



People are more than just data points but a **silent water crisis** continues in ASEAN. For millions in rural communities, groundwater dependency remains over-exploited and unmonitored, becoming a source of inequality. This *last-mile* crisis has been overlooked for too long due to a critical lack of data.

By transforming this challenge into an opportunity through a participatory and data-driven approach, we propose **HydroLink**, a SAP-based solution that empowers communities from the ground up by a low-cost automated hardware to collect real-time water data, which is then translated into simple warnings and predictive insights on a user-friendly mobile app.

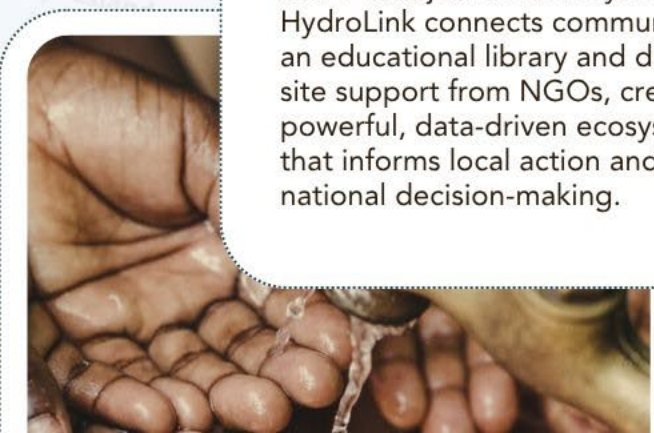
More than just an alert system, HydroLink connects communities to an educational library and direct on-site support from NGOs, creating a powerful, data-driven ecosystem that informs local action and national decision-making.

ASEAN's Silent Water Crisis

A Call for Participative, Data-driven Groundwater Action

Team Sharksfin

Members: Lizzie Annika Montemayor, Val Allen Eltagonde
 Institution: Ateneo de Manila University



GROUNDING THE PROBLEM

Poblacion, Panglao faces salinity and bacterial contamination, threatening access to safe drinking water.



Annals of Tropical Research 46 (1):120-139(2024)
<https://doi.org/10.32945/atr4619.2024>



Assessment of the quality of groundwater wells in the island Municipality of Panglao, Bohol, Philippines

Ma. Grace C. Sumaria^{1*}

ABSTRACT

The study was conducted in the Municipality of Panglao, Bohol, Philippines to investigate water quality in 81 wells using parameters such as pH, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS), sodium chloride (NaCl), temperature, and nitrate-N. Spatial variation is analyzed through ArcGIS 10.6 and regression analyses.

Results showed that about 40% of the study area's nitrate concentration exceeded the maximum contaminant level (MCL) of 10mg L^{-1} as set by US EPA under the Safe Drinking Water Act. The water quality was poor mostly in barangays with high-density built-up and along the foreshore. On the average, pH was 7.44, DO was 4.27mg L^{-1} , EC was $3,954.82\mu\text{S cm}^{-1}$, TDS was $3,480.60\text{mg L}^{-1}$, NaCl was $4,377.50\text{ppm}$, temperature was 29.36°C and nitrate was 11.05mg L^{-1} .

The multiple regression analysis showed that nitrate is significantly predicted by well to shoreline distance and 2D inverse distance weight. The T-test results indicated that the level of nitrate concentration differed significantly between the types of well where it was found to be higher in shallow wells and lower in deep wells.

Based on the overall results, the following recommendations were drawn for the Municipality of Panglao to implement: a) install a wastewater treatment facility to address the unfavorable presence of nitrate and other contaminants in the groundwater, and b) enact

Received: 28 June 2022
Revised: 25 June 2023
Accepted: 30 August 2023
Published: 29 June 2024



© The authors. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

2024
study

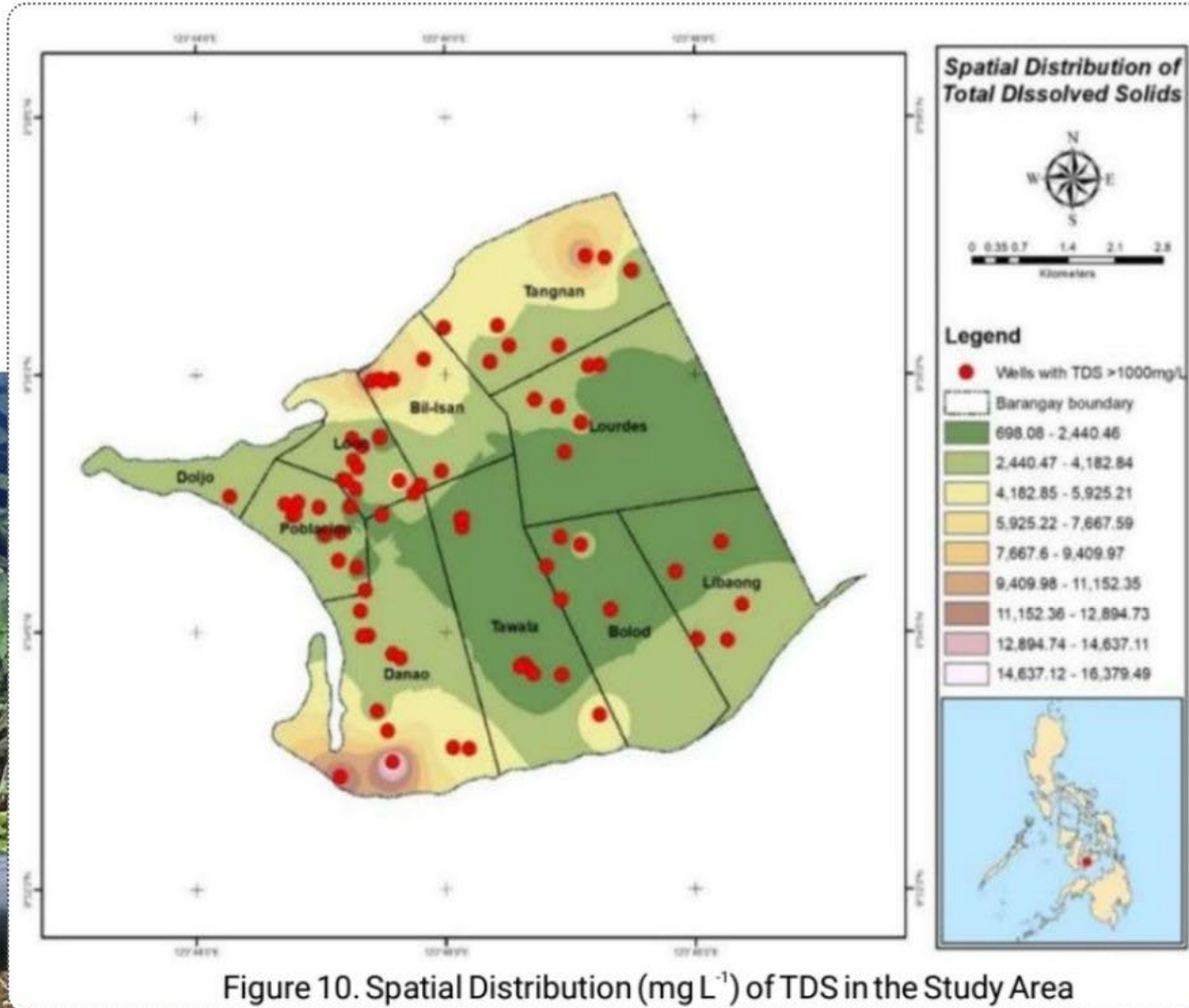
¹Department of Agricultural and Biosystems Engineering, Visayas State University, Baybay City, Leyte, Philippines

*Corresponding Author. Address: Department of Agricultural and Biosystems Engineering, Visayas State University, Baybay City, Leyte, Philippines; Email: grace.sumaria@vsu.edu.ph

Source

Assessment of the quality of groundwater wells in the island Municipality of Panglao, Bohol, Philippines (2024)

GROUNDING THE PROBLEM



Assessment of the quality of groundwater wells in the island Municipality of Panglao, Bohol, Philippines

Ma. Grace C. Sumaria^{1*}

ABSTRACT

The study was conducted in the Municipality of Panglao, Bohol, Philippines to investigate water quality in 81 wells using parameters such as pH, dissolved oxygen (DO), electrical conductivity (EC), total dissolved solids (TDS), sodium chloride (NaCl), temperature, and nitrate-N. Spatial variation is analyzed through ArcGIS 10.6 and regression analyses.

Results showed that about 40% of the study area's nitrate concentration exceeded the maximum contaminant level (MCL) of 10 mg L^{-1} as set by US EPA Drinking Water Act. The water quality was poor in barangays with high-density built-up and nearshore. On the average, pH was 7.44, DO was 4.27 mg L^{-1} , EC was $3,954.82\mu\text{S cm}^{-1}$, TDS was $3,480.60\text{ mg L}^{-1}$, NaCl was $4,377.50\text{ ppm}$, temperature was 29.36°C and nitrate was 11.05 mg L^{-1} .

The multiple regression analysis showed that nitrate is significantly predicted by well to shoreline distance and 2D inverse distance weight. The T-test results indicated that the level of nitrate concentration differed significantly between the types of well where it was found to be higher in shallow wells and lower in deep wells.

Based on the overall results, the following recommendations were drawn for the Municipality of Panglao to implement: a) install a wastewater treatment facility to address the unfavorable presence of nitrate and other contaminants in the groundwater, and b) enact

Received: 28 June 2022
 Revised: 25 June 2023
 Accepted: 30 August 2023
 Published: 29 June 2024

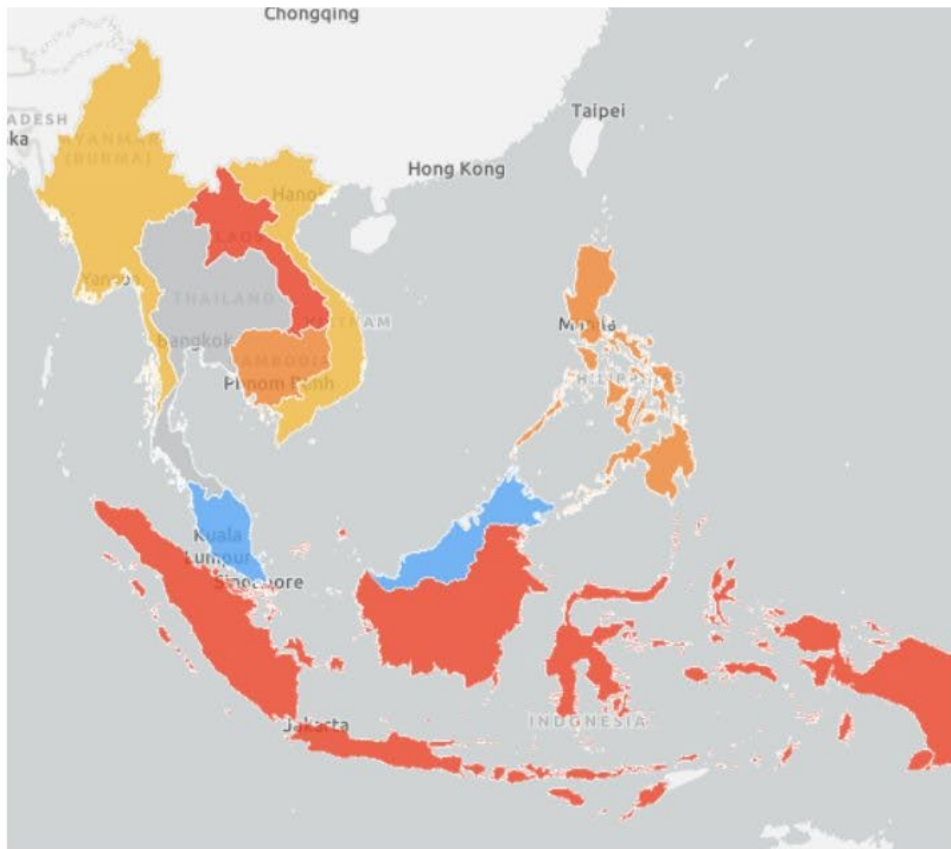


© The authors. This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

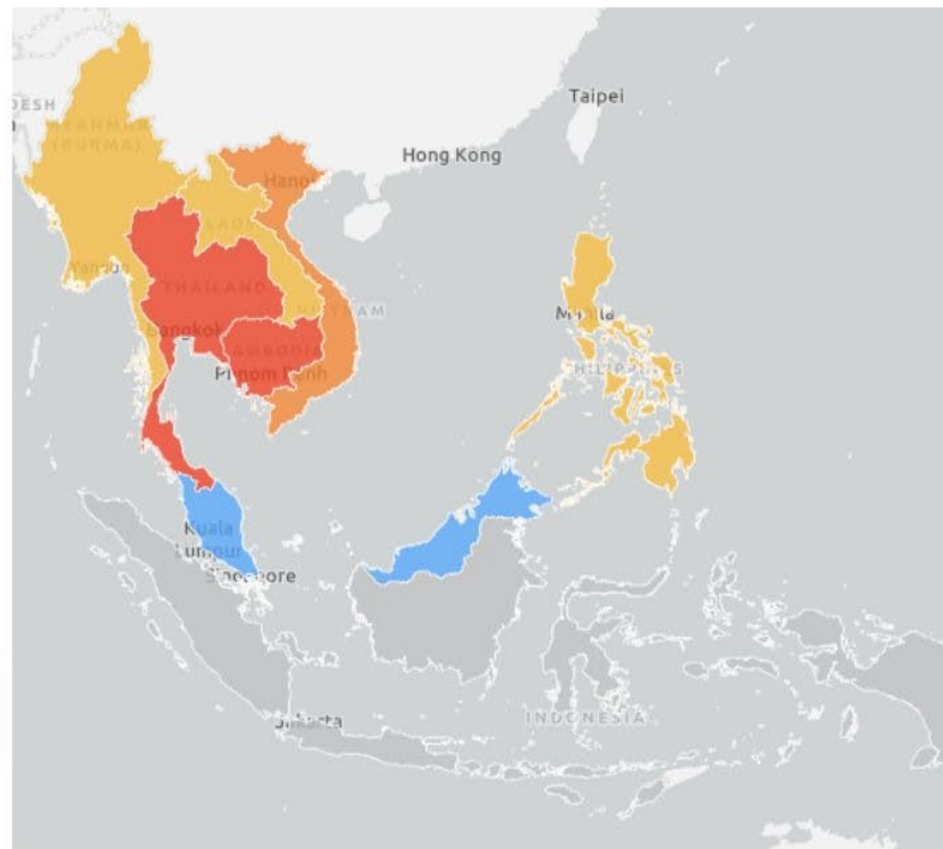
¹Department of Agricultural and Biosystems Engineering, Visayas State University, Baybay City, Leyte, Philippines

*Corresponding Author. Address: Department of Agricultural and Biosystems Engineering, Visayas State University, Baybay City, Leyte, Philippines; Email: grace.sumaria@vsu.edu.ph

Access to clean water in ASEAN is a last-mile crisis because people are more than just data points.



SDG 6.1.1. Population using safely managed drinking water services



SDG 6.2.1. Population using safely managed sanitation services and handwashing facility

LEGENDS

6.1.1

Country (6.1.1)



LEGENDS

6.2.1

Country (6.2.1)

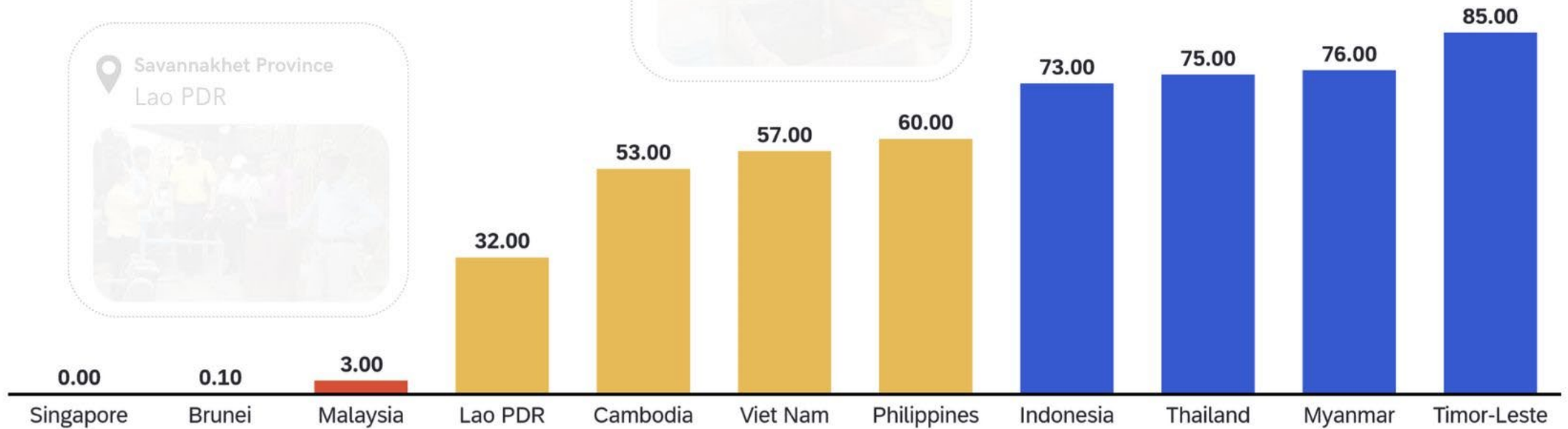


Source

United Nations, Department of Economic and Social Affairs, Statistics | SDG Indicators Database.

In reality, **groundwater still remains a dependency** for many of our communities.

