Report

Building Community Expertise in Water Management

Insights from a Community Hydrology Programme in Raichur, Karnataka

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Cover Image A farmer next to a field irrigation channel in Raichur district, Karnataka. Photo by Anupam Barman

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About CLARE

Climate Adaptation & Resilience (CLARE) is a UK-Canada framework research programme on climate adaptation and resilience, aiming to enable socially inclusive and sustainable action to build resilience to climate change and natural hazards. CLARE is an initiative jointly designed and run by the UK Foreign, Commonwealth and Development Office and Canada's International Development Research Centre. CLARE is primarily funded by UK aid from the UK government, along with the International Development Research Centre, Canada.

About CLARITY

Climate Adaptation and Resilience in Tropical Drylands (CLARITY), a research project under CLARE, is building equitable, sustainable, and climate-resilient development pathways in tropical drylands. This Global South-led project will result in the creation of long-term assets (data and tools) and capacities to achieve transformational change.

CLARITY focuses on Transformation Labs (T-Labs) in Niger-Nigeria, Tanzania, and India. These labs are collaborative spaces for communities and researchers to develop sustainable, equitable pathways. In India, we are establishing two Transformation Labs in semi-arid regions in the state of Karnataka: Chikkaballapur-Chintamani and Raichur. Both are at the urban-rural interface and are characterised by shallow and deep aquifers that have been rapidly depleting for almost two decades.

Our approach is solutions-focused and transdisciplinary. We are:

1. Co-constructing narratives of water management with marginalised groups based on video diaries and interviews, training para-hydrogeologists in the community, and collecting and analysing data for local action.
2. Using the narratives and data to build models that generate disaggregated and technically, socially plausible pathways.
3. Engaging with key changemakers to ensure the research gets embedded in wider policy processes and communities of practice by sharing tools, training materials, interactive reports, and games.

About WELL Labs

WELL Labs is transforming water systems at scale across India through research, partnerships, and collective action. We take on audacious challenges, tackling complex problems by designing comprehensive solutions that provide large social returns. Our work is science-led and community-focused. We address the interconnections between water, environment, land, and livelihoods. To create impact at scale, we embed solutions within governments, work with the private sector, and collaborate with civil society and active citizens. Based in Bengaluru, WELL Labs is part of the Institute for Financial Management and Research (IFMR) Society.

About Prarambha

Prarambha is a charitable trust registered in 1985. It has worked with farmers and youth, and supports manual scavengers, devadasis, and communities vulnerable to climate impacts in north Karnataka.

Executive Summary

The Community Hydrology Programme seeks to build local capacity for understanding and managing water in landscapes where rainfall, canal water, and groundwater interact in complex ways. When communities can measure and analyse their water systems, they are better equipped to make informed choices, negotiate water use, and participate meaningfully in local governance institutions. This granular, locally owned data and evidence-based decision-making are integral to the CLARITY project's goal of co-creating pathways for a water-secure and climate-resilient Raichur.

In this endeavour, the programme worked with a cohort of 35 aspiring community hydrologists of varying ages and education levels to:

1. Inculcate a foundational understanding of groundwater, surface water, hydrogeology, soil, and crop-water relationships.
2. Measure and monitor rainfall, groundwater levels, and streamflow using simple, low-cost methods to leverage data for water management.
3. Prepare water balances and crop water budgets, and use them to decide what crops to grow and when to schedule irrigation.
4. Strengthen community institutions and water governance by providing advisory services to water user cooperative societies and farmer groups.
5. Promote water stewardship by framing groundwater and canal water as shared resources requiring collective responsibility and management.

While their learning trajectories were uneven, the participants gained an understanding of hydrological concepts and could independently take measurements. They were also able to calculate water balances and crop water budgets with an HTML tool that WELL Labs developed.

However, they could not yet effectively translate hydrological insights into practical recommendations for water user cooperative society members. As a result, the programme was not able to develop a model where the former could provide water management advisory services to the latter. To ensure that the role of a community hydrologist is valued and sustainable, it must be clearly defined and remunerated, either through a fee-for-service or barter model. The adoption of efficient agricultural practices to improve water-use efficiency is also challenging as soil and water testing kits are not widely available and farmers require financial support to set up micro-irrigation systems.

The project team has incorporated participants' feedback to shape the programme's second phase. Next steps include merging the programme with the Advanced Centre for Integrated Water Resources Management's (ACIWRM) 'Farmer Water Schools', creating visual guides for different tasks, and formalising the services community hydrologists can provide.

Chapter 1 introduces the programme and its objectives. Chapters 2–4 delve into the four workshops under the programme, including their training modules, participant feedback, lessons learnt, and next steps. Chapter 5 delineates the programme's outcomes, Chapter 6 insights from the workshops, and Chapter 7 the way forward. Chapter 8 compiles resources and presentations.

Contents

1. Introduction

WELL Labs designed the community hydrology programme under the Climate Adaptation and Resilience In Tropical Drylands (CLARITY) project to enable communities to collectively monitor and manage shared water resources. This is part of the project's larger goal to build grassroots resilience against climate change and the depletion of natural resources in the tropical drylands of Raichur and Chikkaballapur districts in Karnataka.

The community hydrology programme provided tools and methods for data collection and informed decision-making regarding water use and management. The data and insights from the monitoring of water resources will contribute to promoting effective water governance through community-based institutions known as water user cooperative societies. By monitoring surface water, groundwater, and rainfall, and estimating crop water requirements, they can make appropriate cropping decisions. This approach improves water literacy in the community and seeds a sense of ownership and stewardship with respect to their water resources.

