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Monitoring, Evaluation and Learning (MEL) for Recharge Pits in Maharashtra's Marathwada Region

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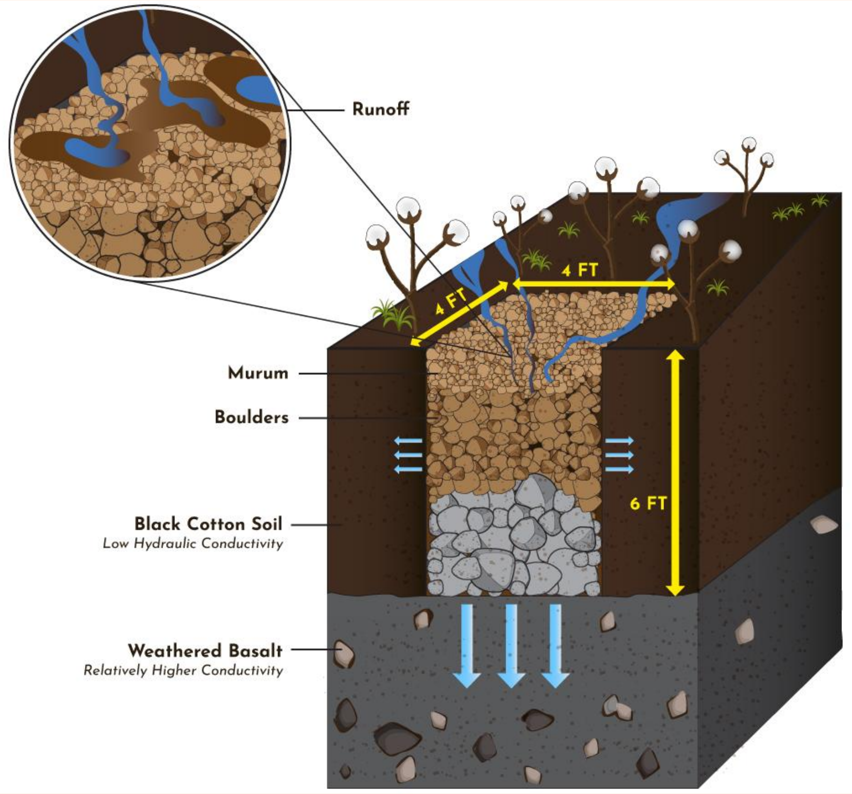
The black soil region of **Jalna** in Marathwada faces a problem of too much and too little water.

Water stagnates in monsoon for >10 days. This causes crops to spoil and income loss for farmers.

With 750 mm annual rainfall, farmers are left with no water by the end of December/January, affecting water supply for rabi crops.

Recharge pits are a classic intervention implemented at the farm scale.

A newly dug recharge pit



Schematic of pit design

What did we measure?

Hypothesis 1

Recharge pits have a significantly higher infiltration rate (10-100X) than the surrounding fields.

Infiltration test

Hypothesis 3

At least 25% of excess runoff within that acre can percolate down via the pits.

Empirical Data Analysis

Hypothesis 2

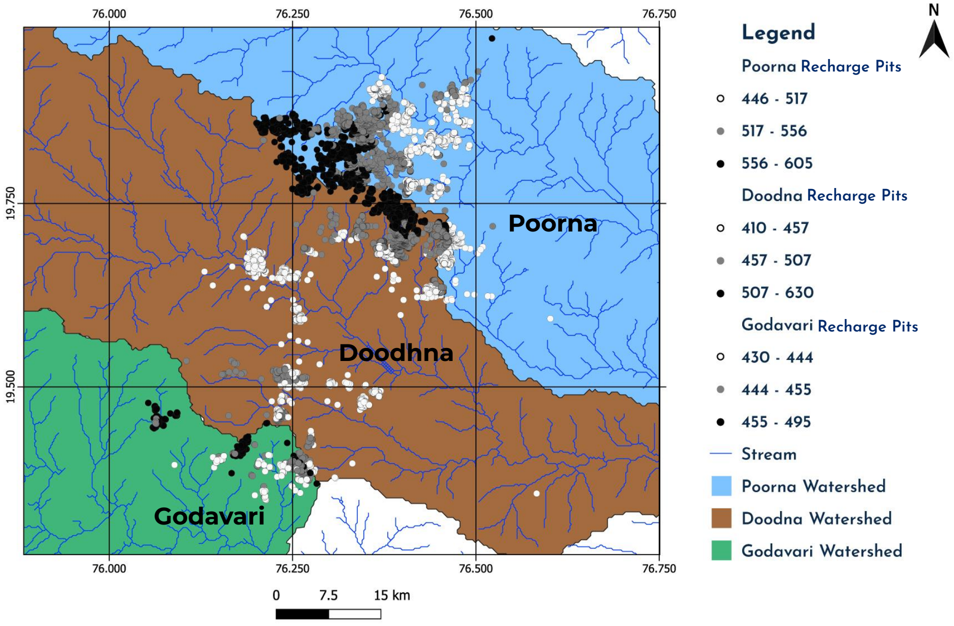
Water ponding reduced in fields with recharge pits.

Farmer survey

Hypothesis 4

Water levels improved at a watershed level as a result of recharge pits.

Paired watersheds analysis



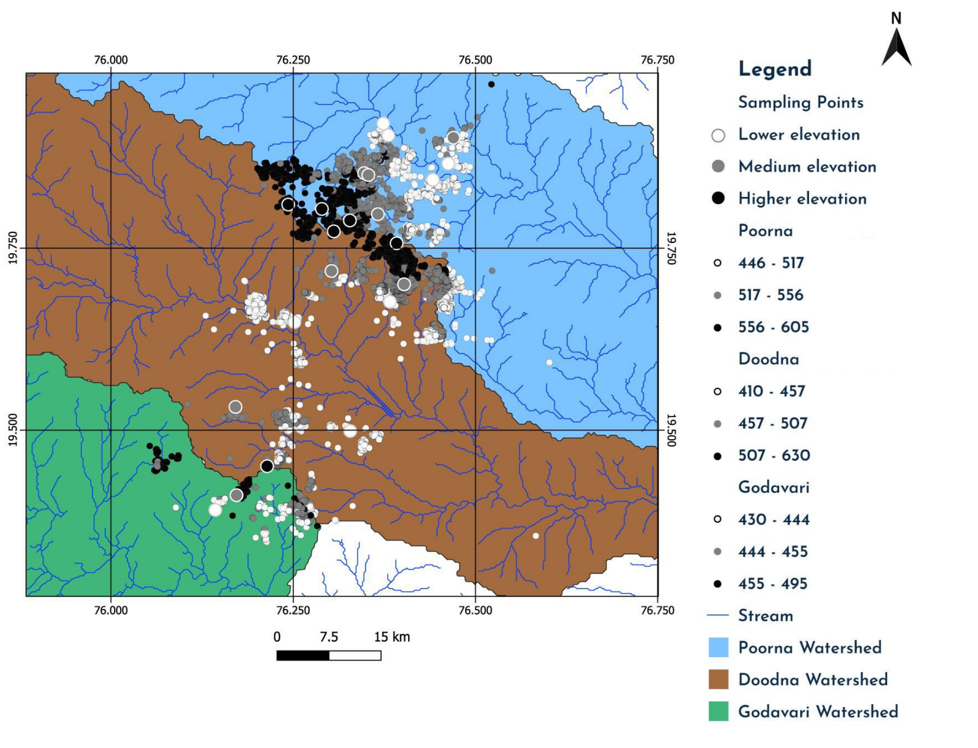
Since 2021, over 60,000 recharge pits have been constructed in Jalna.

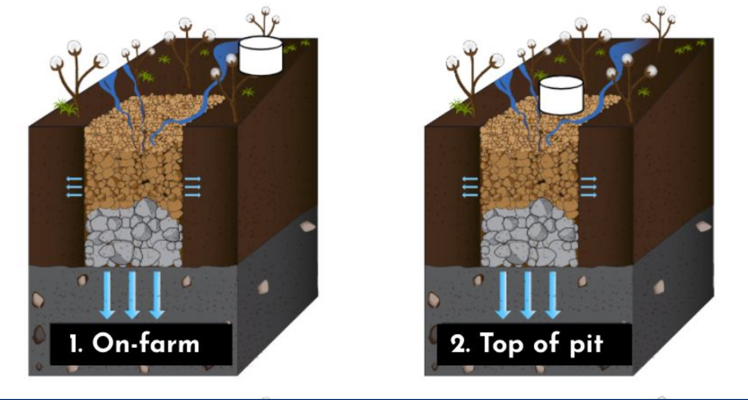
Hypothesis 1

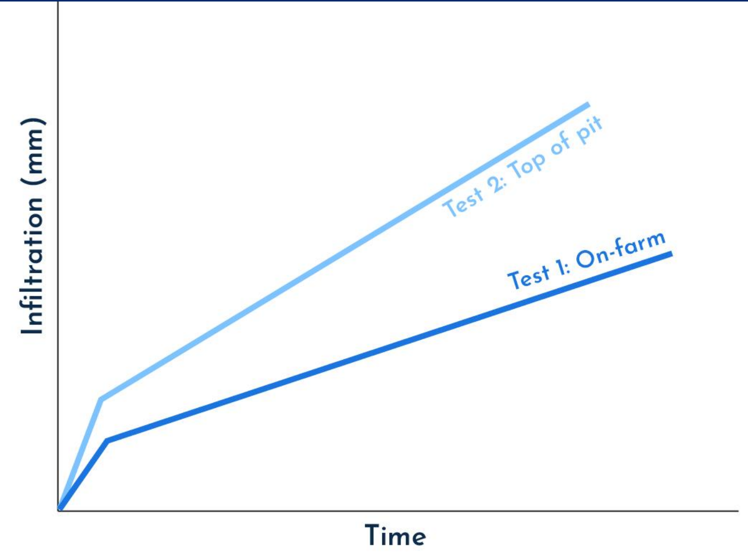
Recharge pits have a significantly higher infiltration rate (10 - 100 x) than the surrounding fields.

