

**Estimation of the availability of Backwater in  
KVK Mandla and its use through Micro Irrigation  
system**

**THESIS**

*Submitted to the*

**Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur**

**In partial fulfilment of the requirements for the award of  
Degree of**

**MASTER OF TECHNOLOGY**

*In*

**AGRICULTURAL ENGINEERING**

**(Soil and Water Engineering)**

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**2020**

## CERTIFICATE - I

This is to certify that the thesis entitled “**Estimation of the Availability of Backwater in KVK Mandla and its use through micro irrigation system**” submitted in partial fulfillment of the requirement for the degree of **MASTER OF TECHNOLOGY** in **Agricultural Engineering (Soil and Water Engineering)** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Miss. Anshita Walkey** under my guidance and supervision. The subject of the thesis has been approved by the Student’s Advisory Committee and the Director of Instructions.

All the assistance and help received during the course of the investigation has been acknowledged by her.

Place: Jabalpur

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## **Declaration and Undertaking by the Candidate**

I, Anshita Walkey D/o Shri Ashok Kumar Walkey certify that the work embodied in thesis entitled “**Estimation of the availability of Backwater in KVK Mandla and its use through Micro Irrigation system**” is my own first hand bonafide work carried out by me under the guidance of Dr. A. K. Bajpai at Department of Soil and Water Engineering, College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during 2019 – 2020. The matter embodied in the thesis has not been submitted for the award of any other degree/diploma. Due acknowledgment has been made to all the assistance and help.

I, undertake the complete responsibility that any act of misinterpretation, mistakes, and errors of the fact are entirely of my own.

I, also abide myself with the decision taken by my advisor for the publication of material extracted from the thesis work and subsequent improvement, on mutually beneficial basis, provided the due credit given, thereof.

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## ACKNOWLEDGMENT

Prostration and adoration to the lotus feet of almighty God and my parents for giving the opportunity to express my heartfelt gratitude, to all those who have extended help to make this study a success.

First and foremost, I offer my sincere gratitude to my major advisor Dr. A.K.Bajpai Associate Professor, Department of Soil and Water Engineering, College of Agricultural Engineering JNKVV, Jabalpur for unconditional support extended to me. I shall remain indebted to him for his patience, encouragement and unfailing enthusiasm. His willingness to share knowledge and resources made my research life smooth and rewarding.

I take this privilege with immense pleasure to express my deep sense of gratitude and feeling of respect to the members of advisory committee Dr. S.K. Pyasi, Professor, Dr. M.L. Sahu, Associate Professor, Dr .R.B. Singh, Professor, Department of Soil and Water Engineering for their incessant help, judicious guidance, constant supervision and valuable suggestions during the entire period of research work.

I avail the great opportunity to express my gratitude to Dr. R.K. Nema , Dean and Head of Department of Soil and Water Engineering, College of Agricultural Engineering, Jabalpur and Dr. Abhishek Shukla, Director of Instruction, JNKVV, Jabalpur, for all possible help and encouragement given to me during the study period.

I sincerely thank Dr. M.K. Awasthi, Dr. M.K. Hardaha, Dr. Y.K. Tiwari, Dr. S.K. Sharma, Dr. R. N. Shrivastava, Dr. Manish Bhan and all the faculties of Department of Soil and Water Engineering, College of Agricultural Engineering, JNKVV, Jabalpur. Who extended whole hearted support and cooperation to me in my research.

Besides I am very much thankful to all the professors and staff members of College of Agricultural Engineering, JNKVV, Jabalpur who directly or indirectly helped me during my study and for completing the work on time.

It gives me immense pleasure in expressing my humble gratitude to Mr. Akash Gautam, Librarian, College of Agricultural Engineering, JNKVV, Jabalpur.

Diction is not enough to express my gratitude from the deepest core of my soul to my respected mother Mrs. Jayanti Walkey and brother Mr. Dikshant Walkey, whose selfless love, constant encouragement, obstinate sacrifices, sincere prayers, exceptions, blessings, affection and care during the study period have always been the most vital source of inspiration in my life.

I would like to thanks all my seniors Ayushi Trivedi, Shilpee shrivastava, Reetu Singh. Also special thanks to my close friends Shivani Wastrane, Anupama, J Himanshu Rao, Pankaj Thakur, Ashish Suryavanshi. Above all, I am thankful to the almighty for his grace and immense blessing always showered upon me.

Place: Jabalpur

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## SYMBOLS AND ABBREVIATION

%	:	Percentage
'	:	Minute
°	:	Degree
°C	:	Degree Celsius
A	:	Area
AMC	:	Antecedent Moisture Conditions
Avg	:	Average
C	:	Runoff Coefficient
CCA	:	Culturable Command Area
CGWB	:	Central Ground Water Board
CN	:	Curve number
E	:	East
e.g.	:	Exempli Gratia (for example)
et al.	:	And others
Etc.	:	Etcetera (and so on)
Fig	:	Figure
GCA	:	Gross Command Area
GIS	:	Geographical Information System
Govt	:	Government
GOI	:	Government of India
GSDP	:	Gross State Domestic Product
Ha	:	Hectare
Hrs.	:	Hours
i.e.	:	id est (in other words)
IDF	:	Intensity-Duration Frequency
ILWIS	:	Integrated Land and Water Information System
IMD	:	Indian Meteorological Department

IRS	:	Indian Remote Sensing
Km	:	Kilometers
km/day	:	Kilometers per day
Kmph	:	Kilometers per hour
km <sup>2</sup>	:	Square kilometers
LISS	:	Linear Imaging Self Scanning Sensor
LU/LC	:	Land use and land cover
m/s	:	Metre per second
m <sup>2</sup>	:	Square metre
mm	:	Millimetre
mm/day	:	Millimetre per day
MP	:	Madhya Pradesh
N	:	North
Q	:	Runoff Depth
Q <sub>p</sub>	:	Peak runoff
R	:	Correlation Coefficient
RR	:	Rainfall Runoff
RS	:	Remote Sensing
S	:	Shape Factor
SCS	:	Soil Conservation Service
T <sub>c</sub>	:	Time of concentration
USA	:	United states of America
USDA	:	U.S. Department of Agriculture
W/S	:	Watershed

## INTRODUCTION

In the age of water scarcity and climate change, micro-irrigation can help increase crop yield and decrease water, fertilizer and labor requirements. Agriculture may have to face the brunt, water would be diverted to other sectors and agriculture would have to make its peace with lesser and poorer quality of water. Climate change too has aggravated water scarcity concerns. Micro irrigation through its water saving approach, has paved the way for higher water use efficiency of around 75%-95%. Another resource saving practice possible through micro-irrigation is fertigation, which comprises combining water and fertilizer application through irrigation (Anonymous, 2020). KVK Mandla situate at the latitude of 22°35'52" N and a longitude of 80°22'16" E. basically the backwater is formed by the Narmada River. The Total length of Narmada River is 1312 Km and length in MP is 1077 Km. The catchment area of river is 85149 km<sup>2</sup>. The estimation of Backwater availability has been suggested in the KVK Mandla, Madhya Pradesh, India, for using this water through micro irrigation system based on the field survey and monitoring.

Backwaters defined as estuaries which occur near sea shore due to tides and in command area as a result of over flowing of canals system. The capacity of most of the canals has reported due to deposition of sedimentation in the canal bed coupled with seepage problem. Backwater can refer to a branch of a main river, which lies alongside it and then rejoins it, or to a body of water in a main river, backed by the tide or by an obstruction such as a dam. Manmade restrictions to natural stream flow or temporary natural obstructions such as vegetation blockage or flooding of a lower stream can create backwater (Qasim *et al.*1973). Heavy rains and release of water from upstream dams on the Narmada River and its tributaries, the backwaters are rising, said the Narmada Valley Development Authority (NVDA).

In the state of Madhya Pradesh (MP) agriculture is the basis of economy. It contributes almost one-fourth of Gross State Domestic Product (GSDP) and the main source of employment for over 65 percent. The geographical area of MP is 30.8252 million ha. As much as 49% of the land is cultivable. Agriculture is the mainstay of state's economy as 74.73 % of the

people are rural. The net sown area during 2010- 11 was estimated at about 2,08,36,000 ha. (Both Rabi and Kharif). Agriculture in Madhya Pradesh is characterized by low productivity and predominated by the use of non-mechanized methods of cultivation. Because only a portion of the sown area is irrigated, the state's agriculture has remained heavily dependent on rainfall; some regions often suffer drought. Irrigation in Madhya Pradesh is carried out primarily by means of canals, wells, and tanks. The food grain production was 171.77 lakh metric tons. The productivity of major crops like wheat, rice, pulses has also been good. Since the year of 2010, the government of MP has embarked on an ambitious irrigation expansion and modernization plan. The net area under irrigation was 65.43 lakh hectares in the year 2009- 10.

The south state of India, Kerala has been blessed with an extensive backwater. These backwaters generally lying parallel to the Arabian sea coast of Kerala (Anirudhan *et al.*, 1987). Large area of backwaters in Kerala is known by different names like brackish waters, lakes, lagoons and estuaries including mangroves and swamps.

Backwater conservation means not only for multi-cropping agriculture in the KVK (Mandla) but also serves as a resource-base for other activities such as the collection of fodder, to irrigate the fields, tourism, etc. The backwaters have a unique ecosystem: freshwater from the rivers meets the seawater. Such fresh water is extensively used for irrigation purposes. Based upon the information collected during research work, it is found that the only a few studies detail about various types of back-water availability carried out over past decades (Das *et al.* 2012).

The district Mandla is situated in the east central part of Madhya Pradesh, III, Agro climatic zone (Northern hill zone of Chattisgarh). The entire district catchments are the Narmada River and its tributaries. In the area KVK Mandla, most of the people are not able to cultivate the Rabi crop even though the available water i.e. the backwater which is sufficient for the enhancement of the economic return by cultivation during Rabi season. The authority is not able to utilize the backwater properly Thus the main objective is to provide a plan for the augmentation of irrigation facilities through micro irrigation system using backwater.

The backwater may be quantified by both methods spatial and temporal method. Data regarding to backwater on spatial and temporal basis can be performed making field visits and the help of government records. Micro irrigation is the slow application of continuous drips, tiny streams or miniature sprays of water above or below the soil surface.

A suitable hydraulic structure (water tank) is needed to design for storing this backwater. A reinforced concrete tank is a very useful structure for storage of water and for other similar purposes. Generally, three kinds of water tanks- resting on ground, underground tanks and elevated tanks are in use. The tanks resting on ground like clear water reservoirs, settling tanks, aeration, tanks etc. are supported on the ground directly. The walls of these tanks are subjected to pressure and the base is subjected to weight of liquid and upward soil pressure. From design point of view, the tanks may be classified as per their shape as rectangular tanks, circular tanks, over- head service reservoir (OHSR), and Intz type tank *i.e.* OHSR for large capacity. In this research work the rectangular shaped tank is selected. Rectangular tanks are provided for smaller to moderate capacity. (Jindal *et al.* 2012). The present study attempts for the people of villages near around KVK Mandla (Phulsagar, village), to create provision for rabi crop during the dry season for sustenance of their livelihood.

Use of Micro Irrigation System can definitely increase the crop productivity therefore, the present study is proposed with following specific objectives:

1. To estimate the spatial and temporal availability of backwater in KVK Mandla.
2. To use this available water through micro irrigation system.

## **REVIEW OF LITERATURE**

This chapter deals with backwater and its use for irrigation in upland unirrigated areas of Northern hills zone of Chhattisgarh by making hydraulic structure (Water tank) to store the backwater and to use it by Micro Irrigation system (MIS) through lift irrigation. The review has been classified into six classes, namely (a) Command areas of Madhya Pradesh (b) availability of backwater and (c) Agro climatic Zones of M.P.(d) cropping pattern of the state (e) Lift irrigation and (f) Micro irrigation system.

