CHAPTER-1

INTRODUCTION
Water is the most precious gift of nature to mankind and has been recognised as one of the most vital natural resources. It is not so just because water sustain life but it is a renewable resource. It is also the most essential input for agriculture, industry and power generation. The availability of water with proper quality and quantity at appropriate time and space are of great importance. The role of water resource development in the over all economic development of the country is well recognised. According to Reddy (1992) agriculture contributes thirty percent of India’s Gross National Profit (G.N.P) and sixty percent of the employment potential; over two third of the country’s population is agriculture dependent and irrigation contributes to fifty-five percent of agricultural out-put. The water management is very essential to maintain quality, quantity and the availability of water due to increase in population, rapid urbanisation and industrial growth. Though its availability is limited, yet demand for water is ever increasing. It has direct impact on human being and socio-economic development. Hence, the need of proper planning and management of the precious resource has become the matter of utmost urgency. Ground Water is one of the national assests which will help to ensure the adequate municipal water supply, to provide growing industrial needs and to ensure constant irrigational use.
even in adverse climatic conditions. Its distribution and occurrence varies in space and time. Sinha (1983) pointed out that ground water claims fifty percent of India's total irrigational requirements.

In our country, while designing almost all the irrigation projects, the effects of irrigation on the total environment of the command area have not been given a serious thought. The effects of introduction of artificially impounding of water on soil, ground water and vegetative environment has generally been neglected. Such planning has created imbalance in the parts of command areas of the exiting irrigation system (Vyas, 1984). The absence of drainage facilities coupled with seepage from unlined canals and distributaries aggravated problems of water-logging, Soil salinity and alkalinity in parts of the command areas consists of alluvial formations. The farmlands of tail end reaches of canals are unable to irrigate due to scarcity of surface water in the reservoirs of the irrigation projects which is due to the vagaries of rainfall.

In recent years, there has been shift in the environmental research from local/regional to national and global level. This is being focused on the extent of human activities which induce global changes, threatening the biosphere, geosphere sustainability. This requires attention towards understanding spatial
change of human activity and environment. Its process and effects, its monitoring and forecasting the development of information system and the application of new areas of science i.e., remote sensing and GIS technology (Deekshatulu and Jairam 1991; Deekshatulu and Rajan 1984; Singh, 1990, 1991, 1992).

The environmental problems are essentially multidimensional and multitiered in character. Recently, scientists from various disciplines approached these problems in a projected and independent manner. There is a need to provide update and reliable environmental information within earthwatch and provide the necessary data integration technology to transform the monitored data into useful information to address environmental issues at global, national and local level (Singh, 1990).

However, policy makers and environmental managers are not getting the information, they need for the sustainable management of environmental resources. Traditionally, information needed for environmental research and management has come from the earth's environment. As conventional ground methods of resource survey are mostly incapable, there is a need for remote sensing application for monitoring dynamic character and up-to-date position of natural resources (Brahdenberger and Ghosh, 1994; Agrawal, 1994). Recently, space
observation through remote sensing has emerged as an extremely powerful tool to detect and monitor such environmental changes and challenges (Madhavan Unni and Roy, 1979; Singh 1991). This provides ability to cover the globe with the uniform instrumental system that integrates data into large scale instruments.

The development of modern data gathering techniques and computer assisted cartography open new possibilities of data storage and exchange. The combined use of Geographic Information System (GIS), and digital image processing provide better prospects of environmental monitoring and forecasting over under areas within limited time span. It would be easy to develop predictive model capabilities in order to achieve effective public policy in the years to come. This has direct implication for national development.