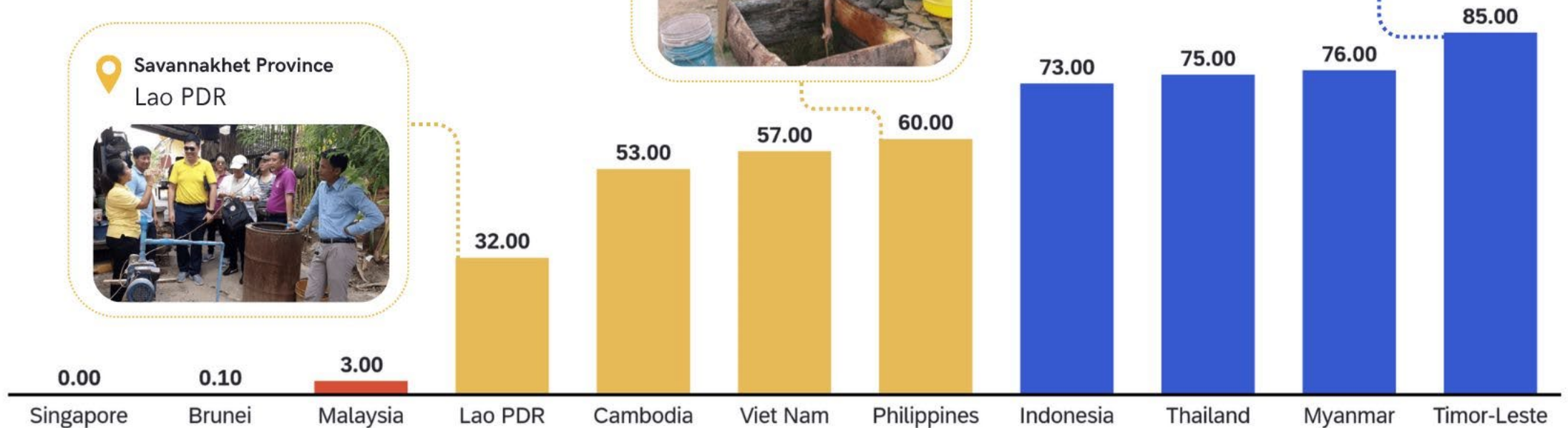
Percentage of Population Reliant on Groundwater, by Country (in %)



 **Source** UN-Water Global Analysis and Assessment of Sanitation and Drinking-water Data Portal

In reality, groundwater still remains a **dependency** for many of our communities.

Percentage of Population Reliant on Groundwater, by Country (in %)



However, groundwater in these communities is over-exploited and **poorly monitored**, lacking *sustainability*.

Rule Definitions for Classification

Near WHO Limit

$\leq 1.2 \times \text{WHO limit}$

Exceeds WHO Limit

$> 1.2 \times \text{WHO limit and } \leq 2 \times \text{WHO limit}$

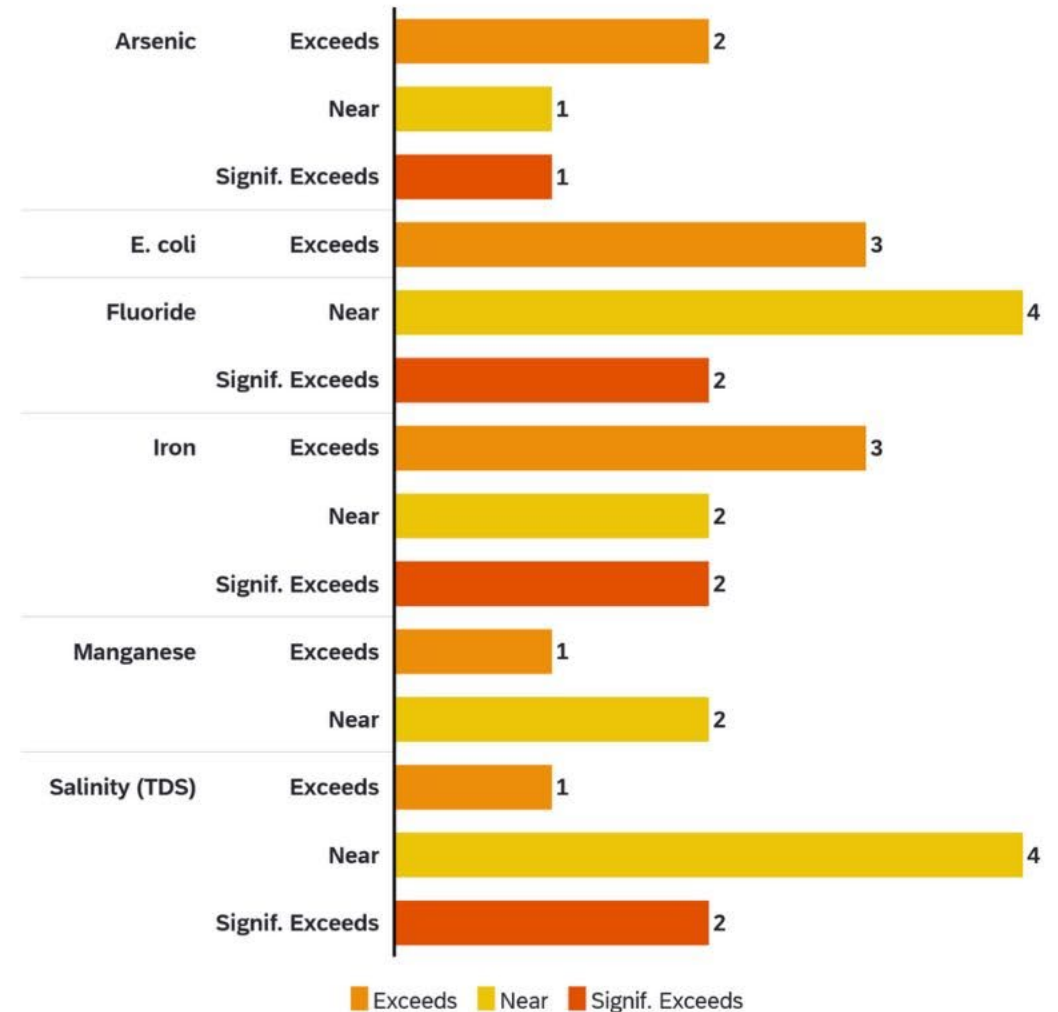
Significantly Exceeds WHO Limit

$> 2 \times \text{WHO limit}$

 Source

WEPA Outlook on Water Environmental Management in Asia (2024)

Number of ASEAN countries per contaminant and contamination level





Republic of the Philippines

PHILIPPINE NEWS AGENCY



HOME NATIONAL PROVINCIAL OPINION BUSINESS FEATURES HEALTH FOREIGN SPORTS TRAVEL ENVIRONMENT SCITECH

9 water sources in Negros Oriental town test positive for E.coli

By Mary Judaline Partlow

February 13, 2023, 6:46 pm

Share



DUMAGUETE CITY – At least nine water sources from different areas in Vallehermoso town, Negros Oriental province, tested positive for E.coli (Escherichia coli) bacteria that left five people dead, and more cases reported over the weekend.

Jennifer Remollo, the provincial officer of the Department of Health (DOH) in Negros Oriental, told the Philippine News Agency in an interview Monday that laboratory tests were done from water samples taken from these sources after the number of cases skyrocketed last week.

“As of today, our office has were earlier reported last we

“Consumption of E.coli cont diarrhea,” she said.



E.coli

568 suffering from **food poisoning**, Vietnam (2024)



5 deaths and **203** cases of acute **gastroenteritis**, Philippines (2023)



Contamination by arsenic and other trace elements of tube-well water along the Mekong River in Lao PDR

Penradee Chanpiwat^a, Suthipong Sthiannopkao^b  , Kyung Hwa Cho^a, Kyoung-Woong Kim^a  , Vibol San^c, Boukeo Suvanthong^d, Chantha Vongthavady^d

Show more 

+ Add to Mendeley  Share  Cite

<https://doi.org/10.1016/j.envpol.2010.10.007>

Get rights and con

Abstract

Arsenic and other trace element concentrations were determined for tube-well water collected in the Lao PDR provinces of Attapeu, Bolikhamxai, Champasak, Savannakhet, Saravane, and Vientiane. Water samples, especially from floodplain areas of central and southern Laos, were significantly contaminated not only with As, but with B, Ba, Mn, U, and Fe as well. Total As concentrations ranged from $<0.5\mu\text{gL}^{-1}$ to $278\mu\text{gL}^{-1}$, with over half exceeding the WHO guideline of $10\mu\text{gL}^{-1}$. 46% of samples, notably, were dominated by As(III). Samples from Vientiane, further north, were all acceptable except on pH, which was below drinking water limits. A principal component analysis found associations between general water characteristics, As, and other trace elements. Causes of elevated As concentrations in Lao tube wells were considered similar to those in other Mekong River countries, particularly Cambodia and Vietnam, where young alluvial aquifers give rise to reducing conditions.

 **Arsenic**

700,000+ cases of **arsenicosis** in Southeast Asia as of 2011

1,000 diagnosed with As-related **skin disorders**, Thailand 1997

 **Source**

Contamination by arsenic and other trace elements of tube-well water along the Mekong River in Lao PDR (2011)



Iron and Manganese

Non-carcinogenic **health risks**, Indonesia (2021)



Salinity

Causes **hypertension** and kidney disease.

Affects **plant production** and **food security**.



Fluoride

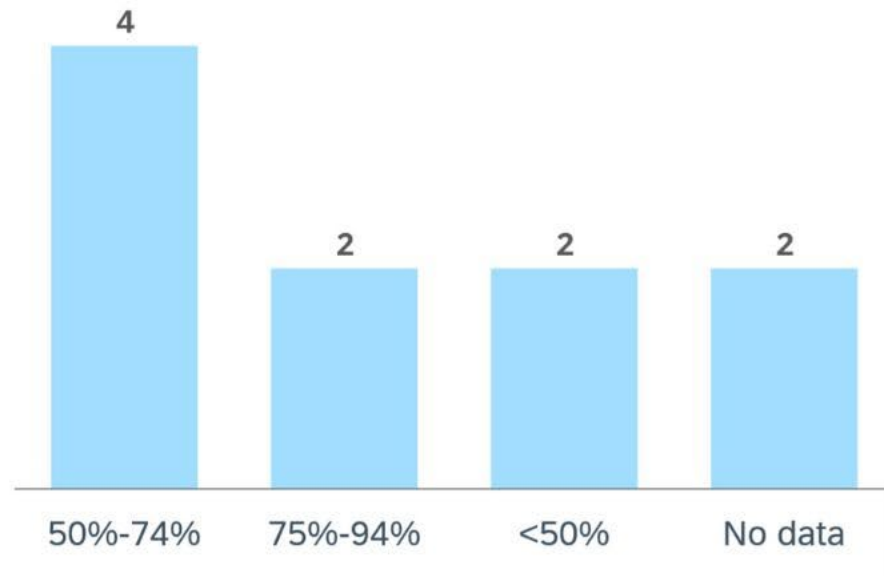
dental and skeletal **fluorosis**

Sources

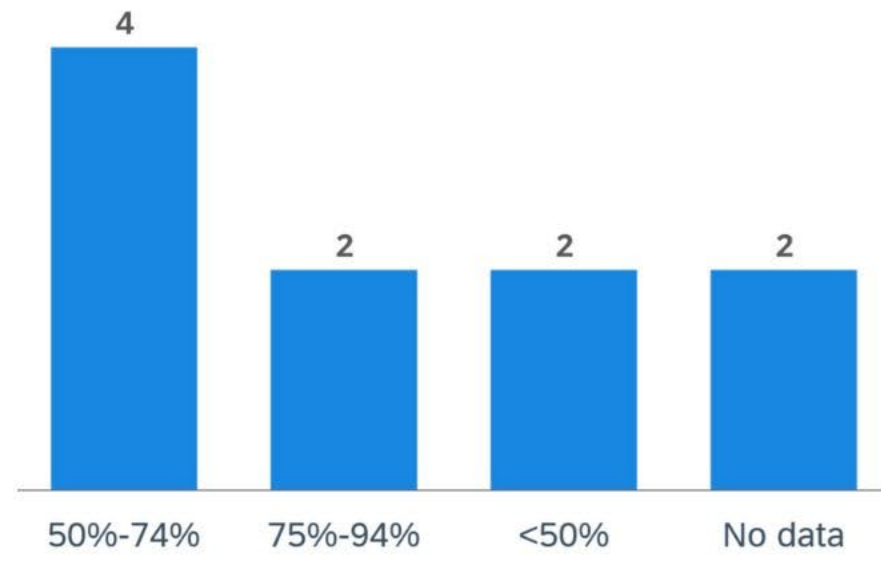
VnExpress International, Philippine News Agency, Arsenic geochemistry and human health in South East Asia (2011), Arsenic contamination of groundwater: A global synopsis with focus on the Indian Peninsula (2020), Vulnerability of groundwater to iron and manganese contamination in the coastal alluvial plain of a developing Indonesian city (2021), Fluoride contamination, health problems and remediation methods in Asian groundwater: A comprehensive review (2019), Assessing Salinization and Water Quality in Koh Kong Coastal Areas of Cambodia: Potential Impacts of Climate Change (2021), Extent of saltwater intrusion and freshwater exploitability in the coastal Vietnamese Mekong Delta assessed by gauging records and numerical simulations (2024)

These inequities **perpetuate a lack of awareness** on proper groundwater use – creating a dangerous cycle.

Number of ASEAN countries with access to water resource management information by population %



Number of ASEAN countries with access to Water, Sanitation, and Hygiene (WASH) information by population %



Without monitoring, no centralized data exists, **blocking data-driven solutions.**

Groundwater Data Concerns in ASEAN

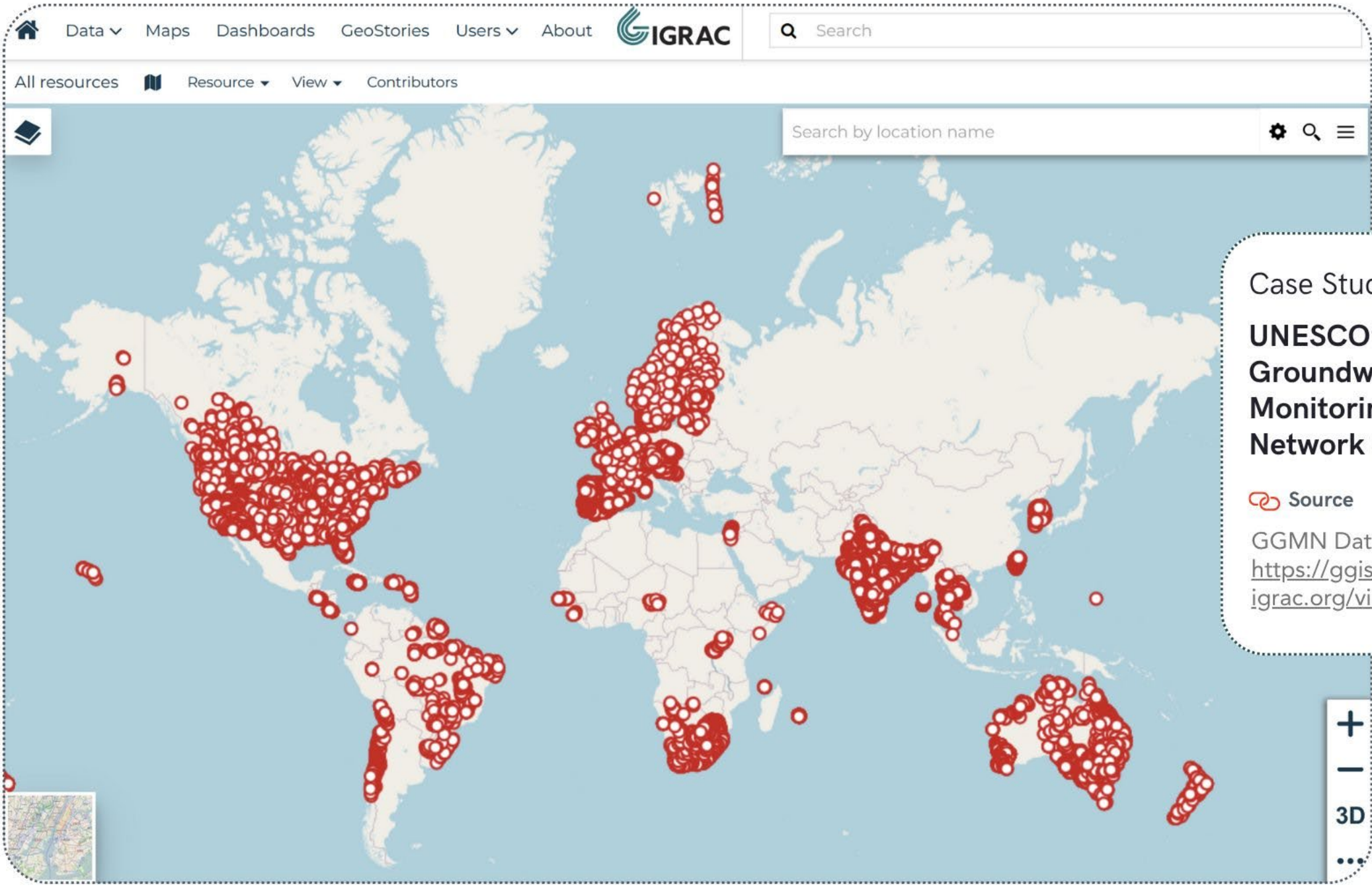
| Country | Data concern |
|-------------|---|
| Brunei | Very limited information, only used by rural areas |
| Cambodia | Fragmented data, no centralized platform |
| Indonesia | No centralized platform for groundwater extraction data |
| Laos | Very limited information, no framework yet |
| Malaysia | No centralized platform for long-term reporting |
| Myanmar | Fragmented data from adhoc surveys |
| Philippines | Fragmented data, weak enforcement of standards |
| Singapore | No natural aquifers or groundwater |

