CHAPTER 8
ENVIRONMENTAL IMPACT OF IRRIGATION
Environmental Impact Assessment (EIA) is potentially one of the most valuable tools for internationalization of environmental concern in the process of planning for economical-development activities. It consists of establishing quantitative values to selected parameters which indicate the quality of environment and natural systems before, during and after the proposed action (Heer and Hagarty 1977). Water Resources Development Projects (WRD) include activities related to catchment area development, construction of dam and other engineering works, and command area development. The major environmental issues associated with WRD projects include rehabilitation of population affected due to submergence, watershed management for soil conservation, preservation of flora and fauna, micro climatic changes, water-logging and salinity in the command area. The Environmental Appraisal Committee (EAC) appointed by the Ministry of Environment and Forest, Govt. of India, evaluates the Water Resources Development projects from the environmental consideration.

The irrigation projects have social and environmental implications. The environmental impacts of intensive irrigation in Command Areas vary considerably with the climate, soil, physiography, the characteristics of river flow, the size of irrigation
projects, canal management and operation, irrigation system practiced, drainage, ground water development and management undertaken, existing of tanks and ponds impacts of supporting inputs eg. fertilizers, pestisides, insectisides used and the maintenance of irrigation system.

A clean and pleasant environment is of high social importance since it affects the people's working and living conditions. It improves the well being of the people, contribute to their cultural education, serve their health and education and promotes sensible use of leisure time. As such clean water and air, soil protection, judicious use of irrigation water and fertilizers and the sensible handling of pestisides and reuse are important conditions for the rational utilization of natural resources in the Command Area. It has therefore, to be ensured that the land and its resources are sensibly and rationally used in the Command Area so that the natural environment remains unaffected as far as possible and does not cause any undesirable side effects leading to unexpected changes in the environment.

The environmental impact assessment requires the greatest degree of scientific application in the production of impacts. Many workers such as Dee, et al. (1972), Krauskof and Bourde (1972), Urban et al. (1975),
Holling (1987), MEP (1988) and Luhar and khanna (1988) have given a significant contribution in the Environmental Impact Assessment Programme. EPCO (1986), has given significant contribution on the environmental aspects of the area. The most logical way of identifying impacts associated with the project is through establishing cause, condition and effects relationship. The methodology for identification of impacts identifies all possible networks related to different activities presenting to the proposed Water Resources Development projects and these allows the identification of impacts by selecting and tracing out appropriate project actions. The identified impacts of dam construction project are given below.

A. Impacts of Dam Site

- Siltation of reservoir.
- Decline in fish resources.
- Public health hazards.
- Decrease in available water supply.
- Water-logging in surrounding area.
- Impacts on human settlement.
- Impacts on sites/monuments of religious, cultural or historical importance.
- Impacts on flora and fauna.
- Reservoir induced Seismic activity.
B Impacts at Down Stream

- Impedence to navigation.
- Impact on industrial / domestic use of water.
- Impact on fish resources.
- Impact on soil productivity in flood plain.
- Impact on land use in flood plain.

C. Impacts in command area

- Public health hazards.
- Decrease in available water supply.
- Decrease in flow rates in canals.
- Primary salinization/alkalinization of soil.
- Secondary salinization /alkalinization of soil.
- Water-loging of soil.
- Increase in soil erosion.
- Pesticides and herbicides in food chain.
- Impact on flora and fauna.

According to Khanna and Kulkarni (1990), the environmental impacts associated with the contribution of dam are presented in fig. 8.1. Keeping the above views in mind, the author has made an attempt to study the environmental impacts of Tawa Dam Project using the remote sensing techniques which are given below:

8.1 IMPACTS OF TAWA DAM SITE

The major environmental impacts of the reservoir site are submergence of extensive areas of fertile land,
FIG. 8.1A. FLOW DIAGRAM IDENTIFYING IMPACT AT DAM SITE
FIG. 8.1b FLOW DIAGRAM IDENTIFYING DOWNSTREAM IMPACTS

