Chapter 12
Environmental and Ecological aspects

12.1 General

Survival of the mankind, with its alarming increase in population growth is linked in the long term, requires a stable eco-system and increase in food production, for which the development of water resources is unavoidable. The development of water resources project is linked with change in the environment of the area due to construction of reservoirs because of submergence of land, displacement of population including the flora and fauna and resettlement in the surrounding catchment, denudation of forest, water logging, salinity and alkality of soil, water quality and ground water table change, etc.

The environment and ecology is degraded by both inappropriate and lack of development. In respect of disturbance of environment, there are two schools of thoughts. One school holds that eco-system is fragile and highly unstable. It is implicit, therefore, that eco-system should be left as much as possible in its natural state and that its diversity should be preserved at any cost. Modification for the purpose of development should be minimal and confine to the range of tolerance limits of various elements of eco-system. The second school of thoughts assuring that the eco-system is globally stable and there is large element of built in resilience in eco-system. In any case, it is realized that the water resources projects should be planned to be aimed for the sustainable developments of the inter-connected elements that co-exist in the system.

Water resources development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs will alone be considered as a sustainable development. It is, therefore, realized that the water resources projects should be planned, implemented and managed in such a way that the future demands of the growing population have to be met with minimum disturbance to the existing eco-system along with the incorporation of adequate control measures at appropriate stages to mitigate the adverse effects, if any; to maintain the sustainability of the system, in long run.

12.2 Basic information

12.2.1 Land use in the catchment area of the project

The catchment area of the Godavari basin up to Inchampalli dam site is 269000 km^2. The length of Godavari River from its source to Inchampalli dam is 1058 km and the catchment area below the existing Sriramsagar dam to Inchampalli dam site is 177249 km^2. The land use data of the catchment between Sriramsagar and Inchampalli dam sites is furnished in Table 12.1.

Table 12.1
Land use particulars of the catchment area between Sriramsagar dam and Inchampalli dam site.

Sl.No	Category	Area in ha	Percentage
1.	Forest	6222628	35.11
2.	Barren land	495374	2.79
3.	Land put to non-agricultural use	784439	4.42
4.	Permanent pastures and other grazing land	979672	5.53
5.	Culturable waste	514108	2.90
6.	Land under miscellaneous crops and trees	109817	0.62
7.	Current fallows	765011	4.32
8.	Other fallows	386089	2.18
9.	Net area sown	7467773	42.13
10.	Culturable area	9242798	52.15
11.	Area sown more than once	620541	3.50
12.	Gross area sown	8088314	45.63
	Geographical area	**17724911**	**100.00**

12.2.2 Land acquisition for link canal

For construction of 312.20 km long link canal, a total area of about 4555 ha will have to be acquired. Out of this, 3817 ha are required for main canal, 33 ha for offices & staff colonies, 5 ha for canal powerhouse and 700 ha for borrow areas. However, care has been taken to avoid the villages and towns enroute, thus eliminating the problem of rehabilitation.

12.3 Environmental and ecological aspects of the Inchampalli reservoir

12.3.1 Submergence by the Inchampalli reservoir

12.3.1.1 Area of submergence

The Inchampalli Joint Project when formed will submerge areas in the States of Andhra Pradesh, Maharashtra and Chhattisgarh. The reservoir stretches in the upstream of the dam for about 100 km. The submergence area in the three states is about 92555 ha with 36876 ha in Andhra Pradesh, 17086 ha in Chhattisgarh and 38593 ha in Maharashtra. The details of different types of land likely to be submerged are given in Table 12.2.

Table 12.2
Details of submergence

Sl.No	Particulars	Area in ha
1.	Forest land	21734
2.	Cultivable land	37782
3.	Wet lands	1480
4.	Shrubs, fallows & rock out crop	2450
5.	Open water bodies	2450
6.	River portion	21830
7.	Other uses	4829
	Total submergence area	**92555**

12.3.1.2 Villages and population

The density of population in the submergence area is about 137 persons per km^2, whereas it is about 100 persons in the command area and about 113 persons in the catchment area. The details of the villages coming under the submergence and the population affected are given in Table 12.3.

Table 12.3
Details of villages coming under submergence and population affected

Sl.No	Name of the State	No. of villages	Population to be displaced (Nos)
1.	Andhra Pradesh	65	38815
2.	Maharashtra	100	43186
3.	Chhattisgarh	64	18079
	Total	**229**	**100080**

Source: Inchampalli Joint Report of Government of Andhra Pradesh – Report on Environmental and Ecological Aspects of Inchampalli Joint Project – Statistical Data Volume – I.