The evaluation and management of ground water resource is very essential in the command area of irrigation projects. The need for evaluation of both surface and ground water has become precious because of the accelerated rise in the investment cost of the irrigation projects for the utilisation of the scarce water resources. Any negligence in the evaluation would result in huge financial losses. Therefore, the precise and systematic evaluation of ground water resources should be done for proper planning and development of
water resources of India. The management of water resources means a programme for ensuring a continuous and adequate supply of requisite quality and quantity of water for various uses, without causing any harmful effect. Such a programme can be successful if efforts are made for maintaining good quality of water, controlling the use and checking the abuse of this scarce resource and ensuring the recharge of the aquifer by adopting appropriate techniques within the command area.

The evaluation of ground water resources includes evaluation of both static and dynamic components of the available ground water in storage. The evaluation of static storage is, however, not normally required for consideration of resources use. What is more needed is the dynamic or replenishable component of the resources, the evaluation of which cover any space and time is best done by the water balance techniques. The remote sensing techniques provide valuable information in the assessment of earth’s water resources. These techniques provide a synoptic view of the terrain which help in rapid reconnaissance studies at regional levels and there by minimising the field surveys. Though the field check is also very necessary at places. Therefore, the author has used remote sensing techniques to work in the Tawa command area of Madhya Pradesh.
1.1 TAWA DAM PROJECT

The Tawa dam (Photo 1.1) is built in 1975 across the river Tawa at a site near the confluence of Tawa and Denwa rivers (77° 58' 30"; 22° 33' 40") in the Hoshangabad district of Madhya Pradesh. The dam is approachable by 33 km. asphalt road from Itarsi railway junction. Tawa reservoir (Photo 1.2) is the source of water for the Tawa command area. The Tawa dam is an earthen dam with masonry structure in river portion. It has created a reservoir capacity of 0.231 million hectare metres of water. About 670 families are displaced from their houses for the direct benefit of a large portion of the state’s population and also of the nation. The location of the dam which appears from its topographical characteristics as suitable for a large structure had certain draw-backs, though the width of the river is narrow, the width of the gorge is very wide here resulting in increased length of the dam. But it is inevitable in order to have a better command for irrigation. The length of the dam precluded the adoption of either the mass concrete or the stone masonry type of dam. Except for the spillway and the non-overflow dam section in the river portion, the flanks consist of earthen section. Earthen dam was adopted due to the prohibitive cost of the concrete of masonry structure in this wide gorge and also in view of the economy resulting from the use of materials
available within resonable distance from earthen dam. The reservoir behind Tawa dam is spread over an area of 20055 hectares (49557 acres) submerging only 1542 hectares of culturable area affecting 3082 persons only. Two villages are fully submerged and 29 villages are partly submerged. The Tawa Canal System covers a gross command area of 2,88,966 hectares on the left bank and 50,587 hectares on the right bank and covers in all 663 villages in the Hoshangabad, Seonimalwa, Harda and Sohagpur tehsils of Hoshangabad district.

The left bank canal (Photo 1.3) takes of direct from the reservoir through a canal intake with a head discharge of 103.6 cumecs. In the first 6.44 km, the canal passes through undulating terrain and is lined with 12.7cm thick concrete. The canal there after enters a comparatively plain area. The main canal is 131 km. in length. It crosses a number of cross drainages. Notable amongst them are Tikher, Ganjal and Ajnal having well foundation. The aqueducts across Morand and Gajnal rivers having catchment area of 1085 Sq.km and 565 sq. km. respectively. Handia branch canal with a head discharge of 29.9 cumecs takes off from the main canal at 92 km. and is 58 km. in length. The total length of the distributaries and minors on left bank canal is 1484 kms.
There is no suitable point for taking off canal in the right bank (Photo 1.4) from the dam. Therefore, a horse shoe shape tunnel with finished diameter of 3.81 meters to carry a discharge of 26.96 cumecs in a length of 4 km. with a bed slope of 1 in 6000 is adopted. A pick up weir is constructed across large nala for providing off take point to the canal. Two canals called "BAGRA BRANCH CANAL" and "PIPARIYA BRANCH CANAL" take off on either side of the pick up weir. They are 27 km. and 50 km. long respectively. These canals also cross a number of cross-drainages. The total length of the distributaries are about 450 kms. The Tawa Canal system is shown in Fig 1.1.

