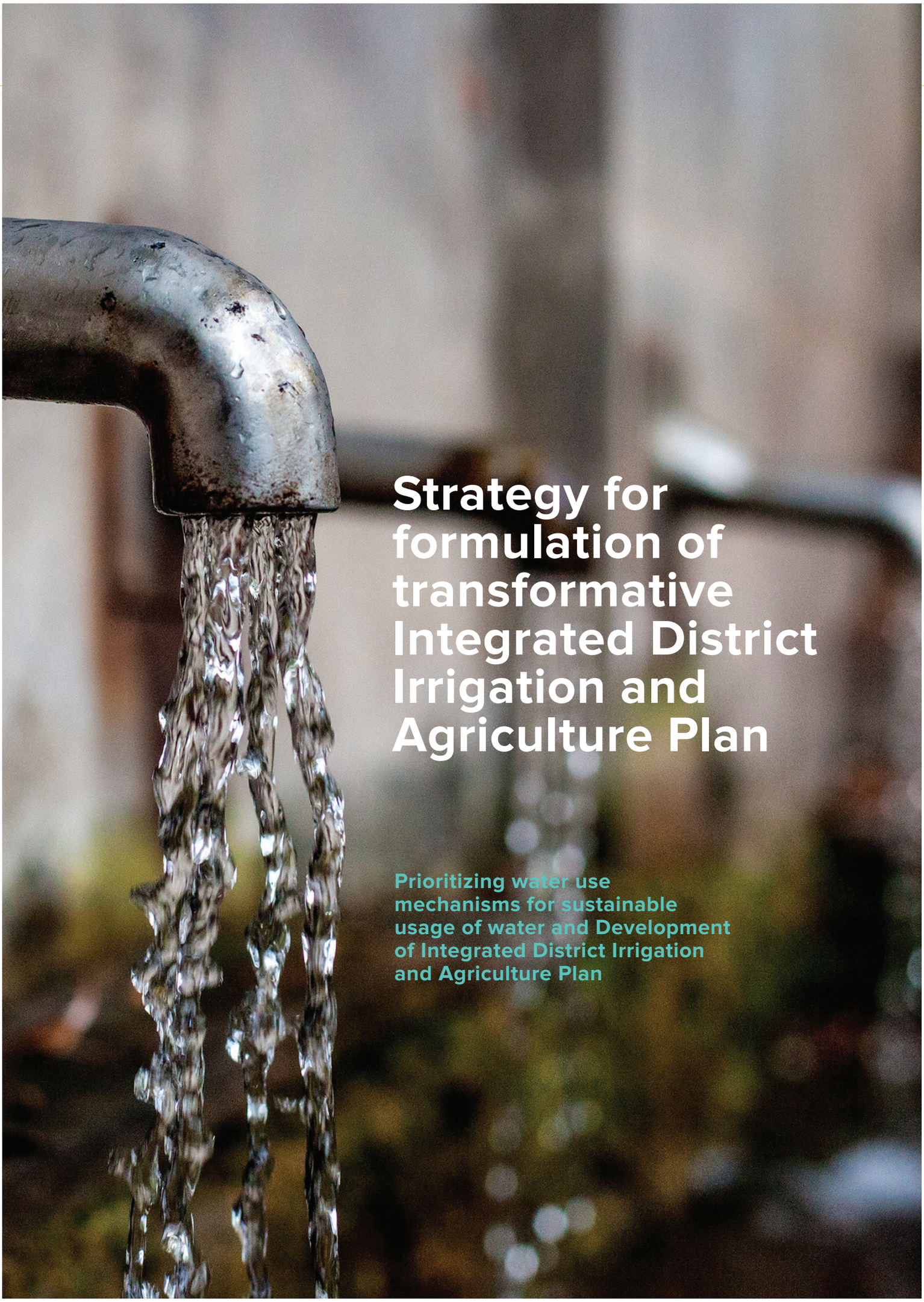

Strategy for formulation of transformative Integrated District Irrigation and Agriculture Plan

Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan

Disclaimer

ACT (Action on Climate Today) is an initiative funded with UK aid from the UK government and managed by Oxford Policy Management. ACT brings together two UK Department for International Development programmes: The Climate Proofing Growth and Development (CPGD) programme and the Climate Change Innovation Programme (CCIP). The views expressed in this document do not necessarily reflect the UK government's official policies.

Strategy for formulation of transformative Integrated District Irrigation and Agriculture Plan

Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS AND ACRONYMS

AAO	Assistant Agriculture Officer
ACT	Action on Climate Today
ADB	Asian Development Bank
AE	Assistant Engineer
ATMA	Agriculture Technology Management Agency
BCM	Billion Cubic per Meter
BDO	Block Development Officer
BKKY	Biju Krushak Kalyan Yojana
BPCC	Basin Planning and Climate Change
CAD	Command Area Development
CADA	Command Area Development Authority
CCA	Culturable Command Area
CS	Cross Section
CWC	Central Water Commission
DAO	District Agriculture Officer
DBT	Direct Benefit Transfer
DDA	Deputy Director of Agriculture
DDH	Deputy Director of Horticulture
DFID	Department for International Development
DIAP	District Irrigation and Agricultural Plan
DLIC	District Level Implementation Committee
DoWR	Department of Water Resources
DRDA	District Rural Development Agency
DS	Design Statement
DTW	Deep Tube Well
DWDU	District Watershed Development Unit
EAP	Externally Aided Project
EE	Executive Engineer
ERM	Extension Renovation & Modernisation
ET	Evapo-transpiration
FGD	Focused Group Discussion
GCF	Green Climate Fund
GIA	Gross Irrigated Area
GoI	Government of India
GP	Gram Panchayat

GSDP	Gross State Domestic Product
GWS	Ground Water Scheme
IPC	Irrigation Potential Created
IPCC	Inter-governmental Panel on Climate Change
IPU	Irrigation Potential Utilized
ISBIG	Incentivisation Scheme for Bridging Irrigation Gap
IWMP	Integrated Watershed Management Programme
IWRM	Integrated Water Resources Management
IRRI	International Rice Research Institute
KBK	Kalahandi-Balangir-Koraput districts Region (Undivided Districts)
Kc	Crop-Coefficient
KFW	Kreditanstalt für Wiederaufbau
LS	Long Section
MB	Measurement Book
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MIP	Minor Irrigation Project
MOWR	Ministry of Water Resource
NABARD	National Bank for Agriculture and Rural Development
NAC	Notified Area Council
NAPCC	National Action Plan on Climate Change
NIR	Net Irrigation Requirement
NWM	National Water Mission
OAIC	Odisha Agro Industries Corporation
OFD	On Farm Development
OIIAWMP	Odisha Integrated Irrigated Water Management Project
OLIC	Odisha Lift Irrigation Corporation
PMKSY	Pradhan Mantri Krishi Sinchai Yojana
PP	Pani Panchayat
PS	Panchayat Samiti
QA	Quality Assurance
QC	Quality Control
RI	Revenue Inspector
RIDF	Rural Infrastructural Development Fund
RKVY	Rastriya Krishi Vikash Yojana
RLS	River Lift Scheme
SPAP	State Specific Action Plan
TSP	Tribal Sub-Plan
TW	Tube Well
UIP	Ultimate Irrigation Potential
VAW	Village Agriculture Worker
WP	Water Productivity

GLOSSARY OF TERMS

Conjunctive use	Combined use of surface water and groundwater is called conjunctive use.
Culturable Command Area (CCA)	The area which can be irrigated from a scheme and is fit for cultivation. (This term is commonly used in India, but elsewhere the term 'Cultivable Command Area' is also used).
Chak	It is a local term. Chak means the area irrigated from a particular outlet
Gross Irrigated Area	The area irrigated under various crops during a year, counting the area irrigated under more than one crop during the same year as many times as the number of crops grown and irrigated.
Irrigation Potential Created	The total gross area proposed to be irrigated under different crops during a year by a scheme. The area proposed to be irrigated under more than one crop during the same year is counted as many times as the number of crops grown and irrigated.
Irrigation Potential Utilized	The gross area actually irrigated during reference year out of the gross proposed area to be irrigated by the scheme during the year.
Minor Irrigation (M.I.) Scheme	A scheme having CCA up to 2,000 hectares individually is classified as minor irrigation scheme.
Medium Irrigation Scheme	A scheme having CCA more than 2,000 hectares and up to 10,000 hectares individually is a medium irrigation scheme.
Major Irrigation Scheme	A scheme having CCA more than 10,000 hectares is major irrigation scheme.
Efficiency	Efficiency is defined as the ability to produce something with a minimum amount of effort.
Irrigation Efficiency	It is the ratio of the amount of water consumed by the crop to the amount of water supplied through irrigation.
Crop Coefficient	Crop coefficients are properties of plants used in predicting crop evapotranspiration (ET). The most basic crop coefficient, Kc, is simply the ratio of ET observed for the crop studied over that observed for the well calibrated reference crop under the same conditions.
Evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

Pani Panchayat	It is local term meaning an association of water users registered and functioning under the relevant act of Government of Odisha responsible for operation and maintenance of canal system, preparation of cropping plan and distribution of irrigation water to all water users under the association. The act has defined Pani Panchayat as an institution at the primary level consisting of all the water users, as constituted within a specified hydraulic boundary of a major, medium, minor (flow and lift- both surface and ground water and creek irrigation projects funded by government).
Solar Radiation	Solar Radiation data used in document is the (average) shortwave radiation measured with a pyranometer or from the (average) daily actual duration of bright sunshine (hours per day) measured with a (Campbell-Stokes) sunshine recorder.
Relative Humidity	The amount of water vapour present in air expressed as a percentage of the amount needed for saturation at the same temperature.
Root zone depth	The soil depth from which a mature crop extracts most of the water needed for evapotranspiration. The crop root zone is equal to effective rooting depth and is expressed as a depth in inches or feet.
Operational Plan	It means a schedule of irrigation deliveries with details of the mode and duration of supplies drawn up for regulation of irrigation in the commanded area of an irrigation system.
Outlet	An opening constructed in an irrigation work through which water is delivered into a water course or directly on to any land.
Tahsildar	Sub-district level revenue officer to function as irrigation officer.
Water Course	Any channel which is supplied with water from an irrigation work and includes all subsidiary work connected with any such channel.
Water Productivity	Water productivity is generally defined as crop yield per cubic metre of water consumption.
Warabandi	It is a local term. “Warabandi” means a system of distribution of water allocation to water users by turn, according to an approved schedule indicating the day, duration and the time of supply.

EXECUTIVE SUMMARY

This report is an outcome of efforts to find remedial actions to deficiencies found during water use study, brainstorming and consultation with people responsible for water management in irrigation projects in Odisha, keeping in mind the need to adapt to changing climate conditions. The report builds off of a prior "Water Use", conducted as an initial activity under the Action on Climate Today (ACT) programme in Odisha. ACT is a technical assistance programme funded by the UK Department for International Development (DFID) that works with selected Governments to help integrate climate change into policies, plans and budgets.

Existing practices of allocation, distribution and water management in irrigation projects in Odisha were assessed through field work, consultation with the personnel in the Government as well as community leaders and farmers in the aforementioned "**Water Use Report**" prepared as the **first report** of the ACT activity in Odisha. From the information obtained, it was felt that practices followed at present both by Government departments/agencies and water users associations (called as Pani Panchayat in Odisha) **need revision** for better management of irrigated agriculture. Hence this **second report has the purpose to turn the findings of the "Water Use Report" into a revised strategy that is more effective and efficient in allocation and management of water for agriculture.**

This strategy report is formulated to support the Odisha Government's commitment to implement climate change adaptation strategies in water and agriculture sector. The main goal of this new proposed strategy is to increase water use efficiency in existing irrigation projects, increase area covered under irrigated crops in Rabi season and ultimately doubling the income of farmers even in spite of changing climate conditions.

This report titled, "**Report on strategy for formulation of transformative Integrated District Irrigation and Agriculture Plan conceptualized based on assessment of current scenario of water use**" is focused on the strategy to be adopted by the Department of Water Resources and Department of Agriculture, District Administrations, Government of Odisha to achieve targets like bridging gap between Irrigation Potential Created (IPC) and Irrigation Potential Utilized (IPU), Improving Efficiency (IE), equitable distribution including gender mainstreaming, crop diversification, enhancing water productivity.

A key recommendation is preparation of district level annual irrigation plans for different districts, which integrate irrigation and agriculture aspects in terms of implementation and monitoring. A sample Integrated District Irrigation and Agricultural Plan (DIAP) will be prepared in 2018-19 taking into account climate change aspects by incorporating scenarios to 2030. The strategy is suggested with an aim for leveraging the activities/ programs under irrigation and agriculture in Odisha to be climate resilient.

Understanding the present practices of water use and insight gained about the operational practices was kept in the backdrop for formulation of strategies. Strategies are aimed at increasing water use efficiency, water productivity, equitable distribution, institutional strengthening in irrigation projects. Intensive field level assessments were conducted to find the irrigation potential utilized against the irrigation potential created as per the irrigation project design. Reasons for gap and poor water use efficiency were brought out in the water use report. This was done for two districts of Odisha as pilot study. Existing practices and comparative strategy for water use has been furnished in a tabular format for easy understanding of the transformation envisaged in the proposed strategy. Salient recommendations furnished in the report are mentioned below on priority with ease of implementation.

1. It is recommended that Pani Panchayat wise jurisdiction maps should be prepared in phased manner depicting all required layers such as position of all outlets, canal, road, field channel if available, and strip of land for suitable for field channel.
2. A complete data base may be prepared by compilation of disparate data from different offices taking Pani Panchayats as units in a phased manner starting with major & medium projects. It is suggested that this may be completed in 5-7 years' time in all types of irrigation projects. Where individual projects are small, like tube-wells, farm ponds, check dams, traditional tanks (locally known as kata and bandha), and clusters for totalling to 300-500 hectares may be taken as unit where 8154 PPs may or may not exist.
3. Concerned irrigation divisions should take up programmes to bridge the gap between irrigation potential created and its utilisation by implementing 3 activities viz. (i) restoration of system deficiency in minors and sub-minors, (ii) Construction of field channels and other on-farm development work and (iii) creation of infrastructure for efficient water application methods like drip and sprinkler irrigation. These activities can be taken up in around 10,000 hectares of area for Cuttack district and 9000 hectares of area in Subarnapur district from the financial resources of the scheme titled Incentivization Scheme for Bridging Irrigation Gap (ISBIG). DPRs have already been prepared by the State Govt. and sent to Govt. of India. It is learnt that financials will be available for such infrastructure related works from the year 2018-19 for a period of 4 years for which Govt. of India has already made budgetary provisions.
4. Outlet registers may be prepared showing sill level, diameter of outlet as all outlets in projects in Odisha are pipe outlets. Design discharge, area to be commanded, length of field channels (with split of lined and unlined portion), number of turnouts, turnout wise area, turnout wise land holders list and their area should form part of the database.
5. It is recommended that all possible activities should be taken to increase water use efficiency. Some important activities are increasing coverage of area under irrigation in Rabi season by growing less water requiring crops, adoption of sprinkler and drip irrigation, reduce water losses in conveyance in canals and application in fields.
6. Benchmarking of irrigation projects for major canals major & medium project, entire minor irrigation project, clusters of lift irrigation projects is recommended as strategy to periodically evaluate the performance of irrigation projects and plan improvement interventions. Water productivity is a composite parameter that gives an indication of efficient water use and crop productivity. Water productivity can be one of the parameters of benchmarking.
7. As the irrigation potential developed to date through various types of projects has not been fully tapped, the available surface water and ground water resources need to be used properly. Conjunctive use of surface water and ground water is recommended. There is a strong need to develop further irrigation potential and utilize the natural resources. River basin planning at macro level and cascade level planning at micro level and construction of new schemes for further irrigation potential has been put forth as one of the strategies.

SECTION 1:
BACKGROUND

Odisha has prepared State Action Plan for Climate Change (SAPCC 2016-2020) which highlights the vulnerability of the state's agriculture due to climate change and climatic variability. Most of these issues are linked to the vagaries of monsoons, creating variability in river flows and increased frequency/intensity in extreme events of droughts, heat waves etc.

Frequent droughts are also major concern in the State and the impact on farmers has been so severe that they are not able to uplift their economic conditions in spite of a number of irrigation schemes implemented by the state Government. Most of the rural population of Odisha are dependent on agriculture and are therefore vulnerable to climate shocks and stress. Ensuring water availability for irrigation to the vulnerable areas and vulnerable population will help in many ways to overcome the stress induced because of climatic variations and other reasons.

This strategy report is formulated in the backdrop of Odisha Government's commitment to implement adaptation strategies in water and agriculture sector. The strategies enumerated in this report when implemented will be a kind of follow-up implementation to suggestions made in State Action Plan on Climate Change (SAPCC), Odisha. The report contains strategies that may remedy some of the key causes of non-availability of water at desirable time and inequity in its distribution.

Over the next few years irrigation sector in Odisha will require a transformation in its governance to enable the state, its government, community or people to meet the needs for food, income, and employment of the state's swelling populations and rising aspirations. The challenge to grow more food with less water under a less predictable climate system requires an increase in efficiency of water use and improvement of water productivity. To produce more crop per drop is increasingly important to meet competing demands for water from other users. Management and accountability need to be improved at all levels of the irrigation service chain. Available funds need to be utilized for more climate resilient irrigation infrastructure. Alongside, better preparedness for climate variability and climate change related disasters like droughts, long dry spells, and floods is to be made as inbuilt mechanism in the overall water governance framework is also required to overcome the climate change shocks.

There is ample opportunity within the irrigation sector in Odisha to increase financing for climate adaptation related activities or projects. It is the right time for the Department of Water Resources (DoWR), Government of Odisha to formulate strategy, develop methodology and procedures for operation of water distribution networks, benchmarking and monitoring. This should be in form of a strategy that includes near-term, short-term, medium-term and long-term perspectives.

World Bank and Asian Development Bank (ADB) have already aligned their programmes to make investments in climate resilient irrigated agriculture. DFID has taken up Odisha state in its country programme for India to leverage more funding to reduce vulnerability. Future funding in irrigation sector therefore will greatly depend on the forward-looking approach of Department of Water Resources (DoWR), Government of Odisha. Something new, innovative, has to be taken up for the first time by the DoWR aiming at climate resilient irrigation water management.

Odisha depends largely upon monsoon for its water resources. Southwest monsoon triggers rainfall in the state. About 78% of total annual rainfall occurs during the period from June to September and the balance 22% in the remaining period i.e. from October to May. In addition to seasonal availability, the rainfall in the state also shows spatial variation i.e. from about 1200 mm in southern coastal plain to about 1700 mm in northern plateau. Due to such variations in rainfall and its erratic nature, management of irrigation, water conservation, catchment treatment including drainage line treatment, creation of additional irrigational potential, better annual maintenance through water users' community and capital maintenance (once in 5-7 years) by government are to be planned in a better manner. In the year 2017, Government announced drought management package to bail out farmers from distress with provision of cash compensation, pump sets, energisation of tube wells, and restoration of defunct irrigation projects and seeds for the next season. This type of situation will continue to occur unless, there are climate change adaptation-oriented action plans in place and implemented. Climate change focus is required to be consistent while preparation of five-year plans, annual plans/ budgets and their implementation with involvement of the beneficiary community institutions

1.1 KEY OBJECTIVES OF THE STRATEGY

This document puts forth different strategies for water management in Odisha which will be climate resilient. The strategy if implemented has the potential to align different programs on irrigation and agriculture to address climate variability and climate change. In Odisha as well as in India, districts have evolved as a critical administrative unit with legacy from the colonial rule. District administration headed by Collector and District Magistrate is the main administrative set up at district level. District level officers of Agriculture Department, Panchayati Raj Department, Irrigation Department, Watershed Agency report to the Collector and District Magistrate. Many programs of the government decided by the state administration are channelized through the Collector. Therefore, district administration is the main implementer after the state administration for policy implementation. Institutional mechanism will accordingly be developed for both state and district level. It is the planning and implementation at district level which is most suitable in Indian context. The latest program of Govt. of India in water sector viz. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has laid emphasis on district level planning and monitoring of irrigation development and management. The district plan for efficient and effective management of already created irrigation potential in an integrated manner and creation of additional potential will have the following objectives:

1. Reducing gap between Irrigation Potential Created and Utilized.
2. Improving efficiency in irrigation projects and increasing water productivity.
3. Enhancing irrigation intensity by maximizing area coverage in Rabi season.
4. Creation of additional irrigation potential by using surface and ground water resources of the district.
5. Preparing short-term and long-term action plans on augmentation, conservation of water resources and catchment treatment.
6. Supporting development of sustainable local institutions for maintenance and management of irrigation systems.
7. Integrating irrigation and agricultural departments for coordinated planning and implementation.

SECTION 2:

REVIEW AND ANALYSIS OF EXISTING WATER USE STRATEGY

Consultations with the stakeholders of District Integrated Irrigation and Agriculture Plan (DIAP), study of available documents and literatures, Government orders, acts and rules, feedback from water users and/or farmers have formed the basis of documentation of the present water use strategy. An insight into the existing practices of water use analysed from the information mentioned was found to be crucial in strategy formulation.

2.1 EXISTING POLICIES AND ACTS IN WATER SECTOR

The Government of India Act of 1935 placed the administrative control of developing and managing Irrigation works under the provincial governments. This arrangement was accepted by the Constituent Assembly that framed the Constitution of India. Unfortunately, this has ensured the loss of an all-India perspective on the subject of development and management of irrigation systems. As a consequence, some states have developed operational plans for water distribution to farms, conducted benchmarking, adopted technologies for automation in canal operation, and installed measuring devices, supplying water on volumetric basis. Odisha has not embarked upon such interventions that have already been made by other states in India. Some contents of National Water Policy 2012 and National Water Mission are discussed in Annexure I and the and state water policies are discussed in Annexure II and the Five-year perspective plan is discussed in Annexure III.

2.1.1 Support of Policy and Programs for formulating the proposed strategy

Irrigation sector in Odisha can derive benefits from the National Water Mission (NWM), take up programmes for increasing water use efficiency by 20% and implementation of Integrated Water Resources Management (IWRM). National Water Policy lays emphasis on improving performance of existing irrigation facilities and on water charges to at least cover the Operation and Maintenance (O&M) costs. As per the Odisha Irrigation Act, 1959 certain basic water rates have been fixed to be paid to the revenue department by farmers. For sustainability under the PIM policy which has already been adopted by Government of Odisha, the Pani Panchayats can collect more water charges

to meet annual O&M costs. However, Government should have a role to take up capital maintenance to restore the canal systems which might have been deteriorated due to deferred maintenance. Under the institutional mechanism of PMKSY, a country-wide flagship programme inter-departmental coordination and monitoring has been proposed through District Level Implementation Committee (DLIC).

2.2 EXISTING AND UPCOMING REGULATIONS

DoWR has taken up many new initiatives to provide irrigation and creating additional irrigation potential in the last two years which are available in public domain, mostly on its website. These initiative/ regulations are presented in a tabular format in Annexure-II. Some of these initiatives are discussed in this section. SWOT Analysis is incorporated to present strengths and weaknesses of the concerned sector including the regulations.

2.2.1 Regular meeting of Pani Panchayats

“Pani Panchayats” is a local term meaning an association of water users registered and functioning under a relevant Pani Panchayat Act of Government of Odisha responsible for operation and maintenance of canal system, preparation of cropping plan and distribution of irrigation water to all water users under the association. Performances of PPs were judged and information as per the grading card was analysed. For democratic functioning and effective roles and responsibilities, the executive committee of PPs need to meet frequently i.e. at least once a month. It is a common scenario that the secretary and president of PPs work with the DoWR officials for construction of field channels and undertake repairing and bring modernisation work. As other functions of PPs like crop planning, canal operation, water distribution, irrigation fees collection are not presently done by the PPs. Meetings are not convened by PP secretaries to deliberate and take decision on these matters. If regular meeting of the executive committee of Pani Panchayats (PPs) are held, then the functioning of these water users’ community will automatically improve. Government has directed to hold monthly meetings of the PPs. It has to be facilitated by the concerned sub-divisional or sectional level officer/engineer. In such meeting, the DoWR or PPs should ensure participation of Block level officials of agriculture department. WALMI with guest faculty can also organise interactive training and facilitate organisation of effective meetings of PPs.

2.2.2 Regulation and Management of Outlets

The number of outlets in canal should not exceed the provision made in the approved Longitudinal Slope (L.S.). Diameter of the outlet pipes should not be more than the design requirement. In cases, where larger diameter of outlet is noticed, a concert sleeve is to be inserted in the outlet pipe to keep the opening to match the design discharge.

2.2.3 Promotion of Micro-Irrigation

As an upcoming intervention, Government has directed to expedite the capacity building of PP or WUA to promote micro irrigation to achieve higher water-use efficiency. It has been indicated in the directive that 10% to 15% micro irrigation is to be planned in five AIBP projects namely, Lower Indra Ext., Rukura, Anandapur Barrage & Subarnarekha Irrigation Project.

Most of the initiatives are kind of directives from the Government. Institutionalisation of the initiatives, directives and making them as routine activities at division or district level as the case may be, is very crucial. New sets of activities are to be framed as rollout plan of the strategy presented in this report.

