IITB Water budgeting
WB Mission March 2026

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18 March 2026
Shimla

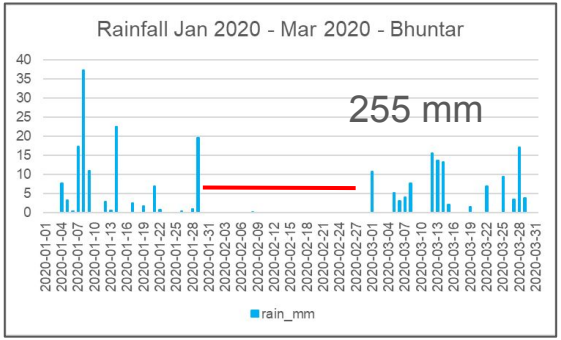
Agenda

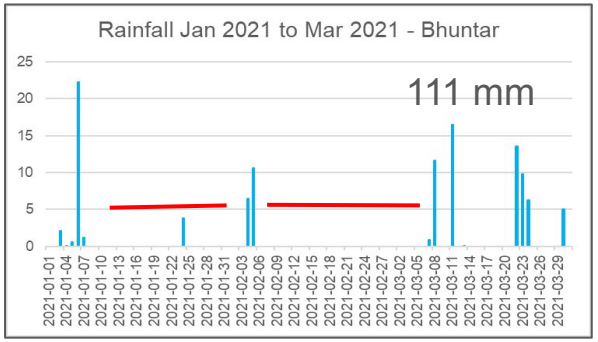
- IITB - HPIDP contract key objective
- Problem formulation
- Designing the model - Demand- Supply - Allocation for the intervention unit
- Field work - 10 GPs, 326 farmers, instrumentation etc.
- Quantifying the demand side - crop model, cropping pattern, farmer survey and kobo tool
- Quantifying the supply side - baseflow model, calibration and validation
- Linking demand and supply, allocation
- The IT part: Web interface, Scalability, integration and mainstreaming
- Future pathways (Scale it to all villages, bring Agri dept. District level SoPs, planning tools - for a pilot district

Key problem

- **Traditional crops** (maize, wheat),
- Less water requirement, **subsistence farming**
- Distributed monsoon and post-monsoon rainfall

- Shift towards **vegetables, high density** apples etc. and **commercial** farming
- **Increased water demand** at crucial times
- Climate change: erratic monsoons, uncertain winters, stressed summers
- **Protective irrigation crucial**





Crop	Rainfed Yield (quintal per bhiga)		Irrigated Yield (quintal per bhiga)
Wheat	1		2 - 3
Tomatoes	5-10		20-30
Cabbage	10-20		50-70
Apple (High Density)	Can't be done		50 - 60

high incomes
→ high investments
→ high yields
→ irrigation

Key problem

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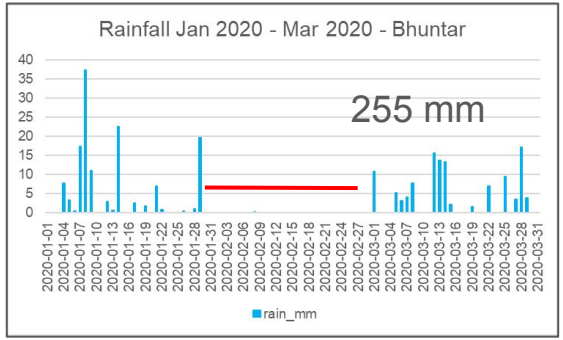