Under the programme, we organised four workshops in collaboration with Prarambha at the office of the Water Resources Department, Government of Karnataka in Devadurga taluk, Raichur district, Karnataka:

1. First workshop: 13–15 November 2024 | Read more in Chapter 2
2. Second workshop: 22–24 January 2025 | Read more in Chapter 3
3. Third workshop: 20–22 May 2025 | Read more in Chapter 4
4. Fourth workshop: 29 September 2025 | Read more in Chapter 4

1.1 Objectives

The programme aims to shift water management from relying on external technical expertise and being institutionally top-down to locally grounded, data-driven, and participatory. In this endeavour, the programme aimed to:

a. Build a foundational hydrological understanding.

Enable the cohort to:

- Understand the water cycle, basic hydrogeology, soil properties, evapotranspiration, etc., and their implications.
- Appreciate the interactions between rainfall, canal water, and groundwater.
- Discern crop water requirements.

b. Develop practical measurement and monitoring skills.

Equip community members to:

- Measure rainfall, groundwater levels, canal flows, and stream discharge using simple, low-cost methods.

- Set up and maintain community-led monitoring networks.
- Record, verify, and manage data through the KoboToolbox.[1]

c. Build analytical and decision-making skills.

Train participants to:

- Prepare simple water balances and crop water budgets for their micro-watersheds.
- Use local data for decision-making, such as what crops to choose and when to schedule irrigation.
- Incorporate the concepts of water-use efficiency and soil-water management in the management of water resources.

e. Strengthen community institutions and water governance.

- Support water user cooperative societies and panchayats (village councils) with locally generated water data.
- Facilitate dialogue between community hydrologists and water user cooperative society members, enabling evidence-based discussions on water rotation, cropping plans, and maintaining the irrigation infrastructure.
- Seed a service model where community hydrologists provide water management and agricultural advisory, thereby reducing the reliance on external experts.

e. Promote collective responsibility and stewardship of water resources.

- Encourage participants to view groundwater and canal water as shared resources.
- Strengthen collective monitoring, reporting, and problem-solving.
- Foster local champions who can take leadership in water governance.

1.2 Participants

To invite applicants for the programme, WELL Labs put out posters in universities and worked with Prarambha to spread the message through word of mouth. Of the applicants, farmers, watermen, barefoot technicians (workers under the Mahatma Gandhi National Rural Employment Guarantee Act), youth, borewell drillers, and Prarambha field coordinators got preference.

Thirty-five participants from eight villages in Devadurga taluk, including three women, registered for the workshop. Of them, 31 completed the programme. The fourth workshop had 20 attendees as it was designed in response to some participants' requests for additional sessions on soil health and micro-irrigation.

[1] *KoboToolbox is a data collection, management, and visualisation platform used globally for research and social impact programmes.*

The participants' age ranged from 28 to 78—half were less than 38 years. A majority had finished secondary schooling (Class 12). All of them received an honorarium to compensate for the time they spent on the programme.

Throughout the four workshops, the participants were attentive, curious and enthusiastic. They were particularly interested in the field visits and practical assignments.

Figure 1: Participants and facilitators of the community hydrology programme

2. First Community Hydrology Workshop

The first workshop took place from 13 to 15 November 2024. It began with an inauguration ceremony attended by trainees, officials from the Water Resources Department, Prarambha staff, and WELL Labs facilitators. The highlight was a performance of folk songs on the significance of water conservation by Rajapa, an artist from Gabbur village, Raichur district. Representatives from the local government, Prarambha, and WELL Labs delivered short speeches on the potential benefits of and need for the programme.

The workshop comprised two days of classroom sessions on groundwater, water balance, and geology, and one day of field demonstration. Siddharth Patil, a hydrogeologist with 15 years of experience across India, led the sessions. It was followed by a 2-day practical assignment: developing a well inventory using KoboToolbox.

2.1 Workshop Modules

2.1.1 Classroom Sessions

The classroom instruction began with an ice-breaking session by the training facilitator. The participants introduced themselves and the names of the villages they belonged to. Then, they played a 'candy game', where they were supposed to grab as many candies as they could from a limited number kept in the centre. A few got hold of many treats, while others were left with none.

The trainer correlated this to the groundwater scenario in the region. Groundwater is a common-pool resource—over-extraction by some people can result in depletion for others. Later, the trainers redistributed the candies equally among the participants.

The classroom sessions over two days included the following topics:

1. Introduction to Groundwater

a. Groundwater parameters
b. Global and Indian groundwater distribution statistics
c. History of groundwater and its significance for agriculture

2. Units of Measurement

a. Units of measurement, such as length, depth, area, and volume
b. Steps for computing derived units (area, volume) from basic units (length, depth)
c. Converting between different measurement systems

3. Introduction to Geology

a. Introduction to geological features and terminologies
b. Formation of igneous, metamorphic, and sedimentary rocks
c. Rock weathering and erosion
d. Typical features of rocks, such as fractures, folds, and strikes

e. Geology of the Raichur region

4. Introduction to Soil Moisture

a. Soil moisture parameters (capillary water, hygroscopic water, gravitational water) and their relation to agriculture
b. Concepts crucial for irrigation planning, such as field capacity and wilting point
c. Crop rotation, cover crops, mulching, and conservative tillage

5. Introduction to Hydrogeology

a. Key aspects of hydrogeology relevant to water issues in the region
b. Relation between geology and hydrology
c. Occurrence, movement, and distribution of groundwater in rocks
d. Zones of fracture, aeration, and saturation
e. Different soils and their components

Figure 2: Classroom sessions during the first workshop delved into hydrogeology

2.1.2 Field Visit

On the third day of the workshop, the facilitators and participants visited a dug well and borewell in Mukkanal village for a hands-on learning experience to understand the local geology and assess the water table.