The DoWR has irrigation divisions administered under Engineer-in-Chief, Minor irrigation divisions administered by a Chief Engineer, Command Area Development (CAD) divisions administered by Director, Command Area Development and Participatory Irrigation Management (CADPIM), and lift irrigation divisions administered by Managing Director, Odisha Lift Irrigation Corporation (OLIC). Structure of DoWR can be considered to be adequate. But what is needed is focus on water management instead of only

construction. Entire set up within the Government has to be sensitive to vulnerable areas and individuals that are likely to be affected by variations in climate and climate change. Institutional bottlenecks that look apparent can be done away with organisation of training programmes and effective monitoring by the available offices assigned with responsibility of monitoring.

For implementation of the activities formulated and incorporated in this report, all activities can be grouped into different phases and could be implemented in tandem with capacity development. It may be worthwhile to take up diagnostic study or assessment of institutional capacities or in other words bottlenecks for deciding the implementation of the proposed strategy.

2.3 POLICY FRAMEWORK

Summary of the recent policies pronounced by Government of Odisha on fishery, agriculture and water is given in tabular format in Annexure-II. The linkage between these policies and the overall framework of the Integrated District Irrigation and Agriculture Plan is indicated in the third column of the table. It may be observed the existing policies of the Government favour the integrated strategy for water allocation and water management as is being proposed by this report.

2.4 SWOT ANALYSIS

SWOT analysis of existing system/mechanism is conducted so as to know the deficiencies, constraints and possible interventions for improving water use in the DIAP framework and is presented in Table-1.

Table 1: SWOT Analysis

Strength
• Few Minor Irrigation tanks have been renovated under Odisha Community Tank Management Project (OCTMP). • Policy of Government to give maintenance grant to PP @ 100 per hector per year. • Arrangement of rewarding PP every year and release of award of up to 3 lakhs for construction of PP office. • Divisions are equipped to take up O&M and water distribution. • Budgets are increasing every year. • Government has a system for review of activities of the water resource department by the Principal Secretary on monthly basis. • Sanction of Artificial recharge shaft under by Green Climate Fund (GCF) to take up recharging in MI Tanks. • Availability of adequate funds under MGNREGA for maintenance of earthen canals through convergence. • System of taking of construction under K2[1] agreement directly by PP without tendering process. • Concrete lining of the canal system in Taladanda Canal, Patamundai Canal, High level Canal, Kendrapada Canal of Mahanadi delta stage –I, Hariharjore main canal in past 2 – 3 years. • ADB project will continue for one more year in Cuttack district. • Command Area Development (CAD) organization having budget to reconstruct field channel or construct new field channel through Pani Panchayat. • Very good training infrastructure of WALMI for capacity building of office bearer and members of PPs, field level functionaries, officers of water resource and agriculture departments.

1 It is a type of contract where the value of contract is very less and meant for piece work of small item of work. Process will be one time and single payment.

Weakness

- Canal operational plans are not prepared.
- Monitoring organization currently not monitoring water release to different systems of canal system.
- Special efforts are not made for making water reach the tail end of the canal.
- Patrol which were operating at beat level are no more, doing the job of water distribution as per request of water users.
- Maps are not available at distributary level showing structures, outlets, field channels and chak-wise boundaries.
- Pani Panchayat are not given responsibility for water distribution in each season by the irrigation officials.
- Crop water budgeting is not being done.
- Water allocations are not properly done. Farmers don't know when they will get water and for how much time.
- Revenue collection system is not adequate; Pani Panchayats are not able to know how much irrigation tax collected each season by the officials of revenue department.
- Pani Panchayats are not getting O&M grants regularly. Deficiencies in PPs are not being sorted out by the concern irrigation officials properly and in time.
- Secretary and President in any PPs are not convening general body meetings regularly. Common water users are not being involved with activities of PP and hence they have apathy.
- Departmental officials from DoWR, Agriculture, and Revenue are either not being nominated or not attending the executive committee meetings of Pani Panchayats. As a result, they get deprived of guidance and encouragement ought to be received.
- Pani Panchayats are not receiving notification regarding district agriculture officer and executive engineer as permanent invite to their executive committee.
- Seasonal planning for irrigation management is not done at the PP level and neither of the departments of agriculture, WORD are interactive with PP in this regard.
- Chak wise maps showing plots and plot numbers are not provided to many PPs by the concerned govt. department.
- Regulation structures in many places are non-operational, damaged impeding water delivery from irrigation canal network.
- Crops are damaged due to non-supply of irrigation in major and medium project towards the end cropping season.
- Less revenue collection mainly because irrigation supply is not ensured.
- Deterioration in canal conditions and reduction in carrying capacity as maintenance is not done regularly.
- Decrease cropping intensity, crop productivity and crop production.
- Pani Panchayat getting defunct as support needed is not provided after transferring the irrigation system to PPs.

Opportunity

- Reduction in gaps between current utilization and irrigation potential.
- Increasing area under irrigated agriculture in Rabi season by growing crops for which irrigation facilities available.
- Crop diversification by converting area under paddy to groundnut, green gram, black gram, potato and sugarcane.
- Increase irrigation efficiency by 10 – 20%
- Introduction of benchmarking of ??
- Openness of the State Govt. for revising policies and program architecture to climate change adaptation.

Threat
• Theft of Transformer, electric wares, etc. when the river lift schemes are not operating for longer periods. Usually live projects with live transformers are not stolen due to fear of electrocution • Tampering of outlets and head regulators. • Climate variability • Climate Change • Slow pace of the irrigation bureaucracy to adapt innovative and technology driven strategies.

2.5 BEST PRACTICES IN IRRIGATION WATER MANAGEMENT: NATIONAL AND INTERNATIONAL

Best practices adopted in different states of India and in other countries were reviewed through extensive literature survey for getting ideas for formulating strategies and its elements concerning to the objectives. The national best practices related to canal operation, modernization and benchmarking etc. are summarised in Table 2 and are elaborately presented in Annexure XII. Similarly, international best practices on automation, river basin planning etc. have been reviewed and few of them are given in Annexure XIII.

There is always scope for learning from other's experience and customizing them to a given situation. MASCOTTE[2] approach of FAO and river basin planning activities being implemented in Karnataka is worth trying in Odisha as they are not only feasible but also likely to bring positive change in the entire spectrum of approach on water management. Crop-water budgeting being promoted in World Bank aided projects in Andhra Pradesh and West Bengal could also be promoted in Odisha particularly in Minor Irrigation projects to be taken up under the new climate change aligned World Bank project in Odisha.

Table 2: Best Practices

State/Region	Good Practices
	NATIONAL LEVEL BEST PRACTICES
Hiware Bazar (Maharashtra)	a) Investment by villagers on additional storage structures. b) Trenches were also built by villagers along contours in the hills to trap and slow rainwater runoff. c) To institutionalise sharing of water, the village introduced a practice of water budgeting about five years ago. Using a 'water bank' principle, the budget ensures that the village does not draw more water than it stores in a year, and a small amount is kept in reserve.
Chambal Project (Madhya Pradesh)	Supplying of water to tail end reaches through proper water management is planned. It is now selected for a UNDP-funded pilot project.
The Majalgaon Project (Maharashtra)	a) The government of Maharashtra has implemented a system of volumetric water distribution to the farmers' association. b) The government of Maharashtra has introduced a pilot project to improve water control management.
Narmada Canal Operational Plan (Gujarat)	a) The Narmada canal system is planned to be operated on a controlled-volume basis by managing the volume of water contained in each canal pool. b) The canal system is planned to be operated using the supervisory automatic control method.

2 MASSCOTE stands for Mapping System and Services for Canal Operation Techniques developed by FAO. It is a tool for management improvement and modernization of irrigation projects

The Tungabhadra project (Karnataka)	a) Improved water management on existing water resource projects. b) This will ensure improved irrigation efficiency at farm level and operational ease and flexibility at project level.
Projects under Karnataka Neeravari Nigam Limited (KNNL)	MASSCOTE methodology was tested in two irrigation projects; studies conducted with staff of Karnataka Neeravari Nigam Limited (KNNL) in Karnataka (India).
INTERNATIONAL LEVEL BEST PRACTICES	
Oakdale Irrigation Project	a) Automation of canal operational plan. b) All regulators are in constant communication with other upstream and downstream regulators and with the server, sharing information about water levels and flows along the length of the channel in real time. This means that water level fluctuations are minimised, ensuring high flows and service levels to all farms along the channel.
Fen River Irrigation, China	a) Coordinating and controlling the gates to optimise the delivery of water and eliminate spills through NeuroFlo software. b) Remote management and data collection through SCADAConnect.
Sunsari Morang Irrigation System (SMIS), Nepal	MASSCOTE methodology of FAO has been used in Sunsari Morang Irrigation System (SMIS) is the largest irrigation system in Nepal. It is located in the southeast Terai, a continuation of the Gangetic Plain. The gross command area exceeds 100000 ha, with an irrigated area of about 64000 ha. The SMIS is served by the Chatra Main Canal (CMC), which extends 53 km from the left bank of the Koshi River. By use of MASSCOTE, Rapid Appraisal Process (RAP) indicators were determined before taking up of modernisation. Some of the indicators are: a) Actual water delivery service to individual ownership. b) Stated water delivery service to individual ownership. c) Actual water delivery service at the most downstream point in the system operated by a paid employee. d) Stated water delivery service at the most downstream point in the system operated by a paid employee.

SECTION 3:

SUSTAINABLE WATER USE STRATEGY

This strategy is formulated to achieve the objectives enumerated in Section 1. The strategy includes management of already created irrigation potential and creation of additional irrigation potential up to 2030. The creation of additional irrigation potential is possible in Odisha as the present utilization of ground water is only 33% and the aquifers are suitable for groundwater extraction.

The State's annual average precipitation is 1442 cm. There are many perennial rivers and rivulets as well as water bodies and tanks. Surface water is therefore available for further development of irrigation potential. The State government has already announced a policy to develop minimum 35% of the cultivable area in all blocks of the state. There are 15 elements of strategy covering 7 key objectives of the strategy report.

3.1 REDUCING GAP BETWEEN IRRIGATION POTENTIAL CREATED AND UTILISED

A study on present usage of irrigation water and performance of irrigation schemes was conducted in two districts namely Cuttack and Subarnapur out of 30 districts of Odisha. Cuttack and Subarnapur district have been selected as pilot districts with former representing eastern coastal region and the latter representing western region. The study had one parameter on the gap between IPC and IPU.

3.1.1 Assessed Gap between Created Potential and Actual Utilization

The gap between Irrigation Potential Created (IPC) and Irrigation Potential Utilization (IPU) was assessed and incorporated in water use report[3]. The gap in major, medium, minor, lift irrigation projects are presented in Table 3 and Table 4 for Cuttack and Subarnapur, two pilot districts of Odisha taken up for the purpose.

3 ODI-06: Project Brief – Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan Water Use Report (First report of the project)

Table 3: Season wise & annual gap between IPC (ha), IPU (ha) in all types of Irrigation Projects/ Schemes in Cuttack

Type	Kharif				Rabi				Annual			
	IPC	IPU	Gap	%age of Gap	IPC	IPU	Gap	%age of Gap	Gross Irrigation Potential	IPU	Gap	%age of Gap
Major	2871	1913	958	33.37	2871	617	2254	78.51	5742	2530	3212	55.94
Medium	767	434	333	43.42	767	0	767	100.00	1534	434	1100	71.71
Minor	5199	2514	2685	51.64	221	18	203	91.86	5420	2532	2888	53.28
River Lift	1912	1089	823	43.04	1912	815	1097	57.37	3824	1904	1920	50.21
Ground water	842	414	428	50.83	842	260	582	69.12	1684	674	1010	59.98
				44.46				73.38				58.224

Table 4: IPC, IPU and percentage gap in different types of irrigation projects/schemes in Subarnapur district

Type	Kharif				Rabi				Annual			
	IPC	IPU	Gap	%age of Gap	IPC	IPU	Gap	%age of Gap	Gross Irrigation Potential	IPU	Gap	%age of Gap
Major	7155	6440	715	9.99	7155	5755	1400	19.57	14310	12195	2115	14.78
Medium	1836	1469	367	19.99	1836	984	852	46.41	3672	2453	1219	33.20
Minor	3971	1557	2414	60.79	1414	24	1390	98.30	5385	1581	3804	70.64
River Lift	2065	1190	875	42.37	2065	350	1715	83.05	4130	1540	2590	62.71
Ground water	270	184	86	31.85	270	164	106	39.26	540	348	192	35.56
				32.98				57.31				

Source: Water use report of the DFID study of Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan

Gap in the irrigation service delivery to cover entire designed irrigable area is an issue which needs regular attention. The gap is created due to various factors, like negligence in dealing with important faucets of canal operation, maintenance, on farm water distribution and in field water management..

After restoration of system deficiencies in minor and sub minor canals and construction of on farm development works including field channels, it should be attempted that the gap is not more than 5%-10% in flow irrigation projects. However, in lift irrigation projects there are problems related to supply of quality power (electricity), power cut introduced by the electrical distribution companies due to less generation, theft of transformers, and failure of transformers which can be rectified by the company. Therefore, the gap in lift irrigation projects for the district as a whole should be targeted reasonably considering the status of pumping systems, condition of motors, overloading in the distribution line. However, efforts should be made to limit the gap for the whole district at 20%.

The key reason for the gap has been listed below:

- Water is not reaching to the tail end of the canals.
- Wastage of water in head reached of canal system due to unregulated flow of water.
- Canal operation plan for Govt. controlled canals, minor canals and field channels are not done.
- Pani Panchayat based irrigation planning is not done.
- Inefficient water application practices in cropped fields.

The gap can be reduced with revised strategies recommended with elaborations wherever needed in the subsequent sections.

3.1.2 Elements of Strategy

Irrigation is a complex subject and encompasses many diverse aspects. While formulating the proposed strategy, all important aspects were taken into consideration to deal with these aspects. For each aspect, one planning element is drafted. There are 15 elements in the strategy report as given below.

1. Pani Panchayat based Irrigation planning
2. Canal operation Plan for Govt. controlled Canals
3. Canal operation Plan for Minor Canals (Pani Panchayat jurisdiction)
4. Operation Plan for Field Channels (Outlet command area, chak)
5. Preparation of Model Irrigation Plans for each major medium and minor project
6. Efficiency improvement in irrigation commands
7. Crop Water Budgeting
8. Assessment of actual cropping pattern in the current scenario
9. Perspective planning of the cropping pattern in the future scenarios (2030)
10. River Basin Planning and IWRM
11. Cascade level planning
12. Development of further irrigation potential
13. Augmentation, Conservation and catchment treatment
14. Requirements and process for preparation of IDIAP and its implementation
15. Monitoring and benchmarking

These elements are briefly described below:

Element 1: Pani Panchayat based Irrigation planning

Around 25000 Pani Panchayats (PP) are constituted in Odisha for management of irrigation projects. Govt. of Odisha is providing all kinds of administrative and financial support to PPs. In 2002, the Government enacted Pani Panchayat Act. The salient points of this act are described in Annexure II. This act empowers the PPs to take over all distributary canals mainly minors and sub minors. The PP has the mandate to prepare crop plans, water distribution plans, and water distribution among farmers through field channels. The act and Governments' administrative instructions also enables the PPs to receive maintenance fund annually. At present it is Rs. 100 per hectare. At present, field channels are constructed only through PPs with a limit of 10 Lakh for an individual work. The PP jurisdiction area as per the act is 300-800 hectares in flow irrigation projects which is a sizeable unit of planning. Database for Pani Panchayat's works constituted in Cuttack District have to be prepared through collection and compilation of disparate data which was laying in silos in different organizations.

Each Pani Panchayat has certain length of distributary and minor canal which have been transferred by the Government to the Pani Panchayat. They are legally entitled and responsible to regulate and operate these canals for equitable water distribution among all water users having irrigated land holdings within the jurisdiction of PP. DoWR has not taken any concrete action so far in this regard. Through the revised strategy, PP planning has to be strictly followed and in few years down the line may be made mandatory for approval of estimates for works to be taken up by the divisions of the department or OLIC.

PP level plans are proposed to be prepared in the strategy that should include:

- Jurisdiction Map
- Thematic maps showing canals, outlets, field channels, drainage system
- Outlet command (Chak) maps showing turn out locations
- Crop plans
- Water distribution plans
- On-farm water management plans

Element 2: Canal operation Plan for Govt. controlled Canals planning

The main canal comprises of a number of distributaries. Each distributary has certain number of minor and sub-minor canals. The scheduling of water supply is also an important criterion here. Rotational Water distribution schedule for main canal or branch canal will consist of discharge rate for distributaries/ minors and duration for which the concerned canal will be opened and operated at full supply level. It will be in a tabular format showing all off-taking canals from the main canal in a template given in Annexure IV.

Element 3: Canal operation Plan for Minor Canals (Pani Panchayat jurisdiction)

Each Pani Panchayat has a definite jurisdiction of irrigation command area which varies between 500 to 800 hectares in flow irrigation projects. To supply irrigation water to this command area falling under the jurisdiction of PP, certain portion of canal network is transferred to the PP by Government. Mostly, these canal systems are minors and sub-minors.

There are a lot of outlets in a Pani Panchayat and scheduling the water supply to ensure equitable distribution is of utmost importance. In most of the PP areas for equitable distribution, it will be necessary to operate the canals on rotation basis. The rotation will be between minors or group of outlets in a particular minor. For irrigation water distribution among outlets in a minor the time allotment for each outlet is to be computed and a rotational plan will be prepared as given in template in Annexure V.

After preparation of the rotational schedule among the outlets, next step is to prepare Warabandi schedule for distribution of water to individual farmers' plots or to plots of a group of farmers from the turn out. For such Warabandi Schedule, data has to be compiled in a template given in Annexure VI. The steps for preparing a Warabandi Schedule are given in Annexure VIII.

Element 4: Operation Plan for Field Channels (Outlet command area, chak)

Warabandi means the rotation of water supply amongst the individuals or a group of farmers below each outlet. 'Wara' means rotation and 'Bandi' means fixation. Under this system, allocations of available water are made on basis of irrigable area of holding of each farmer under an outlet with choice of crops left to him. The system ensures water to the cultivator of the area regardless of the position of his field in the outlet command or his social or economic status.

It leads to more efficient irrigation practices by the farmers. It stands for equitable distribution of water to larger number of farmers in the command. This results in greater overall production per unit of available water. (See Annexure VII)

Element 5: Preparation of Model Irrigation Plans for each major medium and minor project

Utilization in canal/project commands can be achieved by making operational plans for canal, water distribution schedule in outlet commands, computing crop water demand based on climate, crop and soil parameters. Preparation of irrigation management plans for all projects is an important element of the strategy. In the DIAP to be formulated, model irrigation plans (command plan) will be prepared for selected irrigation projects/canals as per the list given below due to limitation of time.

3.2 IMPROVING EFFICIENCY IN IRRIGATION PROJECTS

Element 6: Efficiency improvement in irrigation commands

Irrigation requirement estimation using CROPWAT

Proposed strategy includes computation of irrigation demand from Climatological Data. Institutional arrangements and building capacity for such computation is a prerequisite that has been addressed separately. This computation using CROPWAT will enable the irrigation managers whether at Govt. or at PP level to match the irrigation demand with irrigation supply. CROPWAT is a decision support system developed by the Land and Water Development Division of Food and Agriculture Organization (FAO), United Nations, Rome for planning and management of irrigation. CROPWAT is meant as a practical tool to carry out standard calculations for reference evapotranspiration, crop water requirements and crop irrigation requirements. This tool is used worldwide for better management of irrigation schemes. Outputs from this tool gives an idea on irrigation demand during different time periods like month, week, ten daily periods. This will provide an opportunity to revise the operational plan when there is a change in the cropping pattern. The method for irrigation computation is explained below.

Evapotranspiration is influenced by climatological parameters such as sunshine hours, temperature, wind velocity, relative humidity. These data are recorded in agro-met observatories, hydro-met stations of different state government departments and also of the Government of India's nodal department viz. Indian Meteorological Department. In Odisha, such data can be obtained by Department of Water Resources (DoWR) with some efforts. From these data and other parameters related to crop and soil, irrigation requirements can be calculated using different equations developed over the years. Penman-Monteith equation for calculating reference evapotranspiration (ETo). The Penman–Monteith equation (after Howard Penman and John Monteith) approximates net evapotranspiration (ET), requiring as input daily mean temperature, wind speed, relative humidity and solar radiation. ETc denotes evapotranspiration for a particular crop and is a consumptive use which accounts for water lost by transpiration from the leaves and evaporation from the soil surface. Kc denotes crop coefficient for a particular crop and is a multiplying factor which is multiplied to the potential evapotranspiration for calculating ETc that is the evapotranspiration for the crop. Potential evapotranspiration is a reference value which is dependent on the climatic conditions and unrestricted moisture availability with fully covered canopy of crops over the field. The irrigation requirement values are derived from computed values of ETc and effective rainfall. Irrigation requirement is the depth of water needed to be supplied from irrigation projects after deducting water usable from rainfall from the water required by the crops. Using Penman–Monteith equation, CROPWAT has been developed and has a module to calculate ETo. -

Besides module on ETo, there are four other modules on input side, i.e. i) Rain ii) Crop iii) Soil iv) Cropping pattern. From the data entered through the input modules, outputs like i) Crop Water Requirement (CWR), ii) irrigation schedule and iii) scheme water supply can be obtained from the modules. The output data can be printed from CROPWAT. Graphs can also be generated through CROPWAT.

Based on computed irrigation demand (scheme water supply), canal operation plans can be prepared. Rotational system wherever necessary in irrigation projects can be introduced in the operational

plan in cases where the carrying capacity of canals is a restrictive factor. It allows the development of recommendations for improved irrigation management, the planning of irrigation schedules under varying water supply conditions. The details of CROPWAT and templates for CROPWAT are given in Annexure IX and X respectively.

Drip Irrigation: There is a national policy to improve efficiency in irrigation schemes. Government of India is giving subsidy for drip and micro-irrigation. In Odisha, more and more areas should be brought under drip irrigation. The engineers of DoWR are not very much aware about the planning and installation of drip irrigation systems. They should be trained by WALMI on this subject and hand holding exercises may also be carried out through WALMI by hiring of retired professors as resource persons in the training.

In a recently lunched scheme titled "Incentivisation Scheme for Bridging Irrigation Gap (ISBIG)", Government of India is trying to encourage state governments to work on more efficient practices including drip irrigation which will be covered in more details in the third report[4] i.e. next report of this ACT project.

Mulching: Evaporation loss can be minimized by mulching. Mulching is a practice of covering the soil near plants that restricts depletion of soil moisture by evaporation process. Some examples of mulching are polythene mulching, paddy straw mulching, and other biomass mulching.

Element 7: Crop Water Budgeting

Crop water budget is a budgeting exercise accounting for different components of water used in cropped fields. Once the crop water budget is prepared, any improvement possible can be attempted that will reduce water use from the irrigation systems. The budget can be prepared with different components of water described in terms of depth units. Illustrative components have been given in Table 5. This should be prepared by the Assistant Engineer of Irrigation Division for each of the Pani Panchayat (PP) jurisdiction area.

Such budgeting can be done for individual chaks, outlet commands, Pani Panchayat jurisdictions (CCA), command of minor canals, command of distributaries. This will help the PPs and individual farmers to understand about water need for their crops, motivate them not to over irrigate and thereby minimize losses. This is a big awareness tool and water budgets can be displayed through posters in PP office and other important locations in PP villages. It will also help the irrigation divisions to plan canal operation and optimize water release. It can also be used as a parameter in benchmarking.

Table 5: Crop Water Budgeting

Sl No	Component of Water in cropped fields	Water Depth in mm
	Evapotranspiration (Consumptive use)	
	Water used in Field Preparation	
	Percolation loss	
	Run off losses from field	
	Precipitation	
	Ground water contribution	
	Supply from irrigation sources	

4 This document is the second report. Third report will be on Operational Plan and New Command Plan for Integrated District level management of Irrigation and Agriculture in Odisha

Water rates for irrigation use in Odisha are levied on the basis of area irrigated and the types of crops grown separately for kharif and rabi crops. Kharif crops are levied with a compulsory basic water rate on basis of class of irrigation (the total depth of water) that the project is designed to supply which is to be paid irrespective of its use. But the Rabi crop rate is not compulsory and payable on use. Obviously, this system leads to excess use of water and wastage.

Few states in India initiated action for switching over to volumetric supply and pricing of irrigation water system, in which, the water tax is collected at a rate of unit volume of water supplied. The farmer has to pay depending upon his decision regarding the water usages. The rate and the total revenue vary from farmer to farmer, land to land, and also crop to crop, even in the same ayacut thereby creating a scope for financial incentive for efficiency in water use. Most of the advanced countries advocate this type of tariff structure. The reason for introduction of volumetric measurement and pricing of irrigation water is to use water resources judiciously. In Odisha, volumetric measurement was done in a small way in minor irrigation tanks renovated under OCTMP. But in most of the areas, the water pricing from irrigation schemes is on area basis which is in accordance with the State Irrigation Act, 1959.

Water charges collection is a politically sensitive issue. At the same time, providing access to irrigation is being seriously thought/debated in many forums as it will give direct benefits in terms of increasing crop productivity, agriculture production and household income of farmers. As the act empowers Pani Panchayats to collect water charges particularly in minor irrigation tanks, planning and fixation of some targets for selected PPs farming their tanks should be included in the DIAP.