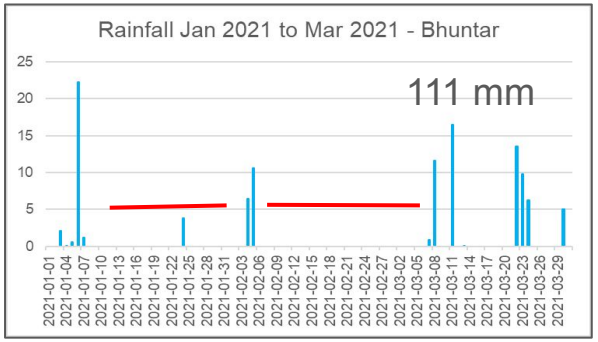

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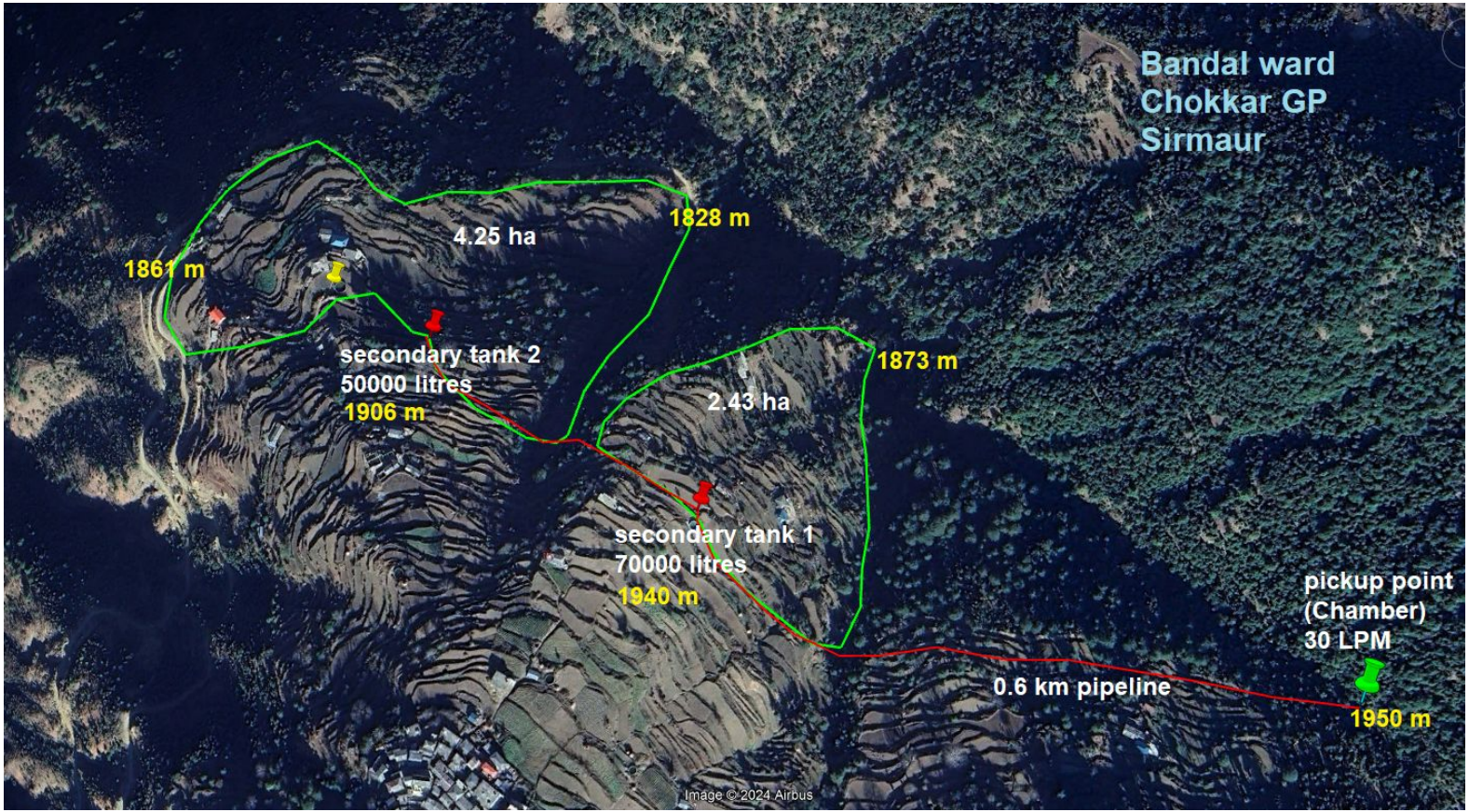
Tomatoes	5-10	20-30
		50-70
		50 - 60