About 90% of the population-affected are backward and forest based and they can be engaged in the project construction work. The project will give adequate employment opportunity during construction as well as during operation stage to oustees and local population.

12.3.1.3 Resettlement

For re-settlement of the affected population, generally a rehabilitation committee will be constituted on the sanction of the project. Compensation and other packages will be decided upon by the respective State Governments as per their norms, which are communicated from time to time. As regards the re-settlement of oustees, 500 to 600 no. of persons can be settled in the existing villages and 2500 to 3000 families in new settlements. The rehabilitation centers and new settlement shall be as far as possible kept at about 20 km from the present habitation. New colonies and model villages will be constructed providing basic amenities such as drinking water, access roads, schooling facilities, electrical lights, post offices, banks, panchayat ghar, health centers, police station etc to its inhabitants.

As regards Maharashtra, various concessions are granted to the project affected persons such as financial assistance for transfer of personal effects, exemption from stamp duty in respect of plots allotted to them, permission to cultivate in the submergence land till they are actually submerged, use of quarry material from forest land as well as from non-forest land with permit issued by Divisional Forest Officer or Local Revenue Officer for construction of their own houses and / or agricultural uses, preferential treatment in the matter of appointment to posts in government offices and in state owned industries in the Kalwan Bhiwandi Industrial Estate (near Thane), priority and assistance in gaining admission to the Industrial Training Schools and sanction of housing loans with subsidized rate of interest etc. Suitable provision for the resettlement has been made in the Inchampalli project estimate.

12.3.1.4 Compensatory afforestation

The total submergence of forestland in all the three states is 21734 ha. The land to be acquired for colony, construction of roads etc; for the Inchampalli project is also from forest land which is about 300 ha. To ameliorate adverse impact of loss of forest, it is proposed to provide compensatory afforestation around the periphery of reservoir in

consultation and association with the concerned state forest departments.

12.3.1.5 Development of aquatic life

There are a few fish breeding grounds in the Andhra Pradesh and Chhattisgarh portions of the submergence area. There are no known fish breeding or crocodile breeding grounds in Maharashtra portion. Crocodile breeding grounds are rarely found in Andhra portion of submergence area.

Creation of the reservoir will increase the fish production and development of pisciculture in the region. The reservoir will be used for fisheries development, both culture as well as breeding. The reservoir will be suitable for fish culture being perennial water source, especially in the shallow upper reaches of the reservoir. Many families will get jobs in the fisheries, which will also reduce the resettlement problem.

12.3.1.6 Loss of minerals and commercial timber

No potential coal bearing area will come under submergence due to construction of the dam with a maximum water level and full reservoir level, if placed at 112.77 m. There are no economic mineral occurrences. However, a few Limestone/Dolomite bands of Pakhals and Kotas lying between Bhopalpatnam and Sironcha are depicted in the available geological map of Maharashtra.

In Andhra Pradesh the mixed forest area of about 9024 ha with 10 to 30% teak wood worth of Rs. 20.85 crores will come under submergence. The Maharashtra Government has reported that the loss under forest will be about Rs. 8.14 crores. It comprises of timber yielding species like Terminals, Tomentesa, Dalbergia, Peniculata, Gimelenn, Arborea, and Desisoo etc.

The loss of minerals and commercial timber coming in the submergence area of Chhattisgarh has not been estimated so far by the concerned departments. This will be estimated at the time of Preparation of DPR.

12.3.1.7 Flora and fauna at proposed Inchampalli project site

The forest type in the submergence area of Andhra Pradesh is a mixed forest with II to IV quality and density 0.4 to 0.6. The forests in Maharashtra are dry deciduous type thickly wooded and dense. In

Chhattisgarh, forest portion contains 47.50% teak and the remaining 52.5% is of miscellaneous type. Teak, Ain, Garedi, Khair, Bhura, Bija, Semal, and Karam are the generally found varieties.

The proposed site for Inchampalli project contains a number of important wild life habitat. The Singaram sanctuary will be directly affected, as a part of the sanctuary will be inundated following the construction of the dam. In addition, there are a number of important sanctuaries situated in the Adilabad and the Karimnagar districts viz., Pranahita sanctuary and Kawal wild life sanctuary which are also likely to be affected by the proposed construction. Further, 65 ha of Indravati National park in Chhattisgarh falls under the proposed project site. The proposed dam site for Inchampalli project is the breeding area of a number of wild animals but at present no precise information as to whether the area falls under the migration route of any birds or other animals, is available. The following animals and birds as given in Table 12.4 are likely to occur in the proposed dam site.