Non-ASEAN Databases



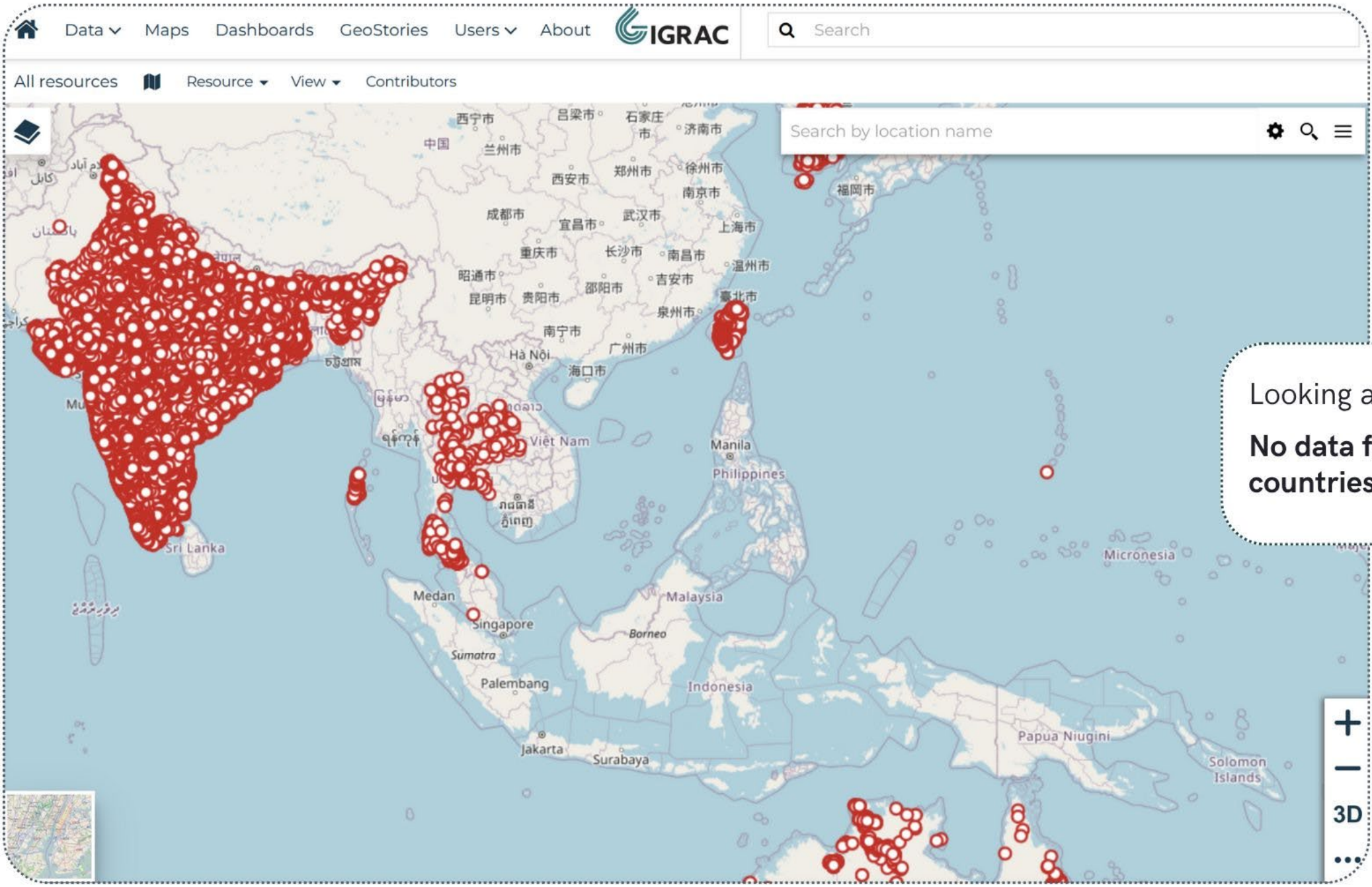
 Source

WEPA Outlook on Water Environmental Management in Asia (2024)



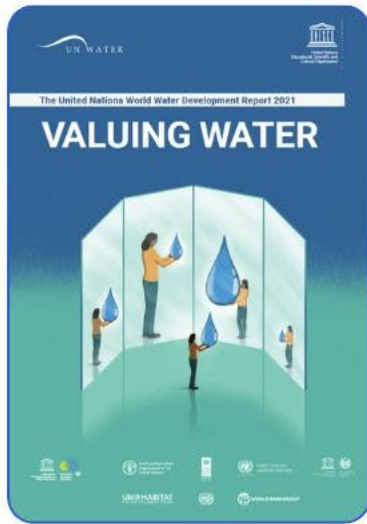
Case Study
**UNESCO's Global
Groundwater
Monitoring
Network (GGMN)**

Source
GGMN Data Portal
<https://ggis.un-igrac.org/view/ggmn/>

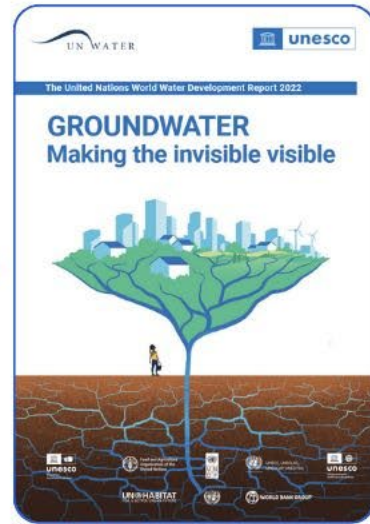


Looking at ASEAN
No data for most countries!

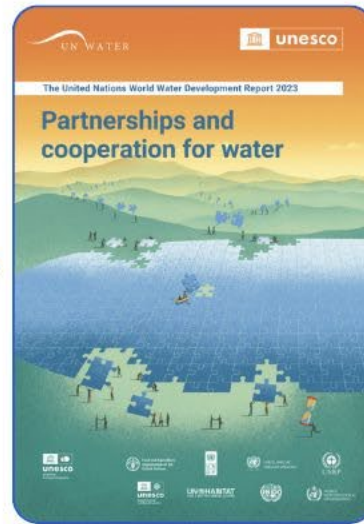
The last five years is still waiting for **innovation**.



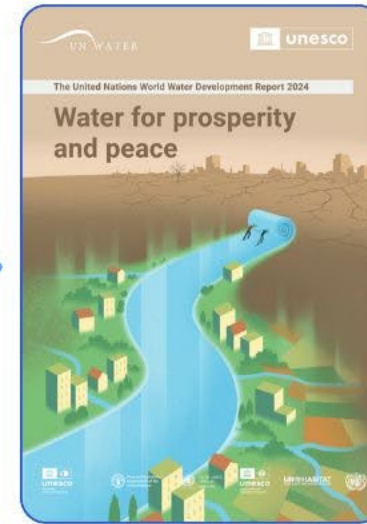
UNESCO 2021:
Groundwater monitoring is neglected due to **lack of data** and initiatives.



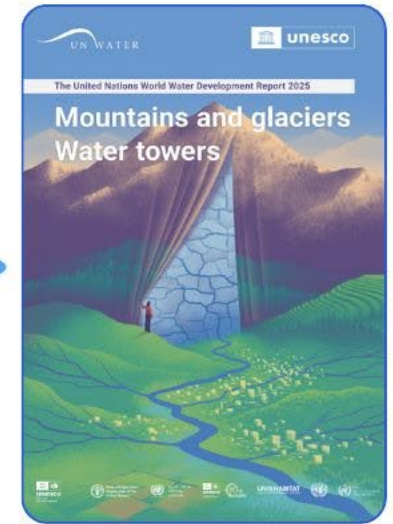
UNESCO 2022:
Low-income countries have very limited or **no monitoring networks** in operation.



UNESCO 2023:
Cooperation and partnership, especially sharing data across international borders remain a key challenge to achieve SDG 6.

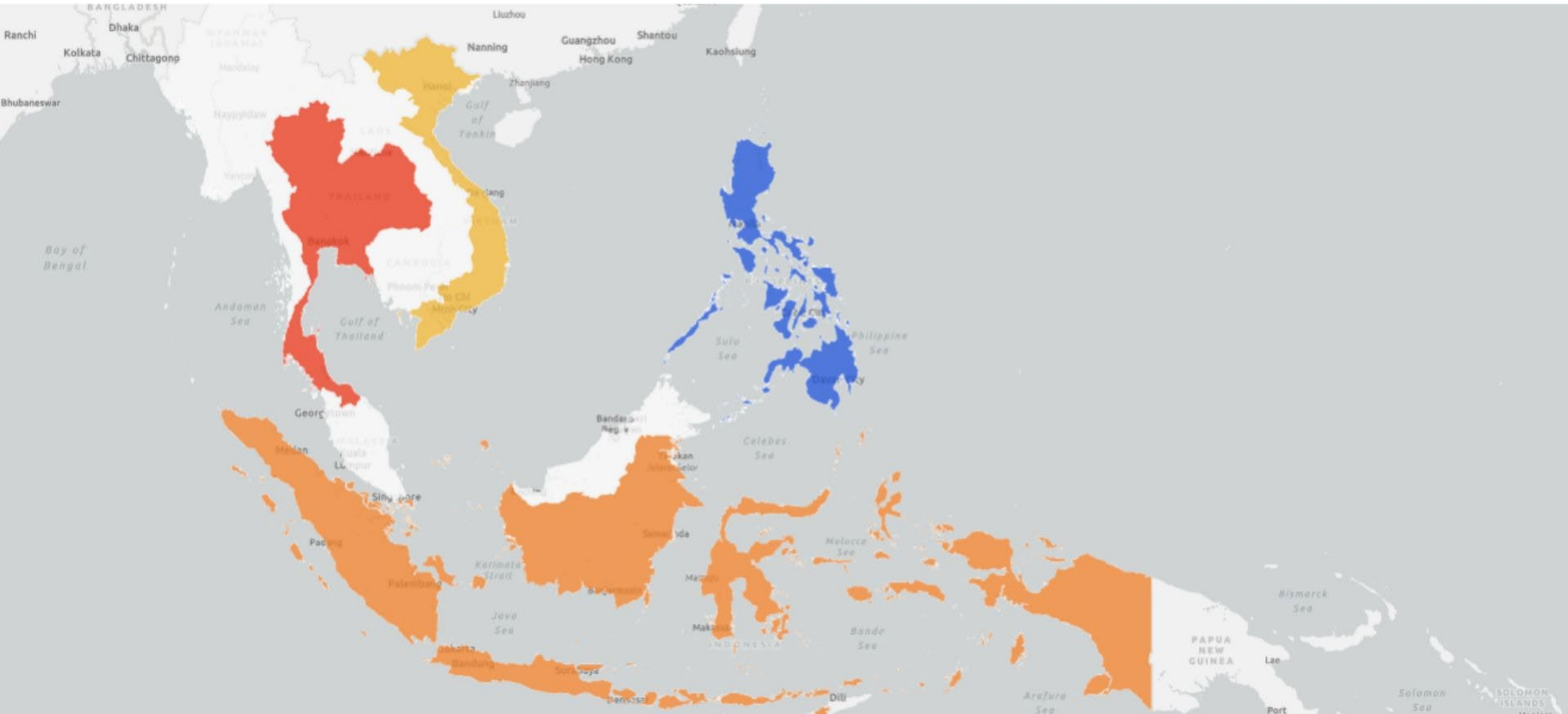


UNESCO 2024:
Social and political resistance to monitoring and data disclosure impede tracking and compliance with regulations.

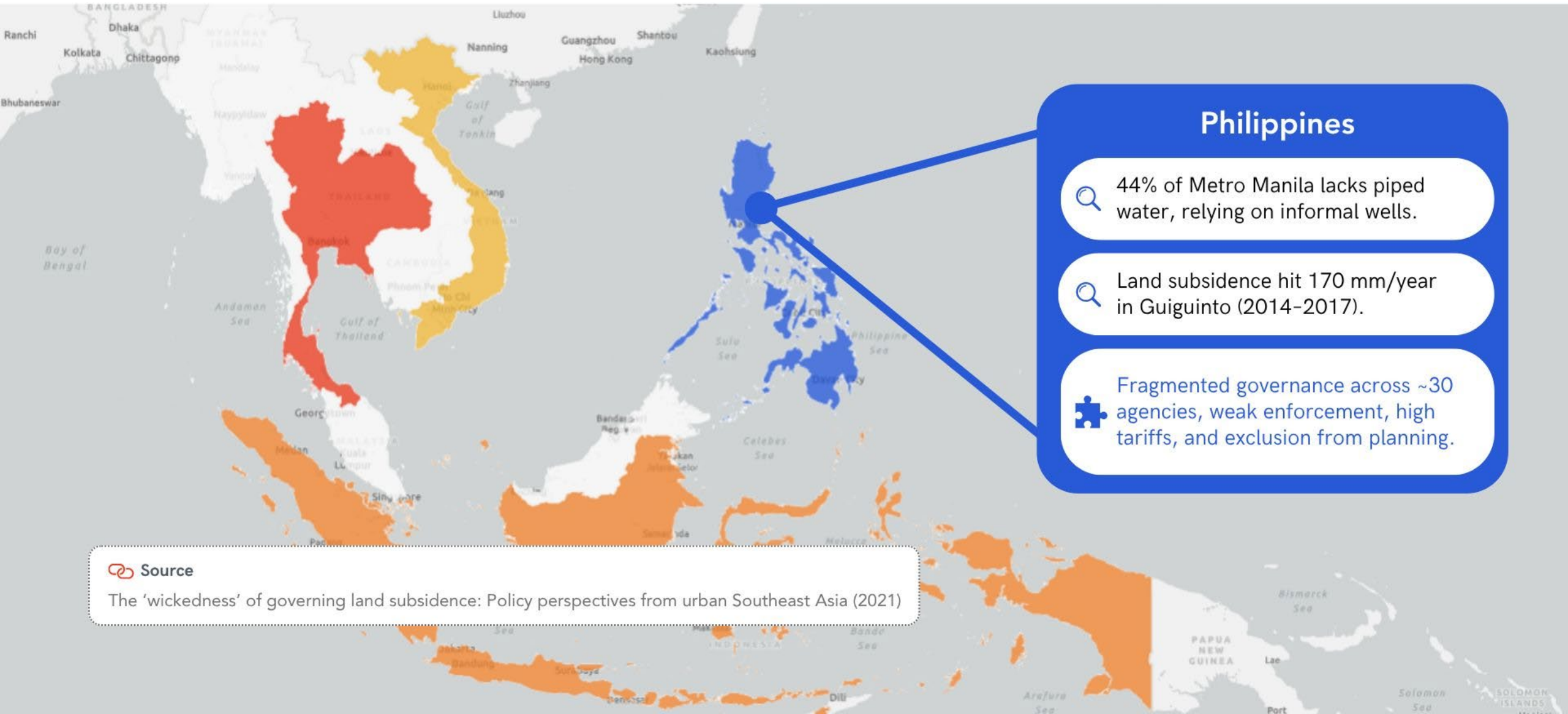


UNESCO 2025:
Reducing **data gaps** is essential for decreasing uncertainty and mitigating risks. Interventions often rely on field-deployed tech.

When **communities** are left out, systems break down.



When communities are left out, systems break down.



Philippines



44% of Metro Manila lacks piped water, relying on informal wells.



Land subsidence hit 170 mm/year in Guiguinto (2014-2017).




Fragmented governance across ~30 agencies, weak enforcement, high tariffs, and exclusion from planning.


 Source


The 'wickedness' of governing land subsidence: Policy perspectives from urban Southeast Asia (2021)

When **communities** are left out, systems break down.

Indonesia

 In Jakarta, legal water connections cost a month's wage, forcing reliance on unregulated backyard wells.

 Subsidence exceeded 100mm/year in some areas.

 High cost, distrust in piped supply, and top-down evictions targeting informal settlements.

 Source

The 'wickedness' of governing land subsidence: Policy perspectives from urban Southeast Asia (2021)

When **communities** are left out, systems break down.

Thailand

🔍 A US\$5M investment (1992-96) failed to improve water governance

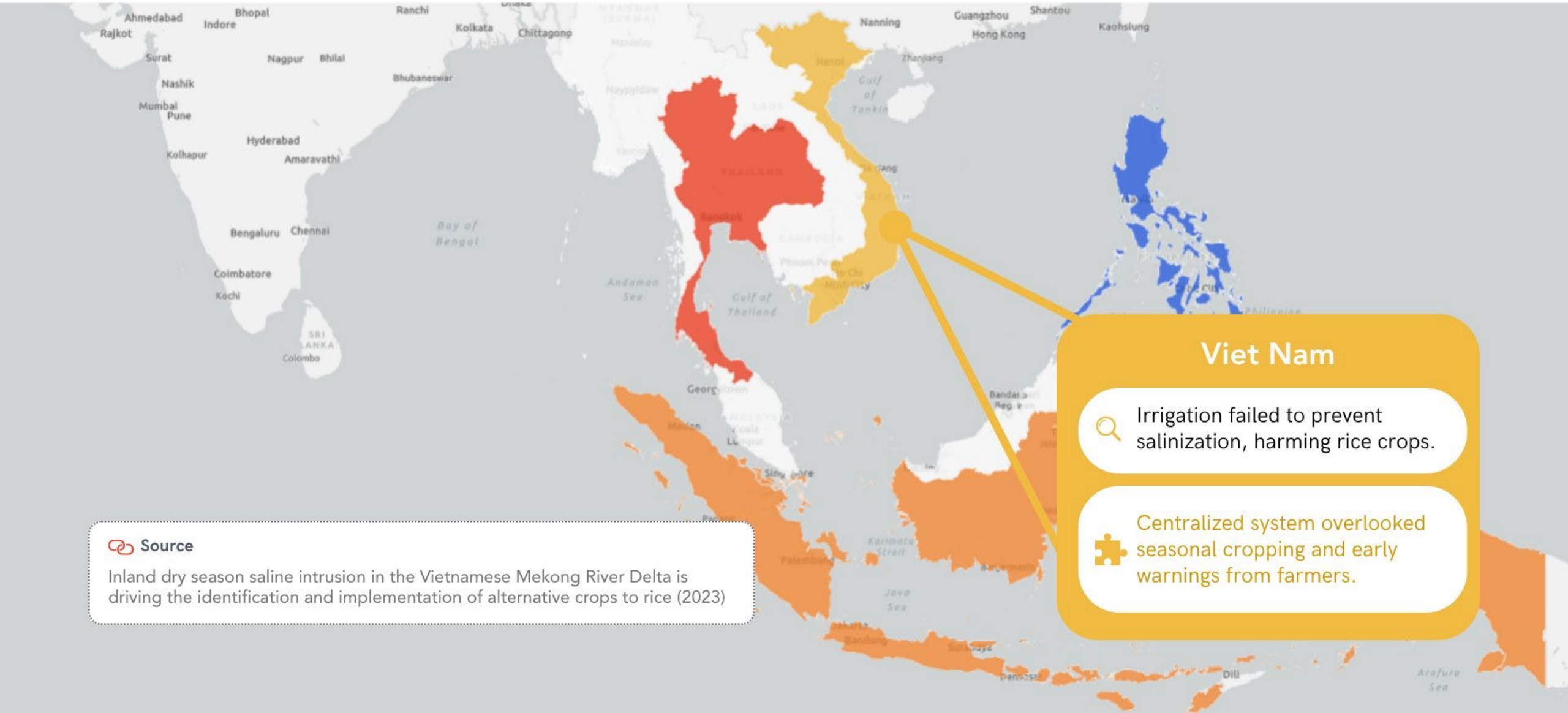
🔍 ECRB still faces floods, shortages, and water contamination.