- Impact on industrial/domestic use
  - Change in water quality
  - Saline return flow from irrigation
  - Increase in salinity
  - Intrusion of saline ocean water
  - Decrease of fresh water flow downstream

- Impact on fish resources
  - Entrance of pesticides into river via groundwater contamination and dilution of effluents
  - Reduced dilution capacity for effluents
  - Use of pesticides in catchment area

- Impact on soil productivity in floodplain
  - Decrease in primary productivity
  - Decrease in influence supply
  - Increased sediment loa downstream

- Impact on landuse in floodplain
  - Increased bank erosion
FIG. 8.1c FLOW DIAGRAM IDENTIFYING IMPACTS IN COMMAND AREA
dislocation of human habitats, changes in the scenic values, modification of micro-climate of the region and alteration in the flora and fauna of the neighbourhood.

The submerged area under the reservoir is about 20055 hectares out of which about 1081 hectares are agricultural land, about 15506 hectares of forest land and about 3443 hectares are culturable waste and minor forest land. As a result of the submergence of extensive areas by the reservoir, eleven villages have been fully submerged and twenty-four villages have been partially submerged. Due to this, about 5969 population of the area is affected and 670 families have shifted to other areas.

The Tawa reservoir has also affected the micro-climate of the region to some extent. After the operation of the Tawa reservoir, the humidity around the area is generally higher than the pre-reservoir period. Although no data of the values of relative humidity at Tawa dam is available, the cultivators in villages near the Tawa reservoir is informed that the intensity of the cold, specially in the morning and the duration of cold weather has since increased considerably. This is mainly due to the increase of humidity specially in the morning period. As a result of the creation of vast reservoir, the flora and fauna of the neighbourhood have also altered to some extent as aquatic species appears to be
on an increase.

The Tawa reservoir has increased the population of wild animals in the neighbourhood of the reservoir. The population of the species of wild creatures that are seen at watering places like frogs and other amphibians has also increased considerably. The creation of the reservoir has isolated a part of the Bagra forest south-east of Tawa reservoir so much so that it has become somewhat difficult to go into the area with the result that population of forest inhabiting animals has considerably increased in this forest area.

The Tawa reservoir has provided considerable scope for development of fish culture on a planned and scientific basis, which is of great benefit to the local population. Most of the fishermen families were formally living along the banks of the Tawa river. Some fishermen whose previous occupation was riverine, fishing have switched over to reservoir fishing as a full time occupation. The steps taken to expand fish population in the reservoir have yielded good results. At present, the Madhya Pradesh State Fisheries Development Corporation is looking after the work of exploitation of fish stocks through licenced fishermen, marketing and formation of fishermen co-operative. The habitat of fish undergoes tremendous change when riverine environment is changed to reservoir environment.
Hence, the seed stocking programme of the reservoir has become very significant in establishing a commercial fishery. The reservoir has however, interfered in the growth of migratory fish.

Most of the recreation areas owe their attractiveness to water like beaches, lake side resorts, stream side picnic spots, falls, etc. After the formation of the Tawa reservoir, the scenic value of area has considerably been enhanced and the recreation value of the area has increased tremendously as it can be used for picnicking, boating, and fishing. Thus, the recreation potential around the area has become enormous. In addition, the Tawa reservoir also serves the purpose of flood protection and fish breeding.

8.2 IMPACTS AT DOWN STREAM OF TAWA DAM

The main impact downstream of the original river course is that the downstream hydrology of the river has been disturbed. The Tawa river flows towards north from the head works of the reservoir covering a distance about 22 km, in Hoshangabad district before joining the river Narmada. The catchment of the river is mostly hilly, which was giving rise to flash floods in the pre-reservoir period. With the construction of the reservoir, flow of water in the river Tawa has been considerably reduced. Due to this, there is reduction of floods in the plains adjoining the river course, which
is a beneficial impact. As a result of the reduced quantity of water in the river downstream, specially during the summer time, there is some deterioration in the quantity of the water down stream the original river course, reduction in sediment carrying capacity of the river, changes in aquatic and river bank vegetation, modification of fish life changes in recreational potential of the river and alteration in the economic and social life of the people living along the banks of the river. Sometime, abnormal and variable flows in the original river course are caused due to different levels of regulation to suit heavy rains and drought periods. Low flows may prevent survival of species adopted in the original river.