How to develop sustainable systems which provide protective irrigation.

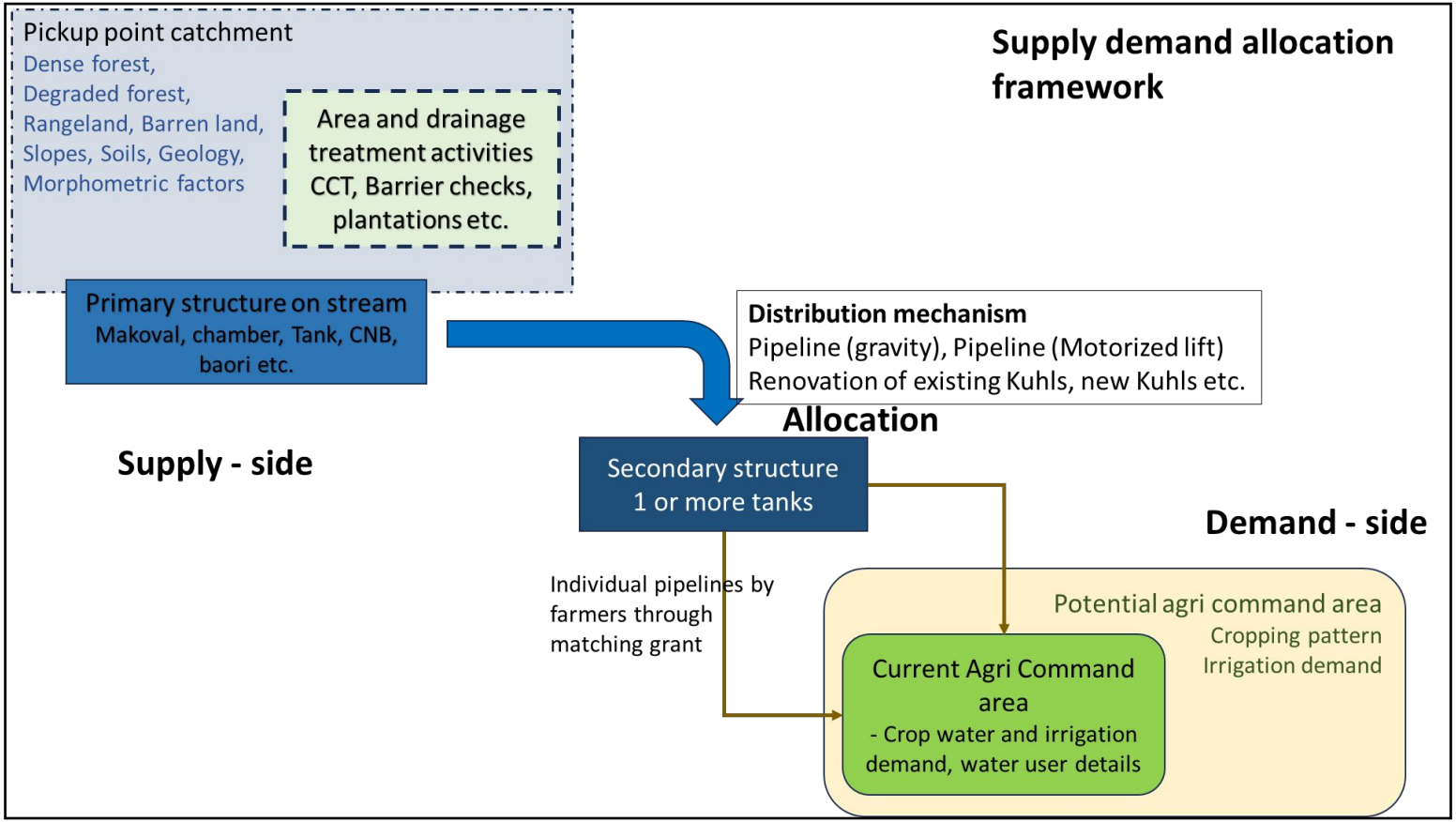
high incomes
→ high investments
→ high yields
→ irrigation

