Chapter 7

Conclusion

7.0 General

The canal irrigation system has a vital role in the Indian agricultural economy. In the agricultural production, India is the second largest producer with 7.68 percent global agricultural outputs. The agricultural share in gross domestic product is 17.4 percent and the employment generation share is 48.9 percent in 2011. Hence, more than 58 percent population depend on agriculture in India. In this scenario agricultural share is declining with the GDP because of the low productivity in agriculture. Inadequate irrigation facilities in command area are one of the major reasons of low productivity in India. Therefore, there is an imperative need of increasing overall efficiency of the irrigation projects in the country. There are several states and many countries, who have successfully replaced the surface canal with pipeline canal and obtained an overall
efficiency up to 70-80 percent. Therefore, the present study has been carried out to design the map of gravitational pipeline for the left bank canal of Nilwande dam and carry out the comparative study of SCIS and PCIS with their merits and demerits.

The sector wise water need of the command area has been calculated to estimate the demand and supply of the water. The tehsil wise increasing irrigable area is also calculated and suggested a sustainable five stage model for adaptation of pipeline for the LBC of Nilwande dam. Therefore, this chapter deals with overviews, suggestions, and scope for the further study.

7.1 Facts and Findings

7.1.1 Chapter I: Introduction to the Topic

- Water resource is a basic need of an entire living organism, and it is a precious asset for everyone.
- Countries from Asia have been facing water stress due to growing population, urbanization, changed lifestyle, and industrialization.
- Imbalance between the demand and supply of water, changes in the allocation of water in various sectors and an unequal distribution of water raises conflict in society.
- Agriculture uses about 73 percent fresh water in the world, and irrigate only 18 percent of cultivated areas.
- In India 83 percent of fresh water is used for irrigation and the net irrigated area (NIA) is only 63.3 million hectares (39%).
- Out of the total NIA ground water irrigating 62 percent and surface irrigation is 38 percent in the county.
- Canal irrigation is the second most important source of irrigation, but there is a wide gap between irrigation potential created (IPC) and irrigation potential utilized (IPU) in India and Maharashtra.
• The overall project efficiency of unlined and lined surface canal irrigation system (SCIS) is only 30-40 percent in India, due to large water loss at various points of water conveys systems and field application.

• It is an urgent need to increase an overall efficiency of the projects to increase the NIA and pipeline canal irrigation system (PCIS) is one of the unrivaled options, to eradicate the water stress problem in the command.

• Analytical hierarchy process (AHP) technique is appropriate for the site suitability analysis for the pipeline canal.

• Geographical Information System (GIS), remote sensing (RS) and Multi Criteria Decision Analysis (MCDA) are more efficient and reliable techniques to provide more accurate and effective decision.

• The potential evapotranspiration (PET) and crop coefficient (Kc) data are used for calculation of crop water requirement.

• Spatial resolution Landsate-8 satellite images are used for the detection suitable site for pipeline canal and procure, Geology, Physiography soil depth and texture, LULC etc maps.

• Geographically, the study area is located between 19˚ 26' 32.59" north to 19˚ 57' 33.55" north latitude and 73˚ 35' 30.48" east to 75˚ 02' 17.22" east longitudes.

• Administratively, the study area includes parts of Akole, Sangamner, Kopargaon, Rahata, Shrirampur, Newasa, and Sinnar tehsils form Ahmednagar and Nashik districts of Maharashtra.

