Chapter 13
Benefit – Cost Ratio

13.1 Benefits

The Mahanadi (Barmul)- Godavari (Dowlaiswaram) link (M-G link) is the principal component of the first phase of the Peninsular rivers development which provides for diversion of surplus flows of Mahanadi basin to the Godavari system and further transfer of these surpluses along with surpluses of Godavari system to the water short Krishna, Pennar and Cauvery basins. As such, the overall benefit of Mahanadi (Barmul) – Godavari (Dowlaiswaram) link project can be assessed only after the Mahanadi-Godavari-Krishna-Pennar-Cauvery-Vaigai link system is finalised, because most part of the benefit of this entire link project will be in Krishna,Pennar, Cauvery and other southern basins. Therefore, the overall benefit of Mahanadi (Barmul)-Godavari (Dowlaiswaram) link canal project can not be assessed at this stage. However, an attempt is made to work out the benefit-cost (B.C.) ratio on the basis of the annual benefits from en route irrigation, power generation and water supply for domestic and industrial uses and the annual cost i.e. worked out as the apportioned cost of the water consumed en-route the link, inclusive of the transmission loss, out of the total estimated cost of link project.

13.1.1 Direct benefits

13.1.1.1 Irrigation benefits

A total quantity of 10105 Mm^3 of water is proposed to be diverted through this link canal, out of which 5059 Mm^3 is proposed to be utilised in the enroute command area including transmission losses of 569 Mm^3 in the entire reach of link canal.

An area of 363959 ha has been identified in Nayagarh, Khurda, Puri, Cuttack, Ganjam and Gajapati districts of Odisha and Srikakulam, Vizianagaram and Visakhapatnam districts of Andhra Pradesh for providing irrigation enroute of the link canal. The assured irrigation facility will also enable to devise new cropping pattern most suitable and beneficial to the area in the region and farmers. With the introduction of irrigation modern agricultural practices like adopting high yielding varieties of crops, fertilisers application and pesticides utilisation can be introduced and extended gradually. In short, it will lead to a green revolution in the region. Probable values of produce in post and pre-irrigation scenarios in the proposed enroute command area have been separately worked out to estimate the direct benefits from irrigation. These are given in **Annexures 13.1 and 13.2**. The details presented in these annexures help in visualising the likely improvement in the crop-wise yield in the post-

irrigation scenario due to assured water supply for irrigation from the link canal. This will help, not only removing uncertainty in the agricultural production in the existing cultivable land, but will also help in extending assured irrigation facilities to the additional areas under cultivation. Gross values of the benefits for the post-project and pre-project conditions are computed adopting the yields and prices of the commodities obtained from the Agriculture Department of the Government of Odisha as well as Government of Andhra Pradesh.

The net receipt before irrigation works out to Rs 885 crore and the net receipt after irrigation works out to Rs 4365 crore. After considering the loss in agricultural productivity due to land under submergence, canal distributary system etc., amounting to Rs 155 crore, the net annual benefit after introduction of irrigation in enroute areas along the link canal is estimated to be Rs.3326 crore.

The annual irrigation from the Six projects in Odisha viz. Ong dam, Uttei – Roul, Khadaga, Upper Udanti, Tel Integrated Project and Salki H.E Project is about 1,82,000 ha. The command area proposed under M-G link is 363959 ha. Hence, the total command area of M-G link including six projects is 545959 ha. The annual benefits from this area are considered along with the link command. The details are given in **Annexure 13.1,13.1.1, 13.2 and 13.2.1.**

13.1.1.2 Domestic and industrial benefits

The water requirements in the M-G link command area for domestic and industrial uses are estimated as 310 MCM and 390 MCM respectively as shown in **Annexure 8.4**. The annual net revenue from the water supplies for domestic and industrial uses is estimated as Rs. 1637 crore.

There is a proposal to supply about 125 MCM of water for domestic use in the Six projects. The net revenue from domestic water supply is estimated to Rs 94 crore. Thus the total annual net revenue from the water supplies for domestic and industrial uses is estimated as Rs 1730 crore.

13.1.1.3 Power benefits

Govt. of Odisha has proposed to generate hydropower at the following projects upstream of Barmul dam site. Details are given in **Table 13.1.**

Table 13.1
Power Generation at six projects

Sl. No.	Name of Project	Installed capacity (MW)	Energy generation (M.U)	Source
1	Ong Project	Nil	Nil	State Govt. Report
2	Tel Integrated Project	18	42.5	DPR, Feb-2015
3	Upper Udanti Irrigation project	Nil	Nil	State Govt. Report
4	Uttei Roul Project	Nil	Nil	State Govt. Report
5	Khadaga H.E Project & others	57	275	PFR/FRs
6	Salki H.E Project	165	840	FR
	Total	240	1157.5	

Source: NIH Report (April,2018).