8.3 IMPACTS IN THE TAWA COMMAND AREA

The ecology of the Tawa Command area has been modified considerably after irrigation in the area. The environmental impacts of the various parameters of the Tawa command area is given below:

8.3.1 Canal System

The impacts along the routes of the canal system including main canal, branch canal, distributaries and water courses are seepage of water along the unlined water conveyance system and rise in water table along their course in addition to major changes in the landscape of the area. As a result of seepage of water,
stagnant water bodies have been formed in the borrow pits on either side of the canals which is not beneficial (Photo 8.1a & b).

8.3.2 Soil Salinity

Salinity of the soil in the accumulation of soluble salts upto the root zone of the soil caused by irrigation water of poor quality or ground water under shallow water table conditions. Salinization of the soil affects, the growth of the crop plants by reducing the amount of water absorbed by the roots. In extreme cases a soil may become so saline that it will not even support the growth of salt tolerant plants. Saline and Saline-alkaline soils contain excessive quantities of salts which increase the osmotic pressure of the soil solution. Saline and alkaline soils contain excessive concentration of either soluble salts or absorbed sodium or both. The original sources of these salt constituents are the primary minerals found in the soils and exposed rocks whose soluble constituents are gradually released from the minerals. These soluble salts in humid are as one carried down-ward by rain into ground water and ultimately are transported by stream and rivers. Leaching is, therefore, undertaken to wash the salts down and out of the root zone to counteract the process of salinization.

Irrigation water, even if it is of good quality is
a major source of soluble salts. Saline and Alkaline problems also rise if drainage facilities are adequate but insufficient water is applied to provide for necessary leaching of excess salts. In the Tawa Command Area, the chemical and electrical conductivity measurements are used for assuming soil salinity. It is found that the conductivity values of nearly 90% of the soils in Tawa Command is below the harmful limit and only a little area is having conductivity in the critical range. It indicates that the salinization of the soil is increasing through the irrigation water of the Tawa Command area and it is of good quality in general.

8.3.3 Soil Erosion

During field investigation of the Command Area, it is noticed that the areas adjoining the natural drains, streams, nalas, has been affected by rill and gulley erosion and badland topography. This erosion was further noticed to be advancing towards upland at the gulley heads. Similar rill and gulley erosion patterns were noticed in large number even in the banks of the main canals, distributaries, their minor water courses, collectors, drains etc. from the micro-level study of the toposheets and imageries of the command area, it has been estimated that due to intensive irrigation about 2--10% of the Command Area is prone to such erosion hazards.
8.3:4 Soil Fertility

The intensive irrigation in the Command Area has resulted in leaching of plant nutrients. It is noticed that the nitrogen content of the soils decreased slightly due to intensive cropping and leaching. As a result the fertility index of nitrogen content of soil is reduced. The available phosphorous content of the area has shown a decreasing trend in the soils, but the status of potash content has more or less remain the same after intensive cropping. This may be due to the proper application of fertilizer on the form soil.

8.3:5 Drainage

In the irrigated areas, the various measures such as construction of water courses land levelling and shaping have disturbed the natural drainage system of the area by reducing the natural slopes of the land surface and by changing the course of natural drains. Besides the rain water, often uncontrolled and over irrigation takes place in irrigated areas. The surplus water from field is causing stagnation. The excess irrigation water can ultimately lead to virtual waste of large track of land. The percolation is contributing to ground water reserves and is slowly raising water table creating water-logging conditions in some pockets in the area. During heavy rain, the stream water, if not drained quickly, increases ground water level due to stagnation. This may create water-logging and make the
land unfit for the agricultural purpose. The rain water or irrigation water collected in the narrow pits excavated at the time of construction of roads causes stagnation in the area as these pits remain unconnected. Therefore, there is an urgent need for providing drainage facilities in the Tawa Command Area.

