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Impact Study of Chamravattom Regulator cum Bridge

Malappuram District

The Report

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Disclaimer

The report has been prepared by the Technical Officers, District Planning Office, Malappuram. The facts and figures in this report are based on primary and secondary data collected by the Technical Officers from District Planning Office, Malappuram and from other sources and it does not reflect the views or policy of Kerala State Planning Board.

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Acronyms and Abbreviations

RCB	- Regulator cum Bridge
CRCB	- Chamaravattam Regulator Cum Bridge
FRL	- Full Reservoir Level
LI	- Lift Irrigation
Nos	- Numbers
CET	- College of Engineering, Trivandrum
IIT	- Indian Institute of Technology
DTPC	- District Tourism Promotion Council
PAO	- Principal Agricultural Officer
Ha	- Hector
BIS	-Bureau of Indian Standards

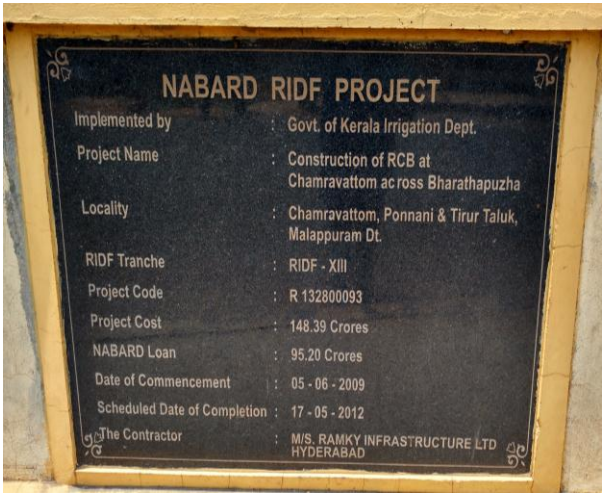
ABSTRACT

The objectives of Chamravattom Regulator Cum Bridge are irrigation, prevention of salt water intrusion to the river from the sea and reducing the distance by road between Kozhikode and Kochi by 38 km. Regulator cum bridge is now just working as a bridge due to technical problems. The present study evaluates the impact of the project in Agriculture, Tourism, Water Supply, Employment Generation and the overall development of the area. Normative survey method has been used for the present study as it involves a process of collecting data from a specific population and the existing data from various departments like agriculture, fisheries, tourism and from various Grama Panchayaths. For the present study, interview schedules and questionnaires are used as tools for gathering primary data from various departments like agriculture, fisheries, tourism and from various Grama Panchayaths. The investigators have also collected primary data from the various beneficiaries of the project like fishermen, farmers & businessmen in the project area and also by visiting the site. The area of agricultural production was increased in Vettom, Mangalam and Purathur Grama Panchayaths after the implementation of Chamravattom project. Except paddy cultivation, an increasing trend is seen in the case of productivity in almost all crops. Salt water intrusion is decreased after commissioning of the project, especially in the upstream of nearby Thriprangode Grama Panchayath. Even though the availability of drinking water is increased in the project area, the availability of drinking water could not achieve as much as the target, due to salt water intrusion. The Project also promotes tourism activities of the locality. Generation of employment and thereby income of the people around the project area have increased considerably after the project.

Chapter I

INTRODUCTION

Chamravattom Bridge also known as Chamravattom Regulator-cum-Bridge is one of the longest bridge in Kerala. The Bridge has 978-meter length and 10.5 m width which is built across Bharathapuza. It is the largest regulator-cum-bridge in the Kerala state. Bridge has 70 shutters. The foundation stone for the project was laid by former Chief Minister VS Achuthanandan on September 13, 2009, and the Bridge was inaugurated by the former Chief Minister of Kerala, Oommen Chandy, on 17 May 2012. Chamravattom project would benefit irrigation, transport, agriculture drinking water supply and tourism.



The road distance between Kochi and Kozhikode stands reduced by 38 km through Bridge, distance between Ponnani-Tirur, Ponnani-Malappuram stands reduced by 20Km, 10Km respectively. The bridge has also helped to reduce the traffic congestion at Edappal, Valanchery and Kottakal towns. Chamravattom regulator cum Bridge has been conceptualizing from early 1977 or 1984 but it has in

dormant position several times. There has been side walls are built across the bridge because there is a possibility of inordinate increase in the water level of the river after the activation of the Chamravattom project. The side walls have built in two shore of the bridge as 1 km and 300 m long to Kuttipuram side and 125 m long along west Ayyappa temple while in other shore 1 km long to Naripparambu side and 150m along west side.

Chamravattom Regulator-cum-Bridge had been developed as a highly perceptible project in the extreme southern state of India. This seems to be the largest of its type in Kerala, India. The project was commissioned at a record pace of two years. The dream behind the 978 mts and 70 shutters of the Bridge cum regulator was that it could provide irrigation facilities to 4000 hectors of agricultural land and drinking water for Tirur - Ponnani Taluks. Sanctioned amount for the project is Rs. 144.65 crores, out of which Rs. 95.12 is from NABARD and the remaining fund is the state plan fund to Irrigation Department. Total fund received from 2009-15 is Rs. 165.53 crores. Work implementaion period is 05.06.2009 to 17.05.2012. The up to date expenditure of the project is Rs. 134.51 crore.

Construction of Regulator Cum Bridge (RCB) is a multipurpose project. The main objective is to evolve sufficient storage for irrigating the gross ayacut area and for meeting the drinking water supply. Another important objective is the effective control of saline water intrusion into the upstream side of regulator. Besides, the river when bridged connecting the two banks, will improve the communication facilities and the employment opportunities in that area. Radial or sluice gates are used in Barrage or RCB to control and raise water levels in their upstream reaches of streams and irrigation canals with mild slopes.

The area housing Chamravattom Regulator-cum-Bridge project is geographically co-ordinate at 10.82085°N 75.959108°E. As an integral part of Chamravattom regulator, this project is geographically crucial who's other name Ponnani-Tirur Bridge is also famous in the region.

The reservoir formed at upstream side of RCB is envisaged to impound 14.20 Mm^3 of fresh water at +4.00 m FRL for stabilizing 4344 hectors of ayacut area for irrigation under 9 Nos of existing L.I. Schemes, and also for providing sufficient drinking water supply to the nearby panchayaths and Tirur and Ponnani Municipalities. It prevents the major problem of salt water intrusion to the upstream side due to tidal effects. Fish farming and Inland navigation are also possible by means of this project. Hence the project opens vide range of employments to the people by participating in all the above activities.

Chamravattom Bridge has provided some disadvantage along with advantage. The main disadvantage comes under the narrow roads on this route. Even the route reduces the duration, though the roads are narrow and damaged, the benefit of reduction of duration actually gets to people only after the development of the route. It has to be said that water near to Chamravattom Bridge has been foul after the making of the bridge. It has made the water to a black colour. According to the people foul is due to improper cleaning of grass land near the bridge while others have the opinion it is due to the blocking of water in Chamravattom regulator. Peoples who are bath on this river has been experiencing itching while bath. Water nearby Nariparambu Pump house also has fouled. The drinking water for Ponnani municipality and nearby places has taken from this pump house.

Peoples have been coming to Chamravattom Bridge to see the largest bridge in Kerala. Tourism department has built variety of projects in the surroundings of this bridge. They have planned to make Chamravattom as the window of tourism in Malappuram by bringing variety tourism projects along Ponnani shore to Kuttipuram costing up to Rs. 100 crore. There is a chance to make tourism project by relating 500 years old Ponnani Juma Masjid, Thirunavaya Nava Mukunda temple, Triprangod temple, Alathiyoor Hanuman Kavu etc and Beeyam Kayal, Tirur Thunjan Parambu, Kanoli Kanal, Nila Park, Padinjarekkara tourism Park. Tourism department have planned to start boating by utilizing the water availability in Nila and planned to build Nila heritage village. Heritage will consist of Museum, Art gallery, Sports complex and convention centre. Whatever happens in projects one thing is sure that the Chamravattom Bridge will open a lot of job opportunities to nearby people.

1. Present Status of the Project

When the 70 Nos of shutters were closed for storage of water on the Ist November 2012 during trial run; the water level raised up to +3.75m on 10.11.2012, Piping was observed on some spans under Solid Aprons. This is mainly due to huge quantity of sand mining in the downstream of RCB. In the Technical Committee meeting, it is decided to ban sand mining from the project area and downstream side. Temporary measures were carried out to stopping the Piping by Pumping sand and broken stones to the Voids, and water were stored up to +3.50m till at the end of that summer season.

The same problem of piping effect was observed in the next summer season at 2013-14 also. The water can be stored only after rectification works to prevent the piping effect permanently. Out of the 70 shutters, 14 in the left side and 10 on the right side are closed and the remaining shutters

are fully open. Even after closing of the 44 shutters, due to the construction of CRCB, there is a dead storage capacity of 1.5 m. A temporary measure was taken by laying stones, but it vain.

Government instructed to prepare a technical report regarding the causes of piping and proposal for permanent rectification measures, after conducting detailed technical studies by reputed agency like College of Engineering Thiruvananthapuram or Thrissur.

The experts from CET Thiruvananthapuram has visited the site and conducted field studies and soil investigation tests and a design have been prepared.

Apart from that the Government decided to refer the matter to IIT, Delhi for getting expert technical opinion to find out a permanent solution to this piping phenomenon.

Accordingly two technical experts from IIT, Delhi visited the site on 14.07.2015 and discussed the matter in detail. Expenditure estimated for their study is Rs. 57.00 lakhs. It is decided to make payments in 4 instalments.

2. Need and Significance of the of Study

The main objective of the project is for irrigation and reducing the distance by road between Kozhikode and Kochi by 38 km. This RCB effectively helps to prevent salt water intrusion to the river from the sea due to tidal effects. The Project also promotes tourism activities of the locality. A project named "Chamravattom Puzhayora Snehapatha" by the Department of Tourism is now opened for public. Regulator cum bridge is now just working as a bridge due to faulty construction. There is also allegation that sand for construction was taken from river without payment for the same. In this backdrop, it is important to study the impact of the project in its stated objectives.

3. Scope and Objectives of the Study

The present study evaluates the impact of the project in Agriculture, Tourism, Water Supply, Employment Generation and the overall development of the area. The specific objectives of the study are:

- To assess the increase in agricultural production and additional area brought under cultivation.
- To assess the variation in salt water intrusion before the implementation and after commissioning of the project.
- To assess the impact on the availability of drinking water after commissioning of the project.
- To assess the impact on income generation through Tourism and Fishing in the project area after the commissioning of the project.

4. Methodology

Methodology is the procedure or techniques adopted in research and it occupies a very important place in any types of research. A suitable method helps the researcher to explore the diverse strands of the study and adequately measures them so as to satisfy the requirement.

4.1 Method adopted for the study

As the present study involves a process of collecting data from a specific population and the existing data from various departments like agriculture, fisheries, tourism and from various Grama Panchayaths, the normative survey method is most appropriate.

Survey method is very useful in getting descriptive data which people can contribute from their own experience. It is the best means through which opinions, attitudes, suggestions for improvement of instruction and such other data can be obtained.

4.2 Tools used for the study

For each and every type of study we need certain instruments to gather new facts or to explore new fields. The instrument thus employed as a means is called a tool. For the present study, interview schedules and questionnaires are used as tools for gathering primary data from various departments like agriculture, fisheries, tourism and from various Grama Panchayaths. The investigators have also collected primary data from the various beneficiaries of the project like fishermen, farmers & businessmen in the project area and also by visiting the site. The investigators have also collected secondary data to conduct study from the existing records of various departments like agriculture, fisheries, tourism and from various Grama Panchayaths by using various tables and proformas.

4.3 Sample for the study

Sampling is the process by which a relatively small number of individuals, objects or events is selected and analysed in order to find out something about the entire population or universe from which it was taken. The term sample refers to a small group of individuals taken from a large population.

