MIXED EXPERIENCES OF PIPED IRRIGATION IN GUJARAT, INDIA

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Abstract

India has been a water stressed country in general. But Gujarat is more deprived of natural gift i.e. water. Lopsided distribution of water resources makes the task further difficult. In the given situation, enhancing water use efficiency is the only solution to deal with the crisis of water for the water stressed states. Because the largest consumer of water is agriculture sector, water saving efforts need to focus on it as a strategic move. In the irrigation projects, efficiency at the project level is generally very low; in some, hardly 45% approximately due to several reasons and hence some attempts to minimize the losses have been made to address the issues of seepage and evaporation. A big move in this direction buy Gujarat is the commissioning of the pipeline network instead of canal network for tertiary and lower levels of distribution system. Gujarat has been trying the pipelines as an alternative to canals since long back, and, therefore, a reach database is available to analyze the success and failure parameters. This paper provides a discussion on several irrigation projects where the pipelines have been tried out along with the reasons for success and failure. Gravity flow and pressurized flow are given due importance in implementation along with a large range of materials from which the pipes are manufactured. Large scale application of piped irrigation in the command area of the Sardar Sarovar Project covering 1.1 million hectares has been recently executed but the performance appraisal requires some time to study the actual functioning of the same.

ISSUE OF WATER AVAILABILITY IN GUJARAT

Gujarat is divided in to four regions - South Gujarat which also includes Central Gujarat, North Gujarat, Saurashtra and Kachchh as shown in Figure-1. South Gujarat is water rich and is also having clayey soil, North Gujarat is water stressed and having alluvial soil, Saurashtra is facing shortage of water and is having a mix of black cotton soil with gravels whereas Kachchh is having sandy soil and a large area of desert. Coastal length of Gujarat is the highest in India which is 1664 Kilometres.

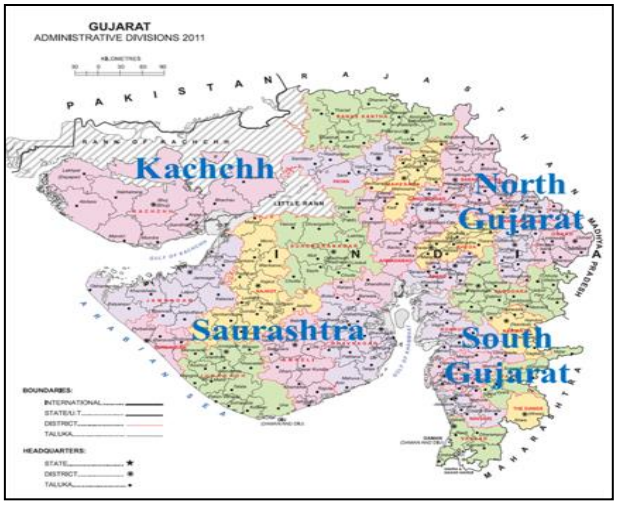

Figure-1 Regions of Gujarat

Except South and Central Gujarat there has been scanty water in the entire state. If compared the per capita water availability, it is much less than India's average and from 2001 onwards there is a significant reduction therein which has caused concern. This is because of population growth, development of industries and climate change. Overall scenario of Gujarat i.e. surface water and groundwater is shown in Table-1.

Table-1 Surface water scenario of Gujarat

Region	**Area in % of Geographical Area of Gujarat State**	**Surface Water in Mm^3**	**Ground Water in Mm^3**	**Total Water in Mm^3**	**Per Capita Per Annum Availability in m^3 in 2011 and (2001)**
South and Central Gujarat	25	31750	3950	35700 (71 %)	1695 (1880)
Saurashtra	33	3600	4300	7900 (16 %)	487 (540)
North Gujarat	20	2100	3300	5400 (11 %)	309 (343)
Kachchh	22	650	450	1100 (2 %)	658 (730)
Total	**100**	**38100**	**12000**	**50100 (100 %)**	**893 (990)**