8.3.6 Water Table

The depth of water table of the existing permanent observation wells in the Tawa Command Area for the pre and post monsoon periods collected by the Ground Water Surveys Deptt. Govt. of M.P. for the periods from 1984 to 1992 indicates that there is a slight rise of the water table in the area. This may be due to lack of subsoil drainage, uncontrolled and continuous flow of water in the irrigation distribution system and excess rainfall or due to some localized phenomenon. However, the problem of the rise of water table in some pockets resulted the water-logging conditions.

To Study the distribution of water-logging in the Tawa Command Area, a map (fig.8.2) has been prepared with the help of remote sensing data. In general, it is noticed from this map that most of the water-logged areas are adjacent to the canals and its distributaries. The area affected by water-logging as on March 1992 are shown in Table 8.1
FIG 8.2 WATER LOGGING MAP OF TAWA COMMAND AREA, HOSHANGABAD DISTRICT (M.P.)
(BASED ON REMOTE SENSING DATA WITH SELECTIVE FIELD CHECKS)

LEGEND

::: WATER LOGGED AREA
### Table 8.1

<table>
<thead>
<tr>
<th>Right Bank Canal</th>
<th>Water-logged area (acrs)</th>
<th>Left Bank Canal</th>
<th>Water logged area (in acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ankhmau -/</td>
<td>700</td>
<td>Chandpura</td>
<td>70.27</td>
</tr>
<tr>
<td>2. Gujarwara -/</td>
<td>450</td>
<td>Neem sandiya</td>
<td>149.38</td>
</tr>
<tr>
<td>3. Kotgaon</td>
<td></td>
<td>Kulhamadi</td>
<td>0.05</td>
</tr>
<tr>
<td>4. Babai -/</td>
<td></td>
<td>Pathodi</td>
<td>94.77</td>
</tr>
<tr>
<td>5. Nagwada</td>
<td></td>
<td>Bioara</td>
<td>31.49</td>
</tr>
<tr>
<td>6. Bagalkheri</td>
<td></td>
<td>Bomangaon</td>
<td>7.84</td>
</tr>
<tr>
<td>7. Tamcharu</td>
<td></td>
<td>Bikhedi</td>
<td>5.40</td>
</tr>
<tr>
<td>8. Dhana (Khargaoli)</td>
<td>1700</td>
<td>Tarodhana</td>
<td>5.00</td>
</tr>
<tr>
<td>9. Bikori</td>
<td></td>
<td>Kodaikala</td>
<td>0.75</td>
</tr>
<tr>
<td>10. Bikor</td>
<td></td>
<td>Chandon</td>
<td>2.02</td>
</tr>
<tr>
<td>11. Panwasa -/</td>
<td></td>
<td>Samjidhana</td>
<td>2.25</td>
</tr>
<tr>
<td>12. Ganera -/</td>
<td></td>
<td>Superli</td>
<td>0.35</td>
</tr>
<tr>
<td>13. Sheopur -/</td>
<td>6</td>
<td>Bamuria</td>
<td>0.60</td>
</tr>
<tr>
<td>14. Simordha</td>
<td></td>
<td>Bamhari Khurd</td>
<td>0.50</td>
</tr>
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<td>15. Kheri -/</td>
<td></td>
<td>Babai Khurd</td>
<td>0.93</td>
</tr>
<tr>
<td>16. Barwani -</td>
<td>3</td>
<td>Bhatti</td>
<td>1.55</td>
</tr>
<tr>
<td>17. Talkeshri/-</td>
<td>100</td>
<td>Naudawara</td>
<td>4.00</td>
</tr>
<tr>
<td>Sirwara</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Baglon -</td>
<td>4</td>
<td>Rohna</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undrakheri</td>
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<td>Anjarakalu</td>
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<td></td>
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<td>Righoda</td>
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<td></td>
<td>Bisaroda</td>
<td>7.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sonasoani</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Sanal Kheru</td>
<td>75.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kodai Khurd</td>
<td>0.50</td>
</tr>
</tbody>
</table>

| Total            | 2513| Total            | 503.17|

Source: Water Resources Department, Ground water surveys
Govt. of M.P.

