Sardar Sarovar Project – More Crop Per Drop

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ABSTRACT
The Sardar Sarovar Project (SSP), originally proposed in the year 1946, is an inter-state multi-purpose project on the river Narmada in Gujarat. The project was inaugurated by the late Prime Minister, Shri. Pandit Jawahar Lal Nehru, on the 5th April, 1961. The joint venture between the states of Gujarat, Madhya Pradesh, Maharashtra and Rajasthan is implemented as per the decisions of the Narmada Water Disputes Tribunal (NWDT) -1979, considering the overall development of water resources of the Narmada basin as a whole. The main dam construction started in April 1987 and was programmed to be completed by January 1998. However, the construction work remained held up for long, due to litigation in the Supreme Court which was resumed after October 2000. Accordingly the spillway portion could be raised up to EL 121.92M by Dec.2006. Further works to complete the dam with FRL at EL138.68M. to harness full benefits of the project are yet to be resumed. Besides hydropower generation capacity of 1450 MW and providing drinking water supply to large number villages and towns in Gujarat, the project envisages irrigation benefits to17.92 Lakh Ha area of Gujarat (including parched areas of Saurashtra and Kutch) and Rajasthan. The irrigation network being implemented includes main canal of about 458 km length is one of the biggest in the world. Expeditious completion of the dam as well as irrigation network are the priorities before the Govt. Secondly, even though irrigation potential (IP) of 5.61 Lakh Ha. has been created, only 1.93 Lakh Ha is under utilization till Sept,2012. All out integrated efforts are needed to minimize the gap between IP created and IP utilized. Moreover, in order to minimize the conveyance and evaporation losses as well as to improve the overall irrigation efficiency, there is a need to use piped distribution system in the network below distributory / minor and extensive use of drip / sprinkler methods.. The piped distribution system will not only save precious land and water but also can spread a given volume of water over a larger area through gravity / pumping. This could bring much of the groundwater irrigated farm lands under a conjunctive management regime. The paper discusses these aspects of SSP, status of IP created & IP utilized, and various measures suggested for improving the water-use efficiency in the command.

1.0 INTRODUCTION

The river Narmada, being one of the least tapped rivers in India, is the largest west flowing river in the country. It traverses Madhya Pradesh, Maharashtra, Gujarat and meets the Gulf of Cambay covering the total length of about 1312 km having catchment of about 97,410 Sq.Km. out of which 85,858 Sq.Km in Madhya Pradesh, 1658 Sq.Km in Maharashtra and 9894 Sq.Km in Gujarat. The mean annual rainfall in the basin is 1120 mm. The maximum recorded flood in the river is about 70,847 Cumec. In spite of the huge potential, there was hardly any development in the basin prior to independence. After independence steps have been taken to resolve the inter-state differences on sharing of waters by constituting the Narmada Water Disputes Tribunal (NWDT) which gave its decision in 1979.The river development works started thereafter. The basin map along with the developmental infrastructure is shown in Fig: 1