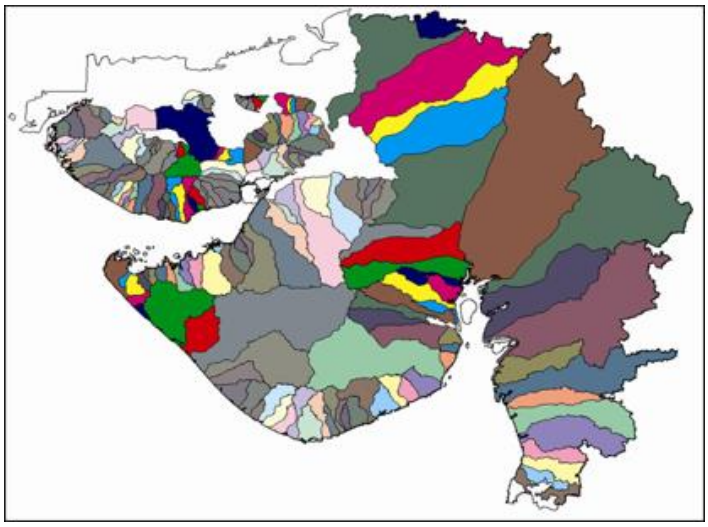

Figure-2 River Basins of Gujarat

Figure-2 shows that in Saurashtra and Kachchh there are many small river basins coupled with low yields due to scanty rainfall. In South and Central Gujarat, a few but big river basins are there. Table-2 shows that rainfall and number of river basins are inversely proportionate and therefore in Saurashtra and Kachchh, rivers are many but small and non-perennial. Medium and

major dams are feasible on a few rivers because of such a discrepant situation. In total 85 major and medium dams have been constructed as per availability of sites and no more sites are technically feasible for such dams.

Table-2 Rainfall Distribution of Gujarat

Name of Region	**Annual Rainfall in mm**	**No. of River Basins**
North, Central and South Gujarat	800 to 2000	17
Saurashtra	400 to 800	71
Kachchh	Less than 400	97

Technical feasibility became a major challenge for the construction of major and medium dams in Gujarat. Obviously, because of scanty surface water, ground water exploitation became a serious in last a few years. Quantity and quality of water always become a contemporary issue in most of the cases.

OVERVIEW OF PAST EXPERIENCES OF SMALL PIPELINES IN GUJARAT

In the context of issues related to quantity of water, Government of Gujarat is aiming at using the available water resources to the maximum possible extent by planning the water resource projects for extensive irrigation rather than intensive irrigation, constructing many small dams wherever feasible, implementing schemes for inter-basin transfer of water, increasing efficiency of the distribution systems, increasing on farm efficiency, recycling of water, etc. Piped irrigation was tried out in several projects to address the issue of seepage and evaporation in most of the cases and of topographical variations in some cases. Another benefit of the pipeline network envisaged was that only Right Of Use (RTU) was required instead of Land Acquisition - the most unpredictable variable leading to time and cost over-run in several projects. In spite of limited choices of material and joinery, several projects were provided with piped irrigation in the past. But now a days the choices are many in the material and joinery and hence the entire problem has been different as compared to the past.

Ukai-Kakrapar Right Bank Canal System

Ukai-Kakrapar is a weir in the Tapi basin with Culturable Command Area (CCA) of 59,523ha. Because of flood plain zone in the tail end, 9,551 ha of the CCA was provided with the pipeline network. The said work was carried out during 1978-83. Gradually the issues like siltation due to low velocity induced because of flat gradient and low discharge, over-drawl of water by pumping by the farmers, vandalism in the form of breakage of scour valves and stealing of brass parts, obstructing the flow to deprive farmers in the downstream, etc. went on hampering the performance and in a few years it was observed that out of 9,551 ha of the pipeline network, only 2,838 ha area could actually avail the irrigation water. Efforts to repair and maintain the pipeline network were made but they could not attain much success. Concrete pipes were used for original construction and subsequent maintenance.

Karjan Reservoir Project

Karjan is a tributary of Narmada river. A dam with 539 Million Cubic Meter (MCM) of gross storage has been constructed across the river Karjan with CCA of 45,000 ha. Because of flood

plain zone in the tail portion of the command area, 20,000 ha of the CCA was provided with the pipeline network in 1992-93 using concrete pipes. Out of 20,000 ha of the pipeline network, only 1,996 ha area actually gets irrigation water as of now. Main reasons for poor performance are – poor construction, improper design, siltation, vandalism and internal rivalry amongst farmers.