The study initially draws a large sample from nearby area from various categories of beneficiaries. The objectives envisaged in these programmes, time, cost factors shall be noted. By examining the records in the related offices, many of the information regarding this would be obtained.

The sample for the present study consists of 10 households from the project affected Grama Panchayaths, 5 fishermen from the each projected affected Grama Panchayaths and 10 business men from the project area.

4.4 Statistical Techniques Used in the Study

The data collected were analysed using statistical techniques such as percentage & graphs. Percentages were calculated for each item for deciding the proportions of various beneficiaries giving the responses.

4.5 Administration of Tool and Collection of Data

The present study is intended to study the impact of Chamravattom Regulator-cum-Bridge on agriculture, drinking water, tourism & fishing in achieving its stated objectives. The investigators from the District Planning Office, Malappuram visited the various Grama Panchayaths which has direct or indirect benefits from the project and collected relevant details from various beneficiaries. The investigators had a discussion with the Secretary- DTPC,

Malappuram, Deputy Director - Fisheries, Malappuram and Principal Agricultural Officer, Malappuram. The investigators were fortunate enough to receive sincere co-operation from all members. Field surveys were conducted in both upstream and downstream sites of Chamravattom RCB.

Personal interactions were made with local people living around the sampling sites and gathered information about water quality, crop yield, ground water level, salt water intrusion and socio-economic status. The investigators have also conducted feedback survey among beneficiaries based on structured questionnaire from randomly selected sample. The investigators could collect information by examining the available records in the various departments.

Chapter II

REVIEW OF RELATED LITERATURE

Review of related literature plays a significant role in any piece of research work. It is a careful review of the professional journals, books, dissertations and other sources of information. It is a prerequisite to actual planning and execution of any research work. Every research project should be based on all of the relevant thinking and research that has proceeded.

In any worthwhile study, the research worker needs an adequate familiarity with the literature available in the field of research. Hence an attempt was made to collect the literature available in the area. Following are the studies reviewed here to get an adequate familiarity with the available literature.

Abdul Hakeem.V.M and his students from Kelappaji College of Agricultural Engineering and Technology, Kerala Agricultural Universities, Thavanur, Kerala, India (2008) had conducted a study on the Kootayi RCB, Tirur, Malappuram District, Kerala. They analyzed the changes brought by the RCB in that area including the pollution in upstream area, increasing in irrigation facility and thereby increase in production of 40% etc.

The study deals with the impact of Kootayi RCB, Tirur, Malappuram District, Kerala with the specific objectives of determining the impact on water quality, agriculture and transportation. The study was conducted in the areas of influence of Koottayi RCB in Malappuram District of Kerala. Water analysis and field survey were conducted for evaluating the effect of RCB on soil characteristics and water quality.

The study analyzed the quality of water which pertains to electrical conductivity, oxygen content, salinity, pollutants and the raise in ground water table. The result of the study reveals that electrical conductivity of water samples at the upstream of Kootayi RCB are within the desired range and in the downstream reach, the main problem faced by the people is poor quality drinking water due to salt water intrusion and it indicates that the salt water intrusion could be successfully prevented by the RCB in the upstream reaches. More fresh water is available for irrigation and drinking in the upstream reaches, hence the RCB is successful in preventing the salt water intrusion. Study also reveals the increase in bacterial pathogens indicating the water is polluted which is mainly due to stagnant layers of impounding water in the upstream due to the closing of shutters, which prevents the natural flushing action of river. Amount of dissolved oxygen were below normal level (5gm/l) leads to the death of fish population in the upstream reach. Study also revealed that ground water table is raised considerably thus irrigation facilities increased and results in the increased production in agriculture.

Even though Kootayi RCB, Tirur, Malappuram District, Kerala has numerous positive impacts, at the same time, it has negatively affected the quality of water due to the restrictions of nature flushing action of the river. A layer of water at upstream of RCB has become stagnant and accumulated the pollutants.

M.P.Ajith, MSc Student, the Department of Biology, Gandhigram Rural Institute, Deemed University, Dindigul , Tamilnadu and Melvin K Games, MSc Student Department of Physics, St.Josphs College P.G and Research Centre Banglore. (2016) had conducted a study on the Chamaravattam RCB, Malappuram District,Kerala, They analyzed the change brought by the RCB in that area. They

found the salinity intrusion of the upstream area is successfully prevented by the Chamaravattam RCB. But in downstream areas salinity balance of the river is affected and even the water in wells became saline and there by drinking water affected. The salinity intrusion also effect breeding of fishes negatively.

The result of study reveals that even though Chamravattom RCB has numerous positive impacts, it at the same time negatively affected the quality of water due to the restriction of natural flushing action of the river. The study also reveals that electrical conductivity values are within the limit, which shows the salinity intrusion of the upstream area is successfully prevented by the Chamravattom RCB. But in the downstream areas, the salinity balance of the river is affected and even the water in wells became saline and thereby drinking water affected. The microbial analysis reveals the increase in bacterial pathogens. The elemental analysis reveals that the concentration of minerals is much lower than the desired values. The dissolved oxygen is lower than the normal limit which can adversely affect the fish population. By the establishment of Chamaravattam RCB Project, availability of water is increased for irrigation and there by an increase of 45% of agricultural production is obtained. Even though the RCB has many positive impacts they were also focus on negative impact of RCB and the result insist the necessity of thorough study to uptake remedial measures and to overcome these negative impacts.

Both of the above analysis is done by testing the quality of water by scientific test. Data regarding agriculture, irrigation, fisheries, tourism etc are not mentioned in the studies. Only a scientific approach of water quality test is done. In this study data is collected by primary and secondary methods. Questionnaires are prepared and data collected from 75 families and connected departments and Local Self

Government Institutions. Afield level study is conducted to find out the ground level issues.

Balachandran Pillai G studied the ground water table fluctuation and its effect on salinity intrusion, ground water availability and its utilization pattern and quality of ground water for drinking and other purposes in the coastal belt of *Chamravattom-Ponnani* region of Malappuram District. The study was conducted in six regions viz. Biyyam, *Puzhambram*, *Chamaravattom*, *Kadavanad*, Ponnani and *Puthuponnani*. The impact of socio-economic changes on salinity intrusion were identified and alternate strategies for better utilization of available water sources in coastal areas were also suggested.

The depth of water table in 41 observation wells was recorded once in 20 days (in monsoon season) and once in 10 days (in summer season). The ground water draw down was high in *Chamravattom* region (4.35 m below ground level) followed by *Puzhambram* and Biyyam. The yearly mean ground water table fluctuation observed in *Chamravattom* was 3.86 m followed by *Puzhambram* (2.75 m).The study reveals that there exists a definite relationship between water table fluctuation and TDS. In some places (Biyyam and *Kadavanadu*), the TDS content was very high throughout the year.The TDS content observed in Biyyam region during summer period was more than seven times the maximum permissible limit (500 mg/l) in drinking water. The quality analysis of water samples show that the water in Chamravattom region is more suitable for drinking purpose compared to other five regions. The TDS content was less in Ponnani and *Puthuponnani* region though they are very near to the sea compared to other regions. This is due to the geological characteristics of the region.

The utilization of ground water is more in *Chamravattom* region (1.16 MCM). In *Puzhambram* and *Biyam* region, the percentage utilization of available ground water is very less, due to the contamination of well water. Only 16.8% of the available ground water was utilized by the people in *Puzhambram* region. The total availability of ground water in *Chamravattom*-Ponnani coastal belt is calculated to be 9.88 MCM, out of which 3.0 MCM is been utilized. The percentage utilization of available ground water resources in this region is only 30%.

Due to increased population density, the fresh water bodies such as ponds, stream tributaries etc… were transformed into dry land. In Ponnani municipality, extend of paddy cultivation has reduced from 104 ha to just 6 ha in the past 25 years. The fresh water storage structures such as *cheeps* (VCBs) built across *Kanjiramukkuppuzha* and *Kannoli* canal were destroyed due to human interventions. The transformation of fresh water bodies into dry land enhanced the depletion of ground water table and thereby increasing the salt-water intrusion. About 30% of the people in Ponnani Municipality are lacking proper latrine facility, which is also a reason for the contamination of water in *Kannoli* canal and *Kanjiramukkuppuzha*. The study reveals that the salinity intrusion and contamination of well water enhanced the following major changes occurred in the past years.

i) Drastic increase of population density (population density of the region is 5555per square kilometre).
ii) Over exploitation of ground water by digging more open wells to meet demand of the growing population.
iii) Transformation of paddy lands for other purpose (in Ponnani municipality alone, paddy cultivation has reduced to 6 ha from 104 ha during the past 25 years).
iv) Filling up of ponds, natural streams in between the dry lands and other water storage structures.

v) Out migration of sacred groves and other soil and water conservation plants such as vetiver, *panthanus* etc.
vi) Damage/removal of vented cross bars (cheeps) in *Kanjiramukkupuzha* and *Kannoli* canal.
vii) Lack of proper repair and maintenance of the vented cross bars (cheeps) across the natural streams flowing in between the dry lands in *Kadavanad*, Biyyam and *Puzhambram* region.
viii) Water logging in low-lying area during monsoon season due to the filling up of natural drainage channels.
ix) Lack of proper toilet facilities for about 30 percent of population in Ponnani municipality.
x) Accumulation of waste from houses, hotels, factories, hospitals, coir mills, fish and meat market, fruits and vegetable shops, fish drying yards etc. in roads, *Kannoli* canal and other public places.
xi) Exposure of outlets of toilets and drainage system into *Kannoli* canal from the houses located on the banks of canal. Digging open wells very close to septic tank and cemeteries due to the lack of awareness and limited space.

The study suggested the following alternate strategies for better utilization of available water resources.
i) Rainwater harvesting to recharge ground water
ii) Roof top rainwater harvesting structures
iii)Construction of Vented Cross Bars (VCBs) in *Kanjiramukkupuzha*, *Kannoli* canal and other streams in the area
iv) Conservation of sacred/natural groves, ponds and natural streams
v) Controlled pumping to eliminate or reduce over draft to protect water quality. That is, maintain proper balance between water being pumped from the aquifer and the amount of water recharging.
vi) Conjunctive use of surface water and ground water.
vii) Control the number of wells per unit area.

viii) Proper awareness campaign to prevent construction of wells very close to the septic tank and cemeteries.
ix) Suitable solid waste management systems has to be implemented in Ponnani municipality in order to avoid the accumulation of waste from households, hotel, factories, coir mills and fish and meat markets on roads and other public places.
x) Necessary toilet facilities has to be provided for the 30 % of the population, who are lacking the facilities at present, in order to avoid the accumulation of human waste in canals (mainly *Kannoli* canal) and other public places. Latrines can be constructed with common septic tank for 10-15 families in colonies.
xi) Avoid the exposure of drainage channels from septic tanks, houses and hotels into the *Kannoli* canal.
xii) Provide suitable drainage facilities in low-lying areas to avoid water logging.
xiii) Mulching has to be done with plant residues and other organic wastes for coconut and other crops, so that moisture can be retained in the soil during dry periods.
xiv) For drying of fish, fish drum or '*choola*' has to be introduced to prevent the contamination of air and water through the traditional method of fish drying.

Basak and Nazimudhin (1984) conducted a study on the behavior of ground water in coastal belt of Malappuram district. The study was carried out through 41 permanent observation wells set up, by the ground water division of CWRDM, Kozhikode. Depth to ground water table and water quality parameters were recorded during pre-monsoon (April-May), monsoon (July-August) and post monsoon (December-January). The ground water utilization and present ground water use pattern along the coastal belt of the district were estimated. Ground water availability was calculated by multiplying the mean ground water level fluctuation with the area over which these mean fluctuations

occur and the assumed specific yield of 0.20. The utilization of ground water in the area was found out by multiplying well density with the average draft in litres/day/well and corresponding area of each zone. The study concluded that the percentage utilization of ground water in the coastal belt was 20 per cent.

