can feel, hear or see something at a distance away from ourselves. It is an old practice because the very first hunters, as they stood high on a hill or a tree looking for animals, used sensing with their eyes, ears and sense of small.

There are several reasons why earth resources survey can best be made through the use of the quick and economical delineation of aircraft and spacecraft. Water resource of a region requires knowledge of the nature of lithological units found in the area, structural deposition, geomorphic set-up, surface water conditions and the climate of the Area. Mapping of the geology of the area is vital since different rock units and structures Governs the occurrence and movement of ground water.

Ground water investigation employs multi-disciplinary studies like geological Mapping, soil survey, study of land use, practices, agronomy, hydrology etc. Most time dependent information is required to be obtained for better budgeting and evaluation of ground water potential.

The ground water wing of P.W.D has procured Landsat images covering the Entire Tamil Nadu area to apply " Remote Sensing'' techniques for delineating potential areas for large-scale ground water development and preparation of accurate geological, Hydro geological maps and other thematic maps of the state.

Landsat, black and white images of 1:50,000 scales are studied and lineament map of Tamil Nadu showing major faults and other minor fracture lines has been prepared. A landsat mosaic of south India has been prepared using band 5 prints of 1:50,000 scale which could be used as a base map for incorporating the interpretation details, field check results etc.

Palar basin in the south west of madras has been selected primarily to study and evaluate a methodology for the applications of "Remote sensing '' techniques for estimating the ground water potential of the country. The lower part, which traverses the Tamil Nadu region, has been interpreted with a 1: 63,000 scale aerial photographs.

The figure is the madras image (no. 811100043325A, 000), which has been interpreted in terms of geology, drainage and structure and these interpretations, are compared with the previous investigations of this area.

The drainage pattern of polar river is mainly controlled by structural elements of E-W, NE-SW and NW-SE trends and slopes towards east. The Cheyyar River, a tributary of polar in the lowest reaches, occupies the NE-SW fracture systems whereas the Ponni River follows the NW-SE fracture system. The main river course now follows a S-W trend.

 

Remotely sensed multispectral data recorded in magnetic tapes (9 track 1600 bytes in per inch) by orbiting satellites are retrieved by special as well as general purpose computers. An F.A.O expert with the ground water department of Tamilnadu under World Bank aid is conducting the polar basin study.

## V. INSTITUTE OF WATER STUDIES

1. **Introduction:** In institute of water studies, the remote sensing lab started on the year 1976. Using remote sensing and GIS application they found on the major and aquifers. They have started use of satellite imagery on the year 1972. The major river basins are Cauvery basin, madras basin, Neyveli and Vellar basins.

2. **Ground water study:** The preliminary studies of ground water as a potential OIS started from the year 1951. They broadly classify India into Himalayan zone, Gangetic zone and central, southern and coastal zone.

   Tamil Nadu being a main state, much importance is given for the exploitation of groundwater for the development of agricultural as about 95% of surface water resources have been harnessed in the state. 73% of the total area of the state in covered by crystalline formations and about 27% is covered by sedimentary formation, which occur all along the coast.

3. **Objectives:** The objectives of state ground water and surface water Resource data centre are
   - Scientific investigation and assessment of ground water potential.
   - Continuous monitoring of monthly hydrological and hydrometerological parameter and periodical assessment of ground water.
   - Consultancy services to Government Departments, Public and private sector undertakings.

4. **Functions**

   - Assessment of ground water potential studied by district wise, blockwise, and watershed wise.
   - Watershed study, water quality study.
   - Evaluation of ground water needs, present and the future.
   - Research and development including conducting training programmes.
   - Rainfall statistics of Tamil Nadu and monthly bulletin indicating percentage of deviation.
   - Special studies on ground water development, management and monitoring.

5. **Activities:** Ground water investigation with UNDP assistance

   - The ground water investigation by the public works, department data back to year 1965. A ground water cell was formed to water to the needs of the industries around Chennai.