The IDP Intervention unit to address the key problem



Example - Chokker GP, Sirmaur

Translating into the supply - demand - allocation framework



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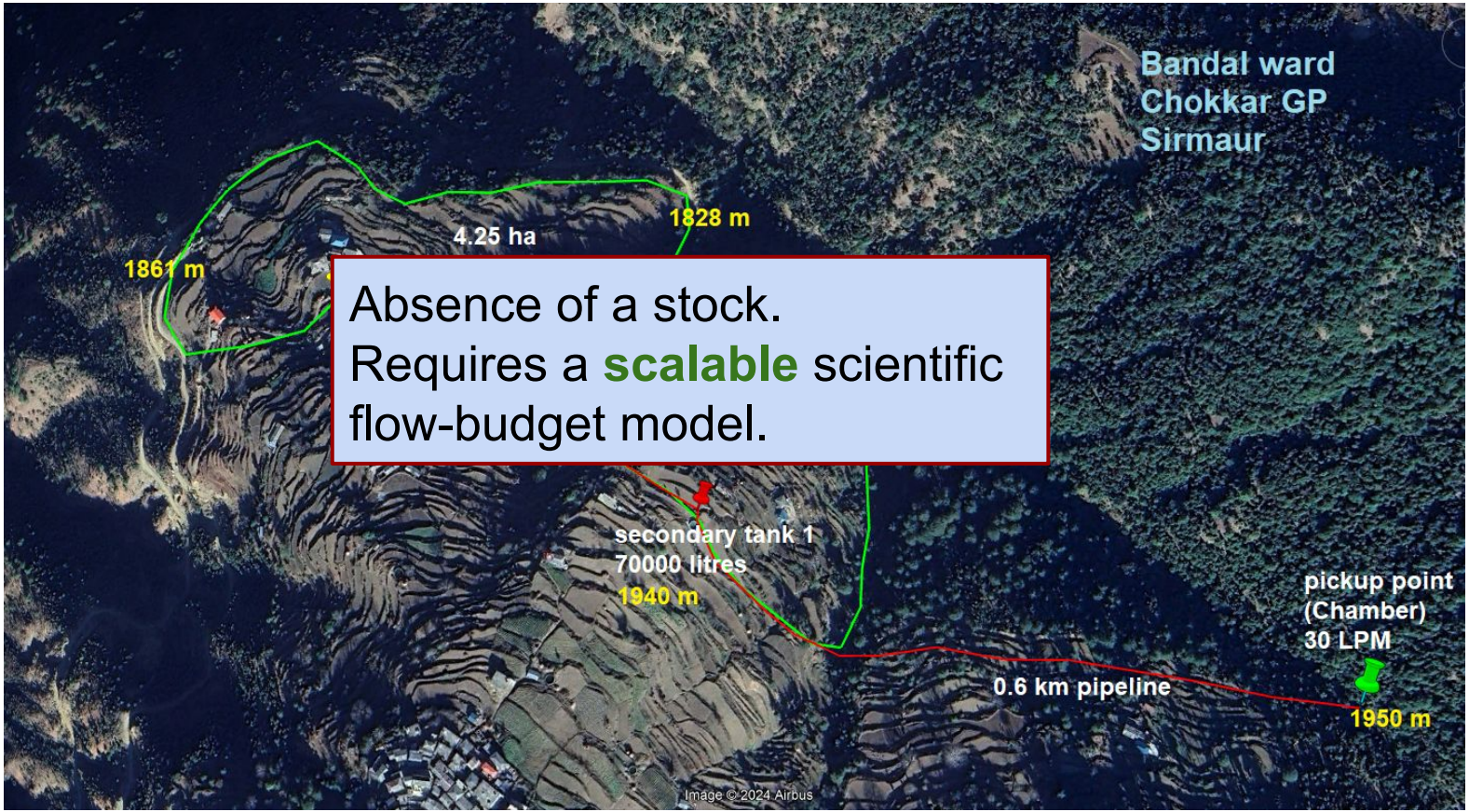
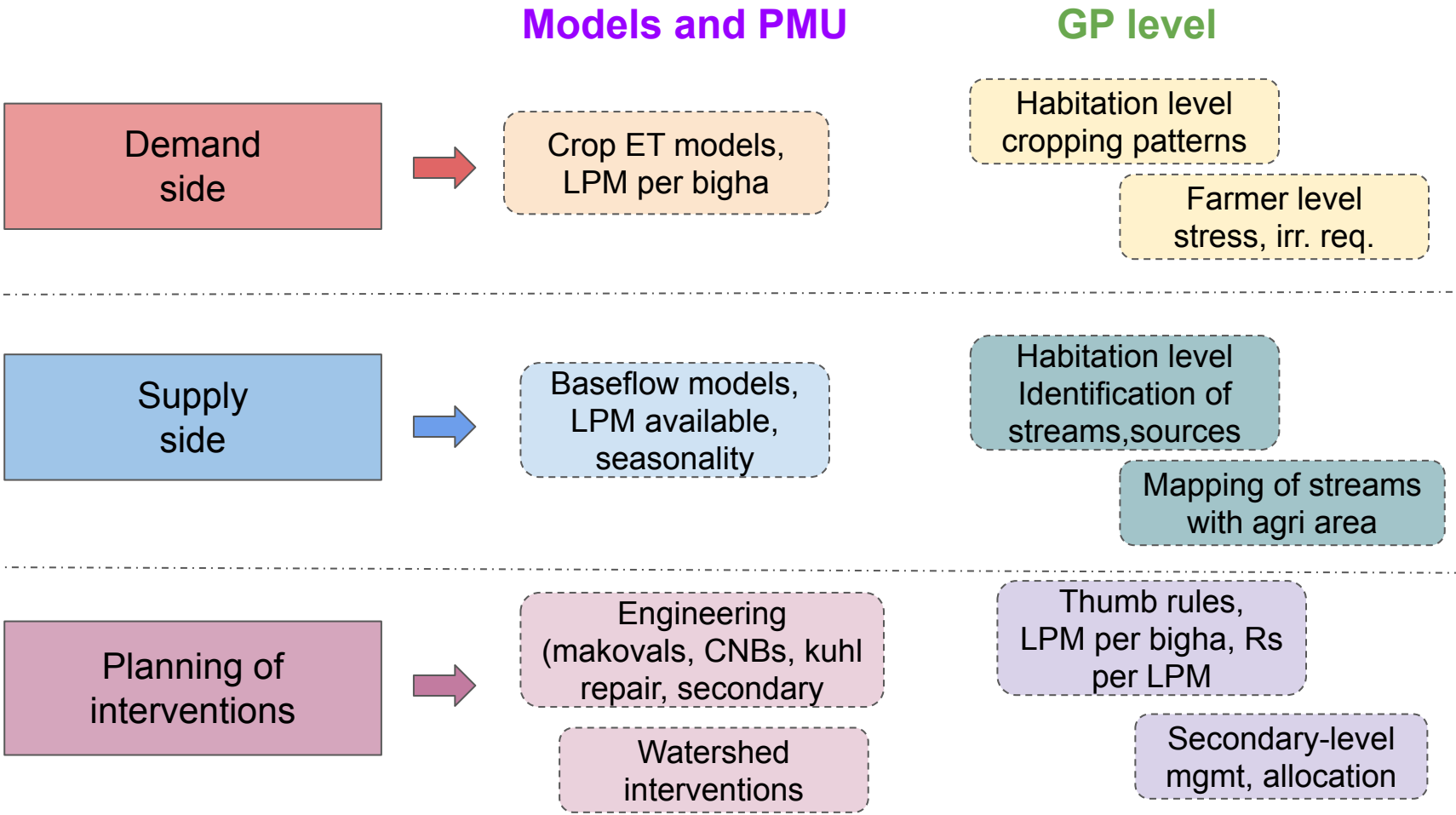


