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Critical analysis of River Linking Projects-Benefits to Gujarat State, India

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ABSTRACT

The Interlinking of Rivers (ILR) is a vast program of country which shall provide additional irrigation potential of 35 Mha over and above conventional means of irrigation potential of 140 Mha. Undoubtedly it will have positive impact on mitigation of adverse impact of climate change. The study is a part of review of ILR program and its likely benefits to various region of country. As we are aware that eastern region of country has abundant water while States like Rajasthan, Saurashtra and Kutch region of Gujarat having nearly arid zone. Present study has been done to critically examine and visualize the ILR Projects benefitting Saurashtra and Kutch regions of Gujarat. The average availability of rainfall varies from 200 cm plus in South Gujarat to less than 10 cm in Kutch region of Gujarat. One of the priority link under ILR viz. Par-Tapi-Narmada envisages transfer of surplus water in water surplus region of South Gujarat to northern region of Gujarat having acute shortage or no water. The study also confirms that Par-Tapi-Narmada Link once implemented with introduction of micro irrigation and introduction of solar power to optimize cost and maximum benefits. The analysis confirms that economic impact of link in the region.

Key words : *Interlinking of rivers, Kutch region, Par-Tapi-Narmada Link Project, Micro Irrigation, Solar power*

Introduction

The Interlinking of River (ILR) program of country having 30 links projects has been conceptualized as a tool to mitigate the analogy of water deficit region to water deficit. The country has various water zones starting from Brahmaputra basin having maximum per capita availability to Saurashtra and Kutch regions of Gujarat having least availability (Gondaliya, 2013). As we are aware abrupt availability of rainfall causes phenomena of floods in eastern part and drought in western part of the country. These variations of water availability clubbed with adverse impact of climate change necessitate the need of water transfer from water surplus region to water deficit regions. Present study has been concentrated towards interlinking of rivers benefitting Gujarat State which itself has extreme variability of water in South Gujarat having plenty of water and North Gujarat and Kutch region having acute shortage of water. Two links which originate from western divide of South Gujarat and Maharashtra are Par-Tapi-Narmada and Damanganga-Pinjal links former benefitting Gujarat and later benefitting Maharashtra State. The objective of study is to examine the benefits of Par-Tapi-Narmada link and extract benefits which can be enhanced due to introduction of latest technologies and multi facial increase in the command area (Gupta, 2014).

Research Methodology

The public acceptability designed water diversion, designed storages and their optimization, area pres-

ently under command crop yield and step by step enhancement of projected benefits are studied (Hassan *et al*., 2007). The cost-benefits with and without introduction of solar power on top of canals and reservoir contemplated has been attempted. Broadly the study has been planned to core following components:

(i) Public acceptability to replacement of traditional irrigation with micro irrigation.
(ii) Saving in water requirement with combination of lower intensity andincreased in project command. By conducting sample surveys.
(iii) Omitting number of dams in various combinations to have optimization of costs.
(iv) Replacement of gravity irrigation with micro irrigation in phased manner.
(v) Existing crop yield and proposed crop yield to maximize benefits.
(vi) Unutilized storages for reducing cost of new reservoirs and maximize benefits.
(vii) Possibility of generating solar power along canals.
(viii) Sample survey of command area and impact of River Linking Projects.
(ix) Possibility of floating solar power generation along the reservoirs.

Analysis and Results

Public Accessibility to Traditional Irrigation with Micro Irrigation System

A representative set of villagers were identified and set of questionnaires were prepared. These were enquired from them during September, 2021, October, 2021 and response analyzed for Valsad/Nashik district (Gujarat/Maharashtra). Out of 70 respondents in Valsad/Nashik district under– project command about 84% of the people were found acceptable to micro irrigation as furnished in Table 1.

The study ascertained acceptability of micro irrigation by 70% people and of Interlinking of River by 50% people.

Savings in Water Requirement Adopting Lower Irrigation Intensity in En-route Command Area

Presently the irrigation intensity in enroute areas of various river linking projects have been gone through and reaches of link canal with detrimental reduction of lower irrigation intensity and its impact on increase in command area derived in various combinations from 125% to 70% and found to have a saving upto 30.81% as furnished in Table 2.