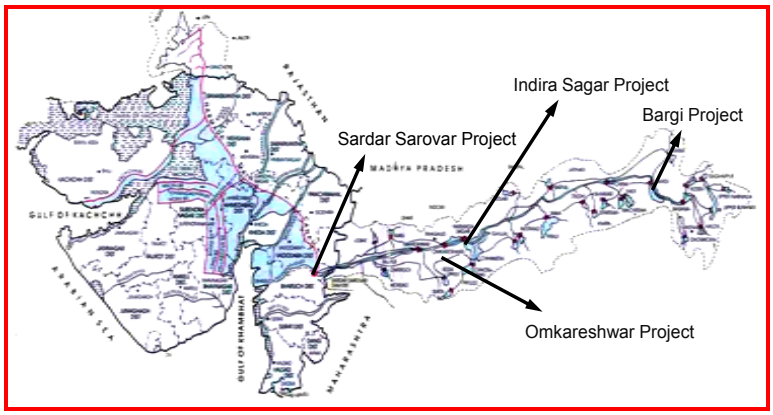

Fig :1 Narmada basin and the projects

2.0 NARMADA WATER ALLOCATION

As per NWDT award, the utilizable quantum of Narmada water at terminal site on the basis of 75% dependability is assessed at 34.5 BCM being shared in the proportion as 73% by M.P. 36% by Gujarat, 1% by Maharashtra and 2% by Rajasthan. For the purpose of computing power generation, NWDT has estimated the utilization of waters in various stages Viz. Stage-I, Stage-II and Stage-III starting after 10 years, 30 years and 45 years respectively from the commencement of construction of dam. The construction work of dam was started in 1987, which is yet to be completed resulting in huge time and cost overrun as well as negation of full utilization of the planned benefits. Utilization of water at various stages of development as considered by the NWDT is as per Table:1

Table:1 Stage wise proposed water utilization (in BCM)

States	Stage-I (10 yrs *)	Stage-II (30 yrs*)	Stage-IIII (45 yrs*)
M.P	7.4	16.0	22.5
Maharashtra	0.3	0.3	0.3
Gujarat	3.1	11.1	11.1
Rajasthan	0.6	0.6	0.6
Total	11.5	28.1	34.5*

From start of construction

The above apportionment relates to actual withdrawals by party states and not consumptive use. The water allocated and utilized by co-basin states during the hydrologic year 2010-11 as is as per Table:2. It can be seen that during 2010-11 the water use by MP, Maharashtra, Gujarat and Rajasthan was 6.625 BCM, 0.0 BCM, 4.375 BCM and 0.18 BCM respectively. Whereas the water flowing down to sea is of the order of 15 BCM. Thus it can be seen that even though the period of stage-II is approaching the actual water use is even less than what envisaged for stage-I

Table :2 Narmada Water Utilization (2010-11)

S. No	State	**Share of utilizable flow**		Actual Withdrawals *		Water Flowing d/s of SSP (RBPH+Spill+Env Flow) **	
		BCM (MAF)	%	BCM (MAF)	%	BCM(MAF)	%
1	M.P.	17.78 (14.41)	65.17	6.625 (5.37)	59.27		
2	Gujarat	8.77 (7.11	32.16	4.375 (3.55)	39.18		
3	Maharashtra	0.243 (0.20)	0.90	0	0		
4	Rajasthan	0.487 (0.39)	1.77	0.18 (0.14)	1.55		
	TOTAL	**27.28 (22.11)**	**100**	**11.18 (9.06)**	**100**	**15.048 (12.2)**	**55.18**

**** As per NCA ** As per G.O.G.***

3.0 SARDAR SAROVAR PROJECT

Sardar Sarovar (Narmada) Project (SSP) is a major multipurpose water resources project with gross storage capacity of 9.5 BCM (7.7 MAF) and live storage capacity of 5.82 BCM (4.72 MAF) which includes a concrete gravity dam across river Narmada near village *Navagam,* two powerhouses with installed capacity of 1200 &250MW respectively and a very vast canal system spread in two states of Gujarat and Rajasthan with annual irrigation of 17.92 Lakh Ha in Gujarat and 0.73 Lakh Ha in Rajasthan. The project is to meet drinking water needs of 9633 villages and 131 urban centres in Gujarat and 124 villages in Rajasthan. The controlled outflow from the reservoir provides flood protection to the lower reaches. In addition, there are several direct and indirect benefits like fisheries, recreation facilities, water supply for industries, forest conservation, agro industrial development, employment generation etc. In addition, navigation & recreation infrastructure if properly planned, implemented and managed may convert the project area to be one of the biggest tourist attractions. Investigations for SSP started in the year 1980 after the award. However till date dam has been completed up to RL 121.92 m as against top RL 146.50m.

