

Chapter 8 Water and irrigation planning

8.1 General

The Mahanadi (Barmul) – Godavari (Dowlaiswaram) link canal is proposed to off take from the right flank of Barmul reservoir proposed by Govt. of Odisha at about 17 km upstream of Manibhadra on River Mahanadi in Nayagarh district of Odisha. The link canal diverts a total quantity of 10105 Mm³ of water annually with FSL 75.06 m at its head. The link canal out falls into Godavari river at 15 km upstream of Dowlaiswaram barrage near Rajahmundry in East Godavari District of Andhra Pradesh.

8.2 Water planning

The total diverted water of 10105 Mm³ from the Barmul reservoir is proposed to be utilised as follows in **Table 8.1**.

**Table 8.1
Water Diversion**

		Unit: Mm³	
		Annual Irr. (ha)	Annual utilisation (Mm ³)
1. Irrigation requirement enroute the link canal	CCA (ha)		
(a) In Odisha State	256770	351784	3184
(b) In Andhra Pradesh State	107189	91110	606
Sub total	363959	442894	3790
2. Domestic and industrial requirements in the command area			700
3. Transmission losses			569
4. Transfer to Godavari for further diversion to southern basins beyond Godavari			5046
	Total		10105

As per the original planning of Mahanadi – Godavari link off taking from proposed Manibhadra dam, about 6500 MCM water is reaching to Godavari River up-stream of existing Dowlaiswaram Barrage for further transfer along with surplus Godavari water for utilization in drought affected Krishna, Pennar and Godavari basins. With a view to keep the planning of link projects to further south beyond Godavari, an attempt has been made that

even with alternative proposal Mahanadi (Barmul) – Godavari link off taking from proposed Barmul dam 6500 MCM water reaches Godavari at existing Dowlaiswaram barrage. The shortage of 1454 MCM will be augmented from the contribution of MSTG link reaching Mahanadi through Ganga – Damodar – Subarnarekha link and Subarnarekha – Mahanadi link.

The details of working out the demands of M-G link are discussed in the following sections.

8.3 Existing Irrigation in the proposed command area

The link canal in its course from Barmul to Godavari passes through the major basin areas of Rushikulya, Vamsadhara and Nagavali. There are 5 major and 25 medium projects existing in the area between Mahanadi and Godavari where link canal passes. The total CCA under these projects is 403739 ha. Out of these projects two major and four medium irrigation projects are falling in the command area of M-G link extending irrigation facilities to a CCA of 149221 ha. Out of the total CCA under existing projects, 142000 ha of area is falling in the link command.

The new gross command area which could be provided with enroute irrigation has been identified on Survey of India's topo-sheets and found to be 495344 ha excluding land covered by water, elevated lands and forest area. The Culturable command area works out to 363959 ha and annual irrigation has been worked out to 442894 ha.

8.3.1 Existing irrigation facilities in the command area

The existing irrigation in the proposed command under the link canal is about 22% of the gross cropped area, indicating that the agriculture in the area is mainly rain-fed. The existing sources of irrigation are mainly canals, tanks and wells. Out of the total area presently being irrigated, 57% is by canals, 28% by tanks, 13% by wells and the rest is by other sources.

The source-wise irrigation in the proposed command area during the year 2014-15 as assessed from district-wise statistics are presented in Table **8.2**.

Table 8.2
Source-wise irrigation in the proposed
command area during the year 2014-15

Unit: ha

Sl. No.	State/District	Area irrigated by				Total
		Canals	Tanks	Wells	Other sources	
I	Odisha					
1.	Nayagarh					
	Kharif	533	13	81	--	626
	Rabi	177	4	27	--	209
	Annual	710	17	108	--	835
2.	Khurda					
	Kharif	5444	304	460	--	6208
	Rabi	1815	101	153	--	2069
	Annual	7259	405	613	--	8277
3	Cuttack					
	Kharif	2921	71	181	--	3173
	Rabi	974	23	60	--	1058
	Annual	3895	94	241	--	4231
4	Puri					
	Kharif	1741	--	384	--	2126
	Rabi	580	--	128	--	708
	Annual	2321	--	512	--	2834
5.	Ganjam					
	Kharif	13180	3020	460	--	16660
	Rabi	4393	1007	153	--	5553
	Annual	17573	4026	613	--	22213
6.	Gajapati					
	Kharif	--	--	--	--	--
	Rabi	--	--	--	--	--
	Annual	--	--	--	--	--
II	AndhraPradesh					
7	Srikakulam					
	Kharif	11530	6236	2700	640	21106
	Rabi	3843	2079	900	213	7035
	Annual	15373	8315	3600	853	28141
8	Vizianagaram					
	Kharif	676	1274	778	62	2789
	Rabi	225	424	259	20	930
	Annual	901	1698	1037	82	3719
9	Visakhapatnam Kh					
	arif	887	497	540	377	2300
	Rabi	295	166	180	125	767
	Annual	1182	663	720	502	3067
	Total					
	Kharif	36912	11415	5584	1079	54988
	Rabi	12302	3804	1860	358	18329
	Annual	49214	15218	7444	1437	73317

There are two existing major irrigation projects viz., Rushikulya and Vamsadhara and four existing medium irrigation projects viz. Salia, Jaymangala, Bahuda and Bagua with a total designed annual irrigation of 151952 ha and designed annual utilisation of 1595 MCM. Thus the existing irrigation facilities in the proposed command area are significant.