The estimated installed capacity is 240 MW and estimated energy generation is 1157.5 Million units. Considering selling rate of Rs.5.50/- per unit, the net benefit works out to Rs.637 crore annually from these projects. The estimated Installed Capacity at Barmul dam after releases into link canal and downstream releases is 210 MW and energy generated is 664 MU.

The benefits estimated to Rs. 365 crore considering a rate of Rs.5.50/- per unit. Thus the total benefits from power generation is estimated to be Rs. 1002 crore.

13.1.2 Indirect benefits

Apart from the direct benefits, many indirect benefits would also accrue from the link project bringing economic prosperity and employment opportunities to the people of the region. The people will come in contact with the urban areas, while selling the agricultural surpluses in the urban market thereby increasing their outlook. The cultural transfer can take place by which true national integration will take place. These indirect benefits, could be visualised or quantified in broad perspective only. Some of these likely indirect benefits are listed below.

(1) Assured irrigation in the enroute region will create direct employment opportunities for the agricultural labourers and for other professionals in this sector and several job opportunities would become available for the local people during the construction of the project.

(2) The project activities will lead to establishment of intensified infrastructure facilities like roads, water supply, power and communication, credit arrangements and extension services, which would benefit the entire region. It will help the people in realising full benefits of developments.

(3) Once the irrigation facilities are developed, agro-based industries, dairy farms, poultry farms, marketing facilities for the agricultural inputs like pesticides and fertilisers etc. are likely to come up in the region, leading to general prosperity and economic upliftment of the people of the towns and villages in the en-route area.

(4) The ground water availability in the command area would get enhanced on account of increased recharge to the ground water as a part of the water supplied for irrigation gets percolated into the ground.

(5) For assessing the indirect benefits in socio-economic terms, a separate socio-economic and environmental study in the districts of the command area has been taken up separately.

(6) Plantation along the canal banks and the proposed afforestation of surrounding areas would enhance environmental status of the region.

(7) Rehabilitated people are likely to have better living conditions in planned colonies provided with all the basic amenities.

13.2 Cost

The cost of this link project is estimated under three main components viz. Unit I- Head works, Unit II - Conveyance system and Unit III - Power. The details are given in **Chapter-12.** The total cost of the project is estimated to be Rs. 54019 crore at the 2018-2019 year price level. For the purpose of working out the B.C. ratio, the annual cost is worked out considering the apportioned cost of the water consumed en- route the link as follows.

A total quantum of 10105 Mm^3 of water is proposed to be diverted through the Mahanadi-Godavari link, out of which, 3790 MCM is proposed to be utilised for enroute irrigation, 700 MCM for enroute domestic and industrial use and 569 MCM is the transmission loss.

Thus, the en-route water consumption from the link canal is 5059 MCM. The transmission losses are worked out to be 102 MCM beyond RD 661.100 km i.e. end of command area under the link canal and the balance quantity of 5046 Mm^3 will be diverted to Godavari basin. The cost for supply of 4957 (3790+700+569-102) Mm^3 has been worked out proportionately from the

total cost of the project for diversion of 10105 Mm^3, which works out to Rs.25659 crore.

The total cost of the Mahanadi (Barmul) - Godavari (Dowlaiswaram) link canal project including six projects are given in **Table 13.2.**

Table 13.2
Estimated cost of M-R-G link project along with six dams

Description	M-G Link (crore Rs)	Six Projects (crore Rs)	Total (crore Rs)
Unit - I Head works	462	4426	4888
Unit - II Conveyance system	45215	2866	48081
Unit- III Power component	561	489	1050
Total	46238	7781	54019

I. Capital cost (crore Rs)

Apportioned cost of the project for
M-G link (Cost of dam +Conveyance in full)
52970

(a)	Enroute irrigation requirement	3790 MCM
(b)	Domestic requirement	310 MCM
(c)	Industrial requirement	390 MCM
(d)	Transmission losses up to end of command area (661.100 km)	467 MCM
	Sub-total	**4957 MCM**
(e)	Transfer to Godavari excluding TL	5046 MCM
(f)	Transmission losses beyond command area	102 MCM
	Total diversion	10105 MCM

A. Proportionate cost of the Project for en-route use 20339
(52970*4957/10105)*(661.100/844.595)

B. Cost of power house (1050*4957/10105) 5149

C. Cost of land development at Rs.3500/- per ha
(assumed) for CCA of (363959-56566+182000) = 489393 ha. 171

Proportionate Cost Total (crore Rs) 25659

13.3 Benefit-cost ratio

The benefit cost ratio is worked out as follows.

