Chapter 11
Environmental and Ecological Aspects

11.1 Environmental and ecological aspects of storage reservoirs

A multipurpose project is proposed at Barmul on river Mahanadi, which will be utilised as off-take point for the link canal. According to the preliminary study, construction of the Barmul project will involve creation of a reservoir having a water spread area of 13768 ha. The National Council of Applied Economic Research (NCAER), New Delhi was entrusted with the Agro-economic, Socio- economic and Environmental impact studies of six link projects including Mahanadi – Godavari link project by the NWDA. The different aspects in this regard as given in the Agro-economic, Socio-economic and Environmental impact study report of six link canal projects prepared by NCAER, (1993) and in the Manibhadra dam project report (1984) prepared by Govt. of Odisha are presented below.

11.1.1 Physical aspects

The impoundment of water shall affect the ground aquifers. Land slides are not expected in the reservoir periphery. The sedimentation in the reservoir is not expected to effect the environment. The reservoir will not create any soil erosion in the catchment. It is expected that there will not be any potential seismic impact due to reservoir loading and there will not be substantial change due to impoundment of water. The existing Hirakud reservoir on the same river upstream gives this experience. There will be improvement in the land use pattern and practices in the vicinity of the water spread. Some aquatic vegetation may grow in the periphery which is expected to be not harmful.

11.1.2 Resource linkage aspect

No mineral deposits, monuments, recreational facilities etc are expected to come under submergence of proposed dam. There will be loss of reserved forests for which provisions have been made for compensating forest growth. The impoundment will improve the aquatic life such as fish, crocodiles etc. Reservoir will help increase in production of power, food grain due to irrigation and flood control in a vast stretch of land in the down stream. There will be dislocation of existing settlements involving 58000 persons in 93 Nos. villages (as per 2011 Census). The liberal policy of the Government in dealing in such rehabilitation will improve the socio-economic standard of the displaced people.

11.1.3 Socio-cultural aspects

As discussed above there will be improvement in the socio-cultural aspects of the displaced persons. Each new resettlement colony will be provided with water supply facilities, schools and community building for recreation purpose. This shall improve the life style of the people.

11.1.4 Public health aspects

The impound of reservoir may not create any public health hazards. The reservoir is located in a remote area with thin population density. This area will not attract much of populations from outside except during the periods of construction for which adequate provision for medical facilities etc. have been made.

11.1.5 Existing land use in the catchment

The upstream area in catchment consists mostly agriculture land, reserved forest, village forest and waste lands.

11.1.6 Area coming under submergence

The area coming under submergence of Barmul dam and six dams will be 21262 ha and 10098 ha respectively.

11.1.7 Population density

The population density in the Barmul submergence area is 3 persons per ha.

11.1.8 Villages affected and population displaced at FRL 80.0 m

(A)	Number of villages	93 Nos.
(B)	Population	58,000 Nos.

Table - 11.1
Details of Submergence and family affected due to proposed reservoirs

Sl. No.	Name of project/ Dam	District	Submerg-ence area (Ha)	No of villages affected	Family affected	Population affected	Remarks
1	Barmul	Nayagarh	21262	93	-	58000	
2	Salia	Khordha	984	-	44	300	Due to additional submergence
3	Ong	Bargarh	5100	32	4140	12075	
4	Tel	Nabarangpur	1330	-	-	2660	Forest area
5	Upper Udanti	Nuapada	1788	8	-	-	Forest area
6	Uttei Roul	Kalahandi	854	-	-	-	Forest area
7	Khadaga	Kandhamal	45	-	-	-	Forest area
8	Salki	Kandhamal	981	11	358	1572	

11.1.9 Resettlement

(a) Details of Rehabilitation Committee

There will be rehabilitation committee under the chairmanship of Revenue Divisional Commissioner. Govt. of India in the year 2013 has prepared guidelines for rehabilitation and resettlement.