A case study was made by Singh H.P. & M.R. Sharma (2013) to assess the performance of irrigation water management of Lift Irrigation Scheme Sirsa Manjholi in Solan area of Shivalik Himalayas. The study was carried out from June 2010 to June 2011. The study has pointed out that the physical performance of lift irrigation scheme is poor. The construction of this scheme has not resulted in any change in cropping pattern of the command area. There are no permanent diversion head works to divert the river water. The water level of the river is going down day by day due to rampant mining of the river bed material. The Krishak Vikas Sangh is non-functional and there is little involvement of farmers in water management of the scheme. The water charges are a very low and that too are not being collected.

Evaluation of the technical functioning and the practical management of Lift Irrigation Scheme Sirsa Manjholi with regard to sustainability was an important aspect of the methodology. The secondary data were collected from estimates, reports, and returns of Irrigation and Public Health Department, and other offices and Departments of Government.

The study has been noticed that although the KVS were registered but they were nonfunctional for all practical purposes. In absence of any schedule of rotation of water, it was common for farmers to divert water to their fields and take water for much longer than is due to them. The underground pipes were cut by the farmers at many locations

to create leakages which were used for irrigation. The quantity of water as well as its timeliness was a major issue for the farmers of second stage as the farmers of first stage use more water, more frequently than their share. The inadequacy and non-timeliness of irrigation water has given rise the need of private irrigation systems in the form of bore wells. More number of private tube wells has been observed in the area where there was problem in availability of water. And in the command of this scheme there were 35 private tube wells which were well maintained and water was sold also to the farmers who did not own a tube well. The study has concluded the following.

The construction of this scheme has not induced any change neither in cropped area nor in the cropping pattern of the command area. Thus the irrigation system has yielded the low returns and the performance of lift irrigation scheme was not satisfactory. There were no permanent diversion head works of the scheme. The water course of the river Sirsa, which is source for this scheme, is changing frequently and its bed level is going down year after year due to rampant mining of sand, gravel and stone as there is heavy construction activity in the near vicinity. The study has shown that the involvement of the farmers in planning and management of scheme is minimal as the KVS is non-functional. The 22.6% of area is not getting any water from the scheme. The remaining area i.e 141.81 hectare is getting water only in July to December months because the water level in river goes down in other months and it is not possible to lift water for the scheme. The cropping intensity was found 198.90%, 203.28% and 187.34% during 1990 (almost after a decade of construction of irrigation scheme), 2000 and 2010 respectively. This mix change was due to installation of number of private tube wells in the command area of the scheme. It was also noticed that the water tariff rates being charged in Himachal Pradesh are very low and that too are

not being collected by the Government. The following recommendations can be made on the basis of study.

On technical and economic grounds, it is suggested that the command area of any lift irrigation schemes should be determined on the basis of topographic features. Further, an undulating land demands a small irrigation set-up for effective performance. To overcome problem of lowering of Sirsa River bed level to non-lifting level of water at the water pumping site from January to June it is suggested that suitable permanent diversion structure be constructed and feeder channel be lined. There should be enforcement of Mining Act to check rampant mining of river bed material. To tackle the problem of soil erosion and gully formations in the command area of this scheme, the construction of small check dams and other vegetative treatments need to be taken up. For the economic well-being of a majority of the farmers, the intensification and diversification of agriculture is required which can be achieved through farmer's participation and imparting extension services by Irrigation and Public Health Department and Agriculture Department.

Nazimudhin and Basak (1998), reported the ground water availability and utilization in the coastal shallow aquifer at Aleppy district. The observations were carried out through the observation well network set up by C W R D M, Kozhikode. Ground water levels and its fluctuation and extent and pattern of ground water availability and utilization in the coastal belt of the district were studied and they concluded that there were three main ground water fluctuation zones along the coast with the annual fluctuation of 0.50, 1.00 and 2.00m.The total ground water availability in the top unconfined aquifer along the entire Alleppy coast was 39.59 million cubic meter and average utilization was of the order of 42 percent through an estimated number of 39,400

open wells scattered over the coast. Studies also showed that, seawater had an effect up to 150 m from the shore.

Wu et al; (1993) observed the seawater intrusion in the coastal area of Laizhou Bay. The study was conducted in two observation wells (No1&No.2) since from 1985. They reported that because of the excessive pumping of ground water from the coastal aquifer, ground water level in the study area have been dropping steady and the water table in the part near to the coast has become lower than the adjacent sea level, thereby giving rise to sea water intrusion. Now the transition zone (mixing zone) was increased up to 1.5-1.6 km wide. In 1985, the chemical quality of ground water from the No.1& No.2 pumping wells was very good. Chloride concentration was less than 70 mg/lit. But the chloride concentration was increased to 1700 mg/l in No.1 pumping well, 520 mg/lit. in the No.2 well on January 3, 1988 and 5140 mg/lit in the No.1 pumping well, 3500 mg/lit in No. 2 pumping well on December 20, 1989.

Nazimudhin and Basak (1998) reported the ground water resources in the coastal belts of Kerala. More than 400 observation wells in the various coastal belts of different districts were established for the study. Ground water levels and quality have been monitored for 3 to 4 years. Sample surveys were also carried out in each district for studying the ground water availability and utilization pattern. In each district, 2 sample areas of approximately 1 square kilometer were first identified and they were chosen based on the accessibility of the area, nearness to the shore, population density and distribution of wells in the area. The total availability of ground water was estimated as 454 million cubic meter, out of which 150 million cubic meter of ground water was utilized. Low pH, high iron content, high hardness, high TDS (total dissolved solids) and salinity were the common quality problems identified in the study area. The

study also revealed that the width of sensitive zone for seawater in the various coastal belts vary from 100 to 500 m from the shore.

Jason (1993) explained about the salt-water intrusion caused by excessive pumping. The study conducted in the city of Laizhou in 1971, and in Longkou in 1979 illustrated that excessive pumping of ground water in these areas had caused salt-water intrusion. In the beginning the observations were taken from some specific, isolated spots (0.5km^2). Eventually the intrusion area spreads as increases in agriculture and industry persisted. In 1979, the salt-water intrusion area covered 16km^2, 39km^2 in 1982, 71km^2 in 1984, 196km^2 in 1987. By 1989, the salt-water intrusion area became a continuous zone covering an area of 238 km^2 in Laizhou. In the 1970's, the salt water intrusion area in the southwestern part of the study area increased by 4km^2 in each year. In the early 1980's, this number increased to 11.1km^2, and after the mid-1980s to 30km^2. This rapid increase reinforces the need for proper monitoring and controlling methods for salt-water intrusion. He suggested that recharge wells, recharge basins and barrier wells were very useful in maintaining the proper equilibrium between ground water recharge and pumping.

The above review of related literature makes it clear that there are some studies about the salt water intrusion, ground water availability and quality of ground water for drinking after the construction of regulator cum bridges. But effort has not been made to study the economic impact of regulator cum bridges. Thus, the review highlights the need for special research in this area too. Hence, the investigators made an attempt.

Chapter III

ANALYSIS

Analysis and interpretation of the collected data is the major step in the process of any study. The mass of data collected may be in raw form. It needs to be systematized and organized for meaningful analysis. The data collected from various sources are analysed under the following headings.

I. Agriculture & Irrigation
II. Salt Water Intrusion
III. Availability of Drinking Water
IV. Income Generation through Tourism and Fisheries

I. AGRICULTURE & IRRIGATION

The main objectives of the Chamravattom project were creating adequate irrigational facilities for agricultural farmers, preventing salt water intrusion to the river, reducing the road distance between Kozhikode and Kochi by 38 km. In the present study, one of the main objectives is to assess the increase in agricultural production and additional area brought under cultivation. For evaluation study, primary data are collected from four Grama Panchayats nearby Chamravattam area i.e., Thirunavaya, Thavanoor, Mangalam and Thalakkad and secondary data are collected from the Principal Agriculture Office, Malappuram relating to crop area under cultivation and production in four Grama Panchayaths namely Thavanur, Kalady, Tripangode and Thirunavaya.

The major crops like Paddy, Coconut, Vegetables (Cowpea, Chilli, Brinjal, Tomato, Ash gourd, Pumpkin, Pulses, Cucumber, Bitter gourd, Ginger etc.), Banana, Pepper, Tapioca are cultivated in these area before and after the Chamravattom Project. There is no change in pattern of cultivation before and after the implementation of the project

since majority of the farmers follow the same crop pattern of cultivation. The Project has been implemented on May 2012.

Analysis is done on the basis of following information collected

1. Availability of irrigation facilities before and after the implementation of Chamravattom Project– Primary Data.
2. Changes in irrigation facilities after the implementation of Chamravattom Project– Primary Data.
3. Impact on Production sector after the implementation of the Chamravattom Project– Primary Data.
4. Excess Benefits after the implementation of the project– Primary Data.
5. Crop wise details and Chamravattom project (2011-12 to 2014-15) – Primary Data.
6. Secondary data collected from the Principal Agriculture Office, Malappuram relating to crop area under cultivation and production.

1. Availability of Irrigation Facilities

Before the implementation of the project, 79.41% irrigation facilities are available to agriculture and allied activities. After the implementation of the project, there is a slight increase in irrigation facilities i.e., 85.29% as it is shown in the Table 3.1.

The Chamravattom area is predominantly agriculture based land area and majority of the land is being utilized for agricultural purposes. As far as the sample survey is concerned, before the implementation of the project, out of 34 respondents, all of them replied that they are actively participated in paddy cultivation. They mainly cultivated mundakan and virippu. Even though irrigation facilities are increased from 79% to 85%, in paddy cultivation is decreased by 2% after the implementation of the project. Before the implementation of the project, 50% of the farmers were engaged in agricultural activities during the whole season but after the implementation of the project there is a slight decrease from 50% to 41% in engaging agriculture during the whole season.

Table 3.1
Availability of irrigation facilities

Items	Before Chamravattom Project		After Chamravattom Project	
	Yes	No	Yes	No
Irrigation facilities are available to agriculture	79.41	20.58	85.29	14.71
Agriculture cultivation is possible during the whole season	50	50	41.18	58.82

(Source: Sample survey)

2. Changes in irrigation facilities after Chamravattom Project.

There is no drastic changes in irrigation facility is being reported in sample survey. Only 50% of the farmers were replied that they have got additional irrigational facilities to agriculture after the implementation of the project at the same time 50% argued that they have not get any additional irrigation facilities than before the project. It is shown in the Table 3.2.

Table 3.2
Changes in irrigation facilities after Chamravattom Project.

Response	Frequency	%
Yes	17	50
No	17	50

(Source: Sample survey)

3. Impact on production sector after the implementation of the Chamravattom Project.

The Chamravattom Project has created a positive impact on agriculture production. As far as survey is concerned, 58.82 % of the farmers admitted that agriculture production had increased while 41.18% replied that there is no change in production after the implementation of the project. It is shown in the Table 3.3.

Table 3.3
Impact on Production sector after the implementation of the Chamravattom Project

Response	Frequency	%
Yes	20	58.82
No	14	41.18
Total	34	100

(Source: Sample survey)

4. Excess Benefits after the implementation of the project

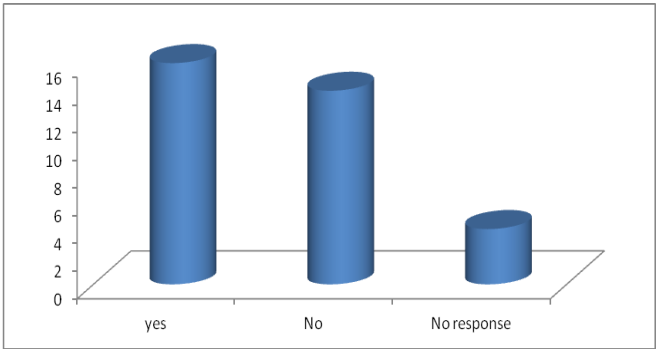
After the implementation of the project, 47.1% of the farmers were admitted that the project has been benefitted to agriculture by creating additional irrigation facilities and more land area is used for agriculture purposes. But 41.18% of the farmers replied that there is no additional benefit is created after the implementation of the project and 11.72% of the farmers not responded to the question which is depicted in Table 3.4 and Figure 3.1.

