Review on Major and Medium Irrigation Projects of Kerala

Internship Report

by

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Introduction

Water is essential to plant growth and for millennium, farmers opted different method to supply water to their crops. The addition of water supply to the crops artificially is called 'irrigation'. Irrigation is essentially the artificial application of water to overcome deficiencies in rainfall for growing crops (Cantor, 1967).

Irrigation is the application of controlled amounts of water to plants at needed intervals. It helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of inadequate rainfall. It also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation.

Irrigation systems are also used for cooling livestock, dust suppression, disposal of sewage, and in mining. It is often studied with drainage, which is the removal of surface and sub surface water from a given area.

History of Irrigation

Irrigation has been a central feature of agriculture for over 5,000 years and is the product of many cultures. Historically, civilizations have been dependent on development of irrigated agriculture to provide agrarian basis of a society & to augment the security of people (Shirsath B. Paresh). Here history of irrigation development has been discussed. Archaeological investigation has identified evidence of irrigation in Mesopotamia, Ancient Egypt & Ancient Persia (at present Iran) as far back as the 6th millennium Before Christ Era (BCE) (Kang, S.T-1972). The Zana valley of the Andes Mountain in Peru, archaeologists found remains of three irrigation canals radiocarbon dated from the 4th millennium BCE, the 3rd Millennium BCE & the 9th century CE (Christ Era). These canals are the earliest record of irrigation in the new world (Dillehay TD, Eling HH Jr, Rossen J 2005). The Indus valley civilization in Pakistan & North India (from 2600 BCE) also had an early canal irrigation system. Large scale agriculture was used for the purpose of irrigation. Sophisticated irrigation & storage systems were developed, including the reservoirs built at Girnar in 3000 BCE (Rodda, J.C 2004). There are evidence of ancient Egyptian Pharaoh Amenemhet-III in the 12th dynasty (about 1800 BCE) using the natural lake of the Faiyum Oasis as a reservoir to store surpluses of water for use during the dry seasons, the lake swelled annually from

flooding of the Nile (Amenemhet III. Britannica Concise). The Qanats, developed in ancient Persia in about 800 BCE, are among the oldest known irrigation methods still in use today. The system comprises a network of vertical wells & gently sloping tunnels driven into the sides of cliffs & steep hills to tap ground water. The irrigation works of ancient Sri Lanka, the earliest dating from about 300 BCe, in the reign of King Pandukabhaya & under conditions development for the next thousand years, were one of the most complex irrigation systems of the ancient world. In addition to underground canals, the Sinhalese were the first to build completely artificial reservoirs to store water. The system was extensively restored & further extended during the reign of King Parakrama Bahu (1153-1186 CE).

In the Szechwan region ancient China the Dujiangyan Irrigation System was built in 250 BCE to irrigate a large area & it still supplies water today (Encyclopaedia Britannica, 1994). In fifteenth century Korea the world‟s first water gauge was discovered in 1441 CE. The inventor was Jang Young- Sil, a Korean engineer of the Joseon Dynasty, under the active direction of the king, Se Jong. It was installed in irrigation tanks as part of a nationwide system to measure & collect rainfall for agricultural applications.

Definitions:

Irrigation is defined as “Artificially supplying & systematically dividing of water for agriculture & horticulture in order to obtain higher or qualitatively better production”.

Irrigation is essentially the artificial application of water to overcome deficiencies in rainfall for growing crops (Cantor, 1967).

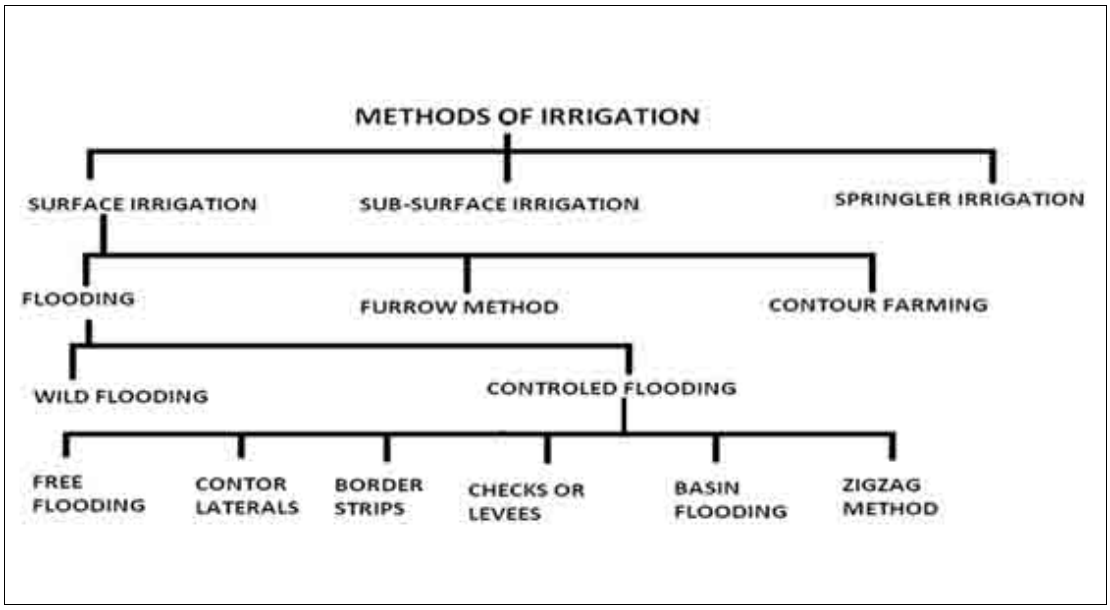
Importance of Irrigation

In the next 35 to 45 years world food production will need to double to meet the demands of increased population. Ninety percent of this increased food production will have to come from existing lands & seventy percent of this increased food production will have to come from irrigated land. Without irrigation farming is very limited & if the rainfall decreases to less than 30cm, agriculture becomes impossible without irrigation (King, 1953). It increases crop yield. It protects from famine. It helps to cultivate superior crops with the water supply as per need of the crops. Ultimately it helps in economic development. Irrigation improves water conditions in the soil, increases the water content of plant fibres, dissolves nutrients & makes them available to plants. Irrigation affects temperature conditions by regulating the

temperature of the surface layer of the soil & the ground layer of the air & also makes possible control of the growth & development of plants & improvement of the quality of the harvest.

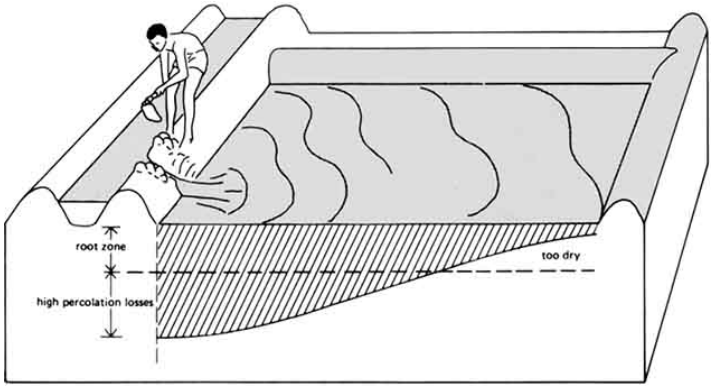
Different methods of Irrigation

The main different methods of irrigations are surface irrigation, sub surface irrigation, Splinter irrigation.



Surface Irrigation: Surface irrigation is the application of water by gravity flow to the surface of the field. Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders).

Basin Irrigation: Basins are flat areas of land, surrounded by low bunds. The bunds prevent the water from flowing to the adjacent fields. Basin irrigation is commonly used for rice grown on flat lands or interfaces on hillsides. Trees can also be grown in basins, where one tree is usually located in the middle of a small basin. In general, the basin method is suitable for crops that are unaffected by standing in water for long periods (e.g. 12-24 hours).



Furrow Irrigation: They are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods (e.g. 12-24 hours). Irrigation water flows from the field channel into the furrows by opening up the bank of the channel, or by means of siphons or spiels.

Figure Furrow Irrigation

Border Irrigation: Borders are long, sloping strips of land separated by bunds. They are sometimes called border strips. Irrigation water can be fed to the border in several ways: opening up the channel bank, using small outlets or gates or by means of siphons or spiels. A sheet of water flows down the slope of the border, guided by the bunds on either side.

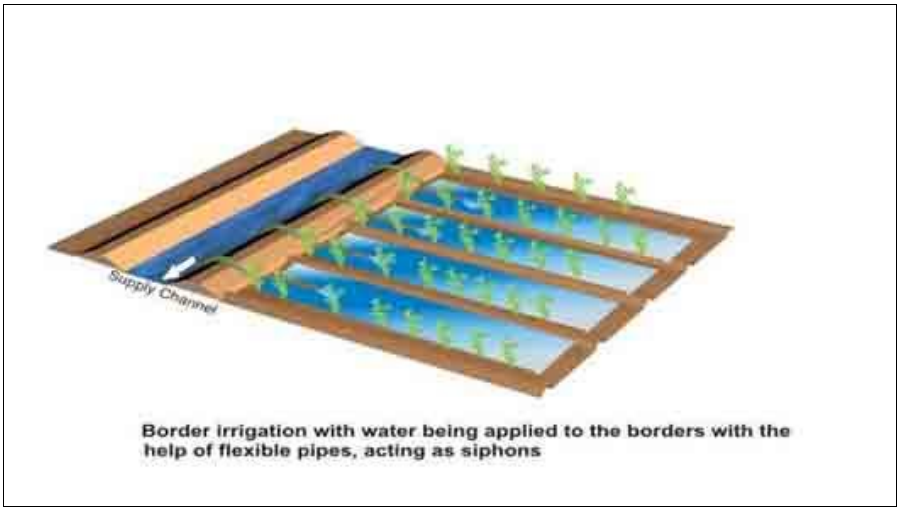


Figure Basin Irrigation

Micro-irrigation: Micro-irrigation, sometimes called localized irrigation, low volume irrigation, or trickle irrigation is a system where water is distributed under low pressure through a piped network, in a pre-determined pattern, and applied as a small discharge to each plant or adjacent to it. Traditional drip irrigation using individual emitters, subsurface drip irrigation (SDI), micro-spray or micro-sprinkler irrigation, and mini-bubbler irrigation all belong to this category of irrigation methods.

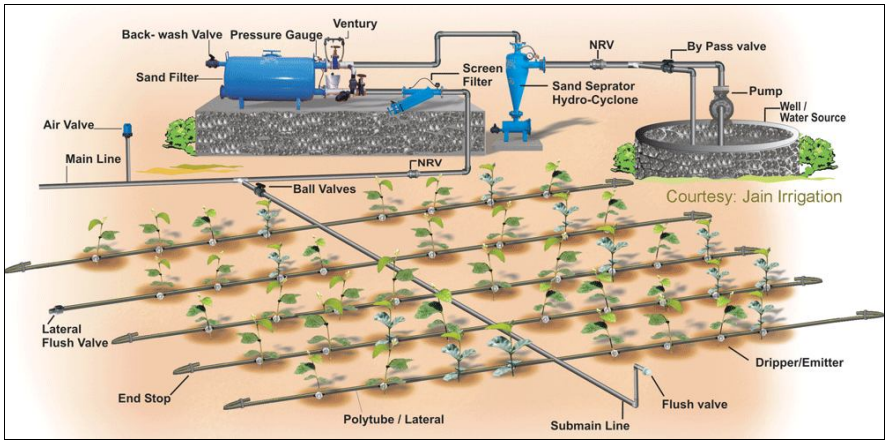


Figure Drip irrigation layout and its parts

In this system waterfalls drop by drop just at the position of roots. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water-efficient method of irrigation if managed properly, since evaporation and runoff are minimized. The field water efficiency of drip irrigation is typically in the range of 80 to 90 percent when managed correctly. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer. The process is known as fertigation.

Deep percolation, where water moves below the root zone, can occur if a drip system is operated for too long or if the delivery rate is too high. Drip irrigation methods range from very high-tech and computerized to low-tech and labor-intensive. Lower water pressures are usually needed than for most other types of systems, with the exception of low energy center pivot systems and surface irrigation systems, and the system can be designed for uniformity throughout a field or for precise water delivery to individual plants in a landscape containing a mix of plant species. Although it is difficult to regulate pressure on steep slopes, pressure compensating emitters are available, so the field does not have to be level. High-tech solutions involve precisely calibrated emitters located along lines of tubing that extend from a computerized set of valves.

Sprinkler irrigation: In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors are driven by a ball drive, gear drive, or impact mechanism. Rotors can be designed to rotate in a full or partial circle. Guns are similar to rotors, except that they generally operate at very high pressures of 40 to 130 lbf/in² (275 to 900 kPa) and flows of 50 to 1200 US gal/min (3 to 76 L/s), usually with nozzle diameters in the range of 0.5 to 1.9 inches (10 to 50 mm). Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging.

Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as travelling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended. Most of these utilize a length of polyethylene tubing wound on a steel drum. As the tubing is wound on the drum powered by the irrigation water or a small gas engine, the sprinkler is pulled across the field. When the sprinkler arrives back at the reel the system shuts off. This type of system is known to most people as a "waterreel" traveling irrigation sprinkler and they are used extensively for dust suppression, irrigation, and land application of wastewater. Othertravelers use a flat rubber hose that is dragged along behind while the sprinkler platform is pulled by a cable.

Sub irrigation

Sub irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table.

Sub irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling. Typically, a solution of water and nutrients floods a container or flows through a trough for a short period of time, 10–20 minutes, and is then pumped back into a holding tank for reuse. Sub-irrigation in greenhouses requires fairly sophisticated, expensive equipment and management. Advantages are water and nutrient conservation, and labour savings through reduced system maintenance and automation. It is similar in principle and action to subsurface basin irrigation.

Another type of sub irrigation is the self-watering container, also known as a sub-irrigated planter. This consists of a planter suspended over a reservoir with some type of wicking material such as a polyester rope. The water is drawn up the wick through capillary action.