🧩 Poor inter-agency coordination, superficial participation, and ignored local proposals in favor of big projects.

🔗 Source

Challenges of water policy involvement of the community in the East Coast River Basin of Thailand (2021)

When **communities** are left out, systems break down.



Viet Nam



Irrigation failed to prevent salinization, harming rice crops.



Centralized system overlooked seasonal cropping and early warnings from farmers.

Source

Inland dry season saline intrusion in the Vietnamese Mekong River Delta is driving the identification and implementation of alternative crops to rice (2023)



Top-down systems have failed,
it's **time to flip** the model.



There is an opportunity to empower rural communities across ASEAN to secure a safe and sustainable water future.

One way to do this is via a **participatory, data-driven** approach that transforms local groundwater management.

Situation

Clean water remains as a last-mile problem in ASEAN

Barrier 1

Overexploitation of groundwater

Barrier 2

Cycle of inequity and lack of awareness

Barrier 3

Unmonitored and unavailable data

SDG 6 Problem Statement

6.1. Universal and equitable access to safe and affordable drinking water for all

6.2. Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation

6.b. Support and strengthen the participation of local communities in improving water and sanitation management



HydroLink

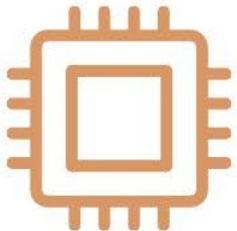
A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Components

Hardware



Software



HydroLink

A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Components

Features

Hardware



Software



HydroLink

A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Data-driven



Participatory



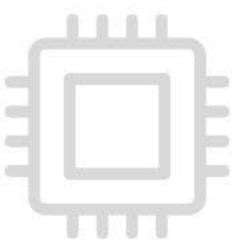
Components

Features

Hardware



Software



HydroLink

A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Data-driven




Participatory





Hardware




Sample Intake

The automated pump draws a precise groundwater sample into the device.




Chemical Preparation

The sample is mixed with test strips & reagents for contaminants like Arsenic.



Data Analysis

The image is analyzed to quantify contaminant levels and data is sent to the cloud.



Visual Capture

Under light, the camera captures an image of the resulting color change.



SDGs

- 1.4.1** Access to basic services
- 6.1.1** Access to safe water
- 6.2.1** Access to sanitation services
- 6.b.1** Community participation in water
- 10.2.1** Social and geographic inclusion



Specific Targets

- ASEAN Economic Blueprint
- B.4: Growth through innovation and technology**
- D.4: Narrowing the Development Gap**
- ASEAN Community Vision
- ¶5: Narrowing development gap, Resilience and inclusion**



Sample Intake



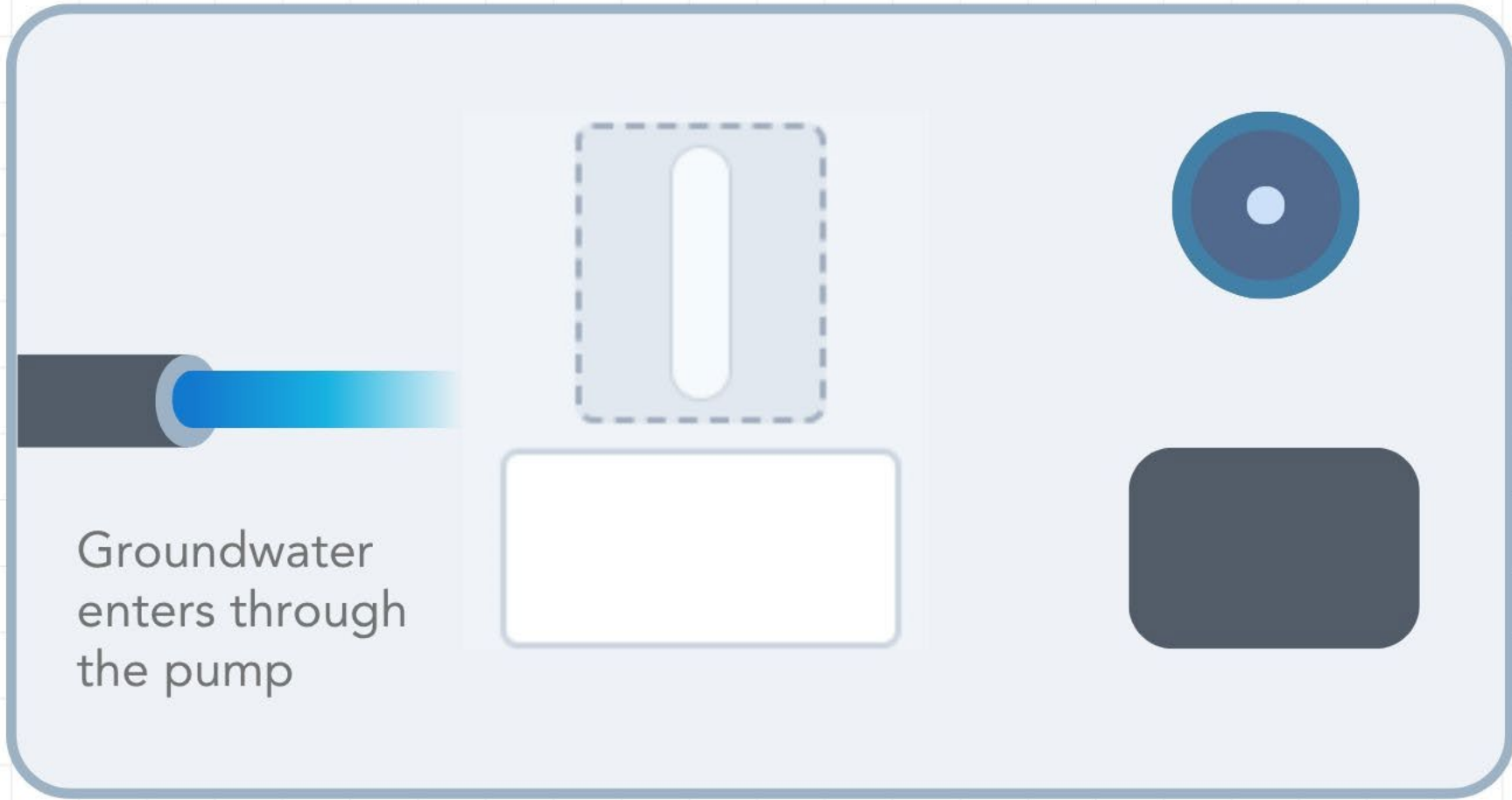
Chemical Preparation



Visual Capture



Data Analysis



Relevant Components





Sample Intake



Chemical Preparation



Visual Capture



Data Analysis



Relevant Components





Sample Intake



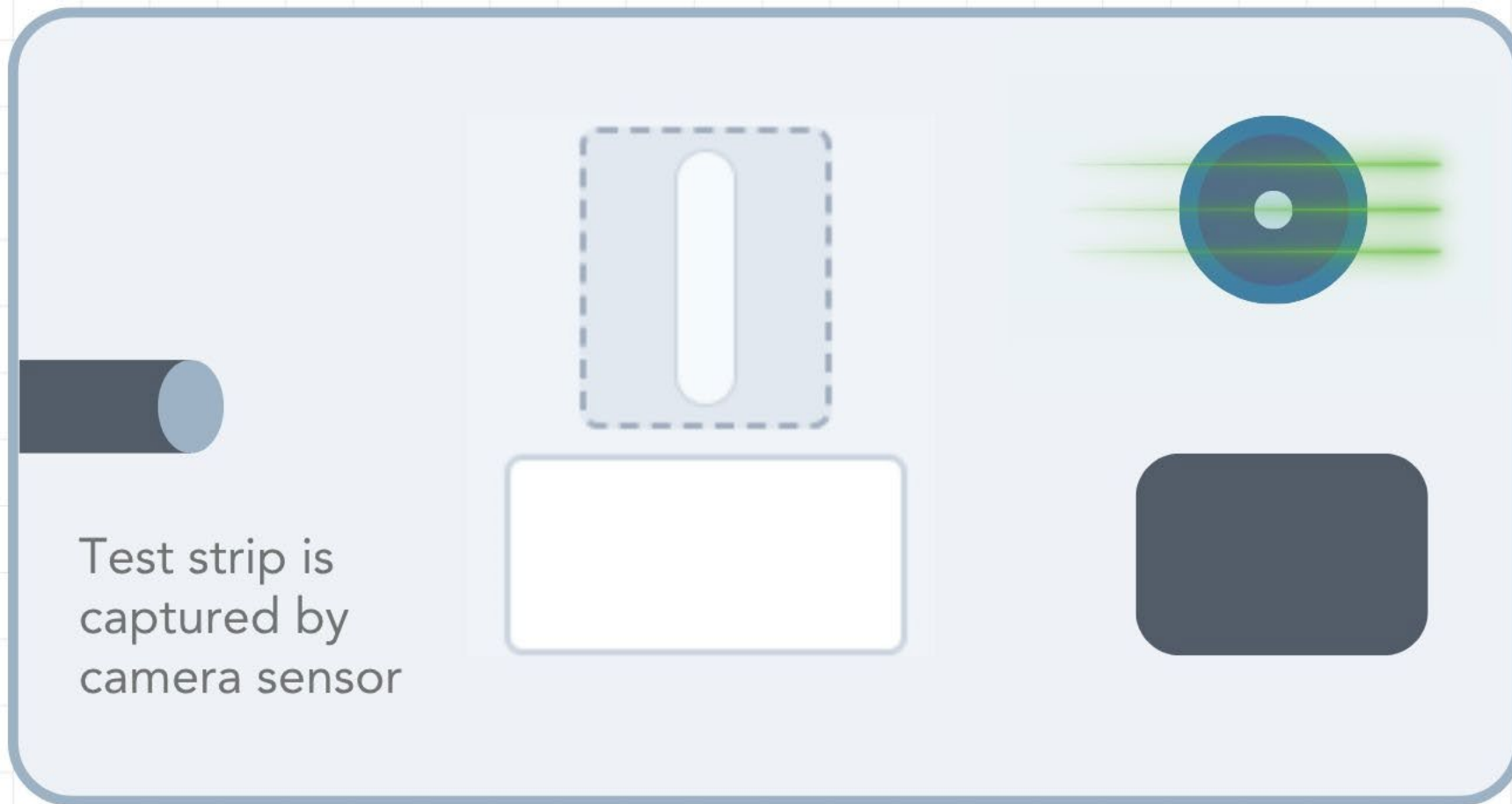
Chemical Preparation



Visual Capture



Data Analysis



Relevant Components





Sample Intake



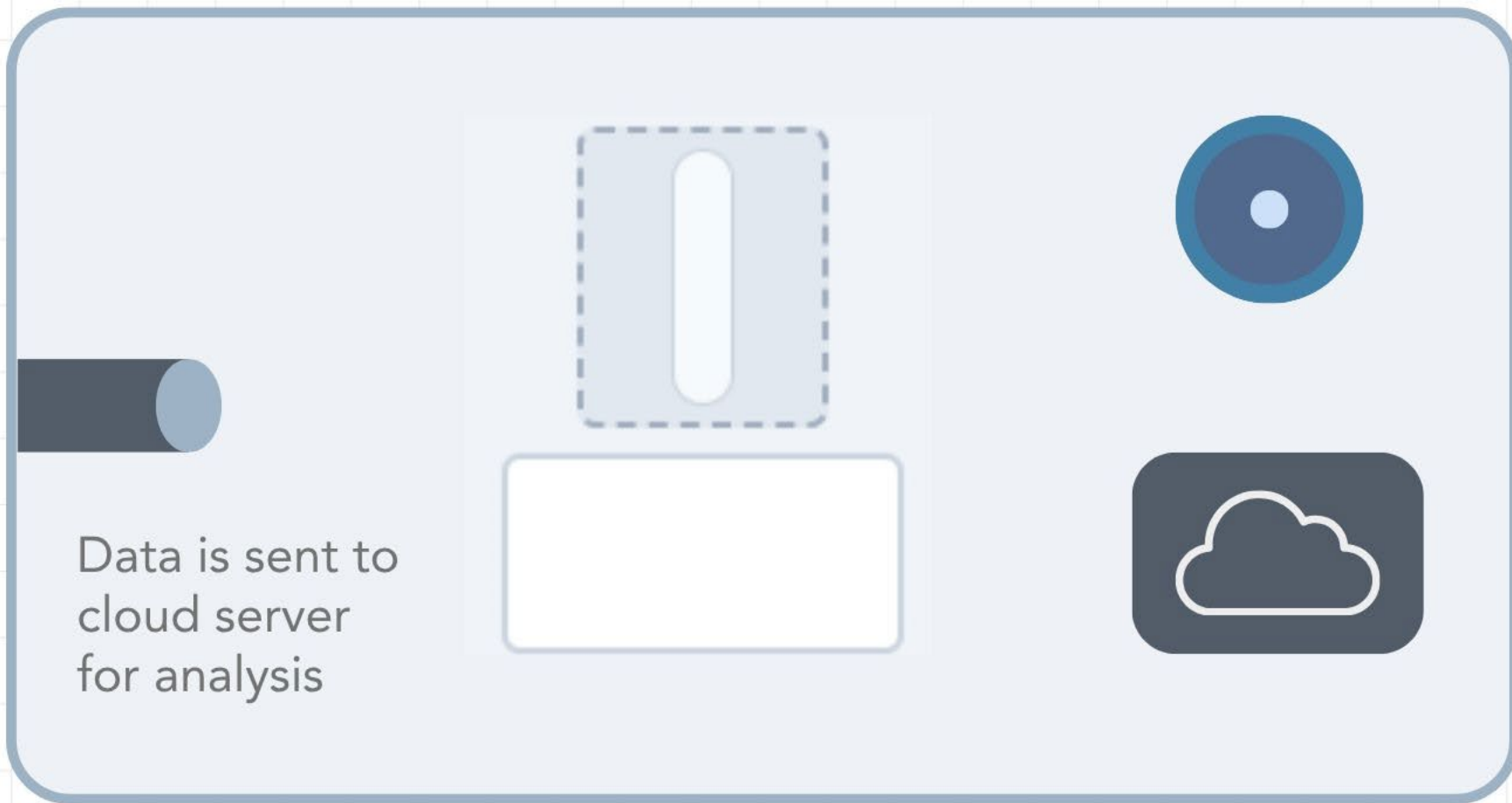
Chemical Preparation



Visual Capture



Data Analysis



Relevant Components



Components

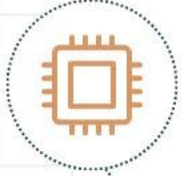
Features



HydroLink

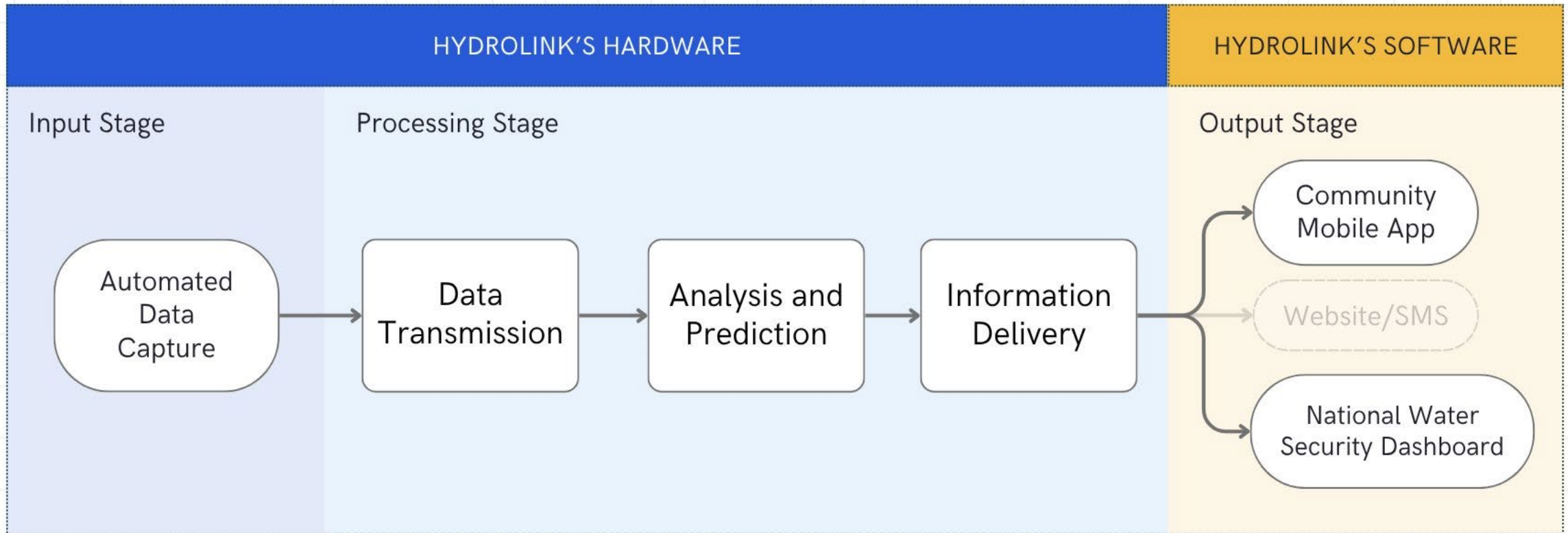
A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