Watrak Reservoir Project

Watrak is a tributary of Sabarmati River. A dam with 158 MCM of gross storage capacity has been constructed across the Watrak river with CCA of 18,341 ha out of which the pipeline network was in 17,341 ha. The aforesaid work was carried out in 1983-84. The main reason of opting for pipeline was semi-hilly topography which made it difficult to design the canals. Maximum irrigation recorded was in 1993-94 which was 12,102 ha. In course of time, vandalism and lack of maintenance made almost the entire pipeline network defunct. The main reason for lack of maintenance was inaccessibility of the target locations as the farmers did not allow the approach due to standing crops. Farmers gradually switched to tubewell irrigation. Actually the availability of groundwater was a discouraging factor in convincing the farmers the real need of surface water based irrigation and maintenance of pipeline network. Originally the pipelines were constructed from concrete pipes. Now the said pipeline network is being replaced by PVC or HDPE pipes. Because groundwater has become an issue at present because of insufficient recharge and over-drawl, the farmers have no option but to depend on the surface water and hence the acceptance of piped irrigation has increased. PIM is also tried to be implemented in simultaneity so that the belongingness could be instilled amongst the farmers and that is how could be avoided the vandalism and internal conflicts of interest.

Mazam Reservoir Project

Mazam is a tributary of Sabarmati river. A dam with 43.86 MCM of gross storage has been constructed across the Mazam river with CCA of 4,717 ha out of which 4,482 ha has been the piped irrigation network. Thus, almost the entire command area is served though pipeline. The main reason for selection of piped irrigation was the semi-hilly terrain and availability of ideal longitudinal slope of 1:500. The aforesaid work was completed in 1984. Maximum irrigation recorded in 1994 which was 2705 ha. In course of time, vandalism and lack of maintenance made almost the entire pipeline network defunct. The main reason for lack of maintenance was inaccessibility of the locations where the pipelines were buried as the farmers did not allow it due to standing crops. This resulted in to reduction in the size of the actually served command area to the extent of only 700 ha. Originally the pipelines were constructed from concrete pipes. Now the said pipeline network is being replaced by PVC or HDPE pipes because groundwater is an issue and hence the farmers have no option but to avail the surface water. PIM is also tried to be implemented in simultaneity so that the belongingness could be instilled amongst the farmers and that is how could be avoided the vandalism and internal conflicts of interest.

Guhai Reservoir Project

Guhai is a tributary of Sabarmati River. A dam with 68.75 MCM of gross storage has been constructed with CCA of 7,111 ha entirely with piped irrigation. The topography is semi-hilly with 1:600 general slope and hence was ideal for the pipeline network. The aforesaid work was completed in 1993-94. Maximum irrigation recorded in 1994 which was 2,705 ha. With proper restoration, at present, actually 3,756 ha area gets irrigation water and gradually the command area is being rejuvenated. Special feature of the project is that there are 29 WUAs controlling 6,839 ha of command area and hence the performance in general is better as compared to other projects. Present efforts of rejuvenation of the entire command area are also gaining results.

OVERVIEW OF RECENT EXPERIENCES OF BIG PIPELINES IN GUJARAT

Big diameter pipeline networks have been taken up by Gujarat on a large scale in order to address the requirements of the no-source villages. Big diameter pipelines being very costly, are implemented mostly in case gravity flow is not available. However, in the command area of the Sardar Sarovar Project, some pipeline networks with big diameters have been laid to serve water in undulated areas.