Different Classes of Irrigation System

Irrigation systems are often designed to maximize efficiencies & minimize labour & capital requirements. There are three broad classes of irrigation system

1. **Pressurized distribution:** The pressurized systems include sprinkler, trickle, in which water is conveyed to & distributed over the fields through pressurized pipe networks.
2. **Gravity flow distribution:** This system conveys & distributes water at the field level by a free surface, overland flow regime.
3. **Drainage flow distribution:** Irrigation by control of the drainage system sub irrigation is not so common but is interesting. Relatively large volumes of applied irrigation water percolate through the root zone & become a drainage or ground water flow. By controlling the flow at critical points, it is possible to raise the level of the ground water to within reach of the crop roots.

Classification of Irrigation Projects

Irrigation projects are classified in different ways, however, in Indian context it is usually classified as follows:

- ✓ **Major project:** This type of project consists of huge surface water, storage reservoirs and flow diversion structures. The area envisaged to be covered under irrigation is of the order over 10000 hectares.

- ✓ **Medium project:** These are also surface water projects but with medium size storage and diversion structures with the area under irrigation between 10000 hectare and 2000 hectare.

- ✓ **Minor project:** The area proposed under irrigation for these schemes is below 2000Ha and the source of water is either ground water or from wells or tube wells or surface water lifted by pumps or by gravity flow from tanks. It could also be irrigated from through water from tanks.

The major and medium irrigation projects are further classified as

- Direct irrigation method
- Storage irrigation method.

Commanded area (CA): defined as the area that can be irrigated by a canal system, the CA may further be classified as under:

Gross command area (GCA): This is defined as total area that can be irrigated by a canal system on the perception that unlimited quantity of water is available. It is the total area that may theoretically be served by the irrigation system. But this may include inhibited areas, roads, ponds, uncultivable areas etc which would not be irrigated.

Culturable command area (CCA): This is the actually irrigated area within the GCA. However, the entire CCA is never put under cultivation during any crop season due to the following reasons:

- The required quantity of water, fertilizer, etc. may not be available to cultivate the entire CCA at a particular point of time. Thus, this is a physical constraint.
- The land may be kept fallow that is without cultivation for one or more crop seasons to increase the fertility of the soil. This is a cultural decision.
- Due to high water table in some areas of the CCA irrigated water may not be applied as the crops get enough water from the saturation provide to the surface water table.

During any crop season, only a part of the CCA is put under cultivation and this area is termed as ***culturable cultivated area***. The remaining area which is not cultivated during a crop season is conversely termed as ***culturable uncultivated area***.

Intensity of irrigation is defined as the percentage of the irrigation proposed to be irrigated annually. Usually the areas irrigated during each crop season (Rabi, Kharif, etc) are expressed as a percentage of the CCA which represents the intensity of irrigation for the crop season. By adding the intensities of irrigation for all crop seasons the yearly intensity of irrigation to be obtained. As such, the projects with a CCA of more than 2000 hectare are grouped as ***major*** and ***medium*** irrigation projects. The ultimate irrigation potential of our country from major and medium projects has been assessed as 58.46 M-hectare.

Objective of the study

- To assess the status of state wise number of major and medium irrigation projects in India.
- To assess the status of union territory wise number of major and medium irrigation projects in India.
- To assess the basin wise number of major and medium irrigation projects in India.
- To assess the plan wise expenditure on irrigation in India.
- To assess the number of major and medium irrigation project executed in Kerala state
- To assess number of irrigation and multipurpose complexes/ hydro power complex
- To assess number of irrigation and multipurpose complexes/ hydro power/electric complex of Kerala
- Other ancillary results of review study (Barrage Weir and Anicut /Types of Irrigation Schemes of Kerala)
- A brief on two long-term pending major irrigation project in Kerala
- A brief on two long-term pending medium irrigation project in Kerala

Materials and Methods

The retrospective method was used to carry out the review study. Retrospective study derives the historical brief of any previous work. Secondary data were only means to study the major and medium irrigation projects of Kerala. The data were collected and compiled from various websites and records that were available;

- Kerala State Five year plan (First Plan to 13th Plan), Archives of Kerala State Planning Board (KSPB), Govt. of Kerala
- Economic review (1959 to 2016) of Kerala State Planning Board, Govt of Kerala.
- Kerala Irrigation Department, Government of Kerala (http://www.irrigation.kerala.gov.in/).
- Department of Agriculture Development and Farmers welfare (Karshika Keralam) (http://www.keralaagriculture.gov.in).
- Irrigation Design and Research Board, Department of Irrigation Government of Kerala (http://www.idrb.kerala.gov.in/idrb/index.php).
- Kerala Irrigation Engineers Association (http://www.keralairrigationengineers.org)
- Kerala State Budget, Ministry of Finance, Government of Kerala (http://www.finance.kerala.gov.in/index.php?option=com_content&view=category&id=18&Itemid=32).
- Agriculture Development - Government of Kerala, India https://kerala.gov.in/agriculture-developement?p_p_id=3&p_p_lifecycle=0&p_p_state=maximized&p_p_mode=view&_3_struts_action=%2Fsearch%2Fsearch&_3_redirect=%2Fweb%2Fguest%2Fagriculture-developement&_3_keywords=irrigation&_3_groupId=0
- IDRB, Irrigation Projects, Govt. of Kerala (http://www.idrb.kerala.gov.in).
- Water Resource Information System of India (WRIS).
- Library Books from Centre for Developmental Studies (CDS), Trivandrum.
- Maps were adopted from Kerala State Remote Sensing and Environment Centre (KSREC), Govt. of Kerala.

The rest of data were attained from document materials adopted from various scientific, non scientific, news, reports, monologue, etc, literatures from internet sources that were available in open access during the study period.

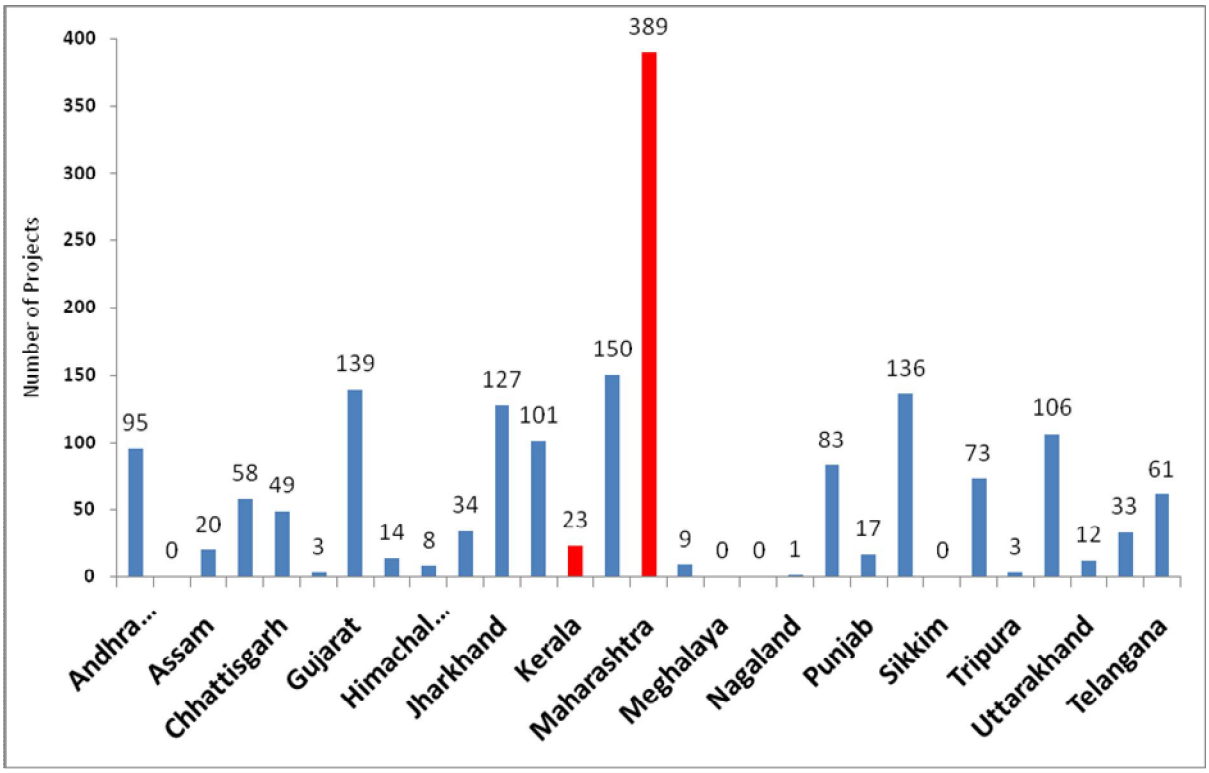
Analysis

The data analysis were carried out by arranging chronologically of the available materials in to Microsoft Excel 2007, year wise, state wise, district wise.

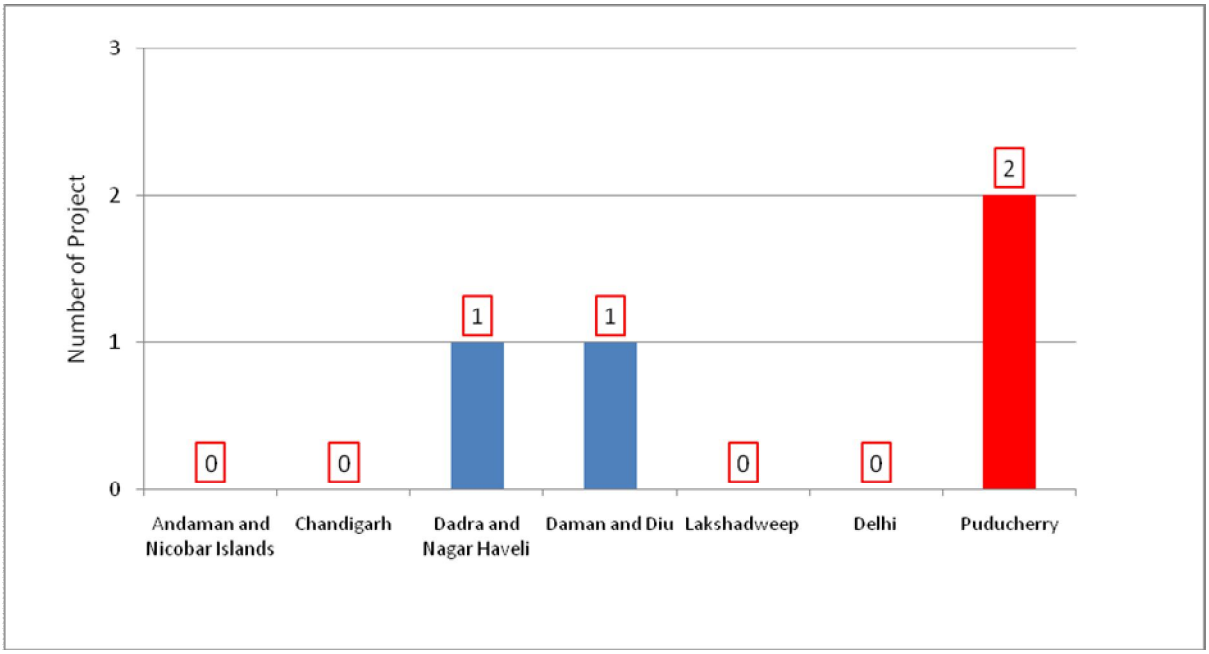
Results

Status of State wise number of major and medium irrigation projects in India

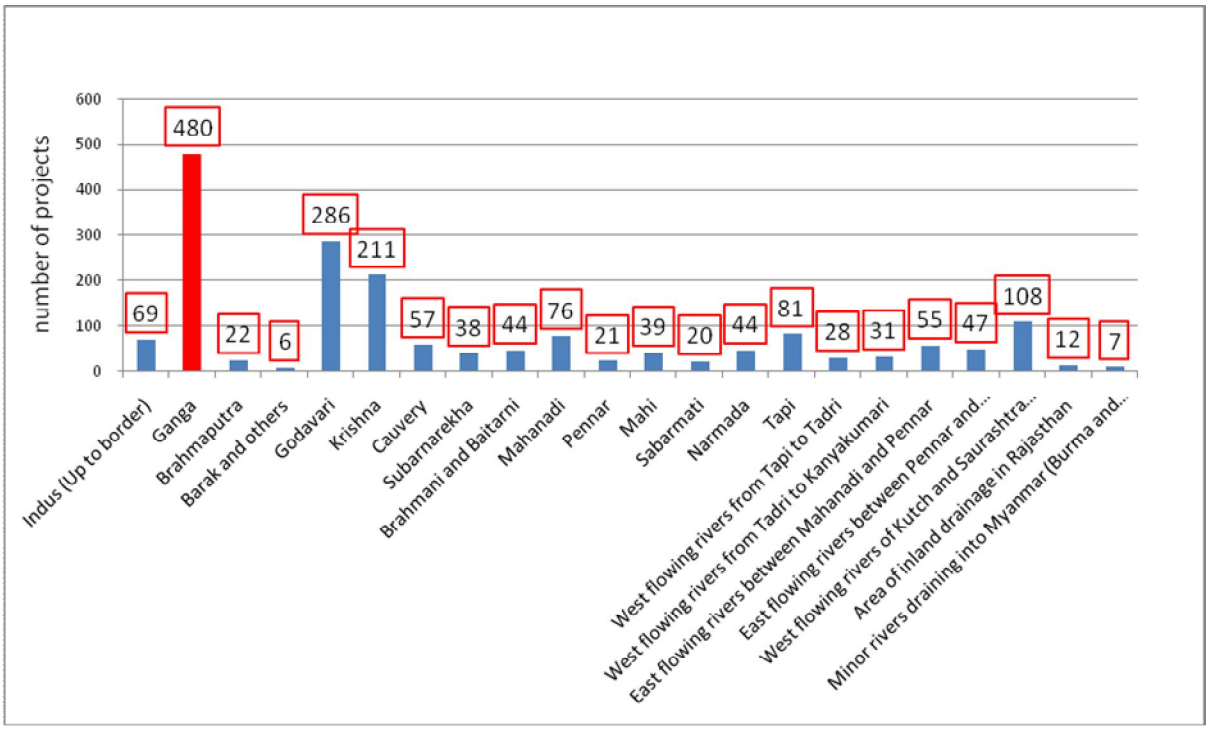
According to the Water Resource Information System of India (WRIS) Wiki the figures below shows the number of major and medium projects state wise (Figure) Union Territories (Figure) from the compendium of XIth Plan issued by Central Water Commission (CWC), The information provided by Munish and Paithankar, 2011 from table has been modified to draw graphical figures below.