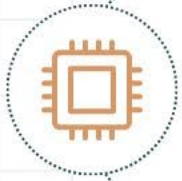




Software

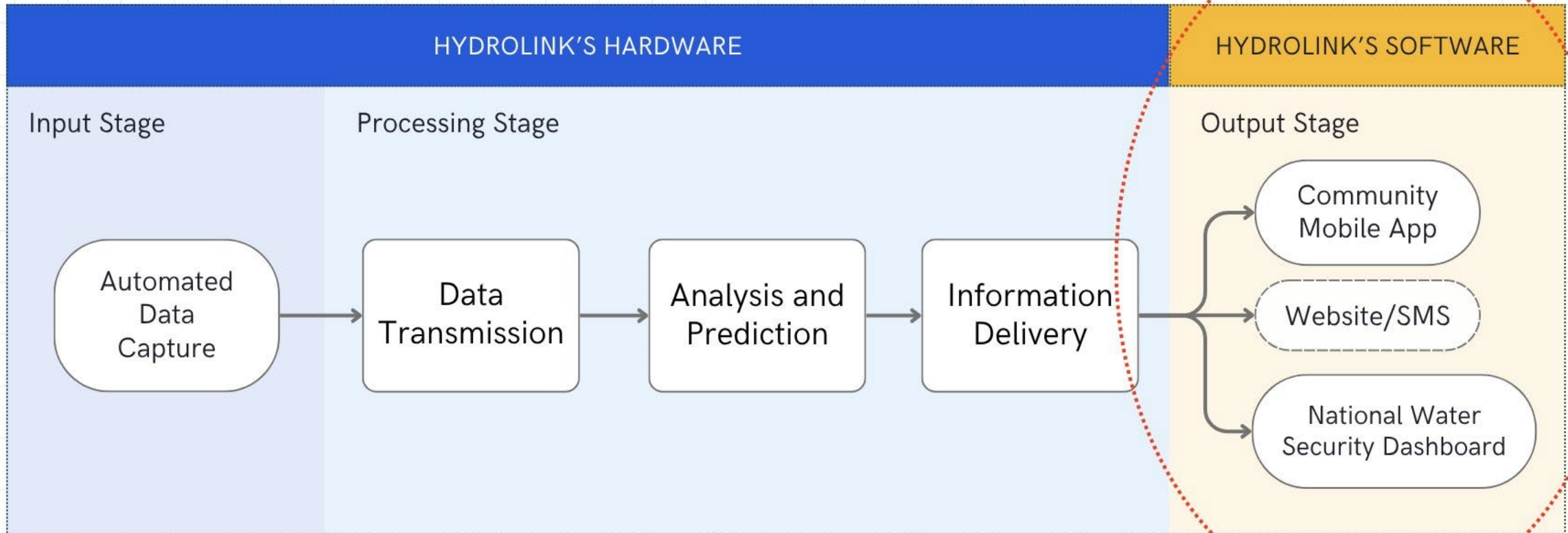
Execution Framework





Software

Execution Framework



Components

Features

Hardware



Software



HydroLink

A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Data-driven



Participatory



Data-driven

Color-based Warning System

Purok 7 Community Well
Last Reading: 6:15 PM, Today

High Arsenic Alert

Detailed Water Report

| | |
|------------------|---|
| ⚠️ Arsenic Level | 0.025 mg/L Safe Limit: <0.010 |
| 🧪 TDS | SAFE |
| 📏 pH Level | NORMAL |

What To Do Now

- 🚫 Do Not Drink
- 📖 Find Safe Well

Home Community Learn Connect

Specific Synergies

- Local Government Units
- Rapid Public Health Responses**
- Health & WASH NGOs
- Targeted Resource Deployment**

SDGs

- 6.3.2** Good water quality
- 3.9.1** Deaths from unsafe water

Specific Targets

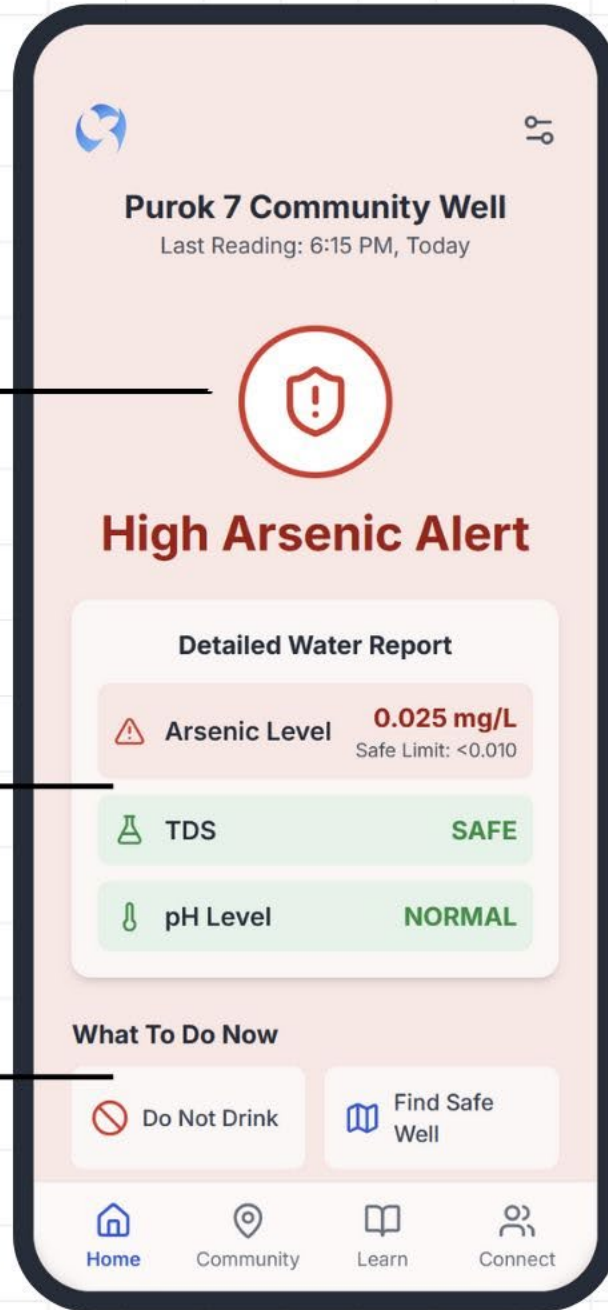
- ASEAN Socio-Cultural Blueprint
- D.2: Health hazard responsiveness**

Data-driven
**Color-based
Warning System**

Intuitive
Color-coded
Interface

At-a-glance
Status Alert

Actionable
Safety
Guidelines



Specific Synergies



Local Government Units
**Rapid Public Health
Responses**

Health & WASH NGOs
**Targeted Resource
Deployment**

SDGs

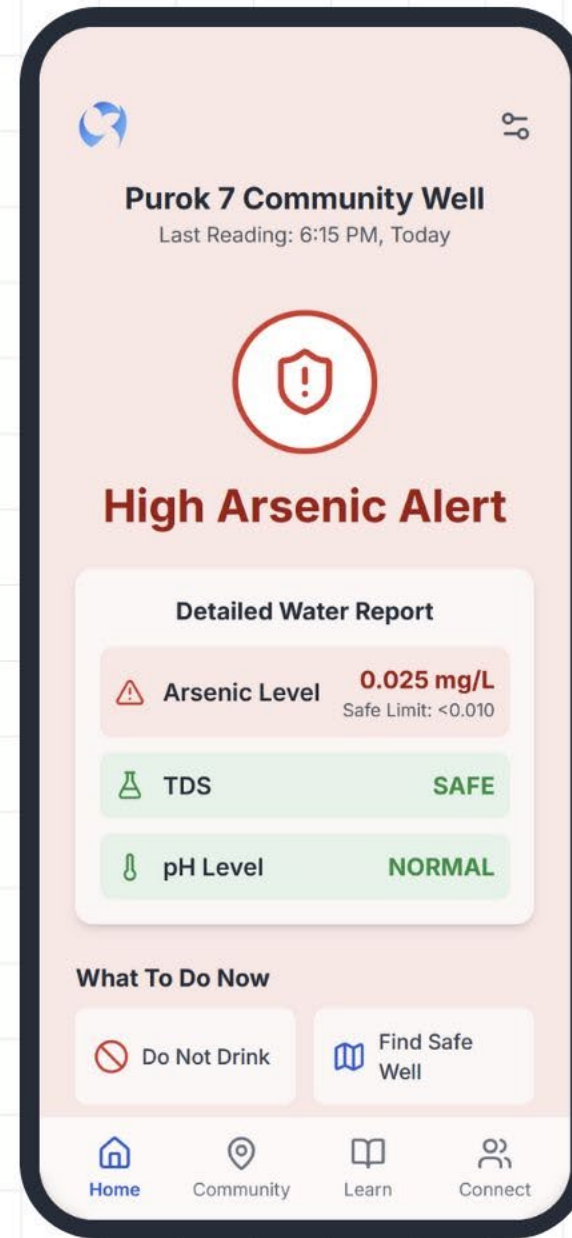
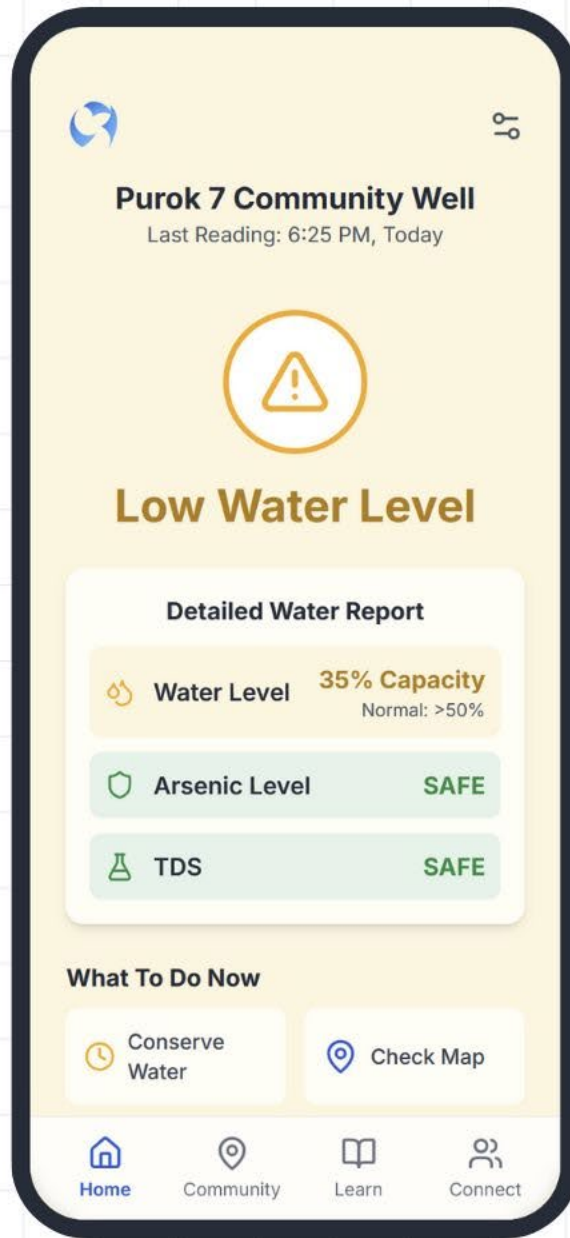
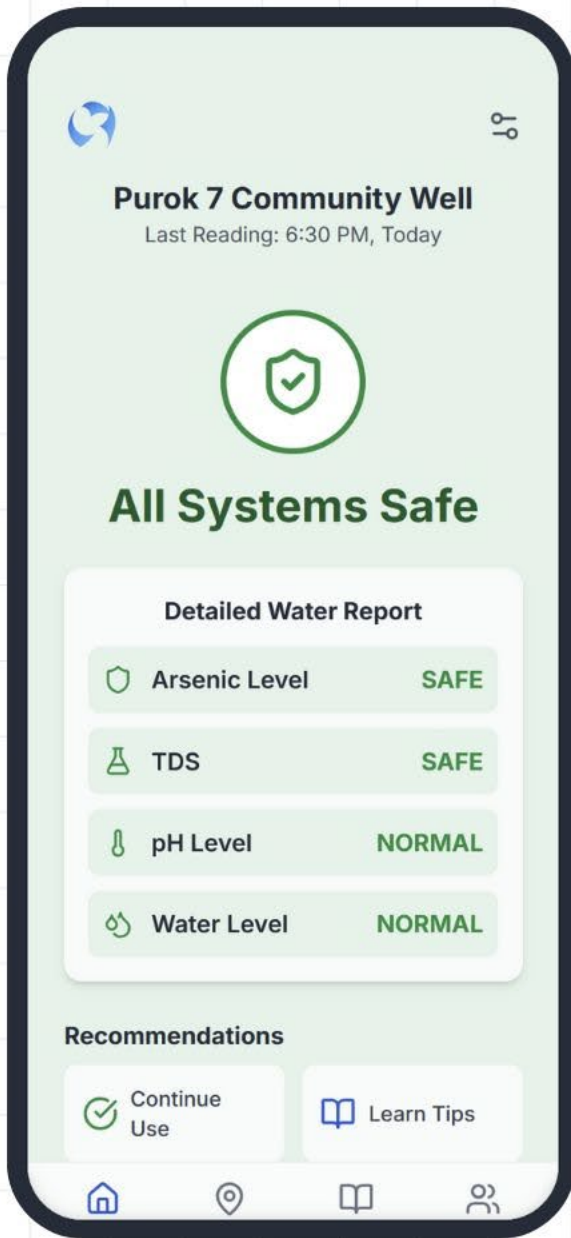


6.3.2 Good water quality
3.9.1 Deaths from unsafe water

Specific Targets



ASEAN Socio-Cultural Blueprint
**D.2: Health hazard
responsiveness**



Data-driven

Predictive Insights for Sustainability

The image shows a mobile application interface for monitoring a well's status. At the top, there is a blue profile icon and a notification bell. The main title is "Purok 7 Well Status". Below this, there are three status cards: 1. "Water Level: Caution" with a yellow warning triangle icon and the text "Increased usage detected this week." 2. "Water Quality: Safe" with a green shield icon and the text "All contaminant levels are normal." 3. "Sustainability Prediction" with a blue line graph icon and the text "Based on current trends, water levels may become critical in the next 7-10 days." Below the prediction card is a link "See Conservation Tips". At the bottom, there is a navigation bar with four icons: Home, Community, Learn, and Connect.

Specific Synergies

Local Agriculture Offices
Forecast Timely Advisories

Academia & Climate Institutions
Datasets for Impactful Research

SDGs

6.4.2 Water stress level
13.1.1 Climate disaster strategies

Specific Targets

ASEAN Socio-Cultural Blueprint
12.4: Adapt to vulnerabilities and climate change

Data-driven
**Predictive Insights
for Sustainability**

Clear Current
Conditions

Proactive Risk
Forecasting

The image shows a mobile application interface for 'Purok 7 Well Status'. At the top, there is a blue profile icon and a notification bell. The title 'Purok 7 Well Status' is centered. Below the title, there are three main sections: 1. A yellow warning box with a triangle icon, titled 'Water Level: Caution' and containing the text 'Increased usage detected this week.' 2. A green safe box with a shield icon, titled 'Water Quality: Safe' and containing the text 'All contaminant levels are normal.' 3. A dashed grey box with a line graph icon, titled 'Sustainability Prediction' and containing the text 'Based on current trends, water levels may become critical in the next 7-10 days.' Below this text is a link 'See Conservation Tips'. At the bottom, there is a navigation bar with four icons: Home, Community, Learn, and Connect.

Specific Synergies



Local Agriculture Offices
**Forecast Timely
Advisories**

Academia & Climate Institutions
**Datasets for Impactful
Research**

SDGs



6.4.2 Water stress level

13.1.1 Climate disaster strategies

Specific Targets



ASEAN Socio-Cultural Blueprint

**12.4: Adapt to
vulnerabilities and
climate change**

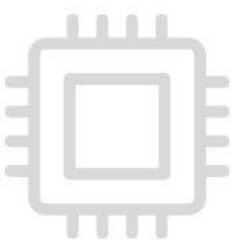
Components

Features

Hardware



Software



HydroLink

A **two-pronged system** consisting of a field-deployed device for groundwater monitoring connected to a user-friendly mobile application and centralized dashboards, founded on the values of **participatory** and **data-driven** action.