I. Annual benefits (crore Rs.)

A. Irrigation

(a)	Post project (from Annexure-13.2)			
	(i)	Gross value of produce	5724	
	(ii)	Expenditure	1358	
	(iii)	Net value of produce	4366	4366
(b)	Pre-project (from Annexure-13.1)			
	(i)	Gross value of produce	1618	
	(ii)	Expenditure	733	
	(iii)	Net value of produce	885	(-) 885
(c)	Loss in agricultural productivity in land under submergence and land going out of cultivation in project area, canal distributary system etc. @ 10% of gross value of produce before irrigation			(-) 155
	Net benefit from agriculture (for M-R-G link CCA of 363959+182000ha) (a-b-c)			3326
	Total (A)			**3326**

B. Power (crore Rs)

(i)	Annual benefits from power generation of 240MW (1157.5 Million units) from Six projects (refer para 13.1.1.3) @ Rs.5.50 per unit	637
(ii)	Annual benefits from power generation at Barmul dam Releases into link canal and downstream releases 210 MW (664.31 Million units) (refer para 13.1.1.3) @ Rs.5.50 per unit	365
	Total (B)	**1002**

C Domestic & Industrial (crore Rs)

(i)	Annual benefits from industrial water supply @ Rs.360 lakh per MCM for 390 MCM and @ Rs.75 lakh per MCM for 310 MCM for domestic water supply through M-R-G-link	1636
(ii)	Annual benefits from domestic water supply of 125 MCM from Six dams @ Rs.75lakh per MCM	94
	Total (C)	**1730**
	Total benefits (A+B+C)	**6058**

II. Annual cost (crore Rs)

The annual cost is estimated considering (i) 10% interest on capital cost of the project (ii) 1% depreciation on the apportioned capital cost excluding land development charges (iii) 8.33 % depreciation on the electrical and mechanical equipment of power house (iv) 3.33% depreciation on items other than the electrical and mechanical equipment of power house (v)annual O&M charges for the project

(taken @ Rs.600/ha) and (vi) 1% for maintenance of head works. The annual cost is worked out to be Rs. 2909 crore as detailed below:

(a)	Interest @ 10% of the estimated cost of the project (Including cost of land development)	2565
(b)	Depreciation of the project @ 1% of cost of the project (Rs 25695-171) (excluding cost of land development)	255
(c)	Depreciation on electrical and mechanical Equipment of powerhouse @ 8.33% i.e. on (Rs 577 lakh*4957/10105) Rs 283 lakh	24
(d)	Depreciation on items other than electrical And mechanical equipment of canal powerhouse @ 3.33% i.e. on (Rs 472)*4957/10105) Rs 232 lakh	8
(e)	Annual operation & maintenance charges @ Rs.600/- ha. (For CCA 363959+182000)	33
(f)	Maintenance of head works @ 1% of its Cost (4879*(4957/10105)/100)	24
	Total	**2909**
	BC Ratio (6058/2909)	= **2.08**

The B.C. ratio is worked out considering the likely enroute benefits and cost of the M-G link and Six upstream projects of Barmul dam site, which is not an independent link project by itself. This B.C. ratio is helpful to have an idea about the worth of the benefits from this particular link in comparison to the annual cost likely to be incurred on the same.

It would be more realistic and appropriate to work out the benefit-cost ratio for the peninsular rivers linking system as a whole to determine the economic viability of the system in its totality.

13.4 Internal rate of return

The internal rate of return worked out considering the annual benefits and apportioned cost of en route water consumption is given in **Table 13.1**.

Table 13.1
Internal Rate of Return

1.	Life of Project	:	100 years	
2.	Construction period	:	8 years	
3.	Apportioned cost of the project	:	Rs. 25635	crore
4.	Annual benefits	:	Rs. 6058	crore
5.	Maintenance cost @ 1% of I –works	:	Rs. 405	crore
6.	Cost of canal Power house			
	(i) Electrical & mechanical equipment (@8.33% depreciation)		Rs. 577	crore*
	(ii) Other than Electrical & mechanical equipment (@3.33% depreciation)		Rs. 472	crore**

Rs. in crore

Year	Cost	Benefits	Net Benefit	Discounting factors		Present worth of net benefit (Rs.in crore)	
				@15%	@16%	@15%	@16%
0	1783	0	-1783	1.000	1.000	-1783	-1783
1	1804	0	-1804	0.870	0.862	-1569	-1555
2	4393	0	-4393	0.756	0.743	-3322	-3265
3	3700	0	-3700	0.658	0.641	-2433	-2370
4	3700	0	-3700	0.572	0.552	-2115	-2043
5	3700	0	-3700	0.497	0.476	-1840	-1762
6	3356	1817	-1539	0.432	0.410	-665	-632
7	3223	4241	1018	0.376	0.354	383	360
8	405	6058	5653	0.327	0.305	1848	1724
9	405	6058	5653	0.284	0.263	1607	1486
10	405	6058	5653	0.247	0.227	1397	1281
Total of 11 to 107 years				1.648	1.417	9313	8007
					Total	**822**	**-550**

IRR = 15+ (822 / 1372) = 15.60 %

* - Cost included at every 12 years
** - Cost included at every 30 years