Example - Chokker GP, Sirmaur

Basic design of the IITB water budgeting model



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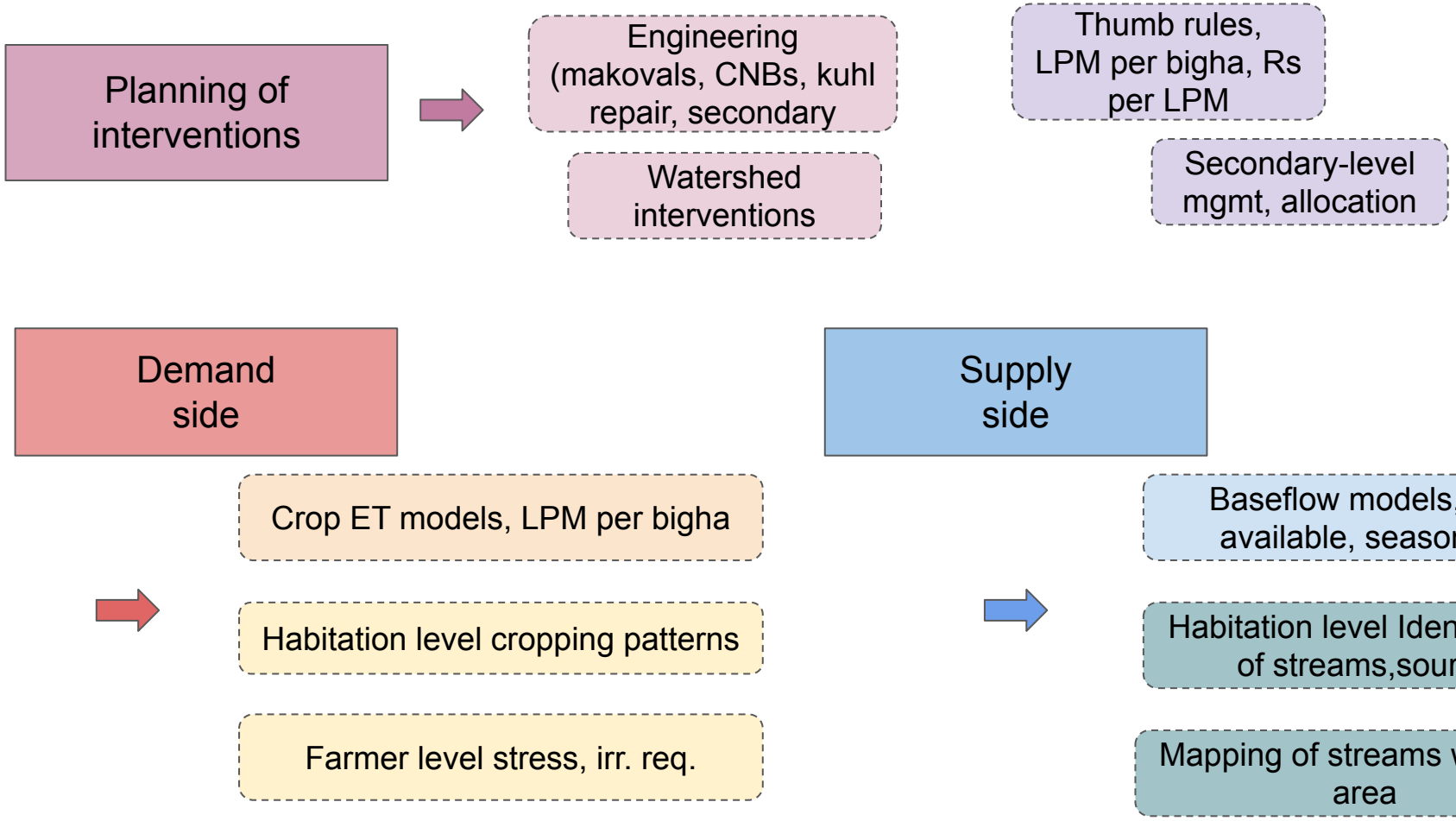


The role of the field - To concretize all three aspects

The project was rooted on 10 GPs - for scientific, socio-economic and agronomic models - formulation, execution, validation and extension.

- **The demand side -** habitation and agri. areas, cropping patterns, aspirations, challenges. Farmers surveys as the basis.
- **The supply side -** actual streams used, basic bio-physical and geographic quantities, seasonality, basic phenomena
- **The allocation side -** modes of extraction, existing and new interventions, formality and informality, modes of transport and allocation, collective actions and hindrances
- **Secondary data -** what is required and what is available

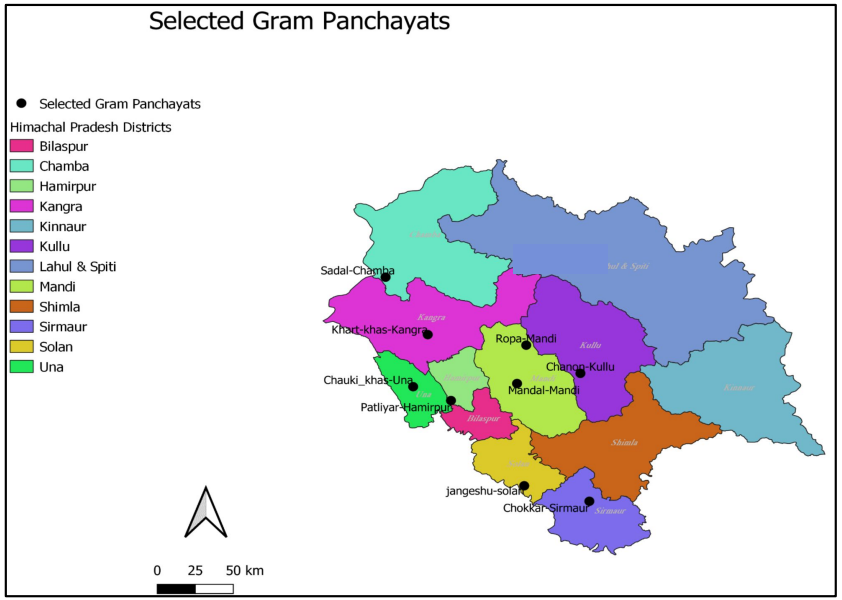
To ensure “efficacy” of our outputs. To inform scalability