Data-driven



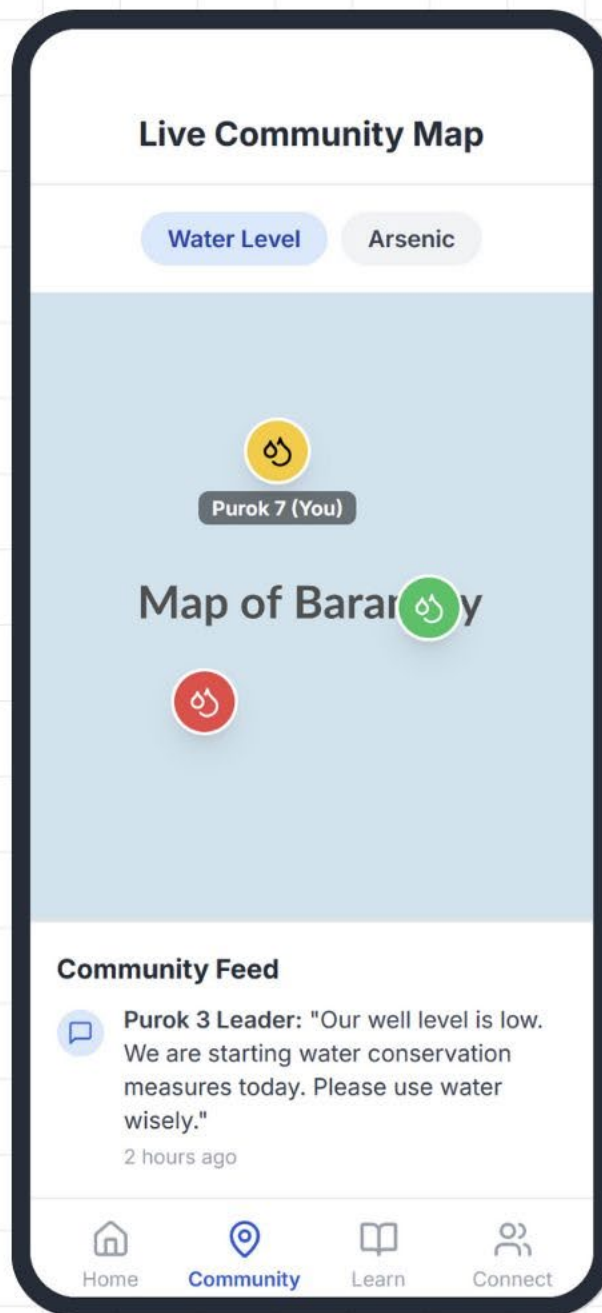
Participatory





Participatory

Community-based Monitoring Platform



Specific Synergies



Local Government Units
**Resource Sharing during
Localized Water Shortages**

Disaster Risk Reduction Agencies
**Ground-level Supplement
to Monitoring Efforts**

SDGs



6.b.1 Community
participation in water

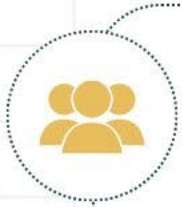
16.7.1 Inclusive decision-making

Specific Targets



ASEAN Socio-Cultural Blueprint
**A.1: Engaged stakeholders
and participatory systems**

ASEAN Community Vision
¶4: People-centered ASEAN

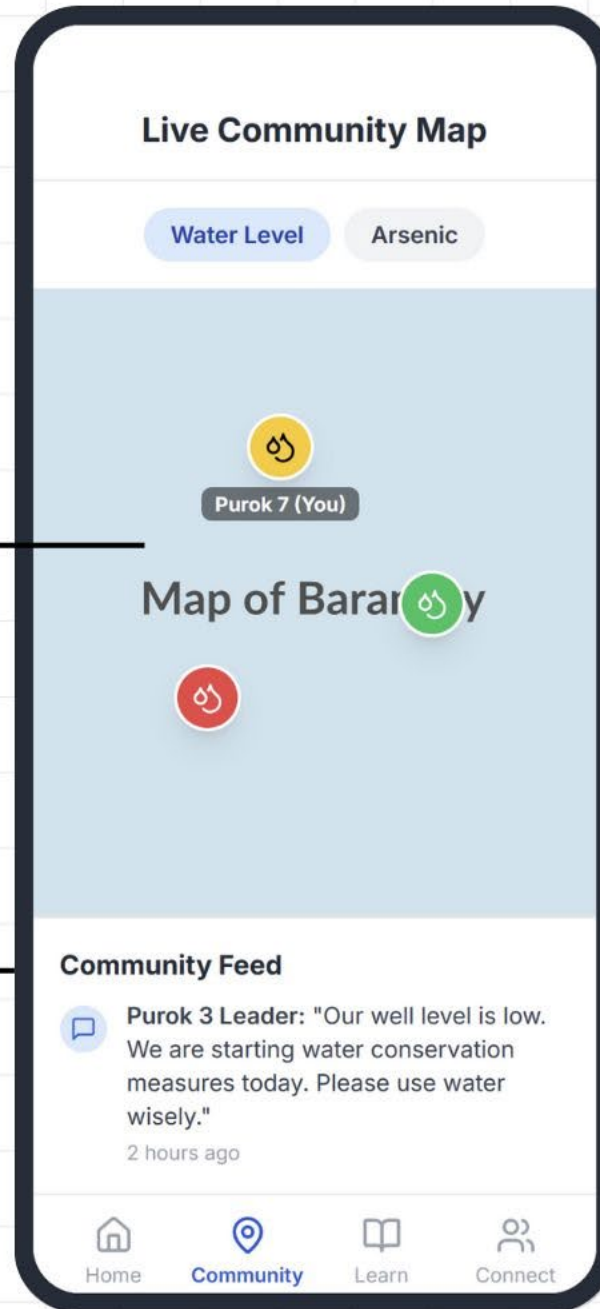


Participatory

Community-based Monitoring Platform

Real-time Neighborhood Status

Peer-to-peer Communication Hub



Specific Synergies



Local Government Units
Resource Sharing during Localized Water Shortages

Disaster Risk Reduction Agencies
Ground-level Supplement to Monitoring Efforts

SDGs



6.b.1 Community participation in water

16.7.1 Inclusive decision-making

Specific Targets



ASEAN Socio-Cultural Blueprint
A.1: Engaged stakeholders and participatory systems

ASEAN Community Vision
14: People-centered ASEAN



Participatory
**Community-NGO
Connector**

Connect for Support

Create a Support Ticket

Request Type
Request Training

Justification (Based on App Data)
e.g., Our data shows a steady decline in water levels over three months. We request an on-site seminar on advanced

Submit Request to Partners

Active Tickets

Training: Water Conservation Approved

Update: Water for ASEAN NGO will facilitate a seminar on July 15th at the Barangay Hall.

Home Community Learn **Connect**



Specific Synergies

NGO & CSR Foundations
Efficient Resource Allocation
Department of Social Welfare and Development
Civil Society Partner Accreditation System



SDGs

6.b.1 Community participation in water
16.6.2 Accountable local institutions
17.17.1 Public-private civil partnerships



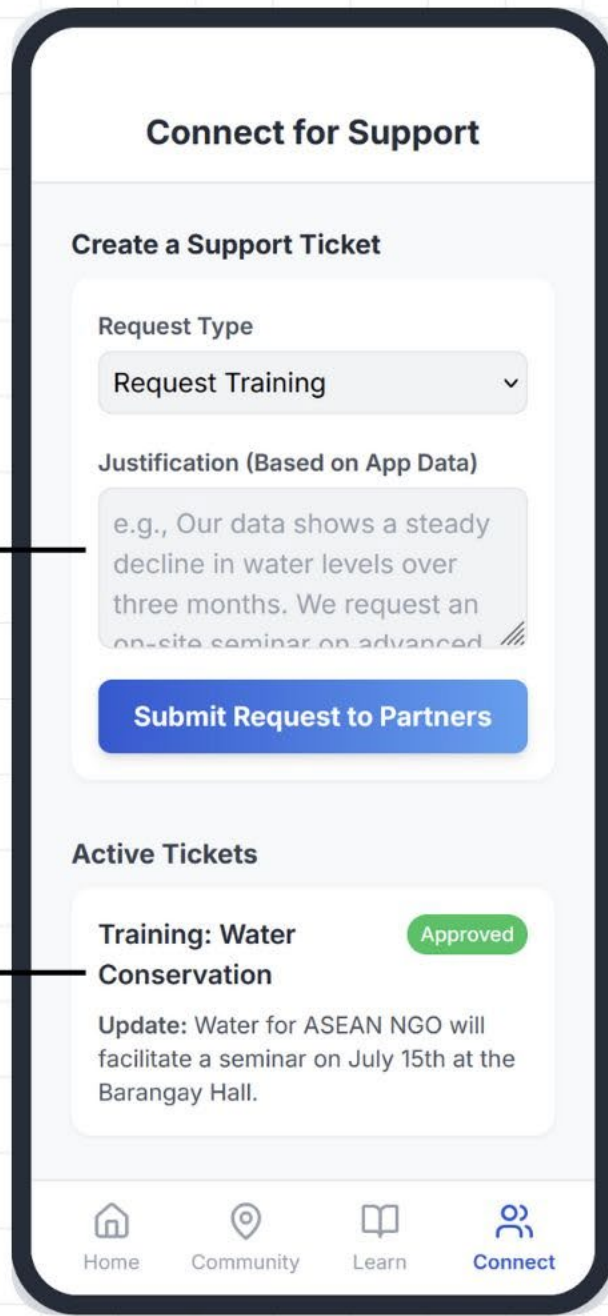
Specific Targets

ASEAN Socio-Cultural Blueprint
C: Promotes Blueprint awareness
ASEAN Community Vision
14: Stakeholder inclusion

Participatory
**Community-NGO
Connector**

Evidence-based
Request System

Transparent Ticket
Management



Specific Synergies

NGO & CSR Foundations
Efficient Resource Allocation
Department of Social Welfare and Development
Civil Society Partner Accreditation System

SDGs

6.b.1 Community participation in water
16.6.2 Accountable local institutions
17.17.1 Public-private civil partnerships

Specific Targets

ASEAN Socio-Cultural Blueprint
C: Promotes Blueprint awareness
ASEAN Community Vision
14: Stakeholder inclusion



Participatory In-App Learning Modules

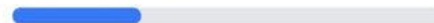
Learn & Grow



Featured: What is an Aquifer?

Learn how our well gets its water.

Your Progress



3 of 10 modules completed



Understanding
Arsenic



5 Ways to Save Water



Why We Test for pH



Home



Learn



Community



Connect



Specific Synergies

Department of Education
**Integration with
Alternative Learning
System (ALS) Programs**



SDGs

4.7.1 Education for
sustainability

6.6.1 Ecosystem
protection progress



Specific Targets

ASEAN Socio-Cultural Blueprint
**A.2: Empowered people
through education**

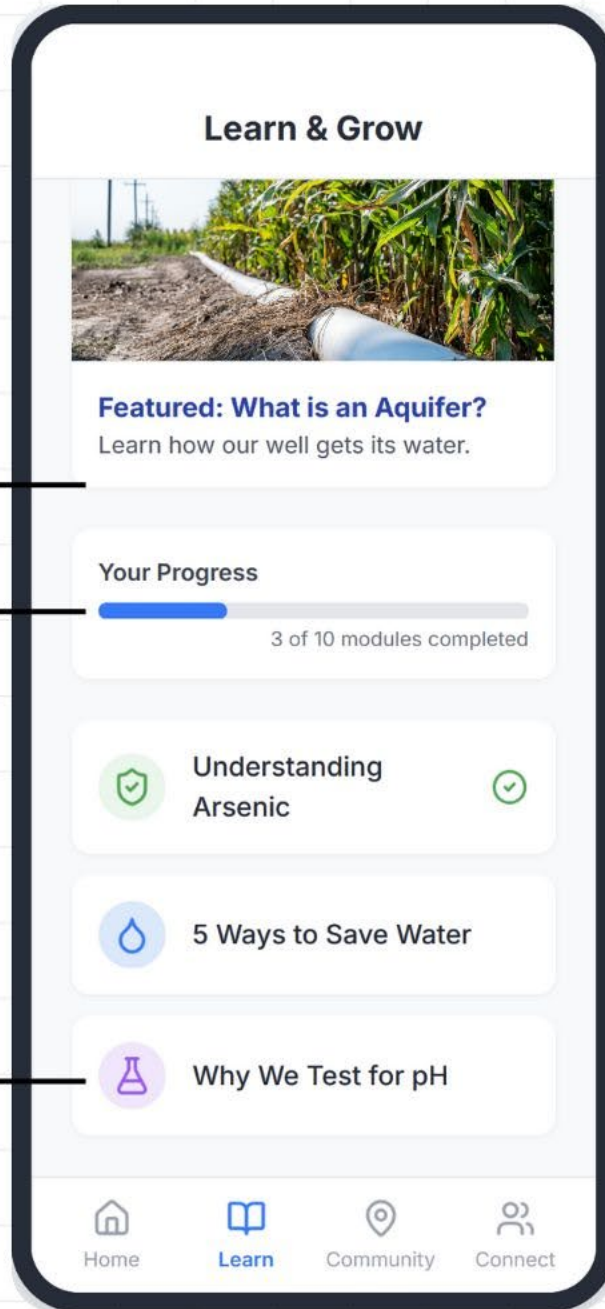
ASEAN Community Vision
**116: Human capital
development**

Participatory
**In-App Learning
Modules**

Curated Content
Delivery

Progress-based
Journey

Bite-sized
Educational
Content



Specific Synergies



Department of Education
**Integration with
Alternative Learning
System (ALS) Programs**

SDGs



- 4.7.1** Education for sustainability
- 6.6.1** Ecosystem protection progress

Specific Targets



ASEAN Socio-Cultural Blueprint
**A.2: Empowered people
through education**

ASEAN Community Vision
**1|6: Human capital
development**



How do we ensure
HydroLink's **feasibility**?

HydroLink uses a modular approach that adapts to **local contamination profiles**.

Coastal Community

Barangay Poblacion, Panglao, PH

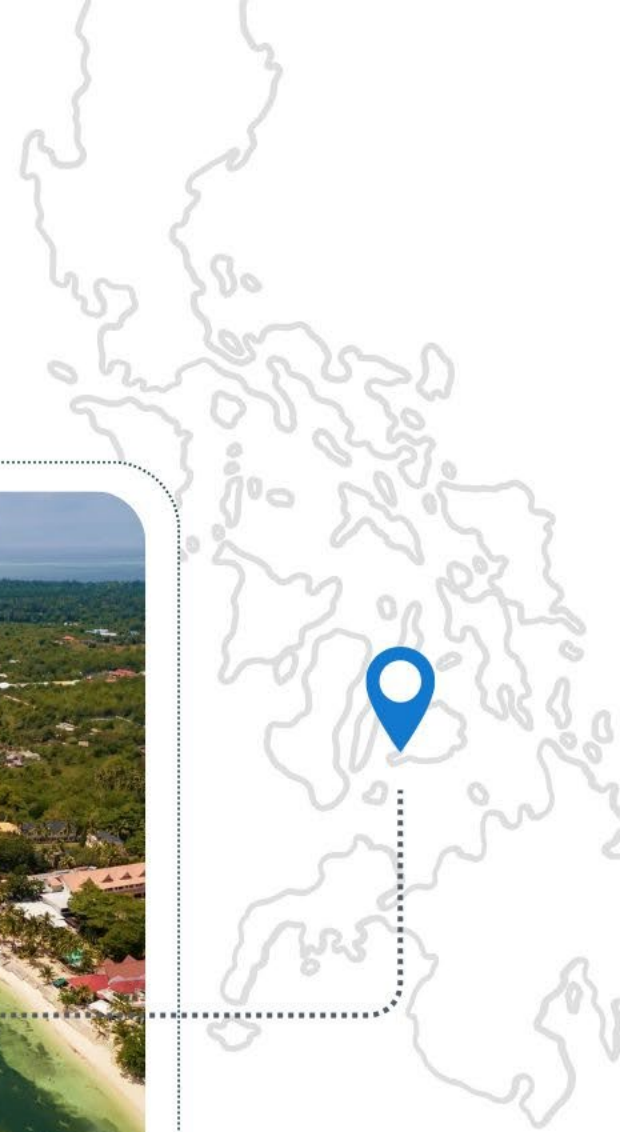
The community has severe salinity/chlorides (up to 8,550 mg/L) and high TDS (3,480.60 mg/L); E. coli contamination renders wells undrinkable.

(••) Main Sensor Needed

- E. coli and total dissolved solids (TDS) sensor

⚙️ Cost and Maintenance

- Lower initial cost due to fewer reagent needs



HydroLink uses a modular approach that adapts to **local contamination profiles**.

Inland (Lakeside) Community

Barangay Bayog, Los Baños, PH

The community has severe *E. coli* proliferation (>1100 MPN/mL) with MDR strains and is at risk for As, Fe, and M contaminants.

(••) Main Sensor Needed

- *E. coli*, Arsenic, Iron and Manganese sensors

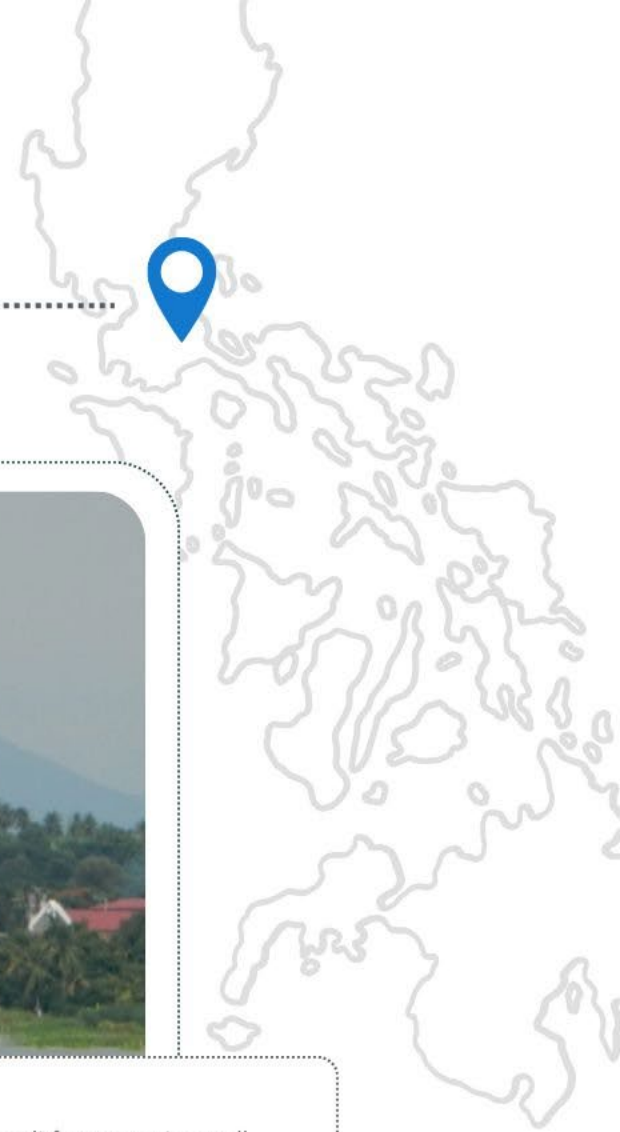
⚙️ Cost and Maintenance

- Higher cost due to multiple contaminants



🔗 Source

Laguna Water, Multidrug-resistant *Escherichia coli* from artesian well waters in Los Baños, Laguna, the Philippines (2024), Audit finds over half of Laguna water pumps exceed arsenic safety limits [Rappler.com] (2025)



Modular hardware design cuts costs while targeting community priorities.