Methodology and Sampling

Infiltration tests (Double-ring infiltrometer)

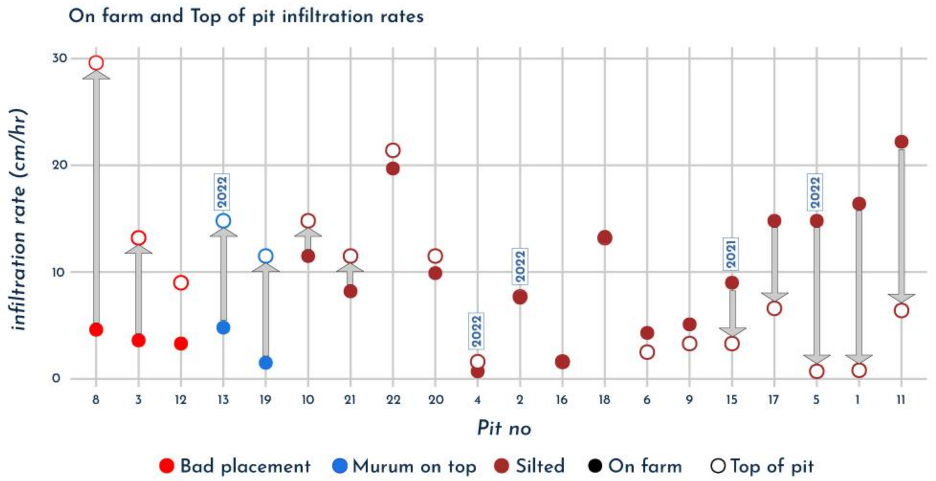




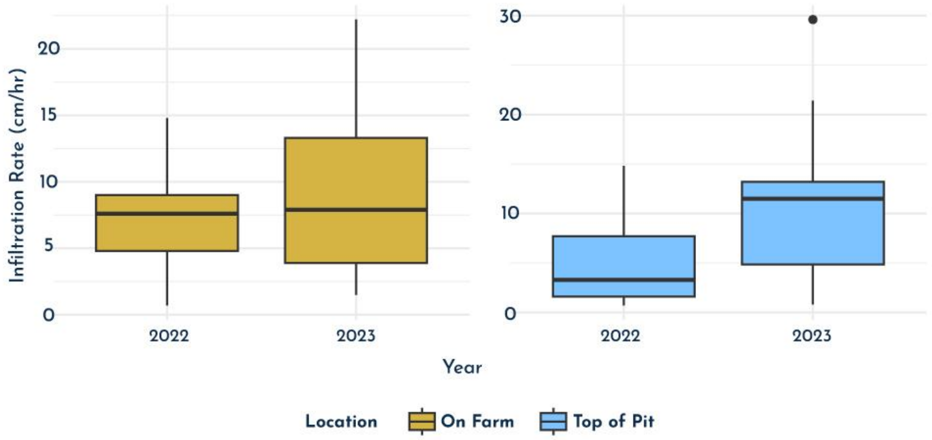


A total of 22 pairs of infiltration tests were conducted.

H1 Results: Recharge pits promote infiltration but get heavily silted.



Median On-farm = 7.7 cm/h On-pit = 8.4 cm/h



Siltation of pits

Existing design of the pits does not capture silt and is onerous to clean.

Location within a farm

Some pits are poorly located—they don’t receive any runoff. The purpose of having a recharge pit is defeated.

Lack of maintenance

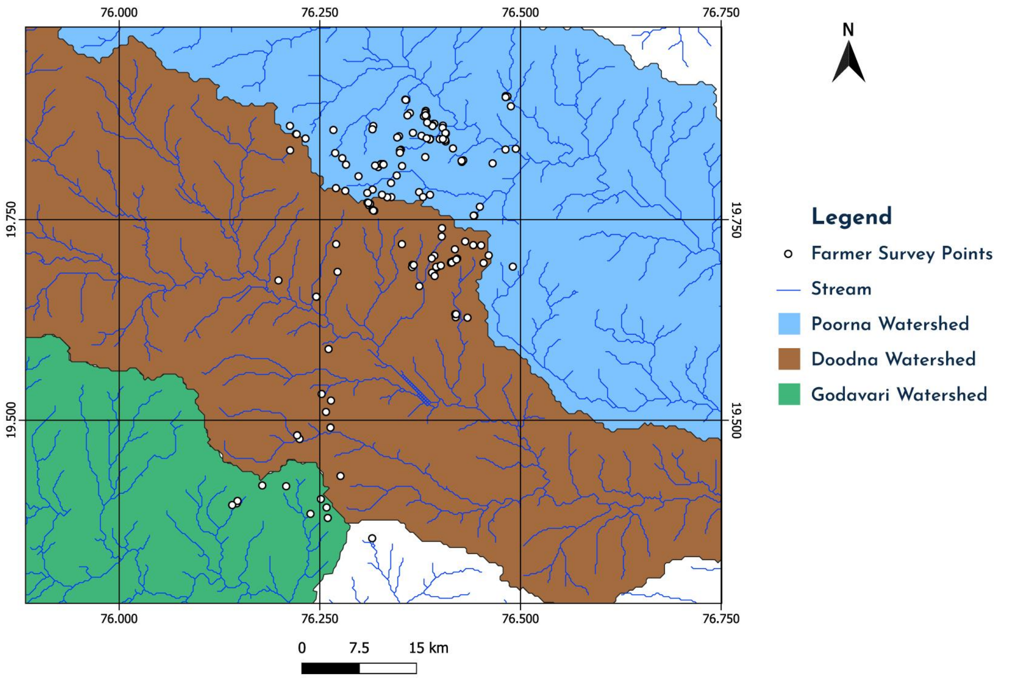
The pits are one and done. They receive heavy runoff during rainfall and get silted with cakey deposits on the top and inside.

Hypothesis 2

Water ponding reduced in fields with recharge pits.

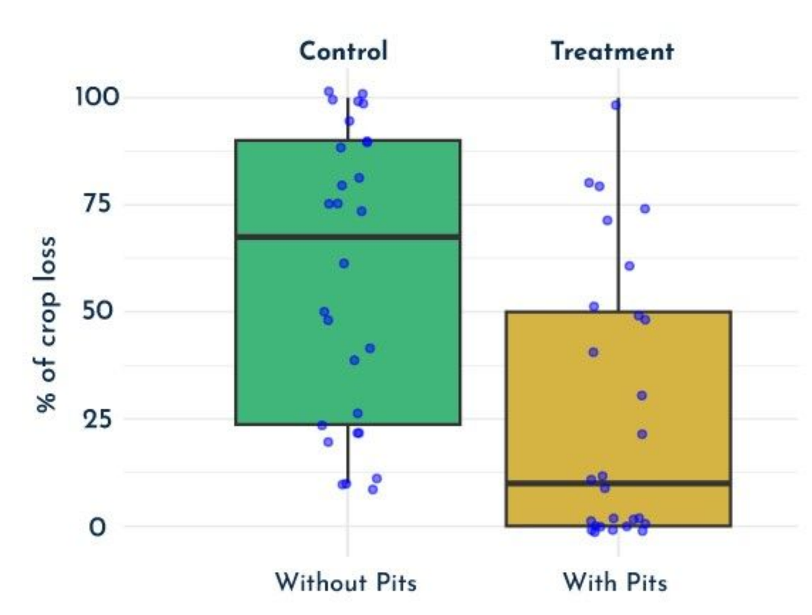
Methodology and Sampling

Farmer survey (Semi-structured questionnaire)



We surveyed 155 farmers—119 who adopted pits in 2021, 2022 and 2023, and 35 who did not adopt pits.