Table 3.4
Excess benefit after the implementation of the project.

Response	Frequency	%
yes	16	47.10
No	14	41.18
No response	4	11.72
Total	**34**	**100**

(Source: Sample survey)

Figure 3.1
Excess benefit after the implementation of the project.



(Source: Sample survey)

5. Crop wise details and Chamravattom projects (2011-12 to 2014-15)

Crop wise details collected from primary data are analysed on the basis of the following 3 items.

A. Agricultural land area under cultivation (in acres)
B. Agriculture production (in tons)
C. Irrigated land area under cultivation (in acres)

A. Crop-wise Cultivation Area (2011-12 to 2014-15)

1. Paddy

The area under paddy cultivation has increased over the years (2011-12, 2014-15) especially after the implementation of the chammaravattam Project. The following table 3.5 and figure 3.5 depict that paddy cultivation has steady increasing trend over the years. Before the implementation of the project, during 2011-12 the total agriculture land area was 32.75 hectors while it has increased to 48, 49 and 53 acres during 2012-13,2013-14 and 2014-15 respectively.

2. Banana and Tapioca

In case of banana and tapioca cultivation, there is a reduction of land area used for the purposes. During 2011-12, Banana was cultivated in 7.6 acres of land while it has decreased during 2012-13 and 2013-14 ie., 2.1 and 1.85 acres of land respectively. Later, banana cultivation has increased to 3.6 acres during 2014-15 as shown the following figure and table. The area used for tapioca cultivation is very little compared to other crops and land area is reduced to .60 acres during 2012-13 and 2013-14 after the implementation of the project at the same time used for the same purpose was 1.1 acres before the cultivation of the project.

3. Vegetables and Coconut

Vegetable production area shows an increasing trend immediately after the implementation of the project ie., 4.35 and 5.05 acres during 2012-13 and 2013-14 respectively and then it has decreased to 4.85 acres during 2014-15. Before the implementation of the project, vegetable cultivation area was merely 2.7 acres during 2011-12, it is shown in table 3.5 and figure 3.3.

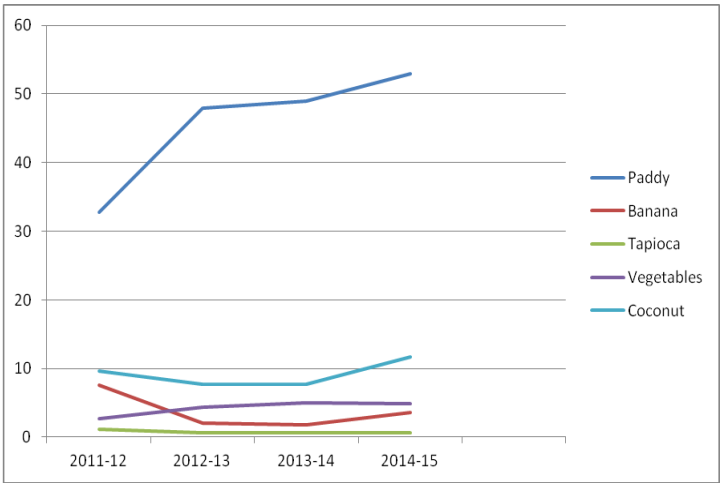
The area of coconut palm cultivation has shown a decreasing trend immediately after the implementation of the project. Before the project, the area used for coconut palm cultivation was 9.68 acres during 2011-12 and it reduced to 7.68 acres during 2012-13 and 2013-14. But it has increased to 11.68 acres during 2014-15 as shown in table 3.5 and Figure 3.2

Table 3.5
Agricultural land area under cultivation (in acres)

Crops	2011-12	2012-13	2013-14	2014-15
Paddy	32.75	48.00	49.00	53.00
Banana	7.60	2.10	1.85	3.60
Tapioca	1.10	0.60	0.60	0.60
Vegetables	2.70	4.35	5.05	4.85
Coconut	9.68	7.68	7.68	11.68

(Source: Sample survey)

Figure 3.2
Agricultural land area under cultivation (in acres)



(Source: Sample survey)

B. Crop-wise Agriculture Production.

Chamravattom Project has a positive impact on agricultural farmers especially to paddy cultivators. The following table 3.6 and figure 3.3 illustrate that paddy production has increased over the years. It is an increasing trend after the implementation of the project. Before the implementation of the project, paddy production was 65.83 metric tons during 2011-12. Paddy production was increased immediately after the implementation of the project. Paddy production has increased to 74.88, 90.26 and 95.4 metric tons during 2012-13, 2013-14 and 2014-15 respectively. The production of Tapioca and Coconut were not increased after the implementation of the project as shown in the figure below.

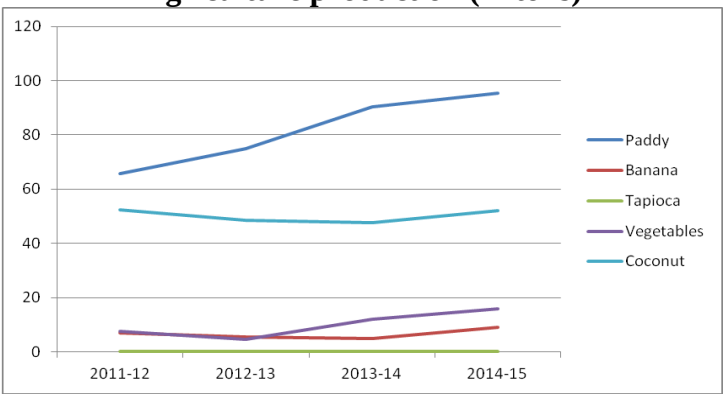
Vegetable production has decreased immediately after the implementation of the project ie.,4.7 tons during 2012-13. It was 7.6 tons during 2011-12. After that vegetable production has an increasing trend ie, 12 and 16 tons during 2013-14 and 2014-15 respectively which has been clear from the table and figure below.

Table 3.6
Agriculture production (in tons)

Crops	2011-12	2012-13	2013-14	2014-15
Paddy	65.83	74.88	90.26	95.40
Banana	7.00	5.40	5.00	9.00
Tapioca	0.01	0.09	0.05	0.01
Vegetables	7.60	4.70	12.00	16.00
Coconut	52.29	48.44	47.60	52.20

(Source: Sample survey)

Figure 3.3
Agriculture production (in tons)



(Source: Sample survey)

C. Irrigated Land Area

As far as the sample survey is concerned, the major achievement gained through the Chamravattom Project is paddy cultivation. Before the implementation of the project, irrigated land area for paddy cultivation was 50.25 acres during the year 2011-12. The irrigated area for paddy cultivation has increased after the implementation of the project. It can be seen from the following table 3.7 and figure 3.4 as 58.25, 61.25 and 66.25 during the year 2012-13, 2013-14 and 2014-15 respectively.

In case of Banana cultivation irrigated land area has increased only in the year 2014-15 to 3.8 acres of land. But irrigated area has decreased immediately after the implementation of the project ie, 2.1 and 1.95 acres of land during the year 2012-13 and 2013-14. At the same time, irrigated land was 2.35 acres of land before the implementation of the project.

Irrigated land area for vegetable cultivation has increased immediately after the implementation of the project. As shown in the table 3.7 and figure 3.4, it has increased from 2.8 to 3.05 acres land during the year 2013-14 to 2014-15.

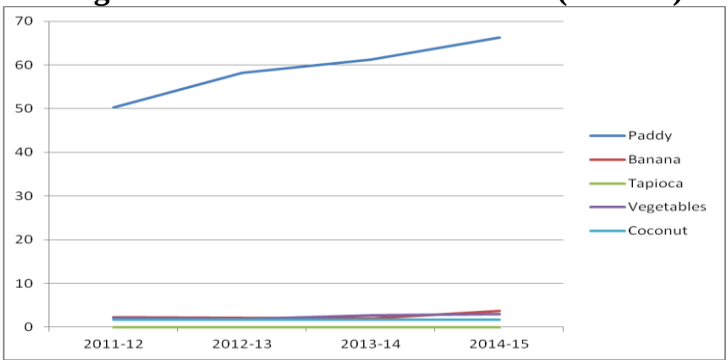
There is no change in irrigated land area for coconut palm cultivation. It remains constantly as 1.7 acres of land over the years.

Table 3.7
Irrigated land area under cultivation (in acres)

Crops	2011-12	2012-13	2013-14	2014-15
Paddy	50.25	58.25	61.25	66.25
Banana	2.35	2.10	1.95	3.80
Tapioca	0.01	0.01	0.01	0.02
Vegetables	2.10	1.85	2.80	3.05
Coconut	1.70	1.70	1.70	1.70

(*Source: Sample survey)*

Figure 3.4
Irrigated land area under cultivation (in acres)



(*Source: Sample survey)*

6. Analysis of Secondary data collected from Department of Agriculture on crop wise agricultural land area and production

Apart from primary data, secondary data are also used for the analysis of this evaluation study. For this purpose, secondary data are collected from Principal Agriculture Office, Malappuram, which comprises of the details of agricultural land area and production in four local bodies located nearby Chamravattom project namely Thavanur, Kalady, Tripangode and Thirunavaya.

While analyzing secondary data it can be seen that extent of paddy cultivation is decreased from 933 hectares to 695.15 hectares over the period 2011-12 to 2014-15. There is a declining trend after the commissioning of the project. This can also be interrupted as a general trend of decreasing paddy cultivation area in the entire state. Similarly, productivity is also decreased during the period in the case of paddy.

In the case of coconut, even though the extent of cultivation is decreased from 2057 to 2002 hectares, productivity is increased from 5571.17 metric ton to 7632.22 metric ton. In the case of vegetables, banana and pepper both production and productivity have shown an increasing trend, ie., respectively 46.5 ha to 89.1 ha, 114 to 117.6 ha and 33.5 to 45.7 ha in the case of extent of cultivation. In the case of productivity, they are respectively 421.5 to 501, 927 to 1325.7 metric tons and 14.25 to 31.71 metric tons.

There is a contradiction in the case of primary data and secondary data in the case of paddy cultivation, but in all other crops an inclining trend in the case of productivity is seen in both primary and secondary data.

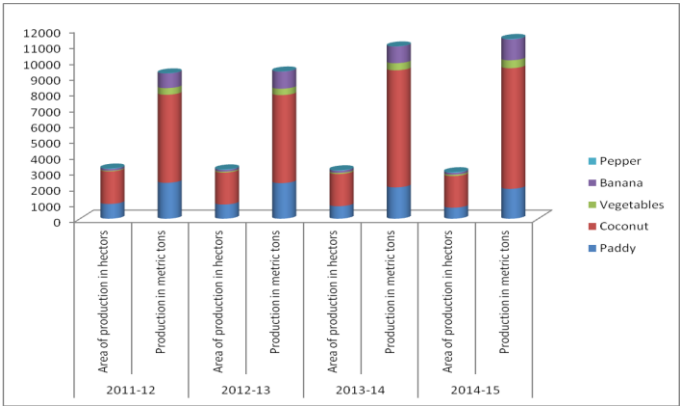
Generally we can arrive at the conclusion that the project has helped to improve the irrigation facilities and thereby an increase in agriculture production.