IIT Bombay field-work geographies

- **Primary scope: 10 selected GPs**

Sr. no.	Name of GP	District
1	Pangran	Kullu
2	Sadal	Chamba
3	Jangeshu	Solan
4	Pathliyar	Hamirpur
5	Chanon	Kullu
6	Mandal	Mandi
7	Chowki Khas	Una
8	Chokar	Sirmaur
9	Kart Khas	Kangra
10	Ropa	Mandi

Installed instruments



Scale up to 428 GPs of IDP

Eventually mainstream into state planning processes

Meeting at GP

Study GPRMP

Identify Cropping pattern

Measure Primary LPM

Examine Storage tank

Field Survey

Instruments

AWS at Ropa

Soil Moisture sensor at Pathliar

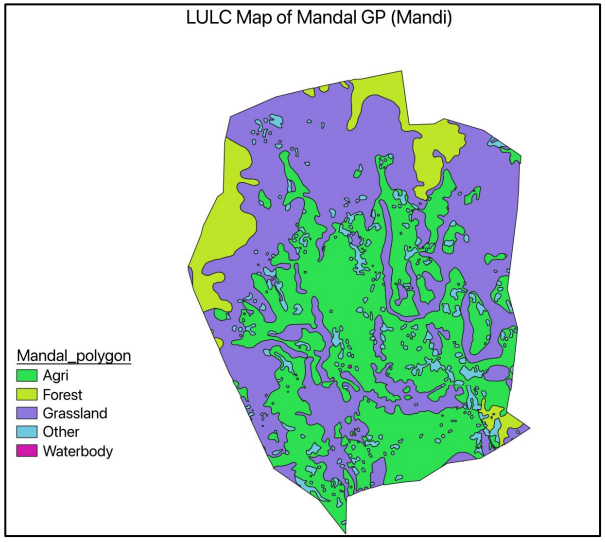
LPM Measurements

Bataal Baudi

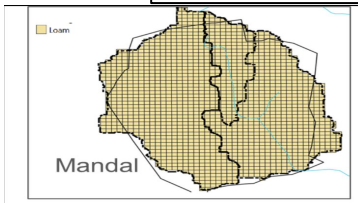
Stream Discharge

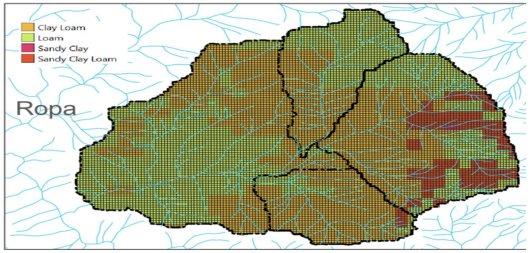
Rada Baudi

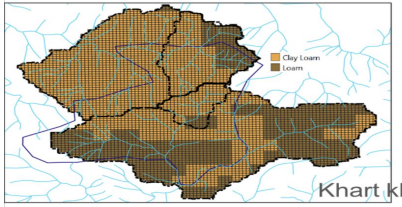
LULC Map



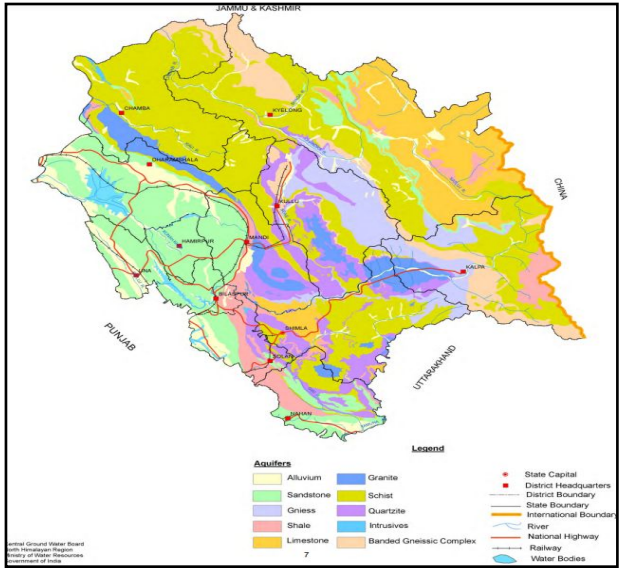
Soil Maps



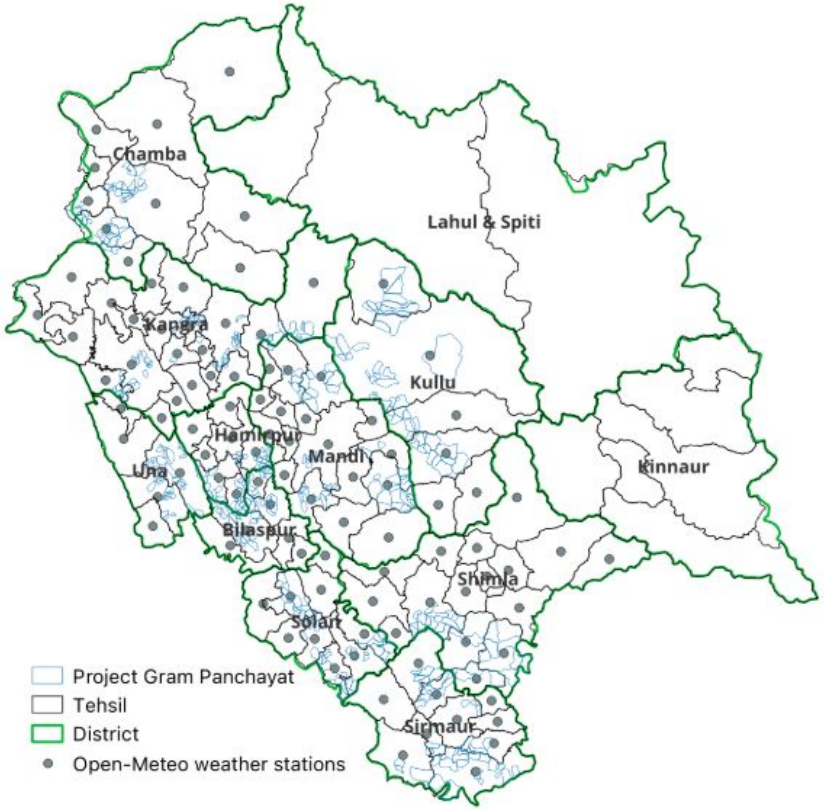




Aquifer Map



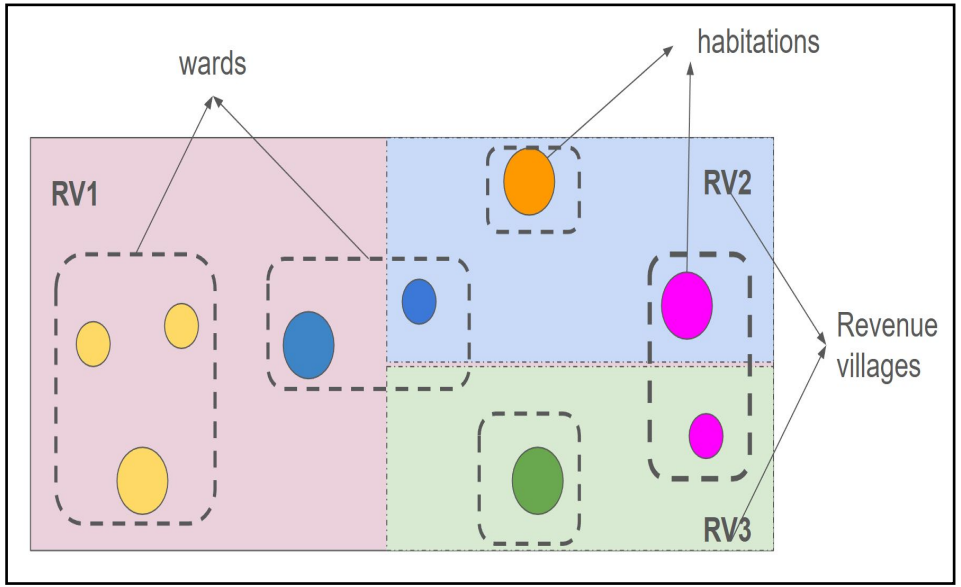
Map with the various location of weather stations