8.3.2 Current agriculture scenario and existing cropping pattern

The total area available for cultivation in the proposed command area as estimated from district wise land use statistics is 363959 ha. The net sown area is 253292 ha of which 154761 ha is in Kharif and 98531 ha in Rabi season.

The principal crops grown in the area are paddy, ragi, vegetables, maize, groundnut, bajra, sugarcane and oil seeds during the Kharif season and paddy, pulses, groundnut and wheat during the Rabi season. Paddy, ragi and vegetables are the main crops each being

cultivated in about 60%, 20%, and 8% respectively of the net sown area in the proposed command.

8.4 Proposed irrigation in the command area

8.4.1 Soil and land irrigability classification

The entire proposed command area was assessed for irrigability classification by using the thematic maps prepared by NBSS & LUP (Nagpur).

Details of soil classification and suitability for irrigation is discussed in detail in **Chapter-4 Surveys and Investigations.**

According to the district-wise statistics 581319 ha of area is considered to be the possible command area, which could be provided with irrigation. Out of this area, 85975 ha is occupied by forest and 131385 ha is by scrubs and barren land and permanent pastures. Thus the culturable command area available for irrigation is 363959 ha.

8.4.2 Layout of branch canals / distributaries and their commands

The 1: 50000 scale toposheets with contours at 20 m interval, of the command area supplied by the Survey of India were used for the purpose. Considering the information on ground elevation available on these maps, the branch canal network was drawn with the branch canals/distributaries

running mostly along the ridges between the local streams, with their commands on both the sides extending upto

the streams, which in turn form the exterior boundaries of the command under each of the branches. The irrigable area under each of the branch canals was then measured by planimeter on the 1:50000 topographic sheets. The areas under each of the branches so measured were adjusted to match with the gross irrigable area of 581319 ha (assessed from land use statistics) in the entire command area, so as to finally arrive at the branch-wise irrigable areas. After deducting the forest, scrub and barren land, the CCA is determined to be 363959 ha.

In all, the total command area is divided into 20 branch canals and branch-wise CCA are given in **Table 8.3**.

Table 8.3
Branch canals with their irrigable areas in the command

Sl. No.	Name of the branch canal	CCA (ha)
1	Kantilo	4281
2	Khalisahi	2590
3	Khurda	130743
4	Tangi	26160
5	Purshottampur	21518
6	Dengari	2491
7	Rushikulya	61158
8	Gorlapadu	28651
9	Mandasa	14221
10	Kasibugga	14221
11	Santa Kaviti	2212
12	Ponduru	3499
13	Etcherla	6198
14	Laveru	4905
15	Teppalavalasa	8890
16	Pativada	5533
17	Denkada	11050
18	Uppada	6936
19	Vepagunta	6936
20	Tungalam	1766
	Total	363959

The proposed command areas under different branch canals is shown in **Plates 27(1/3) to 27(3/3)**.

8.4.3 Suggested cropping pattern

The cropping pattern suggested for future major projects in the respective preliminary water balance study reports of the basin area between Mahanadi and Godavari prepared by NWDA have been adopted without any change for the proposed command area under the link canal. This cropping pattern has been suggested taking into account the soils available in the basin area and prevailing agricultural/irrigation practices. The intensity of irrigation is considered as 150% from Mahanadi to Rushikulya as contemplated by Govt. of Odisha in Manibhadra Project Report. The proposed command area under Manibhadra Right Bank canal which is upto Rushikulya is now taken over by this link canal beyond Rushikulya, the intensity of irrigation is considered as 85%. The proposed cropping pattern for irrigation of the command area en route the link canal is given in **Table 8.4**.