The salient features of Tawa Command are given below:

(A) TAWA DAM

(a) Geography

- State - Madhya Pradesh
- District - Hoshangabad
- River - Tawa (A tributary of Narmada)
- Longitude and Latitude - $77^\circ 58' 30" - 22^\circ 30' 40"
- Location - UP stream of Ranipur village, about 33kms. from Itarsi Railway station on central railway.

(b) Hydrology

- Catchment area - 5982.90 sq.km
c) Reservoir data

- Average rainfall - 1546.13 mm
- Average Annual run-off - 0.3705 m.ha
- Designed flood - 0.308 lakh cumecs

- Top bank level - 359.664 m.
- Maximum water level - 356.692 m.
- F.R.L - 355.397 m.
- Crest level - 343.205 m.
- Gross storage of FRL - 0.231 m.ha.m.
- Dead storage - 0.026 m.ha.m.
- Live storage at FRL - 0.205 mha.m.
- Average river bed level - 309.677m.
- Area under submergene - 20055 ha.

d) Masonry dam

- Spillway - 237.744 m. long
- Left and Right transitions - 149.352 m. long
- Key wall left and right - 30.48 m. long
- Maximum height above the lowest foundation level - 57.912 m.
- Crest gates - 13 Nos (Radial) 15.24 m x 12.12 m.
- Under sluice gate - 4 Nos. 1.852 m x 2.438 m
e) Earth Dam

- Left dam - 690.372 m. long
- Right dam - 521.208 m. long
- Saddle - I - 182.880 m. long
- Saddle - II - 182.880 m. long
- Maximum height above lowest point - 33.528 m.
- Top width - 7.62 m.

B) CANAL SYSTEM

<table>
<thead>
<tr>
<th>ITEM</th>
<th>L.B.C.SYSTEM</th>
<th>R.B.C.SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross command area (available)</td>
<td>449,972 ha.</td>
<td>113,018 ha.</td>
</tr>
<tr>
<td>Gross command area (benefited)</td>
<td>288,956 ha.</td>
<td>505,871 ha.</td>
</tr>
<tr>
<td>Culturable command area (available)</td>
<td>313,073 ha.</td>
<td>89,146 ha.</td>
</tr>
<tr>
<td>Culturable command area (benefited)</td>
<td>186,162 ha.</td>
<td>60,702 ha.</td>
</tr>
<tr>
<td>Area proposed for cropped irrigation</td>
<td>256,904 ha.</td>
<td>75,881 ha.</td>
</tr>
<tr>
<td>Length of main canal</td>
<td>131 km.</td>
<td>-</td>
</tr>
<tr>
<td>Handia branch canal</td>
<td>58 km.</td>
<td>-</td>
</tr>
<tr>
<td>Connecting channels</td>
<td>-</td>
<td>6.44 km.</td>
</tr>
<tr>
<td>Pipariya Branch Canal</td>
<td>-</td>
<td>49.88 km.</td>
</tr>
<tr>
<td>Bagra Branch Canal</td>
<td>-</td>
<td>27.35 km.</td>
</tr>
<tr>
<td>Designed discharge of main canal</td>
<td>-</td>
<td>103.578 m³/Sec</td>
</tr>
<tr>
<td>Bed width sill level of sluice</td>
<td>- 334.243 m.</td>
<td>-</td>
</tr>
</tbody>
</table>

L.B.C. Left Bank Canal; R.B.C Right Bank Canal
(C) CROP INTENSITY

<table>
<thead>
<tr>
<th>Season</th>
<th>Percentage</th>
<th>Area (ha)</th>
<th>% of Total Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>67%</td>
<td>124728</td>
<td>58%</td>
</tr>
<tr>
<td>Rabi</td>
<td>67%</td>
<td>124728</td>
<td>67%</td>
</tr>
<tr>
<td>Summer</td>
<td>4%</td>
<td>7448</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>138%</strong></td>
<td><strong>2,56,904</strong></td>
<td><strong>125%</strong></td>
</tr>
</tbody>
</table>