3.3 ENHANCING IRRIGATION INTENSITY BY MAXIMIZING AREA COVERAGE IN RABI SEASON

The state has net area sown of 54,24,000 ha. In kharif season, most of the net sown area is under cultivation. Farmers grow crops taking advantage of the rainfall and irrigation facilities wherever available but in Rabi season area under cultivation is much less. In the water use report, the cropping pattern in Kharif and Rabi season for both Cuttack and Subarnapur districts were determined which are given in Table 6. It could be seen that substantial area is lying fallow in Rabi season. The coverage in Rabi season can be increased and is taken as a strategy.

Table 6: Cropping Pattern in the study districts

District	Kharif	Rabi
Cuttack	Paddy, Sugarcane	Paddy, Green gram
Subarnapur	Paddy, Ground nut, Green gram	Paddy, Green gram

Source: ODI-06: Project Brief – Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan Water Use Report (First report of the project)

The reasons that can be attributed for less coverage in Rabi are:

- Delay in harvest of Kharif crop, which goes up to December. As a result, the ideal time for sowing of Rabi crops which is normally in October and November, is not being used by the farmers. One important reason for delay is improper water management including lack of drainage in some areas leading to water stagnation. This is not because of any climate change driven shift in monsoon time but because of land terrain and normal monsoon pattern. Other compelling reasons are cultivation of long duration paddy variety in Kharif, shortage of farm machinery like paddy transplanters and combine harvesters. This shortage causes delay in the two important operations like transplanting and harvesting. Transplanting starts in the first week of July and continues till the middle of September, almost two and half months, which could ideally be done in 15 days. Same is the case with harvesting, as farmers are doing it manually.

- Non-availability of assured irrigation for the entire growing period of Rabi season. In minor irrigation projects and reservoirs, the storage gates diminished and in diversion weirs the flow reduces which leads to unreliability of irrigation supply.
- Lack of finances with the farmers to buy seeds and fertilizers for Rabi crops.
- Non-availability of farm machinery and tillage equipment for field preparation in a short time after harvest of Kharif to grow Rabi crops.
- Leaving cattle to graze in the field in Rabi season that prevents some progressive farmers because of threat of damage by the cattle.
- Non-availability of seeds in time for large scale cropping in Rabi and lack of organised planning and mobilization of inputs through grassroot-level community institutions like Pani Panchayat.

Element 8: Assessment of actual cropping pattern in the current scenario

Each Pani Panchayat by using data of land holders and chak map should assess the actual cropping pattern i.e. crop wise areas in their jurisdiction. Each PP should make ambitious plan for growing crops in same area in Rabi as they grow in Kharif and try to solve the impeding causes. Improving water use efficiency, use of drip and sprinkler irrigation, extraction of ground water and conjunctive use are very good options to be tried. For making the PPs financially viable, they can be leveraged for getting financial assistance through MGNREGA[5] and other schemes of agriculture. -

Capacity development of PPs is at present looked after by WALMI[6] with its solitary campus at Pratapnagari, Cuttack. DoWR has already taken a decision to establish three centres at Sambalpur, Baripada and Jeypore to meet the demand of the huge capacity building needs.

Crop modelling can be taken up by WALMI main campus and its three sub centres catering to different reasons and the outputs of the modelling can be disseminated to PPs during the capacity building programmes. WALMI has agriculturalists and agriculture engineers who can do the modelling and use decision making tools for the farmers/PPs.

In places where irrigation is not available at present or irrigation availability is less than the demand, augmentations through appropriate sources should be planned. Bore-wells which are feasible in almost the entire state should be drilled and energized at the same time.

Element 9: Perspective planning of the cropping pattern in the future scenario (2030)

The crop planning suggested in the previous element of strategy is for the 2018-19 period. This strategy should also be extended up to 2030 to cover slightly longer-term aspects of water governance. Selection of crops and crop varieties for climate resilient agriculture and crop water management in the DIAP to be formulated. The team concerned should consult research organisations and seed corporations to take apt decision on the selection of crops keeping in mind the short-term climate projections till 2030. The decision should be such that crop varieties are resilient to drought conditions, moisture stress and at the same time required quantity is available for procurement. New crops, new varieties, changing sowing and harvesting times, etc. should be factored into the perspective plan. Care should be taken for not allowing water stagnation in places and time periods where it was not happening earlier to avoid diseases causing vectors that may spread malaria and other water borne diseases. Present GIS based land use patterns and projected future land use patterns based on planned future cropping practices would be able to provide such spatial and temporal data on water use and water flow.

5 MGNREGA: Mahatma Gandhi National Rural Employment Guarantee Act is an act enacted through Parliament of India. Under this act, 100 days of wage labour is assured to wage seekers mostly for earthwork including works in irrigation, canals and minor irrigation

6 WALMI: Water and Land Management Institute is a training institute established as a society by Govt. of Odisha which is under administrative control of Dept. of Water Resources. This institute has the mandate and being provided budget annually to conduct training and capacity building activities.

3.4 INCREASING WATER PRODUCTIVITY

Water productivity is generally defined as crop yield per cubic metre of water consumption. Water productivity[7] (WP) was determined and presented in the water use report[8]. In the study areas, paddy is grown and data of water supply to canal command areas with paddy crop was available for some canals. The data on water productivity in four canals of Subarnapur and two canals of Cuttack is presented in Table 7. WP is an indicator that is obtained by dividing total production in a canal command to total irrigation water released in same canal system.

Table 7: Water productivity (Paddy)

District	Name of the Canal	Water Productivity (Kg/m^3)
Cuttack	Phulnakhara Distributary of Puri Canal	0.562766
	Distributary No.8 of Kendrapada Canal	0.313329
Subarnapur	Sukha Distributary of Hirakud Project	0.124096
	Rampur Distributary of Hirakud Project	0.473025
	Sarasamal Minor of Hirakud Project	0.729526
	Dhanbasa Minor of Hirakud Project	0.498336
	Average of projects in Cuttack and Subarnapur District	0.450179

By improving farm level water security and through better on–farm water management water productivity can be enhanced. The target for water productivity[9] could be 0.6 kg/m^3 in irrigation schemes of Odisha with the present practices of water management. With efficient methods of irrigation this could be further enhanced. Integrated action by concerned departments will be a driving factor in this direction. Department of Water Resources, Agricultural Department, Soil Conservation Department who are concerned with irrigation, farm level water management, and water conservation should plan water related activities and converge them into a District Irrigational and Agricultural Plan. This has to be an annual exercise covering all cropping seasons and should focus on sustainability. This DIAP strategy will eventually lead to integration, transformation and inclusion of government's effort and communities' effort. Dovetailing of financial resources, man power and material resources and implementation of the plan under the supervision of a district level committee should consist of the framework of proposed strategy and new planning process. This water use strategy document is formulated indicating actions, activities to be taken up and their methods and procedures.

The present system of governance may not be able to accomplish all ideas mentioned above. With the introduction of revised strategy some of the challenges like extra work load, requirement of forums for deliberation and evolving consensus can be overcome.

Required capacity building can be planned and implemented through training institutions like Water and Land Management Institute (WALMI), Institute on Management of Agricultural Extension (IMAGE), Deputy Director Water Management and Agricultural Technology Management Agency (ATMA).

By increasing crop productivity, water productivity can be increased. Crop productivity is obtained by conversion of production of crop in a particular area of farmer to production per hectare. Present level of crop productivity has been assessed in two pilot districts which are given in Table 8. Paddy productivity has been assessed in Table 9 & 10.

7 ODI-06: Project Brief – Prioritizing water use mechanisms for sustainable usage of water and Development of Integrated District Irrigation and Agriculture Plan Water Use Report (First report of the project)

8 Water use report is the first report and this document is the second report. Third report will be on Operational Plan and New Command Plan for Integrated District level management of Irrigation and Agriculture in Odisha and fourth report will be a toolkit which is essentially a guideline for preparation of district irrigation and agricultural plan for all 30 districts on Odisha

9 Water productivity target is kept at 0.6 kg/m3 based on the report of International Rice Research Institute for Asian countries.

Table 8: Crop Productivity in study districts

District	*Kharif*				*Rabi*			
	Crops	Productivity of sample area (Qt/Ha)	District* Average Productivity (Qt/Ha)	State** Average Productivity (Qt/Ha)	Crops	Productivity of sample area (Qt/Ha)	District* Average Productivity (Qt/Ha)	State** Average Productivity (Qt/Ha)
Cuttack	Paddy	46.09	45	25.72	Paddy	49.99	50	51.84
	Sugarcane	557.72	704.9	719.8	Greengram	3.95	4.94	4.8
	Green gram	2.98	3.85	4.64				
Subar-napur	Paddy	39.44	43.06	25.72	Paddy	49.4	46.19	51.84
	Groundnut	9.88	16.95	14.62	Green gram	3.48	4.18	4.8
	Green gram	3.2	3.3	4.64				

Source: Water use Report

Table 9: Project type wise Paddy Productivity in Cuttack district

Type of Scheme	Kharif Area (Ha)	Kharif Production (Qt)	Kharif Productivity (Qt/Ha)	Rabi Area (Ha)	Rabi Production (Qt)	Rabi Productivity (Qt/Ha)
Major	575.6	22023	38.26	66.8	2796	41.86
Medium	154	5755	37.37	0	0	0
Minor	405.2	12791	31.56	61.81	1636	26.47
Lift Irrigation	226	7969	35.26	56.4	2242	39.76

Table 10: Project type wise Paddy Productivity in Subarnapur district

Type of Scheme	Kharif Area (Ha)	Kharif Production (Qt)	Kharif Productivity (Qt/Ha)	Rabi Area (Ha)	Rabi Production (Qt)	Rabi Productivity (Qt/Ha)
Major	273.78	11594.2	42.35	393.6	16987	43.16
Medium	137.77	5767	41.86	29.6	1187	40.13
Minor	157.92	5755	36.44	62.8	2123	33.81
Lift Irrigation	433.97	15540	35.81	216.8	8968	41.37

Source: Water use Report

Crop productivity for paddy in irrigated areas can be targeted to be 5-6 tonnes per hectares. Proper doses of fertilizer application, use of quality seeds, proper water management and use of farm machinery can trigger improvement in productivity to achieve the target mentioned above.

3.5 CREATION OF ADDITIONAL IRRIGATION POTENTIAL BY USING SURFACE AND GROUND WATER RESOURCES OF THE DISTRICT

Odisha is yet to achieve its ultimate irrigation potential in all the districts. There is enough surface water and ground water to be tapped for creation of new irrigation sources and additional irrigational potential. Odisha has annual replenishable ground water

In Cuttack district the annual replenishable ground water is 70646 HM.

Table 11: Ground water availability and utilization in Cuttack District

Particulars	Ground water in Hectare Meter (HM)
Annual replenishable Ground Water Resources	70646
Net Annual Ground Water Draft (irrigation)	17732
Projected demand for domestic and industrial uses up to 2025	7175
Stage of Ground Water Development	33.51%

Element 10: River Basin Planning and IWRM

The long-term average rainfall received in Odisha is 1452 mm which if converted into volume is 230.76 BCM. The state is endowed with an extensive network of rivers and streams. As per State Government's assessment the average annual availability of surface water from State's own drainage boundary is 82.841 BCM. Besides, inflow to the tune of 37.556 BCM is also available annually from neighbouring states through interstate rivers.

Table 12: Annual water availability from Surface water in Odisha

Particulars	Volume of surface water (BCM)
From state's own drainage boundary	82.841
Utilizable surface water	65.679
Inflow from neighbouring states through inter-state rivers	37.556
Utilizable surface water from the neighbouring states	29.861

Table 13: Total surface water and ground water availability

Basin Name	Total Surface water availability (Average Annual Flow)	Total ground water availability	Stage of GW development (%) as on March 2013
Mahanadi	5915500	685477	28.03
Brahmani	1857700	198033	32.43
Baitarani	756800	167215	40.13
Rushikulya	394900	117910	29.54
Vamsadhara	508300	72402	21.18
Budhabalanga	311100	83957	38.09
Kolab	1108900	75343	12.29
Indravati	626500	55912	16.65
Bahuda	43800	11023	33.21

Basin Name	Total Surface water availability (Average Annual Flow)	Total ground water availability	Stage of GW development (%) as on March 2013
Nagavali	285300	26167	17.17
Jambhira	-	38634	46.81
Subernarekha	230800	59855	35.80
Area directly draining to seas (Chilika)	-	27372	21.01
Area directly draining to seas (Kansabansa)	-	49614	49.00
State	**12039600**	**1668914**	**30.07**

From the data above, it is evident that there is huge untapped potential and all efforts should be taken to utilize the state's available surface and ground water for irrigation development. Concept and principles of Basin Planning is described in detail in Annexure XI.

For all river basins and two areas directly draining to the sea, fresh assessment of the actual water availability and its current utilization for different usages viz. drinking water industry, environment etc. may be made. River basin planning will help in knowing the competing demands. During conduct water use study, water users had expressed that the flow has reduced in Hariharjore from which many river lift points are installed. There is a need to know the quantum of flow available during each fortnight. Such information should become part of river basin plans.

Integrated Water Resource Management (IWRM) is one of the key elements in the National Water Policy 2012 and National Water Mission. Central Water Commission issued guidelines and there are many case studies world over from which ideas could be dovetailed for undertaking IWRM in Odisha.

Element 11: Cascade level planning

Cascades are used as units of planning for optimal use of surface water in irrigation tanks and ground water in the influence zone of the tanks. Currently, in World Bank assisted Andhra Pradesh Integrated Irrigation and Agriculture Transformation Project (APIIATP), cascade level planning is emphasized. In Tamil Nadu and Karnataka, tank cascades have been used as planning units since last two decades. In Odisha, there are 4152 minor irrigation tanks. During the last five-six years, around 2500 in stream check dams have been constructed in Odisha. Large numbers of bore-wells have been constructed and there is a great demand for bore-wells by the farmers. At present cascade planning is not undertaken in Odisha. Planning at the watershed or tank cascade level will be useful for integrated action for use of all types of irrigation sources for development and management since it has the advantage of looking at a micro scale in contrast to the river basin planning which is in a macro scale. Cascade Planning helps in manging misuse and maximizing water resource utilisation within the individual hydrological response units of each cascade.

Element 12: Development of further irrigation potential

There are 39 proposed major medium projects which are in various stages. These projects will add to the irrigation potential of the state. OLIC is constructing deep tube-wells and OAIC are constructing tube-wells. Through these scattered sources irrigation potential can be developed practically in all villages.

There is a potential for construction of around 200 minor irrigation projects in Odisha with command area ranging from 40 hectares to 1500 hectares as per discussion with officers of the Minor Irrigation Department. It is to be taken up after completion of Odisha Integrated Irrigation project for Climate

Resilient Agriculture (OIIPCRA). As construction of new MI tanks will take a good number of years starting from site selection, survey, environmental clearance till actual construction, construction of 200 MI tanks will automatically be phased in two different years. If new projects are technically feasible and there is economic viability, then Odisha Government can find out ways and means to allocate budget for creation of additional irrigation potential through minor irrigation projects. Though one may feel that there is budgetary constraint now but the DoWR with its annual budget of INR[10] 9209,93,28 crores (US$1412.133 million) for 2017-18 can make such provisions in future years. On completion of efforts already undertaken and presently ongoing, the command area of all existing minor irrigation projects will be stabilized. Some of the efforts worth mentioning are OCTMP, RRR of water bodies and the upcoming new project on minor irrigation and climate resilient agriculture. Mega lift projects are already under implementation which will provide assured water and create irrigation potential. List of mega lift schemes and scheme wise area is furnished in Table 14.

Table 14: Name and area under different megalift irrigation schemes in cuttack and Subarnapur districts[11]

	Name of the scheme	Scheme wise CCA in Ha		Name of the scheme	Scheme wise CCA in Ha
Cuttack District	Kapasira	860	Subarnapur District	Baliput	2000
	Subalaya	1750		Chakragarh-I	2000
	Badali	1300		Chakragarh-II	2000
	Chadheipank	860		Chakragarh-III	2000
	Doleba	1650		Ghoradia-I	1950
	Goudagaon	1650		Ghoradia-II	2000
	Baghbar	1800		Padmamala-I	2000
	Chattapipal	2000		Padmamala-II	2000
				Padmamala-III	800
Total		**11870**			**16750**

A scheme on ground water recharge and solar micro irrigation to ensure food security and enhance resilience in vulnerable tribal areas of Odisha[12] has been sanctioned from Green Climate Fund (GCF). Under this GCF funded scheme, 10,000 ground water recharge structures are proposed to be constructed in existing tanks. This is to be implemented in a period of 5 years. The project cost is US$ 166.297 million of which US$ 34.357 million has been obtained from GCF.

3.6 SUSTAINABLE LOCAL INSTITUTIONS (PANI PANCHAYAT) FOR MAINTENANCE AND MANAGEMENT OF IRRIGATION SYSTEMS

Climate resilient irrigated agriculture can be achieved through sustainability of the irrigation structures built. This is dependent on proper construction in line with water demand and availability, as well as proper maintenance and renovation of the infrastructure from time to time. Pani Panchayats as water institutions have to play a major role in this sustainability process. Pani Panchayats are already being provided with maintenance funds for routine annual maintenance. They can collect more water fees after ensuring water delivery and farm level water security. From the fund generated through additional water fees collection they will be more sustainable, and Govt. can give the matching grant to the tune of

10 Budget allocated for water resource department for 2017-18as per the document "Demand for Grants, Water Resources Department, Govt. of Odisha"
11 Document on Megalift Schemes uploaded in the website of Department of Water Resources, Govt. of Odisha. Table 14 is prepared from the data given in this document.
12 Project proposal uploaded in the website of GCF

additional revenue generated by them. This progressive system of mobilizing finances is implementable and can be taken up in some pilot projects which could be a few minor irrigation projects or small/ medium project. Virtually the entire management of the irrigation project will remain vested with the Pani Panchayat. In the pilot project, there will be many Pani Panchayats already formed and the remaining can be formed under the sustainable management intervention. After formation of all Pani Panchayats, the apex Pani Panchayat with members from individual Pani Panchayats can be formed and made responsible for canal operation and project management. Government will have the right of the project as it has to take care of the floods, dam safety and safety of other structures. The capital maintenance once in 5-7 years can be done by government. This concept will be tried in a pilot project and required financial support as incentive can be sanctioned by DoWR for a project of small irrigated area of around 2000 hectares. For the year 2018-19 separate budget provisions are not recommended as a strategy, however in subsequent years some of the budget provisions under the existing heads can be realigned to new budgetary heads.

3.7 INTEGRATION OF ACTIVITIES OF WATER RESOURCES AND AGRICULTURE FOR COORDINATED PLANNING AND IMPLEMENTATION

Element 13: Augmentation, Conservation and catchment treatment

Under the MGNREGA scheme, which has a provision for implementation practically in all villages, offers scope for water conservation activities like construction of tanks and ponds. Watershed management activities are implemented under Integrated Watershed Management Programme (IWMP). It offers scope for drainage line treatment, other catchment treatment measures and construction of farm ponds, water harvesting structures and dug wells etc. Conjunctive use means use of ground water in command areas of surface water irrigation schemes. It is intended for augmenting irrigation water for realizing higher production from the canal command and maintaining groundwater level within safe limit.

Element 14: Requirements and process for preparation of DIAP? and its implementation

All irrigation divisions catering to a particular district, Deputy Director Agriculture, Deputy Director Horticulture, Project Director, Watershed, DRDA, OAIC, should prepare list of activities with physical and financial target for the year 2017-18 and also projected activities for the year 2030-31.

All activities listed above should be consolidated into one integrated district irrigation and agricultural plan.

Process for DIAP

The DoWR has to conduct an activity mapping for this transformative planning process which will become part of DIAP. The DIAPs can be prepared from the existing budget with certain appropriations among minor heads. Chief Engineers and basin managers of DoWR can initiate appropriation if at all required and get the approval of the Government which may probably be agreed upon. Other allied departments will also list their activities/programs and show their budgetary allocations for the respective activities.

The process conceptualised for preparation of DIAP and New Command Plans for selected distributaries, command area under Pani Panchayat, outlet commands were discussed in a meeting chaired by Superintendent Engineer, Eastern Circle-I and Nodal officer for PMKSY of Cuttack district attended by executive engineers of irrigation divisions in charge of major and medium, minor, lift, command area development, district heads of watershed, agriculture and horticulture sectors. The data required for

(i) Rotational Water Supply in Main System (Govt. Controlled Canal) (ii) Rotational Water Distribution in Canal System under the Pani Panchayats (iii) Rotational Water Distribution Plan in Outlet Command Area through Field Channels under the PP will be provided by concerned irrigation and CADA officials. Maps of the command area of selected projects/canals/outlets will be prepared by them which are needed for the command plan and will be provided for plan preparation.

In the DIAP, conservation of rainwater through farm ponds, check dams, augmentation through farm level storages and tube wells would be incorporated for farm level water security.

3.7.1. Coordination of Water Management at District Level

Coordination among various Govt. departments is a real challenge. Coordination mechanism confirming to the upcoming policy implementation is discussed here. Coordinated development and management of water is contemplated to be achieved through the District Level Implementation Committee (DLIC) mechanism of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)[13]. In the DLIC, the district collector and district magistrate is the chairman and has enough administrative authority and power in the governance system in Odisha to ensure coordinated planning through the DIAP mechanism. Collector and district management has the authority at district level has the authority to drive cross departmental work effectively. Once the system is introduced and collectors are assigned responsibility by order of government, it could be effectively practiced.

3.7.2. New Command Plan (Model Irrigation Plan)

Command plan will comprise of (i) Plan for rotational Water Supply in Main System (Govt. Controlled Canal) (ii) Plan for rotational Water Distribution in Canal System under the Pani Panchayats (iii) Plan for rotational Water Distribution in Outlet Command Area through Field Channels under the PP besides cropping plans. The data for these plans will be provided by concerned irrigation and CADA officials. Maps of the command area of selected projects/canals/outlets will be prepared by them which are needed for the command plan and will be provided for plan preparation. This can be done by outsourcing to farms and agencies. In Odisha, there are number of private firms and individuals who have surveying instruments, mapping tools like AutoCAD, GIS software. The cost won't be prohibitive, and the divisions would be able to attempt this with proper direction from the Government.

3.7.3. Template for DIAP

District Irrigation Plan will be a comprehensive plan document covering agriculture scenario, irrigation scenario for a particular year, activities of water, watershed, agriculture, horticulture departments, externally added projects, role of institutions including PP institutions, planning process adapted, mechanism for implementation and monitoring and new command plans.

Element 15: Monitoring and benchmarking

Monitoring

Institutional mechanism in Department of Water Resources for planning and implementation of DIAP.

In the transformative planning process and implementation of DIAP, DoWR has to play the following roles:

- Water availability for each minor/sub-minor transferred to PP during different seasons and the operation discharge at Head Regulators.
- Informing the water availability to PPs and agriculture department at appropriate level
- Computation of scheme water supply using CROPWAT model of FAO

13 English translation of 'Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)' could be Prime Ministers' Agricultural Irrigation Scheme launched as an umbrella scheme for coordinated development of water, improving water use efficiency and watershed management. This scheme is being implemented in all states and union territories of India.

- Finalisation of Operation plans of canal system/schemes
- Finalisation of maintenance plans
- Delivery of water in canal system and monitoring of discharge delivered in different canals
- The district/project level officials of WRD will intimate the plan before it is put to implementation and data regarding actual irrigation supplied to DoWR headquarters.

SECTION 4:

IMPLEMENTATION RESPONSIBILITIES

Multi departmental involvement and role envisaged for people's participation through PP in the sustainable strategy is a transformative process to be initiated by Government of Odisha. Key responsibility rests with the Department of Water Resources, Dept. of Agriculture and Farmers Empowerment, Odisha Lift Irrigation Corporation and three tier Pani Panchayat Institutions. Pani Panchayats are the first tier, distributary committees are the second tier, and project apex committee is the third tier which is well defined in the concerned act.

Responsibilities and timing for implementation are suggested in the section below in a matrix form (Annexure XV). This will be a ready reckoner for the Government to assign responsibilities and monitor the progress and achievement. Institutional mechanism for the two key departments is conceptualised. There is a high-power committee which is headed by Chief Secretary, Govt. of Odisha. Consultants have discussed with top level officials and the Principal Secretary, DoWR on this issue. Necessary actions can be taken by the high-power committee to bring desired cross department coordination for the purpose of the DIAP. It is recommended that Principal Secretary DoWR should formally request in the high-power committee where he is a member to take appropriate Government decisions that will percolate down in all concerned departments for coordinated action at different levels. Orders can be issued to the district level officers with joint signature of Principal Secretary, DoWR, Principal Secretary, Agriculture and Farmers' Empowerment. Such types of orders were issued in some other context and are well within the ambit of governance at the highest bureaucratic level.

New activities which are not done on annual basis by the departments and required to be done under the revised strategy are;

- Preparation of database and digitized maps
- Preparation of irrigation project-wise cropping plans
- Computation of crop water requirement, irrigation requirement and scheme water supply using CROPWAT and FAO
- Preparation of Canal Operational Plans
- Benchmarking of irrigation projects for performance monitoring
- Groundwater recharge
- Preparation of annual district irrigation and agricultural plan.