Status of union territory wise number of major and medium irrigation projects in India



To assess the basin wise number of major and medium irrigation projects in India



The plan wise expenditure on irrigation in India

(Rs. in crores)

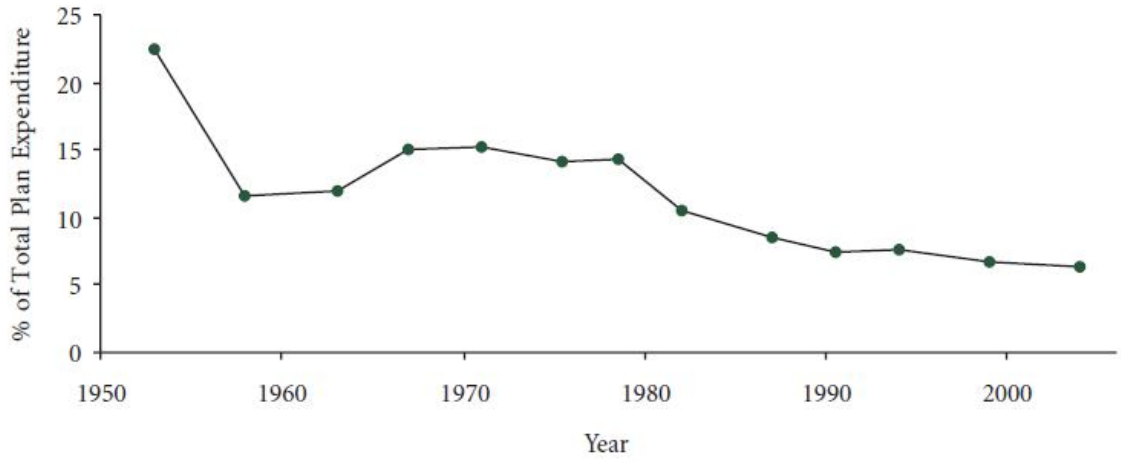
Sl.No	Plan Period	Major & Medium Irrigation (Rs.in crores)	MI/MI& CAD	Total Irrigation (Rs. in crores)	Total Plan Expenditure All Sectors (Rs. in crores)	Percentage of Expenditure on Irrigation
1	First (1951-56)	376.2	65.6	441.8	1960	22.54
2	Second (1956-61)	380.0	161.6	541.6	4672	11.59
3	Third (1961-66)	576.0	443.1	1019.1	8577	11.89
4	Annual (1966-69)	429.8	560.9	990.7	6625	15.04
5	Fourth (1969-74)	1242.3	1173.4	2415.7	15779	15.31
6	Fifth (1974-78)	2516.2	1409.6	3925.8	28653	14.22
7	Annual (1978-80)	2078.6	1344.9	3423.5	22950	14.27
8	Sixth (1980-85)	7368.8	4159.9	11528.7	109292	10.55
9	Seventh (1985-90)	1107.3	7626.8	18734.1	218730	8.56
10	Annual (1990-92)	5459.2	3649.5	9108.7	123120	7.4
11	Eighth (1992-97)	21071.9	13885.3	34957.2	483060	7.59
12	IX Plan (1997-02)	49289.0	13760	63049.0	941041	6.7
13	X Plan (2002-07)	83647	16458.9	100105.9	1618460	6.19
14	XI th Plan (2007-2012) Outlay	165350	46350	211700	3644718	5.81

Source: Plan documents 2010.

Table adopted from Suresh and Philip, 2013; Plan-wise Expenditure on Irrigation in India

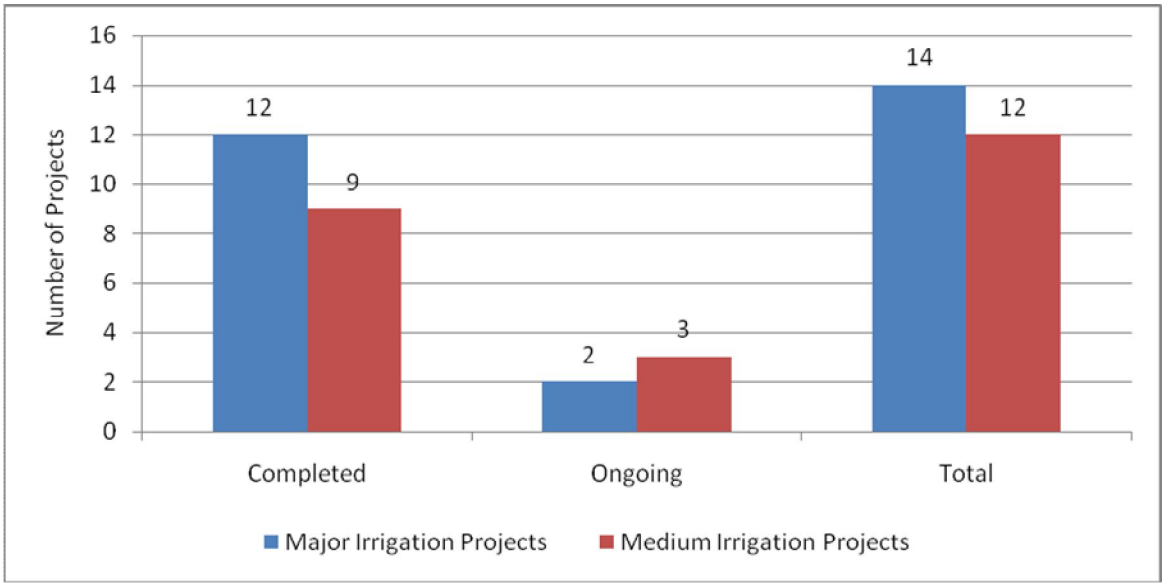
Central Plan Expenditure

Plan expenditure on irrigation has increased from Rs 441.8 crore in the First Plan to Rs 95743.42 crore (outlay) in the Tenth Plan, the share in total plan expenditure has decreased from 23% in the First Plan to 6.3% in the Tenth Plan. The trends in change of per cent of total plan expenditure on irrigation sector are shown in Figure below.



Expenditure on Irrigation

The number of major and medium irrigation project executed and ongoing in Kerala

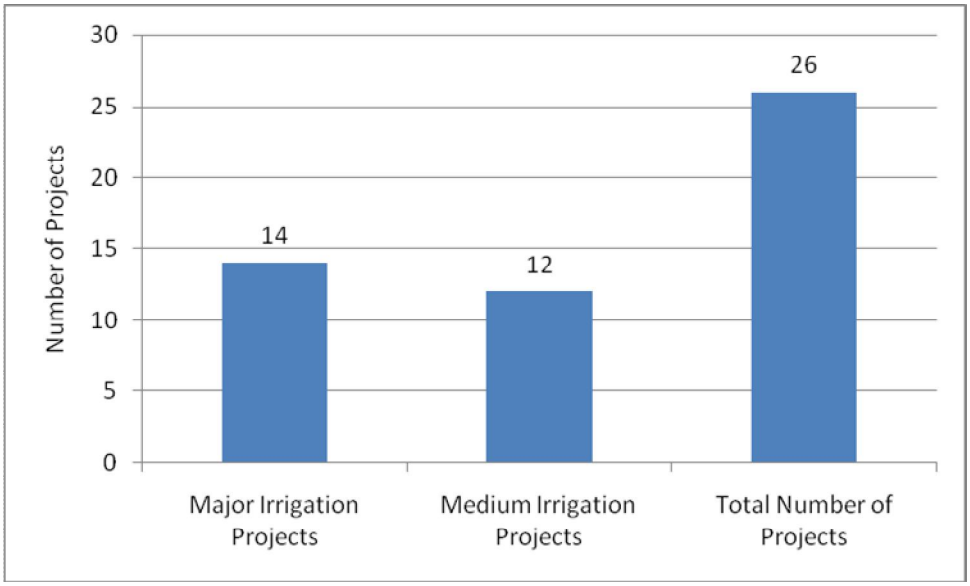


List of Major Irrigation projects of Kerala

Sl no	Irrigation Project Name	Basin	Status
1	Challakudy Stage - I & II Irrigation Project	West flowing rivers from Tadri to Kanyakumari	Completed
2	Chimony Major Irrigation Project	do	Completed
3	Chitturpuzha Major Irrigation Project	do	Completed
4	Kallada Major Irrigation Project	do	Completed
5	Kanhirapuzha Major Irrigation Project	do	Completed
6	Kuttiyadi Major Irrigation Project	do	Completed
7	Malampuzha Major Irrigation Project	do	Completed
8	Pamba Major Irrigation Project	do	Completed
9	Parambikulam Aliyar Major Irrigation	do	Completed
10	Pazhassi Major Irrigation Project	do	Completed
11	Peechi Major Irrigation Project	do	Completed
12	Periyar Valley Major Irrigation Project	do	Completed
13	Idamalayar Major Irrigation Project	do	Ongoing
14	Muvattupuzha Major Irrigation Project	West flowing rivers from Tadri to Kanyakumari	Ongoing

List of Medium Irrigation projects of Kerala

Sl no	Irrigation Project Name	Basin	Status
1	Bridge Cum Regulator At Thirthala	West flowing rivers from Tadri to Kanyakumari	Completed
2	Bridge Cum Regulator at Chamravattam	do	Completed
3	Cheerakuzhi Medium Irrigation Project	do	Completed
4	Gayathri Medium Irrigation Project		Completed
5	Mangalam Medium Irrigation Project		Completed
6	Neyyar Stage I & II Medium Irrigation Project		Completed
7	Pothundi Medium Irrigation Project		Completed
8	Vazhani Medium Irrigation Project		Completed
9	Walayar Medium Irrigation Project		Completed
10	Banasurasagar Medium Irrigation Project	Cauvery, West flowing rivers from Tadri to Kanyakumari	Ongoing
11	Karapuzha Medium Irrigation Project	Cauvery	Ongoing
12	Palakapandi Medium Irrigation Project	West flowing rivers from Tadri to Kanyakumari	Ongoing



Total number of irrigation projects in Kerala

The reports from www.keralaagriculture.gov.in accessed during study period shown the below list of major and medium irrigation projects that were accomplished and ongoing.

Both data reveal & create controversies in knowing the actual number of projects.

The major and medium irrigation projects accomplished in Kerala is as follows

Sl No	Name of Project	District	Year of Start	Year of Completion	Expenditure	Ayacut in ha	
						Net	Gross
1	Neyyar	Thiruvananthapuram	1951	1976	461	15380	23470
2	Pampa	Pathanamthitta	1961	1994	5898.04	21135	48480
3	Periyar Valley	Ernakulam	1956	1994	8350.87	32800	78325
4	Chalakkudy	Thrissur	1949	1966	188.25	19696	27258
5	Vazhani	Thrissur	1951	1962	107.57	2113	4226
6	Cheerakuzhy	Thrissur	1957	1973	90.76	1619	1846
7	Malampuzha	Palakkad	1949	1966	580	21732	40208
8	Peechi	Thrissur	1947	1959	235	18623	23718
9	Mangalam	Palakkad	1953	1966	106	3639	6608
10	Wayalar	Palakkad	1956	1964	131.66	3844	6505
11	Gayathri	Palakkad	1956	1970	220	5466	10114
12	Pothundy	Palakkad	1958	1971	234.25	5466	10046
13	Chitturpuzha	Palakkad	1963	1994	2570.21	15700	29950
14	Kuttiady	Kozhikode	1962	1994	5072.69	14570	34710
15	Chimoni Mupli	Thrissur	1975	1996	5958	13000	26000

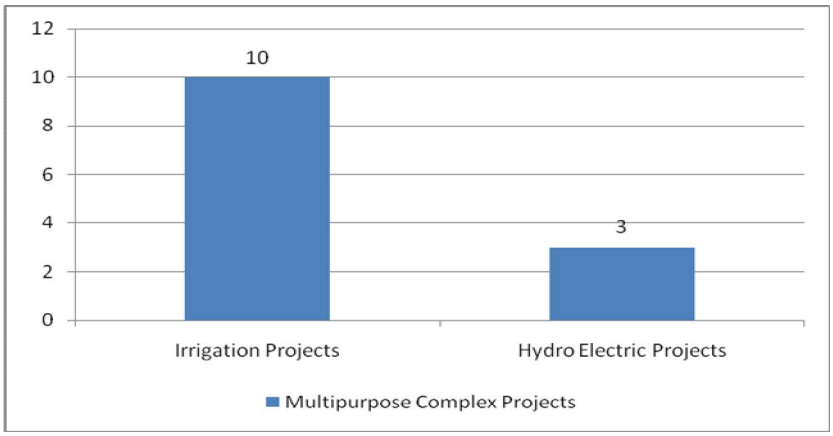
List of ongoing irrigation projects in Kerala

Sl No	Name of Project	District	Year of Start	Estimate	Expected Net	Ayacut in ha. Gross
1	Vamanapuram	Thiruvananthapuram	1981	3640	8057	16436
2	Kallada	Kollam	1961	45780	61630	92800
3	Thanneermukkam	Alappuzha	1975	1650	--	--
4	Meenachi	Kottayam	1980	4956	9950	14510
5	Moovattupuzha	Ernakulam	1974	8925	17737	34737
6	Edamalayar	Ernakulam	1981	6940	14060	43190
7	Kanjirapuzha	Palakkad	1961	7500	9713	21835
8	Kuriyarkutty Karappara	Palakkad	1978	6018	11736	23470
9	Attappady valley	Palakkad	1975	5000	4347	8378
10	Thrithala (BCR)	Palakkad	1998	--	1303	3997
11	Chaliyar	Malappuram	1981	37800	73240	108035
12	Chamravattom(BCR)	Malappuram	1985	1765	3106	9659
13	Banasurasagar	Wayand	1979	1798	2800	4800
14	Karapuzha	Wayanad	1975	4066	4650	9300
15	Pazhassi	Kannur	1962	7736	11525	23050
16	Kakkadavu	Kasargod	1979	9885	13980	41760

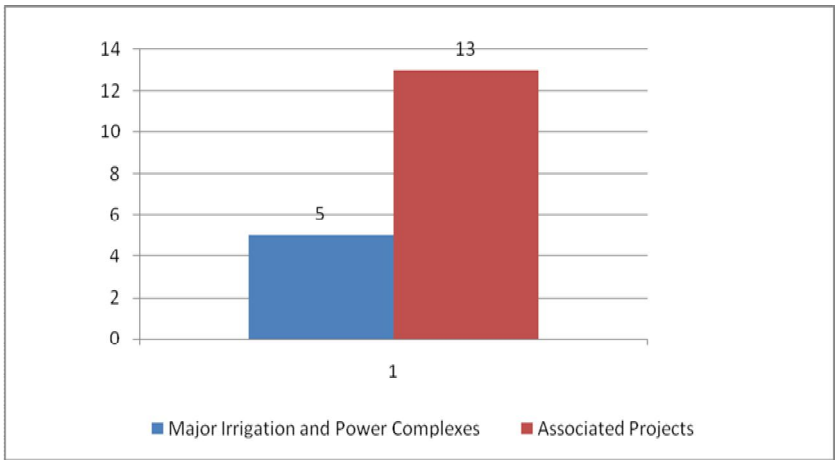
http://www.keralaagriculture.gov.in/htmle/irrigation/irigationproj.html

The irrigation and multipurpose complexes/ hydro power complex of kerala

There are many Irrigation, Hydro Power and Multipurpose projects which were approved initially as independent projects. Subsequently due to Interstate agreements and new projects coming up on downstream and upstream, the water planning was done in such a way that operation of these projects are now done in an integrated manner. Such types of the projects are now being called as Irrigation, Hydro Power & Multipurpose Complex.



Number of Hydro Electric & irrigation Projects



Number of major irrigation and power complexes with associated projects

Name of Irrigation and Multipurpose Complexes	Associated Projects
Pennar Complex	3
Idamalyar Complex	3
Muvattapuzha Complex	2
Kuttiyadi Complex	3
Pamba Complex	2
Total	13

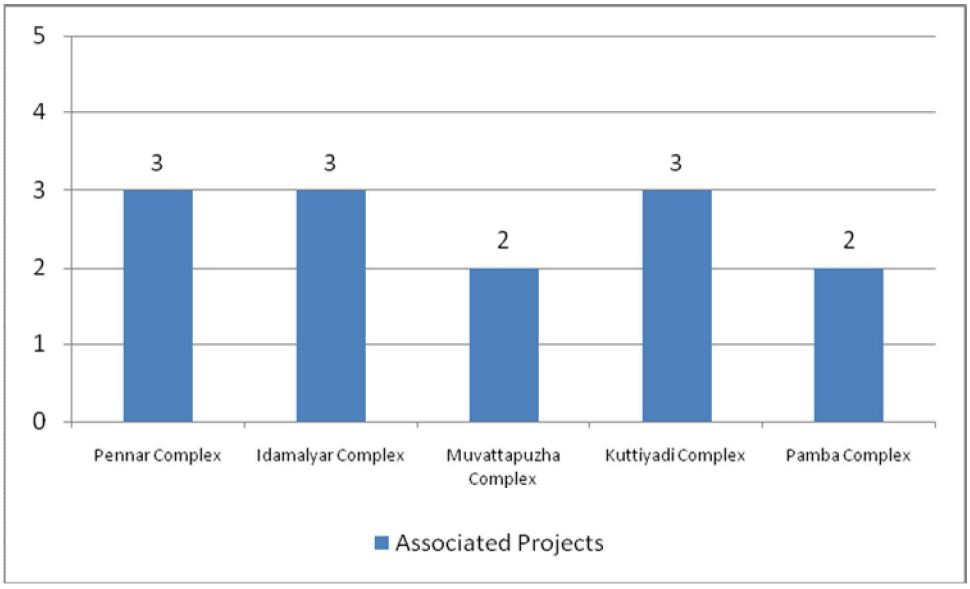
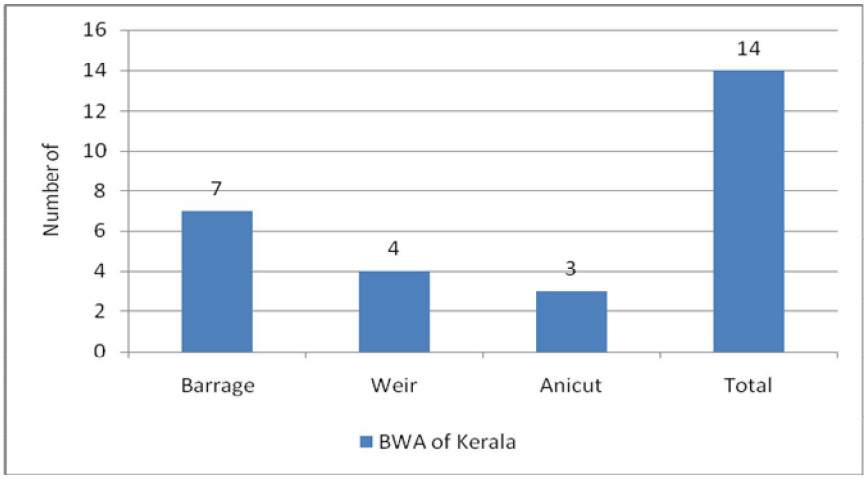


Table Irrigation, Hydro Power & Multipurpose Complex of Kerala

Name of the Complex Project	Associated Projects
Pennar Complex	1. Kanupur Canal Medium Irrigation Project
	2. Pennar Delta system including Kanigiri Irrigation Project
	3. Somasila Major Irrigation Project
Sabri Complex	1. Balimela Hydroelectric Project
	2. Lower Sileru Hydroelectric Project
	3. Potteru Major Irrigation Project
	4. Upper Sileru Hydroelectric Project
Yeleru Complex	1. Yeleru Canal open head channel System
	2. Yeleru Reservoir Project
Idamalyar Complex	1. Challakudy Stage - I & II Irrigation Project
	2. Idamalayar Major Irrigation Project
	3. Periyar Valley Major Irrigation Project
Muvattapuzha Complex	1. Idukki Hydroelectric Project
	2. Muvattupuzha Major Irrigation Project
Kuttiyadi Complex	1. Banasurasagar Medium Irrigation Project
	2. Kuttiyadi Hydroelectric Project
	3. Kuttiyadi Major Irrigation Project
Pamba Complex	1. Pamba Major Irrigation Project
	2. Sabarigiri Hydroelectric Project

Other ancillary results of review study

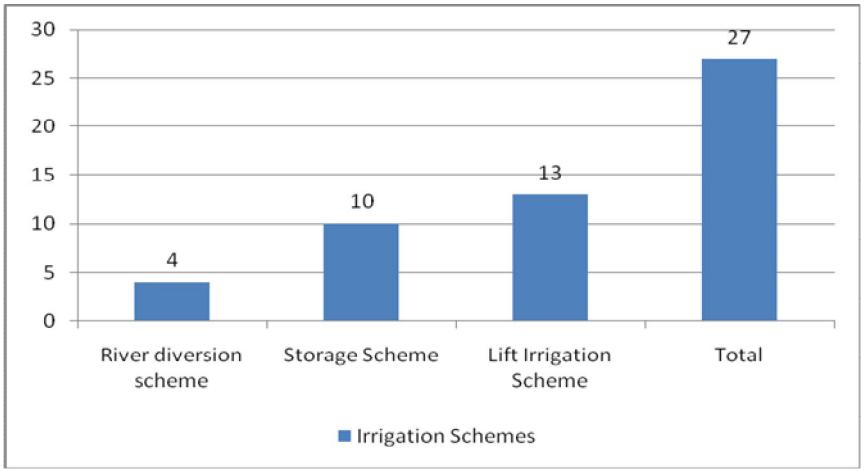
Barrage Weir and Anicut of Kerala



List of Barrages Weir Anicut

Sl.No	Name	Type	River	District	Completion Year	Length (m)	Height upto Crest (m)
1	Bhoothathankettu /Periyar Barrage	Barrage	Periyar	Ernakulam	1967	210.92	11.79
2	Bridge Cum Regulator At Thirthala	Barrage	Bharthapuzha	Palakkad	2007	295	13
3	Bridge Cum Regulator at Chamravattam	Barrage	Bharatpuzha				
4	Cheerakuzhi Weir	Weir	Gayathri	Thrissur			
5	Cheramangalam Weir	Weir	Gayathri	Palakkad	1951	115.98	2.89
6	Kunnamkattupathy weir	Anicut	Chitturpuzha	Palakkad			
7	Maniyar Barrage	Barrage	Kakkad	Pathanamthitta	1993	115.22	16.76
8	Moolathara Weir	Weir	Chitturpuzha	Palakkad		144.84	
9	Nurnee Anicut	Anicut	Chitturpuzha	Palakkad			
10	Ottakkal Barrage	Barrage	Kallada	Kollam			
11	Pazhassi (Kulur Barrage)	Barrage	Valapattamam	Kannur		245	
12	RA Head Work	Barrage		Idukki			
13	Thenbaramadakku Anicut	Anicut	Chitturpuzha	Palakkad			
14	Thumburmuzhi /Chalakudy Diversion Weir	Weir	Chalakudy	Ernakulam	1966	185	4.66

Types of Irrigation Schemes



List of River Diversion Schemes

Sl.No	River Diversion Schemes
1	Palakapandy Diversion Scheme
2	Chalakudy Diversion Scheme
3	Chitturpuzha Diversion scheme
4	Pazhassi Diversion Scheme

List of Storage Schemes

Sl.No	Name of Storage Scheme
1	Idamalayar Irrigation Scheme
2	Moovattupuzha valley Project
3	Kallada Irrigation Scheme
4	Cheerakuzhy Scheme
5	Vazhani Scheme
6	Peechi Scheme
7	Chimoni Scheme
8	Periyar Valley Scheme
9	Pamba Scheme
10	Neyyar Irrigation Scheme

Lift Irrigation Scheme		
Sl No	**Name of district**	**Ayacut (in Ha)**
1	Thrissur	9691.72
2	Palakkad	4571.83
3	Malappuram	7341.29
4	Kozhikode	143.47
5	Wayanad	1596.96
6	Kannur	253.48
7	Kasargode	426.6
8	Ernakulam	12552
9	Kollam	691.3
10	Chengannur	1395
11	Pathanamthitta	3063.02
12	Kottayam	788.8
13	Idukki	332.6

Salt Exclusion Barriers	
Permanent	
1	Thannermukkom Bund
2	Thottappally Spillway
3	Madambam Regulator cum Bridge
4	Manjummal Regulator cum Bridge
5	Chamravattom Regulator cum Bridge
6	Regulator cum Bridge at Thrithala
7	Regulator cum Bridge at Attappilly
8	Kariyar Regulator cum Bridge
Temporary	
1	Orumuttu

A brief on two long-term pending major irrigation projects in Kerala

Muvatupuzha Vally Irrigation (MVIP), Idamalayar Irrigation Project the two major long-term pending irrigation projects.

Long term Pending Major Irrigation

a. Muvatupuzha Valley Irrigation Project
b. Idamalayar Valley Irrigation Project

a. Muvattupuzha Valley Irrigation Project (MVIP)

This Project in Idukki district envisages the utilization of the tailrace water from the Idukki Hydroelectric Project and run-off from the free catchment upstream of Thodupuzha River, which is impounded by construction of a dam across Thodupuzha River at Malankara, 8 km upstream of Thodupuzha town. The water from the reservoir is directed through a system of canals to provide irrigation facilities to 19237 Ha (net) area of land in Ernakulam and Kottayam Districts. The Project was partially commissioned during 1994 after completing the head works and certain length of canal system.

The project MVIP consists of two canal system on the Right Bank and the other on the Left Bank. The left bank main canal is 37-10 km long and has five branches namely Murady, Ramamangalm, Piravom Mulakkulam and Ettumanur. The Right Bank main canal is 28.33km long has only one branch canal-Muvattupuzha branch canal. The main canal and right bank main canal were completed for full length. The branch canals out of the total length of 57.154Km, works for 54.647 Km have been completed and work are in progress for a length of 2.454Km. The work is 0.053 Km arranged. The total length of distributaries comes to 217.997Km & total ayacut comes to 36129Ha. Works 190.554 Km is completed and works of 13.413Km is in progress. The work of 14.03Km is to be arranged. Since 1994, water distribution is being carried out in the completed stretches of canals. Out of the 36129 Ha potential envisaged through the project, 32308 Ha has been created till date. Since some intervening missing links could not be completed till date, the gross potential achieved through the project is 25959 Ha.

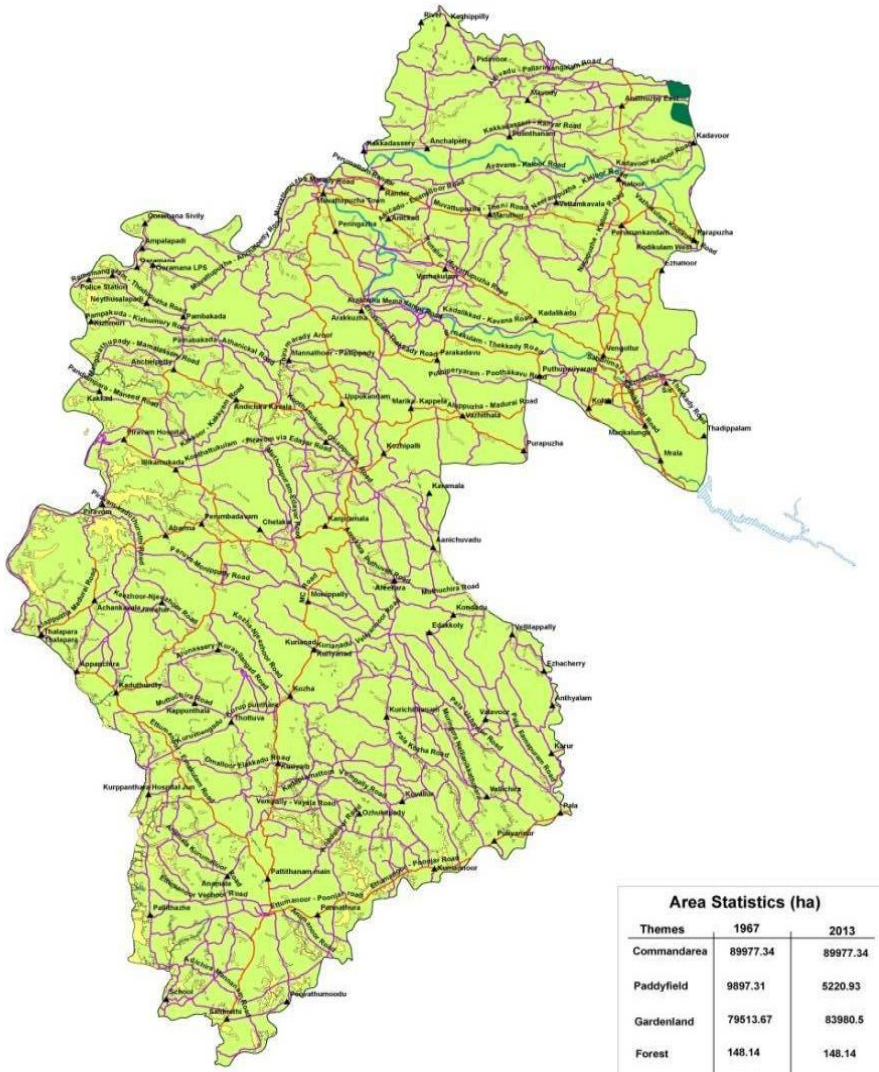
Salient Features of MVIP

Irrigation Project Name	Muvattupuzha Major Irrigation Project
Purpose	Irrigation
Type	Major
Engineering Type	Storage
Status	Ongoing
State	Kerala
Districts Benefited	Kottayam,Idukki,Ernakulam
Basin	West flowing rivers from Tadri to Kanyakumari
River	Thodupuzha
Work Started in 5 Year Plan	V-Plan
Project Approval Status	Planning Commission
Year of Approval by Planning Commission	1983
Approved Cost (Rs. in cr)	48.08
Culturable Command Area (CCA) (th ha)	19.24
Ultimate Irrigation Potential (UIP) (th ha)	37.74
Project Covered under CADA Scheme	Yes
Project Covered under AIBP Scheme	Yes
Project Covered under Tribal Sub-Plan	Yes

MUVATTUPUZHA COMMAND AREA MAJOR LANDUSE CLASSES

0 3 6 12 18 24 km

N



Legend

- Junctions
- RD_TYPE
- District Road
- National Highway
- State Highway
- Paddyfield (5220.93 ha)
- River (418.23 ha)
- Reservoir (209.54 Ha)
- Forest (148.14 Ha)
- Command_Area (89977.34 Ha)
- Gardenland (83980.5 ha)

Area Statistics (ha)

Themes	1967	2013
Commandarea	89977.34	89977.34
Paddyfield	9897.31	5220.93
Gardenland	79513.67	83980.5
Forest	148.14	148.14
River	418.23	418.23
Reservoir	209.54	209.54

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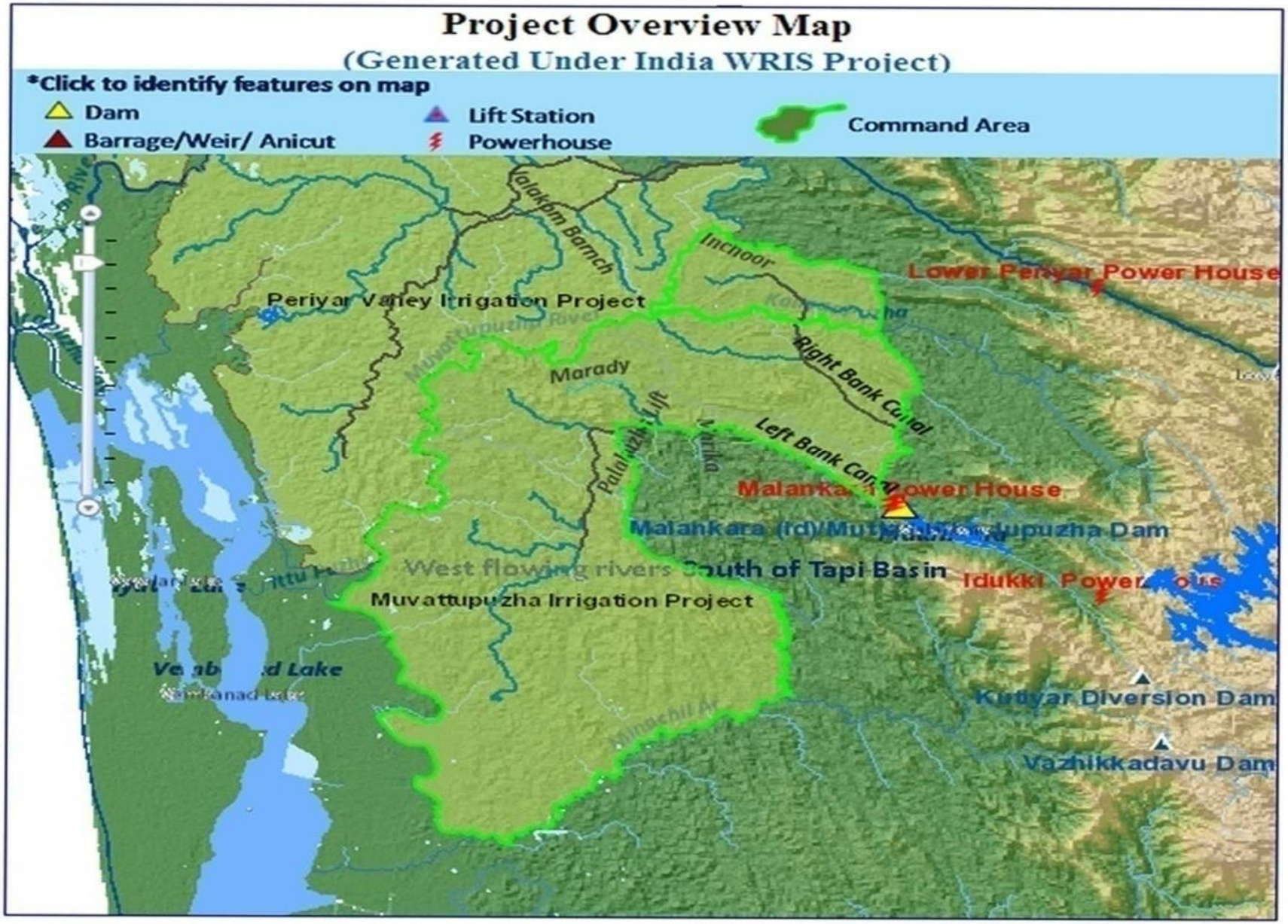

Project Overview Map
(Generated Under India WRIS Project)
*Click to identify features on map
Dam
Barrage/Weir/ Anicut
Lift Station
Powerhouse
Command Area
Periyar Valley Irrigation Project
Marady
Right Bank Canal
Left Bank Canal
Malankara (rd)/Muvattupuzha Dam
West flowing rivers South of Tapi Basin
Muvattupuzha Irrigation Project
Idukki Power House
Kuttiyar Diversion Dam
Vazhikkadavu Dam

Constituencies Benefitted by MVIP

- Thodupuzha
- Muvattupuzha
- Kothamangalam
- Piravom
- Kaduthuruthy
- Ettumanoor

Taluks Benefitted by MVIP

- Thodupuzha
- Muvattupuzha
- Kothamangalam
- Vaikom
- Meenachil
- Kottayam

Additional Benefits

- Drinking water supply schemes(65 Cusecs)
- The ground water level in the surrounding area will be much benefited, solving drinking water problem without incurring any additional expenditure
- Industrial benefit to Hindustan News Print Factory(700 Cusecs)
- Generation of Electricity (10.5 MW at d/s of dam)
- Desalination – The tail end of Kurumulloor MD and Kuravilangadu MD discharge in to Pennarthodu and Meenachil River respectively.

Present Status of the Project

						(Km)
Sl No	**Name of canal**	**Total length**	**Completed length**	**Progress length**	**To be arranged**	**%of work completed**
1	Main canal	65.437	65.437	-	-	100
2	Branches	57.154	57.099	0.055	-	99
3	Distributories	212.997	191.164	15.365	6.468	90
	Grand Total	335.588	313.700	15.420	6.468	93

- Gross ayacut of MVIP - 35619 ha
- Gross ayacut created - 32608 ha
- Gross ayacut achieved - 30627 ha
- Partially commissioned in 1994
- Expenditure including establishment charges as on 31.3.2017 – Rs. 968.60 crore including charged expenditure of Rs. 49.68 crore.
- Targeted date of completion – March 2018

Work to be completed

- Ettumanoor Branch Canal – Ezhuthonipadam Aqueduct ch.18
- Piravom Branch canal from ch.4150 to 6604m (Canal water through)
- Madakkathanam distributory
- Anicad East MD
- Koothattukulam Lift – Errection of motor and pump set
- Onakkur distributory (Canal water through)
- Edayar distributory
- Elanji distributory

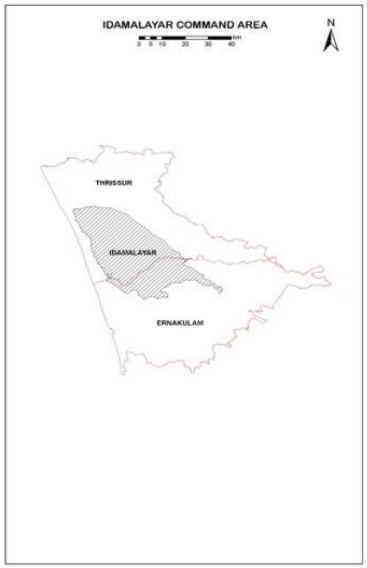
Idamalayar Irrigation Prorject (IIP)

The main canal has a total length of 32.278Km out of which 31.678Km. is completed. The low level canal has a total length of 27.25Km. out of which 12.854Km. is completed. The lining works of main canal for ch 7400m to 7600m including CD works and main canal for ch 7600m to 8000m including CD works have been completed. The link canal has a total length of 7.580Km out of which 2.793Km is completed. Also the low level canal-construction from ch 80m to 715m (Balance work) is completed. Water distribution on a temporary basis was made upto 28th Km of main canal during the festival seasons of 2013 and 2014. Now the entire length of main canal (32.278Km, 999 Ha.) and low level canal upto 7300m (122.66 Ha.) are water through. The upto date potential created is 2291.66Ha. and potential utilized is 128 Ha. (Manappattuchira).

Aim of Project	To provide irrigation on the right side of Periyar river in Aluva and Paravur Taluks of Ernakulam district and MukundapuramTaluk of Thrissur district. It also envisages extension of irrigation on left and right bank of Chalakudy river which is now feeding through Thumburmuzhy weir

- By linking link canal with CLBC of CRDS, CLBC can be fed by IIP water.
- The additional water can be utilized for irrigating an additional layout of 8514 Ha of new proposed branches of CRBC.

IDAMALAYAR COMMAND AREA MAJOR LANDUSE CLASSES



0 4 8 16 24 32 km

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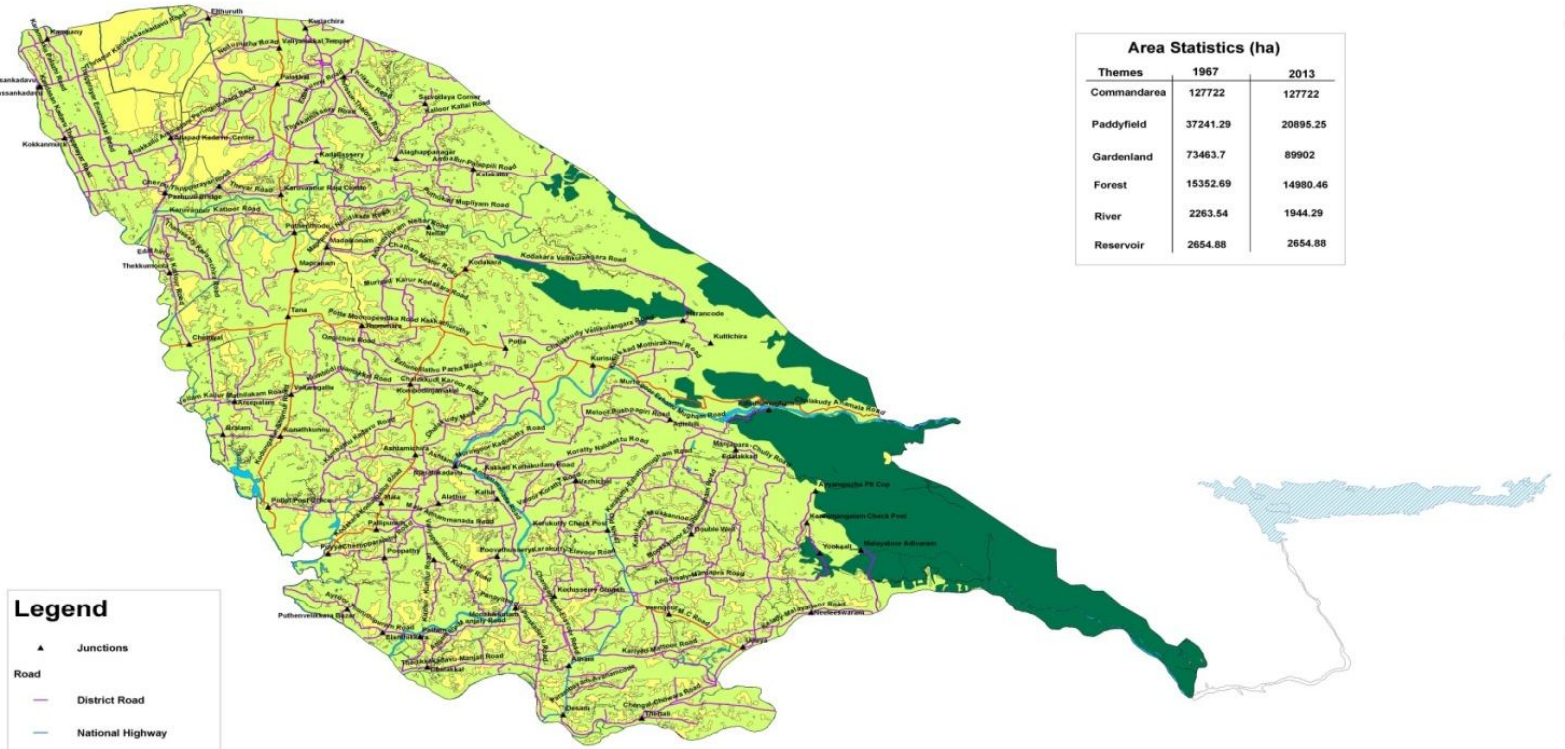

Area Statistics (ha)

Themes	1967	2013
Commandarea	127722	127722
Paddyfield	37241.29	20895.25
Gardenland	73463.7	89902
Forest	15352.69	14980.46
River	2263.54	1944.29
Reservoir	2654.88	2654.88

Legend

- Junctions

Road

- District Road
- National Highway
- State Highway
- River (1944.29 Ha)
- Reservoir (2654.88 ha)
- Paddyfield (20895.25 ha)
- Gardenland (89902 ha)
- Forest (14980.46 ha)
- Commandarea (127722 ha)

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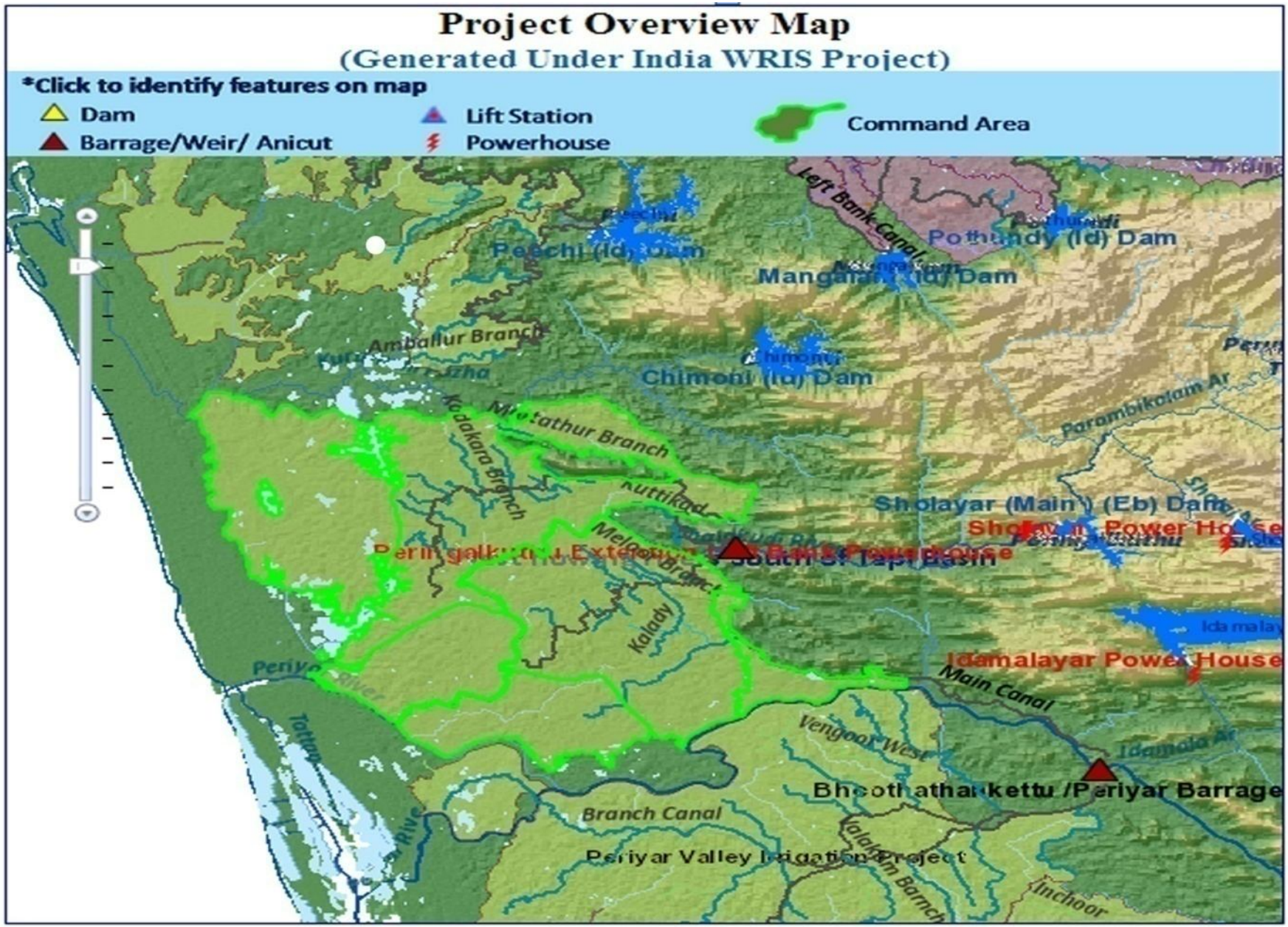
Project Overview Map

(Generated Under India WRIS Project)



Present Status of the Project

Sl No	Name of canal	Total length (km)	Completed length(km)	Length to be completed (km)	% of work completed	Work Progressing (km)
1	Main canal	32.278	32.278	Nil	100%	
2	Low level canal	27.25	12.902	14.348	47.35%	1.901
3	Branches of LLC	26	Nil	26	0	Nil
4	Link Canal	7.575	2.793	4.782	36.85%	0.15
5	CLBC new branches	10.9	0	10.9	0	-
6	CRBC new branches	48	0	48	0	-
	Grand Total	152	47.925	104.03	46%	2.051

- Commenced in 1981 with an estimated cost of Rs. 17.85 crore , revised to Rs. 750.00 crore as per 2012 SOR
- Project was approved by State Government for Rs. 107.00 crore
- Canal system consists of – Main canal (32.278 km),
- Low level canal (27.25 km) & its branches of length 26 km
- Link canal (7.575 km)
- Chalakudy left bank branches (10.9 km)
- Chalakudy right bank branches (48 km)
- Envisaged ayacut -14394 ha, achieved ayacut – 2976.1 ha
- Up-to-date expenditure is Rs. 433 crore

Issues In Storage

- Parambikulam – Aliya Agreement
- Violation of PAP agreement by tamilnadu is the major problem faced by CRD Scheme
- Absence of review of PAP agreement
- Facing acute shortage of water in CRDS

A brief on two long-term pending medium irrigation project in Kerala

Karapuzha and Banasugar projects are two medium irrigation projects

Long term pending Medium Irrigation

c. Karapuzha
d. Banasursagar

a. Karapuzha Irrigation Project

Karapuzha Irrigation Project is located in the Karapuzha stream of Wayanad District. The Karapuzha stream is east flowing which joins the Panamaramriver, which is a tributary of the river Kabini. Kabini river joins the inter - state river Cauvery. Catchment area of Karapuzha river up to dam site is 62 Sq.Km. and lies entirely in the state of Kerala.

Karapuzha Irrigation Project, the first project taken up for execution during Vth Five Year Plan envisaged construction of an earthen dam with concrete spillway across Karapuzha river at Vazhavatta in Vythiri Taluk of Wayanad District for providing irrigation to an area of 5600 Ha with an ultimate irrigation potential of 8721 Ha in Vythiri, S.Bathery and Mananthavady Taluk of Wayanad District through a network of canal system. The reservoir has a gross storage capacity of 76.50 Mm^3 (2.70 TMC) and live storage capacity of 72 Mm^3 water. As per Cauvery Water Disputes Tribunal (CWDT) final award 2.80 TMC water from the Cauvery basin is allotted to this project.

The project was cleared by Planning Commission vide No.11-20(4)/77-1 & CAD dated, 19.4.1978 and Administratively Sanctioned vide G.O. (MS) No.67/78/W&T dated, 28.7.1978 for an amount of 7.60 crore. The upto date expenditure for the project as on 31.03.2016 is 311.00 crore. The revised estimate cost of the project as per 2010 Schedule of Rates is Rs. 441.50 Crore. AIBP assistance is also availed for this project.

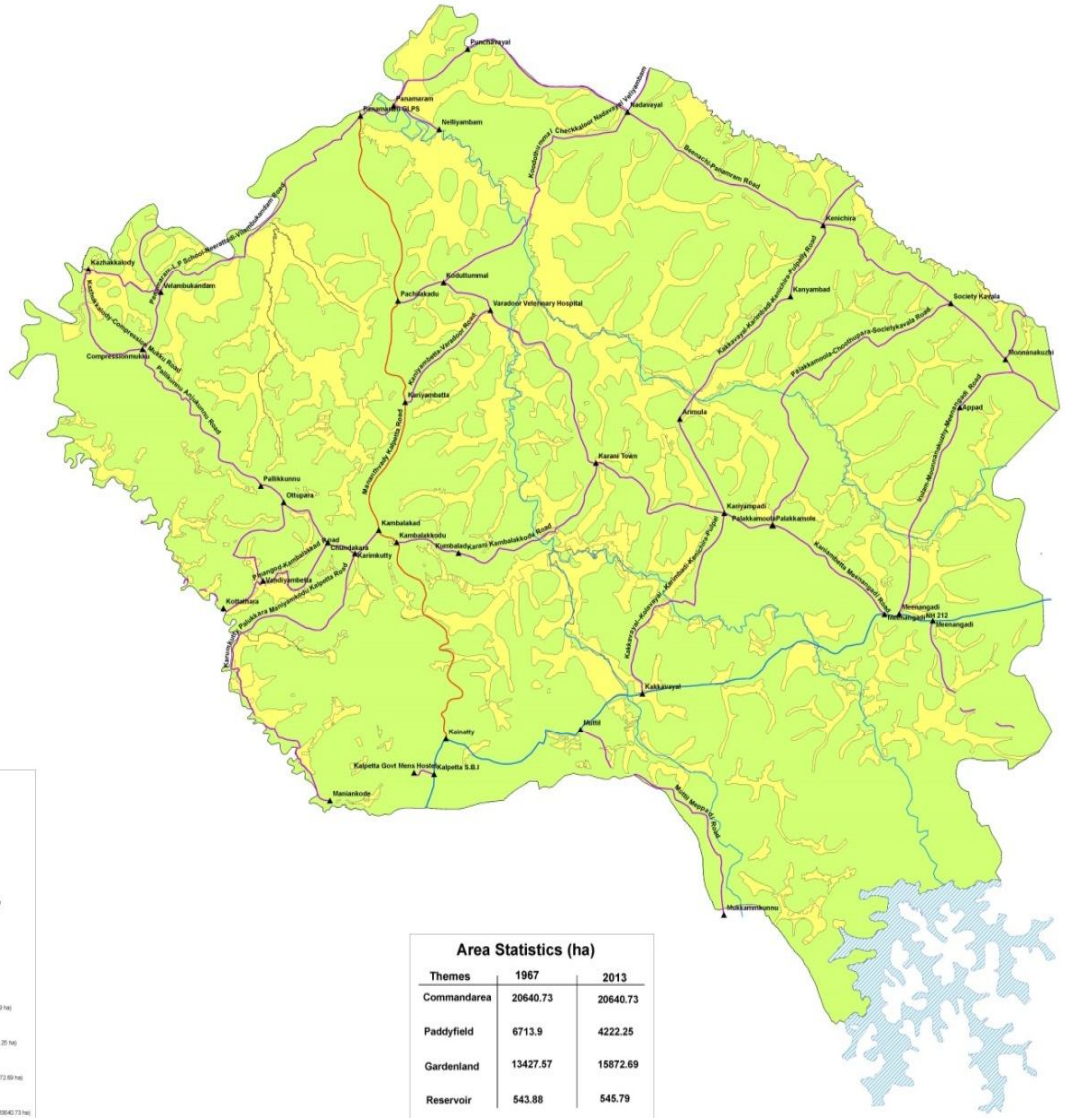
The project was partially commissioned on 20th June 2010. Water distribution has started through RBMC & LBMC for a length of 3.7 km and 8 km respectively since 2011-12 onwards. Water distribution through Arimunda Distributory (RBC) for a length of 2.12 km is also commenced. The total CCA created is 601 Ha. And the corresponding irrigation potential is 938 Ha. There are proposals for incorporating a Mini Hydel Scheme for producing 0.50 to 0.75 MW of electricity by Kerala State Electricity Board and Drinking water supply schemes to Kalpetta Municipality and adjoining Panchayat by Kerala Water

Authority (KWA). The drinking water supply scheme by Kerala Water Authority is under progress and nearing completion. As this project is situated in the Kabini Sub basin of the Cauvery basin and as it is the first irrigation project taken up for implementing as early as in the year 1978 in the Kabini basin of Kerala state and 2.80TMC of water is allotted to this project from the total 30TMC allotted to the state of Kerala from the Cauvery Basin by the CWDT in itÊs final award it is high time that this Project should be fully commissioned urgently to reach the benefits to the farmers and to utilize at least a small portion of the quantity of water allotted to the Kabini basin (21 TMC) by the CWDT.

Identifying the great tourism potential of the Karapuzha Irrigation Project located in the picturesque Wayanad District. The Ministry of Tourism, Government of India have accorded sanction for the development of the Karapuzha dam site and surrounding into a major destination in Kerala with a Central Financial Assistance of Rs. 492.03 Lakh. Government of Kerala accorded sanction for execution of this Project ÂDevelopment of Karapuzha Dam Site and surroundings into a major Tourist destination of KeralaÊ under the supervision of Karapuzha Division, Kalpetta. Beautification work is in progress.

The project was partially commissioned on 20th June 2010.Water distribution has started through RBMC and LBMC for a length of 2.12km. The total CCA created is 601Ha and corresponding irrigation potential is 938 Ha.

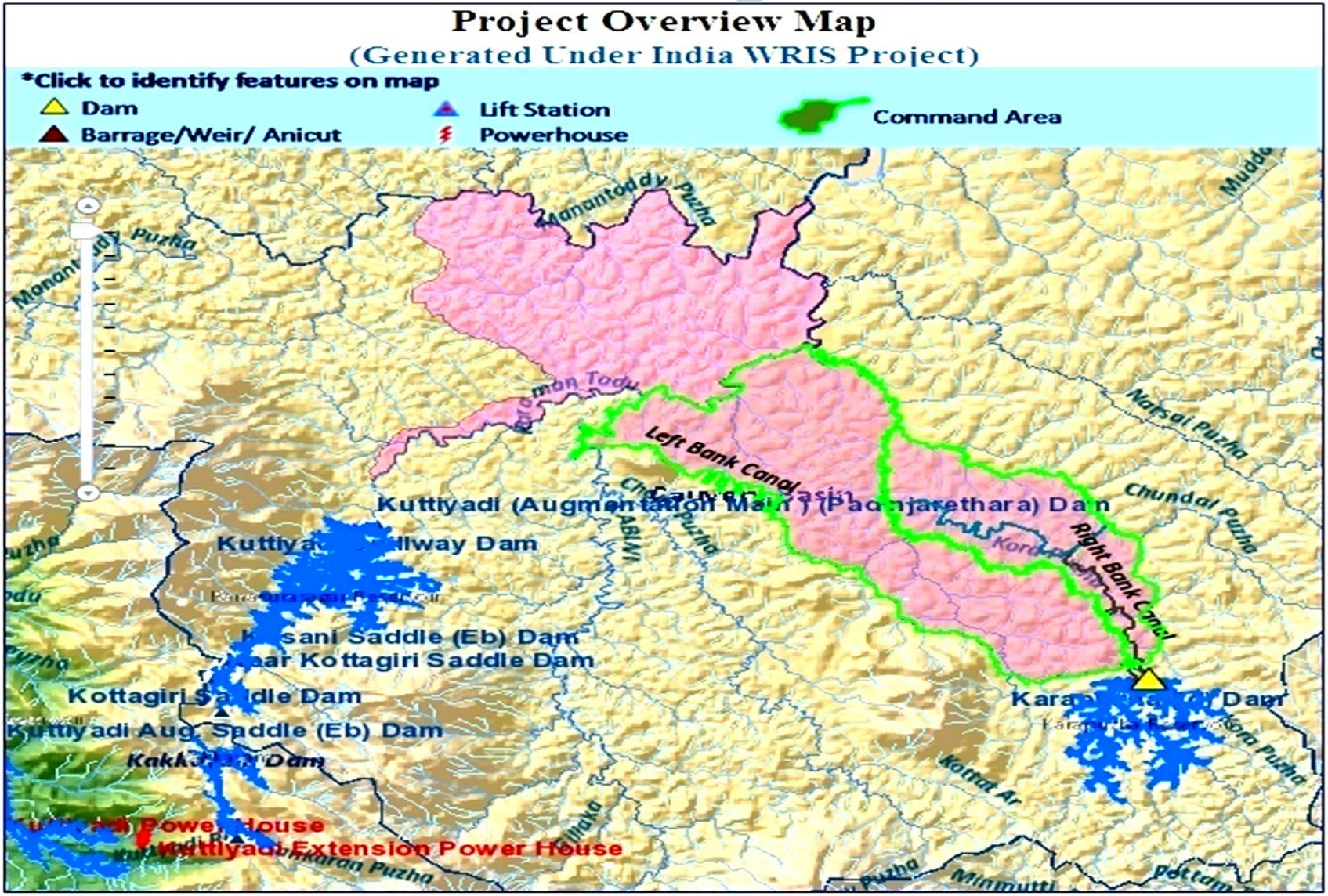
KARAPUZHA COMMAND AREA MAJOR LANDUSE CLASSES



Area Statistics (ha)

Themes	1967	2013
Commandarea	20640.73	20640.73
Paddyfield	6713.9	4222.25
Gardenland	13427.57	15872.69
Reservoir	543.88	545.79

KERALA STATE REMOTE SENSING & ENVIRONMENT CENTRE


Project Overview Map
(Generated Under India WRIS Project)
*Click to identify features on map
Dam
Barrage/Weir/ Anicut
Lift Station
Powerhouse
Command Area
Manantoddy Puzha
Left Bank Canal
Kuttiyadi (Augmentation Main) (Padinjarethara) Dam
Kuttiyadi Extension Power House
Right Bank Canal
Chundal Puzha
Kottiyur
Minmutti

Present Status of Project

- Earthen dam and saddle dam – 100% completed
- Spillway, radial shutter, service gate, emergency gate, diversion chamber - 100% completed

	Description	**Length**	**Length of completed canal**	**Remarks**
a	Main Canal	25.545 km	25.545 km	Completed
b	Branches (5 branch canal)	43.24 km	20.50	47.26 % completed
c	Distributaries	60.145 km	2.12	3.50% completed
	Total length of canal	**128.93 km**	**48.10**	

b. Banasurasagar Project

BanasuraSagar Irrigation Project envisaged to irrigate 2800 Ha (Net) of agricultural land (net) for the second crop and third crops (The first crop being rain fed crop Vythiri and MananthavadyTaluks of WayanadDistrict. The Dam is located at Padinjarathara near Thariode town across Karamanthode, which is a Tributary of Panamaram river.

According to the scheme now finalized, there will be only one common reservoir across Karamanthode for irrigation as well as hydel power. The water required for irrigation under the Banasurasagar project of about 43.40 Mm3 (1700Mcft) annually will be let down as per irrigation requirement from the storage constructed by the KSEB. A share of the cost of the storage scheme will be met by the Irrigation department. The work of main canal length of 2.73Km.was completed except from ch.1130 to 1500.

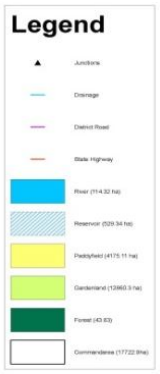
1) Padinjarathara Branch Canal of length - 9.03Km
2) Venniyode Branch Canal of length - 5.39Km

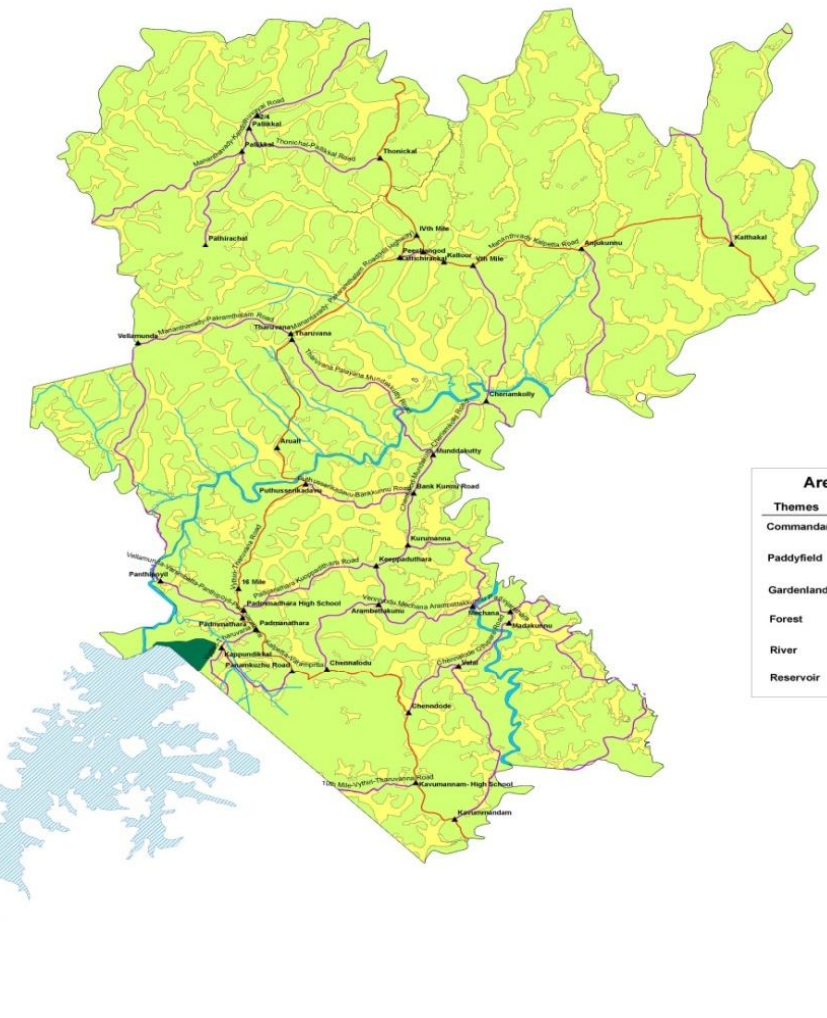
The works of both branch canals are in progress. There are 14 nos. of distributaries in this canal system. Land acquisition process of distributaries is in progress. The total expenditure incurred for the project upto 31.3.2016 is Rs 50.94Crore.

As per GO(Rt) 773/2015/WRD dated 17.09.2015 Administrative Sanction for the Modernisation of field channels and drains of CADA canals of Major Projects have been issued for a total amount of Rs. 28 Crore. Chitturpuzha Project Rs. 15 Crore, Malampuzha Project Rs. 5 Crore, Mangalam Project Rs.4 Crore and Pothundy Projects Rs.4 Crore.

The construction of Kappumkunnu distributaries and three reaches and the main canal except one aquaduct are completed. The concrete core samples from portion of the work (aqueduct ch.1130m to 1500m) already completed, were collected by the NIP, Calicut and report to be received. Land acquisition of the Padinjarathara Branch Canal from from one to 4370m is completed and the remaining is in progress. The land acquisition process of other required reaches and 10 distributaries are yet to be started. The construction of Venniyode branch canal, Kappumkunnu Distributory is in various stages.

BANASURASAGAR COMMAND AREA MAJOR LANDUSE CLASSES

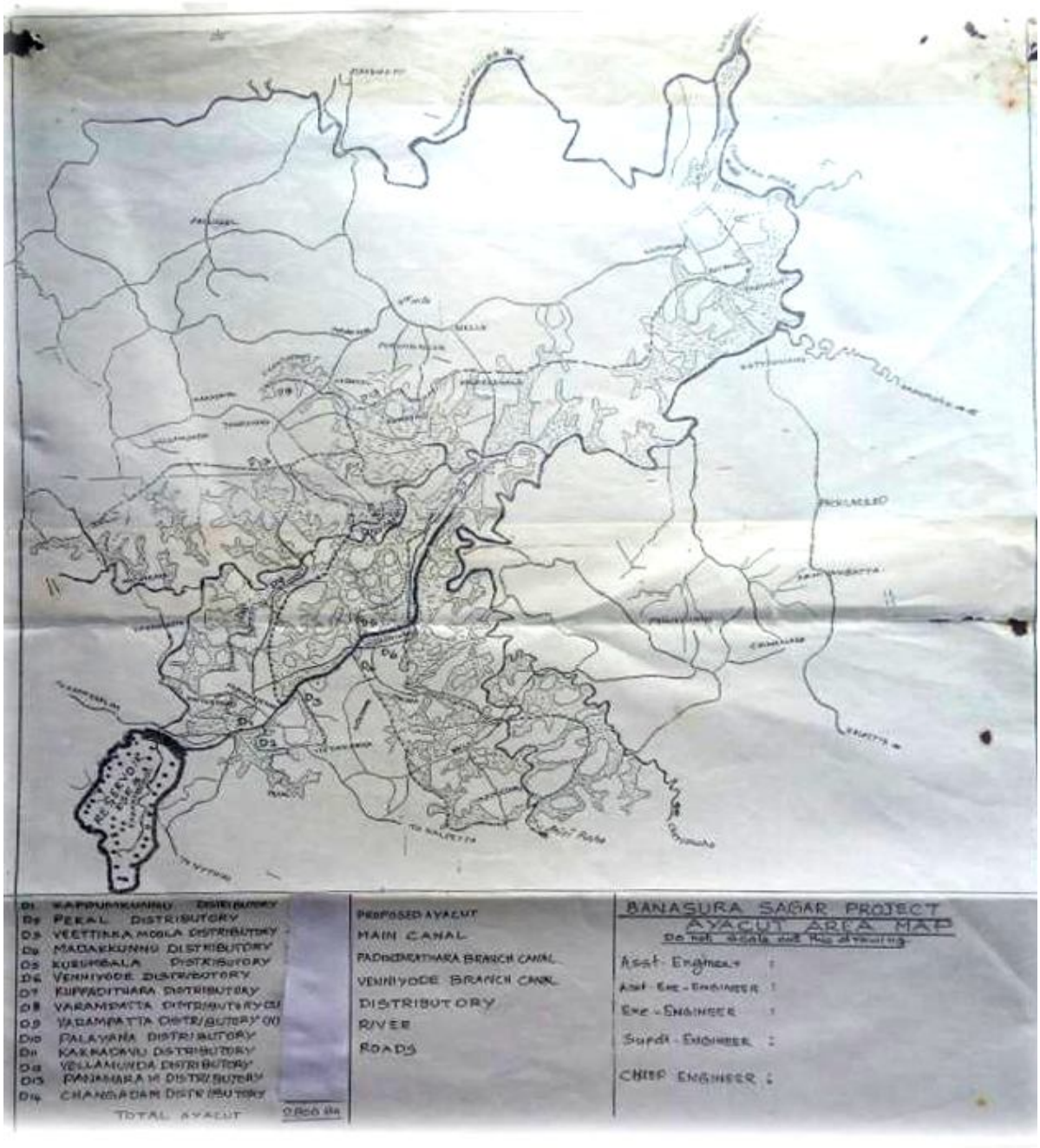




Area Statistics (ha)

Themes	1967	2013
Commandarea	17722.9	17722.9
Paddyfield	5091.86	4175.11
Gardenland	11894	12860.3
Forest	43.83	43.83
River	114.32	114.32
Reservoir	578.91	529.34

KERALA STATE REMOTE SENSING & ENVIRONMENT CENTRE



Present Status

The work of main canal having a length of 2.73 km is completed except one aqueduct from ch.1130 m to 1500 m.

Conclusion

The present study compiled the number of major and medium irrigation project completed and ongoing in the Kerala state. This study has identified the lacunae such like; Lack of availability of irrigation works in digital formats. The data were sparse to avail; proper documentation of the irrigation works in open accesses was major limitation to make a review. The Central government and state government irrigation websites shall be updated with these resources and shall be transparent to avail data in public domain. The electronically documenting the non electronic records shall be encouraged by all irrigation line departments district wise and state wide. It shall be intimated to central authorities to upload in their websites in time to time.

The initial study was to document the history of the irrigation projects in Kerala. But the availability of documents was sparse. So the study just focused only on the number of major and medium irrigation projects. The planning board shall take initiative to encourage documenting the data in correct and chronological order from with detail description of each irrigation project. The working group reports of planning board of irrigation sector shall be placed as available in public domain in planning board.

Technical Terminologies for Irrigation

Actual Utilization - Actual utilization is the gross area actually irrigated each year.

Application Efficiency (AE) - It is the ratio of the average depth of the irrigation water stored in the root zone to the average depth of irrigation water applied.

Area Assessed - The area irrigated on which water rate have been levied.

Base Period - The number of days over which duty of water is reckoned, determined or measured. Base period equals the period between first and last irrigation to raise a crop.

Border Strip Irrigation Method - It is controlled surface flooding irrigation method where the field to be irrigated is divided into narrow strips by long parallel low bunds or levees along the general slope of land which shall normally be sufficiently gentle and each strip of land is irrigated by admitting a stream of water at the upper end.

Canal Irrigated Crop - A crop which is raised predominantly on canal irrigation.

Check Basin Method - The method consists of applying water to an area which is prepared level or nearly level and divided into basins or compartment, usually of rectangular shape with bunds. A supply channel is aligned on the upper edge of the area, and the laterals are dug in between two check basins.

Classification of Irrigation Projects - The irrigation projects can be classified as:

i. Major Irrigation Scheme - Culturable Command Area (CCA) more than 10,000 hectare (ha)

ii. Medium Irrigation Scheme- Culturable Command Area (CCA) more than 2000 hectare (ha) and upto 10,000 hectare (ha)

iii. Minor Irrigation Scheme - Culturable Command Area (CCA) upto 2000 hectare (ha)

Closure period - The period when the canal is closed for regular maintenance, repairs and other purposes.

Consumptive Use Efficiency - The ratio of consumptive water use by crop and the soil moisture stored in the root zone of the soil during the crop growth period.

Consumptive Water Use - The quantity of water cosumed in evaporation transpiration and metabolic processes during crops growth, including water consumed by accompanying weed growths. It is expressed in water-depth units per unit area, also called Consumptive Water Use or Evapotranspiration.

Conveyance - The movement of water from its source through the main or secondary canals or conduits to the tertiary or distributory offtakes.

Conveyance Losses or Transmission Losses - Losses of water in transit from the source of supply to the point of field turn out whether in natural channels or in artificial ones, such as

canals, distributaries or watercourses. They comprise evaporation from the water surface, seepage and incidental transpiration by vegetation growing in or along the canals network. These also include the operation losses in the canal system.

Crop irrigation ratio – The crop irrigation ratio is the ratio of area irrigated under the crop to the total area (irrigated plus unirrigated) under the same crop expressed in percentage.

Crop Water Requirement - The total water needed for evapotranspiration from planting to harvest for a given crop in a specific climate regime, when adequate soil water is maintained, by rainfall and/or irrigation so that it does not limit plant growth or crop yield.

Culturable Command Area - It is the area which can be physically irrigated from the scheme and is fit for cultivation **or** The difference between the gross command area and the unculturable area falling under the command **or** Total area in which cultivation is possible.

Culturable Irrigable area - The culturable command area less the area not available for irrigation due to high relief or other reasons.

Culturable Lift Irrigation - The culturable command area that can be irrigated only by lift irrigation.

Curve of Demand - A graph showing chronologically the amount of water needed for irrigation at various times during a crop season.

Curve of Supply - A graph showing chronologically the quantity of water available for irrigation during a time period from a given source.

Delta - It is the quantity of irrigation water expressed in depth units over the irrigated area. It is stated with reference to the place at which it is measured or reckoned, that is, delta at farm, delta at out-let, head of watercourses, or lateral head, delta at distributary head, delta at head of main canal.

Design Duty of Water - Duty of water assumed in a irrigation project for designing capacities of channels.

Distributary or Tertiary - Canal or conduit taking water from the con-veyance system and supply it to one tertiary unit.

Distribution Efficiency - It is the measure of uniformity of irrigation water distribution over a field.

Diversion Structure - The structure that diverts water from the water sources and supplies it to the irrigation system.

Division Structure - A structure in the conveyance system that divides the flow into two or more canals or conducts, or both.

Drip/Trickle Irrigation - It comprises the application of water in drops close to the plant. The entire space between the plants is not watered.

Dryland Crops - The crops which do not normally require irrigation because the prevailing quantity and incidence of the local rainfall is suitable and sufficient for cultivation.

Duty of a Well - The average annual area of land irrigated by well for maturing a crop.

Duty or Duty of Water - The relation between the area irrigated, or to be irrigated, and the quantity of water used, or required, to irrigate it for the purpose of maturing its crop. Duty is stated as area per unit area of flow.

Farm Field Inlet - A structure which supplies water to a farm field.

Farm Irrigation Efficiency - The percentage of the water consumed by crops in a farm to the water made available at the farm gate.

Farm Losses - Losses of water on the farm due to uneven distribution, evaporation and percolation into the subsoil due to over irrigation. These include surface run-off and deep percolation.

Field Application - The application of water from the field inlet to the field.

Field Application Efficiency - The field application efficiency is made up of two parts (1) the efficiency of water transport system in the field and (2) the efficiency with which the water is applied. It is, by definition, the relation between the quantity of water furnished at the field inlet and the quantity of water needed to maintain the soil moisture above some target level required for the crop.

Field Capacity (FC) - The moisture remaining in a soil following wetting and natural drainage until free drainage has practically ceased.

Field Channel - Channel usually taking water from the watercourse and supplying it to one or more forms or fields.

Field Irrigation Requirements - The requirements of irrigation water for crops at the diversion point of supply channel.

Flow Irrigated Area - Area which can be irrigated from the source of water, by flow under gravity alone.

Furrow Irrigation - It is a method of applying water to crops sown in rows through furrows.

Gross Command Area - The total geographical area which can normally be commanded or serviced from a irrigation project without consideration of water supplies available for irrigation. It is the total area covered by an irrigation project including unculturable area under habitation, road, tanks, waste land, forest land etc.

Gross Irrigated Area – The gross irrigated area is the total irrigated area under various crops during the whole agricultural year, counting the area irrigated under more than one crop during the same year as many times as the number of crops grown. Inter-cultured or mixed crops are treated as one crop.

Gross Irrigation Ratio – The gross irrigation ratio is the ratio of gross irrigated area to the gross cropped area in a year.

Intensity of Irrigation - The percentage of total area of normally irrigated crops in a year to total culturable command area.

Irrigation - The supply of water by artificial means for raising crops.

Irrigated Area - The area to which irrigation water has been applied.

Irrigation Method - The manner in which irrigation water is applied to the land for raising a crop.

Irrigation Potential Created - (As per Planning Commission)

a. The irrigation potential created by a project at a given time during or after its construction is the aggregate gross area that can be irrigated annually by the quantity of water that could be made available by all connected and completed works upto the end of the water courses or the last point in the water delivery system upto which the Government is responsible for construction.

b. Before an area is included and reported under 'Potential Created', it may be ensured that the storage, head-works as well as the distribution system including irrigation outlets to serve the area are completed together with necessary water courses covering chaks or blocks upto 40 hectares in area and that works completed will make available the requisite water for the purpose in a design year for the assumed cropping pattern. The irrigation outlets should be of a capacity of about 0.03 cumec. The capacity may, however, vary depending on local conditions relating to topography, crop pattern, etc. but it should not normally exceed 0.06 cumec. The figures of the potential which relate to the gross irrigated 'new area' and 'old area stabilized' should be reported separately. The potential which refers to the 'old areas stabilized' should, however, not be considered as adding to the total irrigation potential created since this area would have already counted earlier once.

Irrigation Potential Utilized - (As per Planning Commission)

a. The irrigation potential utilized is the total gross area actually irrigated by a project during the year under consideration. The figures relating to the stabilization of 'old area' should be furnished separately in this case also since these will not be additive to the gross area irrigated.

b. As, generally, the utilzation of irrigation potential created can take place only in the year following the creation of such potential, it will be appropriate if the irrigation potential utilized in a particular year is considered with the potential created upto the end of the preceding year for the purpose of comparison.

Irrigation Return Flow - It is the leakage or seepage or both of water from irrigation works, namely, canals and dams or regenerated flow from fields which could be used for irrigation areas downstream.

Irrigation System - It includes storage and diversion structure, main canal, distributory, minors, water courses, field channels, and allied structures including head regulator, cross drainage works and control structures.

Irrigation Water Requirement - The amount of crop water requirement that is not provided by effective rainfall, utilization of stored soil moisture or upward flow of water to the root zone from a saturated zone.

Irrigation Works - The works related to storage, diversion, conveyance and delivery of irrigation supplies to the project command.

Lift Irrigated Area - That area where the level is too high to allow irrigation by gravity flow, but which can be irrigated by lifting water to the necessary level at some point in the supply system.

Lift Irrigation - It is the method of irrigation in which the water is lifted with mechanical or manual means.

Main Canal - Principal canal for the conveyance of water supplied to the branch canal/distributary.

Management Allowed Deficit (MAD) - It is the desired soil moisture deficit at the time of irrigation.

Net Irrigated Area – The net irrigated area is the area irrigated during the year counting the area only once, even if two or more crops are irrigated in different seasons on the same piece of land.

Net Irrigation Ratio – The net irrigation ratio is the ratio of net area irrigated to the net area sown in a year expressed in percentage.

Net Water Requirement - The consumptive use requirements of crops minus the effective rainfall.

Nominal Duty or Normal Duty - The duty sanctioned as per the schedule of an irrigation department.

Non-beneficial Consumptive Use - The water consumed by native non-crop vegetation, evaporated from bare and ideal land surfaces and from water surfaces.

Non-perennial Area - The area which does not receive perennial irrigation.

Outlet Command Area - The area, in irrigation practice, for distribution of water from an outlet. It is the area that can be served by an individual outlet.

Outlet or Turnout - A structure that supplies water to a block in which different farmers use the flow in rotation.

Overall Irrigation Efficiency of the System - It is the ratio of the average depth of irrigation water which is beneficially used to the average depth of irrigation water supplied from the headwork.

Panchnama - A written statement executed by canal authority in presence of and witnessed by the irrigators or members of water committee of the concerned canal system against an offender found misusing, wasting or taking water unauthorizedly.

Peak Period Consumptive Use - It is the average daily water used during the period of highest consumptive use.

Perennial Irrigated Area - The area served by a perennial canal.

Reservoir Storage Efficiency (Es) - It is the ratio of the volume of water released from the reservoir for irrigation, to the volume of water received in the storage reservoir (surface or underground) for irrigation.

Ring/Basin Method of Irrigation - It consists of applying water in level basins either of rectangular or circular shape, generally made around each tree or group of trees.

Rostering of Channels - It is the sequencing of water delivery in different channels as a part of regulation.

Rotational Distribution Water Supply - It is a time table of water supply to individual fields from a particular outlet during one rotation.

Pre-Sowing Irrigation - Water application to a field before sowing of a crop to provide the required moisture in the soil for germination of the seed.

Sprinkler Irrigation - The method of applying water over the land by spraying it under pressure. This is often done by rotating sprinkler heads with one or more nozzles or by using perforated pipes.

Sub-Surface Irrigation - This is the method of applying water to crops below the ground surface through porous tiles or similar other material. This can also be done through low level open ditches. It is generally applicable to layered soil.

Surface Irrigation - Method of irrigation where the water flows on to the field surface by gravity from the head to the tail end.

Surface Irrigation Method - It is the application of water by surface method such as wild flooding, border strip, check basis, and furrows for raising crops.

Ultimate Irrigation Potential -(As per Planning Commission)

i. It is the gross area that can be irrigated from a project in a design year for the projected cropping pattern and assumed water allowance on its full development. The gross irrigated area will be aggregate of the areas irrigated in different crop seasons, the areas under two-seasonal and perennial crops being counted only once in the year.

ii. The following considerations have to be taken into account in estimating the ultimate irrigation potential expected from a project in terms of area:

a. It will not be correct to assume the culturable command area as an arbitrary percentage of the gross command area. The CCA should be assessed from actual and by consulting land records.

b. A part of the area being proposed to be brought under irrigation from a project may be already receiving irrigation from other sources, whether major, medium or minor irrigation works, which might have been commissioned earlier. The benefits from the new project may be by way of an additional water allowance to irrigation more secure or to stabilize irrigation the area. Such area should not be counted in new irrigation potential but considered only as stabilize of irrigation in an old area. The Ultimate irrigation potential should indicate only figures of gross irrigation of new area whether in the new command area or in the existing command (by increasing the intensity of cropping). The old area stabilized may be reported separately.

Unit Irrigation Efficiency (Eu) - It is the ratio of the volume of irrigation water used in evapotranspiration in the specified irrigated area, plus that necessary to maintain a favourable sal concentration in the soil solution, to the volume of water delivered to the area.

Utilization Ratio - The utilization ratio is the ratio of the actual irrigated area to the irrigation potential.

Water Conveyance Efficiency (EC) - It is the ratio of the volume of water delivered by an open or closed conveyance system to the volume of water delivered to the conveyance system at the supply source.

Well Irrigated Crop - A crop which is raised on by well irrigation.

Wild Flooding - It is a method of irrigation by uncontrolled flooding of the area.

Water Use Efficiency (WUE) - It is defined as the marketable crop produced per unit of water consumed in evapotranspiration.

Wilting Point (WP) - It is the moisture content of the soil below which plants can no longer extract moisture at a rate sufficient for its growth.

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