(b) Village and population affected

As per the preliminary assessment done so far based on available records, it is assessed that a total Nos. of 93 villages will come under submergence of proposed Barmul reservoir corresponding to FRL 80 m affecting 58,000 people (2011 census) in four districts viz., Phulbani, Dhenkanal, Cuttack and Nayagarh

(c) Resettlement plan

Total number of persons affected as per the preliminary assessment are 58000. These Project Affected People (PAF) are to be resettled in their respective districts nearby in the ayacut area of projects either under execution or planned to be executed. The families will be grouped between 50 to 100 and settled in separate colonies where community facilities like roads, wells, tanks, schools, dispensary, Thakurani sheds (Temples), communal centers will be provided.

The each affected families will have the benefits of 1.0 acre of land for house site and community purposes. Besides they will be provided with all the facilities like road, inside the colony and connecting road to main road, tanks, wells, school, recreation centre or community centre, shopping centre, place of worship and joint facilities like few high schools, primary health centres and dispensary, post office, veterinary hospitals and panchayat office etc.

11.1.10 Sedimentation of reservoir

(a) The rate of siltation is expected to be 1 acre feet per sq. mile of catchment area per year for the free catchment and at the rate of 0.25 Ac.ft. for the intercepted catchment.

(b) No special soil conservation programme is in the catchment. However, under the normal programme, afforestation and soil conservation measures will be taken up by the concerned department.

(c) There is no apprehension of slips and slides on the periphery of the reservoir.

11.1.10 Wind

There are no such records at head works site for observing wind speed etc.

11.1.12 Cyclone

There is no observation station for observing frequency of Turnado, Cyclone etc. near the project site.

11.1.13 Crocodile Project

There is a Crocodile Project at the Tikarpara gorge which will be affected by the reservoir. To rehabilitate this project in the periphery of this reservoir adequate provision has been made in the estimate. The reservoir will give ample scope for fish breeding.

11.1.14 Wild animal and birds

(a) There are Royal Bengal tigers in the area near the proposed reservoir areas.

(b) There are no birds worth the name in the area.

(c) The reservoir will not affect the habitation of wildlife and local birds.

11.1.15 Flora and fauna

The matter is referred to Forest Department by the Govt. of Odisha.

11.1.16 Tourism

(a) The Satkosia Tiger reserve is located on the right side of the Barmul reservoir which is being developed as tourist resort by Govt. of Odisha. Satkosia spreads along the magnificent gorge over the mighty river Mahanadi in Odisha. Established in 1976 as a wildlife sanctuary, Satkosia is a paradise of immense scenic charm. It is one of the best ecosystems in the country, representing a diverse floral and faunal extravaganza. The name Satkosia originates from two words; sat meaning seven and kos meaning two miles, indicating the length of the gorge as 14 miles or 22 km. The area was declared as Satkosia Tiger Reserve in 2007, comprising two adjoining wildlife sanctuaries; the Satkosia Gorge sanctuary and Baisipalli sanctuary. The Reserve is spread over 4 districts; Angul, Cuttack, Nayagarh and Boudh. The reserve has an area of 963.87 sq km with 523.61 sq km as core area. The area is also a part of the Mahanadi elephant reserve. Satkosia is the meeting point of two bio-geographic regions of India; the Deccan Peninsula and the Eastern Ghats, However, the existing Tikarpara gorge combined with the proposed reservoir and the crocodile project shall offer to develop this locality as a tourist resort.

(b) No religious, archaeological and recreational centres shall be submerged inside the reservoir. The Crocodile Project however will be shifted to the periphery of the reservoir.

11.1.17 Health hazard

There is no health problem due to soil and water borne disease.

11.1.18 Environmental impact

(a) Beneficial impact

The reservoir will offer opportunities for growth of aquatic life like fish, crocodiles etc., gives scope for tourism development. The temperature of the locality will be regulated during summer and winter months. The project will give adequate employment opportunities during construction as well as in the maintenance stage. The project construction will help in creating a lot of personal trained in various trades and this will help in their socio-economic growth.

The tribals will also develop in their outlook due to contact with people from other parts of the country during the construction of the project and this will induce them to the culture of the art of saving and help in their socio-economic upliftment. Notwithstanding the adverse impact, the good impact of the project will out weigh the adverse impact.