Table 2. Saving in Water Requirement Adopting Lower Irrigation Intensity

Sl. No.	Annual irrigation intensity (%)	Water utilization (MCM)	Saving	Saving (%)
1.	125	1350	0	0
2.	100	1274	76	5.62
3.	90	1213	137	10.15
4.	80	1138	212	15.7
5.	70	1032	318	30.81

Table 1. Public Opinion for Traditional Micro Irrigation System and for Interlinking of Rivers

Public Opinion for Micro Irrigation System						Public Opinion for Inter linking of Rivers					
Question No.	No. of Respondent	Fully Accepted	Ready to Move	No Change Required	Against the Project	Question No.	No. of Respondent	Fully Accepted	Ready to Move	No Change Required	Against the Project
1.	7	2	5	0	0	1.	10	4	3	2	1
2.	7	0	0	6	1	2.	10	4	3	3	0
3.	7	5	2	0	0	3.	10	4	0	1	5
4.	7	0	6	1	0	4.	10	8	1	0	1
5.	7	0	7	0	0	5.	10	0	10	0	0
6.	7	0	0	4	3	6.	10	4	3	3	0
7.	7	2	5	0	0	7.	10	2	0	8	0
8.	7	4	3	0	0	8.	10	0	1	9	0
9.	7	0	0	0	7	9.	10	7	0	3	0
10.	7	7	0	0	0	10.	10	0	0	6	4
Total	70	20	28	11	11	11.	10	0	0	1	9
Percentage	100%	28.58	40	15.71	15.71	12.	10	6	3	1	0
						13.	10	4	0	0	6
						Total	130	43	24	37	26
						Percentage	100	33	18.5	28.50	20

Impact of Replacing Gravity Irrigation with Micro Irrigation and Impact on B-CRatio and IRR

An attempt has been made to replace gravity irrigation with pressurized irrigation varying from 0% pressurized to 100 % pressurized irrigation using micro irrigation techniques and observed that culturable command area increases from 1.88 lakh ha to 3.51 lakh ha, which is an increase of 1.63 lakh ha amounting to 86.70 % as given in Table 3.

Table 3. Replacement of Gravity irrigation with Pressurized irrigation

Sl. No.	Item	Value
1.	CCA (ha.)	188414
2.	Annual Irrigation ha. (100% gravity)	169339
3.	Annual Irrigation ha. (100% pressurized)	351795
4.	B-C Ratio (100% gravity)	1.026
5.	B-C Ratio (100% pressurized)	1.61
6.	IRR (100% gravity)	8.08
7.	IRR (100% pressurized)	11.4

Impact of Omitting Dams in Combination to Increase Benefit-Cost Ratio

Par-Tapi-Narmada link is having series of 7 dams connected through link canal. Each Dam has its cost and benefits and by omitting same dams and visualizing impact on benefits has been done (Indra Prakash, 2013; Jain, *et al*., 2022; Moustafa Elshafei *et al*., 2021). In order to have an optimization of cost and maximizing benefits, attempt has been made to visualize cost of dam (head work) per MCM of divertible quantum of water and omit the dams in various combinations. The B-C ratio analysis has been done in base line scenario, i.e. all dams in position and the deleting one or more dam in isolation or combination. Annual benefits pre and post dams and net benefit with reference to reduction in base line scenario has been derived accordingly annual cost of project with reference to deleting dams in various scenario has been computed. The name of reservoir, water diversion, cost of head works and cost per MCM of water diversion are given in Table 4.

In the present analysis 5 scenarios have been considered, analyzed and results are presented in Table 5.

The results ascertain that in a scenario when all dams are in position Benefit-Cost (BC) ratio and Internal Rate of Return (IRR) are increasing with reduction of dam. The best results are when we delete

Table 4. Parameters of Par-Tapi-Narmada Link

Name of Reservoir	Estimate cost of Head work Rs (Million)	Divertible water	Cost in Lakh/ MCM
Kelwan	3907	270	144.69
Dabdar	3263	267	122.19
Chikkar	1836	146	125.74
Chasmandva	4261	76	560.71
Paikhed	5082	212	239.73
Mohankavchali	4566	137	333-.27
Jheri	2543	242	105.074
Ukai Regulator	146	-	-
Sub-Total	25603	1350	189.65

Table 5. Revised B-C Ratio and IRR by Omitting Dams

Option	Quantum of diversion	Capital cost of project Rs. Million	Annual benefits	Annual cost	B-C ratio with power	Without power	IRR
All dams in position	1350	60164	6182	5716	1.08	1.02	8.07
Delete Chasmandva(I)	1274	53895	5814	5106	1.14	1.08	8.35
Delete Mohankavchali(II)	1213	52398	5611	4967	1.13	1.07	8.85
Delete Chikkar(III)	1204	54570	5979	5189	1.15	1.10	8.86
Delete Paikhed(IV)	1138	49366	5993	4687	1.28	1.24	8.68
Delete Jheri&Chasmandva(V)	1032	45084	5509	4281	1.29	1.25	8.34

2 dams viz. Jheri and Chasmandva with increase of B-C ratio 1.0% to 8.34%.