Table 12.4
List of fauna and birds found in the proposed dams Site

Particulars	Andhra Pradesh	Chhattisgarh	Maharashtra
Fauna	Leopard, Jackal, small Indian Civet, Plan civet, Wild bear, Chital, Sambar, Black Buck, Nilgai, Rhesus macaques	Wild buffalo, Bison, Tiger, Panther, Wild Bear, Bear, Nilgai, Sambar, Chital, Barasingha	Panther, Tigers, Pancories, Tanes, Panthe Pardus, Black buck
Birds	Kostrel, Red Kuaded Marlin, Peregrime Falcon, Shikra, Peafowal, Great Indian Horonbill	Portrige, Pegion, Pheasent, Dover etc	Peafowl, Junglefowl, Sandgrouse, Wood-pecker

No rare or endangered species is reported from the project-affected area of Andhra Pradesh and Maharashtra, however, the wild buffalo and the Barasingha are the endangered species of fauna found in the Chhattisgarh portion of the area.

12.3.1.8 Seismicity of the area

The Godavari river valley is within the NW-SE trending faults. These faults still show moderate seismicity occasionally. The Godavari graben area is in seismic Zone III of the seismic zoning map of Bureau of Indian Standard. In this zone an earthwork of magnitude 6 or intensity VIII may be expected. The earthquake of magnitude 5.3 was measured at Bhadrachalam in 1969.

The earthquakes are known to be triggered by reservoir loading in area of moderate seismicity. However, magnitude of the triggered earthquake, is not anticipated to exceed the magnitude of the largest earthquake expected in the area. In the present case, earthquake may be triggered after reservoir loading and the largest expected earthquake in the area will be in the magnitude of 6.

12.4 Environmental and ecological aspects of Pulichintala reservoir

The Pulichintala reservoir when formed, will submerge an area of 14,399 ha at FRL of 53.34 m in Nalgonda (6904 ha) and Guntur (7495 ha) districts of Andhra Pradesh. Out of the total submergence, 10286 ha is under patta land including cultivated & residential, 3238 ha is under barren land and the remaining 875 ha is under the existing Nagarjunasagar ayacut. About 16 villages will be submerged affecting population of 25000 persons as per 1991 census.

12.5 Proposed period of construction

The Inchampalli – Pulichintala link project consists of construction of Inchampalli dam, link canal, CD & CM works and the development of command area. The project is scheduled to be completed in 10 years taking up simultaneously, the head works and the conveyance system. The detailed construction programme is discussed in Chapter on "Construction programme and manpower and plant planning".

12.6 Labour

The employment generation per crore of rupees of the cost of the project is 10 persons in case of a major project comprising 6.63% of engineers, 6.73% of technical, 7.76% skilled & semi-skilled, 60.22% unskilled and 18.66% clerical. This expenditure on manpower includes expenditure on

pay and allowances, bonus, social security, office expenses and traveling expenses.

The total expenditure on the Godavari (Inchampalli) – Krishna (Pulichintala) link project is Rs. 5021 crore excluding on farm development. The manpower required for the construction of the project will be 5021 persons considering the cost of the project. This manpower comprises 333 engineers, 338 other technical, 390 skilled & semi skilled, 3024 unskilled and 937 clerical personnel.

12.7 Population density

The population density in the catchment between Sriramsagar and Inchampalli dam site is 113 persons per sq.km as per 2001 census. The density of population in the command area of the link project is 670 persons per sq.km. The area is mainly lying in the command area of NRBC and NLBC.

12.8 Sedimentation

The Govt. of A.P has anticipated a sedimentation rate of 0.059 $Mm^3/100\ km^2$ /year for the free catchment. However, the actual rate of sedimentation based on observed data of years between 1969-70 and 1991-92 except for the years 1986-87 and 1990-91 at Perur G&D site, maintained by CWC, is of 0.028 $Mm^3/100\ km^2$ /year against the Bureau of Indian Standards recommended rates of 0.048 to 0.096 $Mm^3/100\ km^2$ /year for rivers in India. Another significant feature is that the above sedimentation rate at Perur G & D site is less than the average annual sediment yield of the whole Godavari basin which is about 0.03 $Mm^3/100\ km^2$ /year.