(D) REHABILITATION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>QUANTITY</th>
<th>AMOUNT (Rs IN LAKH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Compensation for immovable property</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Culturable land</td>
<td>600 ha.</td>
<td>6.00</td>
</tr>
<tr>
<td>- Fallow grass and small forest</td>
<td>500 ha.</td>
<td>1.20</td>
</tr>
<tr>
<td>- Abadi land</td>
<td>12 ha.</td>
<td>0.22</td>
</tr>
<tr>
<td>- Fruit trees</td>
<td>2800 Nos.</td>
<td>5.60</td>
</tr>
<tr>
<td>- Concrete building</td>
<td>20 Nos.</td>
<td>0.40</td>
</tr>
<tr>
<td>- Earthen building</td>
<td>660 Nos.</td>
<td>4.29</td>
</tr>
<tr>
<td>- Lined well</td>
<td>15 Nos.</td>
<td>0.30</td>
</tr>
<tr>
<td>- Unlined well</td>
<td>35 Nos.</td>
<td>0.25</td>
</tr>
<tr>
<td>(b) Rehabilitation Grant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Compensation for families</td>
<td>670 Nos.</td>
<td>0.67</td>
</tr>
<tr>
<td>- Construction of new villages</td>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td>- Compensation for acquisition for forest building</td>
<td></td>
<td>1.95</td>
</tr>
<tr>
<td>- Construction of forest roads</td>
<td>113 km</td>
<td>19.66</td>
</tr>
<tr>
<td>- Compensation for acquisition charges on immovable property</td>
<td></td>
<td>2.74</td>
</tr>
<tr>
<td>- Number of villages submerged</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue</td>
<td>13 Nos.</td>
<td></td>
</tr>
<tr>
<td>Forest</td>
<td>16 Nos.</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Water Resource Department, Govt. of M.P.)
1.2 SELECTION OF THE STUDY AREA

The Tawa Command area is yet unstudied and no
detail literature is available as far as hydrogeological
and geoenvironmental studies are concerned. It is
forced with various geoenvironmental problems like
waterlogging, Soil erosion, Soil salinity, Soil
alkalinity and deterioration in the quality of ground
water. Most of the productive agricultural land
existing in the area became barren because of water-
logging and soil salinity. The productivity of such
soil can be restored by adopting 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.

Groundwater 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 ground water is most
essential. Therefore, the author has taken up the study
of these problems in the Tawa command area with a view
to find out solution of these problems which (if
implemented) may be beneficial to the state of Madhya
Pradesh and the cultivators of the area.

1.3 LOCATION & EXTENT OF THE STUDY AREA

The Tawa Command area falls on Survey of
India toposheet nos. 55 B, F & J (1: 250,000). The available gross command area is 279243 acres and area proposed for cropped irrigation is 187492 acres. It falls between longitudes 77° 39' E to 78° 41' E and latitudes of 21° 47' N to 22° 47' N. It is shown in Fig 1.2.

1.4 ACCESSIBILITY

The study area is approachable by train as well as by Bus. Harda, Sohagpur, Pipariya, Seonimalwa, Itarsi and Hoshangabad are the important towns which falls in the command area. Hoshangabad is situated on Bhopal-Nagpur National Highway as well as on the central railway line. Itarsi is the main railway junction of this area. Hoshangabad is the district place and from this town, the Tawa command area is approachable by vehicles. The entire area, except during the rainy season, is approachable by the bullock carts & tractors. Some of the tracks, for example, along the main canal and distributaries are motorable during the dry season.