Table 3.8
Details of agricultural land area (in hectors) and Production (in tons)

Crops	2011-12		2012-13		2013-14		2014-15	
	Area of production (in hectors)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)
Paddy	933	2269	898	2251	788.5	1981.5	695.15	1889.5
Coconut	2057	5571.7	2021.09	5568.11	2040	7406	2002.2	7632.22
Vegetable	46.5	421.5	59.64	404.49	75	450	89.1	501
Banana	114	927	112.72	1086.04	132	1057.5	117.6	1325.7
Pepper	33.5	14.25	35.22	14.36	36	14.6	45.7	31.71

(Source: PAO, Malappuram)

Figure 3.5
Details of agricultural land area (in hectors) and Production (in tons)



(Source: PAO, Malappuram)

Data of two local bodies (Thavanur and Thirunavaya)

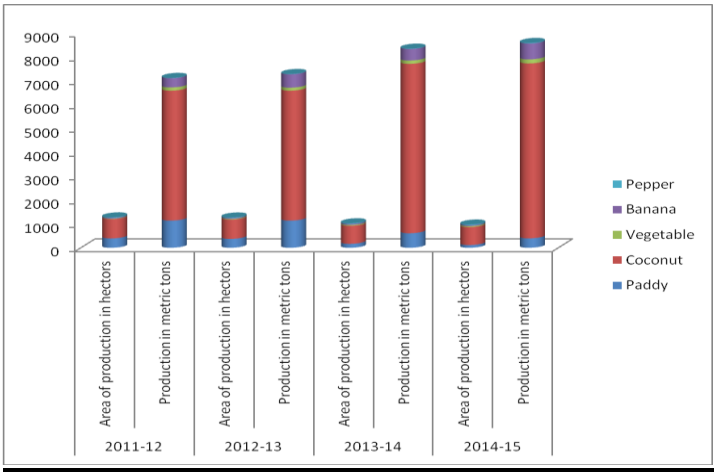
While comparing two Grama Panchayaths i.e Thavanur and Thirunavaya which are commonly taken in to the primary and secondary analysis, it can be seen that the extent of area of paddy cultivation decreased from 193 to 115 Ha.and productivity also decreased from 1139 to 395 metric ton. In the case of coconut, area of production and productivity decreased from 810 to 755 Ha and 5450 to 7335 metric tons respectively. In the case of vegetables, banana and pepper, both production and productivity have shown an increasing trend. In the case of area of production, 17 to 40 Ha, 35 to 37 Ha and 21 to 28 Ha respectively. In the case of productivity it is respectively 136 to 170 metric ton, 387.5 to 670 metric tons and 11.1 to 20.8 metric tons.

Table 3.9
Details of agricultural land area (in hectors) and Production (in tons) Data analysis of two local bodies (Thavanur and Thirunavaya)

Crops	2011-12		2012-13		2013-14		2014-15	
	Area of production (in hector)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)	Area of production (in hectors)	Production (in metric tons)
Paddy	393	1139	373	1139	166.5	609.5	115	395
Coconut	810	5450	810	5450	755	7105	755	7335
Vegetable	17	136	27	126	35	140	40	170
Banana	35	387.5	36	562.5	47	485	37	670
Pepper	21	11.1	24	11.4	24	11.4	28	20.8

(Source: PAO, Malappuram)

Figure 3.6
Details of agricultural land area (in hectors) and Production (in tons) Data analysis of two local bodies (Thavanur and Thirunavaya)

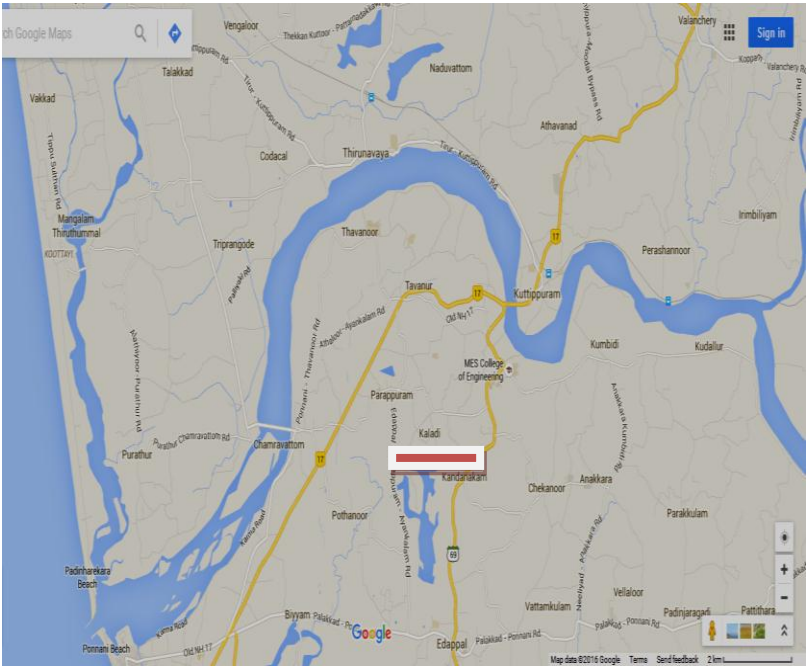


(Source: PAO, Malappuram)

II. SALT WATER INTRUSION

One of the objectives of the project 'Chamravattom Regulator cum Bridge' was the prevention of saline water intrusion. This aspect is taken as one of the objective of the study. For this primary data were collected from 76 families residing in 7 Grama Panchayaths namely Thriprangode, Thirunavaya, Purathur, Thalakkad, Thavanur, Kaladi and Edappal which are in the neighborhood of the project site. Map of the area is given below.

Map of Chamravattom Regulator cum Bridge



(Source: Google Map)

From the map it can be seen that out of the 7 Grama Panchayaths selected for the study, Thriprangode, Thirunavaya, Thalakkad and Thavanur are the upstream Panchayaths, Kaladi is the mid stream Panchayath and Purathur, and Edappal are the downstream Panchayaths.

Details of salinity content in water in well in the neighborhood area is shown in the table given below. Out of 76 selected families, only 19 families (25%) have reported the presence of salinity. No response is received from 1 family.

From the table and figure given below, it can be seen that salinity is reported in only 3 Panchayaths namely, Thriprangode, Purathur and Thalakkad. Thriprangode and Thalakkad are the upstream Panchayaths and Purathur is the downstream Panchayath. Thriprangode Panchayath is lying more nearly to the project and salt water intrusion is more reported (11nos.) in this region before the implementation of the scheme. In Thalakkad and Purathur Grama Panchayaths, the corresponding figures are respectively 7 and 1.

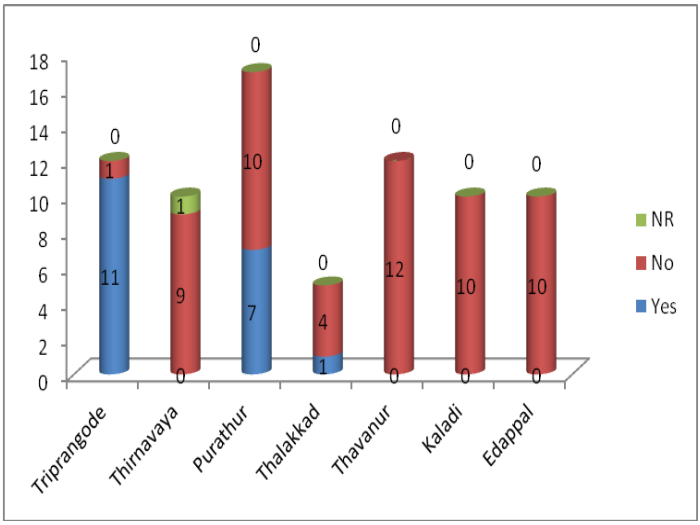
Table No. 3.10

Salinity of water in well before and after the Chamravattom Scheme.

Name of the Grama Panchayath	Salinity of water in well Before the scheme			Decrease in Salinity after the scheme		
	Y	N	NR	Totally	Partially	No Decrease
Triprangode	11	1	0	11	0	0
Thirunavaya	0	9	1	0	0	0
Purathur	7	10	0	0	4	3
Thalakkad	1	4	0	0	1	0
Thavanur	0	12	0	0	0	0
Kaladi	0	10	0	0	0	0
Edappal	0	10	0	0	0	0
Total	**19**	**56**	**1**	**11**	**5**	**3**

(Source: Sample survey)

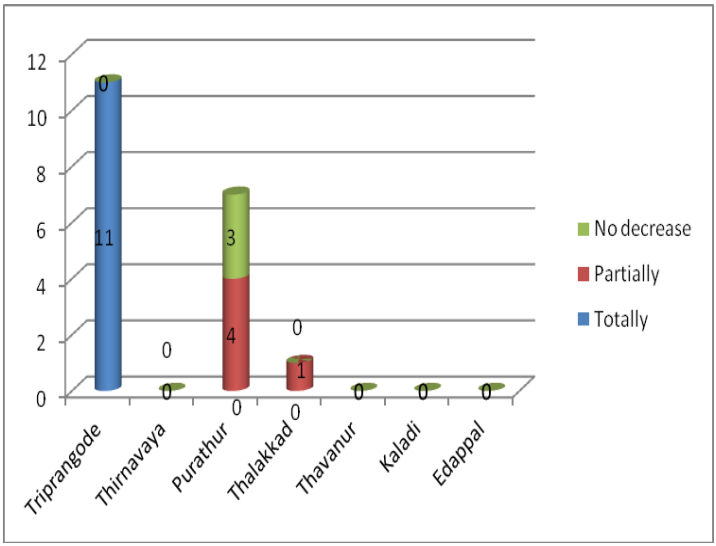
Figure 3.7
Salinity of water in well before the scheme



(Source: Sample survey)

After the implementation of the project salt water intrusion is totally decreased in the upstream nearby Panchayath, Thriprangode. This is a positive impact. In the case of the downstream Panchayath Purathur, total decrease of salinity not occurred. Partial decrease in salinity 57% and no decrease in salinity 43% is the situation in this Grama Panchayath. From this it can be analysed that more impact in the prevention of salt water intrusion is happened in upstream nearby Panchayaths and measures have to be taken to prevent salt water intrusion in downstream Panchayaths. In the case of Thalakkad Grama Panchayath, only 1 case of presence of salinity is observed and it is partially decreased after the implementation of the scheme.

Figure 3.8
Decrease in salinity after the scheme



(Source: Sample survey)

In general, even though the shutters of Chamravattom Regulator cum Bridge are not working properly, the project prevents salt water intrusion in an effective way. In order to get more benefit of the scheme, maintenance of the regulator is essential.

III. AVAILABILITY OF DRINKING WATER

Analysis of drinking water in the seven neighbourhood Grama Panchayaths of the project is done on the basis of primary data collected in two different aspects.

A. Availability of drinking water
B. Scarcity of drinking water in summer season

(Source: Google map)

The area in and around the project faces the problem of scarcity of drinking water. The study tried an attempt to find out the impact of the project on drinking water availability on 7 Grama Panchayaths namely Triprangode, Thirunavaya, Purathur, Thalakkad, Thavanur, Kalady, Edappal. The details of drinking water in the following 7 Grama Panchayaths is given below.

Table No. 3.11

Over all View of Availability and Scarcity of Drinking

Name of the Grama Panchayath	Availability of Drinking Water (Benefited families)					Scarcity of Drinking Water in Summer		
	Before the scheme		After the scheme			After the scheme		
	Y	N	Y	N	NR	Y	N	NR
Triprangode	3	9	11	0	1	4	8	
Thirunavaya	3	7	7	3		6	4	
Purathur	13	4	11	5	1	11	4	2
Thalakkad	2	3	3	2		2	3	
Thavanur	10	2	8	4		6	6	
Kaladi	7	3	8	2		3	7	
Edappal	7	3	5	5		5	5	
Total	**45**	**31**	**53**	**21**	**2**	**36**	**38**	**2**

(Source: Sample survey)

Water before and after Scheme.

Families affected in the nearby Grama Panchayaths in various aspects of drinking water before and after commissioning of the scheme- CRCB is given in the above table. Also the table depicts the families who were benefited and not, in availing drinking water after the commissioning of the project.

It can be seen that the availability of drinking water vary among different Grama Panchayaths after the commissioning of the project.

A. Availability of Drinking Water

Primary data was collected from 76 families. Availability of drinking water before the scheme was 59%. It increased to 72% after the scheme. Therefore it can be concluded that there is an increase in the availability of drinking water due to the impact of the project.

i) Before the Scheme

In 7 Grama Panchayaths, data were collected from 76 beneficiaries. Out of these beneficiaries, 45 reported the access of drinking water facility and 31 are inaccessible to drinking water facility. This means that access is only to 59%. Triprangode and Thirunavaya Grama Panchayaths recorded a small shortage in the availability of drinking water before the Scheme.