Considering the present institutional structure of the department, suggestions have been formulated regarding who will do what activity and it mentioned in the matrix given in Annexure XIV.

At the state level, the following mechanism is proposed for Department of Water Resources.

Chief Engineer (BPCC) and Additional Director (O&M) will be key officials of DoWR. They will coordinate with field divisions on DIAP and place consolidated/compiled data/information to Engineer-in-Chief (Planning & Development) for necessary review and submit to Government for perusal. The flow of instructions from the chief administrator of DoWR i.e. Principal Secretary to functional units like divisions having financial and administrative powers to implement instructions is given below in figure-1. There are three wings of DoWR that deal with (i) Major and Medium Projects headed by EIC, (ii) Minor Irrigation Projects headed by Chief Engineer and (iii) CAD directorate headed by Additional Director. Besides the three wings, Odisha Lift Irrigation Corporation and few units like Pani Panchayat Support Unit (PPSU) headed by Additional Director and O&M additional director have key roles in making annual DIAP as annual affair and providing all kinds of facilitation support which are depicted in Figure 1.

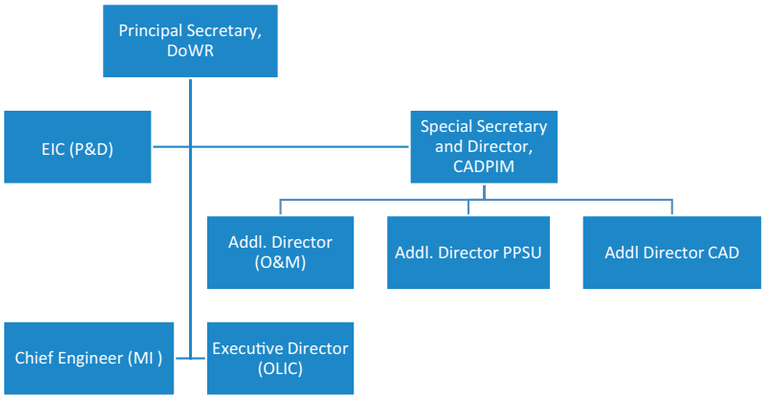

Figure 1: State level Mechanism proposed for DIAP.

Institutional mechanism in Agriculture Department for planning and implementation of DIAP

In the transformative planning process for effective and efficient water use in irrigation projects, Department of Agriculture will have to introduce required institutional changes. This department has the mandate to work on agriculture development and farmers' empowerment. The present set up with officers at revenue district level i.e. Deputy Director of Agriculture, at sub-division level i.e. District Agriculture officers and block level two numbers of Assistant Agriculture Officer with grass root staff like Village Agriculture Worker (VAW) and paid volunteers like farmers friend (called locally as Krishak Sathi) are working for organising meetings in villages to make registration for online direct benefit transfer (DBT). These staff can perform the roles suggested in the revised strategy for irrigation water management. Points covered in this section at 1st and 3rd bullets below are mostly on conduct of meeting of PPs and the staffing pattern narrated above can facilitate/manage the meeting.

The water management specialists and or agronomists, project Director of Agriculture Technology management Agency (ATMA) can be tasked for guiding and supervising the implementing staff. The expenditure required for conducting such training can be met from regular funds allocated to ATMA and special funds received from Ministry of Agriculture, Govt. of India under PMKSY scheme. Training funds of Rashtriya Krishi Vikas Yogana (RKVY)[14] of WALMI also has budget and funds to conduct training at PP level.

- Weekly meeting with all Pani Panchayat members for two months, much before the irrigation season for finalisation of plot wise crop plan, cropping calendar and water requirement (week wise) - by VAW
- Selection of demonstration plots in the PP ayacut area - by VAW
- Fortnightly meeting with PP during irrigation season to monitor water supplied from irrigation projects and cropping practices - by VAW

14 English translation of Rashtriya Krishi Vikas Yogana (RKVY) could be National Agricultural Development Program. It is a scheme under Ministry of Agriculture, Govt. of India. Under this scheme activities are taken up by Agriculture and allied departments.

- Compilation of project/distributary/PP wise cropping and irrigation plan - by AAO
- Preparation of district level integrated irrigation and agriculture plan - by DDA assisted by WMS/ Agronomist

DIAP should be sent to Directorate of Agriculture for scrutiny and approval.

At the state level, an irrigated agriculture cell is proposed to be formed. This cell will be responsible for, scrutiny and finalisation of DIAP, collection and compilation of water use data and crop data from PPs and Irrigation projects/systems on fortnightly basis. In the irrigated agriculture cell, one data entry operator, two junior Assistants, two field Assistants will work to assist the officers to timely compile all data and maintain data base. These staff will be directly under the control of Deputy Director.

BENCHMARKING

In irrigation projects, benchmarking has been introduced as a tool aimed at performance improvement. Benchmarking is a continuous process of measuring one's own performance and practices against the best competitors, and a sequential exercise of learning from other's experience. It is a fundamental management skill that supports quality and excellence. Benchmarking has broad applications in problem solving, planning, goal setting, process improvement, innovation, strategy setting and in various other contexts. Opportunities for improvement are identified by conducting an internal assessment and making comparative measurements with best practice organizations to determine the performance gaps between current practice and best practice. Selected best practices can then be suitably adopted to fit into organization's need and implemented. The cycle of improvement continues.

In irrigation sector that would mean more productive and efficient use of water, more crop per drop. The benchmarking of irrigation projects is widely accepted world over now. To promote benchmarking in irrigation sector in India, a national level workshop was held at Hyderabad. The conclusion of the workshop was that benchmarking is relevant for India and it should be started as per capita water availability in coming years will dwindle and hence efficient use of water would be must. Benchmarking would help in appropriate interventions in monitoring performance of irrigation projects and help in formulation and implementation of policies for improvement of projects. This would result in bringing transparency in irrigation sector along with many benefits such as equitable distribution, improvement in irrigation efficiency, help bringing additional area under irrigation lead to diversification of crops, enable putting cap on O&M expenditure, increased per unit of water etc. 20 main indicators have been identified in the Workshop to assist Benchmarking process which is given in the Table 15.

Table 15: Main performance indicators for benchmarking of irrigation project

Sl. No.	Domain		Performance indicator[2]
I.	System Performance	1.	Water delivery capacity Index
		2.	Total annual volume of irrigation water supplied/delivered (m^3/year)
		3.	Field application efficiency
		4.	Annual Relative Irrigation Supply Index
		5.	Annual Irrigation water supply per unit command area (Cum/ha)
		6.	Annual Irrigation Water Supply per unit irrigated area (cum/ha)
II.	Agricultural Productivity	7.	Output per unit command area (Rs/ha)
		8.	Output per unit irrigated area – Tons / ha crop-wise. (Rs./ha.)
		9.	Output per unit irrigation supply (Rs/cum)
		10.	Output per unit crop water demand (Rs/cum)

Sl. No.	Domain		Performance indicator[2]
III.	Financial Aspects	11.	Cost recovery ratio
		12.	Total O&M cost per unit area (Rs/ha)
		13.	Total cost per person employed on O&M Works (Rs/person)
		14.	Revenue collection performance
		15.	Revenue collection performance
		16.	Maintenance cost to revenue ratio
		17.	Staff numbers for O&M per unit area (persons/ha)
		18.	Total O&M cost per unit of water supplied (Rs./cum)
IV.	Environmental Aspects	19 (a).	Average depth to water table (m)
		19 (b).	Land Damage Index
		20 (a).	Water Quality: Ph/Salinity/Alkalinity Index
		20 (b).	Salt balance (tones)

During 2006-07, it was decided to use benchmarking in the state for improving the performance of irrigation projects. The work was to be taken up in phased manner in selected major & medium irrigation projects and programmed to be extended to all major, medium and minor irrigation projects at later stage. Due to non-availability of measurement arrangements and capacity constraints, benchmarking was not done. In the first phase, 12 medium irrigation projects namely Daha, Ghodahado, Salia, Aunli, Dadaraghati, Derjang, Sunei, Remal, Ramiala Gohira, Salki & Pilasalki were selected. Data required to evaluate the performance of the projects were collected from field units. Data received from field units was evaluated. The first report on Benchmarking of Irrigation Projects was published and circulated among field authorities for study and to furnish views for further improvement of the performance indicators of respective projects. However, enough and meaningful data could not be collected because of reasons explained above. Within a period of one year a benchmarking workshop should be organised for which full financial support can be obtained from government of India. WALMI can be tasked to conduct benchmarking workshop.

Element 17: Capacity Building

Implementation of water use strategy outlined in this report requires orientation of staff and their capacity building. Besides, as the integrated planning will be made taking PP jurisdictions as units, capacity building programmes are also required for Pani Panchayats. There is (nearly always) also the need for follow-on support to ensure training is put into practice – plus, if the training is not happening at the same time as institutional changes that allow the training to be used, the new skill set often just doesn't get used. Hence it is suggested that the institutional changes should be synchronised with the training.

A toolkit is being developed under this project which will serve as the training material/guidebook for use in capacity building. The tool kit will have the following subjects (Table 16).

Table 16: Capacity Building/Training plan

Sl. No	Subject	Session Breakup Theory + Practice	Total Sessions
1	Concept of DIAP and its advantages over the present system water allocation & water distribution in irrigation projects.	1+0	1
2	Climate change and coping mechanism through better water management	1+0	1
3	Crops suitable in the irrigation project and selection of crops and varieties in consultation with Progressive farmers and office bearers of PP	1+0	1

Sl. No	Subject	Session Breakup Theory + Practice	Total Sessions
4	Preparation of cropping calendar	0+1	1
5	CROPWAT Conceptual framework	1+0	1
6	Input data for CROPWAT	0+1	1
7	Running the CROPWAT Model and generation of output on ET0, Irrigation requirement and Scheme water supply	0+1	1
8	Preparation of outlet data base	1+0	1
9	Preparation of PP data base	1+0	1
10	Water measurement	1+0	1
11	Development of maintenance plan	1+0	1
12	Development of Operational Plan	1+2	3
13	Water delivery and distribution in canal distribution system	1	1
14	Warabandi	0+1	1
15	Parameters for measurement, monitoring and analysis	1+0	1
16	Equitability and Gender mainstreaming	1+0	1
17	Increasing efficiency in irrigation water use and enhancing crop productivity	1+0	1
18	Mobile App	1+0	1
19	Annual District Irrigation and Agriculture Plan	0+2	2
19	Report preparation on achievement on irrigation water use and crop production	1+1	2
	Total		**24**

To kick-start the DIAP in Odisha, a transformative planning process aligned to PMKSY, two-day workshop-cum training should be organised involving senior officials at policy level as well as planning, implementation and monitoring level. The strategy proposed for this workshop-cum training is; out of the two days, in the first half of the first day it will be conducted in workshop mode and rest one and half days shall be conducted in training mode.

For organising training, financial resources are available with WALMI, OLIC (NABARD-RIDF), PMKSY, and Agriculture Technology Management Agency (ATMA) in each district. The chairman of ATMA is District Magistrate/ Collector and Project Director is Deputy Director Agriculture. Training modules should be developed for different categories of training as given below (Table 17). Training modules can be prepared by WALMI by engaging capacity building experts by outsourcing mode.

Table 17: Training plan for Capacity building of stakeholders on DIAP

Sl. No	Target Group	Proposed training Institution	Duration	No. of training required to complete the entire target group in the state	Level
1	Executive Engineer, Irrigation (Division level) and Deputy Director Agriculture	WALMI	2 days	3	State Level
2	Asst. Executive Engineer (Sub-Division level), District Agriculture Officer	WALMI	3 days	96	State Level
3	Asst. Engineer/Junior Engineer (Section level, Asst. Agriculture officer (Block level)	DD, Water Management	2 days	12	District level at ATMA Training hall

Sl. No	Target Group	Proposed training Institution	Duration	No. of training required to complete the entire target group in the state	Level
4	Asst. Engineer/Junior Engineer (Section level, Asst. Agriculture officer (Block level)	IMAGE	3 days	12	Institute campus at Bhubaneswar
5	Specialists / nodal officer	WALMI	4 days	6	
6	VAW, Krishak Sathi, one representative from PP	Office of Asst. Agriculture Officer	1 day	300	

Target for completion of capacity building and training

All training for concerned persons to prepare DIAP and its subsequent implementation and monitoring should be completed in around one years' time.

Convergence for Capacity building

Convergence of resources, training venue, logistics, and resource persons from the offices of Engineer-in-Chief (WR), Minor Irrigation, OLIC, Agriculture, ATMA, Watershed departments should be attempted. There are conference halls in some offices of PD watershed which may be utilised for the trainings. The training venue within the district may be decided at district collector level with due consultation with all concerned.

Training Strategy

Director Personnel in the establishment of Engineer-in Chief, WR's, SE in the establishment of Minor Irrigation, Executive Director in OLIC, Deputy Director Agriculture in the establishment of Director of Agriculture and Food Production should be nominated as nodal officers for capacity building and they should be made responsible to ensure all personnel who would be involved in operation and efficient use of irrigation receive training and the necessary capacity of the personnel and offices are developed.

Table 18: Training strategy indicating target group and duration

Sl. No	Target group	Training organiser	Duration of training (Day)
1	VAW	AAO	2
2	KS+PP (WMC), 2 per PP	AAO & JE	3
3	Agronomist + WMS + Nodal Officer (IDIAP), Irrigation	WALMI/ IMAGE	4
4	AAO + AE = JE	ATMA	3
5	DAO + EE + AEE	WALMI/ IMAGE	2
6	DDA + SE	WALMI	1

Inter-Departmental Coordination

The PMKSY Mechanism has already taken care of the issue of interdepartmental coordination both at state and district level. In Odisha the three-tier structure, i.e. SLSC, IWDG and DLIC are constituted for PMKSY by notification of the Government. DLIC is the apex committee at district level and it has adequate powers and authority to bring coordination among departments of agriculture, horticulture and soil conservation. The programs of these departments are to be converged to achieve the goal "Har Khet ko Pani" i.e. "Per drop more crop". The converged integrated irrigation and agriculture plan will be in the DIAP template which is discussed subsequently.

SECTION 5:

INSTITUTIONAL STRUCTURE

Current institutional set-up of the major departments like DoWR, DOA & FE, OLIC and CADA are given in Annexure XV. There is always a need for dynamism in the institutional set up to take up newer responsibilities and address emerging challenges. Strength and weaknesses in the current institutional set up and institutional changes required for implementation of revised strategy are described briefly under the following sub-sections. Critical analysis and recommendations presented in the following three subsections besides the capacity review also has focus on preparation and implementation of DIAP.

Cross-departmental coordination can be driven through deliberations at existing high-power committee headed by either Chief Secretary/Agricultural production commissioner, Govt. of Odisha. Principal Secretary DoWR should formally request in the high-power committee where he is a member to take appropriate Government decisions that will percolate down for required coordination at district/project/village level. If required, orders can be issued to the district level officers with joint signature of Principal Secretary, DoWR; Principal Secretary, Agriculture and Farmers' Empowerment. Similar orders were issued earlier in some other context and are well within the ambit of governance at the highest bureaucratic level.

5.1 CRITICAL ANALYSIS EXISTING INSTITUTIONAL MECHANISM OF DOWR

The Department of Water Resources has the mandate to plan, develop, utilize and manage State's water resources efficiently and effectively. To achieve this objective, the Department formulates Water Policies & Water Plans and undertakes execution, operation and maintenance of irrigation projects, exploration and regulation of ground water, flood control and drainage development, industrial water supply and command area development activities.

Current institutional set up has the strength of taking up works mainly through contractors. The divisions are fully functional, and the executive engineers are sufficiently empowered to act on preparation of estimates and obtaining sanction, preparation of documents, and award of contracts to contractors, supervise the work during construction by the staff, record measurement of work completed in measurable book (MB), preparation of bills and making payment to contractors. In externally added projects additional QC and QA staffs are deployed for better quality of construction. Release from reservoirs and release in canals and distributaries (date, time and flow rate) is also decided by the offices made responsible to do this task. There is inherent weakness because they do not have any decision-making tools for matching demand and supply of irrigation water. In some places, gauge observations in canals are made and discharges are computed. This also needs improvement under the revised strategy.

Pani Panchayats at present are not sustainable institutions. It was revealed during many consultations that PPs have not worked on community co-management of water resources. Pilot projects should be taken up by Govt. of Odisha to try out different mechanisms while working in the irrigation projects with all stakeholders. Through such pilot projects, suitable operational and financial frameworks for PPs and suitable policy corrections to support new operational and financial frameworks can be brought out as recommendations. An important follow up step for the DoWR would be to consider implementation of such a pilot project at least in one irrigation project.

5.2 CRITICAL ANALYSIS OF EXISTING INSTITUTIONAL MECHANISM OF DOA & FE

The Agriculture Department mainly consists of 4 executive wings namely, Directorate of Agriculture (Organogram in Annexure XV), Directorate of Horticulture, Directorate of Soil Conservation and Watershed Mission. Besides these, a number of autonomous bodies like Odisha State Seeds Corporation (O.S.S.C), Odisha Agro Industries Corporation (O.A.I.C.), Agriculture Promotion and Investment Corporation of Odisha Limited (APICOL), Odisha State Seed and Organic Products Certification Agency (OSSOPCA), Institute on Management of Agricultural Extension (IMAGE), Odisha Cashew Development Corporation are also working under the Department.

The department's activities in the context of DIAP are undertaken by Directorate of Agriculture and Food Production and their subordinate offices, watershed mission and the project directors at the district level. Recent interaction by project team under this ACT project with official of agriculture department shows that the department has staff at district level (DDA), sub-division level (DAO), block level (AO), and Gram Panchayat level (VAW). These staff are currently engaged for registration of farmers for enabling them to get direct benefits transferred to their account on account of subsidy for procurement of inputs like fertilizers and farm machineries and taking up other activities like line transplanting etc.

By effecting institutional change and taking up capacity building of these staff they can serve the cause of DIAP as they have the mandate and duty to contact and interact with farmers. For the DIAP, these staff can assist Pani Panchayats in making cropping plans, selecting crop varieties and package of practices and facilitate them for making procurements of inputs and machineries.

5.3 CRITICAL ANALYSIS OF EXISTING INSTITUTIONAL MECHANISM OF DISTRICT ADMINISTRATION IN THE CONTEXT OF DIAP

In Odisha, Collector and District Magistrate is the administrative head of the district. The people in the district are aware about the power and authorities vested with the officials coming under the district administration.

At present, the Collector and District Magistrate is Chairman of most of the district level committees of developmental schemes and social welfare schemes. He is the Chairman of District Watershed Development Unit (DWDU), ATMA, DLIC which are important activities under the revised strategy of DIAP. Tahsildars are the irrigation officers as per Irrigation Act, 1959. They can institute verification regarding supply of irrigation to cropped fields through their staff mainly revenue inspectors. They are also responsible to collect irrigation taxes. Block Development Officers (BDO) have key role to play in sanctioning schemes under MGNREGA for taking up irrigation related works.

The Collector and District Magistrate by virtue of being the Chairman of DLIC under PMKSY will have to lead and guide the preparation and implementation of DIAP because of the legacy and administrative judiciary authority and power under law and order maintenance, conduct of general election as over-arching authority and can affect necessary coordination among the departments and convergence of their activities at the district level.

SECTION 6:

OVERVIEW OF THE PROPOSED STRATEGY AND ITS COMPARISON TO EXISTING WATER USE STRATEGY

Improper operation and maintenance is the root cause of inefficient water use and inequitable water distribution besides variation in water availability compared to water demand in project command areas. Proposed strategy aims at many transformations and innovations in the practices for operation and maintenance. Existing practice and proposed strategy for operation of canals and field channels is given in Table No. 19.

Table 19: Existing Practices and Proposed Strategy for different category of canal network

Category of water distribution network	Existing Practices	Proposed Strategy
Canal under full control of Government for O&M	In the existing practice requirement of Pani Panchayats area are not calculated and compiled before commencement of the irrigation/ cropping season. Canal operational plans are not prepared. Pani Panchayats are not consulted regarding canal operation in most of the irrigation systems.	• Pani Panchayats wise cropping pattern and cropping calendar will be prepared. Based the consolidated cropping pattern the canal will be operated. • Using CROPWAT, crop water requirement and canal water supply based on the net irrigation requirement will be calculated for the actual cropping pattern in the CCA of a particular canal. • Canal operation plan showing time of operation in days and hours of all the off-taking canals like distributary from the main/ branch canal. • Canal operational plan for distributary will be prepared showing time of operation of minor canals. • The operational plan after preparation by the engineers will be discussed with all concerned Pani Panchayats under the distributary and they shall be taken into confidence and they will be motivated to adhere to the canal operation plan. • At all discharge measurement daily discharge observation will be made at all off-taking points for monitoring and ensuring that the operational plan is followed in later and spirit.

Category of water distribution network	Existing Practices	Proposed Strategy
Canals transferred to Pani Panchayats in accordance with Pani Panchayat act 2002.	Officially Irrigation Divisions are not communicating regarding operational plans if any developed by the department	• Operational plans for Minors sub-minors will be prepared under the DIAP system and the same will be communicated to PPs and concerned persons of Water Management Sub-Committee who will be responsible for operation. • They will be trained for the operation based on operational plans. Efforts will be made for water measurement by PP and the record of water delivered in different canals will be maintained by PP. • Each PP will be ensured required water supply by indication in the gauges at the starting point of their jurisdiction at the upstream of the canal network. PPs will distribute water to different outlets involving Chak committees.
Water courses and Field Channels constructed below outlets	At present there is no system enforced by Government for distribution of water to individual water users land.	• Warabandi plans/rosters will be prepared under the DIAP which will be discussed with all water users by the Chak Committee by convening meetings. The plans/rosters will be finalised taking their views into consideration and incorporating modifications. • Each water user will be informed regarding their turn of getting the irrigation water in terms of hours and day of the week. • In the Chak map turn out positions will be marked and the map will be used for not only preparing plan but actual distribution during season.

6.1 OVERALL RISK AND EXPLANATION

Overall risk rating for the proposed planning process including all strategies recommended in this document is considered as moderate. The main risks and its explanation as well as ratings are given in the matrix below.

Table 20: Risk Matrix

Risk	Explanation	Rating	Risk Mitigation
Cross Department Coordination at Project Level	At present management of irrigation project is in the domain of DoWR. On year to year basis cropping pattern planned and achieved is not done due to lack of coordination with agricultural department. However it is a moderate risk and can be mitigated with less difficulty.	●●	Deputy Directors of Agriculture who are district heads should be directed by Director of Agriculture to prepare project wise proposed cropping pattern and achievement after the season in addition to block wise and district wise planning. This will automatically bring Agriculture department closer to irrigation department and there will be automatic coordination.
Cross Department Coordination at District Level	At present there are district level review mechanisms by Collector. He has sufficient administrative authority and magisterial powers to ensure cross department coordination in the district	●	Letters regarding DIAP planning process to Collector and District Magistrate. As and when required video conferencing should be arranged between Principal Secretary DoWR and Principal Secretary, Agriculture so that there is coordination gap.

Risk	Explanation	Rating	Risk Mitigation
Coordination challenge between departments at Govt. Level	At the Govt. level, the Principal Secretaries are very busy and overloaded with responsibilities and have many challenges. Their focus is mostly to execute all activities pertaining to their own departments.	●●	Discussions when required in the high-power committee headed by Chief Secretary will lead to needed coordination for preparation of DIAP in all districts.
Non-availability of data for PP wise planning	This is regarding data on hydraulic structures, command area, field channel systems, cropping, crop calendar, soil etc.	●●●●	This risk can be mitigated by assigning responsibilities to the concerned officer to get the database prepared. Monitoring at the Govt. level should also be done so that there is no unwanted delay.
Water measurement at strategic locations in the canal system	For computation of water productivity, use of irrigation water against scientifically calculated allocations, crop water budget, measurements are necessary. Crop cutting is made by Agriculture Dept., but they are averaged for GP, block and district level.	●●	Measurement structures may be constructed/ installed where Extension Renovation & Modernisation (ERM) works are on-going. Crop cutting data should be averaged for each project.
Institution and capacity risk of irrigation engineers and agricultural officers at state, district and block levels	DIAP will be a new job for irrigation circles, divisions, sub-divisions in DoWR as well as district, sub division and block level officers of Agriculture Department. There is a risk that it may not be implemented or the DIAP preparation is delayed due to capacity gap in institutions and among individuals.	●●	Institutional strengthening and capacity building can be organised to eradicate the risk. Training curriculums are provided in the strategy documents which could be implemented with modifications desired, if any
Conduct of Training by WALMI for required Capacity building	WALMI has to take up capacity building for DIAP preparation as a new activity. There is some risk in planning and implementation of capacity building.	●	WALMI usually have funds and receives funds from Govt. annually as grant-in-aid. It has infrastructure for conduct of training programs. WALMI can hire external resource persons to supplement its own capacity.
Availability of funds	Sometimes people may have perception that the fund requirement of DIAP is very high which is not always correct. However, there will be some requirement of funds and if this is not made available there will be risk of timely completion of DIAP and its implementation.	●●	Govt. of Odisha is among very few states in India who has an Agriculture budget. Water Resources Dept and agriculture department can reallocate some funds in their existing budgeting system for meeting the expenditure on DIAP.