7.1.2 Chapter II: Geographical Profile of the study area

• The study area is classified into the six geological classes, within that 12-14 compound pahoehoes flow and some Aa flows (93.97 %) and alluvium (4.02 %) type of geology covers maximum part of the study area.
• There are several dykes with 0.5m to 33m width, the four fractures are observed in Akole, Sangamner, Rahata, and Kopergaon tehsils.
• One fault and lineament is observed at Akole tehsil and in bank of Godavari river respectively.
• Physiographically, the study area is divided into three groups like mountain region (03.73%), a plateau region (34.30%), and plain region (61.97%).
• The elevation varies from 382m to 1516m above the mean sea level and area mainly divided in to Pravara and Godavari river basins.
• The total study area varies in slope from less than 1° to more than 30°. The gentle slope occupies 58.89 % area of TGA, moderate 23.03%, stiff 7.06%, steep 4.74% very steep 3.23% extra steep 2.11% and precipitous 0.94% areas are occupied out of TGA.
• Mostly very steep, extra steep, and precipitous slopes are distributed in the catchment area of Bhandardara and Nilwande Dams.
• Steep, stiff and moderate slope area distributed in the middle stage of Pravara river and gentle slope presents in Rahata, Shrirampur and Newasa tehsil in the command area.
• The total study area is covered by the undulating pattern which is very favorable for the pipeline canal irrigation.
• The dendric drainage pattern is present in the study area, whereas, Pravara is the main river in the study area.
• Pravara river origin on the eastern slope of Western Ghat at 1070m height from sea level and flows 230km east and confluence Godavari.
• Adhala is a main tributary of Pravara which origins at the eastern slope of Patta and Mahakali mountain range and flows 45 km towards east direction and confluence Pravara at Chikhali Village.
• Mhalungi is the second most important tributary of Pravara. It origins on the southeastern slope of Patta and Aundha mountains and flows to southeast direction and confluence Pravara at Sangamner.
• The soil depth classification is prepared with the six classes. It contains thin soils (16.28%), shallow soil (19.91%), marginal deep soil (17.40%), moderate deep soil (31.08%), deep soil (13.99%) and water bodies occupy (1.33%) area of TGA.

• As per soil texture, the study area has been divided into the nine categories. The maximum area is covered by the deep, moderately well drained fine soil (42.55%), and slightly deep, well drained fine moderately calcareous soil (22.54%).

• Besides this, slightly deep, somewhat excessively drained loamy soil (11.74%), very shallow excessively drained loamy soil on moderately slopping (10.28%), and moderately deep moderately well drained clay soil (5.39%).

• Very shallow excessively drained loamy soil on moderately steeply sloping (2.90%), deep, well drained loamy and calcareous soil (2.60), very shallow well drained loamy and calcareous soil (1.30%) and shallow well drained clayed soil (0.70%) area is covered from TGA.

• Two types of climatic regions are observed in the study area, first is tropical, hot, seasonally dry (AW), which is occupied manly catchment and mountainous region of the study area.

• Secondly, dry, semi arid, hot tropical region (Bsh) type climate is observed in the plateau and plain region.

• The average yearly rainfall is observed in the study area is 547 mm, in that, 85% rainfall is occurring during the monsoon and post monsoon period.

• September (127.77mm) and July (113.83mm) have recorded an average highest rainfall and in February (1.00mm) and January (3.11mm) the lowest average rainfall in the study area.

• Tehsil wise average monthly rainfall shows the erratic distribution of rainfall according to the time and place. It means an irrigation rotation.
schedule shall not be some as per tehsil wise rainfall is considered with time and place.

- Western part of the catchment area is a heavy rainfall region, where the average rainfall is more than 70 cm. The region has been recorded average 160cm to 250cm rainfall annually. It covers only 2.67% area of TGA.
- The central-western part of the study region has medium rainfall within 60-70cm, which has covered 56% of TGA.
- The eastern low rainfall region (below 60cm) has covered 41.33% area of TGA, mostly the plain region of study area lies in this category.
- The Average monthly temperature varies between 11.7˚C to 39.4˚C in the study region.
- The different temperature of the region is responsible for different potential evapotranspiration and it will be resulted in the crop water requirement and schedule for rotations.
- The average maximum potential evapotranspiration (PET) is recorded in June (289mm) and minimum in December (119mm).
- Seasonal variations are observed in PET i.e. Summer (741mm), Winter (414 mm) and Monsoon (459 mm). As per the seasonal variation the crop water requirements are also changed.
- The average lowest humidity is recorded in May, which is less than 20% and higher in September, which is 80%.
- The maximum wind speed is observed within 10.6kmph to 22.5kmph in monsoon season and minimum is recorded within 1.3 kmph to 5kmph.
- Except the monsoon period of time skies are clear.
- Socio-economically, the riverside area have an irrigation facilities by the Pravara left bank canal, but the remaining command area of LBC of
Nilwande dam is a part of the drought prone area of Ahmednagar district.