The Canal Head Power House (250 MW) and River Bed Power House (1200 MW) are already functional but yet to achieve the full capacity. The canal system in Gujarat and Rajasthan is partially achieving the irrigation and other benefits and is proposed to be completed by 2015-16, The SSP complex is shown in Fig:2

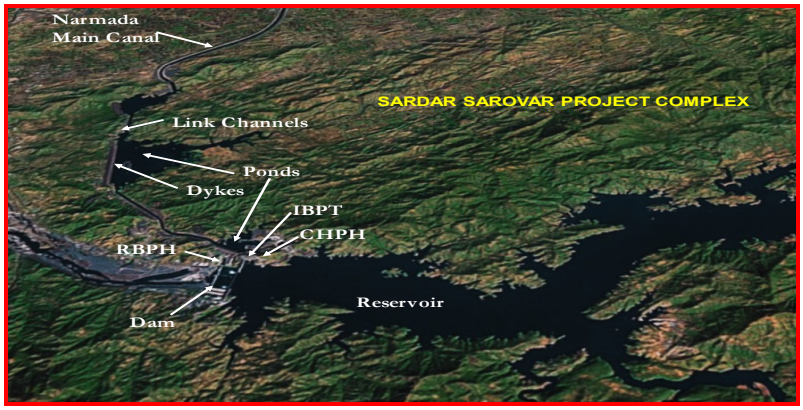

Fig:2 Sardar Sarovar Project Complex

4.0 IRRIGATION COMPONENT OF SSP

The rainfall in most parts of Gujarat and Rajasthan is not only scanty, but very erratic with large spatial variations. Lack of adequate recharge has resulted into over-exploitation of the ground water in major water deficit regions of Suarashtra and Kachchh resulting in salinity ingress. The advancement of desert in many parts of Kachchh and North Gujarat as well as general shortage of power resulting in lack of development in these regions. To address these issues, the Sardar Sarovar Project (SSP), one of the largest interstate water resources projects is under implementation. The irrigation infrastructure having Narmada Main Canal (NMC) of over 458 Km length passing through Mahi, Sabarmati, Banas, Watrak, Som basins in Gujarat as well as river basins of Luni, , Saraswati, etc.in Rajsthan reaching almost up to the tail end of the Indira Gandhi Canal (Rajasthan canal) which carries waters of Satlaj to irrigate desert areas in Rajasthan. These two irrigation canals form one of the biggest engineering achievements instrumental in meeting Satlaj & Narmada waters in deserted commands of Rajasthan. This is a classic case of highly successful inter basin transfer of waters.

4.1 Irrigation Infrastructure

The Narmada Main Canal is to irrigate over 2 M Ha of drought prone CCA in Gujarat and Rajasthan. In Gujarat, the Narmada Main Canal (NMC) off-takes from Sardar Sarovar Dam at a full supply level (FSL) of 91.44 m (300 ft.) and traverses through a length of over 458km before entering Rajasthan near village Silu in district Jalore. In Gujarat, it has 38 branch canals and their distributaries, minors and sub-minors aggregating a network of length about 75000 km. In Rajasthan, the canal runs for a length of 74 km. The Narmada Main Canal is designed to carry a maximum discharge of 1133 Cumec at a FSL of 91.45m (300 ft) at the head regulator. This would taper down to 75 Cumec at the tail end at Gujarat-Rajasthan border.

4.2 Physical and financial progress

The Narmada Main Canal including CD works is completed and is operational. Some of the branch canals have also been completed and are functioning. The works of remaining branches as well as distributaries, minors, sub minors and field channels in the command are under progress. Considering the size of the network, there are many bottlenecks major being land acquisition. Consequently there is substantial gap in irrigation potential created and utilized. Irrigation potential of 5.61 Lakh Ha (31.29%) has been created so far out of the target value of 17.92 lakh Ha. in Gujarat. However, the potential actually being used so far is about 1.93 Lakh Ha. The works at various fronts for achieving full targets are continuing. The physical and financial progress made so far is shown in Fig:3