Very High: ●●●● High: ●●● Moderate: ●● Low: ●

6.2 EXPECTED IMPACTS OF DIAP

Table 21: Expected Impacts, vehicles to achieve and indicators for DIAP

Expected impacts of transformative process of DIAP	Vehicles to achieve impact	Sample Indicators
Raised awareness on integrated action by Irrigation and agriculture department involving Pani Panchayats	PP wise plan preparation for water distribution, training of officials and PP office bearers.	No of PP level plans for minor and sub-minor prepared. No of warabandi plans.
Convergence	District Level Implementation Committee (DLIC)	Activities of different departments.
Inclusion	Rotational distribution with priority for Tail reaches.	Area irrigated vs. potential, area not irrigated in tail reaches (hectare, percentage of CCA).
Institutional Change making the existing departments with focus on climate change and optimal irrigation	Office orders by the Principal Secretary, monitoring by the District Collector, review of achievements of the revised strategy.	Achievement of parameters, no of meetings held under the Chairman, CEO.
Rotational water distribution in canal system enabling environment for equitable water distribution	Regular meeting of PP with irrigation and agriculture officials on agenda of crop plan, water distribution plan.	Participation of PP Participation of official in PP meeting.
Increase in irrigation efficiency	Implementation of operation plans, introduction of drip and sprinkler irrigation.	Area covered in irrigation projects with rigid operation plans. Area covered under drip and sprinkler irrigation.

ANNEXURES

ANNEXURE I: EXISTING NATIONAL POLICIES AND ACTS

National Water Policy

The strategy to be formulated has to factor in the national water policies and other national level programs as the Government of Odisha's plans in water sector may be guided by these national level guiding documents.

The National Water Policy 2012, described in more detail later, provides a comprehensive framework to guide States in setting their own policies and in developing their water resources and key features include:

- Water resource planning should be undertaken for each river basin and include both surface and groundwater, and consider water quality, quantity, and environmental needs.
- Information systems should be standardized to include water availability, actual water use and projections of future demand;
- Institutional mechanisms appropriate to river basin planning should be established taking into account all water users;
- Groundwater should be sustainable and conjunctively developed with surface water; irrigation should be developed on the basis of holistic project planning, with water allocations established considering equity and social justice;
- Command area development should be incorporated into all irrigation projects; participatory approaches to water resources management should be adopted by involving rural water user groups and other local bodies in O&M and management of water infrastructure and facilities, with a view to management transfer;
- Water charges should at least cover O&M costs and subsidized water rates provided to the poor and disadvantaged and well-targeted and transparent;
- Emphasis should shift to improving performance of existing irrigation facilities;
- Private sector participation should be encouraged in water resources management; training of staff and farmers in information systems, sector planning, project planning and formulation, project management and operation and management; and,
- Resettlement and rehabilitation policies should ensure that project-affected persons share in the benefits of water investments. While the policy is comprehensive it has limited coverage of the need for institutional change and lacks targets.

National Water Mission

The National Water Mission (NWM, 2010) and approved by the GOI in April 2011 covers various aspects of the water sector for effective adaptation to climate change. The five goals proposed by the Mission are:

- comprehensive water data base in the public domain and assessment of the impact of climate change on water resource;
- promotion of citizen and state actions for water conservation, augmentation and preservation;
- focused attention to over- exploited areas;
- increasing water use efficiency by 20%; and,
- Promotion of basin level integrated water resources management.

The nodal agency for the National Water Mission is the Ministry of Water Resources, River Development and Ganga Rejuvenation which has established a National Water Mission Directorate for Mission implementation.

Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has been formulated with the vision of extending the coverage of irrigation 'Har Khet ko pani' and improving water use efficiency 'More crop per drop' in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. The Cabinet Committee on Economic Affairs chaired by Hon'ble Prime Minister has accorded approval of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) in its meeting held on 1st July 2015.

PMKSY has been formulated amalgamating ongoing schemes viz. Accelerated Irrigation Benefit Programme (AIBP) of the Ministry of Water Resources, River Development & Ganga Rejuvenation (MoWR, RD&GR), Integrated Watershed Management Programme (IWMP) of Department of Land Resources (DoLR) and the OnFarm Water Management (OFWM) of Department of Agriculture and Cooperation (DAC). PMKSY has been approved for implementation across the country with an outlay of Rs. 50,000 crore in five years.

PMKSY will be implemented in area development mode only by adopting a 'decentralized State level planning and ProjectWise execution' structure that will allow States to draw up their own irrigation development plans based on DIPs and SIPs with a horizon of 5-7 years.

As per the programme architecture of PMKSY, there shall be a District Level Implementation Committee (DLIC):

(i) DLIC will form the third tier of the PMKSY. The DLIC will be chaired by the Collector/District Magistrate and will comprise of CEO Zila Parishad/PD DRDA, Joint Director/Deputy director of Departments of Horticulture, Agriculture, Rural Development, Surface and Ground Water Resources, Irrigation and any other line Departments in the district, District Forest Officer, Lead bank officer of the District.

(ii) The Project Director, Agricultural Technology Management Agency (ATMA) will be the Member Secretary of DLIC. In addition, DLIC may have two progressive farmers, and a leading NGO working in the District, if any. The farmers will be nominated for one year from District Farmers Advisory Committee under ATMA. The NGO representative will be nominated by the Collector/District Magistrate.

The DLIC will oversee the implementation and inter-departmental coordination at district level and will have following role:

i. To act as the field level coordinator between the various implementation agencies/line departments in the District and to ensure that the agreed District Irrigation Plan/ Annual Irrigation Plan is successfully implemented

ii. To prepare the District Irrigation Plan (DIP), showing the contribution of various funding streams and programmes towards specific outputs and outcomes and seek approval of the SLSC for the same.

iii. To prepare Annual Irrigation Plans (AIPs) arising out of the DIPs and to forward them to the SLSC for approval.

iv. To monitor the progress of various components of the AIPs, to remove implementation hurdles and make periodic reports to SLSC.

v. To undertake public awareness and publicity efforts for engaging farmers, PRIs, media and other local stakeholders to build support for the implementation of the DIPs.

ANNEXURE II: EXISTING STATE POLICIES AND ACTS

Orissa (Odisha15) Irrigation Act, 1959

The Orissa Irrigation Act, 1959 was the first act enacted by the Government of Odisha on the subject of irrigation to provide a legal framework for irrigation development and its maintenance. It is an act to consolidate and amend the laws relating to irrigation, assessment and levy of water rate and cess in force in different parts of the State of Odisha, and to provide for the regulation of use of water from Government sources. This act provides for the construction and maintenance of irrigation works and prescribes the basic water rates to be made applicable to various classes of irrigation systems for which water is to be supplied. Under the clause definitions of this act, "Outlet" is defined as an opening, constructed by the State Government in an irrigation work through which water is delivered into a water course or directly on to any land.

"Water course" means any channel or pipe not maintained at the cost of the State Government which is supplied with water from an irrigation work and includes all subsidiary work connected with any such channel or pipe, except the sluice or outlet through which water is supplied from an irrigation work to such channel or pipe. Under the chapter "Construction and maintenance of water-courses" It is stated that Construction of water-courses – For the purpose of making use of the water of an Irrigation Work the water-courses shall be constructed by the persons to be benefited at their own cost.

Under the clause Settlement of disputes concerning water-courses – Whenever a dispute arises between two or more persons in regard to their mutual rights or liabilities in respect of the use, construction or maintenance of a water-course, of among joint owners of a water-course as to their respective shares of the expenses of constructing or maintaining such water-course or as to the amount severally to be contributed by them towards such expenses or as to failure on the part of any owner to contribute his share, any person interested in the matter of such dispute may apply in writing to the Irrigation Officer stating the matter in dispute.

This Act is in force till date. From relevant clauses which are stated above, it can be interpreted that money from government exchequer can be spent on maintenance of canal system up to outlets and not on maintenance of water courses that starts from the outlet for distribution of water to farmers plots.

The Orissa (Odisha) Pani Panchayat (PP) Act, 2002

The PP Act states that the State of Odisha is essentially an agricultural State dependent on an efficient and equitable supply and distribution of water ensuring optimum utilisation of water by farmers for improvement of agricultural production is the utmost need. The scientific and systematic development and maintenance of irrigation infrastructure is considered best possible through farmers' participation. Farmers' Organisation have to be given an effective role in the management and maintenance of the irrigation system for equitable and dependable supply and distribution of water. The act has defined Pani Panchayat as an institution at the primary level consisting of all the water users, as constituted within a specified hydraulic boundary of a major, medium, minor (flow and lift-both surface and ground water and creek irrigation projects funded by government.

Under the clause explanation of this Act "warabandi" means a system of distribution of water allocation to water users by turn, according to an approved schedule indicating the day, duration and the time of supply. Further, it is explained that "operational plan" means a schedule of irrigation deliveries with details of the mode and duration of supplies drawn up for regulation of irrigation in the commanded area of an irrigation system. In accordance with the rules made under this act, in this behalf, delineate every commanded area under each of the irrigation systems on a hydraulic basis ordinarily between 300 to 600 hectares which may be considered administratively viable; and declare it to be the area of

15 Orissa has been renamed as Odisha. Therefore, Odisha is used in the bracket.

a Pani Panchayat for the purpose of this act. In Lift irrigation schemes where the area is less the entire commanded area may, as far as possible, form a single area of Pani Panchayat and may be notified. Every Pani Panchayat's area shall be comprised of several Chaks which shall as far as possible cover the area irrigated by one out let. The number of Chaks shall not be less than four or as may be specified by the competed authority. There shall be a Distributary Committee called by its local distinct name for every distributary area.

Under the section Objects and Functions of the Farmers' Organizations there are sub clauses; (i) to prepare a cropping programme suitable for the soil and agro-climatic condition with due regard to crop diversification (ii) to regulate the use of water among the various pipe outlets under its area of operation according to the warabandi schedule of the system (iii) to promote economy in the use of water allocated.

The section related to Functions of Distributary committee has sub clauses (i) to prepare an operational plan based on its entitlement, area, soil, cropping pattern at the beginning of each irrigation season, consistent with the operational plan prepared by the Project Committee; (ii) to regulate the use of water among the various Pani Panchayats under its area of operation

The section related to Functions of the Project Committee has sub clauses; (i) to approve an operational plan based on its entitlement, area, soil, cropping pattern as prepared by the competent authority in respect of the entire project area at the beginning of each irrigation season.

It is imminent that the Government of Odisha has a clear-cut strategy to involve farmers' organizations to make cropping plans, canal operation plan, in developing and preparing the warabandi schedules. The proposed strategy draws its strength from this Act and offers suggestions with examples and templates on efficient and equitable water distribution.

State Water Plan, 2004

The hydrological unit should be the unit of development and management of water resources, starting from primary watersheds to sub-catchments and catchments, integrated into sub-basins and basins. The State of Orissa has 11 river basins as shown in Table No 5. The State has developed a State Water Plan for a period covering up to 2051 AD when the population of the State is expected to stabilize. With competing demands for water from the same sources, it is necessary to lay down the priorities in its allocation. The State of Orissa adopts the following order of priority in water allocation in tune with the National Policy:

- Drinking water and domestic use (human and animal consumption)
- Ecology
- Irrigation, Agriculture and other related activities including Fisheries.
- Hydro Power
- Industries including Agro Industries.
- Navigation and other uses such as tourism.
- Any alteration in the above-mentioned priorities will demand formulation of a new policy.

The State Water Plan will not only allocate the water resource to different sectors of priority, it will also have a perspective plan for development of these resources in important areas like drinking water, irrigation, hydro-power etc. While developing these resources, people's need preservation of the ecological balance and enrichment of the ecosystem would receive adequate attention. The plan will be holistic, participatory and environmentally sustainable.

Orissa lacks the coherent legal and institutional framework necessary for the effective management of the State's water resources with a view to achieving social and economic development objectives in a context of increasing water stress.

State water plan

The state is endowed with an extensive network of rivers and streams. As per an assessment made in 2001, the average annual availability of surface water from states own drainage boundary is estimated as 82.841 BCM. Considering the topography and geological limitations, it has been assessed that 65.679 BCM of water can be utilized. Besides, inflow of 37.556 BCM is also available annually from neighbouring states through interstate rivers. Out of which, the utilizable surface water resources is assessed as 29.861 BCM. Due to increasing demands of water for various uses, an attempt has been made to assess the availability of water by the year 2051. The assessment reveals that the surface water availability from its own drainage boundary remains more or less fixed but the inflow of surface water from neighbouring states will be reduced from 37.556 BCM to 25.272 BCM. Basin wise availability of surface water (2001 scenario) is depicted in Table 20 and 2051 scenario is presented in Table No. 21.

The State's institutions responsible for water-related matters (stakeholder institutions) are not yet adequately equipped to deal with the effects of increasing water stress. In particular, there is no effective mechanism to ensure the institutions' concerted actions in line with the principles of IWRM.

State water Plan

Table 22: Basin wise availability of Surface Water (Scenario: 2001)

Basin Name	Average Annual flow (in BCM)			75% dependable flow (in BCM)		
	Own	Outside State	Total	Own	Outside State	Total
Mahanadi	29.9	29.255	59.155	25.508	23.225	48.732
Brahmani	11.391	7.186	18.577	8.849	5.521	14.011
Baitarani	7.568	-	7.568	5.434	-	5.434
Rushikulya	3.949	-	3.949	2.782	-	2.782
Vamsadhara	5.083	-	5.083	3.881	-	3.881
Budhabalanga	3.111	-	3.111	2.521	-	2.521
Kolab	11.089	-	11.089	8.885	-	8.885
Indravati	6.265	-	6.265	4.451	-	4.451
Bahuda	0.438	-	0.438	0.213	-	0.213
Nagavali	2.853	-	2.853	2.322	-	2.322
Subernarekha	1.193	1.115	2.308	1.193	1.115	2.308
Total	**82.841**	**37.556**	**120.4**	**65.679**	**29.861**	**95.54**

Source: State water plan

Table 23: Basin wise availability of Surface Water (Future Scenario: 2051)

Basin Name	Average Annual flow (in BCM)			75% dependable flow (in BCM)		
	Own	Outside State	Total	Own	Outside State	Total
Mahanadi	29.9	21.039	50.939	25.508	16.702	42.21
Brahmani	11.391	3.118	14.509	8.849	2.395	10.884
Baitarani	7.568	-	7.568	5.434	-	5.434
Rushikulya	3.949	-	3.949	2.782	-	2.782
Vamsadhara	5.083	-	5.083	3.881	-	3.881
Budhabalanga	3.111	-	3.111	2.521	-	2.521
Kolab	11.089	-	11.089	8.885	-	8.885
Indravati	6.265	-	6.265	4.451	-	4.451
Bahuda	0.438	-	0.438	0.213	-	0.213

Basin Name	Average Annual flow (in BCM)			75% dependable flow (in BCM)		
	Own	Outside State	Total	Own	Outside State	Total
Nagavali	2.853	-	2.853	2.322	-	2.322
Subernarekha	1.193	1.115	2.308	1.193	1.115	2.308
Total	**82.841**	**25.272**	**108.11**	**65.679**	**20.212**	**85.891**

Source: State water plan

State Water Policy, 2007

Table 24: Water demand in 2001 and 2051 for Odisha

Uses	2001 (Assessed)	2051 (Projected)
Domestic	1.99	3.00
Irrigation	22.69	49.41
Industry	0.71	1.95
Environmental	29.40	29.40
Others	0.20	0.40
Total	54.99	84.16

Source: Government of Odisha (2010)
Note: *Water demand in BCM, the data from the source is rounded to two decimals.*

State water policy was drafted by DoWR in 2007. This policy was reviewed, and important relevant contents of the policy are highlighted. It is mentioned in the policy that the annual overall availability of surface water in Odisha is about 85.59 billion m3. Around 11% of the water resources of India is in Odisha whereas the population share is about 4% of the country. Per-capita availability of water in 2001 was 3359 m3 which is likely to reduce to 2218 m3 by 2051. With increasing population and the consequential increase in demand for food and water and with the growth in mining and industrial activities, the demand for water from various sectors is likely to increase by 2051 (Table 22). The vagaries of monsoon cause droughts and floods in different parts of the State on a regular basis. From 1958 to 2005, rain related natural calamities have visited the State 27 times (Quoted from State Water Plan).

The State Water Policy of Orissa, 2007 takes into account all these emerging factors and aims at laying down principles for wise and judicious use of water for survival of life.

Water sector vision

BJD Government has the vision of creating additional irrigation potential of more than 10 lakh hectares in the next five years (By 2019). A new initiative will be launched on mission mode to restore and operationalize all defunct Lift Irrigation points

Source: BJD (Ruling political party) Manifesto

Under the section 'Development of Water Resources for Irrigation and Drainage' of the policy, it is mentioned that measures such as selective lining of the conveyance systems, modernization and rehabilitation of existing systems including tanks, recycling and reuse of treated effluents and adoption of new techniques like drip and sprinkler irrigation will be promoted. There would be coordination by DoWR with Agriculture Department for promoting suitable cropping pattern which would help efficient and equitable use of water.

It is also stated that planning and development of water resources will encompass uniform development of field channels through command area development activities. Such activities will be carried out only through people's participation. Artificial recharge of ground water including roof top rainwater harvesting

would be encouraged to replenish the utilisable ground water resources and improve its quality. The ground water recharge would be a conscious policy of all stakeholders. It would be the focus of the State Watershed Mission's activities. In suitable projects, the State will introduce Irrigation Management Transfer (IMT). This will, however be done in tune with the capacity of the Pani Panchayats to shoulder the responsibility of management of the Projects.

In the policy, it is also specified that the cost of operation and management will be fully recovered from the beneficiaries. Norms will be established for ensuring water rights commensurate with water rates. The State will explore the possibility of setting up a regulatory authority for fixation of water rates in order to achieve full cost recovery of the O&M charges.

Treatment of catchments of all reservoirs will be taken up in an expeditious, systematic and scientific manner in order to prevent premature siltation of the reservoirs. Action plans would be prepared for catchment treatment of all the major and medium reservoirs of the State with the help of satellite data as well as ground surveys. The afforestation and soil conservation measures should be dovetailed with measures for prevention of reservoir sedimentation. The effectiveness of such measures will be monitored, and the impact evaluated at designated intervals. The catchment treatment plans, their implementation, their monitoring and evaluation should be with the full participation of local communities living therein.

The Government and concerned agencies need to adopt a variety of policy changes to improve efficiency and effective service delivery to the farmers. These include promoting the concept of IWRM, setting out priorities with respect to water use, and proper implementation of the same. Reforms in the water sector must take into account the changing needs of the users, particularly in the light of social and hydrological challenges. The law and policy framework need to be revisited, especially making users' participation more effective by strengthening the regulations related to PIM and reducing the role of the government in irrigation. Past experience has shown that overt government control has led to the inefficiency in several irrigation schemes, given the lack of accountability and management skills, and the dependence on practices being followed since a long time. Another important area is the recovery of the costs of operations and maintenance of the water supply schemes (if not the capital expenditure) which has to be progressively achieved through involvement of water users' institutions.

The State Water policy, 2007 has not been revised. In this strategy document suggestion include revision of State Water Policy. However, from available sources, the vision of the present government on water sector is to provide irrigation and creating additional irrigation potential which is stated in the manifesto of the ruling political party.

Upcoming Initiatives/ Regulations and their Objectives

Sl. No	Regulations/ Initiative	Objectives	Remark
1	DoWR is going to bring out a series of publication in the same of 'stories of change'. Each publication would be a success story with photographs of the irrigation projects like check dams, MIPs, LIPs, CADA which have brought visible improvement in agriculture of the local area.	Document the many good works done by DoWR related to irrigation.	Few publications are made. Many more can be prepared.
		The target has been set to bring out 100 such success stories. Executive Engineers (EE) of all irrigation divisions in the DoWR are entrusted to document success stories.	Most of the EEs are yet to prepare the success stories documents.
		Encourage field engineers to do good work and make innovative changes.	This is yet to happen.
		Scaling up best practices.	This is yet to happen.

Sl. No	Regulations/ Initiative	Objectives	Remark
2	Government has directed different wings of DoWR to facilitate conduct of Pani Panchayat meeting regularly in every month.	Strengthening of Pani Panchayats (PP). Effective functioning of PP. Better transparency and involvement of water users in decision making.	Some efforts have gone in it is an ongoing process. Lot of efforts are required. Models of sustainable PP managed irrigation projects should be developed. Govt is thinking in this line. Important but yet to happen.
3	Farmers should be trained to save water and utilize the saved water properly. The number of outlets in canal should not exceed the provision made in the approved L.S. Diameter of the outlet pipes should not be more than the design requirement. In cases where larger diameter of outlet is noticed, a concert sleeve is to be inserted in the outlet pipe to keep the opening to match the design discharge.	Increasing efficiency in irrigation projects. Reducing gap between IPC and IPU. Accessibility of irrigation water by tail reach farmers. Supplying water in each outlet proportionate to the outlet command area. Equitable water distribution among farmers. Making the system conducive for implementing canal operational plans effectively.	Training to fulfil these objectives are being planned by WALMI. New training programs are to be formulated. It is difficult to control farmers and hence the farmers resort to drawing water by making temporary outlets by themselves Inequity in water distribution exists. Canal operational plans are not prepared.
4	Increasing the capacity of the DoWR to incur expenditure from budget to achieve the objective of creation of 24 lakh hectare of irrigation potential and 3 times crop production through 1.00 lakh crore investment in coming 10 years (2016-2026). However, prudent and economic utilization of funds is essential both in construction of new projects and maintenance of old projects to get maximum output. The works are to be executed as per standard design of project components and codal provision of Govt. of Odisha.	Institutional Development Capacity enhancement by evolving standard designs and development of Toolkit.	This is yet to happen. It is a time taking process.
5	In upcoming interventions, Government has directed, expedite the capacity building of PP or WUA to promote micro irrigation to achieve higher water-use efficiency. 10 to 15% micro irrigation are to be planned in five AIBP projects namely, Lower Indra Ext., Rukura, Anandapur Barrage & Subernrekha Irrigation Project.	Complying to the stipulations of the concerned guidelines by MoWR, RD and GR, Govt. of India. Increasing application efficiency.	Planning process has started.

Sl. No	Regulations/ Initiative	Objectives	Remark
6	SMART irrigation Techniques are to be adopted in newly constructed project for most effect management of Irrigation Network. Emphasis is to be given on the possibility of increasing the existing ayacut of MIPs, wherever possible, by exploring the scope of extending the canal beyond tail end and providing water in the head reach of the canal system through suitable lifting mechanism.	Increasing area under MIPs. Extension of canal system with lifting of water.	Superintending Engineers are entrusted to discuss the technical issues with their Executive Engineers and chalk out plan accordingly. This is yet to happen.
7	Annual report should come out for each division giving information on no of projects completed, no. of ongoing projects, water supplied in Rabi and Kharif.	Monitoring of water supply in different seasons.	Annual achievement reports are to be prepared.
8	Geo-tagging of works with photos and data describing the beneficial aspects of the projects.	Better transparency and avoiding duplication/ overlapping of command area. Better visibility of the work of DoWR and monitoring centrally.	It has started in small way for new bore wells. Extending geo-tagging to all irrigation works is yet to happen.
9	Proposals for Periphery development of MIPs should be taken up.	Covering farmers' plots near MIPs which are not covered.	Yet to happen
10	Rengali Left Canal network under construction is proposed to be taken up by involving expected beneficiaries at the beginning.	At the construction stage itself, formation of Pani Panchayats. Building the capacity of PPs newly formed before construction of canals to participate in layout of field channels, water courses and understand the principles of canal alignment.	PP formation has been initiated. It is likely to be initiated from Nov 2017 and will continue for 5 years.
11	Minor Irrigation tanks renovation is to be aligned to Climate change. OIIPCRA is the project which is a upcoming project through which some new mechanisms/regulations are likely to be evolved.	Efficiency improvement Volumetric measurement Collection of irrigation charges by Pani Panchayat Solar power pumping system.	This has been initiated in Sept 2017.