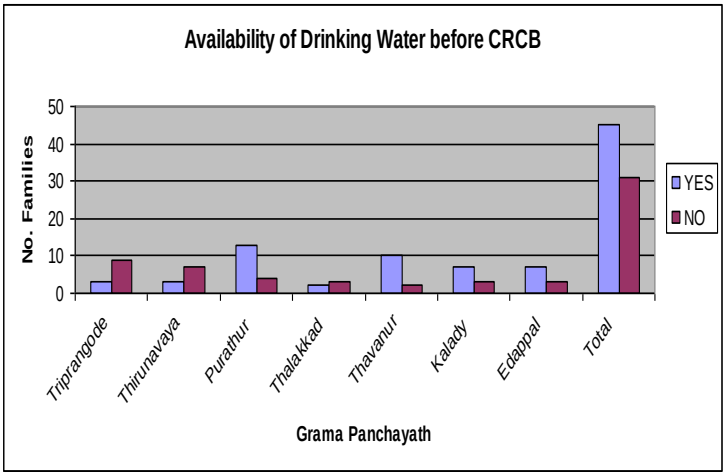
Following table and diagram give the details of the availability of drinking water before the Scheme – CRCB.

Table No. 3.12
Availability of Drinking Water
before the Scheme

Name of the Grama Panchayath	YES	NO
Triprangode	3	9
Thirunavaya	3	7
Purathur	13	4
Thalakkad	2	3
Thavanur	10	2
Kalady	7	3
Edappal	7	3
Total	**45**	**31**

(Source: Sample survey)

Figure 3.9
Availability of Drinking Water before the Scheme



(Source: Sample survey)

ii) After the Scheme

In the table and diagram given below, it can be seen that the availability of pure water has increased remarkably. Thriprangode and Purathur Grama Panchayaths have shown clearly the availability of pure water. But, Thalakkad and Edappal Grama Panchayaths have shown the shortage of pure water. Out of the 76 beneficiaries, 53 marked the availability of drinking water, 21 reported non-availability of drinking water and remaining 2 had no response. This implies that 72% of the beneficiaries have the access of drinking water facility.

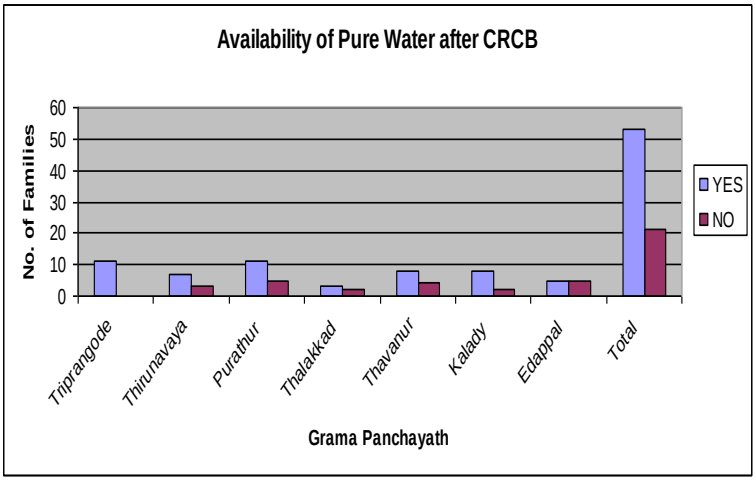
Table No. 3.13

Availability of drinking water after the scheme

Name of the Grama Panchayath	Yes	No	No Response
Triprangode	11	0	1
Thirunavaya	7	3	0
Purathur	11	5	1
Thalakkad	3	2	0
Thavanur	8	4	0
Kalady	8	2	0
Edappal	5	5	0
Total	**53**	**21**	**2**

(Source: Sample survey)

Figure 3.10
Availability of drinking water after the scheme



(Source: Sample survey)

B. Scarcity of drinking water in summer season- General Trend

In summer season, even though the scheme was commissioned, more than 50% of the families face shortage of Drinking Water in summer. In Purathur Grama Panchayath, data shows that the availability of drinking water in summer season is comparatively greater than other Grama Panchayaths.

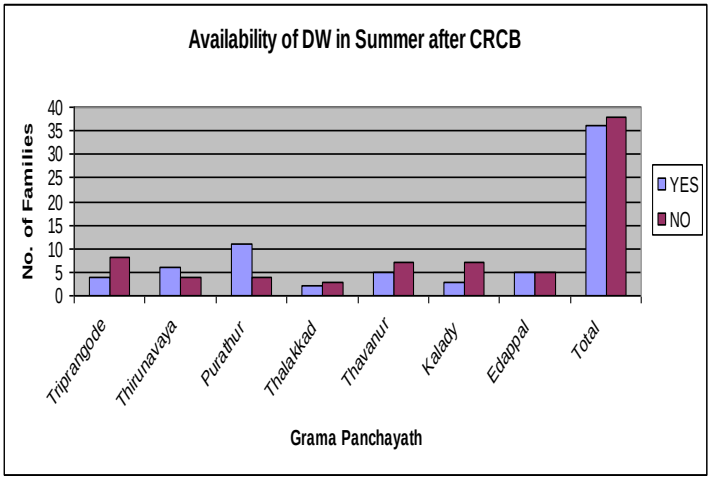
Following diagram explain the availability of drinking water after the Scheme -CRCB.

Table No. 3.14
Availability of Drinking Water in Summer after the Scheme - General Trend

Name of the Grama Panchayath	Yes	No
Triprangode	4	8
Thirunavaya	6	4
Purathur	11	4
Thalakkad	2	3
Thavanur	5	7
Kalady	3	7
Edappal	5	5
Total	**36**	**38**

(Source: Sample survey)

Figure 3.11
Availability of Drinking Water in summer after the Scheme - General Trend



(Source: Sample survey)

Analysis of Quality of Water on the basis of Secondary Data

Data were collected for the analysis of water quality from the study of 'Impact of Chamravattom Regulator cum Bridge on Bharathapuzha River and Adjacent areas' conducted by MP Ajith and Melvin K James. In this study, samples were collected from 8 upstream areas of Chamravattom RCB -Chamravattom, Triprangode, Thavanur, Kadakasseri, Thirunavaya and Kuttipuram which are under the influence of the study area. The study was conducted when all the shutters were closed.

Test was conducted to study the presence of 9 elements in water samples. The data given in brackets shows the desirable limit of the elements in water as per BIS. In this table only those figures which are higher than the BIS level

are taken into consideration. pH value, Sulphate, Calcium and Nitrate elements are within the desired limits. From the elemental analysis of samples it is clear that the concentration of Choloride, Magnesium, Nitrite, Phosphate and Iron elements are above the desired limit in many areas of the upstream of the CRCB. In Thirunavaya GP area, Chloride content is the highest 1603mg/l, where the desired limit is only 250mg/l. Similarly, Magnesium content is also highest in this area 35.2mg/l, where desired limit is 30mg/l. Desired limit of Nitrite, Phosphate and Iron content is zero. They are respectively highest in Thirunavaya Sample 2 (.024 mg/l), Triprangode (0.16 mg/l) and Triprangode (0.25mg/l).

Elemental concentration of water sample
Table No. 3.15
Elemental analysis of the sample

Sampling Location	**Parameters (Mg/l)**				
	Chloride (250)	**Magnesium (30)**	**Nitrite (0)**	**Phosphate (0)**	**Iron (0)**
Triprangode -s1	806.5			0.16	0.03
Triprangode -s2	0			0.01	0.25
Tavannur	1468			0.09	0.02
Tirunavaya -s1	1603	35.2	0.02	0	0.14
Tirunavaya -s2			0.24	0.05	0.2
Kuttipuram			0.04		0.12
Edappal	1311		0.01		1.02

(*Source: Secondary data-MP Ajith,Melvin K James.Impact of Chamravattam Regulator cum Bridge on Bharathapuzha river and Adjacent areas. Indian Journal of Economics Development.vol 4(1), January 2016)*

Table No. 3.16
Electrical Conductivity of water Samples

Sl No	Sampling Location	EC (1500µmhos/cm)
1	Triprangode-s1	190
2	Triprangode-s2	80
3	Tavannur	250
4	Thirunnavaya -s1	120
5	Thirunnavaya -s2	350
6	Kuttipuram	290
7	Edappal	400

(*Source: Secondary data-MP Ajith,Melvin K James.Impact of Chamravattam Regulator cum Bridge on Bharathapuzha river and Adjacent areas. Indian Journal of Economics Development.vol 4(1), January 2016)*

From this table it can be seen that the electrical conductivity, index of the amount of minerals present in the water, of the water in the 7 regions are within the desired limit ie, 50 to 1500µmhos/cm only in the upstream of the CRCB. But in the downstream area there is salt water intrusion which result the poor quality of drinking water.

Table No. 3.17
Dissolved Oxygen(DO)

Sl.No	Sampling Location	Amount of DO(mg/l)
1	Triprangode-s1	4
2	Triprangode-s2	2.9
3	Tavannur	4.5
4	Thirunavaya -s1	4.6
5	Thirunavaya -s2	3.75
6	Kuttipuram	4.00
7	Edappal	3.45

(*Source: Secondary data-MP Ajith,Melvin K James.Impact of Chamravattam Regulator cum Bridge on Bharathapuzha river and Adjacent areas. Indian Journal of Economics Development.vol 4(1), January 2016)*

The desired level of dissolved oxygen in the water is 5mg/l. The concentration of dissolved oxygen below 5mg/l adversely affected the aquatic life. In this study it is shown that the amount of dissolved oxygen ranges from 2.9 to 4.6 mg/l. This indicates that this water is unfit for the aquatic life.

Table No. 3.18
Total Coli forms & E.coli

Sl No	Sampling Location	Total Coli forms MPN/100 ml	E.coli MPN/100 ml
1	Triprangode-s1	500	0
2	Triprangode-s2	1500	200
3	Tavannur	1200	100
4	Thirunnavaya -s1	300	100
5	Thirunnavaya -s2	800	80
6	Kuttipuram	1800	320
7	Edappal	2900	150

(*Source: Secondary data-MP Ajith,Melvin K James.Impact of Chamravattam Regulator cum Bridge on Bharathapuzha river and Adjacent areas. Indian Journal of Economics Development.vol 4(1), January 2016)*

Total Coli forms are a group of bacteria commonly found in the natural environments like vegetation or soil. Their presence in water is the indication of recent faecal contamination and also the presence of disease causing bacteria, virus and other parasites. Normally every 100ml of drinking water tested there is no total coli forms and E.coli should be detected. But the study indicated that the coliforms and E.coli contains in 100 ml water is varies from 500 to3000 MPN/100ml and 0 to 320 MPN/100 ml respectively.

This study was conducted when all the shutters are closed. But now due to piping, 46 shutters are opened. So the quality of water has to be tested again in the present condition for getting more reliable results.

IV. INCOME GENERATION THROUGH TOURISM & FISHING

A. TOURISM

An attempt was made in this section to analyse the developments in tourism sector after the inauguration of Chamravattom RCB. The investigators have collected data from 10 shopkeepers regarding the impact of Chamravattom RCB in the various aspects of development of tourism sector. Out of this 10 shopkeepers only 3 of them were licensed shopkeepers and the remaining shopkeepers have no licence.

a) Level of Income

The following table clearly shows the trend of level of income of the shopkeepers after the inauguration of Chamravattom RCB.

Table No.3.19
Level of Income of Shopkeepers

Level of Income	
Status	No. of Shopkeepers (%)
Increased	10 (100%)
Decreased	0 (0%)

(Source: Sample survey)

It is very clear from the table that income of all shopkeepers has increased after Chamravattom RCB. All

shopkeepers who have responded to the survey have opined that their income has increased after the project.

b) Volume of Consumers

The following table shows the impact of CRCB in the volume of consumers in various shops in and around the Chamravattom RCB.