(b) Adverse effect

The displaced persons shall have a change of place in process of resettlement else where. This may effect their sentiments. There will be immediate loss of forest growth due to the submersion. The concentration of population during the period of construction may create some health hazards, pilferage of forest produce, criminal mishaps, price rise in the local market etc. Adequate provision has been made to over- come these problems.

11.1.19 Salinity effect

The reservoir does not contemplate the change of salinity in the underground water.

11.1.20 Water logging problem

The general layer of the ground being stiff, waterlogging problem is not expected.

11.1.21 Minerals

No injurious minerals under the submergence are expected.

11.1.22 Water borne diseases

The reservoir will be utilised for irrigation and power generation. The Water elevation in the reservoir will fluctuate. Hence, no water borne diseases are expected.

11.1.23 Effect of weeds

The probable growth of the weeds and intermittent hosts etc. shall be looked after with the available technique for which provision has been made in the estimate.

11.1.24 Effect of climate change

The effect of the project on the climatic changes could not be suitably forecasted.

11.1.25 Effect of siltation in reservoir

The fore share land of the reservoir shall be covered by proper contour bunding and schemes like gulley control, percolation tanks to prevent silting.

11.1.26 Reservoir impounded seismicity

The reservoir loading shall not have appreciate bearing on the seismicity.

11.1.27 Impact of population pressure during construction

During construction the impact of extra population will create unhygienic conditions. This can be met by providing adequate drinking water facilities and sanitation to the labour and staff engaged in the project work.

11.1.28 Fuel

(a) The fuel requirement for the labour force during the construction stage shall be met by opening fire wood depot by the forest department who will clear the forest growth from the reservoir area and meet the demand.
(b) Adequate provision has been made for the compensatory afforestation in the estimate.
(c) The anti poaching laws shall be enforced by the forest department who shall be strictly vigilant for the same.

11.1.29 Wild life Sanctuary

Satkosia tiger reserve forest is lying in the periphery of Barmul project. Crocodile sanctuary is in the submergence area of Barmul dam.

11.1.30 SC/ST Population

The details of SC /ST population in the enroute district of link project are given in the **Table 11.2.**

Table 11.2
Details of SC/ST Population

Sl. No.	Name of District	SC Population (%)	ST Population (%)	Remarks
1	**Odisha**			
2	Nayagarh	14.2	6.1	M-G Link
3	Khordha	13.2	5.1	M-G Link
4	Cuttack	19	3.6	M-G Link
5	Puri	19.1	0.4	M-G Link
6	Ganjam	19.5	3.4	M-G Link
7	Gajapati	6.8	54.3	M-G Link
8	**Andhara Pradesh**			
9	Srikakulam	-	-	M-G Link
10	Vizianagaram	-	-	M-G Link
11	Visakha Patnam	-	-	M-G Link
12	Nayagarh (Barmul)	14.2	6.1	Off take reservoir
13	Khordha (Salia)	13.2	5.1	Enroute reservoir
14	Bargarh(Ong)	20.2	19	Ong Basin
15	Nabarangpur (Tel)	14.5	55.8	Tel Basin
16	Nuapada (Upper Udanti)	13.5	33.8	Tel Basin
17	Kalahandi (Uttei Roul)	18.2	28.5	Tel Basin
18	Kandhamal (Khadaga)	15.8	53.6	Tel Basin
19	Kandhamal (Salki)	15.8	53.6	Ong Basin

Source: District statistical hand book 2011.

11.2 Impact of the link canal

Major impact of the link project could be on account of land acquisition for construction of the canal, rehabilitation and resettlement of the displaced population in the affected villages due to construction of the link canal, environmental impact of formation of canal water body and introduction of irrigation in the command area enroute the link canal.

11.2.1 Land acquisition

A total land area of 22587 ha needs to be acquired, of which 13324 ha will be for main canal, 9129 ha for borrow areas, 50 ha for rehabilitation colonies, 79 ha for offices & staff colonies, and 5 ha for power house. Out of the total land to be acquired as above, 19509 ha is patta land, 1178 ha is forest land and 1900 ha is government land other than forest. Details of the land to be acquired are given in **Annexures 11.1 & 11.1.1 to 11.1.3**

Forest land

The proposed link canal passes through two main reserved forests viz. Bankar before Salia and Rukki-Hunnali reserved forests before Mandasa. About 1178 ha of forest land is to be acquired for the construction of canal. These forests mainly consist of open scrubs, thorny bushes, bamboo and common fuel species like maredu, etc. Compensatory afforestation as per the norms, will be taken-up in consultation with the Department of Forests, in the degraded forest lands and other waste lands available nearby the affected forest land. In addition to this, spoil banks of the link canal are proposed to be used for social forestry. Suitable provision for the cost of afforestation is made in the estimate for the construction of the link project.