- The population density of the study area varies from 29 per sq. km to 1827 per sq. km in rural parts and the average population density is 417 per sq. km.
- The demographic features are observed in the study area like literacy rate 71 %, total working population, 46.32%, total cultivators, 17.28 %, total agricultural laborer, 11.25%, total agricultural dependency, 29% of the total population of the study area.
- The agricultural density varies from less than one to 1289 per 100sq. Km in the study area.
- The maximum agricultural density is experienced in the Kakadwadi (1289 per 100 Sq. Km) village of Sangamner tehsil and the minimum is in the Shirpunje Kd of Akole tehsil.
- The highest physiographic density is observed in Loni Kd (6636 / 100 Sq km) of Rahata tehsil and lowest in Panchale (20 / 100 Sq km) village of Sinnar tehsil.
- The average physiographic density of the study area is 482 people per 100 Sq. Km.
- The command area has adequate network of communication and transport with road and railway networks.

7.1.3 Chapter III: Nilwande Dam: Catchment and Command areas

- The Nilwande dam site was approved and construction was started in 1993 at 600mt from the prefixed location near the Nilwande village.
- The cost of dam project was revised to 23440.34 lakh in 1993 and the dam was completed in 2011.
- The source of the dam is Pravara river, a right bank tributary of Godavari river.
The total catchment area of the project is 323.95 Sq.Km in which Bhandardara major project catchment 121.74 Sq.Km is also considered.

The gross capacity of the project is 8.32 TMC, in which 0.256 TMC is dead storage and live storage is 8.064 TMC.

The total land required for the dam is 1000.07 hectares, in which 29.24 ha, Bagayat land, 545.73 ha Jirayat land, 177.25 ha revenue land and 247.85 ha forest land are utilized.

The dam has two canals namely left bank canal (85 Km) and right bank canal (96.50 Km).

The Gross Command Area (GCA) of the project is 111090 hectares; Culturable Command Area (CCA) 86100 hectares, Irrigable Area, or Annual irrigation is 64260 hectares in the command area.

The study area includes the Godavari right canal, it is irrigating 877 Sq. Km. area in the study region.

Nilwande left canal will feed about 907.04 Sq. Km. area, Nilwande high level left pipeline canal will provide an irrigation facility to 12.70 Sq. Km. area.

Pravara left canal irrigates 424.92 Sq. Km. area, Adhala canal has covered 63.35 Sq.Km. area and Bhojapur canal facilitates irrigation to 45.80 Sq.km. areas in the study region.

The Gross Command Area (GCA) of the Left Bank Canal (LBC) is 75870 ha, within that; Culturable Command Area (CCA) is 58800 ha. and Gross Irrigable Area (GIA) is 43886 ha.

The proposed LBC will provide an irrigation facility in the six tehsils of Ahmednagar and Nashik i.e. Akole (4.48 %), Sangamner (35.07%), Rahata (39.26%), Shrirampur (2.28%), Kopargaon (12.91%), and Sinnar (5.95%).
7.1.4 Chapter IV: Water Need: Left Bank Canal