Possibility of Generating Solar Power in Various River Linking Projects

The concept of Solar Power on canal top has been very recent and it is work out for assessing canal top solar power potential for all 5 links thus increasing their financial viability while working out the solar power unitary cost for similar projects in Gujarat and area needed per megawatt in various regions has been assessed. Further for finding out benefits unitary rates has been obtained from respective state electricity boards. The suitable O&M cost 1% of capital cost, 0.5% for insurance, 1% for degradation has been considered for working out the benefits cost ratio. The details of computation of solar power generated are shown in Table 6.

Computation of Solar Power along Reservoirs in various River Interlinking Projects

It is observed that aspect of floating solar power panel will have greater benefits through reservoirs as compared to reservoir and canal hydropower generation (Moustafa Elshafei *et al*., 2021). For working out solar power generation it is observed that throughout the year water will be available for 80% of submergence area at MDDL out of which 20% area has been left out for considering provision of cables etc. Thus, net area for solar panels for various dams has been worked out and using above area required for one MW of submerge area under consideration has been assessed. A typical Floating Reservoir Solar Power Generation (NWDA, 2005) is presented in Figure 1. It is assessed to generate 1412MW of Solar Power at MDDL along the periphery of reservoirs. Assessment of solar power along various reservoirs is presented in Table 7.

Fig. 1. Typical Floating Reservoir Solar Power Generation

Conclusion

In this paper a study on various aspects of Par-Tapi-Narmada river linking project and its benefits to command area is presented. On this basis of this study following conclusions are arrived at.

Table 6. Computation of Solar Power Generation on Canal top of Par-Tapi-Narmada Link Project

Sr. No.	Name of Canal	Link length	Power Generation (MW)	Benefits Annual	Annual cost	B-C Ratio Solar Project	B-C Ratio Power Whole
1.	Main canal Par-Tapi Reach	172.069	180.963	161.129	17.230	9.35	1.62
2.	Feeder canals	33.27	11.928	10.620	1.136		
3.	Tapi-Narmada link	190.14	220.923	196.710	21.035		
	Total	395. 476	413.813	368.459	39.401		

Table 7. The Solar Power Generation Assessment AlongVarious Reservoirs

Sl. No.	Name of Reservoir	Submergence at MDDL (km^2)	Quantum of Water a MDDL (MCM)	Solar Power (MW)
1.	Jheri	1.44	14.40	108
2.	Mohankavchali	9.31	191.7	696
3.	Paikhed	0.90	11.43	67
4.	Chasmandva	0.99	6.92	74
5.	Chikkar	1.27	11.91	95
6.	Dabdar	1.94	17.58	145
7.	Kelwan	3.05	26.510	227
	Total Power Generation	1412 MW		

(1) It is assessed that people in project area are ready for adopting micro irrigation as well as interlinking of rivers.
(2) The command area in Saurashtra and Kutch region can be increased up to 30.81% by adopting lower irrigation intensity.
(3) There is possibility of optimizing water utilization by reducing irrigation intensity in enroute command. Reduction of water can be done by deleting dams from 7 to 5 or 6 and B-C ratio can be increased from 1.08 to 1.29 as observed in various combinations.
(4) Micro irrigation introduction in phased manner annual irrigation will be nearly doubled. Also, B-C ration nearly increase BC ratio 60% and IRR 45%.
(5) The B C ratio goes on increasing with the increase in percentage of micro irrigation. While working out the same, the yield/benefits of the crops have been kept as per FR However, due to introduction of micro irrigation, the yield of crops per ha will increase and lead to BC ratio from 1.03 to 1.80.
(6) For Solar power through top of link canal, it is assessed that 414 MW power can be generated.
(7) For generation of hydro power through 7 reservoirs proposed, have been analysed for generation of solar power. It is assessed that 1412 MW hydro power can be generated which is nearly 3 times to canal solar power and will give boost to the project.

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