Table 8.1 shows that 18 villages are affected by the water-logging in the right canal command area of the Command Area and the total water-logged area is 2513 acres. Twenty-five villages have been affected by
the water-logging in the left main canal command area and about 503.17 acres area is water-logged.

In general, the Command Area between Tawa and Gajral river is much affected by the water-logging. The Command Area between Tawa and Dhudhi river is also highly affected by the water-logging. These facts can very well seen in the Fig.8.2.

The continuing problem of water-logging could be due to the following possible causes in the Tawa Command Area.

- Excessive irrigation in the Command Area.
- Seepage from canal system and consequent rise in the water table.
- Inadequate number of drains to effectively dispose-off the excess rain water from the fields.
- Insufficient capacity of drains to remove collected water from the fields in the stipulated time.
- Inadequate maintenance of drains.

Water-logging in the Tawa Command Area is due to the presence of surplus ground water and inadequate drainage. The approach to solve this problem include the proper understanding of ground water regime and the physiography of the area. Detailed hydrogeological
surveys need to be undertaken in the command area for delineating aquifers and their characteristics for proper planning of subsurface development structures with a strong data base, the simulation studies may also be undertaken for predicting the behaviour of ground water regime with the additional surface water in the command area. The remedial measures of water logging is suggested by Jain (1990) and Chourasia (1984) should be implemented in the Tawa command area which are given below:

- Construction of drainage channels parallel to the main canals at locations where seepages occur through the sides of the canal.
- Lining of canal floors and sides wherever the yellow clay with kankar are exposed.
- Construction of drain to dispose-off the surface run-off of low grounds into the natural drainage.
- Supply of irrigation water should be controlled in the farmlands where ground water have reached up to one meter below the ground surface.
- Adequate provision should be made for run-off from the field.
- Land shaping practices should be implemented and the bunds dividing them into small fields should be spaced far apart.
- The type of crops that are to be grown, should be based on the ground water level depths during different seasons of the year.

- Re-opening of all the effective natural drainage courses, such that the surface water are conducted to their respective river system.

- Deepening and/or widening of the aqueducts as may be necessary in order to prevent formation of water pools.

- Intensive exploitation of ground water for irrigation should be resorted to the command area, where canal water is not being used for irrigation.

- Plantation of more ground water consuming trees such as Eukeliptus in the water logged areas.

It has been noticed that at the present rate of development of irrigation, the water table will continue to rise. Therefore, it is necessary to exploit the ground water of the Tawa Command Area. Intensive development of ground water through wells will change the ground water pockets of the command area would also be gradually altered. The exact impact of ground water development in different parts of the command area have to be assessed by more detailed studies.
8.3:7 Water weeds

Introduction of irrigation water has resulted in rapid increase in water weed and propagation of aquatic plants. Under irrigation condition, the extent of aquatic habits are seasonal and these plants grow quickly. They produce root system and leaf surface that favour them in competition with seasonal crops. Some seeds are poisonous. Some weeds are serious hazards to agricultural lands and some of them reduce the drain capacity and sometimes even block the drains. The stagnation of undesirable water in borrow pits have created water seeds which did not exist in the command area before.

8.3:8 Water Quality

As already stated in chapter 7 that the quality of ground water of the area is suitable for irrigation as well as drinking purposes in general. But at places, the quality of ground water deteriorated to the extent that it is unsuitable for the above mentioned purposes. The causes of the deterioration of the quality of water is the agricultural activities implemented in the Tawa Command Area. The irrigation return flow and the use of fertilizers, pesticides, etc, are the main cause of the deterioration of the water quality in the command area. Therefore, monitoring of quality of ground water in the Tawa command area is essential. The change in the quality of ground water due to irrigation is also found
by Chourasia and Tellam (1992) in the Bila command area which consists of Bundelkhand granites.