1.5 PERIOD OF STUDY

The study of the area was started from December 1987 and the information concerning the previous work about the area was studied. In the first phase, reconnaissance survey of Tawa command area was undertaken in January 1988 to understand the Geology, soil, hydrogeology, geomorphology and geoenvironmental
FIG 1.2 LOCATION MAP OF TAWA COMMAND AREA M.P.
problems. The available data from various organisations were collected. Based on these informations, the author has spent about three months in the Remote Sensing Application Center, Bhopal, and prepared the different maps on 1:250,000 scale using IRS LISS II Row -52 land sat 044-145 imageries.

In the second phase, the Geological, Geomorphological and soil investigation were carried out and the maps prepared using the remote sensing techniques have been verified from December 1989 to April 1990. In the third phase, the field work has undertaken in October and November-1990 to carry out the well-inventory (post-monsoon) of the existing wells in the area. In fourth phase, the field work was carried out in May-June 1991 to carry out well inventory of (Pre - monsoon) and pumping test of the existing wells. The water and soil samples were collected and analysed during this period. In the fifth phase, the geoenvironmental hazards, such as water-logging, soil salinity, alkalinity and soil erosion, etc, have been investigated in the field. In the sixth phase, the electrical resistivity survey data were studied was conducted in March and April - 1992. During the rainy season of these years the laboratory analyses were carried out and the required data were collected.
1.6 REVIEW OF LITERATURES

A review of literatures reveals that a little work on hydrogeological and geo-environmental aspects has been done in the study area. Adyalkar (1975) has estimated ground water potential of the upland alluvial of Tapi and Narmada valley. Roy (1971) has studied the geology and ground water resources of Narmada valley. The Water Resource Department, Govt of Madhya Pradesh have carried out ground water surveys in parts of the Narmada Alluvial Basin. The Central Ground Water Board is carrying out intensive ground water studies in various parts of the basin. Balachandran (1975) has studied the geology of Tawa Dam Site and its geotechnical problems. Trivedi and Ajay Kumar (1993) has carried out preliminary hydrogeoenvironmental studies in Tawa Project Area of Madhya Pradesh. EPCO (1986) has carried out some environmental studies in the command area. Rajeev (1993, 1994) has studied the drainages and chemical quality of ground water of the Tawa River Basin.

1.7 METHODOLOGY

The author has carried out systematic investigation involving interdisciplinary approach to suggest a suitable programme for water resources and geoenvironmental hazards management in the Tawa Command area. A detailed reconnaissance survey in the entire Tawa Command area has been carried out. Based on the
previous work and data obtained from the survey, the following methodology has been adopted for the present study.

- Preparation of geomorphological map and study of physiographic features of the Tawa Command area using remote sensing techniques.
- Collection and interpretation of hydrometeorological data of the area.
- Preparation of geological and structural maps using remote sensing techniques and its interpretation.
- Morphometric analysis of a part of the Narmada drainage basin.
- Preparation of landuse map using remote sensing techniques and its interpretation.
- Preparation of soil map using remote sensing techniques and its interpretation.
- Preparation of hydrogeomorphological map of the area and its interpretation using remote sensing techniques.
- Preparation of maps showing geoenvironmental hazards, i.e. waterlogging, soil salinity, soil alkalinity, etc, using remote sensing techniques and its interpretation.
- Collection of lithological logs of borehole data and preparation of correlation section, fence diagram, etc., in order to study the
subsurface geology of the area.

- Mechanical analysis of aquifer materials of the Command area.

- Preparation and interpretation of ground water level maps e.g. pre and post monsoon, water level maps, fluctuation map and depth to water level maps.

- Interpretation of electrical resistivity soundings conducted in the area.

- Preparation and interpretation of isopach map of the aquifer.

- Determination of aquifer parameters using pumping test data.

- Collection of soil samples and their chemical analysis.

- Collection of surface as well as ground water samples and their chemical analysis to determine its suitability for drinking and irrigation purposes.

- To integrate the above information for suggesting a sound ground water development and management programme for the area.