H2 Results: Farmers who adopted pits saw a reduction in crop loss to 10%



Crop Loss in year 2022

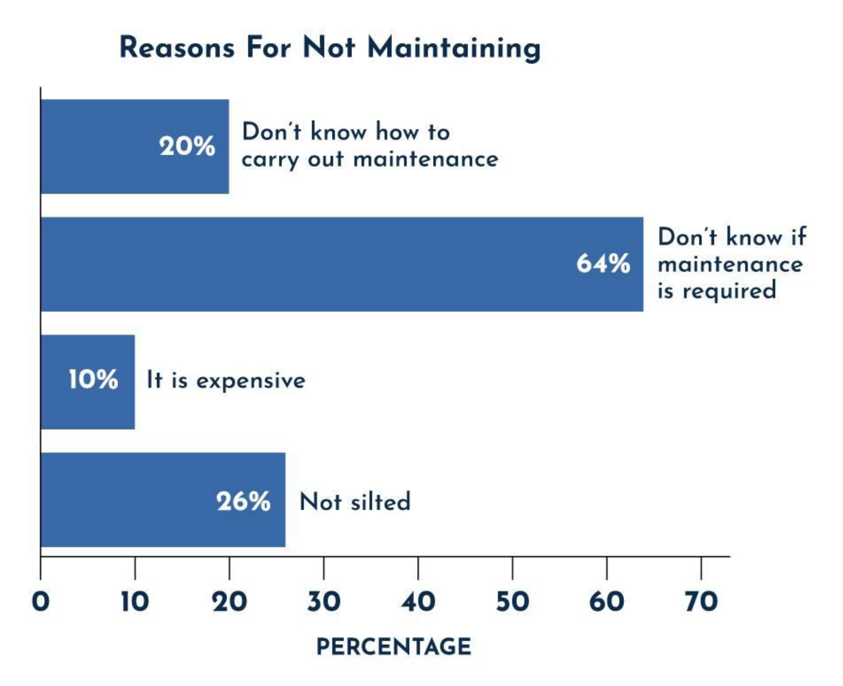
Insights from Farmer Surveys:

- Crop loss in farms (2022) with JalTara was significantly lower (10%) compared to farms without the pits (63%).
- Pits helped reduce waterlogging and ponding, directly correlating to improved crop survival.

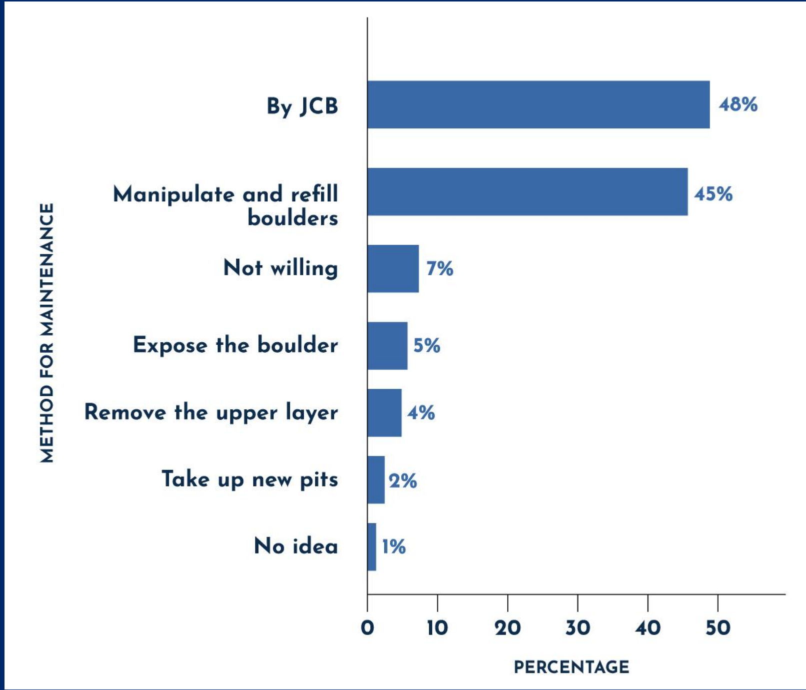
Data was captured both for change in ponding days in their farms and crop losses. However, farmer recall was more reliable for crop losses. Even then there were errors in the approach:

- We understand based on the findings from the study that there was a **confirmation bias** from the beneficiaries.
- Also, f**armer recall was poor** from 2022 on crop spoilage and came with errors. The more recent year 2023 received less rainfall and was not a good year for comparison.

H2 Results: Farmers were willing to carry out maintenance. However, they required guidance.



Farmer survey findings indicate that a majority of farmers were unaware that the recharge pits required maintenance.



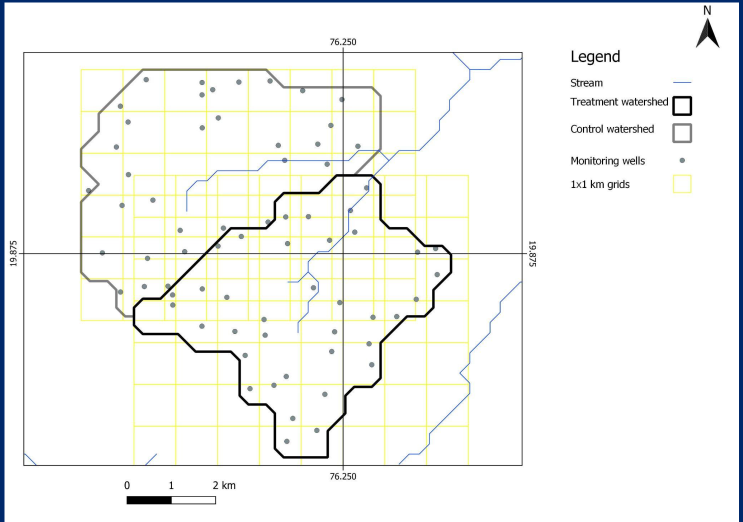
In addition to using earth-movers, farmers were willing to manually work on maintaining the recharge pits.

Hypothesis 4

Water levels improved at a watershed level as a result of recharge pits.

Methodology

Methodology	Instrumentation	Location	Sampling	Frequency
Paired Watersheds	Low-cost Water Level Sounder	Treatment Watershed	Depth to Water Level	Monthly; June 2024 - January 2025
		Control Watershed	Depth to Water Level	



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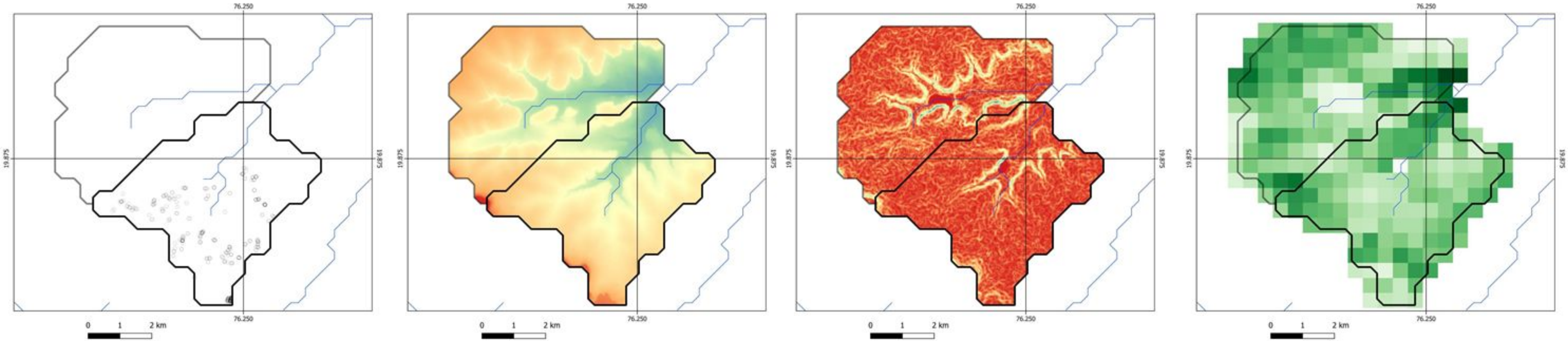
Methodology