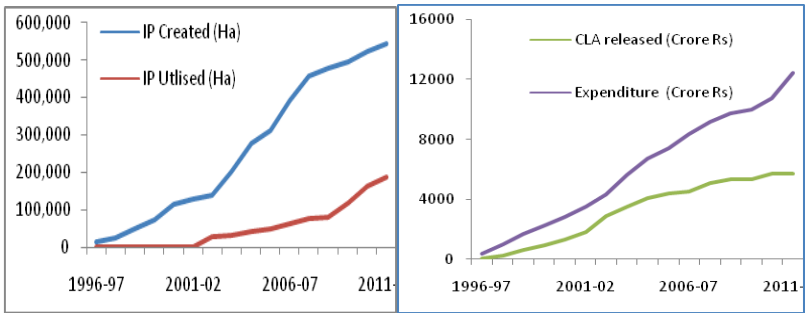

Fig:3 SSP- Physical and financial progress

The irrigation component of SSP is partly financed by Central Govt. under accelerated irrigation benefit program (AIBP) in the form of Central Assistance or Loan Assistance (CA/CLA) since 1996-97. Till date the expenditure on works component of SSP is Rs 12463.81 Crore and total CA released is Rs. 5736.78 Crore. The year wise CA released and the expenditures on SSP are as per Fig-3. From the above, it can be seen that for achieving the full benefits of SSP micro level realistic physical and financial planning, effective implementation and regular monitoring is essential to achieve the water utilization targets as per NWDT award.

5.0 IRRIGATION EFFICIENCY

Gujarat has a share of 11.1 BCM (9 MAF) in Narmada waters. Assuming an average annual delta of about 619 mm. SSP is designed with envisaged irrigation efficiency of about 60% to achieve irrigation potential of 17.92 Lakh Ha. The overall irrigation efficiency is product of conveyance, distribution & application efficiency. For most of the irrigation projects in the country the irrigation efficiency is of the order of 25 to 45%. Low efficiency is mainly attributed to high distribution and application losses. For SSP the main canal, branches and distributaries up to minor are proposed to be lined to achieve substantially high conveyance efficiency. Except evaporation other losses can be theoretically negligible for the main canal. However In view of vast network the evaporation losses can be very high for distribution & application network resulting in huge loss of precious water because of traditional irrigation methods such as flooding, furrow irrigation etc

5.1 Field studies

Govt. of Gujarat carried out studies for arriving at the designed efficiency of SSP on pilot block of Kapurai distributory on Vadodara Branch. The results are taken as a base for calculating the losses in branch canal and the distribution system. The details of results are as per Table:3.

Table:3 Study results for water loss and irrigation Efficiency for SSP

Type	NIR /10000.Ha.	Field App.	Unlined Canal	Dist. System	Branch Canals	Main Canal	Operation	Total	Water Demand	Effic'y
SSP Volume (ham)	5042.08	1008.72	668.2	522.02	267.15	260.91	544.28	3135.9	8177.98	60%
SSP Loss (%)	-	12.33%	8.17%	6.38%	3.27%	3.19%	6.65%	40%	-	60%

Source: SSNNL 1989:371

5.2 Sensitivity analysis

Various on farm studies have shown that by improving irrigation efficiency, crop quality and yield increases due to improved water application and reduced water logging in addition to increase in CCA because of substantial saving in water. For SSP the quantum of water share is fixed at 11.1 BCM. If about 10% of the available water is reserved for other consumptive uses and about 10% of water is considered as return flows the quantum of water available for irrigation is 11.1BCM.For 17.92 Lakh Ha of command area the annual delta works out to be 619 mm and net delta of 372 mm for 60% efficiency. If the efficiency is increased or decreased the respective effect on the area irrigated is shown in Table:4

Table:4 Sensitivity analysis of irrigation efficiency for SSP

Irrigation Efficiency (%)	Annual Delta (mm)	Area Irrigated (Lakh Ha)
40	930	11.94
45	827	13.43
50	744	14.92
55	676	16.41
60	619	17.92*
65	572	19.40
70	531	20.89
75	496	22.38
80	465	23.87
85	438	25.34