Table No. 3.20
Volume of Consumers

Response	No. of Shopkeepers (%)
Increased	10 (100%)
Decreased	0 (0%)

(Source: Sample survey)

It is crystal clear from the table that volume of consumers who visits the shops in and around the Chamravattom RCB has increased tremendously after Chamravattom RCB. All shopkeepers who replied to the

question have told that the number of consumers who visit their shops has increased after the project.

c) Type of Visitors

The below given table depicts the type of visitors in Chamravattom project area.

Table No. 3.21
Type of Visitors

Response	No. of Shopkeepers (%)
Local People	4 (40%)
Outsiders/ Passengers	6 (60%)

(Source: Sample survey)

The table obviously reveals that 'Outsiders/Passengers' are more than the Local People among the visitors in Chamravattom Project area. It can be easily understand from the response of shopkeepers under study. 6 out of 10 shopkeepers (60%) have informed that 'Outsiders/Passengers' are more among the visitors in Chamravattom Project area. The following pie diagram depicts the same.

d) Purpose of Visit of 'Outsiders/Passengers'

The following table shows the purpose of visit of Outsiders/Passengers who are more among the visitors at Chamravattom RCB.

Table No. 3.22
Purpose of Visit of 'Outsiders/Passengers'

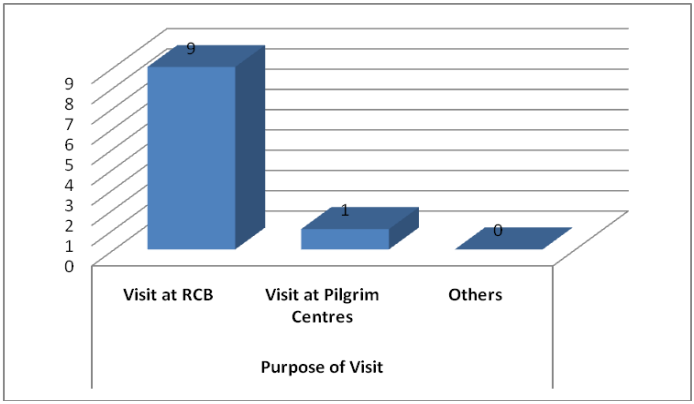
Response	No. of Shopkeepers (%)
Visiting of RCB	9 (90%)
Visiting of Pilgrim Centres	1 (10%)
Others	0 (0)%)

(Source: Sample survey)

It can be noticed from the table that almost all visitors among 'Outsiders/Passengers' visit the project area just for seeing the Regulator Cum Bridge. According to the 90% of the respondents, sightseeing in and around the Regulator Cum Bridge is the main purpose of the visitors. Only 10 % have opined that visit of pilgrim centres in and around Chamravattom RCB is the main purpose of visitors.

The following diagram clearly shows the main purpose of visitors.

Figure 3. 12
Purpose of Visit of 'Outsiders/Passengers'



(Source: Sample survey)

e) Time of Visit

The below given table shows the time of visit of tourists in the project area.

Table No. 3.23
Time of Visitors

Response	No. of Shopkeepers (%)
Holidays	10 (100%)
Working Days	0 (0%)

(Source: Sample survey)

From the above shown table, it is clear that all shopkeepers under study are of the opinion that volumes of visitors are more during holidays when compared to the working days. The below given diagram also depicts the above explained trend.

Various Tourism Projects in and around Chamravattom Regulator Bridge

Department of Tourism and Revenue have started various tourism projects in and around Chamravattom Regulator Bridge. Following are the important projects.

i) Chamravattom Puzhayora Snehapatha

A project named "Chamravattom Puzhayora Snehapatha" by the Department of Tourism is now opened for public.

ii) Puzha Muthal Puzha Vare

'Puzha muthal puzha vare' (From River to River) is the new scheme proposed by the Revenue Department. The Scheme will be implemented in 527 acres along

Bharathapuzha –Thirunavaya stretch in Malappuram District. The scheme would be implemented by the State River Protection Committee. Other than river protection the objective include prevention of pollution and development and beautification of riverbanks through sensible landscaping.

Project Location

As a part of the scheme Puzha muthal Puzha vare the site proposed in Malappuram District is the one adjacent to the existing Nila Park Kuttippuram on the banks of Bharathapuzha River.

Site

Site comprises 19.7 Acres of land adjacent to existing Nila park on the Banks of Bharathapuzha. Major part of the site is oriented North – West direction with south side sharing with Nila park and North part extending beyond Kadavu Road. River is flowing in the south – west direction and that part of the site in an interface of land and water which is to be protected and preserved. The land form is almost filled with river sand haphazardly with undulations which require Grading.

Scope

Scope includes but not limited to protection of banks, water harvesting, articulation of spaces for various and afforested land stretch which can change the micro climate of the areas in vicinity.

Salient Features

Entrance Plaza, Fun Lake, Galaxy park, Blaze forest/ Butterfly park, Rain Forest, Swan lake, Eco pond, Savanna, Rock lake, Bamboo Forest, Sand Trail, Green House, Grass lake, Star Forest (Nakshathravanam), Music lake and Decorative fish ponds.

Estimate Cost

Proposed estimate cost of the project is Rs. 6,39,09,100/-(Rupees six crore thirty-nine lakh nine thousand and hundred).

iii) Nila Tourism Circuit

It is a project to be implemented under Swedheshi Dharsan Scheme of Govt of India for connecting cultural pilgrim centres and historical monuments along the banks of Nila. Various activities for the beautification and infrastructural development of the various tourist places like Nilapadu Thara, Marunnu Ara, Mani Kinar, Changampalli Kalari, Vemanchery Mana, Rayiranelloor Mala, Ponnani Valiya Juma Masjid, Thunjan Gurumadom, Tripangode Shiva Temple, Thirunavaya Navamukunda Temple And Pazhukka Mandapam, Chamravattom Ayyappa Temple, Ivor Madom, Thiruvilvamala Temple & Panniyoor Varahamoorthi Temple.

iv) Renovation of Biyyam Bridge , Ponnani

Biyyam Bridge is located 3 km from Ponnani and 8 km from Edappa on the main Highway to Kozhikode. Biyyam is 50 km from Malappuram and 23 km from Kuttippuram. Biyyam Kayal is a placid, green fringed waterway with excellent boating facilities. In 1936, a regulator was constructed across the kanjiramukku river North East of Biyyam to segregate water from adjoining swamps. The oozing through the regulator from swamps spread over 270 sq.km catchments area created a six km long water body which is popular as the Biyyam Kayal. During Onam, the kayal is the venue of boat race. There is a pavilion at pulikkakadvu near the boat terminal for watching the boat race. Another unique feature is that migratory birds from Siberia come to this place annually. Total project cost

sanctioned is Rs. 2.75 crore. Major components of the project are Watch Tower, Boat Jetty, Children's Park, Lighting, View Point and Restaurant.

v) Marine Museum

DTPC, Malappuram has issued the work order to State Nirmithi Kendra. The project will be started in the land available with the irrigation department in near the chamravattom project area. Architect has to submit full detailed drawings to the agency. Project cost includes 1.0 Crore from the MP fund account of Sri. E.T. Mohamed Basheer.

vi) Cultural Museum

DTPC, Malappuram has taken steps to establish a cultural museum near the chamravattom project area.

B. FISHERIES

Effort has been done in this section to analyse the developments in fisheries sector after the inauguration of Chamravattom RCB. The investigators have collected data from Fisheries Department regarding the impact of Chamravattom RCB in the total production of fresh water fishes.

a) Area of the Availability of fish

The following table shows the area of the availability of fish in the benefitted area before and after the commission of the project.

Table No 3 .24
Area of the Availability of Fish

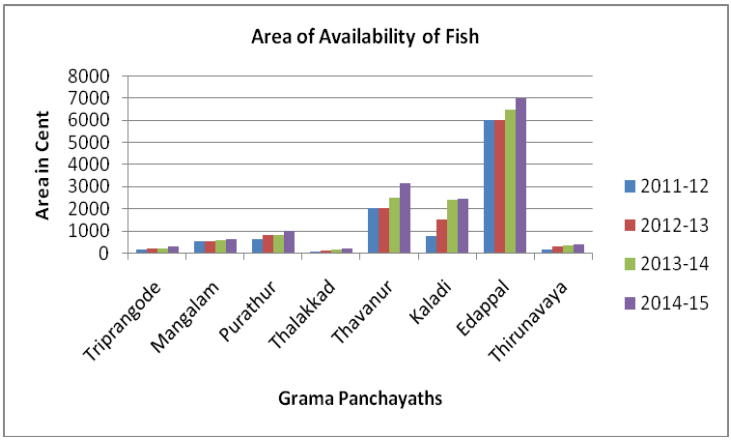
Name of Grama Panchayath	Availability of Fish during the Years (Area in cent)			
	2011-12	2012-13	2013-14	2014-15
Triprangode	150	200	200	260
Mangalam	500	500	570	620
Purathur	600	800	800	986
Thalakkad	70	100	150	195
Thavanur	2000	2000	2500	3151
Kaladi	750	1500	2400	2424
Edappal	6000	6000	6500	7000
Thirunavaya	150	300	350	362
Total	**10220**	**11400**	**13470**	**14998**

(Source: Fisheries Department)

The above given table shows that the area under fishing has increased considerably after the commissioning of the project. Total area under fishing during the year 2011-12 was 10220 cents. It has increased to 14998 cents during 2014-15.

The increasing trend in the area under fishing can easily be understood from the below given graph.

Figure 3.13
Area of the Availability of Fish



(Source: Fisheries Department)

b) Average Production of Fishes

The following table shows the average production of fishes before and after the commissioning of the project.

Table No. 3.25
Average Production of Fish (in Kg)

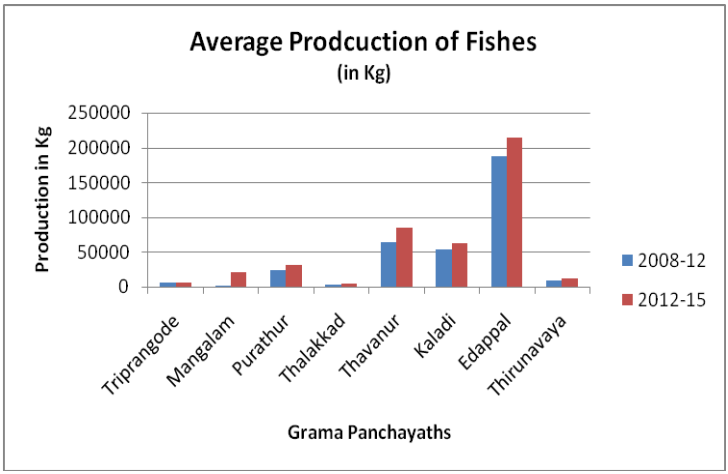
Name of Grama Panchayath	Average Production of Fishes (in Kg)		
	Type of Fish	2008-12	2012-15
Triprangode	Carp	5400	6600
Mangalam	Carp	1498	20280
Purathur	Carp (Cattla, Rohu, Mrigal, Grass Carp)	24243	31032
Thalakkad	Carp	3150	4450
Thavanur	Carp	64250	84161
Kaladi	Carp	54260	63240
Edappal	Carp	186760	214500
Thirunavaya	Carp	8432	12144
Total		**347993**	**436407**

(Source: Fisheries Department)

The above given table clearly depicts that the average production of fishes has increased tremendously after the commissioning of the project. The above given table shows that average production of fishes during the period 2008-12 was only 3,47,993 Kg. it has increased to 4,36,407 Kg during 2012-15.

The increasing trend in average production of fishes can easily be read from the below given graph.

Figure 3.14



(Source: Fisheries Department)

Chapter IV

CONCLUSIONS AND SUGGESTIONS

The present study evaluates the impact of the Chamravattom Regulator Cum Bridge on Irrigation, Agriculture, Water Supply, Tourism, Employment Generation and the overall development of the area. This section of the report provides major findings of the study and suggestions for further research.