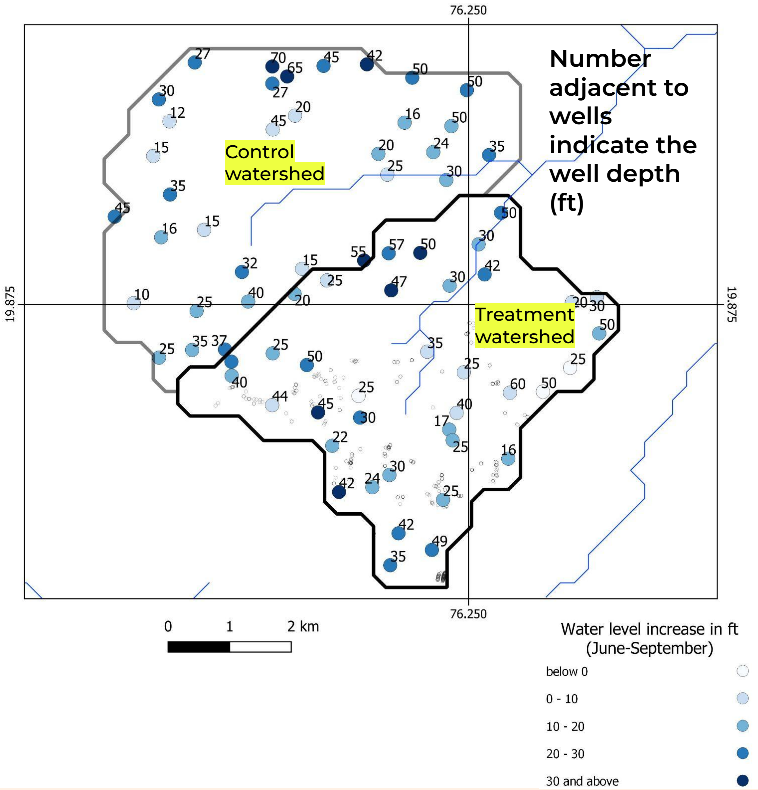
Selection of paired watersheds



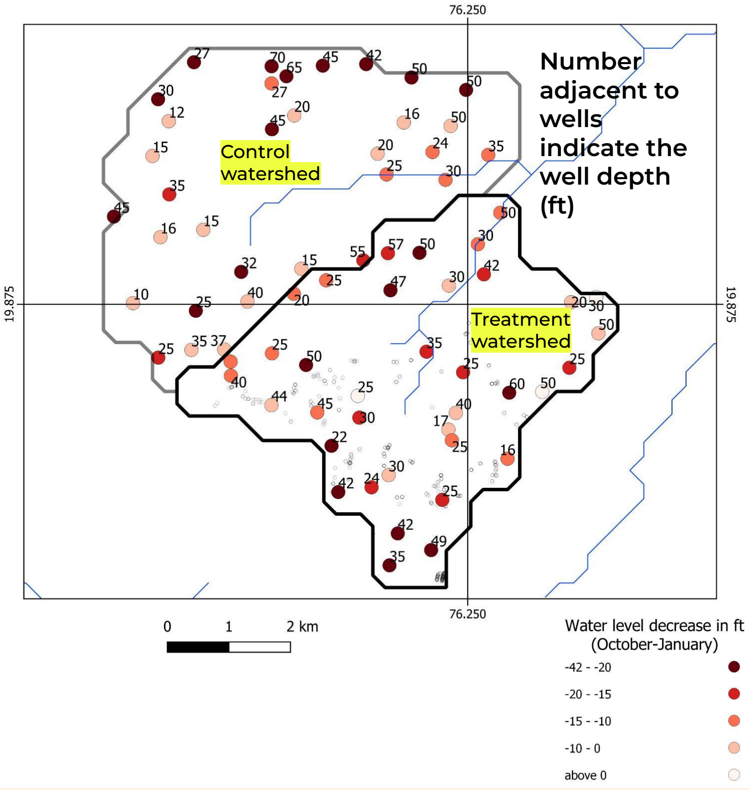
Watershed	Control/ Treatment	Order of stream	Slope (degrees)	Area (sq km)	Presence of reservoir	Area of reservoir (sq km)	Average annual NDVI (for 2023)	Land Use	Number of wells monitored	Number of recharge pits
Poorna	Control	1	0-10	24.18	Yes	0.48	0.51	Agriculture	34	0
	Treatment	2	0-10	24.67	Yes	0.43	0.50	Agriculture	36	463

Finding #1: Groundwater rose during monsoon but receded quickly post-peak monsoon in both watersheds.

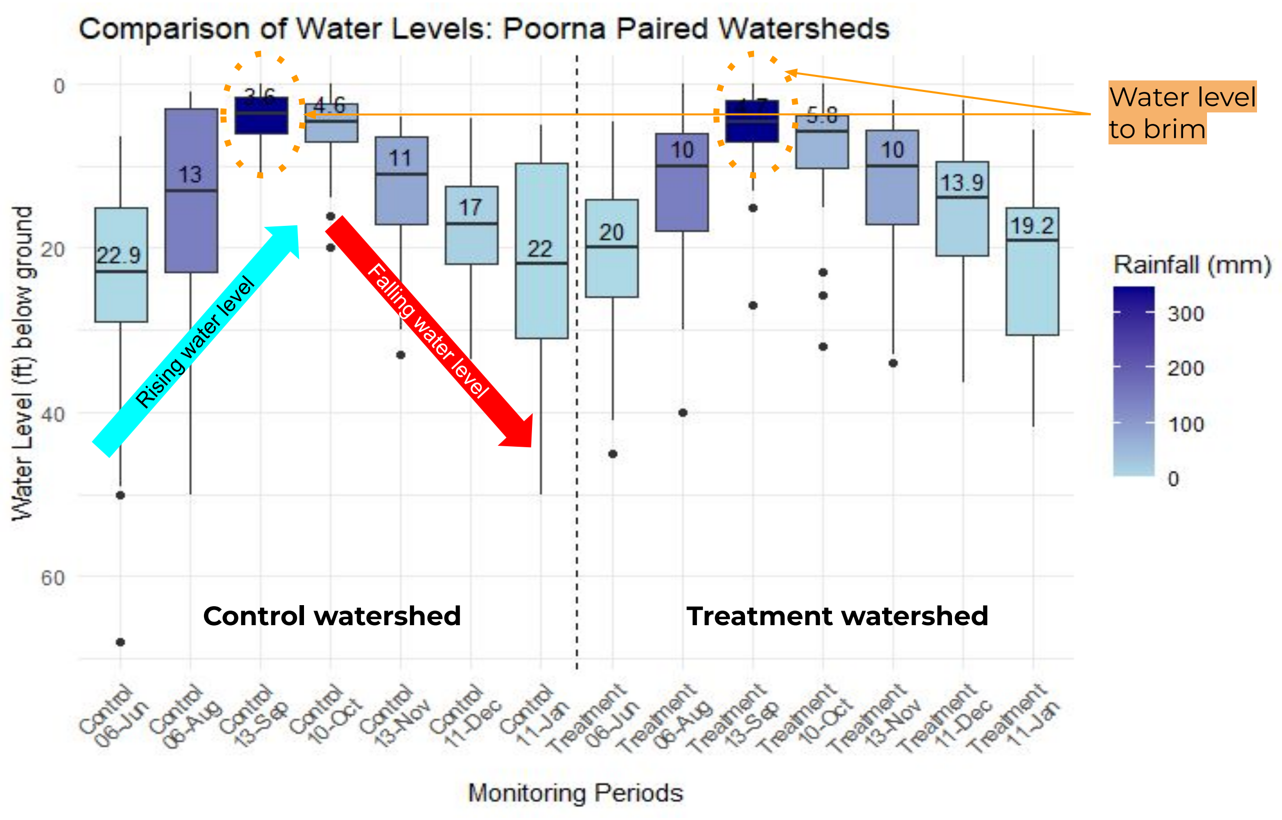
Increase in water level from June to September



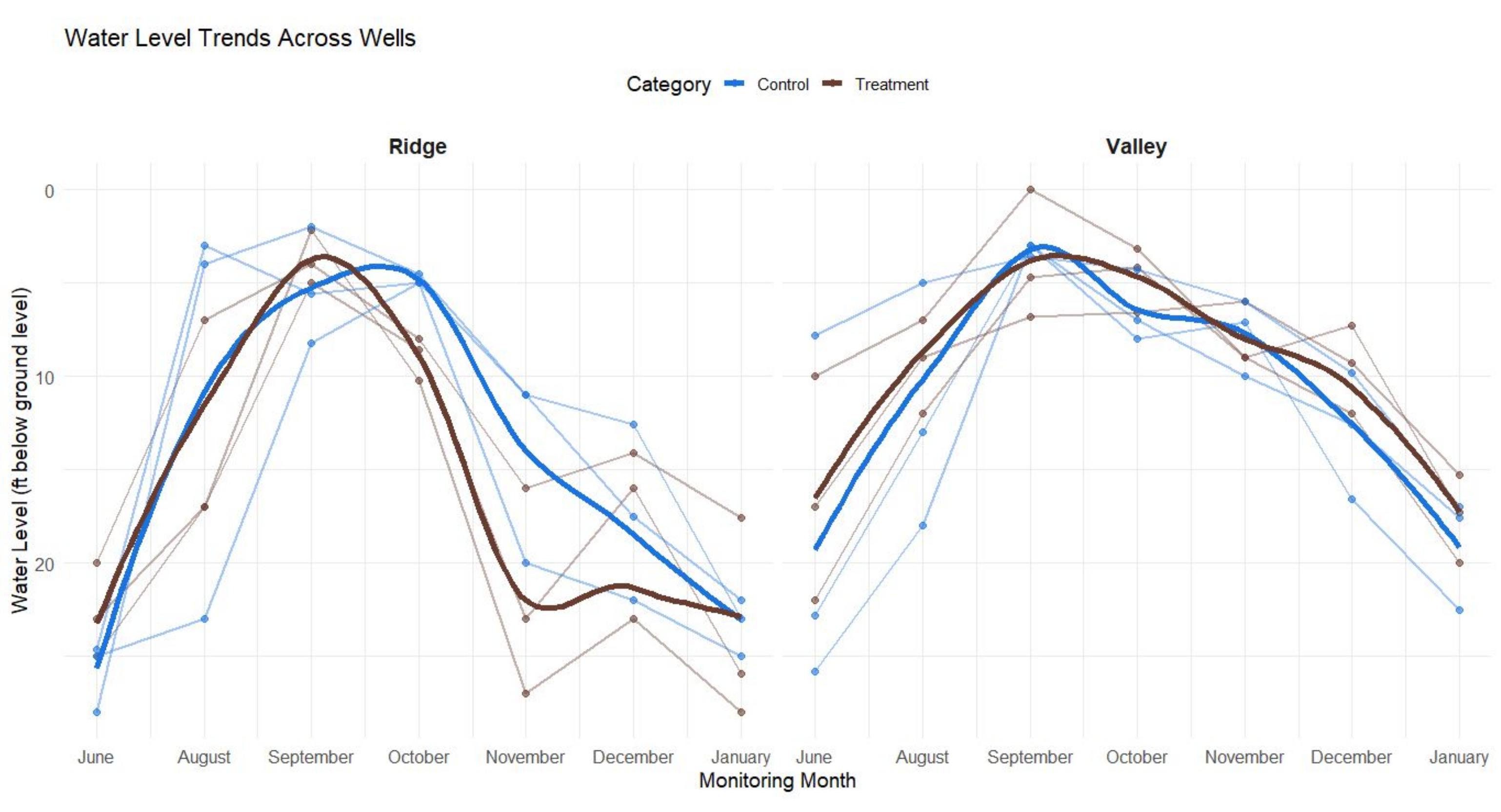
Decrease in water level from October to January



Finding #2: There was no significant difference in groundwater levels between control and treatment watersheds throughout the monitoring period.



Finding #3: The ridges experienced relatively faster rate of groundwater decline compared to valleys.



Hypothesis 3

At least 25% of excess runoff within that acre can percolate down via the pits.

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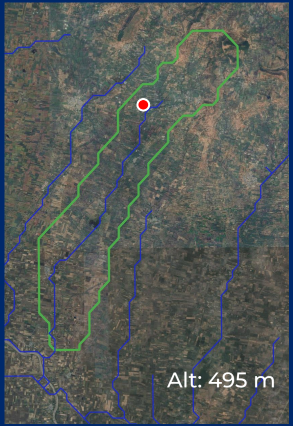
Methodology

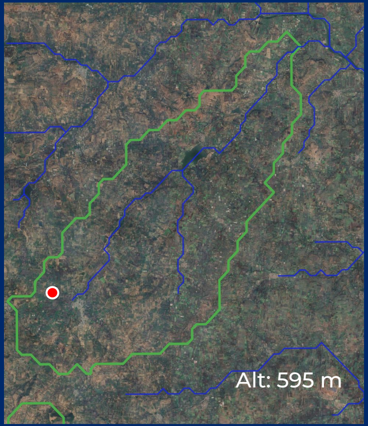
Methodology	Instrumentation	Location	Sampling	Frequency	
Empirical Data Analysis	Rain Gauge Pressure Transducer 1) Pit Top 2) Pit Bottom 3) Control Plot	Ner	Conventional Pit	5-min	July - November 2024
		Ner	Designed Pit		
		Sevalli	Conventional Pit		

Automatic Rain gauge

Pressure transducer on pit top



Watershed of Ner (Rain: 750 mm)

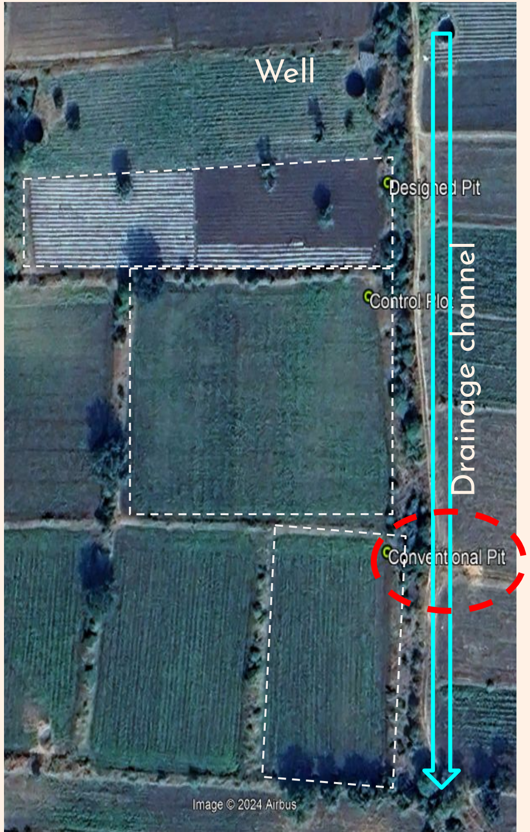


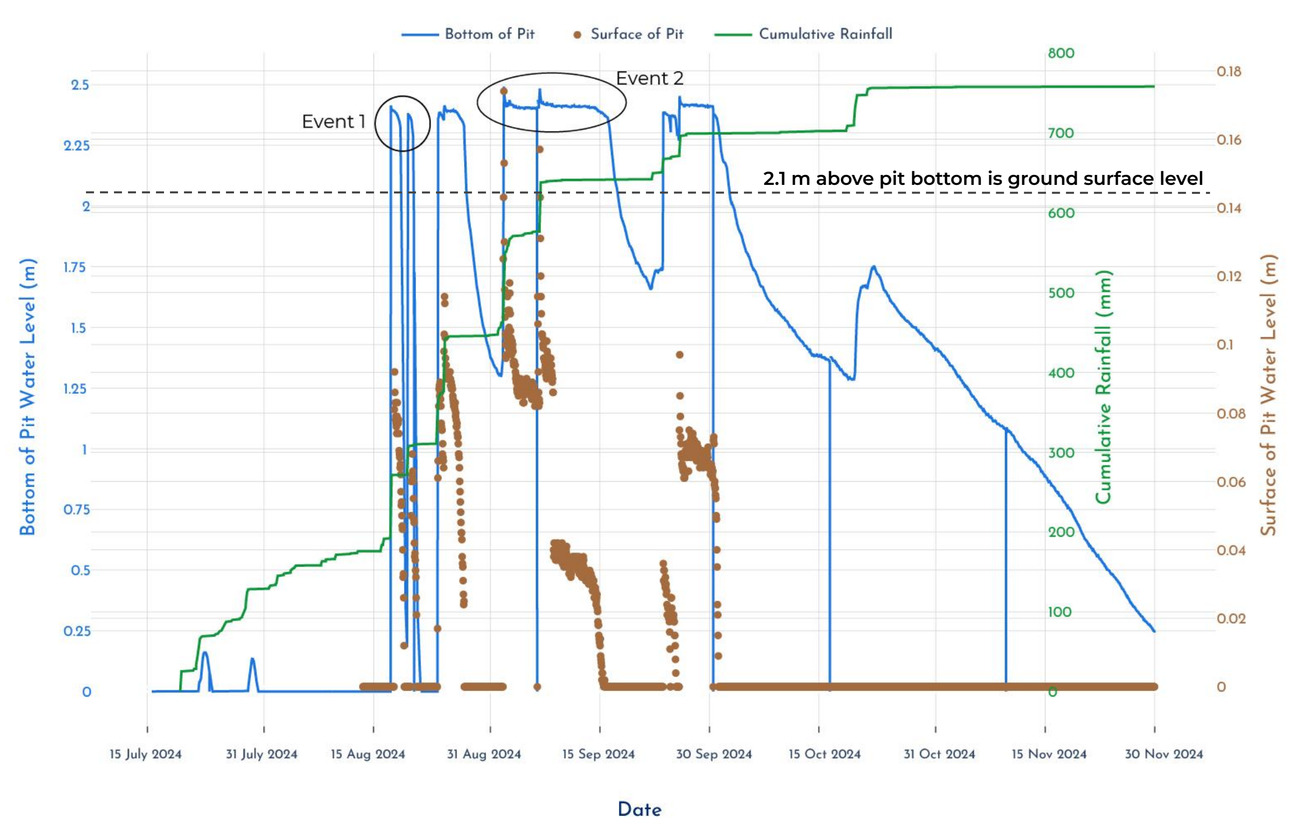
Watershed of Sevalli (Rain: 580 mm)

Designed pit

Water Level Time Series - Recharge pit

High data quality: Every rise in the water level is preceded by a rainfall event.



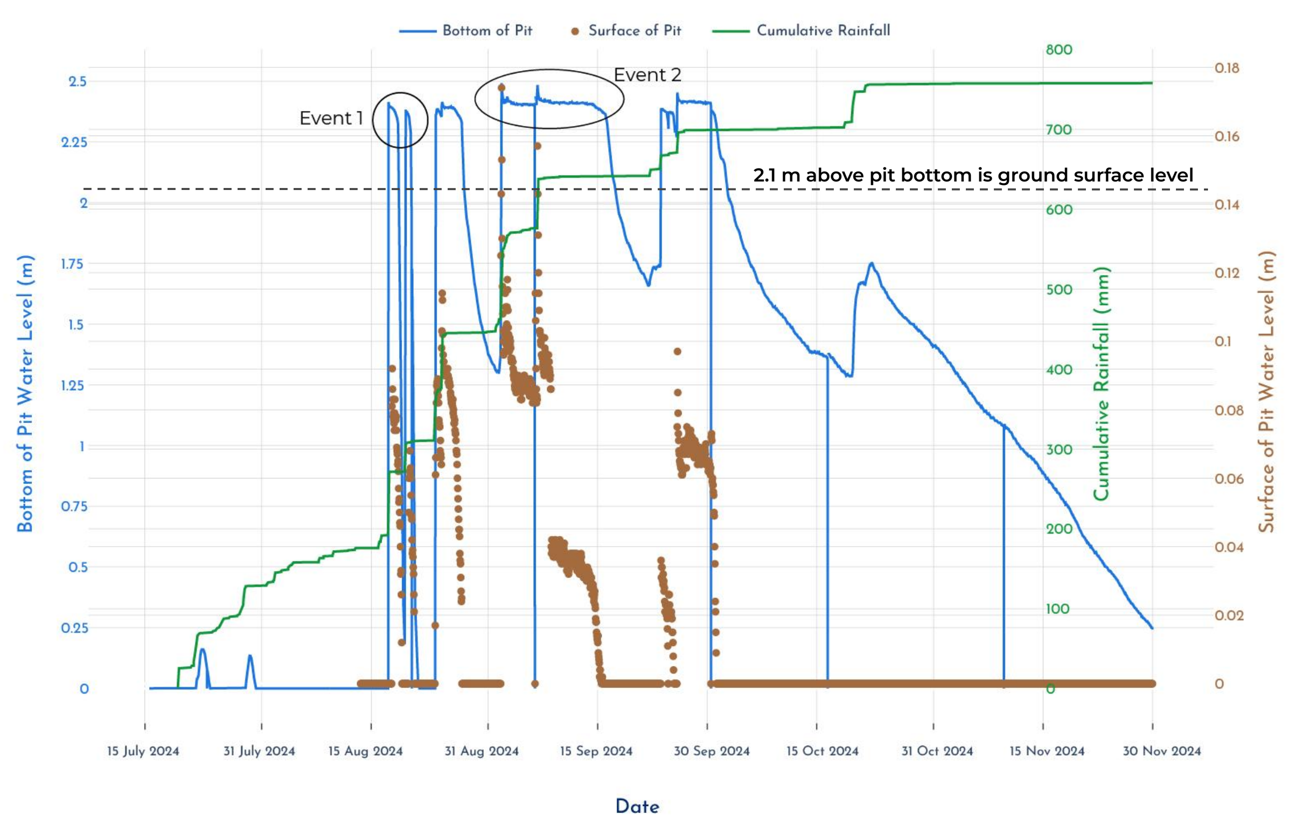


Water Level Time Series - Conventional pit

Two distinct signatures appear in the water level time series.

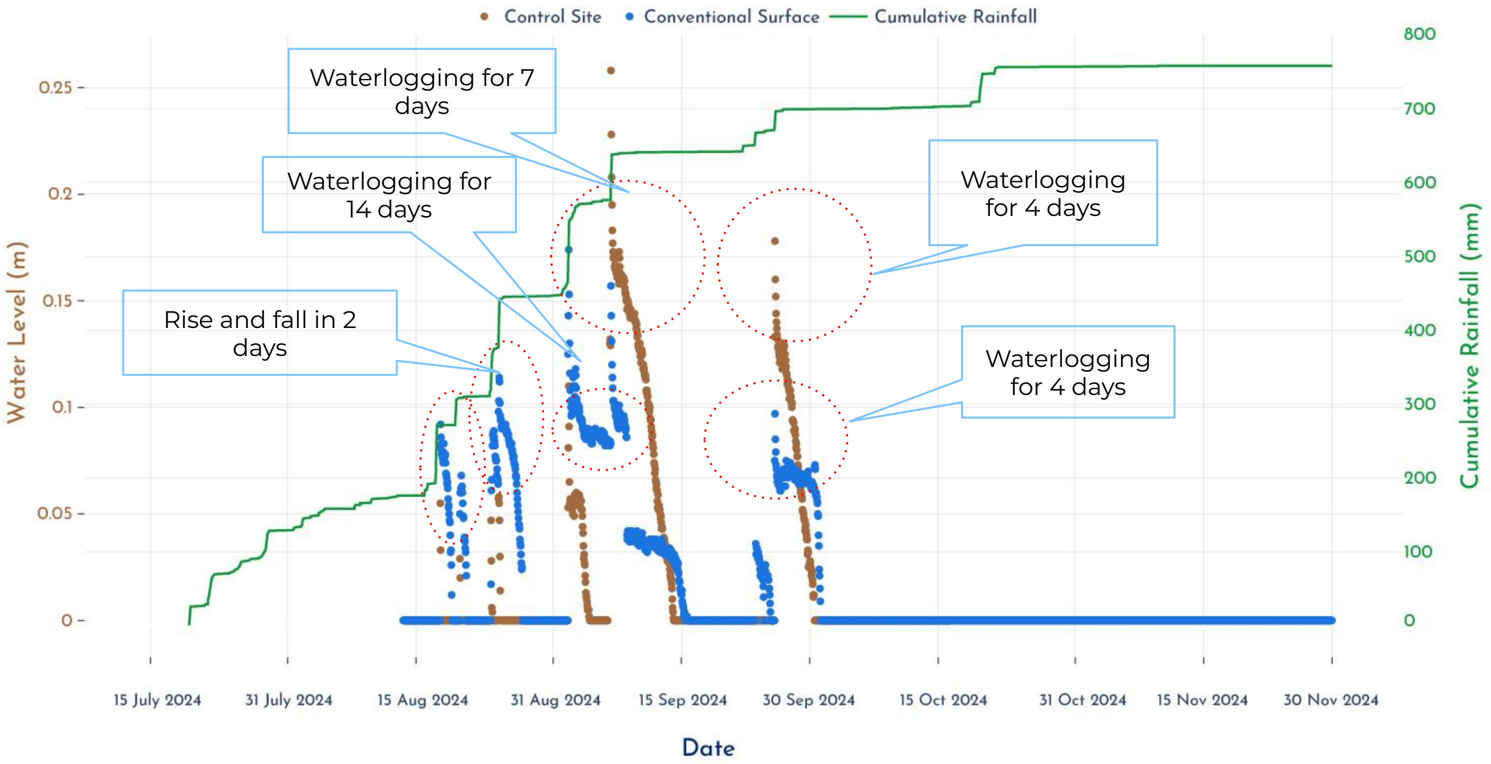
Event 1: Short spikes
(what we thought originally)

Event 2: Slow rate of decline
(the decline is mainly due to pumping + baseflow)



Water Level Time Series - Recharge pit top and farm (control site)

The intensity and duration of waterlogging were not too different in the control (brown) and the surface of the pit (blue).



Conceptual Processes

When does a recharge pit work?

Criteria #1

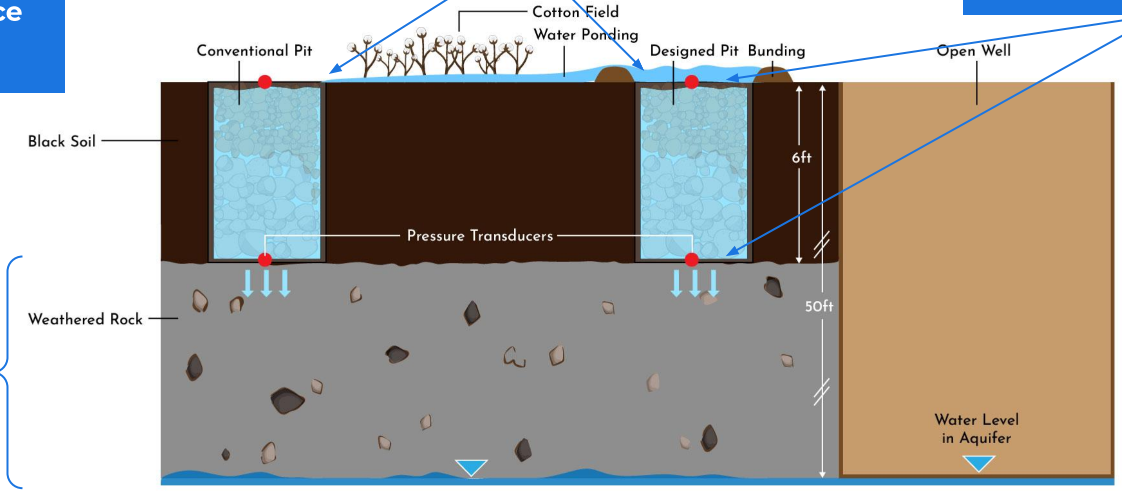
Available subsurface storage

Criteria #2

Surface runoff to the pit as infiltration-excess

Criteria #3

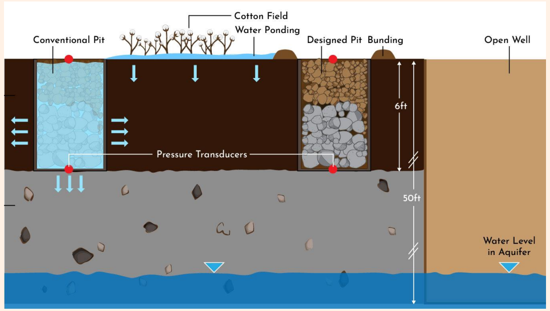
Volumetric rate of water conveyed from surface to aquifers >> rate of infiltration in ponded area



Conceptual Representation of Processes

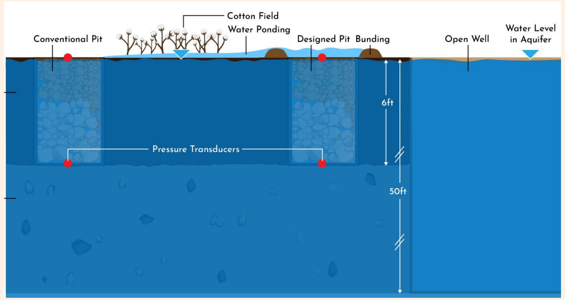
Assessing Criteria #1: Aquifers towards valleys in massive basalts were quickly recharged and became fully saturated.

T1

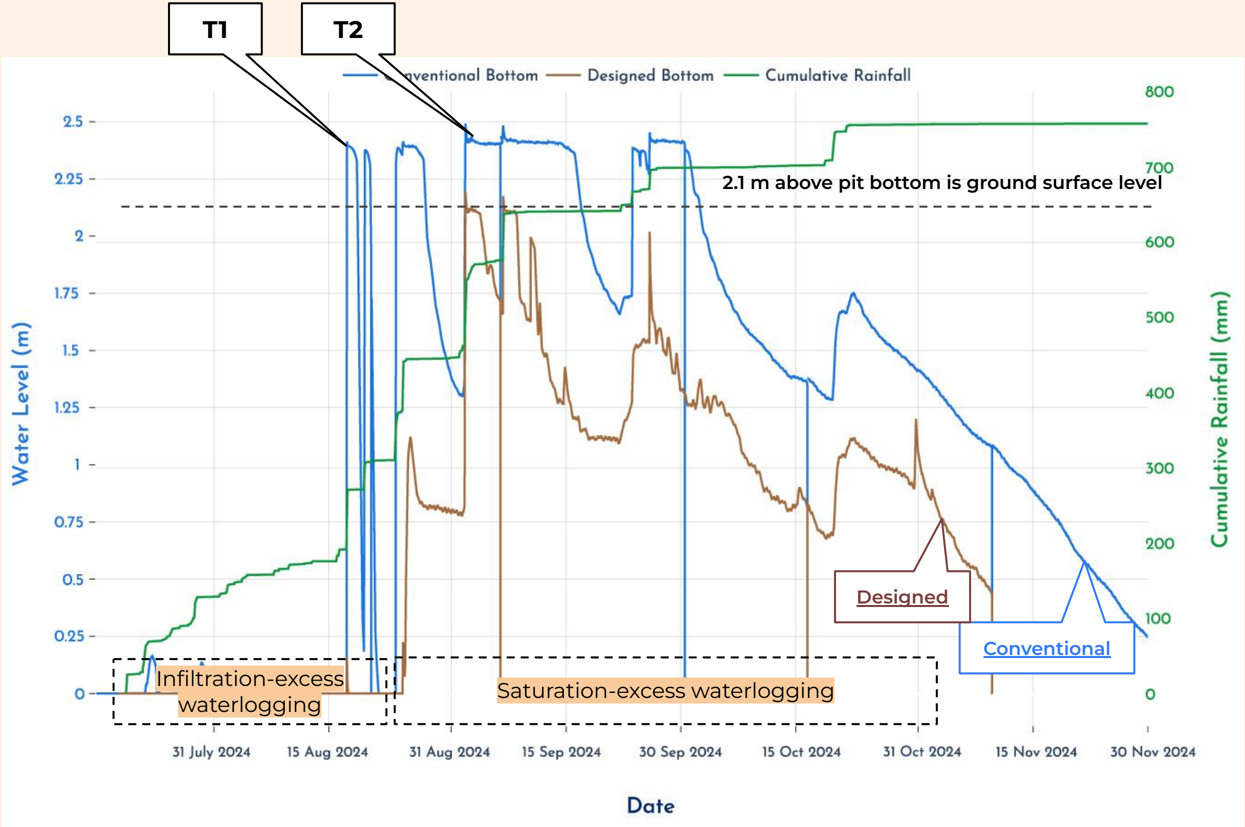


Infiltration-excess waterlogging

T2

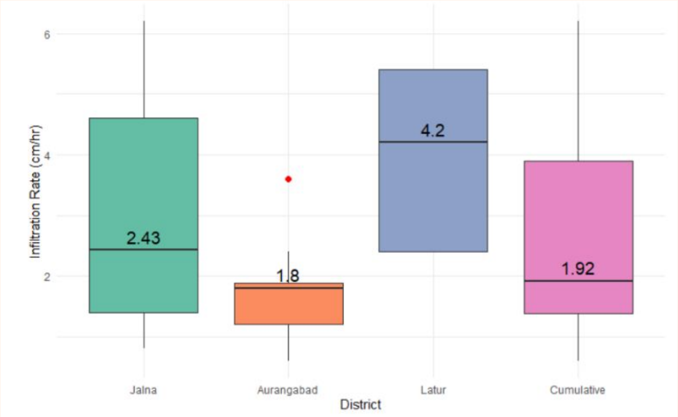


Saturation-excess waterlogging



Assessing Criteria #2: Black soil often has high infiltration rates.

Black soil in the Marathwada region often has **high infiltration rates,** leading to lower propensity for generating infiltration-excess runoff.



- #H1 median infiltration rate **8.8 cm/hr** for 22 sites
- CGWB block level studies covered 23 sites in Marathwada: Median at **1.92 cm/hr**

There are regions where aquifers are deeper (yellow and pink regions) and saturation-excess water logging does not occur.

However, promoting recharge of aquifers through pits might be less worthwhile given the <u>**poor residence time**</u> in subsurface storage.

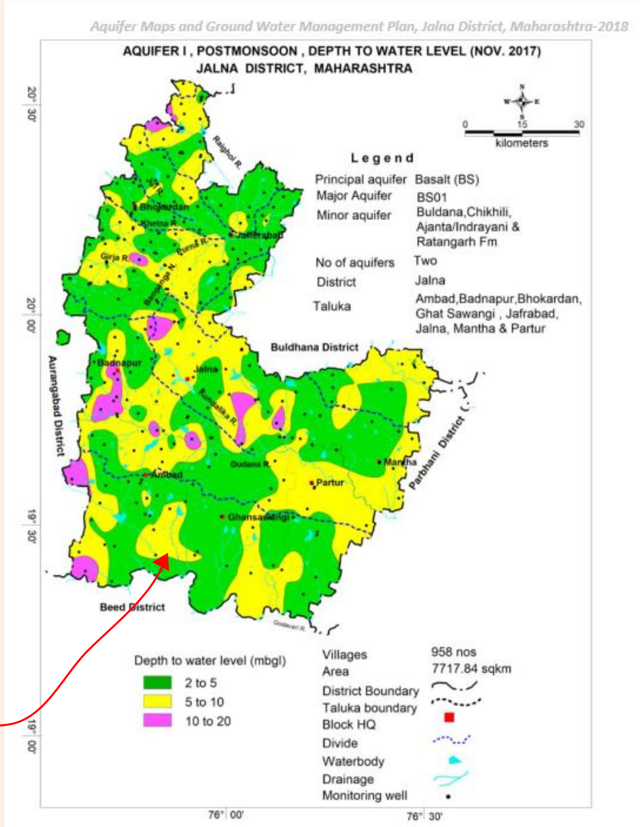
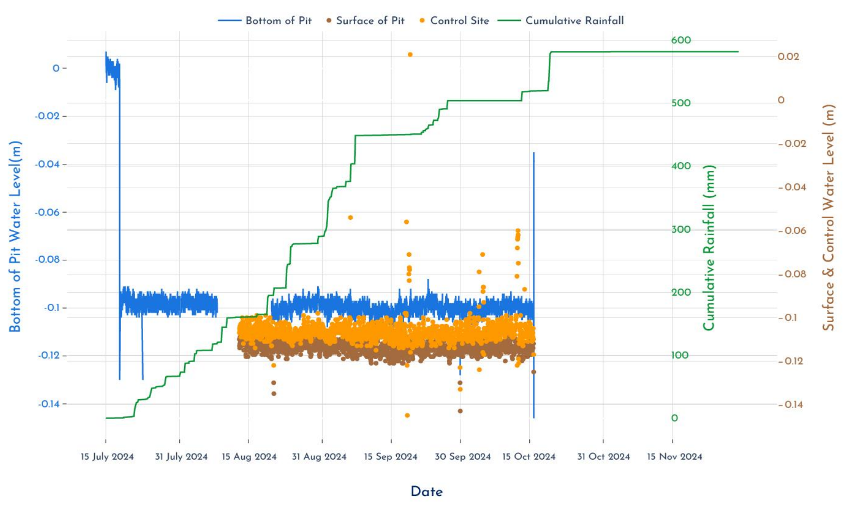


Fig 3.2: DTWL Aquifer-I (shallow aquifer) (Nov. 2017)

Assessing Criteria #3: Pits might have a limited role in capturing runoff and promoting recharge.

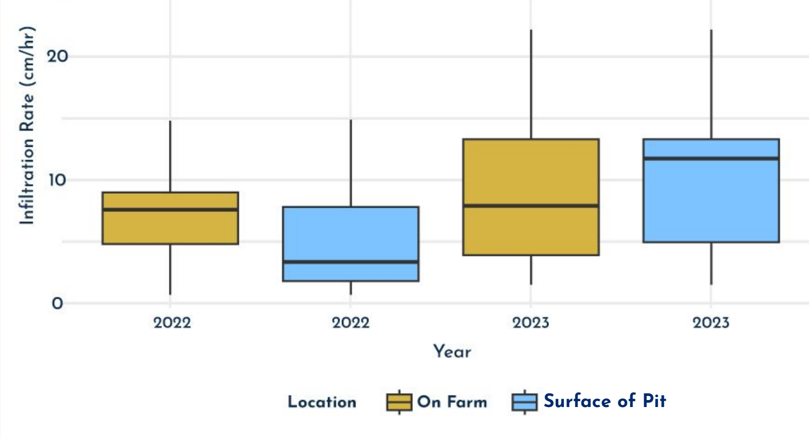
Sevalli Observations



- Well water depth 20 mbgl
- Soil infiltration rate at 12 cm/hr

- No runoff was observed in Sevalli both on the surface of the pit and the control site.
- Downstream well water levels were 20 ft bgl, indicating deep aquifer.
- Our observations for infiltration rate at the surface of pits was lower than for on-farm.

Hypothesis 1 Results



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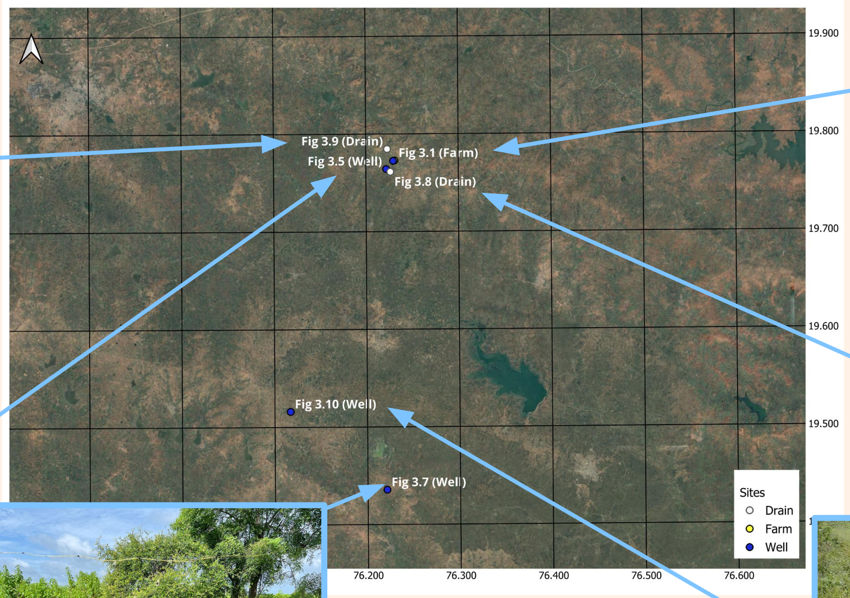
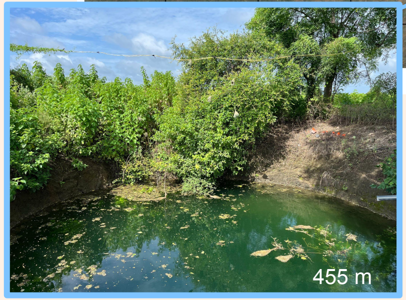
Regional Water Levels

Regional water levels in the aquifers were found to be high as open wells were full to the brim and there was constant streamflow in nearby drainage channels.





Findings

Hypothesis 1

Recharge pits have a significantly higher infiltration rate (10-100X) than the surrounding fields.

Pits did not exhibit any significant increase in infiltration rates compared to on-farm infiltration rates.

Infiltration test

Hypothesis 2

Water ponding reduced in fields with recharge pits.

As per farmers surveyed, they saw reduction in crop losses.

Farmer survey

Hypothesis 3

At least 25% of excess runoff within that acre can percolate down via the pits.

Aquifers saturate quickly due to limited storage and cannot admit any water further through pits.

Empirical Data Analysis

Hypothesis 4

Water levels improved at a watershed level as a result of recharge pits.

Groundwater trends remained independent of whether the watershed received intervention or not.

Paired watersheds analysis

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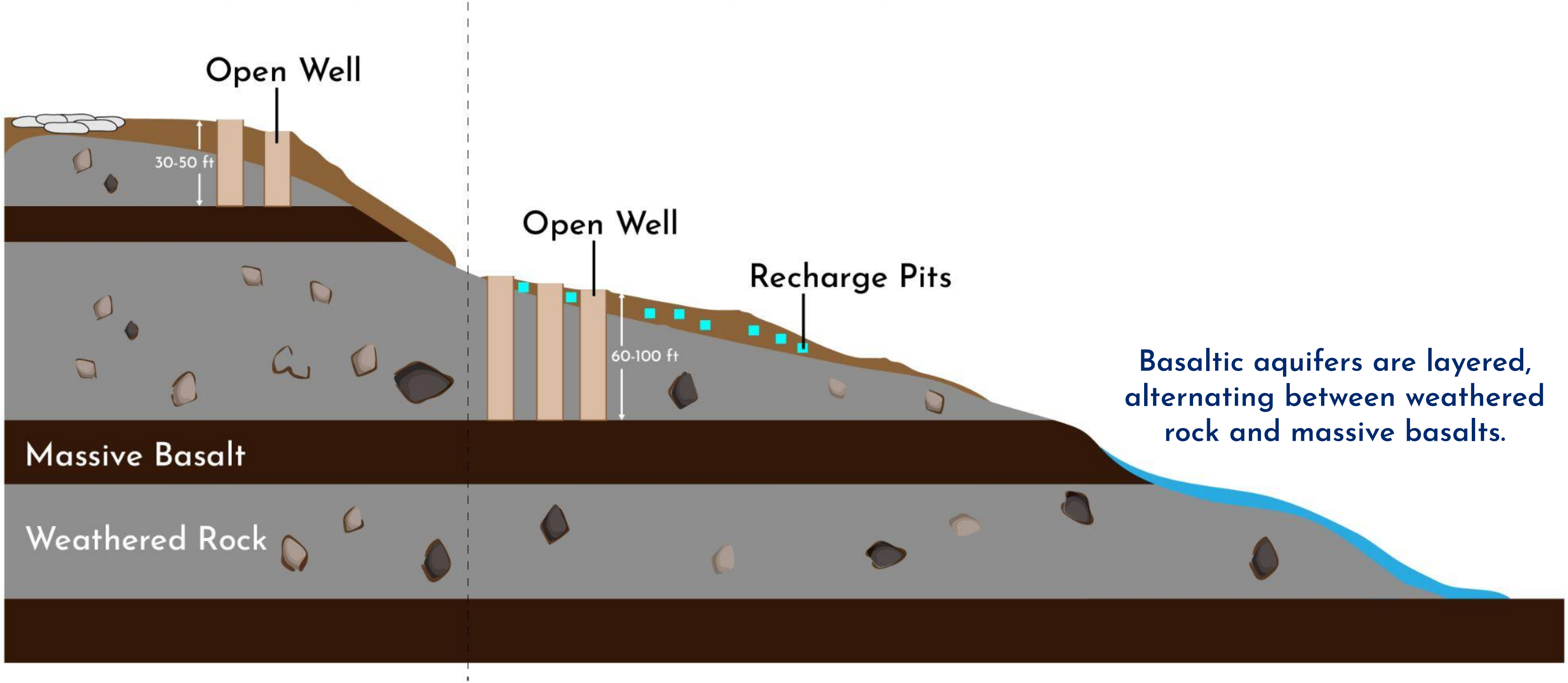
Problem: The black soil region of Jalna in Marathwada faces a problem of too much and too little water.

Learning: Aquifers lack storage and seasonal decline occurs due to short residence time of groundwater.



Basaltic aquifers are layered, alternating between weathered rock and massive basalts.