- The common discharge of LBC and RBC will be 41.05 cumecs at the head, and after separation LBC will have 24.40 cumecs water discharge capacity.
- The bed width of the LBC is 10.05 m, bed slope is 1:5000 with a full supply discharge (FSD) 3.00 m.
- The left bank canal has the four branch canals viz. low level minor (22Km), Talegaon Branch (14.5 km), Kopargaon Branch (14 km) and tail canal (16.5 km).
- The area under agricultural purpose has been estimated about 13.99% of the total geographical area. It is dominantly distributed in the plain area.
- The dense vegetation has occupied maximum area about 21.60% of TGA; it is distributed on the riverside area and foothill side region.
- The barren land has covered 19.91%, fallow land 5.92%, open scrub 11.48%, rock land 13.77%, settlements 2.51% sparse vegetation 9.49% and water bodies have covered of TGA in the study area.
- In the existing cropping pattern a single crop pattern maps have been procured on the basis of data available from the agricultural department of each tehsil during 2001 to 2011.
- According to the physical profile and availability of socioeconomic factors the study area has observed ten plus crop with uneven distribution.
- The major crop observed in the study area is Bajara which is 21.74% of the Net Sown Area (NSA).
- Sugarcane is the second most popular crop in the study area with 17.47% to NSA; it is distributed in the command areas of Pravara left bank canal and Godavari right bank canal.
- Oilseeds include Groundnut, Soybean, Khurasani, and Sunflower and Til sharing 10.15% of NSA.
• The fodder includes wild grass, green grass, *kadval* and maize and share the 9.91% of NSA, whereas 8.70% of NSA under various fruits, vegetables, condiment and spices in the study region.

• The other cereals have covered the 8.26 % area of NSA, Rice, Nachani, Varai and Maize are included in the cereals category.

• Wheat is the major *Rabi* seasonal food grain crop; it has occupied about 7.99 % area of the total NSA. Cotton is the second cash crop in the study region, which has covered 5.76 % of the total NSA.

• About 5.75 % area of NSA under the Pulses which, includes *Mug* (Green Gram), *Udid* (Black Gram), *Math* (Brown gram), *Tur*, *Hoolga*.

• Jowar is a food grain, *Rabi* crop, which has occupied lowest 4.27% of the NSA in the study area.

• Estimating the water demand in the command area and water storage capacity of the dam, Agricultural Department, Pune, Government of Maharashtra has recommended the eight monthly two seasonal crop patterns for the command.

• The *Kharif* season is estimated 40% (17557 ha) NSA out of the total 43886 ha irrigable areas, within that Bajara 13% (5705 ha), vegetables 3% (1317 ha), fodder 2% (878 ha), Groundnut 2% (878 ha), pulses 20% (8777 ha) of the total NSA.

• The *Rabi* season is projected 60% (26332 ha) NSA out of the total 43886 ha irrigable areas, within that, vegetables 2% (878 ha), Jowar 28% (122288 ha), wheat 5% (2194 ha) and gram 25% (10972 ha) of total NSA.

• The suggested crop calendar is useful for calculating the water demand of crops and plan the rotation of watering in the proposed command area.

• In the proposed command area, it is not possible to have the double or multiple cropping patterns due to inadequate water.
According to the norms, the rural area has been set a limit up to 70 liters per head per day (lphd) and 135 / lphd in cities.

There are many villages with existing drinking water facilities, but some of them have not receiving continuous water supply throughout the year.

Out of the total villages in the command, only 14% (17) villages have 12 months drinking water facility, while 42 % (49) have 8 months, 32 % (38) have 4 months and 12 % (14) villages, yet not get the pure drinking water.

The drinking water need is estimated by considering the 2011 census population, the urban center in command estimated 0.545 TMC water, while the rural villages need, 0.156 TMC water, means the total 701TMC water will be used for drinking in the command area.

It is noteworthy that the need for industrial water in the present and future will not be special.

The water requirement of crops in the LBC command area has been calculated by the Modified Penman Method.

The crop coefficient values have been adopted for each crop as per the suggested cropping patterns.

Net irrigation requirement (NIR) at the field has been worked out for each crop as per the suggested crop patterns in the command area.