11.2.2 Rehabilitation and resettlement of displaced population in affected villages

The link canal passes through the periphery of about 76 villages partially affecting the population. All these villages get only partly affected and about 6048 people need to be rehabilitated. The measures proposed to be adopted for the rehabilitation and resettlement of the affected people are dealt in the following paragraphs. The assessment of the requirements of rehabilitation is based on the general information collected from the local agencies. The details of village-wise affected population is given at **Annexure 11.2.1**. The village–wise area to be acquired for rehabilitation and resettlement of the affected population are given at **Annexure 11.2.2.** The location map of proposed rehabilitation colonies along the link canal is at **Plate 31.**

i) Housing

Considering 6 members for each family, the number of families to be rehabilitated would be 1008. It is proposed to allot a modestly constructed house to each of the displaced family for their quick resettlement. Depending on the economic status of the displaced families, plots of area 350, 250 and 200 sq.m per family with a built up areas of 70, 50 and 30 sq. m are proposed for the middle income group (MIG), lower income group (LIG) and economically weaker sections (EWS) respectively. It is proposed to rehabilitate the oustees in the model villages proposed to be constructed nearby the affected villages. Typical lay out of proposed rehabilitation colony and Typical plans of houses are shown in **Plates 31** and **32** respectively.

ii) Basic amenities

All basic amenities for health, recreation, education, water supply, markets, sanitary, communications etc., are proposed to be provided in the model rehabilitated villages.

iii) Rehabilitation grants and maintenance allowance

As per Right to Fair Compensation and Transparency in Land acquisition, Rehabilitation and Resettlement Act,2013 by Govt of India, all project affected people who are not allotted agricultural land should be given alternative employment or other amenities for restoration to their original trade within a reasonable time. One time resettlement allowance of Rs 50,000/- per family and a maintenance allowance of Rs 5000/- per family per month for one year are proposed as per the norms. An additional entitlement of a job to the family member or one-time payment of Rs. 5,00,000/-.

As per the norms of Government of India each displaced family will get land for land as given below. Details are given in **Table 11.3.**

Table 11.3
Govt. of India Norms for Rehabilitation

Elements of R & R	Entitlement / Provision
Land for land	As far as possible and in lieu of compensation to be paid for land acquired, each affected family owing agricultural land in the affected area and whose land has been acquired or lost, or who has, as a consequence of the acquisition or loss of land, been reduced to the status of a marginal farmer or landless, shall be allotted, in the name of each person included in the records of rights with regard to the affected family, a minimum of one acre of land in the command area of the project for which the land is acquired. Provided that in every project those persons losing land and belonging to the Scheduled Caste or the Scheduled tribes will be provided land equivalent to land acquired or two and a one-half acres, whichever is lower.
Transportation cost for displaced families	Each affected family which is displaced shall get a one-time financial assistance of fifty thousand rupees as transportation cost for shifting of the family, building materials, belongings and cattle.

Suitable provision under rehabilitation and resettlement component to take care of the above measures has been made in the estimate for construction of link canal project. Details of cost of rehabilitation and resettlement are given at **Annexure 11.3.**

11.2.3 Environmental impact

The National Council of Applied Economic Research (NCAER), New Delhi was entrusted with studies of socio-economic and environmental implications of 6 inter-basin water transfer proposals of NWDA and the present link is one among them. The present section on the environment impact of the link project is mainly based on the conclusion drawn in their report.

11.2.3.1 Surface water regime

The link canal is proposed to be totally lined and arrangements will be made to provide passages to the streams/rivulets on the route of canal. Therefore, the surface run-off is not likely to be effected in the canal zone.