Sl. No	Regulations/ Initiative	Objectives	Remark
	GCF supported project titled "Ground water recharge and solar micro irrigation to ensure food security and enhance resilience in vulnerable tribal areas of Odisha" is sanctioned in the year 2017.	The project will be implemented in the 15 vulnerable districts viz. Baragarh, Bolangir, Boudh, Gajapati, Kalahandi, Kandhamal, Keonjhar, Koraput, Malkangiri, Mayurbhanj, Nawarangpur, Nuapada, Rayagada, Sambalpur and Sonepur	It is in the planning stage.
		Ground water recharge system for concrete Adaptation	It is in the planning stage.
		Renovation of Community Tank (From Convergence Fund)	Govt. has already initiated implementation of a World Bank Project (OIIPCRA) with a target of renovating 600 tanks.
12		Integration of Solar Pumps for Irrigation	Communication from MoEF & CC, Govt. of India I awaited by DoWR. On receipt of communication site selection will be commenced.
		Capacity Building of stakeholders	It will be taken up at the start of project implementation and shall continue parallelly.
		Quality Management & Monitoring	This will be done by engaging expert agency.
		Knowledge Management	This will be done by engaging consulting firm.
		Project Management	This will be done by setting up state level PMU, district level PMU, and engagement of consulting firm.

key policies and scope for integrated action in diap framework

Name of the policy document	Relevant Policy	Integration with irrigation project management
Odisha Fisheries Policy, 2015	Minor Irrigation Projects (MIP) below 40 ha water area/ Gram Panchayat (GP)/ Revenue tanks shall be uniformly leased for a period of not less than five years for pisciculture. Suitable norms for leasing of these water bodies may be prescribed in consultation with the Department of Fisheries.	Pani Panchayats in MIPs will get benefit from fish production (lease rental) and it will be integrated wherever feasible. Conflict resolution is the key, nature of fish farming should be planned along with water use

Name of the policy document	Relevant Policy	Integration with irrigation project management
State Agriculture Policy, 2013	Individual tube wells and bore wells will be promoted under Jalanidhi program with maximum subsidy up to 75% of the project cost Community Lift irrigation projects with subsidy up to 80% of the project cost in the non-YSP areas and non-KBK districts and up to 90% of the project cost in the TSP areas and KBK districts will be continued under Biju Krushak Vikas Yojana. This policy document says that if a registered society constructs a community-based lift irrigation project then the subsidy will be to the extent of 90% excluding the cost of land. Micro irrigation will be promoted in a big way by providing subsidies for drip and sprinkler irrigation maximum up to 90% of the cost. Small Farm ponds will be executed free of cost in the field of BPL farmers in the State under MGNREGA and State Plan	These policies are very good for creation of irrigation facilities by individual farm families or farming community. In the DIAP, agriculture department can give the target in terms of no of schemes and number of subsidies. District wise and year wise additional area to be brought under irrigation should also be shown as target in DIAP.
State Water Policy, 2007	Development of water resources will encompass uniform development of field channels through command area development activities. Such activities will be carried out only through people's participation. Artificial recharge of ground water including roof top rainwater harvesting would be encouraged to replenish the ground water resources and improve its quality. State will introduce Irrigation Management Transfer (IMT). This will, however be done in tune with the capacity of the Pani Panchayats to shoulder the responsibility of management of the Projects Treatment of catchments will be taken up in an expeditious, systematic and scientific manner in order to prevent premature siltation of the reservoirs. Action plans would be prepared for catchment treatment of all the major and medium reservoirs.	In all PPs, a time bound plan for construction or renovation of field channels should be planned. CADA divisions are already doing all field channel construction through Pani Panchayats only. DoWR is already in the process of implementing ground water recharge at 10,000 tanks and it should be integrated in the DIAP wherever relevant. This is yet to be institutionalized. Some model catchment/cascade level plans encompassing all water related activities will be prepared for two pilot districts.

ANNEXURE III:
FIVE YEAR PERSPECTIVE PLAN, 2009 TO 2014

Department of Water Resources has formulated a five-year perspective plan for the period 2009-10 to 2013-14 for sustainable development of Water Resources. Expansion of irrigation coverage in a sustainable way and at a fast rate is one of the priority agenda of the present Government. Out of the total cultivable land of 61.65 lakh ha., 46% i.e. 28.345 lakh ha., has been provided with irrigation facilities till March 2009. This five-year Perspective plan has the following targets.

- Additional irrigation potential of 5.6 lakh hectare to be created.
- 31 major & medium, 494 minor flow and 7739 Lift irrigation projects to be completed.
- All the balance 169 deficit blocks to be provided with at least 35% irrigation coverage. 71 blocks have been identified.
- Sixteen new major and medium projects namely Ong Dam, Brutang, Samakoi, Upper Lanth, Katra, Upper Udanti, Tel Barrage (Kukudmal & Manikpur), Indravati Barrage, Koksara Lift, Sono Barrage, Bankatira, Sandul, Turi Guntat, Aheerajore, Korapani & Lamdora with designed irrigation potential of 165.393 thousand hectare to be taken up.
- Investment clearance and other statutory clearances of 42 new major and medium irrigation projects and hydroelectric projects from various ministries of central Government to be obtained for implementation.
- Command Area Development &Water Management (CAD&WM) activities to be extended to 16 more major and medium irrigation projects
- 1.89 lakh persons covering farmers, Pani Panchayat office bearers, Government official and staff to be trained through WALMI for skill up-gradation in efficient water management practices.
- All irrigated commands to be handed over to Pani Panchayats for Operation and Maintenance.
- 1681 water bodies to be renovated through RR&R scheme under domestic assistance. This include 711 No. of derelict MIPs with designed ayacut of 102.95 thousand hectare, 20 medium irrigation projects, 950 tanks under PR, H&UD Dept. Out of 102.95 thousand hectare, lost ayacut of 41.09 thousand hectares to be retrieved.
- 900 partly derelict/ completely derelict minor irrigation tanks covering 1.20 lakh hectares to be rehabilitated under OCTMP through World Bank assistance.
- Modernization work of Upper Indravati, Upper Kolab, Potteru and selected medium irrigation projects to be taken up in a phased manner through AIBP / States own resources.
- Rehabilitation of 38 dams comprising of 5 major, 14 medium and 19 minor with estimated cost of Rs. 131.00 crores to be taken up through Dam Rehabilitation and Improvement Project (DRIP) under World Bank assistance.
- Critical drainage congestion clearance activities to be taken up through NABARD, Flood Management Programme and State funds.
- 68.98 thousand hectares of existing irrigated command to be rehabilitated and modernized under Asian Development Bank (ADB) assisted Orissa Integrated Irrigated Agriculture & Water Management Investment Programme (OIIAWMIP).
- Dredging of Hirakud reservoir and balance rehabilitation works in canal system to be completed.
- River mouth clearance of Daya, Bhargavi, Luna and Makara to be completed during 2010-11.
- Coastal erosion and protection work of Rs. 168.00 crores to be taken up under NCRMP & ICZMP.
- 69 flood control and drainage projects under FMP to be completed during 2010-11.
- 45.00 th. Ha of water logged area to be retrieved through FMP & RIDF.
- Basin wise flood control master plans to be prepared for managing the flood and minimizing impact of flood.
- Renovation of storm water drainage system of Bhubaneswar & Puri town to be taken up under JNNURM.

- Tourism infrastructure to be provided in major, medium & minor irrigation projects depending on tourism potential and feasibility.
- About Rs. 10,000 crores to be spent during next five years under Plan.
- Capacity of the department to be suitably augmented in order to achieve the enhanced targets. Outsourcing of activities to be considered for the purpose.

ANNEXURE IV:
TEMPLATE FOR ROTATIONAL WATER DISTRIBUTION PLAN (AMONG MINORS AND DISTRIBUTARIES) CONTROLLED BY GOVT.

Sl. No	Distributary	Length (m)	CCA (ha)	Discharge (cumecs)	Filling Time	Draining Time	Turn Time

Annexure V

ANNEXURE V:
TEMPLATE FOR ROTATIONAL WATER DISTRIBUTION PLAN (AMONG MINORS AND DISTRIBUTARIES) CONTROLLED BY PP

Distributary	CCA (ha)	Length (m)	Filling Time	Draining Time	Turn Time (Hrs)

ANNEXURE VI:
TEMPLATE FOR ROTATIONAL WATER DISTRIBUTION PLAN (AMONG OUTLETS) OF PP

Outlet no	Area (Ha)	Length of Outlet (M)	Filling Time (Hr.)	Draining Time (Hr.)	Net Allotted Time (Hr.)	Total Time (Hr.)	Flow Rate m^3/Hr	Total Allocated Time (Hr.)

ANNEXURE VII:
TEMPLATE FOR DATA TO BE USED FOR PREPARATION OF WARABANDI SCHEDULE FOR WATER DISTRIBUTION IN THE FIELD CHANNEL

Outlet No.	Sl. No.	Khata No.	Name of Beneficiary	Village	Plot No.	Area (Ha)

ANNEXURE VIII:
STEPS FOR PREPARING WARABANDI SCHEDULE

- Calculate Total Bharai
- Total Bharai = Lenghth of channel from Head to tail x rate of filling time per unit length.
- Calculate Total Zharai
- Total Zharai = Length of channel under Zharai x rate of Zharai x rate of Zharai time per unit length.
- Assume seepage losses.
- Calculate flow time per unit area (FT)
- FT (hours)= 168- Total Bharai + Total Zharai
- Calculate flow time for a farmer (FTF)
- FTF (hours)= FT x his area + his bharai- his zharai
- Warabandi schedule is prepared in a tabular form as shown in the example
- Two schedules are prepared with staggering of 12 hours.

Bharai = filling time

Zharai = draining time

Template for Warabandi Schedule for water distribution in a Chak through field channel

Turn out No./ Farmers Name	CCA (ha)	Length from previous turn out (m)	Filling Time	Draining Time	Turn Time (Hrs)

ANNEXURE IX: CROPWAT

Any water resources/irrigation models will need a set of input values. The model or the software has the capability to process the input values using the algorithm and produce output values. The output values of data is used for making decisions and hence such models are called decision making tools. It is imperative that CROPWAT will also need certain input and generates outputs.

Input

There are five inputs modules:

- Climate/Et_o
- Rain
- Crop
- Soil
- Crop Pattern

Calculations of the crop water requirements and irrigation requirements are carried out with inputs of climatic, crop and soil data. For the estimation crop water requirements (CWR) the model requires:

1. **Reference Crop Evapotranspiration (Et_o)** values measured or calculated using the FAO Penman-Montieth equation based on decade/monthly climatic data: minimum and maximum air temperature, relative humidity, sunshine duration and wind-speed. The input data format is given in Annexure X.
2. **Rainfall data (daily/decade/monthly data);** monthly rainfall is divided into a number of rain storm each month. The input data format is given in Annexure X**.**
3. **Soil type:** total available soil moisture, maximum rooting depth, initial soil moisture depletion (% of total available moisture). There are 10 types of soil as per textural classifications as given in Table 26. For each soil texture there are standard values for filed capacity, wilting point and available water capacity.

Available Water Capacity of soils

Texture	Field Capacity (FC)	Wilting Point(WP)	Available Water
Coarse sand	0.6	0.2	0.4
Fine sand	1.0	0.4	0.6
Loamy sand	1.4	0.6	0.8
Sandy loam	2.0	0.8	1.2
Light sandy clay loam	2.3	1.0	1.3
Loam	2.7	1.2	1.5
Sandy clay loam	2.8	1.3	1.5
Clay loam	3.2	1.4	1.8
Clay	4.0	2.5	1.5
Self-mulching clay	4.5	2.5	2.0

4. A **Cropping Pattern** consisting of the planting date, crop coefficient data files (including K_c values, stage days, root depth, depletion fraction) and the area planted (0 -100% of the total area); a set of typical crop coefficient data files are provided in the program.
5. **Scheduling Criteria**: several options can be selected regarding the calculation of application timing and application depth (e.g. 80 mm every 14 days or irrigate to return the soil back to field capacity when all the easily available moisture has been used). The available options are;

Irrigation Timing:

- Irrigate at user defined intervals
- Irrigate at critical depletion
- Irrigate below or above critical depletion
- Irrigate at fixed interval per stage
- Irrigate at fixed depletion
- Irrigate at given ET crop reduction per stage
- Irrigate at given yield reduction
- No irrigation (rain-fed)

Irrigation Application:

- User defined application depth
- Refill soil to field capacity
- Refill soil below or above field capacity
- Fixed application depth

Output

Once all the data is entered, CropWat automatically calculates the results as tables or plotted in graphs. The time step of the results can be any convenient time step: daily, weekly, decade or monthly. The output parameters for each crop in the cropping pattern are:

- **Reference crop evapotranspiration** – Et_o (mm/period);
- **Effective rain** (mm/period) - the amount of water that enters the soil;
- **Crop water requirements** – CWR or Et_m (mm/period);
- **Irrigation requirements** –IWR (mm/period);
- **Irrigation depth** to be applied (mm);
- **Scheme Water Supply**
- **Irrigation interval** (days)

For each minor canal, distributary in major and medium projects and for entire project ayacut of Minor Irrigation Projects, River Lift schemes such outputs are to be generated.

Another tool on Excel is developed to calculate volume of water to be supplied through canals from flow rates/ discharge of the scheme.

Process

After inserting all the required inputs such as data on climate, rainfall, crop soil and crop pattern, one can analyse the Crop Water Requirement, irrigation schedule and the scheme water supply.

ANNEXURE X: CROPWAT TEMPLATES

Input data format on Climate related parameters for CROPWAT

Country: _____ Station: _____ Altitude: _____

Latitude: _____ Longitude: _____

Month	Min Temp (°C)	Max Temp (°C)	Humidity (%)	Wind (km/day)	Sun (hours)	Radiation (MJ/m²/day)	ET_o (Mm/day)

The duration can also be in weeks or days depending on the requirement. Once all the other data is put in the table, Radiation and ET_o will be automatically calculated by the CROPWAT.

Input data format on Rain related parameters for CROPWAT

Month	Rainfall (mm)	Effective Rainfall (mm)

After rainfall data is put month wise the effective rainfall will be calculated by the CROPWAT.

Input data format on soil related parameters for CROPWAT

Soil Name: _____

Total available moisture (FC-WP) _____ mm/meter

Maximum Infiltration Rate: _____ mm/day

Maximum Rooting Depth: _____ centimeters

Initial soil moisture depletion (As % of TAM): _____ %

Initial available moisture: _____ mm/meter

Maximum Infiltration Rate: The infiltration rate is the velocity or speed at which water enters into the soil. It is usually measured by the depth (in mm) of the water layer that can enter the soil in one hour. An infiltration rate of 15 mm/hour means that a water layer of 15 mm on the soil surface will take one hour to infiltrate.

Maximum Rooting Depth: The deepest soil depth reached by the roots of an individual plant.

Input data format on soil related parameters for CROPWAT (For rice)

For Rice

Soil Name: _____

Total available moisture (FC-WP) _____ mm/meter

Maximum Infiltration Rate: _____ mm/day

Maximum Rooting Depth: _____ centimetres

Initial soil moisture depletion (As % of TAM): _____ %

Initial available moisture: _____ mm/meter

Additional Soil Data for rice calculations:

Drainable porosity (SAT-FC): _____ %

Critical depletion for puddle cracking _____ fraction

Maximum Percolation rate after puddling _____ mm/day

Water availability at planting _____ mm WD/% desat/ %depl.

Maximum water depth _____ mm

Availability of water capacity of soils

Particulars	Unit	Value
Texture	Name	
Field Capacity (FC)	Mm/meter	
Wilting point (WP)	Mm/meter	
Available water capacity	Mm/meter	

Input data format for Crop related parameters

Crop Name: _____ Planting date: _____ Harvest Date: _____

Stages	Kc values	Rooting Depth (m)	Critical Depletion (fraction)	Yield Response f.	Crop height (optional)
Initial		**			--
Development	--	--	--		--
Mid-season					
Late season	*	--			--
Total		--	--		--

1. (--) not to be filled
2. (*) end of late season
3. (**) 10-15 days after initial stage.

Input data format for Crop related parameters (For Rice)

Stages	Kc dry	Kc wet	Rooting Depth (m)	Puddling depth (m)	Nursery Area (%)	Critical Depletion (fraction)	Yield Response f.	Crop height (optional)
Nursery			--	--			--	--
Land Prep			***					
Total			--		--	--	--	--
Puddling			--					
Initial			**	--	--			--
Development	--	--	--	--	--	--		--
Mid-season			~~	--	--			
Late season	*	*	--	--	--			--
Total			--	--	--	--		--

1. (--) not to be filled
2. (*) end of late season
3. (**) 10-15 days after initial stage.
4. (***) end of land prep stage
5. (~~) end of mid-season

Input data format for Crop Pattern related parameters

A maximum of 30 crops can be put as input. But since this number of crops is not grown in one place, hence 4-5 crops can be put in the table for further analysis.

Cropping pattern name: _____

Sl. no	Crop file	Crop name	Planting date	Harvest	Area

ANNEXURE XI: BASIN PLANNING

Basin planning is the process by which decisions are made over the competing uses and different demands for water resources and associated systems within a basin. Basin plans set objectives and the measures for developing, protecting and harnessing the resources of the basin in order to achieve these objectives and health and safety of the river itself. In its most developed form basin planning can bring together a range of different disciplines and themes, from hydrology and engineering to ecology and economics.

Basin management: Basins are often recognized as the practical unit of water resources management, because this allows the upstream-downstream hydrological interactions to be considered in holistic solutions. This whole-basin approach also allows a systemic approach to ecological and infrastructure systems.

While approaches to basin planning have evolved over time and are adapted to the local circumstances within a basin, basin planning is ultimately the process of:

- Assessing and prioritizing issues of concern to be managed within a basin
- Deciding on the way in which these priorities should be managed to achieve social / economic / ecological objectives over time
- Specifying the way in which different competing purposes (such as abstraction, hydropower, flood control and navigation) may develop or use the basin water resources.
- Basin planning has historically has been prompted by the need to manage the challenges associated with one or more of the fundamental basin-scale water-related issues:
- Water allocation, reconciliation and utilization planning has tended to be the focus in more arid or seasonally variable basins where population and development has driven water demands.
- Water quality planning has been the focus in highly developed urban, industrial or mining dominated basins, as well as those with intensive irrigation.
- Flood risk management has tended to be the focus in higher rainfall basins, particularly where there is significant downstream development (people and property).

In some large and diverse basins all of these issues require significant consideration. However, in most basins, not all of these issues will be of equal concern.

The water resources assessment component typically consists of various thematic studies around existing or emerging issues for the basin. These studies use a range of disciplinary relevant simulation and/or optimization analysis techniques, the nature of which is relatively standard for most basin planning processes. Data limitations pose the greatest challenge to these studies. The common elements of a water resources assessment include:

- Water demand (and water use) requirements (including water use efficiency)
- Hydrological analysis (historical and current day)
- Water balance (comparing annual or seasonal availability and requirements)
- System analysis (based on infrastructure operation at a specified assurance of supply)
- Water quality assessment (point and nonpoint sources impact on instream quality)
- Flood Risk Assessment

Other potential studies in some basins include:

- Hydropower analysis (linked to energy strategy)
- Navigation requirements (linked to transport strategy)

The process of analysis typically goes through a number of stages, with a comprehensive broad screening (shallow) assessment of all issues, leading to more detailed (deeper) thematically and geographically analysis of specific issues of concern. The historical and present-day situation is the focus of these assessments, but projections of possible trends and future impacts are often included in the analysis process, to inform the scenario-building process. It is important to recognize that the reconciliation of water availability and demand is often built on uncertainty (even without climate change possibilities), because inadequate historical water resources monitoring might restrict the understanding of water availability, and inadequate monitoring of actual water use and restrictions to availability might disguise the demand. The analysis however needs to drive towards confidence in the estimates, rather than reflecting uncertainty alone. A final, but critically important, dimension of the water resources assessment relates to monitoring and information systems, which provide the basis for adaptive management and review. The adequacy of these systems must be assessed against the information management need of the basin.

ANNEXURE XII: NATIONAL LEVEL BEST PRACTICES

Best practices on adoption of Drip and Sprinkler irrigation Hiware Bazar, rotational canal operation in Chambal Project in Madhya Pradesh, scheduling water distribution system in Khadakwasla in Maharashtra, automatic canal operation in Majalgaon project, Narmada Canal Operational Plan in Gujrat, Tungabhadra Project in Karnataka are described below.

Hiware Bazar (Maharashtra): A Water-led Transformation

Hiware Bazar lies across 977 hectares (ha) at the foothills of the Sahyadris. The village receives only 300-400 mm of rainfall a year. Over time, with steady degradation of their forest land, villagers found themselves with little water available post the monsoon. Without water to irrigate their fields, villagers began to migrate to cities. Those that remained cut down remaining forest land for firewood and sustenance. Preparation and sale of illicit alcohol became a source of income, and alcoholism and crime were rife. Over 90 percent of families lived below the poverty line (BPL). To combat these on-going problems in the village the elected Sarpanch took the responsibility to improve the conditions. Under his leadership the village drew up a plan based on priorities set by villagers themselves – with the top priorities on safe drinking water, irrigation water, employment, education and health. The village is now in the top income range in India, has safe water and sanitation for all, and almost universal literacy (compared to national average rural literacy of 69%).

Interventions and Impacts	1991 scenario	2011 scenario
Area under Irrigation (ha)	125	650
Area under Irrigation in non-monsoon period (ha)	1-2	80
Cropping Intensity (%)	94	164
No of dug wells	97	284
Area under drip irrigation (ha)	0	250
Groundwater level	90-120	15-40

With more assured irrigation and therefore lower risk, farmers began to invest more in their land such as by building additional water storage structures. Some families that had migrated returned to the village. Many farmers used their increased agricultural earnings or took loans to buy cattle. The re-vegetation program, as part of watershed development, has increased availability of good quality grass which has in turn contributed to increased milk yield. Today dairying is an important mainstay of their economy. What is most striking about Hiware Bazar's growth is that most families gained from it, either directly or indirectly. Today the village has only three BPL families. Moreover, a commitment to sustainability helps ensure that benefits secured are not lost. Prudent water management coupled with crop planning guarantees drinking water year round, and agriculture and dairying are maintained as far as possible, even in low rainfall years.

Villagers also built trenches along contours in the hills to trap and slow rainwater runoff. Along natural drainage lines, they built shallow dams of stone, cement or earth. To allow groundwater stored in the upper reaches of the village to reach farms downstream, villagers undertook an 'aquifer blast' - a controlled underground explosion to create cracks for groundwater to flow through. In 2011, when rainfall was barely 200mm, villagers collectively decided to reduce area under rabi cultivation and not grow a summer crop. One acre of rabi crop was permitted per private well. Further, more water-intensive wheat was replaced by less water-intensive vegetables. In general, the use of drip irrigation is encouraged as it saves 50 percent of water use, though it is costly.

Water budgeting and crop planning

To institutionalise sharing of water, the village introduced a practice of water budgeting about five years ago. Using a 'water bank' principle, the budget ensures that the village does not draw more water than it stores in a year, and a small amount is kept in reserve (see Figure 2). Depending on rainfall in that year, available water is allocated amongst various uses, with first priority for drinking water for humans at 50 litres per capita per day (lpcd) and cattle (30 lpcd).

Figure 2: Hiware bazar's water budget (crore litres)

	2009-10	2010-11	2011-12
Total rainfall (mm)	427	387	199
Total available water	417	378	194
From available water, exclude:			
Total runoff	31	23	
Evaporation loss	146	132	68
Runoff + Evap (% of available water)	**42**	**41**	**35**
Remaining water is in:			
a. Surface water storage	21	19	10
b. Ground water recharge	42	38	19
c. Soil moisture	125	113	58
d. Artificial groundwater recharge	52	53	29
Actual available water for use (a+b+c+d)	**240**	**223**	**116**
Required water for village (e+f+g)	**234**	**211**	**110**
e. Drinking water need (human & cattle)	4	4	3
f. Agricultural needs	*226*	*203*	*104*
g. Water needs - other uses	5	4	2
Surplus/Reserve water	**5**	**12**	**6**

Source: Hiware Bazar *panchayat*

In low rainfall years, water for agriculture is adjusted. To aid crop planning, the village has evolved rules-of-thumb:

Rainfall (mm)	*Allocation*
< 100	Drinking water only
100-200	*plus* kharif crop
200-300	*plus* rabi crop
> 300	*plus* summer crop

Source: Indian Water Portal

Chambal Project in Madhya Pradesh

The Chambal project is a multipurpose project, a joint venture of the states of Madhya Pradesh and Rajasthan. It is comprised of a cascade of reservoirs, i.e. the Gandhisagar reservoir in Madhya Pradesh, the Ranapratapsagar reservoir in Rajasthan and the Jawaharsagar reservoir in Rajasthan, (with a powerhouse at the foot of each of the reservoirs), and of a terminal barrage at Kota in Rajasthan, which has two main canals for irrigation purpose. Total installed capacity of hydropower generation at the three dams is 386 MW. The state of Madhya Pradesh is served by the Right Main Canal (RMC), which cuts across Rajasthan for about 130 km, then crosses over the Parvati River and enters Madhya Pradesh with a design discharge of 110.4 cubic meters per second (cumecs) at the Parvati aqueduct. The entire Chambal command area has been divided into seven administrative divisions, namely Sheopur, Sabalgarh, Joura, Morena, Ambah, Gohad and Bhind.

The Chambal project was commissioned in 1961-62 with a projected irrigated area of 283 500 ha annually (85 050 ha for kharif and 198 450 ha for rabi crops). The maximum irrigation achieved so far was 188 307 hectares in 1977-78, and the minimum 124 016 ha in 1982-83. The average area under irrigation over the last fifteen years is of 148 000 ha. Large areas at the tail-ends of the Ambah Branch, Morena

Branch, Bhind Main canal and Mau Branch canal have not received the benefit of canal irrigation since the commissioning of the project.