Major Findings of the Study

Following are the major findings of the study

- It is a multipurpose Irrigation Project which comprised of regulator with 70 Nos of vertically operated M.S Shutters of size 12.76x4.00m and a bridge having length of 978m with approach road on both banks.
- The Project was commissioned at a record pace of two years.
- It reduces the distance by road between Kozhikodu and Kochi by 38 km.
- Regulator cum bridge is now working as a bridge only due to faulty construction.
- Due to the construction of CRCB, the project had dead storage capacity of 1.5mn even after opening all the middle 46 shutters. This may be the reason for the positive impact of the project.
- The project envisaged to provide water to around 4000 hectors of agricultural land.
- The area of production was increased in Vettom, Mangalam and Purathur Grama Panchayaths due to the implementation of Chamravattom project.

- Except paddy cultivation, an increasing trend is seen in the case of productivity in almost all crops in both primary and secondary data.
- Salt water intrusion is decreased after commissioning of the project, especially in the upstream of nearby Thriprangode Grama Panchayath.
- Even though the availability of drinking water is increased in the project area, the availability of drinking water could not achieve as much as the target, due to salt water intrusion.
- More than 50% of the families are suffering from scarcity of drinking water in summer season.
- The Project also promotes tourism activities of the locality. For tourism development, a project named "Chamravattom Puzhayora Snehapatha'' is now opened to public.
- Arrival of foreign tourists has increased considerably. Foreign tourists who visited Kottakkal Aryavaidyasala also visited the project area to see backwater tourism.
- Generation of employment and thereby income of the people around the project area have increased considerably after the project
- Unlicensed shopkeepers are selling on road side due to scarcity of land. A master plan is required to settle the problem.

Findings based on the Meeting of Stakeholders

- Before the implementation of CRCB, water scarcity was severe in the neighbouring GPs. Now it is reduced to a remarkable extent.
- Similarly, salt water intrusion in water resources and agricultural lands is also reduced after the execution of CRCB.

- When all shutters were closed, water was used to overflow over the Kuttippuram bridge.
- Since the scheme is not fully functional, water scarcity exists in Mangalam GP.
- Construction of retaining wall for a length of 20 mtr is to be completed in the scheme. It is the only activity left in the scheme.
- There is an increase in agriculture and the production of due to the effective involvement of concerned departments.
- As per the existing rules, vehicles for loading sand have to be stopped 50m away from the river banks. So sand mafia are taking sand from convenient places by parking vehicles in nearby regions of banks of the river. Due to this practise, middle part of the river remains high compare to the edges, resulting into the overflow towards banks during rainy seasons. In other words water storage is not occurring.
- Due to the execution of the scheme production of fresh water fish is increased and salt water fish is decreased. Prawn cultivation is decreased by almost 15 acres.
- Full capacity of CRCB is storage of water up to 4.00m height. Estimated target was storage of 14.20 million lakh cu m water. According to the path metric survey during 2012-13, it was observed that almost 32.00 million lakh cu m water can be stored in the present status. More than double storage can be expected now due to the formation of deep pits by sand mining.
- Ground water level is increased after the execution of this scheme and 9 lift irrigation schemes are benefitted due to this.
- EE, Minor Irrigation reported that there is a chance of getting Rs. 30.00 crores for the rectification of the scheme during this financial year(2016-17).

Suggestions of the Study

Followings are the important suggestions of the study

Even though the positive impacts can be seen after the implementation of the project, all the objectives are not achieved in its full resolution. A high-level investigation only can bring out the defects in the construction of the regulator cum bridge. The RCB worth Rs 148 crore was built to resolve the severe drinking water shortage and of improving irrigation in Malappuram, Palakkad and Thrissur districts. But, RCB, commissioned a year ago failed to fulfill the purpose as envisaged because of leakage of water. It had caused acute shortage of drinking water in the region, which affected the cultivation of thousands of acres of farm lands in these districts. All the issues should be resolved as soon as possible to make the project helpful for the farmers.

Suggestions based on the Meeting of Stakeholders

1. Full-fledged functioning of the project without piping is required for achieving the targets.
2. If the regulator is functioning in its full water storage capacity, then irrigation facility for agriculture in summer

season can be ensured in regions like Ponnani-Kattakampal, Madirassery, Thandalam, Pothannur etc.

3. Besides the piping of the water, water level on both sides of the river will rise if water is stored at its full capacity. This causes damage to houses lying on both sides of the river near the adjacent areas of CRCB. So retaining wall is essential to protect the banks.
4. Frequent cleaning of water source is required, since there is chance of decaying grass/moss in stagnant water.
5. Protection of water source is essential in order to avoid waste dumping, rearing of domestic animals, bathing etc.
6. Recharging of nearby water resources are occurring even after opening of all shutters due to storage of water in almost 1.5 m depth. So it may be concluded that if water is stored in its full capacity, its benefits can be feel to even the interior areas of distant places.
7. Water can be distributed to the downstream areas by gravitational force through canal. Lift irrigation schemes will be necessary only to small regions. Then, paddy cultivation and vegetable cultivation can be done even in summer season.Through this agriculture production can be increased.
8. Further functioning of CRCB has to be done through co-ordination of all related departments.
9. The activities of sand mafia adversely affect the functioning of CRCB.
10. In order to reach the full advantages of the scheme to people, water has to be stored till Chembickal region.
11. Water supply can be extended to neighboring places by connecting canals. If water is accessible in fallow lands through these canals, farming can be done in these lands and agriculture production can be increased.
12. If piping of the CRCB is solved, water may reach Anakkara GP of Palakkad District.
13. Study of ground water table, environment, etc has to be included in the impact study.

14. Water quality test has to be conducted in the present condition.
15. Study should include the availability of fresh water fish wealth.
16. After execution of the scheme, distance between Kozhikode-Kochi is reduced by 38 Km. In order to get full benefit of the scheme, project has to be implemented by redesigning approached roads with increased width.
17. At present, out of 70 shutters, 14 shutters on the right side and 10 on left side are closed. All the remaining shutters are open. Due to sand mining there is a dead storage of water up to 1.5m depth. Under these circumstances, if water is stored by closing all the shutters, there is greater chance for the damage of CRCB.
18. Maintenance fund for the project has not been received yet. 70 motors are required for functioning the shutters and it needs adequate fund. If these are not operated regularly, it will be damaged.

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APPENDICES

1. **Questionnaire on Developments in Agriculture & Irrigation.**
2. **Questionnaire on Developments in Drinking Water.**
3. **Questionnaire on Developments in Tourism Sector.**
4. **Questionnaire on Developments in Fisheries Sector.**

Appendix-1

AN EVALUATION STUDY OF CHAMRAVATTOM REGULATOR-CUM-BRIDGE ACROSS BHARATHAPUZHA

Questionnaire on Developments in Agriculture & Irrigation

Name :
Age :
Address :
Phone No. :
Local Body :

Before the Commissioning of Chamravattom Scheme

1. What were the crops cultivated before the Commissioning of Chamravattom Scheme ?
   A:
2. Whether irrigation facility was available for farming?

Yes	No

3. If Yes, name the source of water
   A:
4. Whether cultivation was possible in all season?

Yes	No

5. If No, the reason ?
   A:
6. Have you cultivated paddy?

Yes	No

7. If Yes, in which seasons?
   A:

8. If No, give reason
   A:

After Commissioning of Chamravattom Project

9. What are the crops cultivated after the Commissioning of Chamravattom Scheme ?
   A:
10. Whether irrigation facility is available?

Yes	No

11. If Yes, name the source of water
    A:
12. Whether cultivation is possible in all season?

Yes	No

13. If No, the reason
    A:
14. Have you cultivated paddy?

Yes	No

15. If Yes, in which seasons?
    A:
16. If No, give reason.
    A:
17. After commissioning of Chamravattom project, Is there any change in water availability?

Yes	No

18. After commissioning of Chamravattom project, is there any change in production sector ?

Yes	No

19. Whether more benefits are available after commissioning of this project?

Yes	No

20. What are the benefits after commissioning of Chamravattom project?

21. Total area of cultivation (2011-2015)

Year	Paddy (cent)	Banana	Tapioca	Vegetables	Coconut	Areca nut
2011-12						
2012-13						
2013-14						
2014-15						

22. Quantity of corps (2011-2015)

Year	Paddy (cent)	Banana	Tapioca	Vegetables	Coconut	Areca nut
2011-12						
2012-13						
2013-14						
2014-15						

23. Width of cultivation land under irrigation

Year	Paddy (cent)	Banana	Tapioca	Vegetables	Coconut	Areca nut
2011-12						
2012-13						
2013-14						
2014-15						

24. Do you think that the increases in production sector are due to irrigation facility or other means?

Appendix-2

AN EVALUATION STUDY OF CHAMRAVATTOM REGULATOR-CUM-BRIDGE ACROSS BHARATHAPUZHA

Questionnaire on Developments in Drinking Water

1. Name :
2. Address :
3. Phone No. :
4. Local Body :
5. Ward No. & Name : House No.
6. Whether drinking water was sufficiently available before the Chamravattom project ?

Yes	No

7. If yes, from which source

Open Well ☐ Bore Well ☐ Public Tap ☐

Line Extension ☐ Others ☐

8. Whether the drinking water was contaminated with saline?

Yes	No

9. Whether the quantity of saline water is decreased after this Project in your well?

Yes	No

10. If yes, How much ?
    Partially ☐ Fully ☐

11. Whether pure drinking water is sufficiently available after Chamravttom project ?

Yes	No

12. If yes, from which source?

    Open Well ☐ Bore Well ☐ Public Tap ☐

    Line Extension ☐ Others ☐

13. Whether you have scarcity of drinking water during summer season, even after commissioning of Chamravattom project ?

Yes	No

14. What is your opinion about drinking water after commissioning of Chamravattom project ?

Place: Signature

Date

Appendix-3

AN EVALUATION STUDY OF CHAMRAVATTOM REGULATOR-CUM-BRIDGE ACROSS BHARATHAPUZHA

Questionnaire on Development in Tourism Sector

Name :

Address :

Telephone Number :

Grama Panchayath /municipality :

Ward :

Institution established in the year :

Other source of income :

Details of Institution :

Item	Established Year	Place of Institution	Total Number of Employees	Monthly Income
Regional production centre for attracting tourists / Marketing of fancy items/ Hotels/ Petty shops/ Others				

1. If the institution was established before the year 2012, is there any increase in income after the implementation of the project.?

Yes ☐ No ☐

2. If Yes, how much increase in income?

3. Any increase in number of consumers?
   Yes ☐ No ☐

4. Whether the visitors of your institutions are natives or outsiders?
   Natives ☐ Outsiders ☐

5. If visitors are outsiders, explain the categories of visitors

Category	Number (Per day)	
	In Holidays	In working Days
Visitors for the project		
Pilgrim visitors		
Others		

Appendix-4

AN EVALUATION STUDY OF CHAMRAVATTOM REGULATOR-CUM-BRIDGE ACROSS BHARATHAPUZHA

Questionnaire on Development in Fisheries Sector

Name :

Address :

Telephone Number :

Grama Panchayath/municipality :

Ward :

1. Are you living in nearby Chammaravattom region?
   Yes ☐ No ☐

2. Are you included in the category of traditional fishing employee?
   Yes ☐ No ☐

3. Do you have any other source of income?
   If yes, please explain :

4. Are you selected the fishing sector after the Chammaravattom Project?
   Yes ☐ No ☐

5. Which methods of fishing you follow?

Method		**Monthly Income**		**Types of fish**	
Gaffs/ Net/ Boat/Thotta/ Others	**Number of Employees**	Before the project	After the Project	Before the project	After the Project

6. How many days you go for fishing in a week?

7. Availability of fish (Quantity in Kg per Week).

Before 2012	After 2012

8. Do you have fish farm?
   Yes ☐ No ☐

9. If yes, whether it is started after the implementation of the project.?

   Yes ☐ No ☐

10. Details of fishing farm.

Total Area	**Monthly Production**	**Number of employees**		**Marketing method/ Direct/ Export/ Intermediate**
		Natives	**Other states**	