COST BREAKDOWN

| Component | Modular (Brgy. Poblacion) | Non-modular |
|--------------------|--|---|
| Power | MYR 103.28 (\$21.68) | MYR 103.28 (\$21.68) |
| Central Controller | MYR 39.29 (\$8.25) | MYR 39.29 (\$8.25) |
| Sensors | MYR 192.00 (\$40.30) <i>(only needed sensors)</i> | MYR 512.03 (\$107.46) <i>(includes more sensors)</i> |
| Transmitters | MYR 82.86 (\$17.39) | MYR 82.86 (\$17.39) |
| Lights & Enclosure | MYR 53.54 (\$11.24) | MYR 53.54 (\$11.24) |
| Pumps & Valves | MYR 19.52 (\$4.10) | MYR 19.52 (\$4.10) |
| Total | MYR 490.48 (\$102.94) | MYR 810.52 (170.12) |

Modular hardware design cuts costs while targeting community priorities.

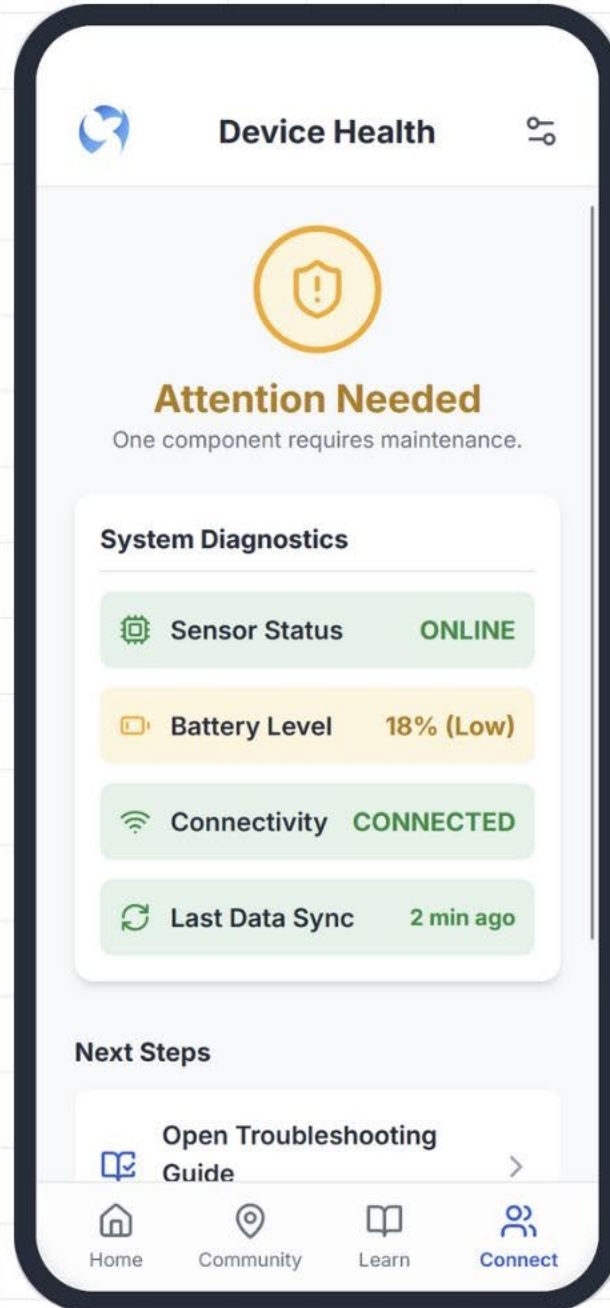
COST BREAKDOWN

| Component | Modular (Brgy. Poblacion) | Non-modular |
|--------------------|--|---|
| Power | MYR 103.28 (\$21.68) | MYR 103.28 (\$21.68) |
| Central Controller | MYR 39.29 (\$8.25) | MYR 39.29 (\$8.25) |
| Sensors | MYR 192.00 (\$40.30) <i>(only needed sensors)</i> | MYR 512.03 (\$107.46) <i>(includes more sensors)</i> |
| Transmitters | MYR 82.86 (\$17.39) | MYR 82.86 (\$17.39) |
| Lights & Enclosure | MYR 53.54 (\$11.24) | MYR 53.54 (\$11.24) |
| Pumps & Valves | MYR 19.52 (\$4.10) | MYR 19.52 (\$4.10) |
| Total | MYR 490.48 (\$102.94) | MYR 810.52 (170.12) |

~40%
cost reduction

By deploying only necessary sensors, HydroLink cuts costs while directly targeting each community's priorities.

Feasibility
Preventive Maintenance



Device Self-Diagnostics

- Checks reagent image quality
- Confirms sample delivery
- Ensures data validity

Predictive Maintenance

- Monitors battery and connectivity
- Alerts before failures occur
- Detects sensor drift

HydroLink builds on existing technology from ASEAN, just waiting to be applied.



Advances in Science, Technology and Engineering Systems Journal Vol. 5, No. 6, 1007-1012 (2020)

www.astesj.com

ASTESJ
ISSN: 2415-6698

Design of a Remote Real-time Groundwater Level and Water Quality Monitoring System for the Philippine Groundwater Management Plan Project

ARTICLE INFO

Article history:
Received: 30 August, 2020
Accepted: 21 November, 2020
Online: 08 December, 2020

Keywords:
Groundwater Level Monitoring
Groundwater Quality Monitoring
Sensor Systems
Remote Real-time Systems
Water Quality Sensors

ABSTRACT

Recent technological advances allow us to utilize remote monitoring systems or real-time access of data. While the use of remote monitoring systems is not new, there are still numerous applications that can be explored and improved on, one such is groundwater level and quality monitoring. In the Philippines, the extraction of groundwater for both domestic use and industrial use are manually monitored by the government's concerned agency and is done at least once per year. With this current setup, the real and significant state of the groundwater is not reflected in a way that is most valuable to the government and to the community. This project aims to design and develop a remote real-time groundwater level and quality monitoring system. It is intended to provide quantitative data for policy makers in addressing recurrent water shortages in the Philippines. This paper discusses the designed system composed of three modules: power module, sensors and control, and data visualization. These three modules provide real-time data from far-flung locations while being energy-sustainable. Dry runs of the system in a controlled environment yielded excellent results — average data accuracy of 96.63% for all six (6) groundwater quantity and quality parameters namely: pH, temperature, electrical conductivity, total dissolved solids, salinity, and static water level (SWL), and 90.63% data transmission reliability. Initial deployment of the system on one of the groundwater monitoring well in Metro Manila, Philippines returned a 91.16% data transmission reliability. The system is currently installed in 20 groundwater monitoring sites all over the Philippines and is scheduled for more installations.

1. Introduction

In the Philippines, the main freshwater sources are inland surface water and groundwater. These water sources are used by the agricultural, industrial, and domestic sectors [1]. For the domestic sector, the ideal setup utilizes the surface water as the main source and the groundwater as a reserve during a water crisis [2]. But in the current recurring water shortage crisis, it is inevitable that these groundwater reservoirs are tapped as additional water resources.

The monitoring of water supply and water quality using observation wells is paramount. There are calls for deployment of sensor systems for monitoring wells for dense communities with high water usage and industrial areas producing wastes and contaminants [2]. If the rate of potential groundwater recharge is lower than the rate of extraction, the extraction well could dry up.

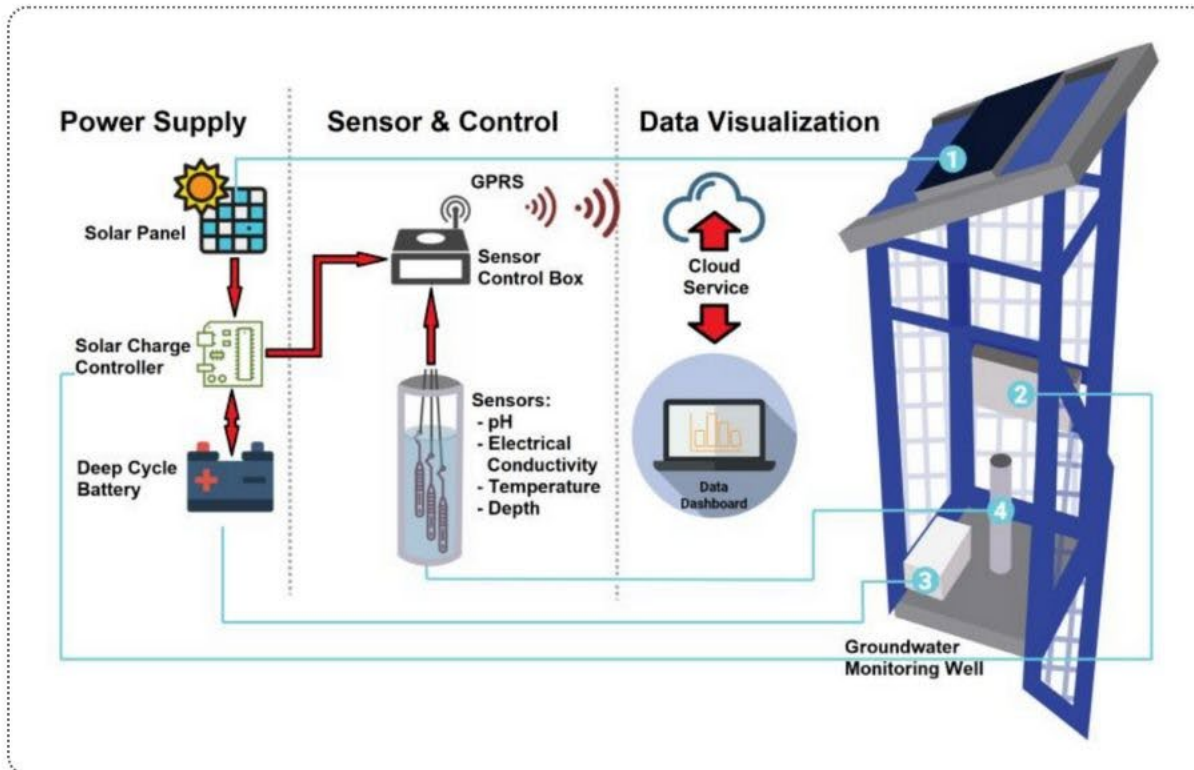
Additionally, water contamination including agricultural farms and industries [3].

Regular monitoring of the water quality using automated water quality monitoring systems can provide data from observation wells at design intervals every day. This lessens manual collection and reduces the hard-to-reach and dangerous areas [4]. Wireless sensor networks (WSNs), deployed on-site to monitor water quality at specified intervals, has been found to be an effective way for regularly monitoring and ensuring that water quality remains consistent and compliant with standards [5]-[7]. This setup provides needed information to relevant agencies that allow them to make well-informed decisions and guidelines for water conservation.

In full, this paper focuses on the design of the sensor system.

Source

Design of a remote real-time groundwater level and water quality monitoring system for the Philippine groundwater management plan project (2020)



2020 study



How do we ensure
HydroLink's **sustainability**?



HydroLink will operate under a
B2B2C Social Enterprise Model.

B2B2C

Institutions as customers

- Government agencies
- NGOs

These have the mandate and budget to address water security.

B2B2C

B2B2C

B2B2C

B2B2C

B2B2C

Communities as end-users

They are the rural communities who use the mobile app, receive warnings, and benefit from the clean water data.

B2B2C

B2B2C

B2B2C

1

Hardware Sales

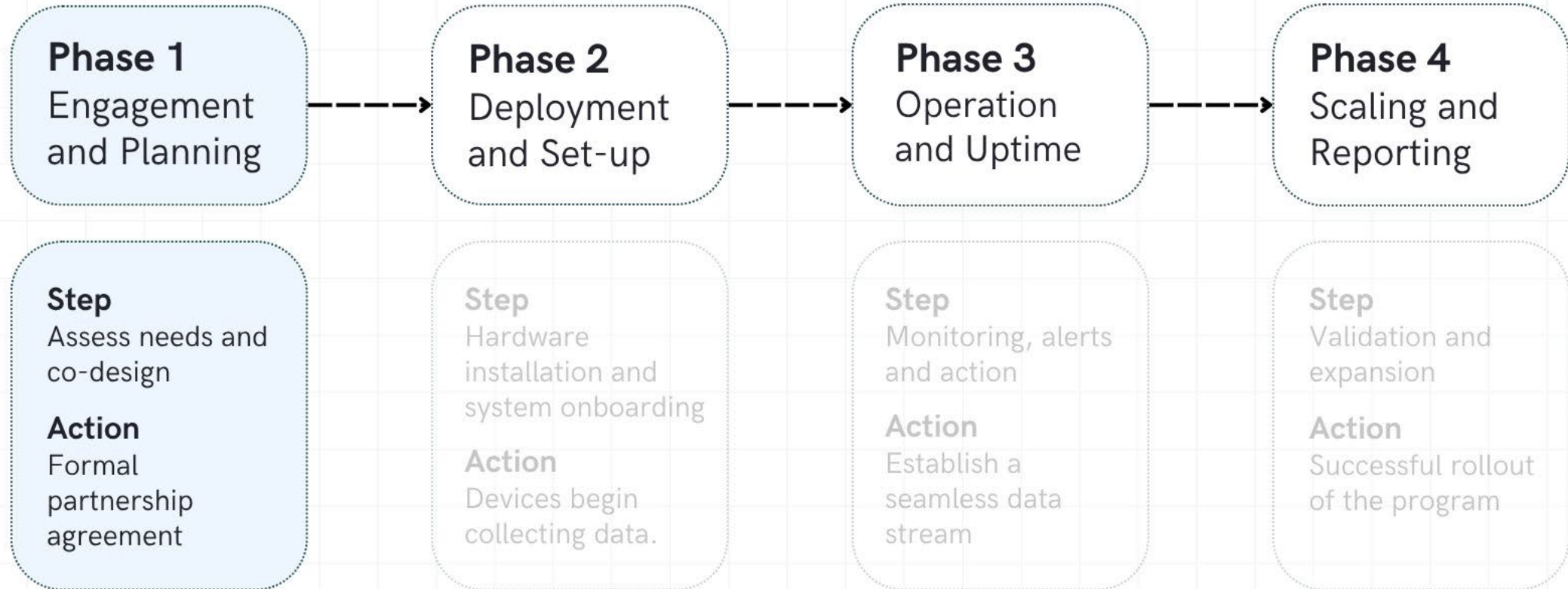
A one-time fee for the physical HydroLink monitoring device that covers manufacturing and installation costs.

2

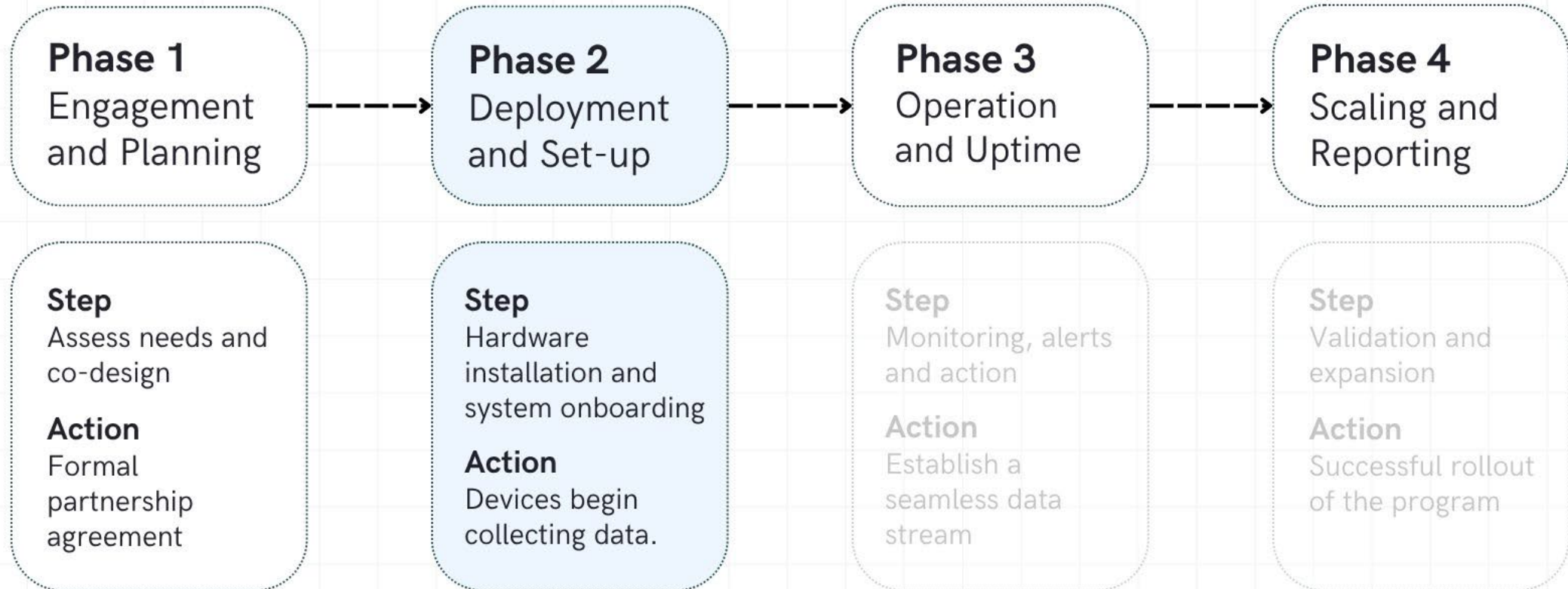
Platform Subscription

Recurring annual or monthly fee for access to the SAP-powered data platform and analytics.