In the present system of operation of the Chambal canal network, the availability of water at the beginning of the rabi season, i.e. on 15 September, is assessed. In the Chambal command area, water is allocated from crop season to crop season, through an announcement called `Sinchai Ghosna', which is issued before or on the eve of the crop season and contains figures of areas to be provided with water at the subdivision, block, tehsil, assembly and branch-distributary levels. The names of the villages to be irrigated, and in each village of the channel and the reduced distance from the heads up to which water will be provided, are also indicated. During the first fortnight, the Right Main canal with all distributaries under its direct command, the Lower Main canal, the Morena Branch, the Bhind Main and the Mau Branch canals are supplied with water. During the second fortnight, while they continue to get water, the Ambah Branch canal in turn is supplied but all the direct command distributaries on the Right Main canal are closed. During the third fortnight, the Right Main and Ambah Branch canals with all their direct distributaries are supplied with water. The minors, sub-minors and fields get their water by adjustments. Although the announcement is made at the start of the rabi season, it has not been possible, so far, to really supply the allocated water and the tail-end users have always suffered. An analysis of pattern of deliveries at the Parvati aqueduct indicates that the supplies have wide fluctuations daily, monthly and yearly, and also vary according to the crops. Due to the unreliability of flows, many farmers are left guessing as to the quantity and timing of the supplies they will receive.

A part of the Chambal canal system in Madhya Pradesh has been selected for a UNDP-funded pilot project, in the Sabalgarh administrative division, and in association with the local Central Water & Power Research Station.

Khadakwasla Project in Maharashtra

The Khadakwasla irrigation project consists of three dams, viz. the Tanaji Sagar dam (Panshet dam) on the Ambi River, the Veer Pasalkar (Warasgaon) dam on the Mose River and the Khadakwasla dam on the Mutha River. The Khadakwasla dam is located downstream of the confluence of the Ambi and Mutha rivers, some 17 km west of Pune city, near the village of Khadakwasla. The New Mutha Right Bank canal is a contour canal, with a design discharge capacity of 58 cumecs. It is planned to irrigate 97100 ha of gross command area, with 62146 ha of irrigated area over the district of Pune. The command is covered by 60 distributaries off-taking either directly from the canal or from the Bhigvan branch (located about midway along the canal) and the Indapur branch in which the New Mutha Right Bank canal tails.

The New Murtha Right Bank is a long canal, and the effect of a change made in the release of water at its head will take time to be felt at the distributary heads downstream. A rough estimate is that it will take about 24 hours for a change made at the head to get transmitted down to the tail. When a canal has to be run with requirements down the line changing from day to day, operation becomes complicated for the following reasons:

(i) Changes have to be made in the releases at the head of the canal in anticipation of the change of demand (closing of running distributaries and opening of new ones) and associated travel time to the various distributary off-takes.
(ii) When level changes occur down the main canal as a consequence of a change in release at its head, the discharge into the distributaries will change. Therefore, unless close watch is kept on distributary off-takes and gate settings are adjusted, deliveries into distributaries will not match what is planned. The operating staff will tend to play safe and ensure that their distributaries are drawing more than what is strictly required.
(iii) Gate settings at cross regulators will need to be adjusted to reduce fluctuation in water levels in the different sections of the canal. The frequency of adjustment will depend on how releases into the canal change to satisfy the changed demands at distributary off-takes.

The decision on the release of water into the New Mutha Right Bank canal from the reservoir is taken at the main administrative headquarters, i.e. in Pune, which must decide whether it is appropriate to release

the entire amount of water determined based on the requirements arrived at from the operational schedule received from the field, or to cut down on the requirements. The decision will be made in the light of the current storage available in the reservoir and of an assessment of the likely demand and inflows in the reservoir for the rest of the season, and of the storage that is desirable at the beginning of the next season.

The water delivery system as practised in the state of Maharashtra is known as the shejpali system. In this system, at the beginning of the season the farmers make applications in prescribed forms for the irrigation of specific areas. The Department of Irrigation accedes to the requests depending on the availability of water and other relevant factors. In the shejpali irrigation delivery system, the distributary is considered as a unit, i.e. with all minors and sub-minors if any is running for the same number of days as the distributary. The irrigation schedules are prepared taking into account more or less uniform characteristics of the command, as it is very difficult in practice to calculate the demand based on the condition of the various fields in the command. In the shejpali system, the Department of Irrigation commits itself to providing adequate water at the outlet to meet the irrigation requirement of a crop till maturity. What is adequate for the standing crop in the field is decided by the farmer and the effectiveness of irrigation is judged by the degree to which the irrigation department is able to fulfil its commitment to the farmer. For the success of this system, it is necessary to have reliable irrigation supplies at least at the head of the distributaries.

The pilot project is conceived as one unit, integrating telemetry, communication, computers and decision support software to improve system operations. It covers the operation of the New Mutha Right Bank canal and its distributaries. Three agencies, i.e. the Department of Electronics of the central government, the Department of Irrigation of the government of Maharashtra and CMC Ltd. are associated in the project.

The Majalgaon Project in Maharashtra

The Majalgaon irrigation project is located in the Marathawada region of Maharashtra, south-east of Aurangabad, in the valley of the Godavari River. It constitutes the downstream part of the Jayakwadi project, which is planned to irrigate about 350000 ha of cultivable command area. In this region, the Paithan dam on the Godavari has a gross storage capacity of 2950 Mcm, supplying water to the Paithan left bank and right bank canals, and the Majalgaon dam on the Sindhphana river, with a gross storage capacity of 450 Mcm, is supplying water to the Majalgaon right bank canal. The runoff of the Sindhphana basin is insufficient to meet the water requirements of the Majalgaon project, and shortages are to be supplemented by additional releases from the Paithan dam.

Compared to other Indian states, Maharashtra is poorly endowed in water resources. Even with full exploitation of the available water resources, the total area that could be brought under irrigation, including well irrigation, would be about 34 percent of the total cultivable area. The water delivery schedule popularly known as the shejpali system has been in practice in the state for over fifty years.

In its present form, any change made at the head of a canal to suit the changing demands down below takes a long time to be felt at the distributary. If there are frequent changes in the demands on the distributary, the releases at the head reach must be changed accordingly, and unless a very close watch is kept on the distributary off-takes and there are frequent gate settings adjustments, the deliveries in the distributaries will not match what is anticipated.

To overcome the problem, the government of Maharashtra has implemented a system of volumetric water distribution to the farmers' association on the Majalgaon project. This requires that the volumes, flows and levels in the main and branch canals be controlled to suit the operational philosophy. Improved water control with the help of constant water level gates, baffle distributors and remote monitoring and real-time computer-assisted management control has been executed on the Majalgaon project.

The government of Maharashtra has introduced a pilot project to improve water control management on the Majalgaon Right Bank canal from Km 0 to Km 165 in two successive phases. The first phase has covered the entire 100km length of the canal and the entire length of its Ganga Masla branch. Technically it consists of a combination of control and regulation techniques associated with remotely monitored computer-assisted control on the main canal and local control using float gates, long crested weirs, baffle distributors and self-regulated outlets on GMBC distributaries and minors.

The Majalgaon Right Bank canal has a design discharge capacity of 83 cumecs at its main head regulator. Ten cross regulators are planned over its 100 km. The Ganga Mala branches off at about 8 km on the Majalgaon Right Bank canal and has a designed discharge capacity of 9 cumecs. Upstream control with avio gates and baffle distributors at the head gate of the Ganga Mala branch, along which nine duckbill weirs have been installed over a 13km stretch for improved water control. The length of weir is about 50 m for a discharge of 9 cumecs.

The constant volume concept of operation will be used on the Majalgaon Right Bank canal. When it will be extended beyond Km100 and the demand of irrigation water at main-head regulators will increase beyond 60 cumecs (as against a designed discharge of 83 cumecs), the canal will be operated on the concept of controlled volume.

At each remote location, remote terminal units will be installed. Sensors will measure water level upstream and downstream of the gate and at the centre of the pool. The gate position sensor will sense the position of each gate in the control structure. Data will be transmitted by radio. The main control centre will be located at the Majalgaon dam site and will have the usual hardware and software necessary for remote monitoring and control functions.

Water will be supplied by volumetric allocation with a rotational water delivery system. User associations, covering an area of about 200-300 ha, will receive water from the canal system and will distribute it to their members on a rotation basis.

The second phase will be implemented on the remaining part of the Majalgaon Right Bank canal and its distribution system, based on experience gained in the first phase. The pilot project is carried out under an Indo-French co-operation programme in water resource management. The government of Maharashtra, in consultation with the French consulting firm Gersar, has implemented the first phase of the project at a cost of Rs136.7 million.

A pilot project of “dynamic regulation” has been selected for the Majalgaon right bank canal, covering 100 km in length for the main canal, 18 km for the Ganga Massla branch canal and its distribution systems.

The initial cost estimate of the pilot project, at the 1992-93 price level, was Rs30 million plus 7.3 million French Francs. At the conversion rate of FF1 = Rs7.5, the total estimated cost of the pilot project was Rs84.75 million.

The detail of expenditure incurred on the various components of the pilot project is as follows: Rs17.8 million for civil engineering works, Rs28.7 million for mechanical engineering works, Rs90.1 million for electrical and electronic components. This means a total expenditure of Rs136.6 million. The cost of dynamic regulation works out at Rs1 663 per ha on the Majalgaon canal, Rs2 961 per ha on the Ganga Massla branch canal and Rs3 755 per ha on the Minor branch canal.

The cost of canal automation on an existing irrigation project and on a new project cannot be compared, as the built-in constraints in an existing irrigation project will not only limit the degree of automation but also increase the cost by way of remodelling the existing canal systems. It can be concluded that the cost of automation on a main canal can vary from Rs1 500 to Rs2 000 per ha and that on a secondary canal from Rs3 000 to Rs4 000 per ha.

The cost of improved water control methods depends on the degree of automation desired. Even though supervisory control may amount to about one and a half percent of the project cost, it is not desirable to directly employ the said technique. When new technology is applied, one must keep in mind that high technology by itself has not been found to be very effective. It has to be matched by a proper environment and by proper user response. A farmer can receive the maximum possible benefits if there is flexibility in water distribution in terms of frequency, rate and duration. But this may not be practicable in our irrigation canal systems, as water has become a scarce commodity. If we are in a position to offer reliable water supplies to the farmers for irrigation, the goal to improve our water management plan can be considered as achieved. Water management is now viewed as a scientific art.

Narmada Canal Operational Plan

The Sardar Sarovar (Narmada) project, currently under construction, is one of the largest multipurpose water resource development projects in India. It will consist of a large concrete gravity dam on the Narmada river in the state of Gujarat, a riverbed powerhouse (underground, with an installed capacity of 1200 MW), a canal-head powerhouse (surface, with an installed capacity of 250 MW) and a widespread network of canals and drainage channels as required to irrigate about 1.792 million ha of land out of the 3.428 million ha of the gross command area.

Operation of the Narmada canal system:

Canal operation in general centres on the pivot point of the canal pool's water surface. The pivot point is the location within a canal pool at which the depth remains constant while the water surface slope varies. The Narmada canal system is planned to be operated on a controlled-volume basis by managing the volume of water contained in each canal pool. There is no well-defined pivot point. The volume can be made to change to satisfy operational criteria, allowing the pivot point to move within the pool. The water surface may sometimes rise or fall without a pivot point, like a reservoir. Since the operation is based on volume, either flow or depth may be used as the measured quantity. The Narmada canal system is also planned to work on the upstream operational concept. The upstream operational concept is used when the upstream conditions or supply dictate how the system is to be operated. As the availability of water for irrigation is limited to the availability of water in the Sardar Sarovar reservoir, the upstream operational concept is used.

The operation of a canal system is accomplished primarily by controlling the flow through the check structure. Flow charges which are initiated by gate movements create the translator wave phenomenon. The Narmada canal system is planned to be operated by the simultaneous control structure operating technique. Adjusting all the canal check structures simultaneously can establish the new steady state flow condition in the canal system in the shortest possible time.

The Narmada canal system is planned to be operated using the supervisory automatic control method. The supervisory control method involves monitoring and control of the control structures from a central location referred to as the main control centre. Monitoring is the collection of data from various sites on the canal system and the presentation of this information for use in determining control actions. Data such as water level, gate positions, flow and pump status are collected at each remote location, including check gate structures and pumping plants. The information collected at all remote locations is transmitted to the control centre, where it is analysed and presented in a suitable format. Control commands are then transmitted back to the remote sites, creating control actions such as gate movements. Supervisory control enables control decisions to be based on comprehensive information. A change in any portion of the system can be recognized promptly and the appropriate control action taken. This capability maximizes the operational flexibility of a canal system.

The system is also planned to be operated on the upstream control concept. The control concept in general is defined by the location of the information needed for control relative to the control structure. This information can include the flow, depth or volume at one or more points in the canal system. In the case of the upstream control concept, the control structure adjustments are based on information from

upstream. The required information could be measured by a sensor located upstream or based upon the upstream water schedule established by the irrigation management authorities. Upstream control transfers the upstream water supply (or inflow) downstream to points of diversion or to the end of the canal and is compatible with the upstream operational concept.

The Narmada canal system is thus planned to be operated on the controlled volume method with an upstream operational concept. The control action is initiated with an upstream control concept and with the supervisory automatic control method. The simultaneous control structure operating technique will enhance the canal operation. Based on these, for the purpose of irrigation management it is proposed to divide the 3.428 million ha of gross command area into blocks of approximately 26 000 ha. The irrigation management data for each of the blocks will be collected by a data collection centre, using very high frequency radio. One hundred thirty-two such centres are planned. They will communicate data required for the regulation of branch canals to divisional operational centres, which will be in charge of branch canals. Taking into account the limitations imposed from a hydraulic and canal operation point of view, 15 divisional operational centres are planned. They, in turn, will report to the main control centre, which will be in charge of the overall operation of the Narmada canal and will be located near Gandhinagar.

The Narmada canal conveyance and delivery system of up to 8.5 cumecs designed discharge capacity has been planned and designed to be operated on the controlled volume operational method with remote monitoring and control system for its operation. The construction of the canal conveyance and delivery system in Phases I and II of the project area is in full swing. The work in Phase I is about to be completed. One divisional operational centre in Phase I of the command area will be selected to carry out the pilot project. It will cover about 100 km in length over the canal system with some 120 flow control gates and about 0.15 million ha of irrigated area. The Sardar Sarovar Narmada Nigam Co Ltd, in consultation with experienced consultants, will take up the task of implementing the pilot project in the near future.

The feasibility study presented in April 1990 by the Gujarat Communications & Electronics Co Ltd on a control and communication network for the Narmada canal proposed a supervisory control system based on the controlled volume concept. The Narmada main canal has a designed discharge capacity of 1134 cumecs at its head tapering down to 71 cumecs at the Gujarat-Rajasthan border and it would be operated on the automation concept. The main canal has 42 branch canals. Most of them would have a designed discharge capacity of more than 8.5 cumecs. Optical fibre would be the communication medium. A canal network with a designed discharge capacity of less than 8.5 cumecs would be operated by local manual control. Information on irrigation water demand would be sent to a data collection centre through very high frequency radio. The data collection centre would be the terminal point at which the design discharge capacity of the canal system would be of 8.5 cumecs. The cost of the control system, which includes the cost of the communication system up to the village service areas, was estimated at Rs1 970 million, for a total project cost of Rs64 800 million.

As the command area of the project covers 1.863 million ha, the cost per hectare works out at Rs1057. This figure can go up if the project authority decides to extend the canal automation to the grid with a discharging capacity below 8.5 cumecs. It is difficult to come out with a realistic figure of the cost of canal automation until automation has been implemented. Also, in the case of this project, the cost of civil, mechanical and electric works incurred for the control structures is not included in the cost of canal automation, as it is a component of the overall project cost.

The Tungabhadra project in Karnataka

The Tungabhadra project was conceived and executed to serve the chronically drought-prone districts of Raichur and Bellary of Karnataka, and the Anantpur and Kurnool districts of Andhra Pradesh. To manage this project the Tungabhadra Board was constituted by the Government of India in 1955. From the 2300 Mm3 of water expected to be developed by the project on average over the long-term, Karnataka receives 1515 Mm3 and Andhra Pradesh 785 Mm3.

The Tungabhadra project involves three main canal systems, viz. on the right side (both a low-level unlined and a high-level lined canal systems) and on left side (lined canal system), running for a total length of 750 km and covering an irrigated area of more than 0.5 million ha.

The present canal operational procedure is based on the following principles:

i. Canal capacities are designed for average duties. If a canal serves areas of mixed crops, its capacity is sufficient to provide authorized discharge for the seasons with the maximum requirement. In other seasons it is operated at a reduced discharge.

ii. Continuous flow is provided to the outlets so that, in principle, canals run continuously to provide a specified discharge to the controlled outlets. If a full supply is not required, then its discharge can be reduced.

iii. Variable supply and flexibility are important operational objectives since variable discharge may be required at any level, either to serve different localised areas in different seasons or to meet different crop requirements within a season.

The flexibility provided in the present distribution system requires that gates at every control structure be adjusted to respond to variable flows in the parent canal. For the system to work, it is necessary that the gate operators perform their duties correctly and on time, and that there be no interference in the gate setting or in the flow regime of the parent canal.

The pilot project has been executed in the state of Karnataka on the right bank high-level canal up to the Karnataka-Andhra Pradesh state border. In this task, four agencies are associated. The Central Water Commission of the government of India, the Tungabhadra Board, and Bharat Electronics Co Ltd, in consultation with USAID experts, have executed the pilot project.

From the above case studies it can be noted that the Central Water Commission and the Department of Electronics of the central government, various state governments and public- and private-sector companies have entered programmes to improve water management on existing water resource projects by involving engineers and scientists from various disciplines, all of them with the goal to satisfy the desire of end-users for reliable and timely delivery of irrigation water. With the improvement in water management now being planned, it will be possible to improve the irrigation efficiency at farm level and operational ease and flexibility at project level.

Best Practice of Bench marking in Rajasthan

One of the issues in irrigation sector in Odisha is bridging the gap between the irrigation potential achieved over that created. The Benchmarking process involves identifying certain common parameters among similar irrigation systems, and choosing the best or an Ideal Irrigation System which excels the other systems (with reference to the identified parameters), and then comparing with the ideal system so as to find how best the other system too could be brought at par with the ideal project. This is a continuous process in which efforts are made to bridge the gap among similar irrigation system in the range. The performance evaluation and benchmarking of irrigation systems both ultimately aim at maximizing the crop production per unit of the command area or per unit of the available water.

Benchmarking is a process of “introspection” since it is a continuous of measuring one’ own performance. Benchmarking has also broad application in problem solving, planning improvement etc. In the irrigation sector that would mean more productive and efficient use of water i.e. “more crop per drop”. Benchmarking process, an important tool, is proposed to be increasingly used in irrigation sector so as to improve water use efficiency and management of irrigation projects.

Irrigation projects have been designed and constructed with some parameters as quantity of water to be received, irrigation to be achieved, irrigation to be done, losses in canals etc. But during the course of time, it is observed that the irrigation projects are not performing as per designed parameters and there is a big gap between perception and practical achievement of project. Benchmarking is the process

of studying the existing system & to the net deficiency and suggests the strategy to bridge the gap between designed parameters and actual achievement so as to maximize the use of available water. It also includes the methods / study to be adopted for increasing inflow in the structure without effecting adjacent structures adversely.

Performance Indicator	Estimated Values
Water delivery capacity	0.74
Total annual volume of irrigation supply	1.02
Field application efficiency	39.8%
Annual Relative Irrigation Supply	3.85

Benchmarking of 20 major and medium irrigation projects were carried out by Water Resources Department, Rajasthan. Estimated values of some important performance indicators of Udaisagar Project are in the adjacent box.

Cost aspect of canal automation in India, based on case studies

Economic and financial analyses should not be limited to only the costs and benefits associated with operating the project facilities. Improved irrigation systems and better water management by way of automated irrigation canal systems provide each farmer with the ability to improve his on-farm management through flexible scheduling. Cost savings to the farmer and benefits from increased crop yields, better quality of products and ability to diversify crops must also be considered in the analysis.

The computation of the benefits of an automation project is quite complex. An automation project is undertaken to improve irrigation systems so that they can meet enhanced operating criteria. Usually this implies increased water volumes and improvements in conveyance, distribution and application efficiency. These, in turn, may require the re-dimensioning of some structures and, if enough water is expected to be saved and additional land is available nearby, may lead to an expansion of existing irrigation projects by increasing their command areas.

The decision to implement a control system should not be justified solely on tangible benefits. Intangible benefits are significant on most canal projects. Estimating tangible benefits and properly describing intangible benefits related to the need to upgrade a canal operation is essential when one examines the feasibility of a proposed automation system.

Implementing automation on new projects is a comparatively simpler task than on existing projects. Built-in constraints and limitations in existing projects must be identified, evaluated and answered on a project-by-project basis. As these constraints are different in each project, their economic evaluation will also differ. It is not possible to assess the cost of automation on existing projects by rule of thumb. In the case of a new project, one can estimate a two-to-three percent cost for automation. In reality, the cost of civil, mechanical and electrical engineering structures and components in water resources projects increases during the execution of the project, the cost of electronic components either remains at the same level or decreases; thus, cost figures may come down when the cost of the completed project is considered.

Conclusion

The management of irrigation systems has gained importance over the last five decades due to a tremendous increase in irrigated area in India, primarily as a result of massive investments in new and existing surface irrigation projects. There has been a growing realization of possible improvement in water management for a more efficient use of available water resources. The potential of information technology applications for improved irrigation system management was realized long ago, but concerted efforts on this front have only been made in the last ten years. The use of computers,

communication and information to control irrigation systems will yield many benefits, resulting in obvious economic savings and in intangible benefits whose value cannot be measured in monetary terms.

Water is no longer defined as a natural resource but as a commodity, the value of which has been recognised both at administrative and farm levels. Unless reliability in irrigation is achieved, all other efforts to boost the irrigated agricultural sector will not reach the required goal. With limited water resources, it is now the responsibility of the engineers to create water which can be used on farm by reducing the operational and conveyance losses in the system.

Inadequate water in quantity, time and space is the primary constraint on agricultural production. However, when water reaches an outlet in an irrigation system, we cannot afford to remain despondent or indifferent to its proper distribution. Experience teaches us that inefficient water management below outlets not only results in lag of use, but also leads to serious legal complications due to inequity in water distribution. Normally, tail-end users are those who do not get their legitimate share of water. Furthermore, the farmers generally irrigate their farms with as much water as possible and as frequently as possible whenever water is available. This practice cannot be continued when water for irrigation is insufficient. Application of more water to crops does not necessarily mean better yields; on the contrary, it may lead to problems of waterlogging and thereby adversely affect crop yields.

There is considerable interest among farmers in technologically and economically advanced countries over the use of personal computers to implement their own irrigation scheduling programmes. Data collection equipment gathers necessary details about evapotranspiration, rainfall and irrigation. The irrigator selects the parameters of allowable soil water depletion and application depth. Irrigation scheduling forecasts the date and amount of the next irrigation, but does not check the ability of the distribution system to supply the required flow.

Though the below-par performance of an irrigation system is primarily attributed to inefficiency in water distribution below the outlet, it is not the only factor. Problems also lie in the main system operation, and reliable supply of water to the outlet is indeed a prior requirement for success of any management scheme below outlet. Water conveyance could be readily made automatic from the main canal headwork for the scheduling of irrigation at farm level. It requires linkage of the actual requirements of the irrigated crop or plant to the farm outlet as well as to the source of supply.

Recent advances in irrigation have related irrigation scheduling to the complex climate-crop-soil relationship. Increased knowledge of soil and plant characteristics combined with better methods of measuring soil moisture content and estimating soil moisture depletion are available to predict with greater accuracy the time and actual quantity of water needed for the next irrigation. The sensor element for measuring the prevailing soil moisture content could be a commercially available instrument or even a trained technician. The information could then be fed into an automatic data-processing digital computer which has available in its memory the information concerning the characteristics of the soil such as its moisture-holding capacity, the type of plant and its maturity, an estimate of evapotranspiration and many other parameters which may affect the quantity and timing of the next irrigation. A digital computer using many reference inputs determines the irrigation schedule, which is then provided to the computer centre controlling the canal conveyance and delivery system to update the weekly and daily schedule of irrigation as set up at the start of the season, based on the data available then. Thus the assessment of water needed to be released into the main canal can be forecast on a scientific basis, and this will allow a more flexible operation of the canal system. Linkage of real-time data collection and monitoring of the climate-, crop- and soil-related parameters with the canal automation of the conveyance and distribution system is the ultimate goal, and use of information technology below outlet level will be assigned equal priority. The scientific use of water to satisfy crop water requirement should be an integral part of irrigation and agricultural plan.

ANNEXURE XIII: INTERNATIONAL LEVEL BEST PRACTICES

Oakdale Irrigation Project

Following a comprehensive evaluation of system performance, Oakdale Irrigation District (OID), Australia, embarked on a program to modernise their gravity distribution system. In particular, they aimed to reduce outfalls and improve service by reducing fluctuations in channel water levels. With stable water levels, OID would be able to provide more consistent flows at customer service points and channel offtakes supplying downstream districts. As part of its modernisation program, OID identified two key channels where improved control would realise significant benefits:

The 10 km Claribel channel, which has 17 pools and supplies water to 75 farmer service points and four channels off takes. It was a priority for OID to significantly reduce annual outfalls of more than two gigalitres, while ensuring that customer service was not adversely affected. The 14 km Cometa channel, which has 13 pools and a channel slope of up to 0.8%. This swift moving channel required frequent operator adjustment to supply water to 21 farmer service points, seven channel offtakes and two separately managed downstream districts. It was difficult to meet required flow set points for downstream districts while maintaining stable water levels at all farm service points using traditional methods. On both the Claribel and Cometa channels, Rubicon implemented a Network Control solution, which is one of a range of solutions built from our TCC® (Total Channel Control®) technology. This involved replacing 42 gates in 30 structures with Rubicon FlumeGates™. OID also automated six service points along the Claribel channel with Rubicon SlipMeters™.