Sujalam Sufalm Canal Based Lift irrigation Schemes

Sujalam Sufalam Project envisages surplus flood water of Kadana reservoir to North Gujarat by a channel. As the water of Kadana is not sufficient, additional water is taken from Narmada Main Canal. From various locations of the Main Canal of the Sardar Sarovar Project, water is lifted to fill up different reservoirs like Dharoi, Watrak, Mazam, Meshwo, etc. which are located in the Sabarmati basin. As these reservoirs are at higher elevations as compared to the Narmada Main Canal, lifting is essential and hence pipelines are installed. 12 such schemes have been implemented to lift approximately 900 MCM of water annually. Their average lift is 76 m. They are almost all steel pipelines with diameter ranging between 1.5 m and 3.0 m. Only in one scheme, Glass Reinforced Plastic (GRP) pipeline has been used. As such their performance is found very good but the cost of the operation and maintenance is so high that the economic viability is really a matter of concern. As farmers' internal conflicts are not required to be addressed in this case, most of the issues are automatically avoided. However, performance of GRP pipes in this project is not found satisfactory as the surges are so strong that the pipeline frequently bursts. It is found that the design of the pipeline was not done properly considering the surges. From the choice between compelling the people to migrate for existence and heavy capital and recurrent costs to be borne by the Government, the latter has been chosen in this case.

Tertiary Network of Sardar Sarovar Project with Pipelines

Sardar Sarovar Project became a classical example of extensive irrigation in India. It is one of the largest projects of the world with 1.8 million hectare of command area and 75,000 km long canal network, having a large encompassment of 9,600 villages and 135 towns to be supplied domestic water, has been designed with protective irrigation approach of planning and design. When the rainfall is delayed or insufficient during monsoon, limited water is supplied to the farmers so that their kharif crop is protected is the basic idea. Average delta designed in the command area is 45 cm.

Tail stretch of the command area of the Sardar Sarovar Project is adjoining the dessert of Kachchh. There are undulations in the sandy soil strata and very high temperature due to vicinity of dessert and hence serving water through open channels was very difficult in some areas. Availability of soil of required quality was also an issue. Therefore, some stretches of tertiary canals i.e. distributaries and minors had to be in the form of pipelines which were gravity essentially. The diameter varied between 0.6 m and 2.8 m and the material used was GRP. Five distributaries in total approximately 45 Kilometer length were constructed in the form of pipelines in 2013 and there has not been found any problem till now. The main reason for success is that the design was properly made and wherever the road crossings were there, there was a concrete box provided to cover the GRP pipe in required length and the GRP pipes were designed for the different loadings as per situations. Hydro testing was also conducted precisely in the laboratory and field.

CONCLUSION

Benefits of piped irrigation like avoiding seepage and evaporation losses unlike canal irrigation, ROU instead of land acquisition, etc. generally encourage the use of pipeline on a large scale. However, all the applications of the pipeline have not been successful due to various reasons. In some applications the material chosen might be a problem, in some the joinery, in some the workmanship, in some the vandalism, in some the conflicting interests of farmers and so on. All the factors if work together in a proper coherence, then only the pipeline applications can be successful. For example, GRP as material is not a problem but if the design is not made properly considering all the forces, failures would affect the performance and people may take an impression that GRP as a material is not good but the reality is different. The same way, everything is all right but vandalism is unavoidable and then pipeline becomes very difficult to maintain.

Maintenance of pipeline is difficult especially in case of irrigation application because approaching the site is the real issue due to standing crop and for minor repairs, excavation and replacement of an entire pipe is needed in most of the cases. Thus, initial benefit of avoiding land acquisition results in to a subsequent problem of paying crop compensation or resistance of the farmers because of standing crops. Therefore, comparing with the canal irrigation and piped irrigation, what is an asset at the initial stage is the liability for the future.

There are some cases in which neither canal, nor pipeline could work well. In flood plains, canal in embankment would be destabilized due to sheet flow and canal in cutting would be silted or deshaped because of its functioning as a drain. On the other hand, the pipeline in case is installed in such case, the gradient would be insufficient causing siltation in no time.

Where groundwater is available, importance of surface water based irrigation whether in the form of canal irrigation or of pipe irrigation is not appreciated by the farmers.

In all, piped irrigation can not be viewed as an alternative to canal irrigation to overcome the shortcomings of canal irrigation; rather, case specific appropriateness of any of the two based on pros and cons of each should be the basis of selection of methodology of supplying irrigation water. None of the two is a panacea in any situation.

REFERENCES

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