At the dug well, the trainer explained the different geological layers visible on the face of the well. He demonstrated how to measure the static water level and total well depth using a measuring tape, and do a well inventory using the KoboToolbox. A similar exercise followed at the borewell. The trainer additionally shared precautions to take while measuring water levels in wells and generally during field work.

Figure 3: Field visit during the first workshop

2.1.3 Assignment: Well Inventory Using KoboToolbox

After the training was over, 28 participants took part in the field assignment on the following weekend (16 and 17 November). They were divided into 14 groups of two members. The young were paired with the elderly and the tech-savvy with those who were not. At least one member belonged to the village where the well survey was to be conducted.

Each group was instructed to survey five dug wells and collect information through the KoboToolbox. The participants completed the field assignment with satisfactory results. They surveyed 82 wells with the help of WELL Labs and Prarambha field coordinators and mapped the locations of dug wells around the Narayanpur Right Bank Canal's Distributary 10 (Figure 4).

Some entries had incorrect water level readings, which were evident from the photographs taken by the participants during the assignment. The project team cross-checked the data entries and corrected them before further analysis.

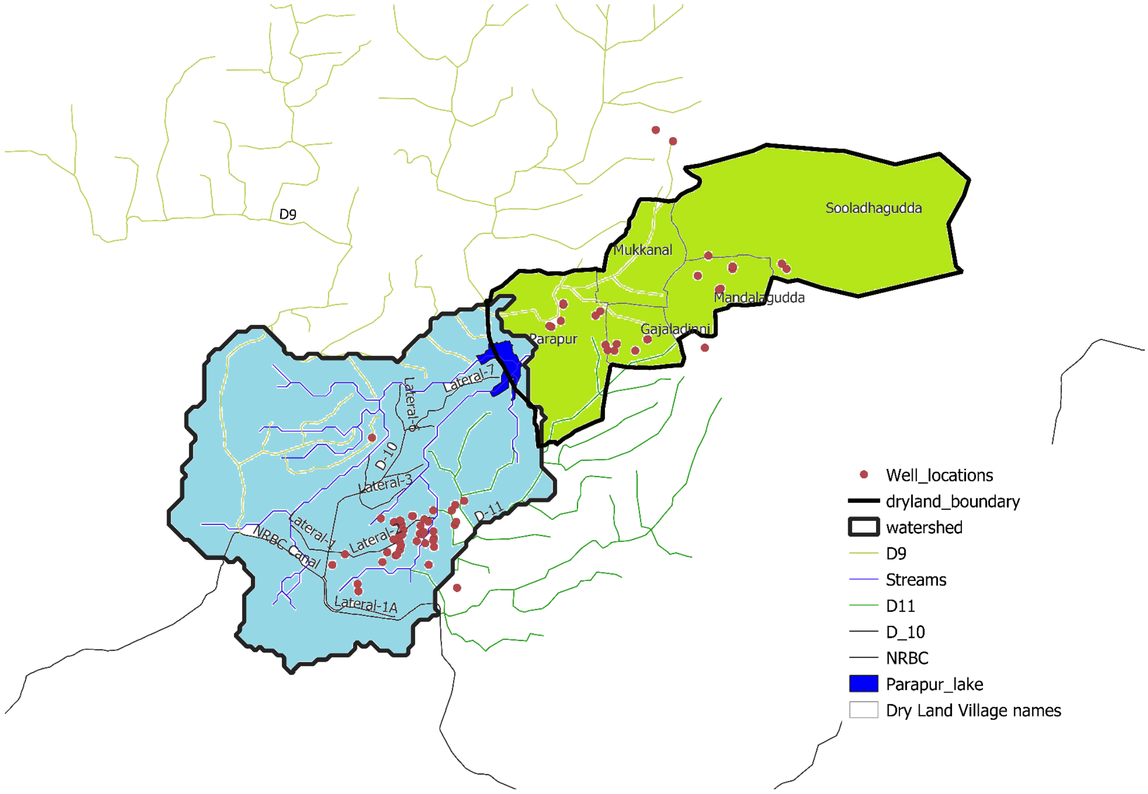

Figure 4: Well inventory around Distributary 10 of the Narayanpur Right Bank Canal. The blue-shaded region is the canal command area and the green the rainfed area

2.2 Participant Feedback

We distributed feedback forms to the participants after the 3-day session. Most rated the workshop 4 out of 5. However, they found the course material heavy on theory and suggested incorporating more practical, hands-on learning and field demonstrations. We used the participant feedback to make real-time changes to the first workshop's schedule and better plan subsequent workshops.

2.2.1 What They Want to Learn in Future Workshops

1. Quantification of wasted water and potential water-saving avenues
2. Sustainable agriculture in the local context
3. Information on water requirements of different crops
4. Soil testing methods and measures to improve soil quality

2.3 The Way Forward

The first community hydrology workshop yielded significant insights to help us make the upcoming workshops more effective. Here are the key lessons we learnt and proposed modifications for subsequent sessions.

1. Change the language of instruction to Kannada.

Conducting the sessions in Hindi, followed by a Kannada translation (at times by 2–3 people) was difficult to follow and at times, distracting. The considerable back and forth also delayed the programme schedule. To address this, all future communication will be in Kannada, both the presentations and the language in which they are delivered.

2. Reduce theoretical instruction and increase practical, hands-on sessions.

Long sessions that required sitting in the classroom did not appeal much to the participants. Instead, they preferred field exercises. They also found some sessions, such as on units, measurements, soil moisture, terminologies, etc. too academic and not useful for their context. Rather, they wanted more contextual and practical information: how to identify where they can obtain groundwater, when to dig a borewell, how to waste less water, how to cope with lean summer months and drought, groundwater-saving and recharge methods, and using groundwater data to make better crop choices.

Keeping these preferences in mind, we shall redesign the course material to suit the participants' comprehension levels and learning goals. We shall also incorporate more props and activities in the workshops, and keep presentations to under 15 minutes..

3. Revise the practical assignment

Due to the wells' remote location and the lengthy form on the KoboToolbox, each well inventory took 60–90 minutes. Participants also faced issues with network connectivity and form submissions.

Since the hydrologists have to inventory around 1,000 wells in 15 villages, we shall make the form more concise. The modified form will contain the following entries: geolocation, water level, well photo, whether it was pumped in the last 24 hours, and if yes, the depth where the soil is moist. We shall share with participants the offline mode of storing information in the form and submitting it later. We shall also check the data entries in the KoboToolbox backend to quickly identify errors and course-correct.

3. Second Community Hydrology Workshop

The second workshop took place from 22 to 24 January 2025. The classroom discussions delved into surface and groundwater hydrology, rainfall measurement, and assessing water flows in canals and natural streams. To clarify theoretical concepts, there were demonstrations of tools (for example, tipping bucket rain gauge), models (aquifers), and methods (the leaf and stopwatch method to measure water velocity). Pandu Shetty and Shreenivas Dharmaraja of WELL Labs conducted the second workshop.

3.1 Objectives

The second workshop's objectives can be broadly divided into the following categories:

Concepts

1. Explain the fundamentals of the water cycle, including the relationship between rainfall, surface water, and groundwater.
2. Understand the role of local geology in groundwater storage and recharge.
3. Differentiate between units of measurement for water flow (such as one cubic foot per second or cusec) and storage (such as thousand cubic feet or TMC).

Skills

1. Accurately measure rainfall using a rain gauge.
2. Apply basic, low-cost methods (e.g., using a bucket and stopwatch or leaf and stopwatch) to measure water discharge and velocity.
3. Record and monitor water levels in canals, streams, and wells.
4. Use digital tools like KoboToolbox for data collection and management.

Attitudes

1. Appreciate the relationship between surface and groundwater, and begin seeing the value of conjunctive use of both sources of water.
2. Recognise groundwater as a shared, finite resource that requires collective management.
3. Take on a proactive role as a community hydrologist to promote effective water governance.

3.2 Workshop Modules

3.2.1 Classroom Discussions

The sessions comprised simple, graphic presentations to introduce the cohort to the following concepts and methods:

Catchment Area

The cohort learned about how rainfall within a watershed flows towards lower elevations as surface runoff, forming streams or rivers. Some of this water seeps into the ground, contributing to groundwater recharge and raising water levels in wells. Part of it is stored in lakes and ponds as surface water, which further percolates to replenish groundwater. The role of rainfall as the primary input to the watershed was also explained to the participants.

Rainfall movement and measurement

Participants learned to measure the amount of precipitation at a specific location, where the incoming water is collected without allowing it to run off, infiltrate into the soil, or evaporate. A rain gauge is used for this purpose, as it captures rainfall at a point location. The rainfall recorded at that point is generally assumed to represent the rainfall over the surrounding area.

Water flow from dams

Another key input into the canal command area is the water inflow from the dam through the canal. Participants were introduced to the concept of measuring flow in the canal, which has a defined geometrical cross-section.

Water flow from natural streams

Unlike canals, natural streams do not have a well-defined cross-section and their channel slope changes over time. Therefore, measurement requires a different approach. The stream's cross-section was determined by recording water depth at regular intervals, while the velocity was measured using the float-and-stopwatch method.

Apart from the above concepts, the classroom discussions also introduced different methods for capturing data on water flow, storage, discharge, and velocity.

Flow and storage measurements

To set the foundation for data collection and analysis, common units of measurement, such as cusecs (cubic feet per second) for water flow and TMC (thousand million cubic feet) for water storage, were introduced. The trainers showed participants a 1 cubic foot model to demonstrate that it contains 28.3 litres of water and explained that a discharge of 1 cusec equals 28.3 litres per second. They also shared flow rates for the Narayanapura Right Bank Canal.

Discharge measurement

The cohort learned how to calculate discharge, that is, the amount of water flowing past a certain point in a water body over a period of time. The trainers introduced the bucket-and-stopwatch method (a simple, low-cost way of calculating water discharge for small water flows), which the cohort later used on the field. The trainers also showed how they could use the method to measure the discharge (pumping rate) of water pumps.

Canal water and streamflow measurement

The participants learnt to measure discharge for larger water flows, such as in canals and streams. We introduced them to the leaf-and-stopwatch method, a simple, low-cost method for measuring surface velocity, along with tools to measure cross-sections of large water channels.

3.2.2 Classroom Demonstrations

Along with the classroom discussions, there were demonstrations of tools and models to strengthen the cohort's foundational understanding of hydrology.

Ordinary Rain Gauge

In an ordinary rain gauge, rainwater collects in a small jar or cylinder. The reading is usually recorded in millimetres. The cohort learned about the importance of rainfall measurement and the correct way to install a rain gauge to gather accurate data.

Tipping Bucket Rain Gauge

This is an instrument to measure the amount and intensity of rainfall at a specific location. Rainwater collects in a small bucket that tips when full, automatically sending a signal to record the amount and timing of rainfall. The cohort learned how to install it and how the data derived from this differs from, and complements, the data collected by an ordinary rain gauge.

Figure 5: Demonstrating how an ordinary rain gauge (left) and a tipping bucket rain gauge (right) works

Aquifer Model

A physical model depicting groundwater behaviour under different conditions, such as when the water is confined by layers of impermeable rock (confined aquifer) and when it moves through porous rock and soil (unconfined aquifer). The demonstration included pumping water from one well and observing the drop in water level in a nearby well, reinforcing the idea that groundwater is a shared resource whose use or overuse impacts everyone.

One Cubic Foot Model

We showed the cohort a model to give them a sense of the look and feel of one cubic foot, that is, 28.3 litres of water.

Figure 6: Demonstration of confined and unconfined aquifers (left) and a one cubic foot model (right)

3.2.3 Field Demonstrations

The classroom demonstrations helped the cohort learn about different tools and instruments used for water resources management. Building on this foundation, the training moved outdoors, where the participants applied in real-world settings what they had learnt in the classroom.

Bucket-and-Stopwatch Method

Figure 7 (right): Demonstration of discharge calculation using the bucket-and-stopwatch method

The cohort experienced the real-world application of this method using water flowing from a can. They recorded three readings with a stopwatch and used them to calculate the average time taken to fill a bucket of a known volume. With this data, they calculated the discharge rate. Further, the facilitators explained the applicability of this method to measure the discharge rate of a water pump as well as the rate of domestic water wastage that can occur through leaking taps.

Water-Holding Capacity of Soil

The trainers explained the water-holding capacity of the aquifer materials using demonstrations of different particle sizes. On one side, they placed fine sand, which has larger pore spaces and thus, allows water to pass through easily. On the other, they put clayey soil, whose smaller pore spaces make it hold on to water.

Canal Cross-Section Measurement

The cohort visited a canal and stream to measure discharge in open channels. They learned to measure their cross-sections by identifying different points along the water channels and recording the width from bank to bank. At each of these identified points, they learned to measure and record the depth of the water channel. In small channels, they measured it directly at the specific point using a scale/staff gauge. In larger channels, they recorded the slant distance from a marked point on the bank to the water surface and used it to calculate the water depth (by using a mathematical conversion factor that derives actual depth from the slant depth and the cross-section measurements of the canal when it is dry).

Figure 8: Stream cross-section and depth measurement (left); Canal cross-section and depth measurement (right)

Leaf-and-Stopwatch Method

The final demonstration helped the cohort understand and measure surface velocity in a nearby canal and stream. A floating object (a leaf in this case) was released into the water to travel a set distance. The time it took was measured across three rounds. The average time was used to calculate the water velocity.

Figure 9 (right): Measuring water velocity using the leaf-and-stopwatch method

3.2.4 Field Assignments

To foster continuous monitoring, learning, and ownership, some participants did field assignments: taking real-time measurements of canals and natural streams. However, where all participants completed the assignment in the first workshop, in the second, only those who lived close to canals and streams did it.

Measuring Canal Depth and Water Velocity

Thirteen members of the cohort used the leaf and stopwatch method to calculate the canal's water velocity. They also measured the water depth using methods appropriate to the size of the water channel, and recorded their readings on the KoboToolbox.

Figure 10: Measuring water depth in a small canal (left) and a main distributary (right)

Natural Streamflow Measurement

Three participants installed staff gauges along a natural stream to measure water levels at different points. They were instructed to record the readings daily and upload the data onto the KoboToolbox.

Figure 11 (right): Staff gauge reading taken by a participant

3.3 Insights from the Second Workshop

In the second workshop, participants strengthened their grasp of surface and groundwater hydrology foundational concepts. They applied the skills they had learnt on the field and excelled in using low-cost measurement tools and collecting digital data. They found the following aspects of the workshop interesting and useful:

1. Demonstration models and fieldwork

The cohort appreciated the emphasis on demonstrations and practical sessions, which were more in number compared to the first workshop. Moreover, sharing a glossary of terms before the session helped facilitate discussions and data collection.

2. Insights into groundwater movement, availability, and over-extraction

The combination of theory and practical exercises helped the cohort learn about groundwater availability in their region and why it is important to collectively monitor and manage it. They were able to relate this to the local geology, the functioning of the water cycle, and human activities.

3. Knowledge of tools and methods to record and monitor rainfall, water discharge, and water velocity

The cohort found the measurement techniques—using a leaf, stopwatch, or bucket—simple and relatable. They could quantify water flows and correlate the measurements with local water availability. Further, they started thinking about the significance of such efforts in developing informed water management plans.

3.4 The Way Forward

1. Provide reference materials.

A few participants mentioned that visual guidebooks or playbooks as reference materials would be helpful for field work.

2. Simplify calculations.

Some found the calculations challenging and requested simpler thumb rules in place of formulae or calculations.

3. Incorporate modules on the topics participants want to learn more about.

The cohort expressed their interest in learning more about:

a. How surface and groundwater hydrology concepts can be applied to water management practices in farms
b. Crop-specific irrigation practices
c. Soil health management
d. Tools and methods to assess water quality
e. How to effectively recharge borewells

4. Third and Fourth Community Hydrology Workshops

4.1 Introduction

The third workshop took place from 20 to 22 May 2025 and the fourth on 29 September 2025. The former focused on water balances, crop water requirements, and water budgeting, while the latter introduced two additional sessions based on participant feedback—on soil health and improving water-use efficiency through micro-irrigation. It also included the review and consolidation of concepts covered in previous sessions, and facilitated dialogue between community hydrologists and water user cooperative society members, particularly regarding the acceptance and application of water budgeting for crop planning.

While the first two workshops helped participants measure and monitor water, the next two helped them progress to analysing and applying this knowledge for crop planning, irrigation management, and soil and water conservation.

4.2 Objectives

After the fourth workshop, participants were expected to develop the following competencies:

Concepts

1. Explain the components of a water balance (inflows, outflows, and storage).
2. Describe how soil characteristics and crop choices influence water availability and use.

Skills

1. Carry out crop water budgeting using local rainfall, canal, and groundwater data.
2. Measure and interpret soil moisture, texture, and pH, and learn to apply these insights to irrigation and crop management.
3. Understand and evaluate micro-irrigation systems suited to local soil types and water availability.

Practices

1. Have peer-to-peer and institutional discussions with water user cooperative members to support collective water governance.
2. Translate hydrological and agronomic insights into water-use plans and cropping recommendations for water user cooperative societies.
3. Identify and articulate specific services that community hydrologists can provide to support local water governance.

4.3 Third Community Hydrology Workshop Modules

Pandu Shetty and Shreenivas Dharmaraja of WELL Labs were the trainers for the third workshop.

Classroom Sessions: Water Balance

The workshop began with a recap of earlier modules and established the link between surface and groundwater monitoring and water balances. Participants learned to use the measurements of hydrological inputs and outputs (rainfall, canal inflow, evapotranspiration, and runoff) to estimate their combined impact on water availability.

They used an HTML tool WELL Labs developed, which calculated the water balance upon entering relevant hydrological measurements. With the data from the Narayanpur Right Bank Canal Distributary 10, the cohort used the tool to arrive at a simplified water balance for the region:

1. Inflow: 45 inches (rainfall and canal inflow)
2. Outflow: 40 inches (evapotranspiration and runoff)
3. Change in storage: 5 inches (groundwater infiltration)

A simple takeaway helped consolidate their understanding: If the inflow exceeds the outflow, water is saved. If the outflow exceeds the inflow, there is a need for additional water.

Field Exercise: Measurements

Participants measured soil moisture, recorded casing depth (as an estimate of weathered zone/ aquifer thickness), and observed soil water retention to visualise the storage component of the water balance. These field exercises bridged classroom theory with local, observable processes.

Figure 12: Mapping the weathered zone by assessing the casing depth and well history

Field Exercise: Crop Water Budgeting for the Kharif Season

The participants used the water balance exercise to create a water budget for kharif season (June to October) crops. They were divided into three groups based on where they lived:

1. Areas irrigated by the head end of canals
2. Areas at the tail end of canals
3. Rainfed areas

They estimated available water in their respective regions using rainfall, canal flow, and groundwater data, and compared it to the water requirements of different crops: paddy (40 inches), cotton (30 inches), and chilli (20 inches). Wherever there were deficits, they modified cropping patterns to achieve sustainable water use plans. The exercise demonstrated the importance of equitable distribution and efficient irrigation practices, such as alternate wetting and drying for paddy, and drip irrigation for cotton and chilli.

Figure 13: Measuring soil moisture (left);
Calculations of available water and crop water requirements (right)

Interaction with Water User Cooperative Society Members

The workshop's concluding session brought together the community hydrologists and seven members of the local water user cooperative society to discuss potential services that the former could provide to the latter. They discussed water-budget-based crop planning, monitoring of local water resources, soil testing, how to support government programmes, and maintaining canal infrastructure. They also touched upon low-cost solutions for seepage and conveyance losses, which generated considerable interest.

Post-Workshop Assignment: Crop Water Budgeting for the Rabi Season

Having completed water balance calculations for the kharif season during the workshop, the three groups calculated water balances for the rabi cropping season (October to March) using synthetic data. The inputs for the water balances included rainfall during the kharif season, estimated groundwater levels, planned rabi crop patterns, and sowing areas.

Where the water budget indicated a deficit, participants recalculated it using alternate crop combinations or modified sowing areas to achieve a realistic balance between available water resources and crop water demand. They presented the results of this assignment during the fourth workshop. It formed the basis for discussions with water user cooperative society members on the feasibility of modifying cropping patterns in response to local water availability.

Figure 14: Crop planning based on water budgets (left);
Community hydrologists interact with water user cooperative society members (right)

4.4 Fourth Community Hydrology Workshop Modules

We held the fourth community hydrology workshop on 29 September 2025 to accommodate participants' feedback and learning demands. In the earlier workshops, they had asked for sessions on soil health, micro-irrigation, and seasonal crop planning. Only those who had requested additional sessions attended the workshop—it included 20 people, including four field staff from Prarambha.

4.4.1 Assignment Review and Dialogue with Water User Cooperative Society Members

Participants presented their crop water budgeting exercises and reflected on the differences across command and dryland zones. A structured discussion followed between the community hydrologists and water user cooperative society members, focusing on the use of water budgets for planning and decision-making. The dialogue helped align community data collection efforts with institutional water management goals.

4.4.2 Soil Health and Analysis

Led by Lokappa Nayak, this session covered the physical, chemical, and biological properties of soil, and how these characteristics influence water retention and productivity. A demonstration of soil texture and pH testing helped participants understand the importance of maintaining soil structure, organic content, and nutrient balance to sustain water availability and crop growth.

4.4.3 Water Use Efficiency and Micro-Irrigation

Professor Rajkumar R Halidoddi and Professor Prasad Kulkarni of the University of Agricultural Sciences, Raichur introduced the principles and practices of micro-irrigation, highlighting its potential to reduce over-irrigation and prevent soil degradation. The session covered drip and sprinkler system components, filtration requirements, and soil-based dripper spacing. Participants also discussed saline water management, pressure regulation, and maintenance for reliable performance.

Figure 15: Soil texture classification and pH measurement (left);
Discussion on micro-irrigation principles and practices (right)

4.5 Learning Outcomes

1. Conceptual understanding

Most participants developed a basic but clear grasp of the water balance framework and could articulate how rainfall, canal inflow, and groundwater interacted.

2. Technical and analytical skills

The cohort became comfortable with measurement tools (rain gauges, sounders, tapes, and scales) and could carry out water budgeting exercises in guided settings. The assignment showed their capacity to use these tools independently.

3. Community and institutional roles

The interactions between community hydrologists and water user cooperative society members increased awareness regarding the potential services the former can offer. However, the communication of technical findings to society members still needs strengthening to ensure the understanding and uptake of evidence-based insights.

4.6 Participant Feedback

1. Participants expressed a need for simpler calculation tools and continued mentoring to reinforce applied numeracy and data interpretation.
2. Access to field instruments such as soil testing kits and irrigation efficiency tools is limited.
3. They requested continued support and refresher sessions to sustain engagement and confidence.

5. Programme Outcomes

This section delves into the progress the programme made on its goals and the intended learning outcomes. The assessment draws from the workshop trainers' observations of the cohort's performance in the classroom, field exercises, and assignments.

Objective	Outcomes	Progress Status
Understand the links between rainfall, canals, groundwater, and geology.	Participants could explain these links.	*Achieved* The aquifer model and casing-depth demonstration were helpful in understanding these topics.
Measure discharge, flow, and soil moisture.	Participants were able to measure water flow and discharge (using the bucket,leaf, and stopwatch methods), cross-sections, and soil moisture.	*Achieved* The participants measured soil moisture as a group as there was only one kit available.
Set up and run a monitoring network for rainfall, surface water, and groundwater, and use the KoboToolbox.	- Participants surveyed 82 wells in the first workshop. - They measured canal depth, water velocity, and streamflow in the second workshop. - They were comfortable using the KoboToolbox.	*Achieved* In the beginning, they made errors, but as we worked with them, their data entries became more accurate. The scale they used to measure the canal depth had readings in inches as well as centimetres. This caused some confusion.
Calculate water balances and crop water budgets.	- They developed water balances with an HTML calculation tool. - They calculated crop water budgets for the kharif season during the third workshop. - They did the same for the rabi season as an assignment after the third workshop.	*Partially achieved* They can compute water balances and budgets with the HTML tool. However, instructors need to explain concepts like irrigation days and inches of water in the field to help calculate water balances.

Translate hydrological insights into recommendations and provide advisory services to water user cooperative societies.	The third and fourth workshops initiated dialogue between community hydrologists and water user cooperative society members and provided a glimpse of the possible services the former could offer to the latter.	*Not achieved yet* - Community hydrologists were not able to effectively translate hydrological insights into practical recommendations for water user cooperative society members. - As a result, the programme was not able to develop a service model where the former could provide water management advisory to the latter.
Adopt better agronomic practices (maintaining soil health, micro-irrigation, etc.) to improve water-use efficiency.	While the participants learnt more regarding these practices, to put them into action, they require low-cost testing kits to assess soil and water quality, and financial support to set up micro-irrigation systems.	*Not achieved yet*

Table 1: Objectives vis-a-vis outcomes of the community hydrology programme

The programme's second phase will build upon the first phase to address the pending objectives.

5.1 Achievements

1. As part of their practical training in groundwater monitoring, participants independently carried out an inventory of water sources. This included 978 dug wells and borewells across rainfed lands and the command area of Narayanpur Right Bank Canal's Distributary 10.
2. After the programme, we hired four community hydrologists under the CLARITY project to generate a time-series groundwater database across Distributary 10 and the Raichur Transformation Lab[2]. They have been monitoring groundwater levels monthly since April 2025 using electrical sounders. Their successful development of the database serves as a proof of concept for the programme's goal of strengthening hydrological skills at the grassroots.

[2] *The Raichur Transformation Lab is a collaborative space where communities co-develop and test sustainable, equitable solutions. The command area of Distributary 10 (~50 sq. km) is part of the larger Raichur Transformation Lab (~5,500 sq. km).*

3. The four community hydrologists have also been taking rainfall measurements using a manual rain gauge (daily during the monsoon and whenever it rains during other times of the year) and canal water measurements at four locations daily since 26 August 2025.

5.2 Learning Outcomes

With the first phase, participants gained a scientific understanding of water issues and how to measure rainfall, water levels in wells, and streamflow in canals. They are also aware of the data inputs required for water balances, how to calculate it with the help of a tool, and interpret the results. However, given their varying literacy levels and backgrounds, their learning trajectories varied.

To gauge participants' understanding of key hydrology and water management concepts, we conducted an assessment with 10 multiple-choice questions at the end of the fourth workshop. Since only half the cohort took the test and the questions were the same for all the participants regardless of what assignments they participated in[3], the results do not accurately reflect their knowledge and what they retained from the workshop. However, those who took the test got most answers right, especially those regarding measuring rainfall and soil moisture, the effects of over-irrigation, and the purpose of well inventories.

[3] *As mentioned in Section 3.2.4, only the 13 participants who lived close to canals took part in the assignment to measure canal velocity.*

6. Insights from the Programme

1. There is significant interest in and demand for hydrological expertise and technical skills among the community.

The cohort took out time from their busy schedules to attend the workshops, often for three days at a stretch. During each session, they paid attention, had informed discussions, completed assignments, and shared feedback. The CLARITY project team was heartened to see the high levels of engagement. The sustained participation in the programme over months demonstrates that community members saw value in building their hydrological expertise and technical skills.

2. The cohort knew what they wanted from the workshops and voiced their demands, which ensured that they shaped the programme along with the planning team and instructors.

Initially, the CLARITY project team designed the workshop based on preliminary insights from community members. However, what researchers perceive as the need of the hour does not always align with what the community identifies as priorities. Spreading out the programme across months and keeping an iterative structure for the modules helped incorporate participant feedback and build a cadence of learning.

As the programme unfolded, the cohort asked for simpler calculators and playbooks, soil testing, groundwater-recharge techniques, localised crop-water guidance, and assistance in making water budgets usable for water user cooperative society members.

3. While community members and institutions acknowledge the need for community hydrologists, it is not yet a clearly defined, valued, and remunerated service.

There is a lack of technical skills at the grassroots, which cannot always be fulfilled by external experts. Given how crucial effective water management is to people's lives and livelihoods in semi-arid Raichur, there is a need for hydrology expertise to support farmers, those working on natural resources management projects, and water user cooperative societies. While community members and institutions acknowledge their need for this expertise, we need to develop service models to ensure that community hydrologists are valued and compensated for their work.

4. Future phases and editions of the programme must focus as much on data analysis and use as on collection.

Participants found it easier to pick up data measurement and entry (measuring rainfall, reading sounders, filling the KoboToolbox, etc.) than making sense of the data (discerning patterns, drawing conclusions, etc.). Thus, while they could understand hydrological concepts, they found it challenging to explain why a particular measurement mattered or how to join the dots between different data points to make water management decisions.

5. We must emphasise precision and consistency in data collection, and explain the rationale behind this emphasis.

While teaching groundwater data collection, it is important to explain basic principles that might seem obvious to those with more experience in the domain. For example, if someone has measured the water level in a dugwell at a particular spot, they cannot choose a different spot the next time and use the data to make deductions about changes in water levels. Similarly, if someone has measured the water level in a dug well as 4.75 feet, they cannot round it off to 5 feet to simplify calculations. The small difference in rounding off the length can give a radically different result when calculating the volume of water it can store. Thus, data collection should emphasise precision and consistency to reduce the possibility of errors and ensure that measurements accurately reflect ground realities.

6. Community hydrologists should explain what they do and why to seed awareness in the community.

When community hydrologists collect data in the field, passersby often ask them about what they are doing and what purpose it serves. Often, their first response is to say that they are collecting data as part of a workshop. Instead, they should explain their work in simple, accessible language to increase awareness regarding water management in their communities. As communities understand the significance of their work, it would also become easier to collect data, especially from private lands, where the owners might have apprehensions about letting people in.

7. A key barrier to hydrological data collection is the lack of locally available equipment.

While we gave the participants instruments to take measurements, they could not continue learning on their own as they did not have access to equipment. Thus, basic field kits for community hydrologists could make a significant difference. These could include a sounder/tape, portable soil testing kit, stopwatch, and guide. Since funding these kits is a challenge, we could explore cost-sharing arrangements or micro-grants provided by water user cooperative societies to ensure community ownership.

7. The Way Forward

The Advanced Centre for Integrated Water Resources Management (ACIWRM), a think tank of the Government of Karnataka, invited us to incorporate the Community Hydrology Programme with their 'Farmer Water Schools'.

These schools seek to build a cadre of trained community water service providers to support farmers in making better crop choices, manage soil health, and optimise groundwater use. We shall merge the Community Hydrology Programme's curriculum with that of the schools. It will also incorporate elements from the manuals and guidelines of the Atal Bhujal Yojana and the Food and Agriculture Organization. Many community members have expressed interest in becoming part of this cohort.

Further, we shall co-create a 'service menu' for community hydrologists to realise the 'service model' envisioned in the programme's first phase.

The range of services community hydrologists can provide include well inventory, monthly canal or well readings, water quality checks, soil testing, advice on crop choices and sustainable farming, support with the maintenance of irrigation infrastructure, etc. For each service, there could be a fee-for-service or barter model that could be decided in consultation with the target client (water user cooperative societies, farmer groups, etc.). This is key to developing a model where community hydrologists are valued service providers rather than volunteers. For its sustainability, we would also have to ensure that consistent work is available throughout the year and that community hydrologists' wages match, if not exceed, their current incomes.

To improve learning outcomes, we shall also create guides for various activities.

Printed materials that community hydrologists can easily refer to on the field not only reduces their cognitive load, but can also promote uniformity, consistency, and precision in data collection. Short guides to various tasks, such as installing a rain gauge, using the leaf-and-stopwatch method to measure water velocity, entering data into the KoboToolbox, and testing soil texture and pH, can help community hydrologists independently do their work or troubleshoot. These guides will largely rely on visual cues with minimal text on how to use instruments or carry out a particular task.

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Meanwhile, some of the trained community hydrologists are providing their services to the CLARITY project and other initiatives in the region.

Those who would like to continue learning can be paired with Prarambha and WELL Labs staff to monitor water resources and engage with water user cooperative societies. This can more reliably build expertise at the grassroots and facilitate long-term knowledge transfer.

8. Annexure: Workshop Modules and Presentations

This section compiles the resources and presentations we used during the programme.

First Community Hydrology Workshop, November 2024

1. Workshop Overview (Kannada) | View Here
2. Workshop Overview (English) | View Here
3. Presentation: Introduction to Geology (English) | View Here
4. Presentation: Units of Measurement (English) | View Here
5. Presentation: Groundwater and Hydrogeology (English) | View Here
6. Presentation: Importance of Groundwater (English) | View Here

Second Community Hydrology Workshop, January 2025

1. Presentation: Recap of the First Workshop and Introduction to Hydrological Parameters (English) | View Here
2. Presentation: Rainfall, Natural Streamflow, and Discharge Measurement (English) | View Here
3. Presentation: Streamflow Measurement (Kannada) | View Here
4. Presentation: Groundwater Yield (English) | View Here
5. Presentation: Groundwater and Aquifers (English) | View Here

Third Community Hydrology Workshop, May 2025

1. Presentation: Day 1 (Kannada) | View Here
2. Presentation: Day 1 (English) | View Here
3. Presentation: Day 2 (Kannada) | View Here
4. Presentation: Day 2 (English and Kannada) | View Here
5. Presentation: Day 3 (Kannada) | View Here
6. Presentation: Day 3 (English and Kannada) | View Here

Fourth Community Hydrology Workshop, September 2025

1. Presentation: Recap of the First Three Workshops (Kannada) | View Here
2. Presentation: Recap of the First Three Workshops (English) | View Here