Table 8.4
Proposed cropping pattern for irrigation
under the link canal (% CCA)

Crop Kharif	Mahanadi to Rushikulya	Rushikulya	The Streams between Rushikulya and Vamsadhara	Nagavali	The streams between Nagavali and Godavari
Paddy	66	66	45	43	40
Maize	-	-	-	6	8
Jowar	-	-	-	4	8
Bajra	-	-	-	4	6
Jute	-	-	-	-	-
Cotton	-	-	-	6	6
Fodder	8	6	15	4	6
Chillies	-	-	-	-	5
Ragi	-	-	-	4	6
Groundnut	8	6	15	4	-
Pulses	8	6	15	4	-
Vegetables	-	-	-	6	-
Rabi					
Paddy	20	18	-	-	-
Potato	3.6	6	-	-	-
Wheat	-	-	-	-	-
Groundnut	12	12	-	-	-
Pulses	12	12	-	-	-
Fodder	-	-	-	-	-
Oil seeds	5	6	-	-	-
Vegetables	5	6	-	-	-
Cow peas	2.4	-	-	-	-
Perennial	-	6	-	-	-
Total	150	150	85	85	85

8.4.4 Crop water requirement

The proposed command area is falling in various basins between Mahanadi and Godavari viz., Lower Mahanadi, the streams between Mahanadi and Rushikalya, Rushikalya, the streams between Rushikalya and Vamsadhara, Vamsadhara, Nagavali and the streams between Nagavali and Godavari. The crop water requirement has been computed using climatological approach. There are four IMD observatories at Puri, Gopalpur, Kalingapatnam and Visakhapatnam in and around the proposed command area. Normal monthly values of potential evapotranspiration and rainfall of all the four observatories are available in the IMD publication. These have been used in computing the net irrigation requirements of different crops as per the suggested cropping pattern. The gross irrigation requirements of the crops have been worked out considering an irrigation efficiency of 70% for the crops as under major schemes except paddy for which 80% is considered. The details of computation of net and gross water requirement for the crops are given in **Annexure 8.1.1 to 8.1.5**. Computation of the Weighted average deltas for the proposed command area are given in **Annexure 8.2.1 to 8.2.5**. The monthly water requirement of the entire proposed command area is given at **Annexure 8.3.1 to 8.3.6**. The annual water requirement for enroute irrigation including supplementation to the existing Rushikulya system during Rabi season is estimated to be 3790 Mm³.

8.5 Supplementation to existing Rushikulya system

The existing command of Rushikulya system falling left of the link canal is proposed to be supplemented during Rabi season with the diverted waters from Manibhadra reservoir. The extent of this command area for supplementation is 56566 ha. Adopting the delta of 0.86 m worked out by climatological approach considering the designed cropping pattern of major project in Rushikulya basin area and annual intensity of irrigation as 100%, the annual utilisation of this existing command supplementation works out to 486 MCM. The designed cropping pattern and the computation of month-wise water requirements are given in **Annexure 8.3.2**. **Plate 27(2/3)** shows the part command area of existing Rushikulya system to be covered by the diverted waters from Manibhadra reservoir.

8.6 Domestic and industrial requirements of the proposed command area

The requirement of water for domestic consumption in the rural and urban areas and for livestock has been computed by projecting the rural and urban human population and livestock of the proposed command area and of the towns situated outside the command area to the right side of the link canal alignment, within a distance of 20 km and not involving lifts of more than

100 m from link to 2050 AD by considering the per capita daily requirement of 70, 135 and 50 liters for the rural, urban population and livestock respectively.

The total population of the command area in 2011 was 37.88 lakh and has been projected to 2050 AD which works out to 59.85 lakh. The total population of the towns situated to the right side of the link canal alignment (within a distance of 20 km) as per 2011 census was 35.21 lakh and it is estimated to be 55.62 lakh by 2050 AD. Out of the total projected population, 60.7% is taken as urban population and remaining as rural population.

The existing urban population is deducted from the projected urban population presuming that its domestic requirement is already being met by existing sources and only the remaining urban population is considered for working out the urban domestic requirement to be provided by the link canal.

The total livestock in the command area as estimated on proportionate area basis from census data of 2012 and it was projected to 2050 AD assuming an annual compound growth rate of 1% and works out to 27.14 lakh.

The water requirement for the entire urban and 50% of the rural population is proposed to be met from the surface water resources, which works out to 310 Mm³.

Table 8.5
District wise break up of drinking water
in the proposed link project command area

Sl. No.	Name of State/District	Drinking water in (MCM)	Percentage of CCA in the command area
A	Odisha		
1	Nayagarh	23.90	7.71
2	Khordha	90.55	29.21
3	Cuttack	17.42	5.62
4	Puri	8.28	2.67
5	Ganjam	78.43	25.30
6	Gajapati	0.12	0.04
	Sub Total	218.70	70.55
B	Andhra Pradesh		
1	Srikakulam	62.62	20.20
2	Vizianagaram	12.84	4.14
3	Visakhapatnam	15.84	5.11
	Sub Total	91.30	29.45
	Grand Total	310.00	100.00

In the absence of relevant data to estimate the industrial water needs, the industrial requirement has been assumed to be the same as the domestic water requirement, i.e. total of urban, rural and livestock requirements, which is 390 MCM. Thus the total domestic and industrial water requirement of the en route area to be supplied from the Mahanadi - Godavari link canal is estimated to be 700 MCM. The details are given in **Annexure 8.4**.