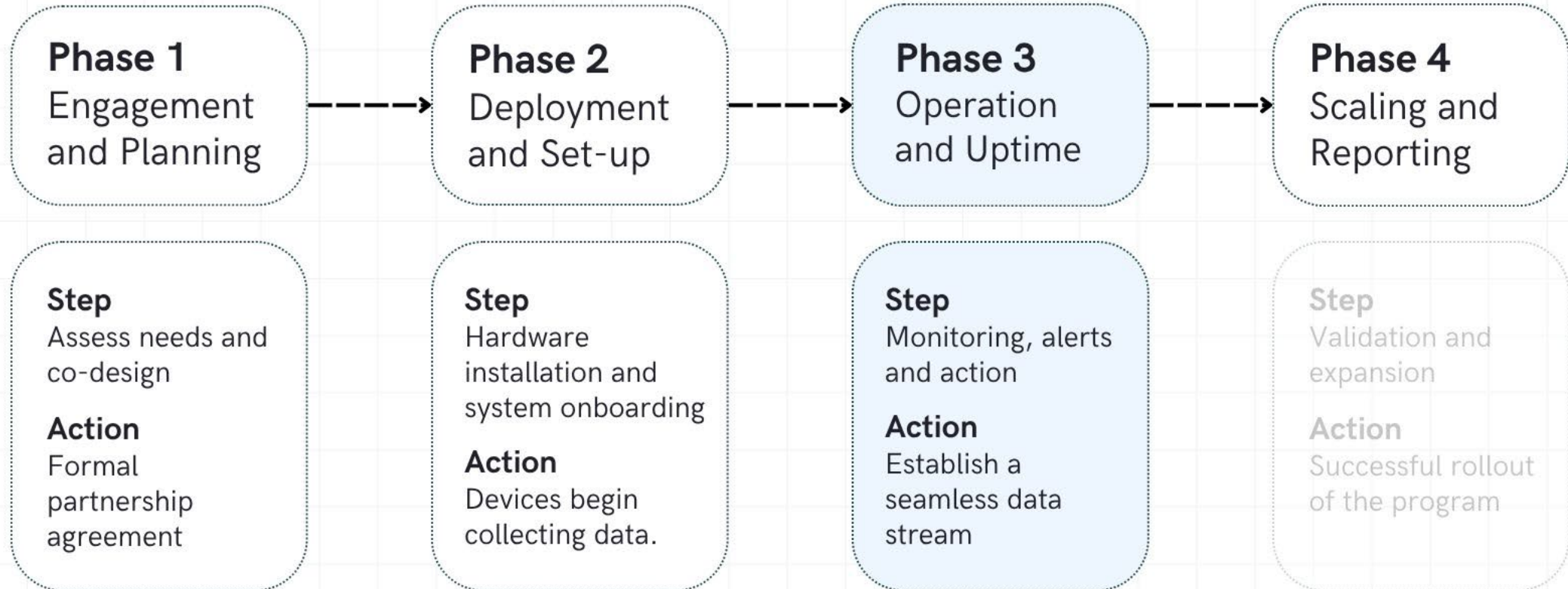
Business Model Implementation



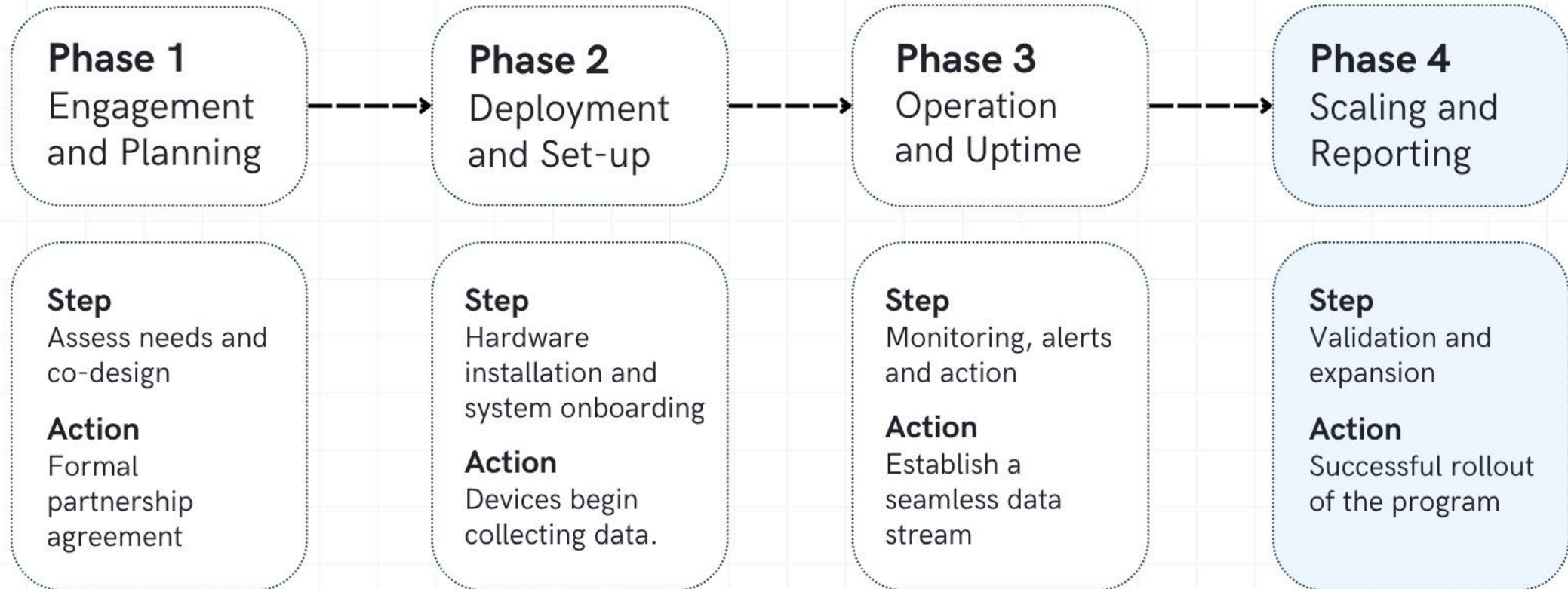
Business Model Implementation



Business Model Implementation



Business Model Implementation





Under this model, we create a win-win sustainability framework.

Gov't and NGOs

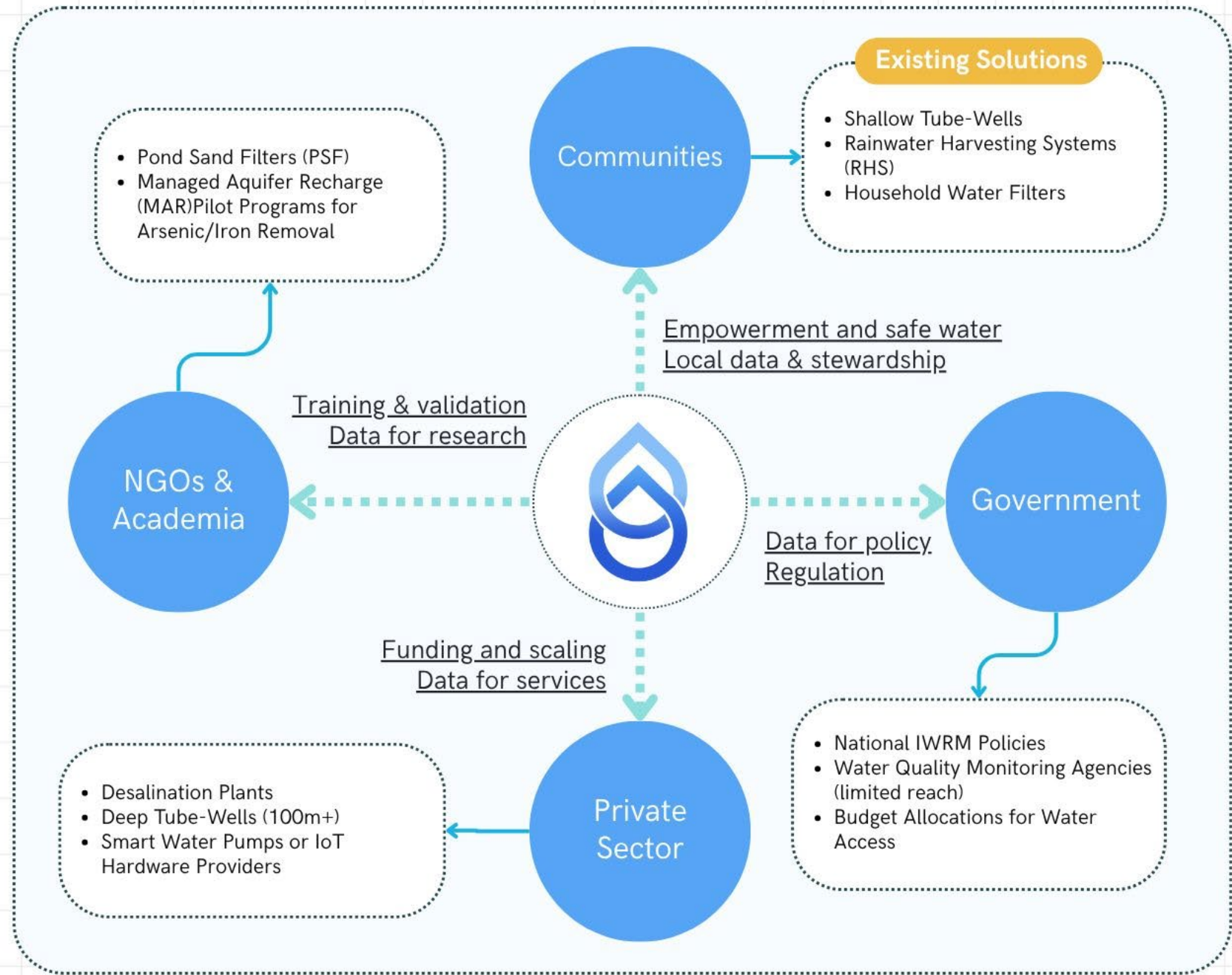
Receive guaranteed, reliable data and a predictable budget for water management.

Communities

Receive a service that's always on, always reliable, and always free to them.

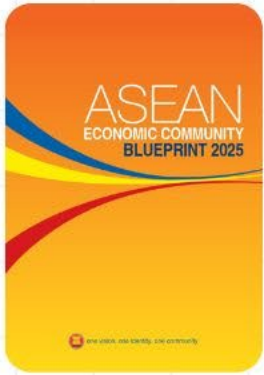
HydroLink

Receives long-term, recurring revenue stream for continuous improvement.



 Big Picture

HydroLink synergizes well with various institutions.



ASEAN Framework Alignment

ASEAN Economic Community Blueprint 2025

Hardware

Affordable Hardware

B.4: Innovation-driven growth

Hardware for All Locations

D.4: Reduce development gap

Data-driven Software

National Water Security Dashboard

C.2: ICT for sustainability

Real-Time Monitoring App

C.9: Science & tech
B.8: Sustainable development

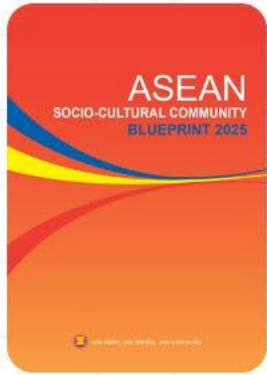
Participatory Software

Community-NGO Connector

D.3: Public-private cooperation

Potential MSME Deployment

D.1: Strengthening MSMEs



ASEAN Framework Alignment

ASEAN Socio-Cultural Community Blueprint 2025

Data-driven Software

Color-Based Warning System

12.4: Climate and vulnerability adaptation

National Water Security Dashboard

D: M&E system

Participatory Software

Community Monitoring Platform

A.1: Engaged stakeholders

In-App Learning Modules

A.2: Empower people

Community-NGO Connector

C: Promote Blueprint



ASEAN Framework Alignment

ASEAN 2025: Forging Ahead Together

Hardware

Affordable Hardware

Vision 15: Narrowing development gap

Hardware for All Locations

Vision 15: Resilience and inclusion

Participatory Software

Community Monitoring Platform

Vision 14: People-centered ASEAN

In-App Learning Modules

Vision 16: Human capital development

Community-NGO Connector

Vision 14: Stakeholder inclusion

Potential MSME Deployment

Vision 15: Inclusive business opportunity

ASEAN Framework Alignment

UN Sustainable Development Goals

Hardware

Affordable Hardware

- 6.1.1: Access to safe water
- 6.2.1: Access to sanitation services
- 1.4.1: Basic services

Hardware for All Locations

- 6.b.1: Community participation
- 10.2.1: Inclusion

Data-driven Software

Color-Based Warning System

- 6.3.2: Water quality
- 3.9.1: Preventing deaths from unsafe water

Predictive Insights

- 6.4.2: Addressing water stress
- 13.1.1: Disaster response

National Water Security Dashboard

- 6.5.1: Water management
- 6.a.1: Aid for water

Participatory Software

Community Monitoring Platform

- 6.b.1: Local participation
- 16.7.1: Inclusive governance

In-App Learning Modules

- 4.7.1: Education for sustainability
- 6.6.1: Ecosystem health

Community-NGO Connector

- 6.b.1: Participation policies
- 17.17.1: Civil partnerships

1

Foundation &
Community
Co-Design
(Months 1-3)

2

Agile
Development
& Prototyping
(Months 4-6)

3

Pilot
Deployment &
Validation
(Months 7-12)

4

Training & Full
Rollout
(Months 13-18)

5

Strategic
Scaling
(Months 19+)

HydroLink's Roadmap

1

**Foundation &
Community
Co-Design
(Months 1-3)**

ACTION

Develop the integrated hardware and mobile app platform, ensuring sensors are calibrated for region-specific contaminants like arsenic, a known issue in Cambodia and Myanmar.

KPIs

2+ formal partnerships established; 50+ community members engaged in design workshops; baseline water quality data collected from 10+ wells.

In Poblacion

Partner with Panglao officials and Barangay Poblacion leaders to finalize the custom Salinity and E. coli setup.

2

**Agile
Development
& Prototyping
(Months 4-6)**

ACTION

Secure pilot-site partnerships by aligning with local initiatives, such as the governing boards of the PH's Water Quality Management and Conservation Areas (WQMACA), to co-design the system with community leaders.

In Poblacion

Deploy HydroLink units in Poblacion wells to test system performance, troubleshoot issues, and refine the hardware and self-diagnostics under real field conditions.

KPIs

50 prototype monitoring units produced; Beta mobile app (iOS/Android) passes user acceptance testing; Cloud dashboard for stakeholder monitoring is live.

3

**Pilot
Deployment &
Validation
(Months 7-12)**

ACTION

Deploy devices in the pilot community and validate our real-time data against the standards used in national programs, such as the Philippines' Tap Watch Program.

KPIs

95% hardware uptime;
Data accuracy validated with <5% variance from lab tests; 80% user engagement on the beta app.

In Poblacion

Poblacion becomes the pilot site; water stewards are trained and data accuracy is cross-checked against lab tests.

4

ACTION

Implement a full community rollout using a proven public awareness model, similar to Malaysia's CEPA approach, to ensure high adoption and empower local water management.

KPIs

Expansion plan developed for 2+ new countries; Secure funding/partnerships for 500+ new devices; Measurable improvement in community water security metrics.

**Training & Full Rollout
(Months 13-18)**

In Poblacion

The successful modular model expands to other high-risk barangays in Panglao Municipality.

5

**Strategic
Scaling
(Months 19+)**

ACTION

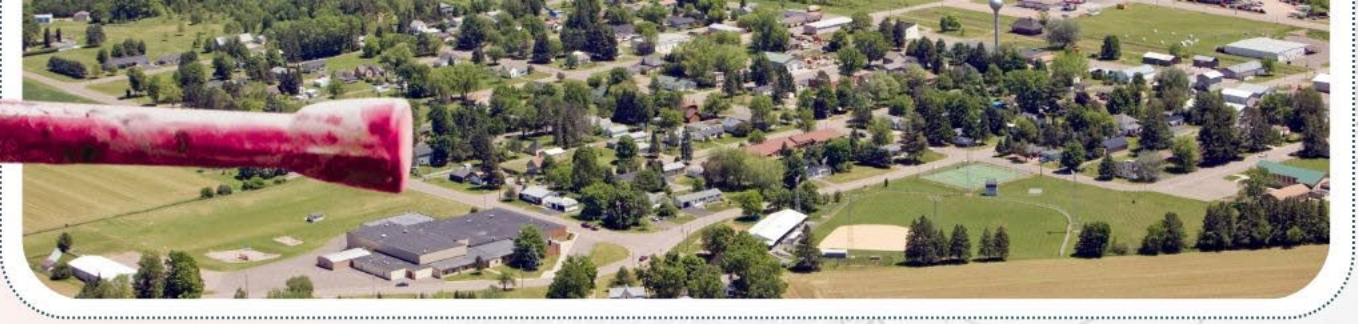
Leverage validated pilot data to support national goals, such as Vietnam's digital water database initiative or Indonesia's community-based EKORIPARIAN program, to secure partners for scaling.

KPIs

3+ community-wide training sessions conducted; 90% of target households actively using the app; Stakeholder dashboard adopted by local government partners.

In Poblacion

Poblacion's success proves the model ready for expansion across the Philippines and ASEAN.



ASEAN already has the technology and the strategy to transform a last-mile crisis into a first-mile opportunity for data generation and community empowerment.

6 CLEAN WATER AND SANITATION





ASEAN already has the technology and the strategy to transform a last-mile crisis into a first-mile opportunity for data generation and community empowerment.

Join us in making groundwater visible, safe, and sustainable for millions.

6 CLEAN WATER AND SANITATION



References are accessible through



bit.ly/hydrolink_references

or by scanning the QR code below:

