



'Government of Karnataka
Advanced Center for Integrated Water Resources Management (ACIWRM)
Water Resources Department

Loan No. 3836-IND: Karnataka Integrated and Sustainable Water Resources Management
Investment Program (KISWRMIP)
Tranche-2

Section 7 of RFP : TERMS OF REFERENCE
(Technical Support Agency)

Subject: Implementation of Land and Water Management Pilots in
Tungabhadra Left Bank Canal (TLBC) of Tungabhadra Reservoir

Contract	Implementation of Land and Water Management Pilots – ACIWRM [Ref. No.: ACIWRM/Study-2/LWM-TSA/2020-21/..... dated 05.12.2020]		
Project	L3636-IND: Karnataka Integrated and Sustainable Water Resources Management Investment Program (KISWRMIP) – Tranche 2		
Expertise	Discharge Digitization; Soil Moisture Sensors; Crop-Water Requirements; Remote Sensing and GIS; Training & Capacity Building; Irrigation Scheduling using real time data; Coordination with govt. agencies		
Source	National	Category	Organization / Agency

1. Project Background:

Karnataka's 61% geographical area, the 5th highest, is drought prone due to erratic rainfall and the average annual rainfall being less than 750 mm. Many parts of the state (>60% of the taluks) have experienced drought conditions for 9 years from 2001 to 2019. Government of Karnataka decided to develop Integrated Water Resources Management (IWRM) approach and sought the support of Asian Development Bank (ADB) through Government of India and a multi-tranche financing facility (MMF) for the Karnataka Integrated Sustainable Water Resources Management Investment Program (KISWRMIP) was signed and made effective on 13 July 2015 for a period of 10 years from 2014 to 2024.

ACIWRM is preparing sub-basin plans for sustainable management of water resources through implementation of IWRM principles. Land and Water Management (LWM) Plans preparation as part of river basin planning through participatory approaches assumes importance as more than 80 per cent of the water is used for irrigation. ACIWRM during KISWRMIP Tranche-1 had prepared the profile and plan of Tungabhadra & Vedavati sub-basin on pilot basis. The stakeholders' consultation process was undertaken to further strengthen the plan and the stakeholder understanding of their respective roles and responsibilities to implement the developed river basin plan on integrated approach.

There are isolated efforts in the past made by the State Agricultural Universities, Agriculture Department by implementing demonstration of water saving technologies in small areas (less than one ha to 50 ha area) on farmers' fields. Recently, large scale (about 25,000 ha at contiguous block) micro Irrigation schemes are implemented in the State. However, implementation of integrated projects, with focus on agricultural water management, duly including water, land, crop and other uses of water and environmental aspects is felt need in the state.

2. Purpose of the Assignment

The purpose of the assignment is to implement LWM plans including interventions aimed to conserve and develop water, land, agriculture production; and address environmental concerns, sustainability and livelihoods of people. Pilots will include:

- measuring canal discharges, groundwater levels, precipitation
- development of irrigation schedules based on crop water requirement, weather forecast, soil moisture measurement, and availability of water,
- communication to the WRD Engineers and Farmers and for better water supply and use
- documentation and dissemination of information to all relevant stakeholders

The proposed LWM Plans implementation needs to partner with a Technical agency as "**Technical Support Agency (TSA)**" experienced in installation and providing on-site and off-site services for measurement of precipitation, canal, surface and groundwater, soil moisture with telemetry for real time water availability assessments; application of remotely sensed weather products for weather forecast; recommending irrigation schedules based on the data analysis and prevailing field conditions; capacity building and information dissemination to WRD engineers, Support Organization (SO) staff, Water Users Cooperative Societies (WUCS) members and farmers. TSA will also prepare the reports as per the agreed schedules and

disseminate the information. The learnings from the implementation of these pilots will systematically feed into the river basin plans preparation and implementation.

Improvement in Water Productivity (WP), equity in water distribution can be potentially realized with coordinated efforts of concerned departments with an integrated approach. The Water Resources Department, Agriculture Department, Rural Water Supply and Sanitation Department, among others have to work in an integrated way with all water user groups, including WUCS to achieve water security and address environmental concerns on a sustainable basis.

The pilot involves the development of irrigation management solutions for two Distributaries selected for pilot interventions in Distributary No. 17 at Head reach and Distributary No.95 at tail end of TLBC. The pilots are planned to take up to develop options for sustainable use of land and water resources management including soils, water, vegetation and livestock, for the production of goods and services to meet changing human needs, while ensuring long-term productive potential of these resources and maintenance of environmental functions.

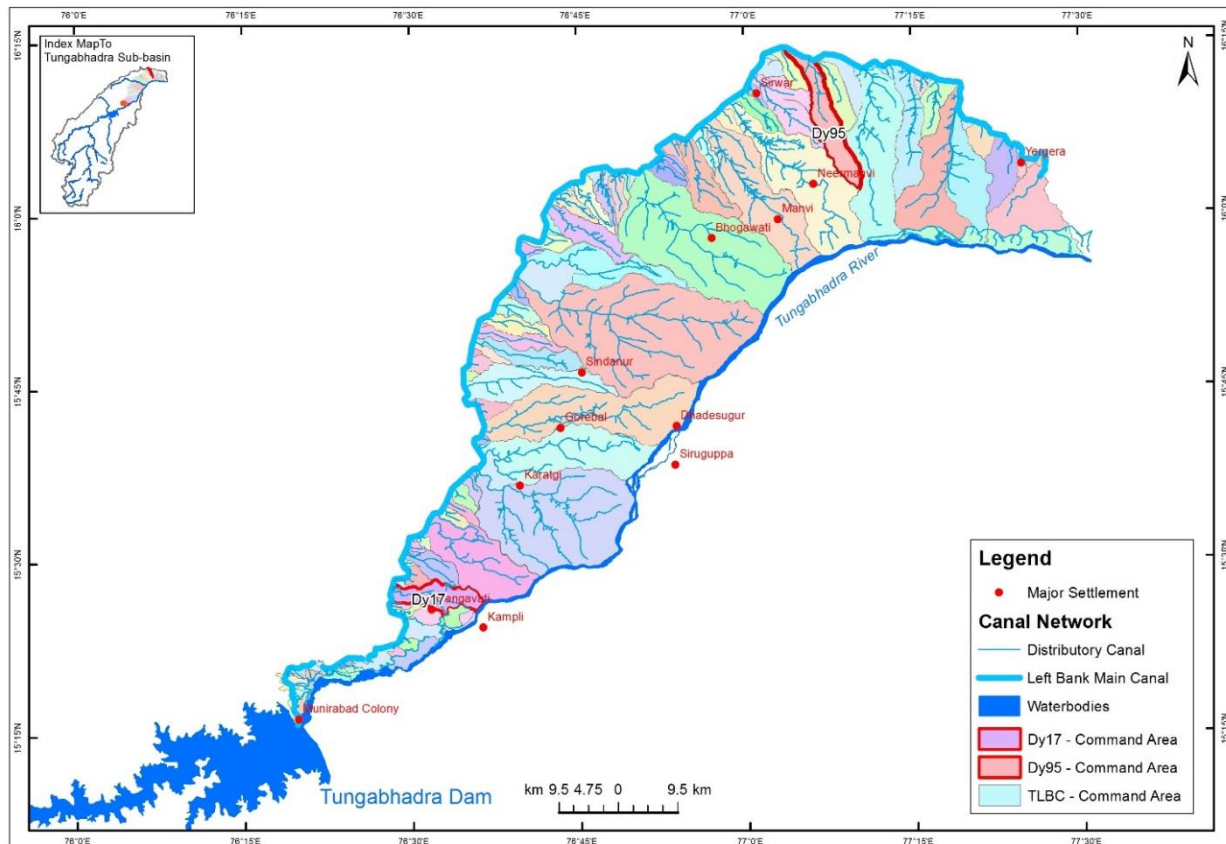
3. Duration and Location of the Services

Duration: LWM Pilots at two locations will be implemented for three years from April 2021 to March 2024.

Location: Distributary no. 17 as Head reach situated in Koppal District and Distributary no. 95 as tail end situated in Raichur District of the Tungabhadra Left Bank Canal (TLBC) are selected as pilots to implement the Land & Water Management Pilots. The Distributary number 17 (D-17) takes off from main canal at 47 kms from reservoir, gets divided into three branches and has a length of 14.90 kms with 36 Pipe Outlets. The D-17 is adjacent to Gangavati town of Koppal District falls in the head reach area with abundant of water supply for kharif season and experiences shortfall of water for rabi season. First half of the head reach area of the of distributary command is with sandy loam soils and rest is black soil. The Distributary has a culturable command area of 3,954 ha. The command area has about 1,468 borewells and experiencing lowering water level over the years. Paddy is the dominating crop in both kharif and rabi seasons. Distributary No.95 of TLBC falls in the tail end of TLBC which experiences water shortages. D 95 takes off at 178.63 kms from the Reservoir on TLBC and runs for a length of 11.00 kms with 10.50 kms lined and another 0.5 kms unlined. It has 25 Pipe Outlets and the water reaches up to 14 Pipe Outlets. Deep black cotton soils are predominant in the command area. Distributary has

around 3,020 ha as culturable command area. There are more than 50 Farm Ponds towards tail end areas of distributary to harvest rain fall runoff and canal water in times of surplus. About 60 per cent of area is cultivated with rainfed crops such as cotton, pigeon pea.

Map showing the Pilot locations in the Tungabhadra Left Bank Canal



4. Scope of Services

The Scope of the Work is to implement Land and Water Management Plans in the select areas of the TLBC in convergence with relevant stakeholders. “Technical Support Agency (TSA)” will develop methodology and framework to arrive at optimum irrigation schedules derived based on water supply available from canal releases, groundwater, projected precipitation and available soil moisture and crop water demand estimated based on soil type, crop wise area sown, stage of crop and crop water requirement. It is expected to quantify water supply and water demand on near to real time basis. These estimations will generate data base which can be used as Decision Support System (DSS) tool by the Irrigation Engineers and managers and also farmers. This component includes quantification of water through use of measuring, transmitting devices and development of software packages for large data analysis, generating results and dissemination

of information to all the diverse stakeholders. The TSA needs to install required gauges, sensors, procure satellite imageries, develop framework and prepare optimum irrigation schedules, develop software's and put into operation in pilots.

Key activities of the assignment include:

- ✚ Digitization of distribution network of the project area
- ✚ Installation of ground sensors
- ✚ Retrieval of satellite data
- ✚ Estimation of crop water requirements
- ✚ Development of web-app
- ✚ Generating optimum water allocation schedules
- ✚ Implementation of the proposed system
- ✚ Estimating water savings
- ✚ Training and Capacity building
- ✚ Dissemination of information to various stakeholders

5. Detailed Outputs of the assignment

The following outputs are anticipated from the assignment:

- Distribution network of the project area digitized
- All measuring devices installed as per the project requirement
- Weekly irrigation schedules worked out and shared with engineers, SO staff and farmers
- Organized training programs for engineers, SO staff and WUCS representatives
- Water savings for each of the seasons assessed and documented
- Framework for water scheduling worked out for different scenarios

Other Output(s) also include:

1. Evapotranspiration - Weekly
2. Weather forecasts - Weekly
3. Crop water demand current - Weekly
4. Crop water demand forecast - Weekly
5. Ground water extraction - Weekly
6. Dynamic roster plan - Weekly
7. Canal water reach and losses estimation – Weekly

5.2 Team composition and qualification requirements for key experts:

The agency should have experienced professionals as shown in the following table to deliver the expected outputs & deliverables. Individual ToR for all TSA positions are presented in Annex-1.

SN	Position	No. of persons	Qualification	Relevant Experience
1	Project Team Leader	1	Ph.D. Hydraulics/ Hydrology/ Remote sensing or M.Tech. in above subjects	Ph.D. with 2 years M. Tech. With 5 years' experience
2	Senior Project Engineer	1	Masters in Hydrology/ RS/Electronics Instrumentation/ Computer Science	4 years
3	Project Engineers	2	Masters in Hydrology/ RS/Electronics Instrumentation/ Computer Science	2 year
4	Project Associates	2	BE Civil/ Mechanical/ Computer Engineering	1 year
5	Senior Project Mechanics	2	Secondary School Leaving Certificate (SSLC)	5 years
			Graduate	2 years

Note: It is desirable that the agency has an academic partner from premium institutes like IIT's, IISc, NITs etc. A letter from faculty member to be a co-project investigator be submitted.

5.3 Reporting Requirements and Time Schedule for Deliverables

The agency, as part of assignment has to submit the following reports periodically to ACIWRM:

Sl. No.	Type of report	Dates of submission
		The table of content will be agreed with ACIWRM prior to the report preparation
1	Inception Report – 1 no.	Within 30 days from date of signing the agreement
2	Annual Plans – 3 nos.	1 st Annual Plan: Within the 60 days after submission of inception report 2 nd Annual Plan: Along with 1 st Annual Report 3 rd Annual Plan: Along with 2 nd Annual Report
3	Quarterly Report – 12 nos.	Within 30 days after completion of every 3 months
4	Annual Report – 3 nos.	Within 60 days after completion of every 12 months
6	Completion Report -1 no.	60 days after completion of completion/agreement period

(i) Number of copies: Six number of hard copies, and soft copy in pen drive.

(ii) All reports shall be submitted to

The Registrar/ Engineer-in- Chief,

ACIWRM, # 1/1, 1st Floor,

KSFC Bhavan, Thimmaiah Road, Bengaluru – 560052

5.4 Relevant background information or materials for the assignment

The existing irrigation systems in the Tungabhadra Left Bank Canal Command area are experiencing low (30% to 40%) water use efficiency, crop water productivity (of rice 2.39 kg/ mm & cotton 3.27 kg/mm), inequitable distribution of water among farmers (around 40 % of tail end farmers are facing water shortages) for irrigation, growing water intensive crops and flood and plot to plot irrigation leading to degradation of precious natural resources. There is a need to develop sustainable options for addressing land and water problems.

Two Distributaries are selected, viz, Distributary No. 17 at Head reach and Distributary No.95 at the tail end of Tungabhadra Left Bank Canal (TLBC) to implement the interventions potential to address identified issues in an integrated and participatory manner. The pilots will develop options for sustainable use of land and water resources management including soils, water, vegetation and livestock for the production of goods and services to meet changing human needs, while ensuring long-term productive potential of these resources and maintenance of environmental functions.

Distributary No.95 (Dy-95) of TLBC falls in the category of tail end of TLBC which always experiences water shortage. Deep black cotton soils are predominant in the command area. Distributary has around 3,020 ha as culturable command area with 25 Pipe Outlets (POs) along the Distributary. Only the first 14 POs of initial reaches get water and subsequent POs from 15 to 25 get less water for irrigation. It is observed that, fluctuating pattern of discharge is maintained. There are more than 50 Farm Ponds towards tail end areas of distributary to harvest rainfall runoff and canal water in times of surplus. About 60% area is cultivated with rainfed crops such as cotton, pigeon pea. The area receives average annual rainfall of about 620 mm per annum.

The Distributary number 17 (D-17) takes off from main canal at 47 kms from reservoir. The D-17 is adjacent to Gangavati town of Koppal District falls in the head reach area of main canal with abundant water supply for *kharif* season and experiences shortfall of water for *rabi* season. First half of the head reach area of the of distributary command is with sandy loam soils and rest is black soil. The Distributary has three branches running into 14.9 kms length with 36 POs with

culturable command area of 3,954 ha. The conveyance losses at head reach is 0.49 m to 0.56 m and towards tail end is 1.83 m to 1.93 m. The command area has about 1,468 borewells and experiencing lowering water level over the years. Paddy is the dominating crop in both kharif and rabi seasons. It is noted that, there exists scope to save the water in the distributary through implementation of concerted interventions.

5.5 Indication is downstream work is potentially considered

Not applicable

5.6 Seminars, Workshop and Training Required:

Capacity building of WRD Engineers, SO staff and WUCS representatives is considered as important intervention in the pilots. The themes of trainings are as follows:

- Maintenance of measuring devises
- Method of recording observations of water delivery,
- Crop water requirement,
- local weather,
- Soil moisture measurement
- Sharing data with stakeholders and archiving/storing.