### **2.1 COMMAND AREAS OF M.P.**

During the post-independence era, a large number of irrigation projects were constructed for increasing the agricultural production in the country. However, during early seventies analysis of irrigation potential created and utilized revealed that there was a substantial gap between them. The Irrigation Commission made specific recommendations in its report that systematic development of commands of irrigation projects should be taken up in order to fully utilize the irrigation potential created. Subsequently, a Committee of Ministers set up by the Ministry of Irrigation and Power analyzed the issue and suggested that a broad-based Area Development Authority should be set up for every major irrigation project to undertake the work of comprehensive area development. Based on this recommendation, the Government of India initiated a Centrally Sponsored Command Area Development Programme (CADP) in December 1974 to improve the irrigation potential utilization and optimize the agricultural production and productivity through integrated and coordinated approach of efficient water management (Anonymous). Table 2.1 shows the ongoing command area development project:

**Table 2.1 Ongoing Projects under Command area development & water management (CADWM) during the Period of XI Plan (2007-08 to 2011-12) (March 2012)**

Sr. No.	Project Name	Districts benefitted	Year of Inclusion	CCA (Thousand Ha)	Cumulative MoWR 31.03.2012	Reported balance of executable CCA(th.Ha)
1	Kolar	Sehore	1985-86	45	11.354	33.646
2	Rani Avanti Bai(Bargi)	Jabalpur, Narshinghpur	1990-91	157	33.967	123.033
3	Upper Wainganga	Seoni	1985-86	112.9	103.007	9.893
4	Bagh	Balaghat	1985-86	16.6	16.412	0.188
5	Harsi	Gwalior	1985-86	44.354	41.979	2.375
6	Kunwar Chain Sagar (dudhi) Project	Rajgarh	2003-04	3.7	3.136	0.564
7	Rajghat Canal Project	Ashok Nagar, Shivpuri, Tikamgarh, Datia, Bhind	2010-11	164.789	0.388	164.401
8	Bariyarpur Left Bank Canal	Chhatarpur	2011-12	46.682	0	46.682
9	Bansagar Project	Rewa, Satna, Sidhi and Shahdol	2011-12	154.687	0	154.687
			<b>Total</b>	<b>745.712</b>	<b>220.478</b>	<b>525.234</b>

CGWB(Central Ground Water Board)

### **2.1.1 Kolar**

Kolar is a right bank tributary of the Narmada River. It flows for a total length of 101 km, all of which is in the state of Madhya Pradesh. Kolar river arises in the Vindhya Range of Sehore district and flows in a south westerly direction to meet the Narmada near Nasrullaganj in the Sehore district of Madhya Pradesh, Its total drainage area is of 1347 km<sup>2</sup>, is spread across the two districts. The upper part of the river basin lies at an elevation of 350 to 600 meters and much of it is under tropical deciduous forest. The river debouches into the plains near Jholiapur. Much of the upper basin has poor soils and agriculture here is largely of wheat and gram. The lower basin has better soils and a flatter slope and has been used extensively bunded allowing for impounding water during the monsoons.

Near Lawakhadi in Sehore, the Kolar Dam, a masonry dam has been built across the river and it provides about 70% filtered water to Bhopal city and provides for irrigation and inland fisheries.

### **2.1.2 Rani Avanti Bai (Bargi)**

Bargi dam is the one of the first completed dams out of the chain of 30 major dam to be constructed on Narmada river on Madhya Pradesh, India Here Narmada fully Submerge Bargi river that it can't be seen as it exist or not. Two major irrigation projects, named Bargi Dversion Project and Rani Avanti Bai Lodhi Sagar project have been developed by Bargi Dam, The Narmada is the Largest river in Madhya Pradesh, flowing towards the west and falling in the Arabian Sea. Its total length is 1312 km of which it covers 1072 km in Madhya Pradesh.

### **2.1.3 Upper Wainganga**

Upper Wainganga (Sanjay Sarovar) Dam, is built across the Wainganga river in Chhapara tehsil of Seoni district of Indain state of Madhya Pradesh.

#### **2.1.4 Bagh**

River Bagh at Rajgaon, a tributary of Wainganga in Balaghat district in Madhya Pradesh is flowing near to its High Flood Level (HFL) attained in its catchments.

#### **2.1.5 Harsi**

Harsi dam at Bhitwar, Gwalior will be developed as a tourist destination. The dam was built in 1935 with purpose of irrigation for farmers in Bhitwar&Dabra. Harsi dam provides water for irrigation to 198 villages of Dabra&Bhitwar. Dam water capacity is 195 million cubic meter, right now 151 million cubic meter water is available. Water is provided through canals in an area of 65 km through Harsi dam.

#### **2.1.6 Kunwar Chain Sagar (Dudhi) project**

Kunwar Chain Sagar dam is a medium Project, which is nearby 25 km from Narsinghpur and about 95 km from Bhopal and is constructed across Dudhi River, a tributary of Newaj River. The project has an annual irrigation potential of 4810 ha, Culturable Command Area of 4225 ha and Gross Command Area of 5715 ha. Kunwar Chain Sagar dam is a composite project having 3570 m long earthen zonal embankment and 102 m long central ogee spillway portion having 9 radial gates of size 4.50 m (high) x 6.0 m (wide) with maximum height of earthen 12.5 m at RD 1440 m above deepest River bed level (without parapet wall height) to pass maximum flood discharge of 1733 cumec (revised ). One sluice outlet for off taking LBC from RD 720 m has been provided for irrigation with head discharge 2.59 cumec. It is located in Chambal Betwa Basin.

#### **2.1.7 Rajghat Canal project**

Rajghat Dam Project is an interstate project of Madhya Pradesh and Uttar Pradesh The dam is constructed across betwa river and is suited on the borderd Ashoknagar District of Madhya Pradesh and Lalitpur District of Uttarpradesh. The dam is constructed in accordance to joint Agreement between the two states dated 01.08.1972 & 09.12.1973. The reservoir has a capacity of 1500.00 Mcum. The live storage of Rajgaht dam is 62.00 TMC is

divided in equal share of 26.50 TMC each for M.P. & U.P. The share for downstream committed use from the Rajghat complex below Rajghat dam is in ratio of 30:70 of which Madhya Pradesh gets 8.50 TMC of water. So total share of M.P. is 35.00 TMC.

### **2.1.8 Bariyarpur Left Bank Canal**

Bariyarpur left bank canal is a ongoing irrigation project in Chhatarpur District of Madhya Pradesh. It is a type of major irrigation project. Also a part River Ganga basin.

### **2.1.9 Bansagar Project**

Bansagar or Ban Sagar Dam is multipurpose river Vally Project on Sone River situated in the Ganges Basin in Madhya Pradesh, India with both irrigation and 435 MW of hydroelectric power generation. The Bansagar Dam across the Sone River was constructed near the Deolond village in the Shahdol district. It is surrounded by Satna, Katni, and Rewa districts. The Project was called “Bansagar” after Bana Bhatt, the renowned Sanskrit scholar of the 7<sup>th</sup> century, who is believed to have hailed from this region in India. Bansagar Dam is located at Latitude 24°11'30" N and Longitude 81°17'15" E.

The project was initially called the “Dimba Project” in 1956 by the Central Water Commission, New Delhi to be constructed on the Sone River at the confluence of the Sone and Banas Rivers near Shikarganj town 30 km down river from the present site. Later it was shifted to the present site at Deoland CGWB(Central Ground Water Board).

## **2.2 BACK WATER AVAILABILITY**

George and Kartha (1963) in connection with the prawn studies of the Sub-station, routine observations on the surface salinity, temperature, oxygen etc., were conducted regularly in the Cochin backwater for the past few years. A paper on the plankton and its relationship with salinity of the Bunder canal at Narakkal connected with the backwater has been published (George, 1958). For this study, observations along the canal were made throughout during the high water. A doubt then arose whether it would give a true picture of the conditions of the canal by following only the high waters of each day since

varying amounts of sea water might enter into the backwater and from there into the canal during the high water, bringing with it planktonic organisms and salinity conditions which are more marine than what had existed during the low water. Balakrishnan (1957) while studying the surface salinity of Ernakulam channel noticed a number of rapid fluctuations which were attributed, to a certain extent, to the influence of tide. The present work is an attempt to understand the amount of tidal influence, if any, on the salinity of the backwater, at the various heights of the tide and to see whether two different conditions, one during high and the other during low water, exist in the area.

Alexander (1990) The calculated existing design discharge (3,050 cubic feet per second) water-surface profile is compared to the expected water-surface profiles from three assumed alternative channel modifications within the Honey Creek study area. Emphasis is placed on evaluating the potential effects of each alternative to reduce backwater flooding along the upstream boundary of the Honey Creek reclamation site near an agricultural field. The alternative channel modifications used in these analyses include 1) improvement of channel bottom slope, 2) relocation of spoil material, and 3) improved by-pass channel flow conditions. Study results indicate a 0.39, 0.43, and 0.30 foot backwater reduction at the agricultural field based on the assumed channel modifications of alternatives 1, 2, and 3, respectively. Several combinations of these alternatives were analyzed, and in each case the reduction in backwater flooding was numerically equal to the sum of their individual decreases. For example, a 1.12 feet lower water-surface elevation results when the channel modifications of alternatives 1, 2 and 3 are combined and analyzed. The concurrent water-surface elevation reduction (1.12 feet) of alternative 1 (design discharge increase of 400 cubic feet per second), alternative 2 (design discharge increase of 600 cubic feet per second), and alternative 3 (design discharge increase of 250 cubic feet per second) can be converted into a Honey Creek design discharge increase from 3,050 cubic feet per second to 4,300 cubic feet per second. Thus, the alternative 1, 2, and 3 design discharge increase will reduce the agricultural field current (1990) frequency of backwater flooding from a 3-year to a 6.5-year event. It was not within the scope of this study to conclude that these are the only viable individual alternatives or combinations thereof.

Menon *et al.* (2000) expressed that on the south west coast of India, there is an extensive estuarine system of backwaters, of which Vembanad Lake is the largest. The backwaters of Kerala support as much biological productivity and diversity as tropical rain forests. They further concluded that this backwater is responsible for the rich fisheries potential of Kerala. Cochin backwaters situated at the tip of the northern Vembanad lake is a tropical positive estuarine system extending between 9° 40' and 10° 12'N and 76° 10' and 76° 30' E with its northern boundary at Azheekode and southern boundary at Thannirmukham bund. The lake has a length of 80 km and the width varies between 500 and 4000 m. A channel, about 450 m wide at Cochin gut and another at Azheekode, make permanent connections with the Arabian Sea. The depth of the estuary varies considerably. While the shipping channels are maintained at a depth of 10–13 m, the major portion of the estuary has a depth range of 2–7 m. Water from two major rivers viz., Periyar and Muvattupuzha drain into this estuary. During south west monsoon, the estuary is virtually converted into a freshwater basin even in areas around barmouth where salt water penetration occurs below 5 m depth only. The major hydrological variable in the Cochin backwaters is salinity, similar to the situations encountered in estuaries with a gradual declension of salinity from 30 at the entrance of the estuary to 0.2 at the point of entry of the rivers. Salinity gradient in the Cochin backwaters supports diverse species of flora and fauna depending on their capacity to tolerate oligohaline, mesohaline or marine conditions. Low lying swamps and tidal creeks, dominated by sparse patches of mangroves with their nutrient rich physical environment, support larvae and juveniles of many economically important species. Backwaters also act as nursery grounds of commercially important prawns and fishes. The fields around the backwater are suitable for aquaculture. These areas support traditional, seasonal and perennial prawn fishery. The changes in the hydrology controlled by the seasons play an important role in regulating the migrant fauna of the estuary. The Cochin backwater supports a well established endemic fauna. The nutrients and pollutants introduced into the estuary control to a great extent the distribution and abundance of less tolerant species in ecologically sensitive areas in the backwaters. Cochin backwaters, widely regarded as one of the polluted estuaries in India,

receive contaminated freshwater inputs and discharges of effluents and partially treated sewage from many points throughout its tidally mixed zone. Recently, changes brought about in the estuary like reclamation and consequent shrinkage of the backwaters and the discharge of pollutants have made an adverse impact on the potential of aquatic ecosystems that used to support high levels of bioproductivity and biodiversity. The construction of Thannirmukham bund and Thottapally spillway to prevent salt water penetration into the paddy fields during pre-monsoon has led to serious ecological problems by interrupting the natural ebb and flow of tides. The hydrography, floral and faunal composition – its spatial and temporal variation plus assessments of the impact of the anthropogenic activities is presented in this review.