The NIR of water is calculated 106399767.7 m³ / (3.76 TMC) as per the Modified Penman Method.

The overall irrigation efficiency of the Nilwande irrigation project is 42 %. Hence, to fulfill the 3.76 TMC (42 %) water requirement at the root zone level, the canal head will be supplied with 8.95 TMC (100 %) water from the reservoir.

As per WALMI's suggestion, the total water requirement is reduced to 20 % due to the ET values estimated by the Modified Penman Method which is higher 15-20% than measured by Lysimeter.
Finally, The total water requirement of the left bank canal command area of the Nilwande dam for the suggested cropping pattern is 202666224.23 m³ (7.16 TMC) with the 42 % overall irrigation efficiency.

The ground water resource estimation has been worked out for the command area, recharge from the canal seepage, return flow of irrigation and recharge from the rainfall are considered.

The total recharge will be available in the proposed left bank canal command area is 5613 Mcum (1.99 TMC).

The GIR for 43886 hectare irrigation is calculated as the total NIR (7.16 TMC) minus available recharge (1.99 TMC) in the LBC command area, it means an actual 5.17 TMC, water will be required for the suggested cropping pattern.

The total water demand for the LBC, including the drinking and agricultural purpose is 5.87 TMC against the 8.32 TMC the gross capacity of the reservoir Nilwande.

7.1.5 Chapter V: Merits and Demerits –SCIS and PCIS

The open surface canal helps the ground water to recharge in case of the LBC. It is worked out as 34.04 M. cum will be available in the LBC command area.

The other merits of the SCIS are flood control, help to provide transport and communication facilities, tree plantation, land values are increasing, helps to general development of the region.

The seepage loss of SCIS is worked out. It means 2.66 M. cum (0.09 TMC) water will be lost through the seepage in main canal and branch canals.

About 1.23 TMC (21 % to total requirement) is the annual transit loss in the LBC.
- Water logging area in Maharashtra is 426.41 thousand hectares by the various major and minor irrigation projects. The Bhandardara Major Irrigation Project has 4.78 Th ha area under water logging problem.
- Evaporation loss and soil degradation are the demerits of SCIS, in Bhandardara major irrigation command area about 2.50 Th ha area has been found salt affected.
- The siltation in the canal, weeds and plants, uneven distribution of water, water theft, social conflicts, canal burst and low overall efficiency area the demerits of SCIS.
- Besides that SCIS water is not possible on demand, environmental problems like unwanted bushes become colonies of mosquito, water born diseases, water pollution, the effect on the biodiversity of flora and fauna.
- Water distribution with minimum loss and high efficiency are the key factors in the modernization of the irrigation projects for that pipeline canals, are the widely accepted water convey system in the world.
- Water loss is saved in PCIS at various points like, zero seepage and water logging problem, no evaporation loss and soil degradation in the command area.
- With the PCIS water shall be distributed equally as per the allocation; it helps to control the malpractices and social conflict among the stakeholders.
- PCIS offers the diversification in cropping patterns and it is possible to provide water on demand in the context of time and place.
- The overall project efficiency of the PCIS is estimated up to 75-95 % for water utilization and no land acquisition is required.
- It is easy to install pipeline canal compare to the SCIS, and flexible for automation and computerization of the canal.
Besides the irrigation facilities, PCIS provides permanent, pure and clean drinking water facility in the command area.

In addition to the above advantages, some disadvantaged are also observed in PCIS. They are large initial capital investment, corrosion problem in case of the iron pipelines and design and installation requires high skills etc.

7.1.6 Chapter VI: Geographical Site Suitability Analysis for PCIS

There are many multi criteria analysis techniques used for decision making in which, Analytical Hierarchy Process (AHP) is a popular technique. This method gives flexibility in decision making process and consider the qualitative and quantitative aspects for analysis.

The physical factors selected for the analysis include elevation, slope, and soil depth while the socioeconomic factors include the land use and land cover and road proximity.