 

- Having felt the need of systematic investigation in an around Chennai, the government of Tamil Nadu approached united nations and the ground water investigation, started with the assistance of UNDP.

- During the period between 1965-72 with the assistance of UNDP ground water investigation were carried out and ground water potential in the above said areas was assesses on scientific basis.

## VI. GROUND WATER INVESTIGATION BY A SEPARATE WING OF PWD

Based on the experience gained under UNDP, scientific investigations are found essential for assessment of ground water potential for the entire Tamil Nadu. Accordingly a full-fledged Ground water Directorate started functioning since November 1970 and during 1972. The activities of the ground water department from 1970 can be broadly classified into 3 phases.

1. **I Phase (NOV. 1970):** Investigation was carried out at macro level and basic data like infiltration through rainfall, seepage from applied water for crops, from tanks, from canals, were collected.

2. **II Phase (1978-86):** From the Macro level studies conducted during the first phase throughout Tamil Nadu among 50% was found to over develop. But the field findings such as water level fluctuation and related hydro geological conditions are different from the assessment made by the macro level studies and hence it was decided to be out micro level survey.

3. **III Phase (From 1987 onwards):** Under phase III the investigation of ground water survey was reoriented on the following lines.

    - Investigation, monitoring and assessment of the groundwater potential.
    - Consultancy services.
    - Special investigations.

## VII. WATERSHED STUDY

In order to know the inter-relationship between rainfall and infiltration, the various parameters like rainfall, evaporation, temperature, wind velocity etc. are being observed in smaller water shed by setting up 21 meteorological stations.

1. **Water quality study:** About 3400 water samples are collected from various source like shallow observation well, bore well, surface water samples, etc. and tested for the suitability of domestic, agriculture and industrial purposes. For carrying out the above study, four labs have been established at Chennai, Madurai, Tirchi and Pollachi in the state ground and surface water resources data Centre.

2. **Monitoring of water levels:** Since groundwater is a dynamic resource, continuous monitoring of water level is essential which helps to assess the gravity of the situation during adverse seasonal condition like drought. For this purpose, about 1748 wells

 

including 618 drought wells spread over the state are under observation during the first week of every month.

3. **Collection of rainfall data:** Rainfall data are being collected from 400 rain gauge stations throughout the state of Tamilnadu. Based on the data collected, the maximum and minimum rainfall with percentage deviation is being worked out. The histograms are drawn based on the 70 years rainfall data. The isohydral maps are also prepared to demonstrate the rainfall pattern in the district.

4. **Salt water / Fresh water interface studies:** In Tamil Nadu the length of the coastal stretch is about 920 km. The entire stretch has been taken up to find out the salt water – fresh water interface studies. Meenjur well fields which is located north of Chennai city where the salt water fresh water interface studies conducted during 1978was located 3.2 km from sea coast, during 1999 this has moved to about 16 km from sea coast. This has been confirmed by water quality studies.

5. **Pollution study:** Cause and extend of pollution on groundwater due to industrial effluents are being carried out in 18 locations in various river basins by the departments.

## VIII. FIXING SPACING NORMS IN GENERAL AND FOR RIVER COURSES

The commercial banks are launching minor irrigation schemes and lift irrigation schemes wells. Under lift irrigation schemes wells are being sunk near the river coarse and water is lifted and conveyed to far away places for irrigation. It has been decided to fix spacing criteria for sinking wells all along the river courses. Necessary studies have been undertaken in 10 locations in different basins.

## IX. DRILLING OF EXPLORATORY BORE WELLS

**As a part of investigation, exploratory boreholes are periodically drilled with the following.**

1. To explore the sub-surface lithological characteristics
2. To arrive at the sub-surface hydrogeological parameters.
3. To find out the quality of groundwater at different aquifers.