**Targeted potential*

On one hand considering the efficiency values for other projects in the country, it is feared that because of lower efficiency there can be considerable loss of CCA for SSP as well. However it is also possible that by adopting piped distribution below distributory / minor and pressure/micro irrigation system for application can result in increase of about 7 Lakh Ha of command which can prove to be boon for the state of Gujarat or the saved water can be used for meeting other consumptive demands. Based on the various on farm studies conducted it is estimated that the field application losses in Table:3 can be further reduced from 12.33 % to about 5.33% (saving of 7%), unlined sub-minors losses can be reduced from 8.17% to about 4.17% (saving of 4%) and distribution system losses can be limited to 3.38% (saving of 3%). Thus utilising piped distribution system and use of drip/ sprinkler irrigation methods extensively in the command of SSP can not only save the precious land from acquisition and water logging /salinity in long run but also result into increase in irrigation efficiency to about 80-85% with increase in productivity of the order of over 50%

6.0 MEASURES FOR IMPROVEMENT

Owing to low irrigation efficiencies, the water does not reach the tail end farms leading to reduction in utilisation. Many studies infer that following major reasons for low efficiency as well as gap between irrigation potential created and utilisation which include

- Conventional irrigation practices
- Huge losses in evaporation & seepages
- Tendency of farmers to grow cash crops which are highly water intensive
- Low utilization during Kharif season
- Reduction in storage capacity due to silting
- Low water yield in the reservoirs
- Diversion of irrigation water to non-irrigation uses
- Non accounting of irrigated area outside the command (influence area)
- Poor maintenance of the infrastructure due to financial constraints
- Non participation of beneficiaries in irrigation management
- Lac of awareness/ training of stake holders

It is absolutely essential to take corrective measures on war footing for all above aspects while utilizing the available water of SSP so that the designed irrigation efficiency of 60% or even higher is achieved to irrigate the proposed command area. Any reduction in the efficiency will result in drastic reduction in the command, especially those at the tail end of the canal system i.e. Kutch and Saurashtra which are already water starved regions of the Gujarat State.

In view of the above, the suggestions to utilize the available water prudently are listed below:

1. On pilot basis, Participatory Irrigation Management (PIM) to be implemented using PPP model with appropriate share/role of local farmers and Govt. Departments below distributory including installation, running & maintenance of the piped & pressure irrigation system using modern technology.
2. Appropriate restructuring of the Water Users Association (WUA) needs be undertaken for water management below distributory. This should be followed by aggressive training for organizational development, leadership, maintenance of, financial and operational records, training in the basic technical components of canal system and in the methods of monitoring technical work.
3. There is a need to develop a mechanism for proper coordination between relevant government departments, such as the irrigation, agriculture, revenue and the land development department for holistic development of the command area *pari-passu* with the main / branch canal/ distributory works.
4. Device mechanism to make farmers to adopt appropriate cropping pattern for optimum use of water. A balanced ratio has to be introduced between high, medium and low water consuming crops. It is in the interests of the farmers to adopt balanced cropping pattern to avoid fertile agriculture land turned into infertile because of over irrigation and imbalanced cropping pattern.
5. Training and awareness among every stakeholder for a role to play in ensuring that the water resources of the SSP are harnessed and utilized properly for the maximum good of the people resulting in the long term sustainability of the economy, food security and stability of prices.

7.0 CONCLUSIONS

Numerous factors will continue to encourage improvements in on-farm irrigation efficiencies. The conversion from surface to pressurized systems needs to be adopted in SSP command The reduction in runoff and percolation translates into fertilizer and chemical savings has very positive environmental implications and makes it possible to maintain good production in parched areas.SSP is still to attain its full conservation level. Effective irrigation methods such as piped distribution system below distributory & micro/pressure irrigation for field application if adopted with appropriate participation of local farmers, Govt Depts and reliable and well reputed private players can prove to be boon for the state of Gujarat

(Note: the views expressed in the paper are of authors and may not necessarily of their organisation.)

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