11.2.3.2 Groundwater regime

Provision of canal irrigation in the proposed command area causes additional recharge to the ground water. As a result the ground water levels will rise gradually year by year. Part of this augmented ground water 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 off the surplus recharge alongwith the surface drainage.

11.2.3.3 Flood control

The protection of delta region of Mahanadi from floods is an important benefit of the project. This region is subjected to frequent floods and cause suffering to large population. The flood water can be diverted into the proposed link canal. A number of canal escapes are proposed at suitable intervals along the link canal to drain out the excess flows, if any, into the natural strings nearby the link canal which help in controlling the floods more effectively.

11.2.3.4 Pollution and industrial development

The proposed command area does not have any major industries at present and no development projects to be taken-up in the immediate future and as such, the area is free from industrial pollution.

The introduction of irrigation is likely to give an impetus for the growth of agro- based industries leading to some pollution in a very few limited pockets

of the area, where strict measures may have to be undertaken to control the pollution. However, this is not expected to lead to any large-scale pollution.

11.2.3.5 Aquatic life

There will be sufficient improvement in development of fisheries in the canal net work and in the command of link canal.

The formation of the link canal will have a positive impact on the aquatic life.

11.2.3.6 Public health

The area at present does not come under malaria zone and no health risks are involved. However, formation of a water body in the shape of the link canal and conversion of the hitherto dry area into wet area might result in introduction of water borne diseases unless precautionary measures are taken. Adequate supplies of medicines to the public health centres will have to be ensured to prevent and contain the flare up of epidemics, apart from creating adequate infrastructural facilities for the same.

11.2.3.7 Water-logging and salinity

The link canal passes through the districts where the ground water is exploited upto the maximum extent. However, the irrigation supplies to the command area would add to the groundwater recharge. This might raise the groundwater table which may lead to water logging and salinity conditions. Adequate natural drainages are available in the area to drain the water from the command area. Though no serious water logging problems are anticipated, studies and regular observations on the behaviour of the soils in the area will have to be carried out for a few years before and after introduction of irrigation in the area.

11.2.3.8 Climate and ecology

The construction of the link canal is not likely to cause any significant changes in the ecology of the area. The climatic and ecological conditions of the area continue to remain more or less the same even after construction of the link canal.

11.2.3.9 Natural resources

The major minerals available in the link command area are lime stone, manganese, fire-clay, monazite, quartz, lime kinakar, lime shell, graphite and mica, bamboo, cashew, kendu leaves, timber, teak, beedi leaves, casuarine

and the eucalyptus are the forest produces in the region. No mineral resources are likely to be lost as a result of construction of the link canal.

11.2.4 Beneficial impacts of the link canal

11.2.4.1 General benefits

The link project would greatly help in improving the general prosperity of the region on account of the following:

i) Introduction of the irrigation in about 5.46 lakh ha (3.64 + 1.82 lakh) of the area would increase the agricultural production by nearly 3 to 4 times. This would lead to substantial rise in the average annual income of the local population, as they are mostly dependent on agriculture.
ii) Agricultural development by introduction of irrigation would give impetus to agro-based, small scale and cottage industries, dairy and poultry development, development of communication network, infrastructural, health and educational facilities, rise in the economic activities, rise in the living standards of the general public and several other aspects of socio-economic development.
iii) Environmental enhancement of the region on account of the afforestation programmes on the banks of link canal, branch canals and distributaries.
iv) Adequate protected and fresh assured drinking water supplies to the rural and urban population.
v) The link project would create a lot of employment opportunities to the local population during its construction spreading over considerable number of years. The continuous and increased agricultural operations due to irrigation and development in industrial, infrastructural and economic aspects would largely enhance the continued employment opportunities even after construction of the link project.

11.2.4.2 Employment generation during the construction of the project

The data on employment generation in respect of Upper Ganga Canal Development & Modernization project (Govt. of U.P) has been taken into consideration for assessing the employment generation in this report. This project is one of the nine irrigation projects considered by the Advisory Group on Expenditure and Employment Generation in Major and Medium Irrigation Projects set up by Central Water Commission in their study. As this project suits the scenario of the proposed link canal project in its nature, the employment norm of 35 persons per one crore value of project (1991-92) achieved in the above mentioned project has been taken into account for arriving at the employment generation potential during the construction of this link canal project.