## X. TO PREPARE A BASE MAP

To identify the groundwater potential area, we have to prepare the base map by using toposheets. By using the GIS software, we have to prepare many layers and there we have to insert these layers into the computer software using a scanner. The layers, which are scanned, should be a common latitude and longitude position. There are mainly 7 layers, namely

1. Base map
2. Physiographic map
3. Geology map of the area
4. Drainage map
5. Geomorphology of the area

 

6. Land use of the present data
7. Land use of the past data using aerial photographs.

**Basemap:** Base map covers the contours, roads and drainage systems.

**Physiographic map:** It covers the altitude of contours, hilly terrains, structural hills or residual hills.

**Geology map:** It covers the formation of the study area, Igneous, Sedimentary and Metamorphic rocks, alluvium, weathered soil that are differentiated with latitude and longitude of the study area. This map is very useful for the Hydro geological survey.

**Structural map:** It delineates the fault zone and fractures and ridges.

**Administrative map:** It includes villages, town's settlement areas only.

**Processing:** After preparing the different layers of thematic maps, insert them into the scanner. Through the scanner the computer software scanned and recorded the maps. Now we can process the maps.

The blocks are mainly categorized into 3 blocks.
Dark block = 85% of exploitation and only 15% of recharge
Grey block = 65% of exploitation and 35% of recharge.
White block = below 65% of exploitation.

**To register the map:** Using Intergraph software, to register the map we have to set all the scale, latitude, longitude etc.

**Vectorization:** 'Micro station" is the tool to correct vectorization. It is in 3 features. In registration same important symbols are used for the following features.

P – Pediment
SBP – shallow buried pediment
DBP – deep buried pediments
BP – buried pediments
SH – shallow hill.

In selected area – using interpretations, to calculate the discharge recharge exploitation of ground water.

## XI. FACTORS

**Rainfall = Average Tamilnadu Rainfall 908 mm.**

1. Potential = $\frac{\text{Area} * \text{Min (Rain fall)}}{12} * 20\%$

 

$$2.\ \text{Recharge of Infiltration} = \frac{(\%) = \text{Area} * 36\%}{12}$$

Recharge through water Spreads are normally 18 inches available 18/12, there will be water lies tanks with in the selected basin.

Recharge and water flow in the pumped area.

In auyacut area – 90% of the wells around 60% return flow to the ground water around 50% in the net ratio.

For Non Auyacut area 90% well in graduated crop-80%

Wet crop – 1 unit
Dry crop - 0.25 unit
Percentage of applicable water utilized to crop.
1/1.25 * 100 = 80%
In filtration is 40- 50 %.
Loss of evapo transpiration – 15%.
Water fluxation also calculated using mean, mode all should be calculated.

## XII. EXTRACTION OF THE AREA

4 Feet rigid to paddy from their pumping out and the water drubs in also calculated with these requirements.

Average extraction for energized well in an auyacut or non-auyacut is equal to average consumption x average discharge by 1,71,00.

Water balance = total recharge – ground extraction

## XIII. QUALITY OF WATER

1. Calcium chloride
2. Calcium bicarbonate
3. Sodium chloride
4. Sodium bicarbonate

$$\text{In milli equivalence} = \frac{\text{Ca + Mg x 10,000}}{\text{electric conductivity}}$$

Net result if above 50 it will be calcium and below 50, it will be sodium.

$$\text{bicarbonate + carbonate} = \frac{}{\text{electric conductivity}} \text{ X 1,00,000}$$

 

Above 50 it will be bicarbonate type less than 50 it will be a chloride.

Normal drinking water Electric conductivity = 1,000 – 1,500. micro mohrs.cm.

Distilled water electric conductivity = 1 to 5

**pH (Hydrogen ion concentration)**

Fresh water – 7.75
Sea water - 8

$$\text{Specific Capacity} = \frac{\text{Discharge}}{\text{Residual draw}} \text{ X } 3.28$$

Maximum possible yield = water column available for pumping x specific capacity x 3.28.