Geographical information system (GIS) has supported multi criteria decision analysis (MCDA) based on analytical hierarchy process (AHP) applied for the site suitability analysis.

Arc GIS 10 and Earth Resource Development Application System (ERDAS) software's are used for processing data and prepare result maps.

Elevation is a major criteria to determine the PCIS, because the scope of the command area depends on the elevation of the source. It has 48% influence on the site suitability of pipeline canal.

The gravitational pipeline canal is governed by the topography of the command area due to the slope of area which is second most important criteria.

The cropping pattern of the region is mainly depend on the soil depth, the specific characteristics of soil like water holding capacity, Infiltration
rate of the soil, intensity of moisture, agricultural productivity, ground water level and soil nutrients depend on the soil depth.

- Land use and land cover map of the study area are used to work out the agricultural land under various crops, where the irrigation facilities will be provided.
- The high road proximity shall be useful for inspection of the pipeline canal, therefore, roads are considered one of the important criteria in the pipeline route analysis.
- The ranks assigned to the criterion on the basis of expert's opinion and literature surveys.
- After rank assigned to criterion, the pairwise comparison matrix is converted into the normalized pairwise comparison matrix, with weighted overlay analysis, the researcher has studied the influence of the criterion.
- After Accuracy Assessment, the final site suitability map has been prepared according to the criterion influence.
- The five stage model of PCIS has been suggested for application in the command area.
- The first stage suggests converting or installing the main canal, with the pipeline canal, which reduces water loss 10%.
- The second stage is related to converting the branch canal with pipeline canal. Hence, the total 20% of water loss will be reduced.
- In the third stage, along with the main and branch canal minor canals to be converted into the pipeline, in this stage also water loss reduced by 10%.
- In the fourth stage, individual farmer or farmers association shall carry irrigation water from the hydrant by pipeline.
- The fifth stage is applied in the field application. If, on farm, farmers adopt micro irrigation systems like, drip and sprinkler, 15% of water loss shall be reduced at farm level.
- The water loss in the SCIS is calculated 20-30 %, but, in PCIS maximum water loss is eliminated.
- The overall efficiency of the LBC is 42 %, whereas the pipeline estimated overall efficiency is 75-95 %.
- The government has acquired 1212 hectares of land for LBC, in case of PCIS, there is no of need to land acquisition and compensation.
- The earthen canal construction requires comparatively more time, but the PCIS requires low execution time.
- The SCIS creates water logging and soil degradation problems, but PCIS eliminates the water logging and soil degradation and additionally provides drinking water facilities in the command area.
- Water on demand and flexibility in crop pattern is not possible in SCIS, whereas in PCIS it is possible.
- The SCIS is complicated for operation and maintenance and gain low economic returns, whereas the PCIS is easy to operate and maintain and can be gained high economic returns.
- The SCIS has low efficiency in equal water distribution and high chances of malpractice, social conflict, and environmental problems. In case of the PCIS equality in distribution can be implemented and helps to minimize malpractices, conflict and environmental losses.
- Finally, the irrigable command area in the SCIS remains same or may be decreased with time, but in case of PCIS 10106 hectares additional land will serve an irrigation facilities.