The total estimated cost of the Mahanadi–Godavari link project is Rs. 54114 crore (based on 2018-19 price-level). The employment generation potential of the project following the norms as mentioned above will be 33821 personnel per annum in the order of 7102 in the technical and 26719 in the non-technical categories. The technical category comprises of 2131 engineers, 2343 other technical, 26628 skilled and semi-skilled personnel whereas the non-technical category comprises of 20306 un-skilled and 6413 administrative personnel, annually. The details of different categories of manpower / employment, which can be generated annually in the link canal project are shown in **Annexure 11.4** and is presented in the form of a bar chart in **Plate No.33**

11.3 Impact matrix

An impact matrix including the beneficial/adverse impacts relating to physical, biological and socio-economic aspects is given in **Table 11.2.**

Table 11.2
Impact matrix of Mahanadi- Godavari link project

	Impact	Assessment
(A)	**Physical Impacts**	
(i)	Sedimentation	No significant additional sedimentation is expected. The available dead storages at Hirakud and Manibhadra are adequate.
(ii)	Seismic	The filling of the reservoir will not have appreciable bearing on the seismicity.
(iii)	Forest area	Small patches of forests totalling to 1178 ha are to be acquired along the link canal to facilitate its construction. Suitable provision has been made in the estimate of the link project for compensatory afforestation.
(iv)	Other area	An area of 21409 ha consisting of both private and government land is to be acquired for construction of the link canal. Adequate provision towards cost of acquisition kept in the estimate of the link canal.
(vi)	Ground water recharge	The groundwater condition will improve along the link canal and in the command area due to irrigation.
(vii)	Natural resources	No impact
(viii)	Irrigated area	An area of 545959 ha (363959 + 182000) will be provided with assured irrigation by the link project. The area currently under irrigation from canals under existing projects in the proposed command would also get stabilised.
(ix)	Hydro power	210 MW (35 MW at Canal Power House + 175 MW at Dam Toe power House)
(x)	Historical monuments and	No historical monuments or archeological structures are affected by the construction of the link project.

	archaeological structures	
(xi)	Salinity intrusion	Lean season flows in natural drainages do not get reduced but get increased to some extent and thus reduce the adverse impacts.
(xii)	Salinity in irrigable area	No serious impact is anticipated.
(xiii)	Waterlogging	No serious impact is anticipated.
(xiv)	Availability of drinking water	As the link canal is planned for providing domestic water to en route areas, availability of water for drinking would improve.
(xv)	Quantity of water diversion	10105 Mm^3 at the off-take point.
(B) (i)	**Biological impacts** Public health aspects	No hazards are expected. Infrastructure for health aspects are likely to improve.
(ii)	Wild animals and birds	No adverse impacts are expected.
(iii)	Other species	No adverse impacts are expected.
(iv)	Availability of bio-mass	Increases.
(C)	**Socio-economic impacts**	
(i)	Socio-economic aspects	Tremendous socio-economic upheaval expected.
(ii)	Resettlement plans	The resettlement of displaced people from 76 affected villages on account of construction of the link canal in model colonies with all basic amenities is planned. Adequate provision for R&R is made in the estimate.
(iii)	Land acquisition	A total area 22587 ha of land is to be acquired for the purpose of laying the link canal. Suitable provision is made in the link project estimate.
(iv)	Farmers to be benefited	All the farmers of the land holdings of the command area will get the irrigation facilities.
(v)	Water quality downstream of storage	Water quality in the stream will improve with the addition to the lean season flows due to irrigation.
(vii)	Employment generation	Tremendous potential for employment generation during the construction of the link project and continued large scale employment opportunities thereafter, are expected.
(viii)	Infrastructure development	Impetus to various infrastructure development aspects like industries, agricultural and related activities, communications, economic activities, health, education and all other spheres of socio-economic aspects is expected.
(ix)	General prosperity	The living standards of the population substantially will improve and the general prosperity of the region would get boosted during and after implementation of the link canal project.