5.7 Equipment procurement:

Equipment such as water measuring devises, discharge measurement, soil moisture measurement and dissemination systems needs to be procured, installed and maintained for 3 years project period by the Technical Support Agency as part of the assignment. The specifications of the equipment's to be procured is presented in the following Table.

Water measuring & information dissemination devices particulars			
SN	Devise	Purpose	Specification
1	Ultrasonic Flow Meter- 30 Nos	Flow meter is required to measure water discharge/ flow rate at Pipe Outlet in near to realtime	Accuracy to be at +/-2%. Data transmission interval hourly/ daily.
2	Ultrasonic water level measuring instrument – 30 Nos	Water level monitoring devices to install over Distributary canals. Comprising sensor, transmitter units, batteries pack with GPRS communication.	Accuracy to be at less than +/- 20 mm. Data transmission interval hourly/ daily customizable, computer, GPRS/GSM interface. Cellular transmission, Dedicated secure server. Alerting option when instrument gets disturbed.

3	Radar type water level measuring instrument - 2 Nos	Water level monitoring devices to install over main canal. Comprising sensor, transmitter units, batteries pack with GPRS communication.	Accuracy to be at less than +/- 20 mm. Data transmission interval hourly/ daily customizable, computer, GPRS/GSM interface. Cellular transmission, Dedicated secure server. Alerting option when instrument gets disturbed
4	Soil Moisture measuring sensors - 8 Nos	Track soil moisture near real time.	Must have communication facility - can transmit data through GPRS/3G/4G/LoRa/WiFi.
5	Micro/ mini weather station- 4 Nos	Monitor weather parameter such as precipitation, temperature, relative humidity, Pan-evapo-meter,	Comprising set of Rain-gauge, temperature, humidity, pan evaporation & wind velocity – real time transmission
6	Piezometer- 4 Nos	Measure groundwater level fluctuations	Should have 0.05% of Full-Scale Output with data transmission 2G/3G/4G
7	Current meters- 4 Nos	Used to determine the current velocity in water ways & channels,	Cup/ propeller type, ultrasonic with data display/ recorder

6. Scope of Services, Tasks and Expected Deliverables:

It is expected that, the TSA provides a Decision Support System (DSS) to enhance synergies between water managers and water users by streamlining exchange of real-time data on water requirement and water available for supply. The DSS will enable decision making that ensures the provision of right amount of water at right time. The following tasks need to be performed to achieve the objectives of the assignment.

1. Site inspection: The Distributary canal and its command areas to be visited and examined. Additional information required may be collected based on need. Plan already prepared will be utilized for the purpose.
2. Digitization of canal network: The non-GIS maps and data needs digitized; canal network drawings validated using ground data. Existing rating curves needs to be digitized and their accuracy tested.
3. Installation of ground sensors: The water level instruments/ ultrasonic/radar technology with GPRS/GSM/3G/4G/LoRa or any wireless communications should be deployed in the canal network. Soil moisture and micro-weather stations to be installed on representative farms

to estimate crop-water requirements. Groundwater levels monitoring instruments to be installed in sample locations.

4. The water level monitoring instrument can be installed at any of the following options:
 - a) Existing gauge wells if available and suitable for installation
 - b) On existing bridges
 - c) Construct suitable gauge well/ hume pipe arrangement
 - d) On cantilever from the canal bank.

(If the firm is opting for No 3 or 4 it shall happen under the supervision of concerned department official of the site so that safety of the canal bank is not compromised.)