## XIV. TRANSMISSIVITY

**This can be obtained by draw down method and for recovery curve method.**

$$\text{By draw down curve method} = \frac{264 \times Q \text{ (discharge)}}{\triangle^{3} \text{ (times draw dine)}}$$

$$\text{Recovery method} = \frac{264 \times G}{\text{Time/ depth if water column rising in tube}}$$

$$\text{Average transmissibility (T value)} = \frac{\text{Draw + recovery}}{2} = \text{gpf/m gpd- ground per depth /mts}$$

$$\text{Permeability} = \frac{\text{Transmissibility}}{\text{Saturated thickness}} \text{ x } 3.28$$

## XV. GEOPHYSICAL METHOD

**Wenners configuration and Slumberger configuration one the method used to find out underlying rocks.**

Using ohms law
V/I = R
Sandstone = 20 ------ dry > 100 ----
Hard > 1000 ------

 

## XVI. GROUND WATER POTENTIAL ZONE

Shallow pediment, bazada pediments as well as weathered rock- should not above 5%
Run off – moderate
Geology – Alluvium rock
Land use – barren, cultivatable, water land
Lineaments – Moderate
Water level - low
Water quality – less than 1000
Water quality stated in following measure in small tank reservoirs – million cubic feet.
TMC- thousand million cubic feet
1 TMC – 2830 crores litres.
Arce level- 43560 q. feet x 4 feet for paddy.
Filter pore – 15 m
Shallow tube well – 100 m

1. **Digital planimeter:** It is to measure the area using satellite image by using specified scale.

2. **Topographic features:** Rivers, Valleys, surface features

3. **Geomorphology of the area:** Type of rock, nature of rock, favorable for ground water occurrences.

4. **Drainage pattern of the area:** What is the source of water origin of river, tributary.

5. **Land use:** How study area is utilized. Auyacut, Non auyacut, elevated irrigation done or water how much.

6. **Geophysical:** Passing the current from the earth surface to depth and study the resistance that the formation underlying given

   - Wenner Configuration
   - Slumber configuration.

7. **Pumping test:** Select a representative well . Study the underlying acquifer by the time vs D.D and residual DD and recover graph.

   **We can calculate, Transmissibility of the formation (T)**

$$T = \frac{264 \times Q}{\blacktriangle_s}$$

Q- Discharge (GPM)
K= T/sT
ST – saturated thickness
S- find out by done along the bore well
$S = 0.36\ T\ t_o / r^2$

 

$T_o$ – time when draw down in zone.
R – distance between pumping bore well and to the observation.
Alluvium – T more than 3000- 1,00,000
Weathered – T medium 2000- 3000
Charnackite – T low <1000

**Recharge boundary:** If well which is have a hydrate connection with river or Tank nearby

**Barrier boundary:** Not have any nearby river or hard rock terrain without any hydraulic conductivity

- Rain fall – histogram
- Water level - hydrogram

**Geochemistry:** Water quality well started 1972. 4 Geochemical labs are situated in Tamil Nadu.

Tharamani. Tirchi, Madurai, and Pollachi They measure the water quality every /or once in premonsoon or post monsoon. To analysis the long-term water quality changes and also character of water is there any sea water intrusion, pollution contamination, corrosive nature of water.

**Domestic purposes:** Agricultural purposes, irrigation industrial samples once in 3 months.

**Different test:** physical, chemical, biological and bacteriological test.

**Physical test:** Temperature, colour, odour and taste turbidity density pH, E.C.

**Chemical test:** Estimation of acidity, alkalinity calcium, magnesium, sodium, potassium, Iron, Manganese, silicon.

**Bacterologial test:** This test in adopted for only drinking purpose. They cheece the qualiform and fequal qualiform bacteria.