8.3.9 Fertilisers, Pesticides and Insecticides

The use of proper fertilisers in adequate quantity and providing suitable protection against crop pests are essential inputs in an integrated programme of development of agriculture. Intensive farming resulting from the intensive irrigation of Tawa Command Area has led to increased use of pesticides, insecticides, fungicides and herbicides with a view to have maximum agricultural production.

It is estimated that the annual crop losses due to weeds, plant diseases and crop pests in the Tawa Command Area are about 15-20% of the agricultural production. As such, the use of pesticides has assumed great significance in reducing these production losses. It is observed that nearly about 75% of the consumption of pesticides in the study area is accounted by pulse crop and cotton and hence, its demand mainly depends on the area shown under pulse crops. With the increase in the area under irrigation, the incidence of pests and diseases may increase, resulting in higher demand of insecticides and pesticides in future.

The use of many pesticides and insecticides adversely affect men, animals, birds and plants. Some
of the major impacts of insecticides and pesticides and fertilisers in intensive irrigated areas of Tawa Command Area are given below:

- Direct application of pesticides and insecticides and fertilisers is a major pathway to adequate environment.
- Herbicides are generally less toxic to aquatic fauna than insecticides and pesticides and usually they do not result in adverse effect.
- Run-off and subsurface flows from irrigated areas got polluted due to indiscriminate use of insecticides, fertilisers and pesticides.

8.3:10 Tanks and Ponds

Irrigation tanks and ponds when used in conjunction with cannaal irrigation, function as storage reservoirs into which surplus water could be diverted so that the same could be utilised during the periods of scarcity. There are four minor tanks in Tawa Command Area. These tanks are HiranKheda, Hirapur, Pokharni and Shivpur. All these tanks get charged by the run-off from their catchments. The effective utilisation of all these tanks are reported to be poor, the Command Area of these tanks are declining. The main cause of low utilisation of these tanks is the problem of water-logging which is attributed to the lack of adequate drainage system in
the area surrounding the tanks.

8.3:11 Human settlement

The creation of irrigation facilities have cause intensive cropping in the Command Area which has led to the growth of population, higher agricultural production and impact on environment. These have necessiated substantial improvement in medical, Educational and Recreational facilities.

Eight towns in the command area declared us urban areas these are Hoshangabad, Itarsi, Harda, Seoni Malwa, Timarni, Khirkiya, Sohagpur and Babai. It is considered that with the increase in the area under irrigation, the number of farm labours in rural area will further increase in future. In the Command Area the male-female ratio is 1,000 males for 913 females. The male-female ratio of rural and urban population is 1000 males for 926 females and 1000 males for 879 females respectively.

8.3:12 Community Health

The relation of geological environment with chronic disease is complex and difficult to analyse. Nevertheless, considerable evidences are being gathered and studied. Preliminary results show that the geological environment is indeed a significant factor in the incidence of several hygenic problems such as Cardio Vascular disease, hypertension, stomach disease and Cancer. Recent environmental health studies found a
direct link between various chronic disease and a particular geologic environment. Recent works of Crawford et al (1971), Lingston (1970), Voors (1970) and Blackley (1969) have shown that Cardio Vascular diseases are apparently related with hardness of water.

In the Tawa Command Area, a health hazard study has been undertaken in order to establish a correlation between quality of water and the disease prevalent in the area. The data with respect to the health hazards have been collected from the local health centres and also a cursory health survey has been made in the area. It is found that people are suffering from cathartic physiological effects due to presence of high sulphate concentration in ground water where as people living in the vicinity of the wells containing higher concentration of sodium are suffering from Hypertension. The other miscellaneous disease prevalent in the people living in the Command Area are congestive Cardiac failure, cirrhosis of the liver, Toxemia of pregnancy etc. The people living near the water-logged pools are also suffering from the Malaria.