5. The agency shall develop a web app and android mobile app with good Graphical User Interface (GUI) to view real-time discharge data as per the need of the department.
6. Retrieval of satellite data: Data for meteorological parameters from satellites needs to be retrieved for the command area, compared and integrated. Satellite data needs to be used to estimate cropping area, types of crop, crop stage and surface soil moisture. All satellite data of agro-meteorological parameters needs to be compared with data from sensors deployed in field and manual data collected from selected farms and farmers. The satellite data will be bias corrected, downscaled and validated for entire area.
7. Weather models: available models need to use for weather forecasts.
8. Estimating water demand: Crop models needs to be used to estimate daily water demand for cropping area of WUCS command area or PO.
9. Generating optimum water allocation schedules: The engineer-in-charge will receive the sub command area-based water demand with a goal to maximize overall productivity. The final allocated plan needs to be conveyed to farmers using an SMS.
10. Estimate water saved: Difference between the optimal supply and actual supply needs to be assessed and saving in water and gain in crop yield needs to be estimated.
11. Implementation of the proposed system: After assessment, the proposed system needs to be operational in pilots command area. Weekly roster plan will be generated. The same information will be conveyed to farmers. The data collected will be used for testing, evaluating, and making the system more robust. The system then will be handed over to the KNNL for adoption in larger areas.
12. Handover infrastructure at nil cost in functional state at the end of project.

Expected Deliverables

1. Inception Report
2. Annual Plans

3. Quarterly Report
4. Annual Report
5. Completion Report

7. Client's Input and Counterpart Personnel

(a) ACIWRM Input:

- (i) Orientation on LWM pilots.
- (ii) LWM plans
- (iii) Periodical monitoring
- (iv) Advisory input as and when required
- (v) Available maps and data with ACIWRM

(b) Professional and support counterpart personnel to be assigned by the Client to the Consultant's team: Director (Technical) and "Land and Water Management Specialist" of ACIWRM will advise and monitor Technical Support Agency.

8. Client will provide the following inputs, project data and reports to facilitate preparation of the Proposals: Client shall provide all published reports in respect of implementation plan and facilitate in collection of secondary data.

- (a) Baseline information
- (b) Draft plan

9. Basis of Payment:

First quarter advance, other than equipment's cost, will be released to Technical Support Agency after appointment of project staff, establishment of project office and submission of Inception report. Releases for subsequent quarters will be made after submission of quarterly progress reports, financial reports with necessary supporting documents and other deliverables as indicated in ToR.

Payments towards equipment's: 80% of cost of equipment's for experimentation will be released once installation is over, operational and verified by the ACIWRM. 10% of cost of equipment's will be released after complementation of first year and submission of reports with periodical data. The final 10% of final payment will be made after complementation of third year and submission of completion report.

ANNEX-1

Individual Terms of Reference (ToR) for all TSA positions

Project Team Leader:

- (i) Responsible for overall coordination of all the project activities and coordination with ACIWRM, Support Organization and WUCS.
- (ii) Responsible for remote sensing data collection and analysis
- (iii) Develop models for crop water estimation
- (iv) Develop models for canal scheduling
- (v) Develop Graphical User Interface (GUI)
- (vi) Field data analysis and model training, testing and validating.

Senior Project Engineer:

- (i) Coordinate the ground survey and farmer interaction
- (ii) Responsible for digitization of canal network
- (iii) Model the weather nowcasts and forecasts
- (iv) Coordinate with the WUCS, farm surveys and farm registration
- (v) Develop canal hydraulic model and estimate flows
- (vi) Coordinate the instrument deployment and strategize the locations for the same

Project Engineer:

- (i) Deploy and maintain the on-ground instruments
- (ii) Engage with farmers continuously and understand their needs of water
- (iii) Asses the performance of current canal system on ground
- (iv) Check the instrument data continuously and make sure the data is correct
- (v) Interact with WRD & coordinate development of software as per user needs
- (vi) Coordinating with WUCS

Project Associate:

- (i) Constant touch with WUCS
- (ii) Conduct farmer registration
- (iii) Analyze farm and crop data periodically
- (iv) Collect canal discharge data periodically
- (v) Analyze feedback from farmers and WUCS
- (vi) Coordinate the dissemination of data to farmers

Senior Project Mechanic:

- (i) Instrument maintenance and deployment
- (ii) Interact with irrigation department employees, gauge readers and gate operators
- (iii) Collect farm data periodically
- (iv) Collect canal data periodically
- (v) Collect feedback from farmers and water user associations
- (vi) Collect crop data periodically

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