12.9 Flood situation

The downstream area of the project has a long history of floods. The highest recorded flood is in the year 1986 and the maximum flood discharge is 77500 cumecs at Perur G&D site located 10 km downstream of Inchampalli dam site.

12.10 Frequency of cyclones

Number of occurrences of severe cyclone storms that affected the area during past seventy years is given in Table 12.5.

Table 12.5
Number of occurrences of cyclonic storm

Month	Near Visakhapatnam	Near Kakinada
May	4	1
June	1	5
July	0	2
Sept	2	3
Oct	13	11
Nov	8	2
Dec	0	1

12.11 Groundwater regime

The bore wells and filter point wells are feasible in the alluvium formations whereas bore wells of depth more than 100m can yield more than 200m^3 /day in sand stone formation. The density of wells at present are negligible. The yield from filter point existing in the area is 130m^3 /day and each filter point gives a continuous discharge of 12m^3 /hour. Along the canal alignment, the water table is 2-4m upto Bhadrachalam, 4.7 m upto Kothagudem and 2-4 m thereafter.

The quality of groundwater is generally good and suitable for drinking and irrigation purposes. Chemically the water is slightly alkaline with average pH of about 7.9. However, in Nalgonda district near Pulichintala reservoir, the pH is observed to be 8.0 to 8.49.

The balance ground water potential available for exploitation as estimated based on the Central Ground Water Board data in the districts of Warangal, Khammam, Krishna, West Godavari, Guntur and Prakasam lying in the command area is 1003 Mm^3**.**

12.12 Pollution and industrial development

There is one prominent industry i.e. the Kothagudem Thermal Power Station along the alignment, which will contribute to pollution to some extent. However, the industry under the reputed NTPC might have arranged its own non-pollution measures and hence the pollution would be minimum. There are no development projects to be taken up in the immediate future.

12.13 Tourism

The area can be developed as a tourist resort after the formation of reservoirs. The existing Kinnerasani dam located down stream of proposed Inchampalli dam is a scenic spot and can be developed as a tourist resort.

12.14 Archaeological centers

No archaeological researches were attempted in the past on account of the presence of impregnable forest with wild animals, though it is well recognized and acknowledged that the two banks of the river Godavari and adjoining areas have been treasure houses of undiscovered cultural, archaeological and historical sites. Detailed survey of the adjoining areas covered has however been proposed by the state Archaeological Department. Before the reservoirs are formed, the detailed survey is proposed to be completed and any archaeological finds will be retrieved to safer places.

12.15 Health hazards

There is no indication of any health problem due to water and soil borne diseases in the area.

12.16 Environmental impact

The National Council of Applied Economic Research (NCAER), New Delhi was entrusted with the studies of socio-economic and environmental implications of the Inchampalli–Pulichintala link project along with other five inter basin water transfer link projects of NWDA. The present section on the Environmental impact of the link project is based on the conclusions drawn in their report.

12.16.1 Surface water regime

The canal is aligned to be a contour canal and will interfere with natural surface drainage of the area. As such adequate cross-drainage works are provided in the project.

12.16.2 Impact on groundwater

Provision of canal irrigation in the proposed command area causes additional recharge to the ground water. As a result, the groundwater

levels will rise gradually year by year. Part of this augmented groundwater reserves find its way into the stream. To avoid likely rise in water table with consequent harm to crop pattern, the drainage system will have to dispose of the surplus recharge along with surface drainage.

12.16.3 Aquatic life

The reservoirs can be utilised for development of fisheries. However, pre and post impoundment surveys have to be undertaken to work out the steps needed for development of fishery in the reservoirs.

Fish ladders will be provided to allow movement of important migratory fish population. Provision for the construction of fish ladders is made in the estimates.

12.16.4 Natural resources

The submergence under Inchampalli dam is limited to river portion and that under Pulichintala reservoir is mostly of cultivated land. As such, the mineral resources likely to be lost will be very negligible.

12.16.5 Effect of water body

The formation and use of water bodies in the region is not likely to result in introduction or enhancement of water borne diseases provided no heavy industrialization around the area takes place.

12.16.6 Aquatic weeds

The chances of impounded reservoir leading to noxious aquatic weeds and intermittent host are remote in the given circumstances. The nature

of existing aquatic weeds in submergence area and their impact on fisheries development has to be studied in detail after the formation of the reservoir to evolve possible remedial measures, if necessary.