Pinar *et al.* (2011) in the field experiment found that a major coverage of backwater lies in western coast of Kerala and collected data for the same. These data were used in the analysis. The main aim of this study was to develop a suitable model for estimating backwater through arched bridge constrictions with normal and skewed crossings using both experimental and field data. Therefore, different artificial intelligence approaches, namely multi-layer perceptron (MLP), radial basis neural network (RBNN), generalized regression neural network (GRNN), and multi-linear and multi-nonlinear regression models, MLR and MNLR, respectively were used. The comparison between these developed models and one of the most commonly used traditional methods (Biery and Delleur 1962) has been made. The test results showed that the MLP model gave highly accurate results than those of Biery and Delleur, MLR, MNLR, and GRNN and gave similar results with the RBNN model when applied to both field and experimental data. Pollutional stand point is also done.

Seckin and Atabay (2005) conducted a series of five experiments was performed in a two-stage compound channel including various roughness conditions and different types of bridge models, namely, single-opening semi-circular arch bridge model (ASOSC), multiple-opening semi-circular arch bridge model (AMOSC), single-opening elliptic arch bridge model (ASOE), and single-opening straight-deck bridge model with and without piers (DECK) including different span widths. The performances of six different methods for computing backwater around bridge waterways were compared using the

experimental data carefully taken on many combinations of cases. The results of the energy method, momentum method, WSPRO method, Yarnell's method, USBPR method, and arch bridge method were compared with experimental results. The results showed that energy method was able to simulate more accurately the measured backwater values than the other methods. The backwater differences between the experimental values and computed values by the energy method are generally within  $-3.2\%$  and  $0.8\%$  in terms of flow depth. A simple generalized function for estimating bridge backwater is also proposed.

Hidayat *et al.* (2011) in their study they found that Variable effects of backwaters complicate the development of rating curves at hydrometric measurement stations. In areas influenced by backwater, single-parameter rating curve techniques are often inapplicable. To overcome this, several authors have advocated the use of an additional downstream level gauge to estimate the longitudinal surface level gradient, but this is cumbersome in a lowland meandering river with considerable transverse surface level gradients. The discharge station represents an area influenced by variable backwater effects from lakes, tributaries and floodplain ponds, and by tides.

Fernandes *et al.* (2016) concluded that fluvial channel encounter a backwater reach when they approach a standing body of water, and recent studies have shown that the transition from normal flow to backwater-influenced flow is associated with sediment mass extraction through deposition.

Ganti *et al.* (2016) River delta's worldwide are currently under threat of drowning and destruction by sea-level rise, subsidence, and oceanic storms, highlighting the need to quantify their growth processes. Deltas are built through construction of sediment lobes, and emerging theories suggest that the size of delta lobes scales with backwater hydrodynamics, but these ideas are difficult to test on natural deltas that evolve slowly. We show results of the first laboratory delta built through successive deposition of lobes that maintain a constant size. We show that the characteristic size of delta lobes emerges because of a preferential avulsion node—the location where the river course periodically and abruptly shifts—that remains fixed spatially relative to the prograding shoreline. The preferential avulsion node in our experiments is a

consequence of multiple river floods and Froude-subcritical flows that produce persistent nonuniform flows and a peak in net channel deposition within the backwater zone of the coastal river. In contrast, experimental deltas without multiple floods produce flows with uniform velocities and delta lobes that lack a characteristic size. Results have broad applications to sustainable management of deltas and for decoding their stratigraphic record on Earth and Mars.

### 2.3 Agroclimatic Zone

Based on similar climate, topography and soil type the state of Madhya Pradesh has been classified into 11 Agro climatic zones (figure 2.1)

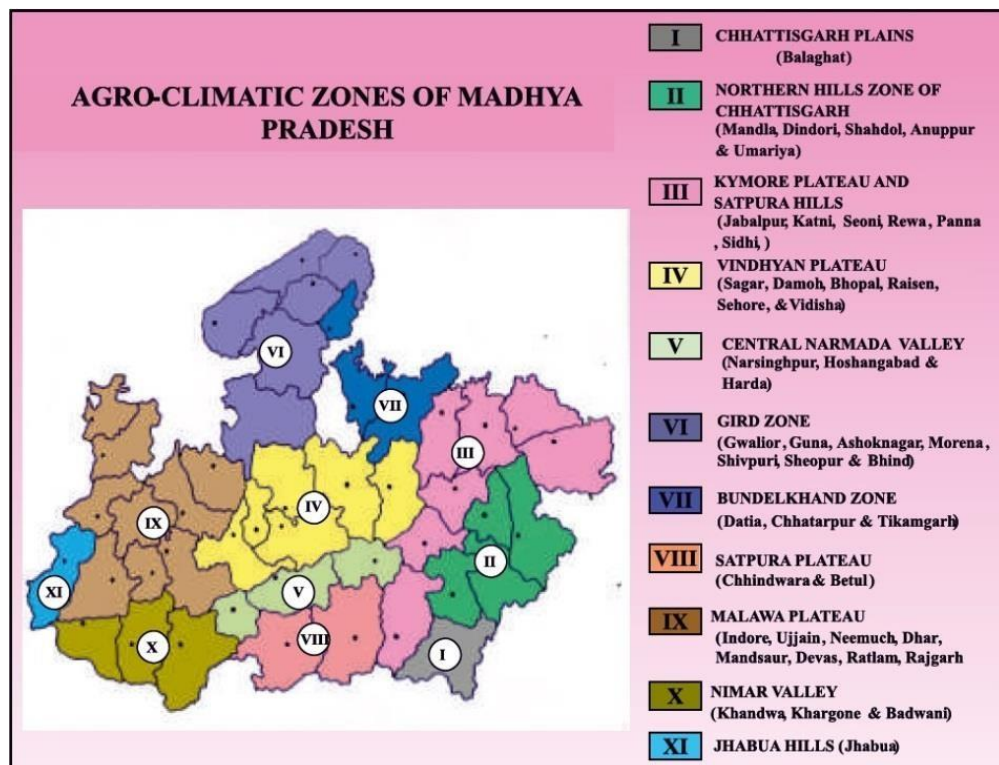


Figure 2.1 Agroclimatic zones of Madhya Pradesh

### 2.3.1 SOIL

Anonymous (2001) studied infiltration rate (Table 2.3) of soil profile indicating upper limits for irrigation application rates on various soil texture in the river. More accurate readings can be obtained in field measurement of actual infiltration rates, as they are known to vary between soils of similar texture.

**Table 2.2 Indicative Infiltration Rate for Soil Texture**

<b>Texture</b>	<b>Infiltration rate (mm/hr)</b>
Sand	13
Loamy sand	12
Sandy loam	10
Light sandy clay loam	7
Sandy clay loam	5
Light clay	5
Light clay	4
Medium clay	3

Soil - Light to Medium light (Red – Yellow Medium black soil)

Bauder (2004) studied on the available water holding capacity of soil is a function of the texture. This is the amount of water that would and could be made available to plant after the soil has been irrigated (Table 2.4)

**Table 2.3 Available Water Holding Capacity of Soils**

<b>Soil Texture</b>	<b>Inches of water per cubic feet of moist soil</b>
Sandy and fine sand	0.75
Very fine sand, loamy sand	1.00
Sandy loam	1.5
Loam	1.90
Silt loam, silt	2.20
Silty clay loam	1.90
Clay loam, sandy clay loam	1.70

The model presented by Philip (1957) is given as

$$Y = St_{1/2} + At \dots \dots \dots \text{Eq. (1)}$$

Which on differentiation with respect to time and yields  $I = 0.5St^{-1/2} + A$  Eq. (2)

Where,

I = infiltration rate, cm/h

Y = cumulative infiltration, cm T = time, h

S and A = soil constants

### 2.3.2 CLIMATE

Ministry of water resources (2013) Climate of the Mandla district is tropical with moderate winter and severe summers and well distributed rainfall received from southwest monsoon. However due to higher general elevation and abundance of forests, summer temperature do not rise as much as in other areas. The normal annual rainfall of Mandla district is 1427.7 mm.

### 2.3.3 TOPOGRAPHY

The district of Mandla lies in the Southeast part of the state of Madhya Pradesh spanning over an area of about 7544 km<sup>2</sup>. Mandla district is situated in the south eastern part of Madhya Pradesh and cover an area of 7544 sq km falling in survey of India degree sheet no 64A, B, E and F, 55 N between north latitudes 22° 12' : 23° 22' 02" and longitude 79° 59' 23" : 81° 44' 22" E. It is bounded by Jabalpur on the North West, Dindori and Seoni district in south west and Kawardha district and Chhattisgarh state on the South East.

## 2.4 CROPPING PATTERN

Cropping Pattern of Madhya Pradesh

**Table No. 2.4 Cropping pattern of Madhya Pradesh**

<b>CROP GROUPS</b>	<b>CROPS</b>	<b>AREA</b>	<b>% TO GROSS CROPE DAREA</b>
CEREALS	PADDY	17.40	8
	WHEAT	46.70	23
	JOWAR	6.74	3
	MAIZE	8.01	4
	SMALL MILLET	76.62	4
	<b>TOTAL</b>	<b>86.47</b>	<b>42</b>
PULSES	ARHAR	3.11	2
	URAD & MOONG	5.16	2
	GRAM	25.76	13
	OTHERS	8.23	4
	<b>TOTAL</b>	<b>42.26</b>	<b>21</b>
OIL SEEDS	SOYA BEAN	44.40	22
	GROUNDNUT	2.24	1
	MUSTARD	6.26	3
	SESAMUM	1.37	0.5
	NIGER	1.21	0.5
	LINSEED	2.31	1
	OTHERS	0.11	NEG.
	<b>TOTAL</b>	<b>42.26</b>	<b>21</b>
COMMERCIAL CROPS	COTON	4.88	
	SUGARCANE	0.43	
		<b>5.31</b>	<b>3</b>
OTHER CROPS	VEGETABLES, FRUITS, FODDER & MEDICINAL CROPS	12.25	6

## 2.5 LIFT IRRIGATION

Zende (2012) During the recent decades, there has been an increasing effort to transfer the management of irrigation schemes from government organizations to nongovernmental organizations as decentralization gained momentum and as states started to devolve some of their functions to different groups in the society. Irrigation management in India was also affected by these developments. Since 2005, in India approximately 50% and in Maharashtra approximately 30% of the public irrigation schemes were turned over to the locally managed farmer organizations. This study was conducted in the Takari Lift Irrigation Scheme, to assess the temporal variations of agricultural, water use, environmental and financial performance indicators for the pre-transfer (1984–2000) and the post-transfer (2001–2010) periods. Results showed, after 10 years of transfer, a continued improvement in irrigation performance. The most important finding of the study was a considerable increase in output per unit of land and per unit of water after turnover. Irrigation management transfer (IMT) provided a dramatic achievement in water fee collection efficiencies and more financially self-sustaining organizations. Therefore, it can be safely concluded that the transfer process created more sustainable management for irrigation.

Purandare *et al.* (2016) Water availability is the main & the most important parameter for the success of any water Resources Project. By means of analysis of hydrologic data through statistical techniques one can arrive at appropriate value of water availability in the reservoir. The present paper discusses the water availability & reliability for a lift irrigation scheme, where water is lifted from river Krishna in rainy season. And water from a reservoir, Shivajisagaris demanded as and when required. Water from Krishna River is lifted at Mhaisal Kolhapur Type (K.T.) weir in rainy season with the available discharge. Based on the data, discharge values are examined for existence of persistence, randomness, consistency. Also 75% & 90% dependable values are estimated. Autoregressive model is fit. Analysis shows existence of persistence, randomness, consistency of the data. This will help assess water availability & its reliability.

Shiyekar *et al.* (2017) as per the NABARD – National Bank for Agricultural and Rural Development (India), there are 1401 LIS financed by them. The total financial outlay (TFO) is Rs. 6462.5 million. The proposed area under irrigation is 22000 hectare. Out of these LIS, as many as 573 LIS are defunct. The main reason is poor distribution of water. In addition there are LIS which are financed and implemented by government, sugar factories and individual farmers. In case of irrigation schemes, the importance of “Lift Irrigation Schemes” is unique and distinctive. In such schemes, many farmers can come together and implement a large lift irrigation scheme on private or co-operative basis. This way, they get certain benefits of large schemes.

## **2.6 MICRO IRRIGATION SYSTEM (MIS)**

Renault *et al.* (1999) they concluded that Irrigation modernization is increasingly recognized as a fundamental transformation in the management of water resources within agricultural areas. Such transformation may include improvements to physical and/or institutional structures, rules and water rights, water delivery services, accountability mechanisms, and incentives. By incorporating broader perspectives and taking more consideration of the spatial distribution of significant variables, this report defines new approaches for the allocation of operational resources.

Namara *et al.* (2005) The study to utilize the backwater had shown that Micro irrigation technologies are aggressively promoted in India by the central government, state governments and many nongovernmental organizations (NGOs), both local and international, by providing different kinds of financial, institutional and technical support systems. These technologies are promoted primarily for one or more of the following reasons: (1) as a means to save water in irrigated agriculture, (2) as a strategy to increase income and reduce poverty, and (3) to enhance the food and nutritional security of rural households. Despite the reported significant economic advantages and the concerted support of the government and NGOs, the current micro irrigation area in India remains an insignificant proportion of its potential. Based on the data from recent field studies in Maharashtra and Gujarat, this report analyzes:

(1) the economics of alternative micro irrigation technologies ranging from low- cost drip and sprinkler systems to the capital-intensive systems, (2) the determinants of adoption of micro irrigation technology, (3) the poverty outreach of the different micro irrigation systems, and (4) the sustainability implications of micro irrigation adoption.

Nambiar and Raveendran (2009) Back water system of Kerala is well known for its fertility. Fungi play a vital role in detritus decomposition, nutrient cycling and energy flow in marine food web including backwater ecosystem. Present investigation on the diversity of marine fungi from two back waters of Kerala resulted in the isolation of 20 marine fungi. These include 11 Ascomycetes, 1 Basidiomycete and 8 Mitosporic fungi. In terms of percent frequency of occurrence the most common species obtained were *Aniptoderachesapeakensis*, *Verruculinaenalia*, *Savoryellalignicola* and *Clavatosporabulbosa*. *Ascochyta* sp. was represented by only a single isolate.

Das *et al.* (2013) Management measure for Irrigation water by tidal back-water influx is an important issue for the sustainable living of rural communities in the areas where the rainfall is insufficient for Rabi crop cultivation. Tidal back-water influx is one of the sources of irrigation water in the lower gangetic planes of West Bengal, India. Based on that concept, a plan is provided for the Magrahat basin of South 24 Parganas district in West Bengal for the augmentation of irrigation facilities through excess amount of tidal back-water entry during the post-monsoon period when the salinity of water is considerably low. In the present study, twenty major canals or khals of Magarahat basin are considered. Volume of available tidal water for irrigation of Rabi crops was determined from the gauge data of tidal rivers. Here an attempt has been made to delineate not only the enhancement of the economic return of the people of the Magrahat basin but also to create provision for multi-cropping (Rabi crops) pattern of agriculture/horticulture facilities during the dry season for sustaining of their livelihood. Also the tidal backwater surface profiles have been suggested for all the major canals of Magrahat basin using standard step method of gradually varied flow.

Eid *et. al.* (2014) the country lies in arid region. This study was conducted in farmers' fields during 2009/2010–2010/2011 to evaluate the water

use efficiency and economic viability of sprinkler irrigation system for growing wheat crop. Two field experiments were conducted in the Research and Production Station of the National Research Centre in El-Nubaria El-Behera Governorate. The water-use characteristics of wheat were studied in the field under sprinkler irrigation system. Treatments consisted of two sprinkler irrigation systems, solid set sprinklers (S1) and hand move laterals (S2), and three irrigation frequencies (IF1: once per week; IF2: twice per week, IF3: three times per week). Total irrigation amount values varied from 3924.373 - 4081.3 m<sup>3</sup>ha<sup>-1</sup> in 2009-2010 and 4313.6 to 4486.2 m<sup>3</sup>.ha<sup>-1</sup> in 2010-2011. The highest seasonal ET was obtained from the S2IF3 treatment in 2010-2011 (5417.1 m<sup>3</sup>ha<sup>-1</sup>) the lowest value was observed in the S1IF1 treatment in 2009-2010 (4513.0 m<sup>3</sup>.ha<sup>-1</sup>). On average, the S1IF3 treatment gave the highest grain yield (5832.5 kg.ha<sup>-1</sup>), whereas S2IF1 treatment gave the lowest grain yield (3332.5 kg.ha<sup>-1</sup>). IWUE values varied from 1.0 - 1.43 kg.m<sup>3</sup> in 2009-2010 and from 0.87 to 1.34 kg.m<sup>3</sup> in 2010-2011. WUE values varied from 0.87 to 1.19 kg.m<sup>3</sup> in 2009-2010 and from 0.79 -1.16 kg.m<sup>3</sup> in 2010-2011. Also, under solid set sprinkler irrigation system and irrigation frequency occurred maximum value of net income. For winter wheat in the El-Nubaria, the recommended sprinkler system and irrigation frequency for each event is solid set sprinkler (S1) and irrigation three times per week (IF3). Therefore it was concluded that backwater can also be used for irrigation.

Kumar (2014) the backwaters were formed by the action of waves and shore currents creating low barrier islands across the mouths of the many rivers flowing down from the western Ghat range. Drip irrigation system is provided the root to zone of plant drop by drop which results in saving of huge amount of water. The target of this system is following: a) Save energy and water resources. b) Manually and automatic control the system. c) Detect the water level. c) To increase the productivity of crop. e) To increase the efficiency of water. f) Selection of irrigation based on the different parameter.

Anonymous (2019) Water Resources Department, Madhya Pradesh besides, implementation and monitoring of various major, medium, minor and micro irrigation projects adopting pressurized distribution Network (PDN) system under its own Jurisdiction is engaged in implementing and

monitoring different schemes which are sponsored/financed/assisted by central Govt. World Bank, NABARD etc.

Goyal *et al.* (2019) discussed the management practices in micro irrigation system to avoid its failure in the field. Most systems would stop operating properly if not adequately serviced and maintained. Training on adoption and service is as important as the initial steps.

## MATERIAL AND METHODS

This chapter deals with the methodology adopted and theoretical considerations made for achieving the objectives of the present study. The whole methodology of present research comprises two parts namely determination of temporal and spatial availability and use this backwater for irrigation by adopting Micro Irrigation System (MIS). Data pertaining to backwater on spatial and temporal basis performed making field visits and the help of government records Based upon the availability of backwater an attempt made to use this precious backwater. Taking into consideration main crops of Rabi particularly in upland areas, MIS designed for selected crops.

### 3.1 General Description of the Area

#### 3.1.1 Location

KVK Mandla situated at the latitude of  $22^{\circ}35'52.52''$  N and a longitude of  $80^{\circ}22'16.99''$  E or 22.597922 and 80.371385 respectively. Mean sea level of (elevation) Mandla 445m (1,460ft). The Total length of Narmada River is 1312 Km and length in MP is 1077Km. The catchment area of river is 85149 Sq Km. As a hole, the available Backwater in KVK Mandla occupies an approximate area of 46.22 hectares.

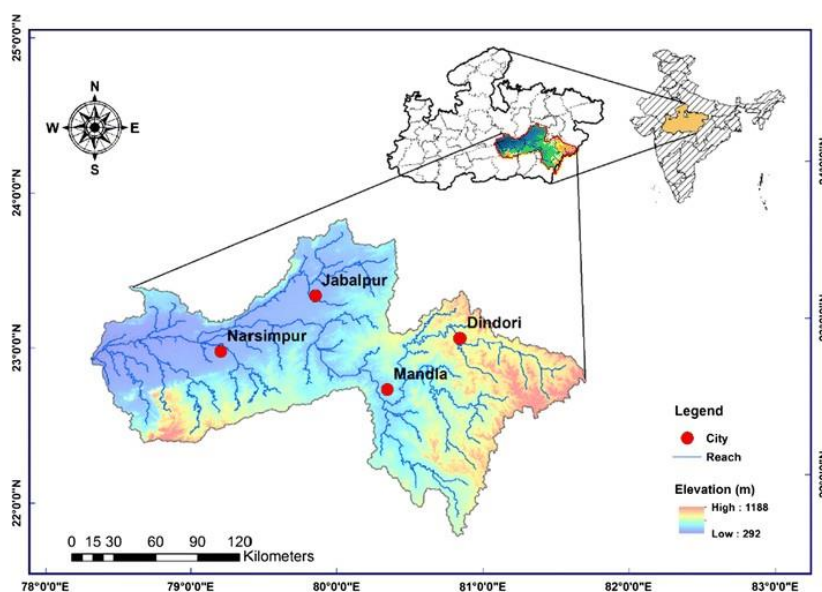
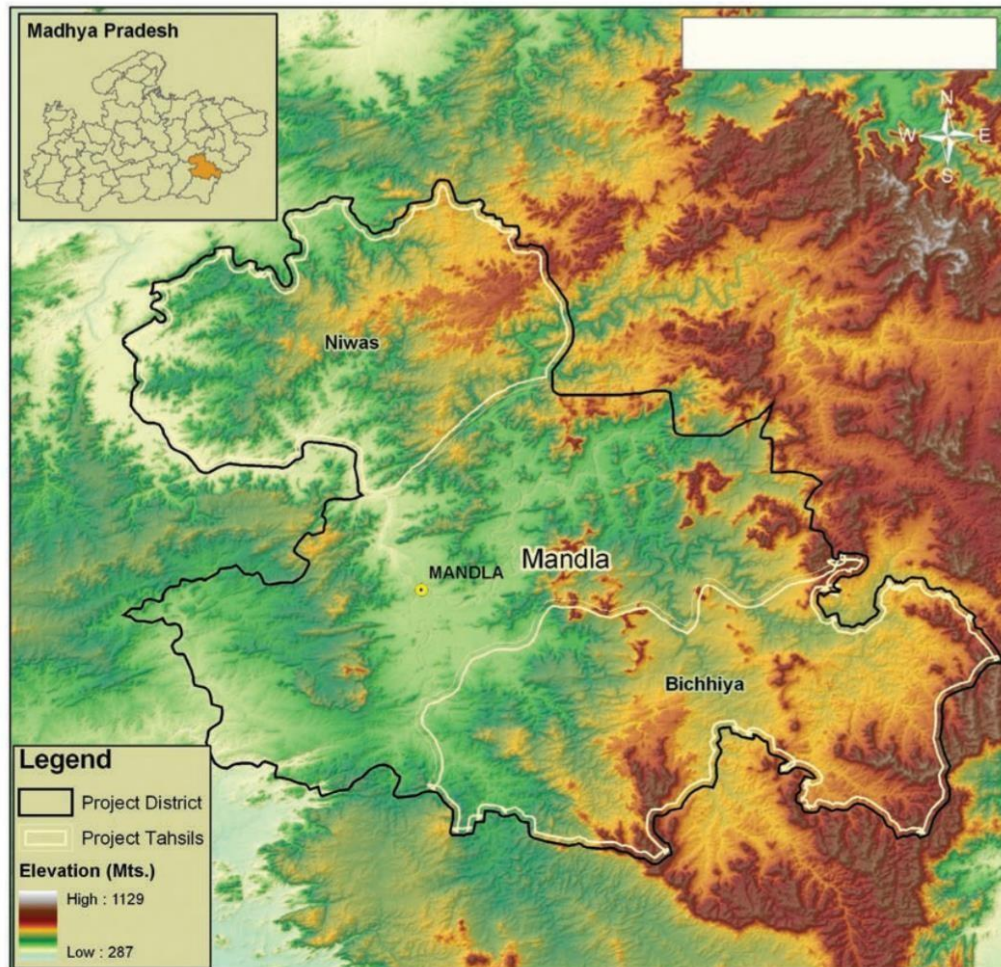


Fig : 3.1 Index Map of the study area



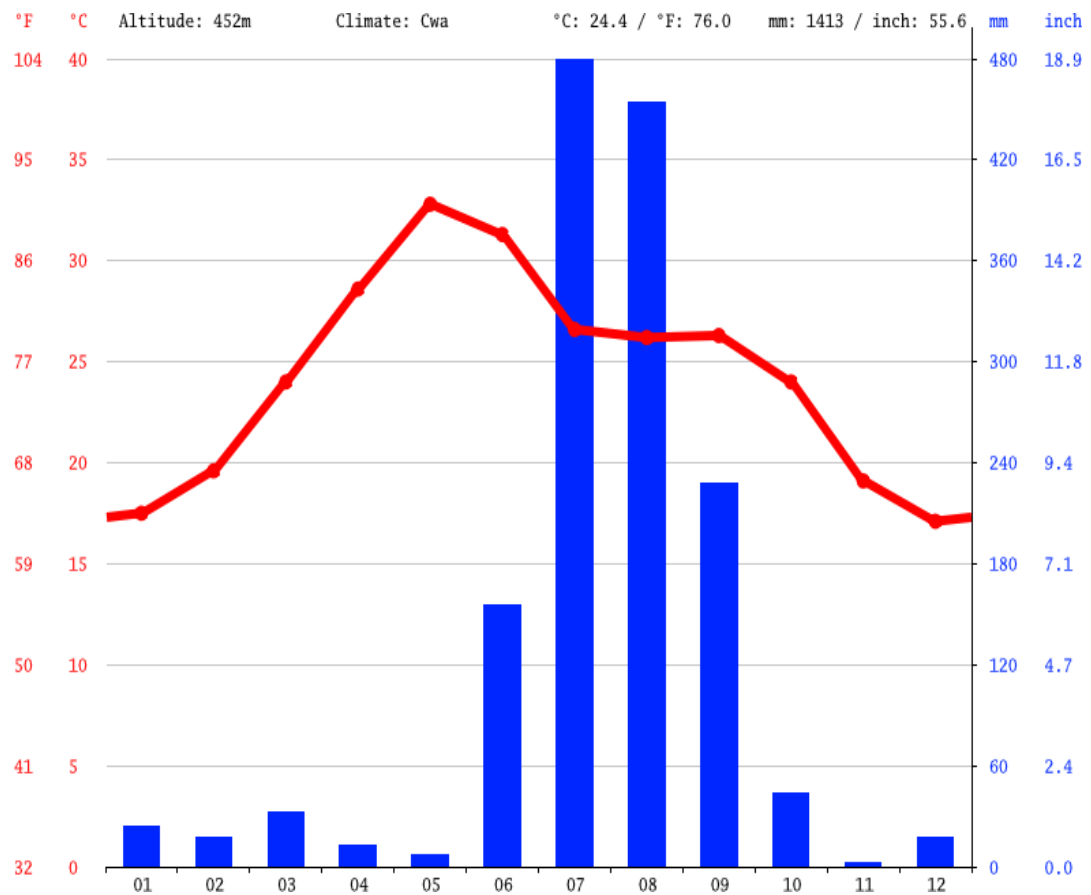
**Fig: 3.2 Geographical location of the study Area**

### **3.1.2 CLIMATE**

Climate of the Mandla district is tropical with moderate winter and severe summers and well distributed rainfall received from southwest monsoon. However due to higher general elevation and abundance of forests, summer temperature do not rise as much as in other areas. In winter, there is much less rainfall in Mandla than in summer. The average annual temperature in Mandla is 24.4°C/76.0°F. The normal annual rainfall of Mandla district is 1427.7 mm.

### 3.1.2.1 WEATHER AVERAGES MANDLA

The driest month is November, with 2 mm/0.1 inch of rainfall and the second driest month is May, with 4 mm/ 0.2 inch of rainfall. With an average of 480 mm/ 18.9 inch, the most precipitation in July and then 460 mm/ 17.6 inch is in August.

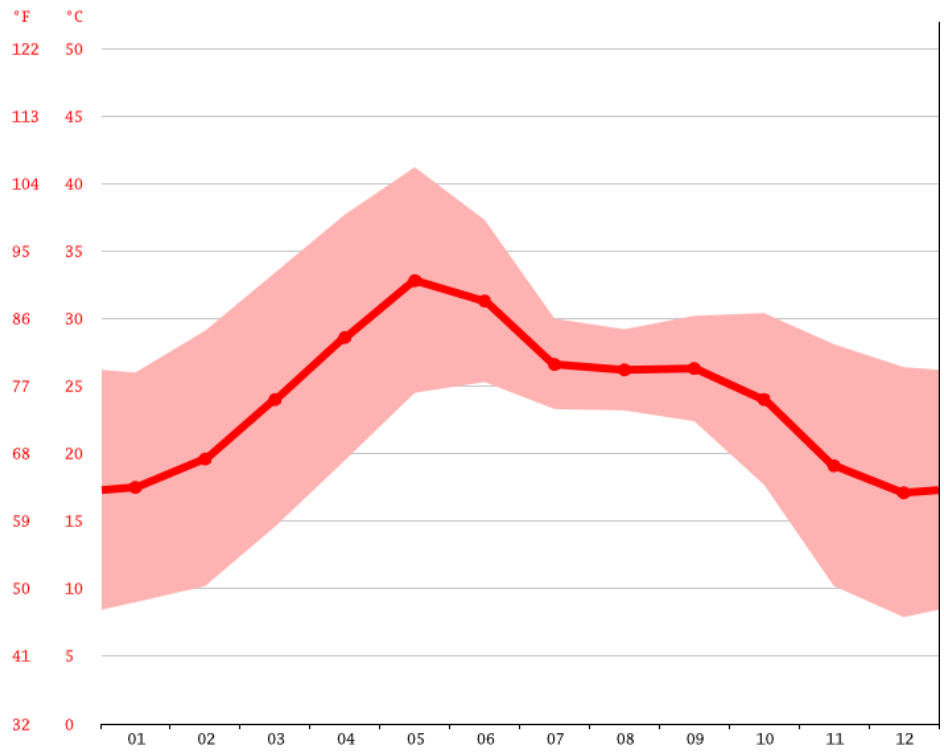


**Fig 3.3 : Weather averages Mandla**

(Source:- Climate data .org)

### 3.1.2.2 AVERAGE TEMPERATURE MANDLA

The warmest month of the year is May, with an average temperature of 32.8 °C /91.0°F and then the second warmest month of the year is June, with an average temperature of 31.4 °C/89.0 °F. December has the lowest average temperature of the year. It is 17.1 °C/62.8 °F and then the second lowest month of the year is November has average temperature 19.1 °C/66.4 °F



**Fig :- 3.4 Average Temperature Mandla**

**Table 3.1 Weather by Month**

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	17.5	19.6	24	28.6	32.8	31.3	26.6	26.2	26.3	24	19.1	17.1
Min. Temperature (°C)	9	10.2	14.6	19.5	24.5	25.3	23.3	23.2	22.4	17.7	10.2	7.9
Max. Temperature (°C)	26	29.1	33.4	37.7	41.2	37.3	30	29.2	30.2	30.4	28.1	26.4
Avg. Temperature (°F)	63.5	67.3	75.2	83.5	91.0	88.3	79.9	79.2	79.3	75.2	66.4	62.8
Min. Temperature (°F)	48.2	50.4	58.3	67.1	76.1	77.5	73.9	73.8	72.3	63.9	50.4	46.2
Max. Temperature (°F)	78.8	84.4	92.1	99.9	106.2	99.1	86.0	84.6	86.4	86.7	82.6	79.5
Precipitation / Rainfall (mm)	23	17	31	12	7	149	460	435	218	42	2	17

The difference in precipitation between the driest month and the wettest month is 458 mm/ 18 inch. During the year, the average temperatures vary by 15.7°C.

### 3.2 Estimation of temporal and spatial availability of backwater

Data pertaining to backwater on spatial and temporal basis was performed making field visits and the help of government record & help of google earth was also taken. On this context, it was found that the perimeter is 3.62 km. Therefore the area in which backwater spread is 46.22 ha.

#### 3.2.1 Crop water requirement

Selection of crop based on Rabi season specially, such crops are Wheat, pea, mustard, lentil, and gram. Research work was done mainly for the wheat crop. The water requirement of wheat is 450- 650 mm/day.

### 3.3 Design of Tank

The tank has been designed to store this backwater as well as rainfall-water for convince use of water. For designing the tank, Bureau of Indian Standard has set standard according to that the water storage tanks have been designed. A rectangular water tank has been designed to store this backwater.

#### 3.3.1 Design data & main dimensions of the tank

Capacity of tank =  $Q = 2500 \text{ m}^3$

Safe bearing capacity of soil =  $p_a = 75 \text{ KN /m}^2$

Free Board = 0.15 m.

#### The allowable stresses are:

M – 30 grade concrete and

Fe- 415 grade tor steel, for calculations relating to resistance to cracking (IS : 3370)

$$\sigma_{ct} = 1.5 \text{ N/mm}^2, \sigma_{cb} = 2.0 \text{ N/mm}^2$$

$$\sigma_{st} = 150 \text{ N/mm}^2$$

For strength calculations the stresses in concrete and steel are same as that recommended in IS: 456

$$\sigma_{cc} = 8.0 \text{ N/mm}^2, m = 9.34$$

$$\sigma_{cbc} = 10.0 \text{ N/mm}^2, Q = 1.3, J = 0.9$$

Assuming a clear height of the tank as 5.25 m,

$$\text{Clear base} = \frac{2500}{5.25-0.15} = 490 \text{ m}^2$$

Assuming the clear dimensions of the tank :

Height = 5.4 m

Length = 24.6 m

Width = 19.6 m

And the rest of the design is according to Limit state design method of designing rectangular tank. (IS 3370 – 2009)

### **3.4 Use this backwater for irrigation by adopting Micro irrigation system (MIS)**

Micro irrigation is the slow application of continuous drips, tiny streams or miniature sprays of water above or below the soil surface. Micro irrigation system is effective in saving water and increasing water use efficiency as compared to the conventional surface irrigation method. Besides, it helps reduce water consumption, growth of unwanted plants (weeds), soil erosion and cost of cultivation. Micro irrigation can be useful in undulating terrain, rolling topography, hilly areas, barren land and areas having shallow soils. It is, therefore, one of the most inefficient surface irrigation methods. As the aim is to utilize this Backwater for irrigation a micro irrigation system has been proposed.

#### **3.4.1 Classification of micro irrigation system**

Micro irrigation system can be broadly classified into two categories: (1) Drip irrigation system (2) Sprinkler irrigation system However, there is distinct differences in the water flow rate, operating pressure requirement and measurement of the wetted area between drip and sprinkler irrigation systems. Water flow rate means the amount of water discharged in an area at a particular time. It is expressed in litre/minute (lpm) or gallons/ minute (gpm). The system operating pressure must compensate for pressure losses through system components and field elevation effects.

### **1. Drip irrigation system**

Drip irrigation system, also known as 'trickle irrigation systems', is a method of applying the required amount of water directly to the root zones of plants through drippers or emitters at frequent intervals.

### **2. Sprinkler irrigation system**

Sprinkler irrigation is a method of applying water in a manner similar to rain. It is suited for most row, field and tree crops. Water can be sprayed over or under the crop canopy.

## **3.4.2 Design of Micro irrigation System**

### **1. Design of drip irrigation system**

Drip irrigation system consists of pump unit, head control unit, main line, sub-main lines or sub-mains, laterals and emitters or drippers.

#### **Typical spacing of 4 lph (1.06 gph) emitters**

Medium soil: 1m (39")

#### **Typical spacing of 2 lph (0.53 gph) emitters**

Medium soil: 60 cm (24")

### **2. Design of sprinkler irrigation system**

Sprinkler irrigation system consists of a pump unit, main line, laterals, risers and sprinkler heads along with filter screens, desilting devices, flow regulators and fertiliser application system.

#### **Pump unit**

A pump is used for developing the required pressure. It can be used under the following conditions.

- The land is undulating for levelling (the levelling work will be cost-intensive).
- The soil is porous, erodible and impermeable (which makes it difficult to irrigate it by any other method).

- The flow rate is too less for employing surface irrigation method.

### **Filtration unit**

Filtration unit is required to remove the impurities present in the irrigation water. Hydro-cyclone, media and screen are the different types of filter. The choice of filter depends on the quality of water. If the quality of water is poor, then a filter of higher mesh size is used.

### **Pipeline**

The layout of mains, sub-mains and laterals depends on local conditions like topography, soil characteristics and source of water. The main line must be laid along the slope and the laterals across the slope or nearly on the contours. In portable system, the laterals need to be of the same size so that they can be changed easily.

### **Sprinklers**

The selection of sprinkler depends on its nozzle size and the pressure with which it discharges water. It must also be ensured that the water discharged does not cause run-off or damage to the crops. It must meet the irrigation water requirement of a crop and the irrigation frequency. The common symbols used when designing sprinkler irrigation plans are as follows.

Sprinkler – full

This nozzle will, generally, throw water all around it at 360° and at a distance of 3.6–4.5 metre.

Sprinkler – half  
This nozzle will, generally, throw water all around it at 180° and at a distance of 3.6–4.5 metre.

Sprinkler – quarter

This nozzle will, generally, throw water all around it at 90° and at a distance of 3.6–4.5 metre.

Sprinkler – one-third

This nozzle will, generally, throw water all around it at 120° and at a distance of 3.6–4.5 metre.

Sprinkler — three quarter

This nozzle will, generally, throw water all around it at 270° and at a distance of 3.6–4.5 metre.

Sprinkler — two-third

This nozzle will, generally, throw water all around it at 240° and at a distance of 3.6 to 4.5 metre.

Sprinkler – variable arc nozzle

It represents a pop up with a variable arc nozzle, which means it can be adjusted from 0 to 360 degree. This nozzle will, generally, throw water at a distance of 3.6–4.5 metre.

### **3.5 Design procedure of Sprinkler Irrigation system involves**

1. Calculation of peak crop water requirement.
2. Selection of impact sprinkler.
3. Design and selection of sub main line.
4. Design and selection of main line.
5. Selection of filters.
6. Selection of venturi injector.
7. Design and selection of pump.

#### **Calculation of area**

Area= 200× 250m = 50000m<sup>2</sup> = 12.35 acre

#### **Calculation of design**

##### **3.5.1 Calculation of peak crop water requirement**

$$PWR = \frac{A \times B \times C}{E} \times D \text{ (For area having large spacing) (mm/day)}$$

Where,

A= Potential Evapotranspiration Rate (mm/day) B= Crop Factor (depend upon

growth stage)

C= Canopy Factor ( $C = \frac{\text{area of plant shadow at 12 noon}}{(\text{plant spacing} \times \text{row spacing})}$ )

E= Efficiency of System (for drip-90% and for sprinkler- 80%)

$$PWR = \frac{1.2 \times 0.85 \times 6}{0.8} = 7.65 \text{ mm/day}$$

### 3.5.2 Selection of impact sprinkler

The spacing of sprinkler was varied from 0.5D - 0.7D

Water Application Rate,  $WAR = SD$

$(SSS)^2$  (mm/hr)

Where,

D= Diameter of wetted area SD = Sprinkler Discharge

SSS= Sprinkler to Sprinkler spacing

JIS – 4 model having discharge of 50 lpm, radius of throw of 19m and operating pressure of 2.5 kg/cm<sup>2</sup> selected.

Formula for spacing,

$$\text{Spacing} = 0.5 \times 38 - 0.7 \times 38 = 19 - 26.6$$

Selected SSS (Sprinkler to sprinkler spacing) as 24m.

$$SSS = 24$$

$$WAR = \frac{50 \times 60}{24^2} = 5.2083 \text{ mm/hr}$$

#### a. Irrigation Time

$$\text{Irrigation Time} = \frac{PWR}{WAR} \text{ (hrs)}$$

Where,

PWR= Peak water requirement WAR= Water application rate

$$\begin{aligned} IT &= \frac{7.65}{5.20} \\ &= 1.4608 \times 60 \\ &= 88.128 \text{ min} \end{aligned}$$

**a. Total Time of Irrigation Shift**

Total Time of Irrigation Shift = Irrigation Time (IT) + Shifting Time (ST)

$$= 88.128 + 10\text{min}$$

$$= 1.6354 \text{ hr}$$

**b. No. Of irrigation shift (NOS) possible according to time**

$$\text{NOS} = \frac{EA}{\text{Time of Irrigation shift}}$$

Where,

EA= Electricity available

$$\text{NOS} = \frac{12}{1.6357} = 7.3373$$

We can irrigate the 9 sections by selecting 8 shifts to irrigate the wheat.

$$\text{End distance (ED)} = \frac{R}{\sqrt{2}}$$

$$\text{ED} = \frac{19}{2}$$

$$\text{ED} = 14.435$$

$$\text{ED} \approx 14\text{m}$$

Long side

Short side

No. of division on long side 17

no. of division on short side 16

$\frac{ED \text{ long side} - 2 ED \text{ long}}{SSS}$        $\frac{ED \text{ short side} - 2 ED \text{ short}}{SSS}$

$$\frac{250 - 2 \times 14}{24} = 9.25$$

$$\frac{200 - 2 \times 14}{24} = 7.16$$

$$\frac{250 - (9.25 \times 24)}{2} = 17$$

$$\frac{200 - (7.16 \times 24)}{2} = 16$$

No of sprinkler on long side

No of sprinkler on short side

$$9+1= 10$$

$$7+1 = 8$$

### 3.5.3 Design and Selection of Sub-main Line

Poly Vinyl Chloride (PVC) or High Density Polyethylene (HDPE) pipes are mainly used as sub main material having sizes 50 mm, 63 mm, 75 mm diameter etc.

#### Deciding length by limiting frictional head loss & design tolerance

For deciding length of submain by limiting frictional head loss & design tolerance is normally taken upto 2m or 0.2 kg/cm<sup>2</sup>.

#### a. Calculation of Specific Discharge Rate (SDR, lph/m) –

SDR is mathematically expressed by following formula,

$$\text{SDR of Sub-main} = \frac{\text{No. of Dripper covered by submain} \times \text{Dripper discharge}}{\text{Length of Submain}}$$

For Sub-main, the frictional loss is given by Hazen-Williams formula,

$$h_f = 5.35 \frac{Q^{1.852}}{D^{4.871}} \times L$$

Where,

$h_f$  = Total energy drop by friction at the end of laterals.

$Q$  = Total discharge at the end of laterals.

$D$  = Internal diameter of pipe in meter

$L$  = length of pipe in meter

$C$  = Hazens-Williams constant (friction factor), 150 assumed for PVC/HDPE.

$$\text{SDR submain} = \frac{8 \times 50 \times 60}{184 \times 60} = 130.434 \text{ lph}$$

For SDR Curve, we selected 75 mm dia Quality control pipe tp run 184 m length of sub- main pipe. ( $h_f = 1.6\text{m}$ )

### 3.5.4 Design and Selection of Mainline

Poly Vinyl Chloride (PVC) or High-Density Polyethylene (HDPE) pipes are mainly used as main line material having sizes 50 mm, 63 mm, 75 mm diameter and above.

### Calculation of Mainline Sectional Flow

It is mathematically expressed as,

$$\text{Main line (sectional) flow} = \frac{\text{No. of Drippers covered by section} \times \text{Dripper discharge}}{3600} \text{ lps}$$

$$\text{Flow} = \frac{8 \times 50 \times 60}{3600} = 6.67 \text{ LPS}$$

Calculating frictional loss is given by Hazen-Williams formula,

$$h_f = 5.35 \frac{Q^{1.852}}{D^{4.871}} \times L$$

Where,

$h_f$  = Total energy drop by friction at the end of laterals.

$Q$  = Total discharge at the end of laterals.

$D$  = Internal diameter of pipe in meter

$L$  = length of pipe in meter

$C$  = Hazens-Williams constant (friction factor), 150 assumed for PVC/HDPE.

### 3.5.5 Selection of filter

Filter is selected based on its capacity which is calculated by the following formula.

$$\begin{aligned} \text{Filter capacity} &= 3.6 \times Q \text{ main (m}^3/\text{hr)} \\ &= 3.6 \times 6.67 = 24.012 \text{ m}^3/\text{hr} \end{aligned}$$

JIS – 4 model screen filter was selected of discharge 25 m<sup>3</sup>/hr with plastic manifold.

**Table 3.2: Various Parameters considered for selection of filter of different types**

Filter	Water source	Impurities
Sand separator or Hydro cyclone filter	Canal, river, dam, farm pond, tube well.	Heavier than water- sand, silt & clay particles.
Sand filter (media filter)	Open water source exposed to sun light-open well, canal, river, dam, farm pond.	Lighter than water –algae & other living organism like plant residue, organic matter etc.
Screen filter Compulsory filter in MIS	All water source	Fine silt and clay particles
Disc filter Precision filter	Open well, tube well, canal, river, dam, farm pond.	Fine silt & clay particles, Algae, plant residue, organic matter etc.

### Selection of Venturi injector

The venturi injectors are selected basing upon the sizes in centimeters  
5.08,3.81,3.175,2.54,1.905

### Motive flow of venturi

It is calculated by the following formula.

$$\begin{aligned} \text{Motive flow of venturi} &= \frac{Q_{main}}{2} \\ &= \frac{6.67}{2} \end{aligned}$$

**Table 3.3 : Various Parameters for selection of motive flow of venture**

Venturi size (cm)	Motive flow (LPS)	Pressure difference(kg/cm <sup>2</sup> )	Suction rates (lph)
5.08	5	0.8- 1	1400-1900
3.81	3	0.8- 1	800-1200
3.175	2.5	0.8- 1	400-550
2.54	1.5	0.8- 1	150-300
1.905	0.75	0.8- 1	40-60

### 3.5.6 Design and selection of pump.

**Table 3.4 :** Design Parameters considered for selection of pump

Suction head	Vertical distance between the water level to centre of pump.
Delivery Head	Vertical distance between centre's of pump to centre of outlet.
Filtration Losses	Frictional head loses in different types of filters. It is assumed hydro cyclone filter 3m, sand filter 3-5m, screen filter-2m.
Mainline Losses	Frictional head losses occur in main line.
Operating Pressure	In general 10m pressured is required for non-pressure compensating and 15m for pc drippers.
Fittings Losses	Loss in fittings like bend, elbows, tees, reducers & valves etc& is assumed to be 2m overall.
Venturi Head	Pressure required to operate the venturi or fertilizer application and is assumed to be 5 m.
Elevation	Vertical distance between ground level near to water source to the highest level of ground.

#### a.Total head required

Total head required (m) = Suction Head +Delivery head +head loss in filters+ head loss in mainline + Operating pressure of system + head loss in fittings + head loss in venturi + upward elevation if only.

$$= (21+2)+2+10+2+0.8823+1$$

$$= 38.8823 \text{ m}$$

#### b. Pump Power Calculation

$$P = \frac{Q \times H}{75 \times \eta}$$

Where,

Q = required discharge (LPS)

H = Required total head (m)

a = Efficiency of motor (assumed 85%)

b = Efficiency of pump (assumed 80%)

$$P = \frac{6.67 \times 38.8823}{75}$$

$$= 3.457$$

$$= 3.5 \text{ HP}$$

$$= 5 \text{ HP}$$

The pump is selected according to head and discharge, and not to the power (HP)

### c. Irrigation Scheduling

**Table 3.5: Various Parameters considered in irrigation scheduling**

No. Of shift(No.)	Flow(LPS)	Time(hrs)	Total Time(hrs)
6	6.67	1.63	9.78

Total time will be less than electricity available, therefore it will be alright.

### 3.6 System Installation

The following items are suggested for proper design of sprinkler irrigation system & its cost estimation.

**Table 3.6: Design of Sprinkler Irrigation System**

Crop	Wheat
Irrigated area	5 ha
Irrigation interval	20
Irrigation period	1.63 hours
Irrigation depth	7.65mm/day
Size of pump	3.5 HP =(5HP)
Size of laterals	184 m
No. of nozzles	18
No. of sprinklers	18

## RESULT AND DISCUSSION

The present chapter deals with the material and methods adopted and results obtained as per the objectives.

### 4.1 Availability of backwater

The available Backwater is sufficient for irrigation purpose. In this research work the spatial and temporal methods are adopted to estimate the availability of back water. By using spatial method, the total estimated area of backwater is 46.22 ha. Thus the amount of available approximate waters  $231100 \text{ m}^3$  or  $2311 \times 10^6 \text{ lit}$ . Images of available backwater for different season are given below.

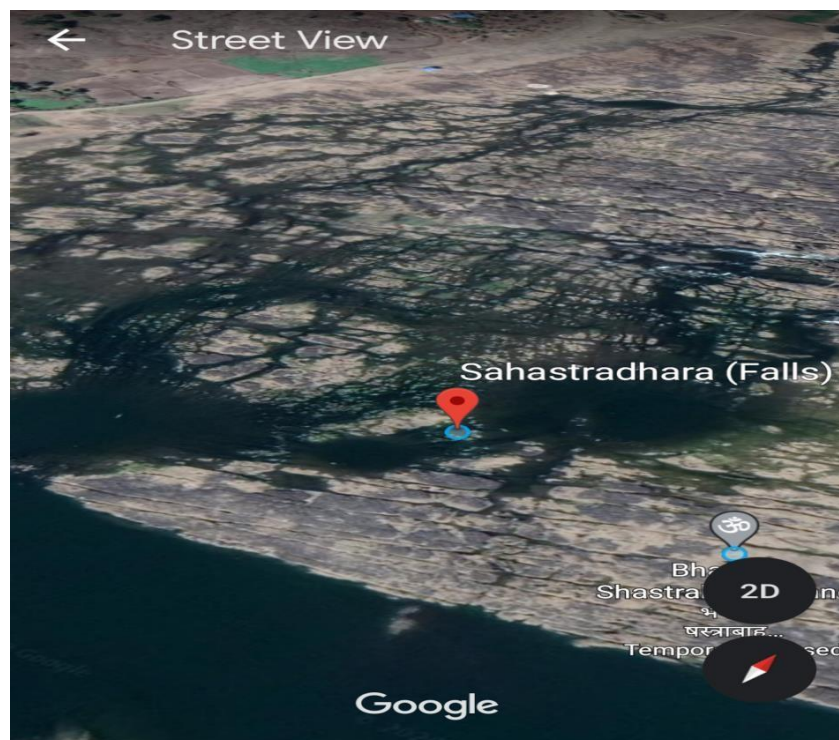


Fig 4.1 (a) The availability of backwater (Source: - Google earth)

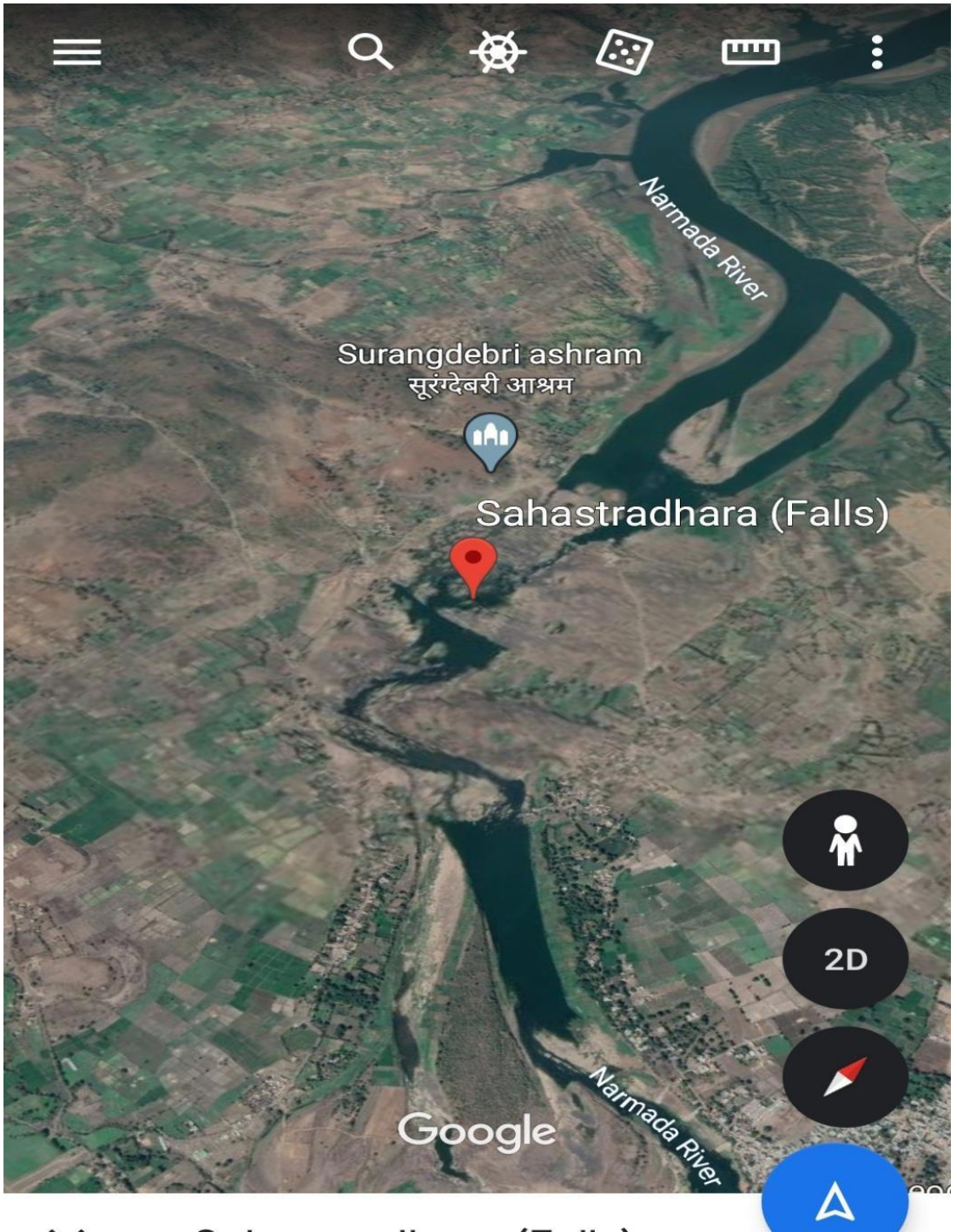


Fig:- 4.1 (b) Back water availability



**Fig 4.1 (c) Back water availability**

#### **4.1.1 Spatial Resolution**

Spatial resolutions are analogous to the sharpness as the image in conventional photography. It also refers to the size of the smallest feature that can be detected by a satellite sensor or displayed in a satellite image. It is usually presented as a single value representing the length of one side of a square. For example, a spatial resolution of 250 m means that one pixel represents an area 250 by 250 meters on the ground.

#### **4.1.2 Temporal Resolution**

It refers to the frequency of data collections. In remote sensing to capture changes in environmental phenomenon occurring, the data may have to be collected either daily, monthly, seasonally or yearly. Temporal resolution is the time between images. The capability for satellites to provide images of the same geographical area more frequently has increased dramatically since the dawn of the space age.

#### **4.2 Damage possible if backwater remains unutilized**

Backwater is very useful and important also. If this backwater remain unused there may be chances of loss of water by evaporation and also the problem of salinization or alkalization. So this backwater is proposed to be stored in water tank and utilize it for agriculture purposes by Micro irrigation system in upland area of 5 ha.

#### **4.3 Use of backwater in upland un irrigated areas**

In this research work it was found that in upland areas government is providing water by canal system but there are few more farmers who are deprived of this facility use of backwater through micro irrigation system in upland unirrigated areas will help to improve farming. Farmers can use this backwater for irrigation.

#### **4.4 CWR for different crops**

The water requirement of wheat crop simulated by CROPWAT 8.0 model has been given in table 4.1, 4.2, 4.3. Water requirement of wheat crop simulated by CROPWAT 8.0 model was 210 mm for the whole crop season during 2016-17. The wheat crop season was divided into four stages i.e. Initial stage, development stage mid stage and late stage. The effective rainfall during whole crop season was 4.8 mm during years 2017-17. In the initial stage of wheat crop growth, it needed minimum quantity of water (17.5 mm /decade) in the November month and Etc was 17.5 mm/decade. The crop water requirement increased the growth stage of wheat crop. The highest crop water requirement (85.3mm / decade) recorded in the late stage of growth was 40 % of total water requirement of wheat crop during the years 2016-17.

Similarly the water requirement of gram and pea was 286.8mm, 124.9 mm respectively and the effective rainfall during the whole crop season of these crops was 169.1 mm, 6.5 mm, respectively.

**Tables 4.1 Water Requirement of Wheat Corp using CROPWAT Model**

Month	Decade	Stage	Kc	ET <sub>c</sub> mm/day	ET <sub>c</sub> mm/dec	Eff. Rainfall Mm/dec	Irrigation Requirement Mm/dec
Nov.	2	Init	0.05	1.17	7.0	0.0	7.0
Nov.	3	Deve	0.05	1.05	10.5	0.0	10.5
Dec.	1	Deve	0.68	1.26	12.6	0.1	12.5
Dec	2	Deve	0.97	1.54	15.4	0.0	15.4
Dec	3	Mid	1.19	1.86	20.5	0.0	20.4
Jan	1	Mid	1.21	1.85	18.5	0.1	18.4
Jan	2	Mid	1.21	1.82	18.2	0.2	17.9
Jan	3	Mid	1.21	2.10	23.1	0.5	22.6
Feb	1	Mid	1.21	2.39	23.9	1.0	22.9
Feb	2	late	1.12	2.47	24.7	1.3	23.4
Feb	3	late	0.88	2.18	17.4	0.9	16.5
March	1	late	0.64	1.76	17.6	0.5	17.1
March	2	late	0.46	1.38	5.5	0.1	5.4
					<b>214.8</b>	<b>4.8</b>	<b>210.0</b>

**Table 4.2 Water Requirement of Gram Crop using CROPWAT Model**

Month	Decade	Stage	$k_c$	$ET_c$ mm/day	$E_t$ Mm/dec	Eff. Rainfall Mm/dec	Irrigation Requirement Mm/dec
Nov.	2	Init	0.40	0.93	5.6	0.0	5.6
Nov.	3	Init	0.40	0.83	8.3	0.0	8.3
Dec.	1	Deve	0.45	0.83	8.3	0.1	8.2
Dec.	2	Deve	0.68	1.08	10.8	0.0	10.8
Dec.	3	Deve	0.93	1.45	16.0	0.0	16.0
Jan.	1	Mid	1.12	1.71	17.1	0.1	17.0
Jan.	2	Mid	1.13	1.69	16.9	0.2	16.7
Jan.	3	Mid	1.13	1.96	21.5	0.5	21.0
Feb.	1	Mid	1.13	2.23	22.3	1.0	21.3
Feb.	2	Mid	1.13	2.49	24.9	1.3	23.6
Feb.	3	Mid	1.13	2.79	22.3	0.9	21.4
March	1	Late	1.10	3.00	30.0	0.5	29.5
March	2	Late	0.96	2.88	28.8	0.2	28.5
March	3	Late	0.80	2.65	29.2	0.1	29.1
Apr.	1	Late	0.65	2.34	23.4	0.1	23.3
Apr.	2	Late	0.55	2.16	6.5	0.0	6.5
					<b>291.9</b>	<b>5.1</b>	<b>286.8</b>

**Table 4.3 Water Requirement of Pea Crop using CROPWAT Model**

Month	decade	Stage	K <sub>c</sub>	ET <sub>c</sub> Mm/day	ET <sub>c</sub> Mm/dec	Eff. Rainfall mm/dec	Irrigation Requirement mm/dec
Oct.	3	Init	0.40	1.09	3.3	3.3	3.3
Nov.	1	Init	0.40	1.01	10.1	2.4	7.7
Nov.	2	Deve	0.41	0.97	9.7	0.0	9.7
Nov.	3	Deve	0.61	1.26	12.6	0.0	12.6
Dec.	1	Deve	0.85	1.56	15.6	0.1	15.5
Dec.	2	Mid	1.08	1.71	17.1	0.0	17.1
Dec.	3	Mid	1.13	1.76	19.4	0.0	19.3
Jan	1	Mid	1.13	1.73	17.3	0.1	17.1
Jan	2	Late	1.07	1.60	16.0	0.2	15.8
Jan	3	Late	0.67	1.17	7.0	0.3	6.8
					<b>128.1</b>	<b>6.5</b>	<b>124.9</b>

#### 4.5 Installation of 50 HP pump

The pump has been taken of 50 HP looking to the quantum of backwater. A 50 HP motor power horizontal centrifugal pump has optional input voltage 3 phase AC 220V/230V/240V/, 380V/400V/415V/ to 440V/460V/480V and optional input frequency 50 Hz/60Hz. 50 hp centrifugal pump with maximum flow 65m<sup>3</sup>/h (286 gpm), maximum head 128m/s and same diameter of inlet and outlet 80 mm. This specification satisfies the requirement of power to irrigate 5 ha of upland.

#### 4.6 Construction to store water discharge from pump

The required design parameters and the required section designed component wise has been detailed here as follows

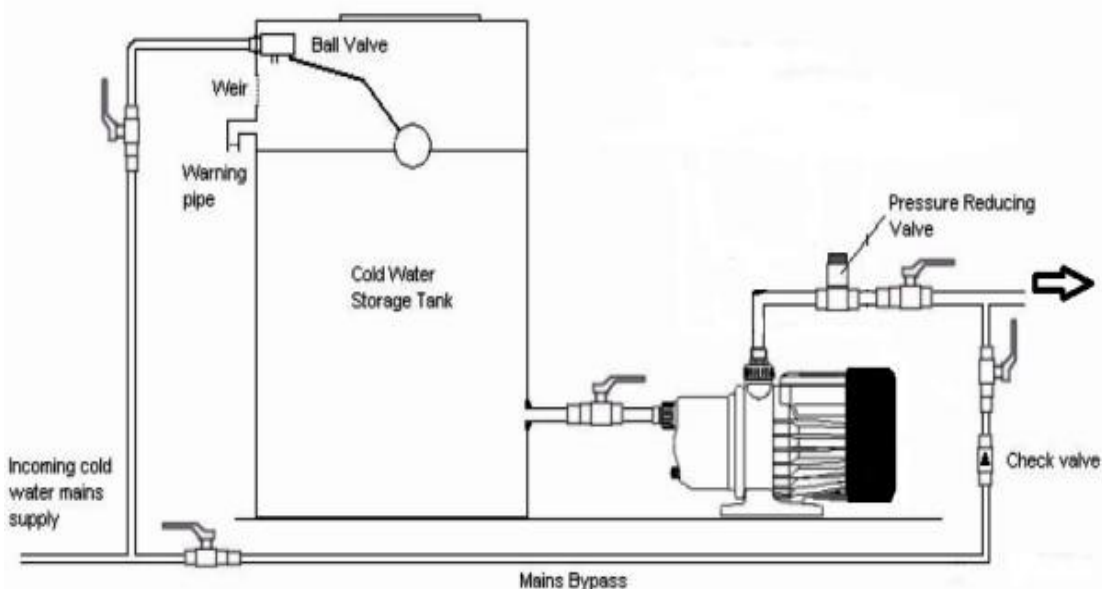


Fig :- 4.2 Cross section of proposed storage tank & pump

Thus, the calculations which are well established which has been depicted in table 4.6

**Table 4.4 Result of Rectangular Water Tank resting on ground**

Structural Element	Limit State Design Method	
	Crack Theory	Deemed to Satisfy
<b>ROOF SLAB</b>		
Thickness	154 mm	154 mm
<b>%age Change</b>	<b>-38.4%</b>	<b>-38.4%</b>
Steel	Not Applicable	Not Applicable
<b>COLUMNS</b>		
Area of Cross Sections	40000mm <sup>2</sup>	40000mm <sup>2</sup>
<b>%age Change</b>	<b>-67.34%</b>	<b>-67.34%</b>
Area Of Steel Reqd.	1206mm <sup>2</sup>	2387mm <sup>2</sup>
<b>%age Change</b>	<b>+ 23 %</b>	<b>+ 143 %</b>
<b>VERTICAL WALL</b>		
Wall Thickness at bottom	230mm	<b>230mm</b>
<b>%age Change</b>	<b>-55.76%</b>	<b>-55.76%</b>
Wall Thickness at mid Height	180mm	180mm
<b>%age Change</b>	<b>-6%</b>	<b>-6%</b>
Steel at Base	1570mm <sup>2</sup>	3900mm <sup>2</sup>
<b>%age Change</b>	<b>+21%</b>	<b>+21%</b>
Steel at mid Height	904mm <sup>2</sup>	4830mm <sup>2</sup>
<b>%age Change</b>	<b>-78%</b>	<b>+15.4%</b>
<b>BASE SLAB</b>		
Thickness	230mm	230mm
<b>%age Change</b>	<b>+0%</b>	<b>+0%</b>
Steel	1950mm <sup>2</sup>	4137mm <sup>2</sup>
<b>%age Change</b>	<b>-30.1%</b>	<b>+48.2%</b>

#### **4.7 Design of MIS for wheat crop**

At the present time, the farmers have been using various irrigation techniques through which the farmers irrigate the land at regular intervals through flood irrigation. So there is need of more water to irrigate. Keeping this in view the design of Micro irrigation system has been designed which is

economical method for using this backwater in an efficient manner. In this research work the design is mainly for wheat. Micro irrigation systems for another Rabi season crop can be designed accordingly. Rabi season crops like gram, pea, mustard, lentil, irrigation is essential to maintain the grain production, especially for winter wheat. Early showing and adopting micro irrigation technology could result in 50% reduction in water usage and improved yields. The filter model selection. JIS – 4 model screen filter was selected which can discharge 25 m<sup>3</sup>/hr with plastic manifold.

# **SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE WORK**

## **Summary**

In this research work it has been proposed that estimation of backwater availability and its use through micro irrigation system. A backwater zone occurs in all rivers entering a receiving basin, but it is longest in deep, lowland rivers with gentle gradients. Upstream of the backwater zone, gravity-driven normal-flow conditions dominate; within the gradually varying flow of the backwater zone, both gravity and pressure gradients are important. Manmade restrictions to natural stream flow or temporary natural obstructions such as vegetation blockage or flooding of a lower stream can create backwater. Backwater is very useful and important also.

If this backwater remains unused there may be chances of loss of water by evaporation and also the problem of salinization or alkalization. So, this backwater is proposed to be stored in water tank and utilize it for agriculture purposes by MIS (Micro irrigation System) in upland area of 5 ha.

This backwater may be quantified both spatially and temporally. Data pertaining to backwater on spatial and temporal basis can be performed making field visits and the help of government records. Conservation of backwater and its use for irrigation through MIS can definitely increase the crop productivity. Micro irrigation is the slow application of continuous drips, tiny streams or miniature sprays of water above or below the soil surface. MIS is effective in saving water and increasing water use efficiency as compared to the conventional surface irrigation method.

## CONCLUSION

- The study concludes that Backwater may be utilized for irrigation. As there are 33.00 Lakh ha command areas in Madhya Pradesh and all of them formed Backwater that has been estimated.
- This will also help to utilize the backwater in upland unirrigated areas through MIS system.
- It has been found that  $2311 \times 10^6$  litres of backwater remains unutilized. With due time it get evaporated thus making the saline or alkaline on the other hand most of the upland areas in that area remains unirrigated. Therefore it has been decided to use this water through lift irrigation and by using micro irrigation system.

### **Suggestion for Further work**

1. Back water that is available in different, command area should be studied on spatial & temporal basis.
2. This unused backwater should be used for irrigation in unirrigated area. Study of micro irrigation system to use this backwater heads more research work.
3. In the present study, MIS had been designed for 5 hectare, upland area. However, due to abundant backwater, there is total volume of 231100 m<sup>3</sup> The further study should concentrate on more area under can be irrigation.

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