Key elements of the solution included a server running Rubicon's SCADAConnect® software and NeuroFlo® network control software, the brains behind the coordination and automatic control of the entire network of FlumeGates and SlipMeters. Communications were supplied using a Rubicon telemetry network.

The Network Control solution automatically coordinates all the regulators in the two channels so that the water passed through any regulator exactly matches measured outflow at all points downstream.

All regulators are in constant communication with other upstream and downstream regulators and with the server, sharing information about water levels and flows along the length of the channel in real time. This means that water level fluctuations are minimised, ensuring high flows and service levels to all farms along the channel.

This had impacts like the outfall reduction, water level control, service to irrigators and delivery of flow commitments at offtakes have all greatly improved since the implementation of Rubicon's Network Control solution.

Over-extraction of water from the Murray River has led to the degradation of many areas of significant environmental value along the river's 2,500 km. Poor management practice has led to increased salinity of water in such areas. The river basin is also home to an agricultural area that produces over one-third of Australia's food supply. The Living Murray program was established to restore health to key areas of the river system through environmental water recovery, while balancing this with the competing need for sustainable agricultural production. A key focus of the program was the modernisation of inefficient irrigation infrastructure.

The Shepparton Irrigation Area, typical of many areas in the basin, lost 30% of the water it diverted from the river during transmission. It also provided a poor service to irrigators, which resulted in inefficient on-farm water use. The main problems include; conservative (generous) channel regulation and manually controlled regulators resulted in water in excess of farmers' needs being spilt out the end of the channel

system, oscillating channel water levels resulting in inconsistent flows through service points, inflexible operations resulting in crops not getting water when needed.

Using a radio telemetry network, Shepparton's FlumeGates are in constant communication with adjoining FlumeGates and with a central server, sharing their accurate measurements of levels and flows in real time.

NeuroFlo software uses this information and detailed mathematical models of hydraulic behaviour in each reach to coordinate the control all the FlumeGates in the network. Only the exact amount of water required to meet downstream needs is released. By matching delivery with demand, spills are eliminated and water level fluctuations are minimised resulting in consistent high flows for farmers.

The two year Shepparton modernisation project was completed in late 2009 and has resulted in major operational improvements given below

- Delivery efficiency improved from 70% in the 2007/08 season to 90% in the 2010/11 season
- Improved management control and planning with rich, real-time information
- Compliance with new metering and reporting regulations demanded by government
- Farmers benefiting from a reliable system with delivery almost on-demand, which means they can now maximise the productive output of every litre of water used
- Greater water use accountability, transparency and distribution equity for all stakeholders

The 29% improvement in delivery efficiency has resulted in the annual recovery of 39 giga litres of water. Of this, 29 giga litres have been permanently transferred to the Living Murray program for environmental use. This water is retained in storage and is periodically released into the river system in a controlled manner to maximise environmental benefit to downstream wetlands and lakes.

Fen River Irrigation, China

The District in China's Shanxi province consists of two reservoirs and three weirs diverting water from the Fen River into five main channels for irrigation and industrial uses. In recent years the province has faced serious water shortages resulting from drought and growing demand from domestic and industrial water users.

Built in 1950, the district's infrastructure mainly consists of manual control gates and almost no flow measurement. The distribution efficiency of the system, which includes farm channels, is estimated to be around 45%, meaning most water is lost before it reaches farmers' fields.

However, in recent times greatly reduced inflows have meant that the district has struggled to supply water to irrigators reliably and equitably. Shortages are now common, particularly for irrigators whose farms lie furthest downstream.

A series of central government directives requiring irrigation district modernisation provided the catalyst for the Fen River Irrigation Authority to look for a solution. The Water Reform and Development Plan required districts to improve distribution efficiency through infrastructure modernisation, which had traditionally involved lining channels with concrete and replacing control gates. Additionally, the Rural Water Information Transformation Plan required districts to introduce automation, metering and comprehensive data collection by 2020.

NeuroFlo® software coordinating and controlling the gates to optimise the delivery of water and eliminate spills and SCADAConnect® would provide -

Impressed with the performance of the pilot installation, Fen River authorised the China Irrigation and Drainage Development Center (CIDDC) to assess the pilot project and compare the costs and benefits

of implementing Network Control throughout the district with the alternative of lining all channels and replacing existing gates with new manual gates.

The CIDDC report found that Network Control:

- Would provide farmers with an equitable, reliable and flexible water supply
- Could improve efficiency by up to 20%.
- Could be implemented at 25% of the cost of channel lining and would enable the easy identification of high-loss areas of channel for targeted lining.
- Could be deployed much more quickly than traditional channel lining and gate replacement.
- Was the most effective way of reducing losses. The cost of each percentage point improvement in distribution efficiency for Network Control was 1.9 million RMB ($300 000) compared with 8.9 million RMB ($1.4 million) for lining all channels with concrete.
- Should be used by other large irrigation districts to enable them to meet their modernisation objectives.

CIDDC concluded that Network Control should be implemented throughout the district. In late 2016 Fen River completed installing Network Control on the 56km East Main channel and a 17km secondary channel.

Murray-Darling Basin Management, Australia

There are approximately 14 sub-basins within the Murray-Darling Basin. The Ministerial Council of the Commission has agreed that specific water resource use and protection plans will be developed by the member-state(s) in which the sub-basin is located, but in accordance with the overall natural resource policy and planning approach. Therefore, a single Murray-Darling Basin Sustainability Plan does not exist. There are 14 sub-basin plans, which collectively achieve the same purpose with a much greater local focus.

The Murray-Darling Basin Commission (MDBC) is principally a coordinating basin agency that oversees planning and management activities to ensure the realization of basin objectives. Thus it does not do any of the planning itself. This is the responsibility of the member-states. Since the level of community awareness regarding natural resource issues is very high, the states have all adopted very participative forms of water resource planning cantered around the sub-basins.

Each of the 14 sub-basins has a Catchment Management Committee or Board; in this context, catchment means the same as sub-basin. The Committees or Boards are comprised of community or stakeholders representatives, as well as technical experts from the various agencies operating in the sub-basins. The role of these boards is to prepare a natural resources sub-basin strategic plan and a set of priority action plans to implement the overall sub-basin plan. The Boards also prepare investment scenarios for the implementation of the action plans and negotiate with governments for the acquisition of the necessary funds. Major works, such as dams, weirs, or field reservoirs, are usually still funded directly by the government. Funds can also be obtained for these and other works from donors.

The planning process followed by the sub-basin Boards is very similar to that described above. The steps are as follows:

- Review data and analyse the condition or health of the basin's resources
- Develop knowledge on the degree of stress or impact that the key resource areas can withstand due to any increases in water development
- Identify the national, regional, and sub-basin goals and objectives
- Develop specific water and natural resource policies, procedures, plans, and strategies to guide how and when the resources can be utilized within the agreed stress limits (these policies may already exist from higher-level decisions at the national or state government level, or by the MDBC)

- Identify and then undertake the range of planning that needs to be done to respond to the higher-level policy decisions – at the sub-basin level and also at specific lower levels
- Obtain input from relevant groups and people in the sub-basin as to the appropriateness of the recommendations from all the plans
- Finalize the best mix of proposals at both the higher and lower planning levels and develop an investment plan for the priority projects
- Develop and implement a monitoring plan to ensure that the sub-basin plan is being followed.

To this end, caps or quotas have been imposed on the diversions in each sub-basin and the MDBC has adopted new policies to manage the basin's natural resources. A sustainable level of catchment health has been defined for each sub-basin and a range of targets and corresponding timeframes set to achieve these. Using a regular monitoring program, MDBC assesses how the states are managing each of the 14 sub-basins and seeks to establish whether the reductions in water diversions and the changes in land use practices and water use efficiencies are in fact achieving the improvements and the sustainability targets.

A set of policies has been agreed to by all members of the MDBC for four key resource areas or components. These are considered to be the best indicators of catchment health. These are:

- Water quality (salinity and nutrients)
- Water sharing (for both consumptive use and in-stream environmental flow requirements)
- Riverine ecosystem health (recognizing the essential needs of aquatic life)
- Catchment/sub-basin biodiversity (flora and fauna).

Compliance targets have been set for these in each catchment or sub-basin.

The views of the different stakeholders often conflict which inevitably means that the basin organization, the minister, or the agency responsible for river basin management must decide on a workable compromise after an appropriate level of consultation with all the stakeholders.

Issues to be debated include economic assets (such as those for supplying water for urban uses, irrigation, and hydropower), environmental issues (such as protection of wetlands, fish, birds, native vegetation), and social issues (such as poverty reduction, gender issues, community improvements, cultural sites and requirements, recreation use of water).

The Sub-basin (or Catchment) Management Committees/Boards, with expert help from the agencies working in the sub-basin, prepares the sub-basin plan. This plan includes a range of higher-level projects and programs that should be considered to move the health of the sub-basin resources in the direction identified by the MDBC. Many lower level land and water management plans that cover the smaller sub-catchments or integrated irrigation areas are also included.

Each LWMP covers an area of some 50 to 200 square kilometres. It may include works and measures aimed at increasing water use efficiency, farm productivity levels, and environmental health at the small catchment or water user association level. These lower- level plans are undertaken progressively and are ongoing. One important purpose of the LWMP is to offset the social and economic impacts by any water reallocations back to the environment mandated by the higher-level sub-basin plans.

This lower-level planning is best overseen or coordinated by those persons or groups that are directly affected by any changes in water allocation volumes, such as farmer groups (or Water User Associations), towns, and local industry. Murray-Darling Basin planning is one important international best practices of basin level water resources management.

ANNEXURE XIV: IMPLEMENTATION RESPONSIBILITY MATRIX

Action Points	Responsibility	Timeframe
Preparation of database on all completed and ongoing irrigation projects	All Irrigation Divisions under DoWR	2017-2019
Preparation of distributary wise maps and PP wise maps of all irrigation projects	All Irrigation Divisions under DoWR	2017-2020
Digitization of data and geo-tagging the projects/ important distribution points like head regulators, outlets	All Irrigation Divisions under DoWR, OLIC, Asst. Agriculture officers of all blocks, Joint Director Engineering of Dept of Agriculture and Farmers empowerment	2018-2022
Project/ Cluster wise irrigation management plans	All Irrigation Divisions under DoWR, OLIC, OAIC	2017-2019
Project/ Cluster wise cropping plans for short-term (year wise for next three years)	Asst. Agriculture officers of all blocks, Agronomists and Water management specialists in the office of DAO and DDA	2017-2019
Benchmarking	Addl. Director O&M	2018-2023
Climate Change adaptation related funding status	Chief Engineer, BPCC	2018-2019, 2022-2023, 2028-2029
Climate Change adaptation related program planning	Chief Engineer, BPCC	2018-2019, 2022-2023, 2028-2029
Installation of discharge monitoring sites	All Irrigation Divisions under DoWR	2017-2022
Capacity building of in service personnel of DoWR (1st round)	DoWR	2017-2022
Capacity building of in service personnel of DoWR (2nd round)	DoWR	2025-2030
Capacity building of in service personnel of Dept.of Agriculture and Farmers empowerment (1st Round)	Institute of Management of Agricultural Extension (IMAGE), ATMA, AAO	2018-2022
Capacity building of in service personnel of Dept.of Agriculture and Farmers empowerment (2nd Round)	Institute of Management of Agricultural Extension (IMAGE), ATMA, AAO	2025-2030
Capacity building of PP (1st Round)	WALMI	2017-2019
Capacity building of PP (2nd Round)	WALMI	2020-2022
Capacity building of PP (3rd Round)	WALMI	2023-2025
Capacity building of PP (4th Round)	WALMI	2026-2027
Hydrological Studies of major medium reservoirs	Chief Engineer, Hydrology Project	2020-2022
Assessment of water surface area and water volume for all minor irrigation tanks and preparation of detailed maps	Chief Engineer Minor Irrigation	2018-2024
Groundwater Recharge planning and execution	Chief Engineer Minor Irrigation	2018-2021
Increasing existing area in blocks to 35% where it is less	DoWR, OLIC, OAIC, DoA & FE, DRDA blocks, Gram Panchayats	2019-2025
Propagation of drip irrigation with target of 10% coverage of cultivable area	CADA, Agriculture and Horticulture officials	2018-2023
Laser Land Levelling with target of 50000 hectares in major and medium projects	CADA, Agriculture and officials, DRDA	2018-2028
Command Area Development (10,000 Ha/year)	CADA	2017-2026

Action Points	Responsibility	Timeframe
Preparation of Canal operation plans for Govt controlled canals in major medium projects	All Irrigation Divisions under DoWR under EIC	2017-2022
Preparation of Canal operation plans for Govt controlled canals in Mega Lift projects	All Divisions under Chief Engineer, Megalift	2018-2021
Preparation of Canal operation plans under PP	All Irrigation Divisions under DoWR	2017-2025
Preparation of Canal operation plans river lift projects	All Divisions under OLIC	2018-2023
Preparation of Canal operation plans for minor projects	All Divisions under Chief Engineer, MI	2018-2023
Preparation of operation plans for field channels (major medium)	All CADA Divisions under DoWR	2018-2030
Preparation of operation plans for field channels (MI division)	All Divisions under Chief Engineer, MI	2018-2023
Computation of Crop water requirement for command areas of different projects	Water Management Specialists under DoA and FE	Every Year
Monitoring	Director Monitoring (EIC Office), SE, Monitoring, Chief Engg MI Office, Executive Director OLIC, Addl Director CADA	Every Year
Revision of State Water Plan	Chief Engineer BPCC	2019-2022
Updated basin plans for all river basins	Chief Engineer BPCC	2021-2025
Watershed Level (Cascade) Water conservation and catchment treatment plan	PD Watershed at district level and State Watershed Mission, Chief Engg, MI	2020-2027
Rehabilitation and Modernization of MI Tanks	Chief Engineer MI	2017-2023
Construction of new tanks and farm ponds (target 200 nos by Chief Engg MI, 500000 by DRDA, 30000 by Agriculture, 10000 by Horticulture)	Chief Engineer MI, Director Agriculture, Director Horticulture, All DRDAs	2020-2030
Construction of new bore-wells (target 200000)	OLIC	2017-2030
Compilation of annual achievement report on physical infrastructure and other activities designed for adaption of climate change	Depty. Director Climate Change (EIC Office) and Climate Change Cell, DoA &FE	Every year

ANNEXURE XV: INSTITUTIONAL MECHANISM OF DIFFERENT DEPARTMENTS

The subject assigned to the Department as per Odisha Government Rule of Business is as follows.

- Administration of various Navigation, Embankment and Drainage Act and Rules made there under.
- Water for irrigation and navigation canal, drainage embankments and water storage and all works connected therewith.
- Maintenance of Indian Waterways. Construction and maintenance of building required solely for the administration of canals and embankments of Major and Medium Irrigation.
- Flood control and river taming works.
- All matters relating to civil construction and maintenance of Dam projects except Upper Indravati Hydro-electric Project up to the point of generation in coordination with Energy Department. All matters relating to land acquisition, land reclamation and resettlement in connection with the projects pertaining to the Department.
- Command Area Development.
- Excavation, execution and maintenance of Minor Irrigation as defined by Govt. of India from time to time and Tank Projects.
- Lift Irrigation Corporation.
- Pani Panchayats

The Department is headed by the Principal Secretary. The functions of the Department are carried out through following organizations /wings, public sector undertakings.

- Major & Medium
- Minor (flow)
- Ground Water Survey & Investigation
- Command Area Development
- Odisha Lift Irrigation Corporation Ltd
- Water & Land Management Institute
- Odisha Construction Corporation Ltd (OCC)

Institution Mechanism for Major & Medium irrigation projects

Major and Medium irrigation projects are under the administrative jurisdiction of Engineer-in-Chief. There are Chief Engineers and Basin Managers for all 11 river basins of Odisha. Another Engineering in Chief for Planning and Design also works at senior level for major, medium and river basin planning related activities (Figure 3).

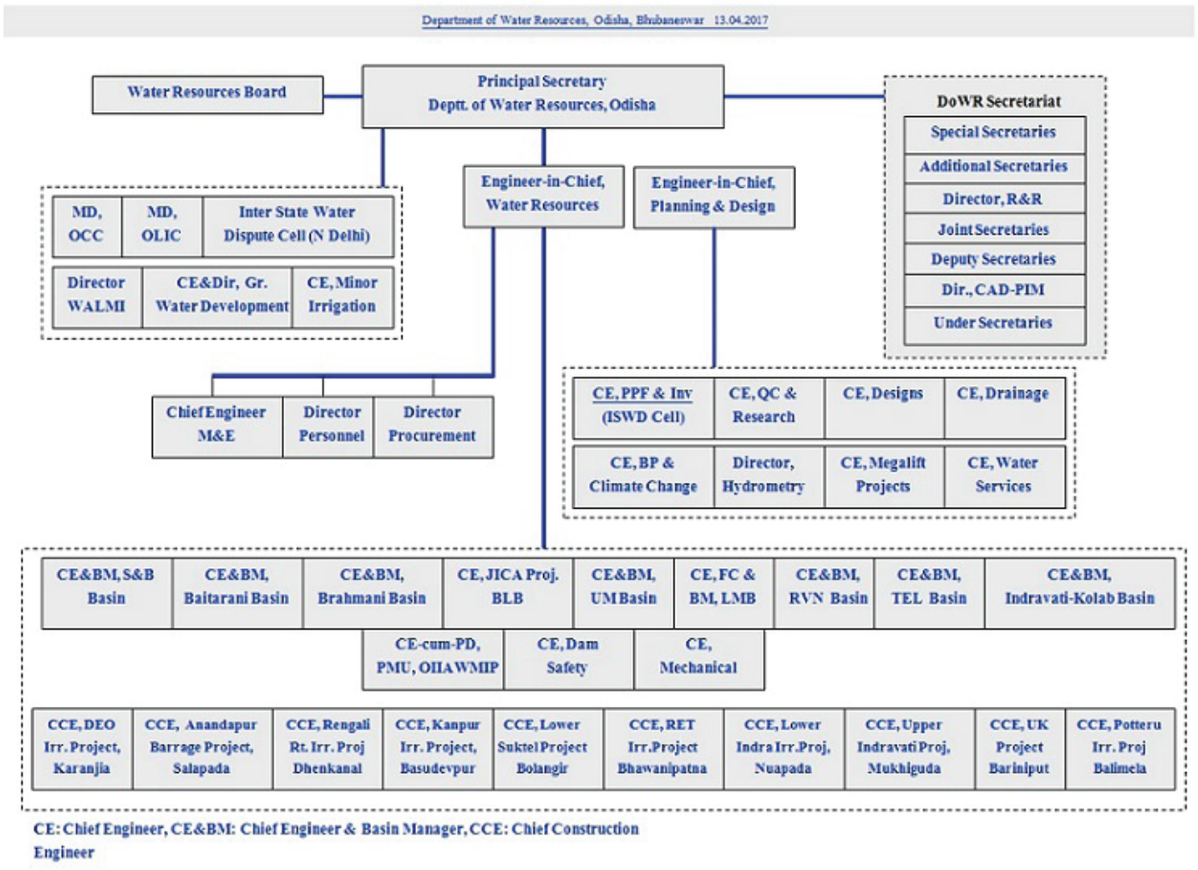

Figure 3: Structure of Department of Water Resources, DoWR

- Chief Engineer, Flood Control & Basin Manager, Lower Mahanadi Basin, Bhubaneswar
- Chief Engineer & Basin Manager, Upper Mahanadi Basin, Burla
- Chief Engineer, Designs, Bhubaneswar
- Chief Engineer, Dam Safety, Bhubaneswar
- Chief Engineer cum Project Director PMU (OIIAWMP), Bhubaneswar
- Chief Engineer, Project Planning Formulation & Investigation, Bhubaneswar
- Chief Engineer, Basin Planning & Climate Change, Bhubaneswar
- Chief Engineer, Quality Control and Research, Bhubaneswar
- Chief Engineer, Water Services, Bhubaneswar
- Chief Engineer & Basin Manager, Rushikulya, Vansadhara and Nagavali Basin, Berhampur
- Chief Engineer & Basin Manager, Brahmani Basin, Samal
- CCE, Rengali Right Irr. Project, Dhenkanal
- Chief Engineer JICA Project, Brahmani Left Basin, Sukinda
- Chief Engineer & Basin Manager, Subernarekha and Budhabalanga Basin, Laxmiposi
- CE &B.M, Indravati - Kolab Basin, Khatiguda
- Chief Engineer, Drainage, Cuttack
- Chief Engineer & Basin Manager, Tel Basin, Bhawanipatna
- Chief Construction Engineer, Upper Kolab Project, Bareniput
- Chief Construction Engineer, Lower Suktel Project, Bolangir

- Chief Construction Engineer, Potteru Irrigation Project,Balimela
- Chief Construction Engineer, Ret Irr. Project, Bhawanipatnaf
- Construction Engineer, Anandapur Barrage Project, Salapada
- Chief Construction Engineer, Deo Irr. Project, Karanjia
- Chief Construction Engineer, Lower Indra Irr. Project,Nuapada
- Chief Engineer and Basin Manager, Baitarani Basin, Keonjhar

Institution Mechanism for minor irrigation projects

Entire activities for training to development, operation, modernisation and management of minor irrigation project in Odisha is look after by a Minor Irrigation Organization headed by a Chief Engineer. This organization was created under rural development and subsequently transferred to the State Water Resource Department. There are different irrigation circles and irrigation divisions covering the entire state. Each district has a minor irrigation division who is responsible for operation and maintenance of all minor irrigation projects in the district.

Institution Mechanism for River Lift and Ground Water irrigation projects

River Water and Ground Water Schemes are planned and constructed by Odisha Lift Irrigation Corporation Ltd. which is a Govt. of Odisha undertaking. As it is a corporation, the OLIC has board of directors and Chairman who are concerned and responsible for policy related matters and overall governance of the corporation. Managing Director is the Chief Executive and has to play key role in day to day administration and management concerning project construction, financing including borrowing from NABARD, Procurement and Achieving targets for new constructions of River Lift schemes, Deep Bore Well, Shallow Tube Well. In additions to above, old project revival, canal extension and stabilization of old ayacut are taken up by OLIC. It has four Superintending Engineers having their offices at Cuttack, Sambalpur, Bhawanipatna and Berhampur. Catering to the needs of different zones formed OLIC. The organogram of OLIC is given in Figure 4.

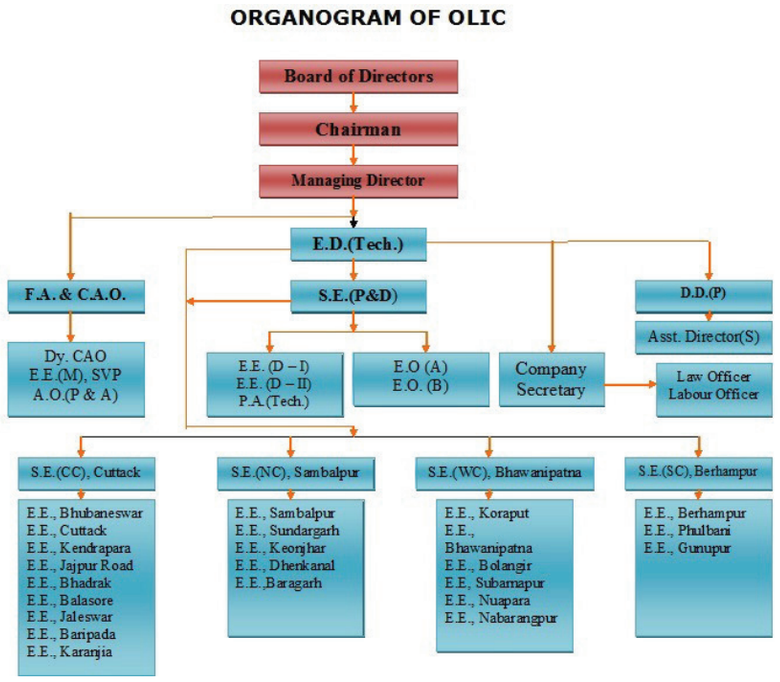

Figure 4: Organogram of Odisha Lift Irrigation Corporation

Institution Mechanism for Command Area Development, OFD Works and PIM irrigation projects

In 2007-08, Government of Odisha has created a separate directorate namely Directorate of CAD and PIM, headed by a commissioner working under Water Resource Department. In the headquarters, Additional Director, O&M, Addl. Director PPSU, Addl. Director, CAD work under the director and they are supported by other officers and experts. For field activities executive engineers, asst. engineers and junior engineers work under the CAD.

Existing Institutional Mechanism- Department of Agriculture

Department of Agriculture and farmers empowerment has staff up to Gram Panchayat (GP) level. Thus, it has manpower to reach out to all villages in the state.

Action on Climate Today (ACT)
For more information,
Email: info@actiononclimate.today
www.actiononclimate.today

ACT CCIP
ACTION ON CLIMATE TODAY

Department of
Water Resources,
Government of Odisha