12.16.7 Climatological changes

Some induced climatological changes may happen in the long run. But the type of changes cannot be outlined at this stage.

12.16.8 Impact on seismicity

The Godavari river flows along a faulted graben, with the highest recorded earthquake in the region having occurred in 1968 near Bhadrachalam. The Director (Seismology), India Meteorological Department, has opined that for the dams of height less than 100 m, seismological observations are not necessary.

The dam sites falls in Zone –III as per the map of India showing the various seismic zones (IS code: 1893-1975 "IS criteria for earth quake resistant design of structures"). The horizontal and vertical inertia coefficients worked out by Govt. of Andhra Pradesh for Inchampalli dam and adopted for various components are as given in Table 12.6.

Table 12.6
Seismic coefficients adopted for various components

Component	Horizontal	Vertical
Spillway	0.04	0.02
Earth	--	--
NOF dam	0.04	0.02

12.17 Adverse impact of the project

Implementation of any irrigation project helps in raising the prosperity level in the region. However, some adverse effects bound to occur which should be mitigated through suitable remedial measures. Some of the adverse impacts could be as listed below.

1. Resentment of the affected people in the project area as well as submergence area, since most of the benefits of the project are for the people living in the far away command area.
2. Formation of water body may result in introduction of water borne diseases unless precautionary measures are taken.
3. The shortened drainage length due to reservoir formation may cause additional silting.
4. Forest area will be submerged causing environmental and ecological degradation.
5. Water logging and salinity due to increased irrigation in the command area.

12.18 Resettlement and Rehabilitation

The proposed Godavari(Inchampalli) – Krishna(Pulichintala) link project involves the creation of reservoir at Inchampalli, which submerges cultivated land, villages etc. The effect of submergence leading to loss of homes and means of sustenance will have a traumatic effect on the affected population. Proper and timely steps for resettlement and rehabilitation of these persons is essential to minimize their suffering. However, the problems relating to resettlement and rehabilitation (R&R) are quite complex. Efficient institutional arrangements for implementing the entire programme of R &R effectively is equally important. Active co-operation of the affected persons will be beneficial for successful implementation of the project.

In the recent times, there has been increased awareness about the issues involved in R & R programme and to frame proper policies for the purpose. It is also desired to demonstrate the will of the authorities to implement the R & R programme sincerely. The consciousness is growing among the persons likely to be affected with regard to their right for having an adequate rehabilitation package. It has been observed that many of these persons are unwilling to hand over the physical possession of the land acquired for the projects. This leads to delay in many projects incurring cost over runs. Therefore, enlisting the co-operation of affected persons has become an important aspect of project implementation. The attractive R & R packages along with effective implementation in reasonable time schedule has become an essential input for construction of major projects.

During their study, The National Council of Applied Economic Research (NCAER) has not observed any specific resistance among people who are small-scale farmers and who are engaged in allied business. However, big cultivators were resistive. This is contrast to the general perception that a small farmer worries about losing his land but a big farmer need not generally worry as he loses a small fraction of his land and gets water facility for the remaining land because of the project. Further, the area is infested with naxal activity because of its backwardness. The project authorities should convince people that only irrigation projects could bring development in the region and reduce unemployment problem thus gradually diminishing the resentment of the people in the region. The project implementation could be made easy through attractive R& R package, its proper implementation and the socio-political will.

The R & R package for the link canal will be outlined in detail by NWDA during the preparation of detailed project report keeping in view, the prevailing demand from the project affected persons, institutional provisions and legal directions of the time.

12.19 Economic impact

The increase in income from crop farming with the availability of irrigation facilities is considered as the direct benefit of the project. The changes in income of the other activities of the households in the command areas and consequent changes in total employment are taken as the indirect benefits due to higher benefits in agriculture. Table-12.7 below provides average income per household in various economic activities and total amount of employment generated for households with and without irrigation facilities.

Table 12.7
Average annual household income from various sources and total employment (1993)

(Rupees/ Man days)

Description	Average annual household income	
	With irrigation	Without irrigation
Income from crop farming	22360	11570
Livestock & allied activities	3815	2676
Farm wages	1898	5837
Non-farm wage and salary	1227	2116
Other activities	335	1399
Total income, rupees	29634	23598
Total employment, man days	459	507

Naturally, the income from farming and allied activities is increased in the scenario with irrigation. The reduction in employment with irrigation is due to the fact that the use of mechanical power for land preparation in this command. Accordingly, the income from wages and employment is reduced in the scenario with irrigation.