## XVII. CHEMICAL ANALYSIS

**Quantitative and qualitative:**

Gravimetric – To measure the ionic condition.
Volumetric - To measure the volume of alkalies carbonate/ bicarbonate.
Calorimeter - To identify the Fe by the colour
Temperature – 25 $^oC$
Colur – hazons units max 15 hazons
Tests,dissolved salt, turbidity

**Optical property:** silt, clay, waste material

**Electrical conductivity:** ions change E.C.

 

Specific conductivity of iron present in the cubic cm of micro mohrs / $cm^2$
Conductivity depends on temp, concentration iron T$^o$c increase every E.C change 2.1. When E.Cx 0.001 = Total anion or cation of water sample in milli equivalents per litre.
E.C x 0.64 = Total dissolved solids in mg per litre or ppm.

**Electrical conductivity** (E.C)

Purest water – 0.05 micro mohr/$cm^2$
Distilled water – 0.755 micro ohr / $cm^2$
Rainwater - 530 micro meter/cm2
Metroguate – 30- 2000 micro meter/$cm^2$
Seawater – 45-55000 micro meter/$cm^2$
Oil fields -more than 1,00,000

**Based on electric conductivity**

Excellent – below 250
Medium and good – 250 – 750
High salinity – 750 – 2250
Very high salinity – 2250

**pH VALUE**

p – potential of alkaline or acidic
H – hydrogen
pH differs from 1 – 7 acidic
Neutral has 7
Water 1-7 acidic
7-14 alkalic
Mostly ground water 6 – 8.5
Surface water 6
Sea water 8
If pH is 5,6,7unit difference is only one.

**Two types of pH mean**

Calorimetric – based on colour
Electrometric – based on electric node.

**Acidity:** Formed by hydrogen ions, natural line less acidity, industrial area has more.

**Alkanity**

Formed by bicarbonate and carbonate ions, hydroxyl ion and silicon also if pH is 9.
pH 8.2 carbonate 10 – 5000
4.5 bicarbonate 50 – 100 bicarbonate.

 

## XVIII. GEOCHEMICAL ANALYSIS

Geochemical Analysis for water study quality is analysed for all over Tamilnadu mostly in Chennai, Thiruchendur, Kanchipuram.

**The analysis is done in three levels.**

Level I – Analysis done for 7 parameters – 9 labs.
Level II – Analysis done for 36 parameters – 3 labs.
Level III – Analysis done for 50 parameters only in one lab in tharamani.

## XIX. INTERPRETATION

Using Remote sensing and GIS as a tool we can easily democrat the alluvium land without went for field trip. Which is going on long period.

With the help of satellite imagery and Aerial photos. There are different interpretation key elements to identify a point or a polygon.
**The most important key elements are**

1. Tone
2. Texture
3. Size /shape
4. Pattern
5. Association

## XX. GLOBAL POSITIONING SYSTEM – (GPS)

Global positioning system – GPS space – based radio navigation system consisting of 24 satellites and ground support. GPS provides users with accurate information about their position and velocity, as well as the time, any where in the world, and in all weather conditions.

GPS become attractive to a broad spectrum of users. GPS has been successful in classical navigation application and become its capability are accessible using small, in expensive equipment, GPS has also been used in many new applications.

## XXI. CONCLUSION

The two weeks industrial training Programme organized by Public Works Department (Water Resources Organisation) Tharamani, Chennai-600113 which was very useful for our study and my future carrier in geological field. Now modern 2K Decade, water is a big economic source in India particularly Tamil Nadu. So, this type of study was very useful how to manage and protect ground water potential. Based on this knowledge with my master degree I can help to explain about ground water management, protection, recharge methods to the society.

I thankful to my research advisor Dr. S.G.D. SRIDHAR for arranging a wonderful industrial training Programme in PUBLIC WORKS DEPARTMENT (WATER RESOURCES ORGANISATION) Tharamani, Chennai-600113 at summer holidays (02-06-2016 to 20-06-2016). This summer holiday period went on well with geological knowledge. Through this training program we have learned more about Remote Sensing, Geohydrology, Geochemistry and also new kind of practical knowledge about the same.

These types of training Programme will helpful to educational and industrial collaboration work/study and our further research study. Every staff this organization rendered full support to solve our geological/practical questions and gave a nice training.

 