8.7 Transmission losses

The transmission or conveyance losses through evaporation and seepage in the link canal during its course from the Manibhadra reservoir to the Godavari have been estimated month-wise, considering 0.60 cumec per million square metre of wetted area of the canal as per Bureau of Indian Standard Code and the annual losses on this count work out to 569 MCM.

8.8 Transfer to the Godavari basin

After meeting the enroute irrigation and domestic requirements, the link canal is proposed to transfer 5046 Mm³ of water to the Godavari upstream of Dowlaiswaram barrage. The equivalent quantity of water thus available in Godavari will be further diverted from upper reaches of Godavari to water short Krishna basin and further south.

As per the original planning of Mahanadi – Godavari link off taking from proposed Manibhadra dam, about 6500 MCM water is reaching to Godavari River up-stream of existing Dowlaiswaram Barrage for further transfer along with surplus Godavari water for utilization in drought affected Krishna, Pennar and Godavari basins. With a view to keep the planning of link projects to further south beyond Godavari, an attempt has been made that even with alternative proposal Mahanadi (Barmul) – Godavari link off taking from proposed Barmul dam 6500 MCM water reaches Godavari at existing Dowlaiswaram barrage. The shortage of 1454 MCM will be augmented from the contribution of MSTG link reaching Mahanadi through Ganga – Damodar – Subarnarekha link and Subarnarekha – Mahanadi link.

8.9 Month-wise distribution pattern of water for various demands from Mahanadi(Barmul)- Godavari (Dowlaiswaram)link

The month-wise distribution pattern of various demands from the Mahanadi-Godavari link is shown in **Table 8.5**.

Table 8.5
Month-wise distribution pattern of water for various demands from the Link canal with supplementation from M-S-T-G link

Unit: Mm³

Month	Proposed command		Transmission loss	Diversion to Godavari	Supplimentation from M-S-T-G link	Total (MCM)
	Irrigation Use	Domestic & Industrial uses				
June	110	57	33	488	0	702
July	851	60	86	842	0	1859
August	601	60	76	851	0	1609
September	459	57	64	779	0	1376
October	146	60	49	766	0	1044
November	40	57	37	623	0	776
December	143	60	37	531	0	786
January	507	60	55	35	428	1046
February	347	52	44	36	342	789
March	338	60	42	34	284	729
April	205	57	32	32	225	529
May	43	60	14	29	175	314
Total	3790	700	569	5046	1454	11559

In addition to the diversion from Barmul dam 10105 MCM, an additional quantity of 1454 MCM will be supplemented from M-S-T-G link to ensure 6500 MCM water to reach Godavari.

The feasibility studies of MSTG link have been carried out in following three scenarios.

- Alternate I: Considering Manas and Sankosh dams
- Alternate II: Without Manas dam but with Sankosh dam
- Alternate III: Sankosh-Tista-Ganga link

Alternate I: In this alternate, the link canal is proposed to take off from the proposed barrage (d/s of proposed Manas dam) on Manas river. Total 41968 MCM is proposed for diversion through MSTG link, of which 37913 MCM water will be available at Ganga, upstream of Farakka barrage.

The water received in Ganga river is proposed for further diversion through Ganga-Damodar-Subarnarekha link, Farakka - Sundarbans link, Subarnarekha-Mahanadi link and Mahanadi-Godavari link. In this scenario, demands of all the successive links are met fully.

Alternate II: In this alternate, the link canal is proposed to take off from the proposed barrage (without Manas dam) on Manas river. In this alternate total 34424 MCM water is proposed for diversion of which 30566 MCM water will be available at Ganga, upstream of Farakka barrage.

In this scenario, demands of GDS are 95% met, demands of FS link 63% met (only flushing requirement of Kolkata port is partially met), demands of SM link 80 % met and 8724 MCM will be available at the end of SM link for transfer through MG link.

Alternate III: In this alternate, the link canal is proposed to off -take from the right flank of proposed barrage across Sankosh river. Total 23083 MCM water is proposed for diversion through MSTG link of which 21313 MCM water will be available at Ganga, upstream of Farakka barrage.

In this scenario, demands of GDS are 58% met, demands of FS link 25% met (practically no flushing requirement of Kolkata port is met), demands of SM link 73 % met and 8724 MCM will be available at the end of SM link for transfer through MG link.

Supplementation from MSTG link for diversion to Godavari through MG link is required during non-monsoon period and in case of Alternative – III only 477 MCM (but 1/3rd) water can be supplemented to MG link from MSTG link. However, in case of Alternative I and II 1454 MC can be supplemented to MG link from MSTG link.