7.2 Suggestions

✓ The state government should work out the primary feasibility report (PFR) of the pipeline canal for Nilwande Project.
✓ Farmers from Akole tehsil have still rigid on their demand for buried pipeline canal instead of the open surface canal, authority should resolve the problem and adopt the pipeline canal.
✓ The state government has also prepaid budgetary provision for the pipeline canals on the lines of the Marathwada water grid.
✓ Maharashtra government has signed a memorandum of understanding with Israeli company, Mekorot Development & Enterprise for drought management and efficient use of water in Maharashtra water grid, likewise MoU should be signed for an implementation of the LBC pipeline canal.
✓ Nilwande and Bhandardara projects are part of the Godavari Water grid, therefore the government should apply pipeline canal for LBC on the priority basis.
✓ The agricultural department of Maharashtra should suggest a new cropping pattern in the command area, considering farmers’ opinion and the present cropping pattern.
✓ All stakeholders of LBC should be aware about the efficient utilization of available water and adopt maximum micro irrigation systems at farm level.
✓ It is possible to supply irrigation water to the Pravara Left Bank Canal in the command area, through the LBC pipeline canal and save tremendous water loss.
✓ Maharashtra government has declared to build a water grid, in drought prone areas, like Gujarat, Madhya Pradesh, Andhra Pradesh and Telangana, it should be implemented immediately.
✓ The pipeline canal gives further scope for diverting surplus water in the different command area in the same geographical area.
✓ Finally, any strategy will not be complete without strong political willpower. Therefore, all political leaders of the study area need to come together and make honest efforts for implementation of pipeline canal.
7.3 Scope for further Study

The present study has made a geographically suitable criteria and a site for the gravitational pipeline canal. With growing demand for water, there is an ample scope for water management. The further study includes the micro level survey of the command area and has divided the total irrigable area into the blocks according to the topographical characteristics. As well as planned for minor pipeline and hydrant at field level. The study has further scope in designing drinking water pipelines for the urban and rural settlements in the command area. Moreover, it has further scope to critically examine the feasibility of the suggested model of pipeline and integrate the civil engineering techniques. Consequently, there is an ample scope for automation and digital management of the canal irrigation.

7.4 Limitation

Despite the satisfactory achievements of the present study, a number of restrictions have been encountered in the work. The present study is mainly based on the geographical approach towards the water management. Therefore, the civil engineering and cost benefit have not been included in the present study. It is concerned about the gradient and diameters of pipeline as per the discharge requirement, material pipes, Valves and regulator types and engineering design of the pipeline. Another limitation is the left bank canal is under construction, therefore, assessing the merits and demerits become difficult and there is no option for the pilot project.

7.5 Conclusions

The ultimate objectives of the study are to attain irrigation efficiency and adopt modernized and sustainable water distribution system. The efficient implementation of any canal system would need to exercise the physiographic potential of the region and to estimate the water requirement at various sectors. The first objective is achieved during the physiographic study of the region. It is important to mention here, the study area has an undulating pattern, which is favorable for an execution of the pipeline canal irrigation system. The second objective of this research work is obtained during the
evaluation of the present canal irrigation system. It is confirmed, that the present canal irrigation system has very low overall efficiency in the context of rising demand for water at different sectors. The study of SCIS and PCIS contribute to prove that, there is an urgent need to adopt a pipeline canal irrigation system in the LBC command area. The fourth objective is achieved using the AHP methodological approach, with the GIS based MCDA systems. The topographic maps of the study region and, spatial resolution Landsat 8 satellite cloud free image dataset have been used for analysis. The statistical correlation technique and experts view have considered for determining the rank of affecting factors. Normalized pairwise comparison matrix and software are used for weighted overlay analysis. The score assigned for the criterion is based on the field survey and reviews of published literature. Hence, the final suitable site for gravitational pipeline canal has been worked out. The clarification of the final objective has highlighted the causes of a wide gap between the IPC and IPU by the conventional irrigation system.

Thus, the major objectives of the present research work are achieved successfully and suggested sustainable gravitational five stage pipeline model. The stage wise implementation of the pipeline model resulted in efficiency, utilization of available water resources and increase an irrigable area in the command area. Ultimately, an equitable and trustworthy, water supply in the command area will be ensures a high productivity and boost the regional economy.

The output of the present research work is useful for researchers, planners and authority, concerned about water management. Farmers in command area will offer, or modify the cropping pattern, instead of the notified cropping pattern, obviously, it will benefit to all stakeholders in the LBC command area.

* Sustainable Modeling of Gravitational Pipeline Irrigation System: A Geographical Focus on Left Command Area of Nilwande Dam in Ahmednagar District

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