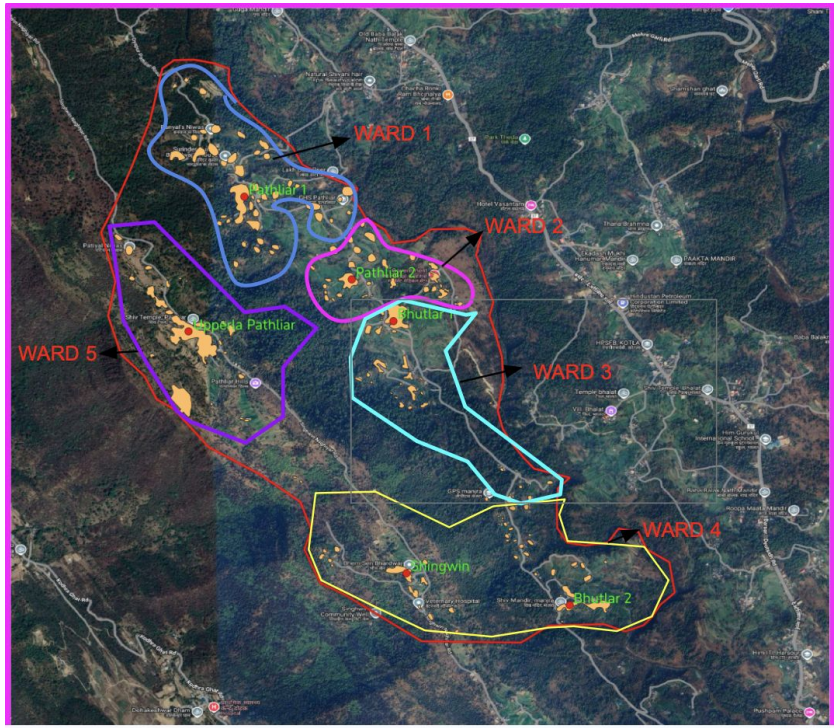


Demand side

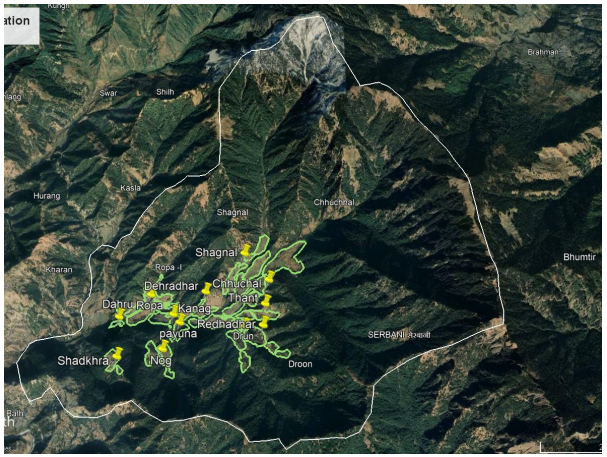
Understanding the GP, its structure, expanse and problems

GP conceptual diagram





The key dataset - the cropping pattern and irrigation demand



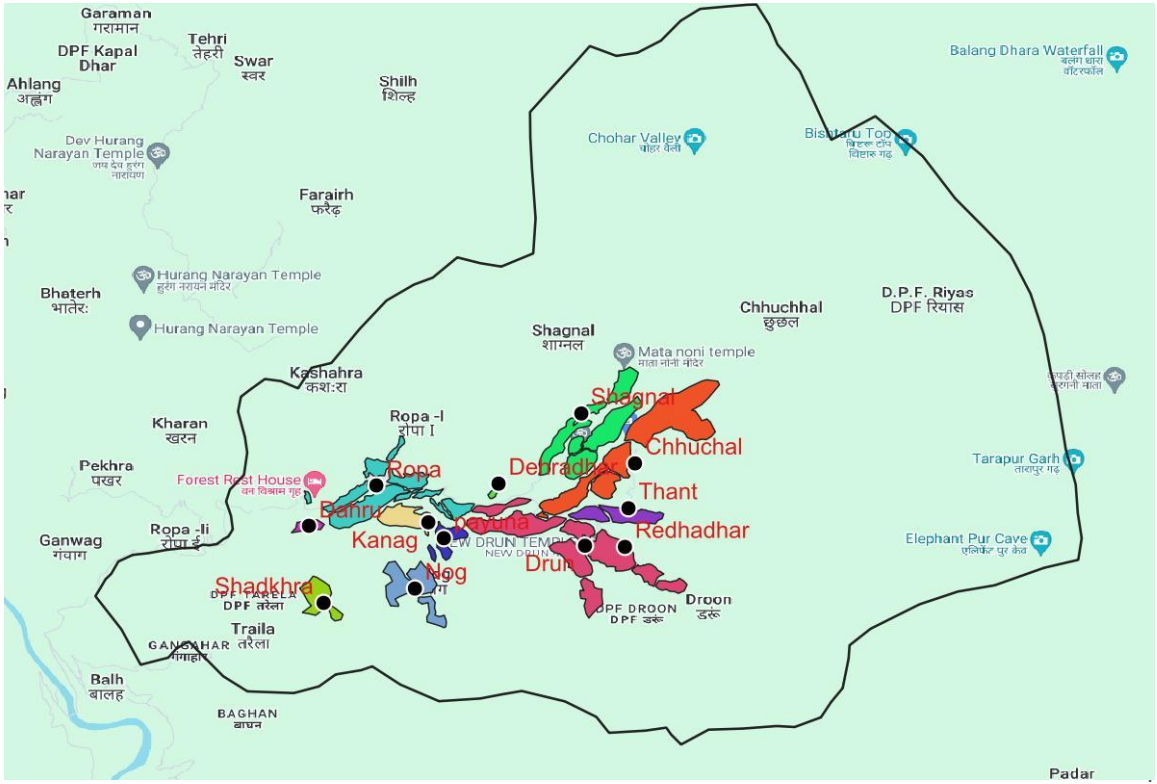
Habitation surveys

Cultivable area, cropping pattern, irrigation sources, methods etc.

Farmer surveys

Crops, soils, yields, water stress, irrigation sources, methods,

Habitation Map-Ropa GP

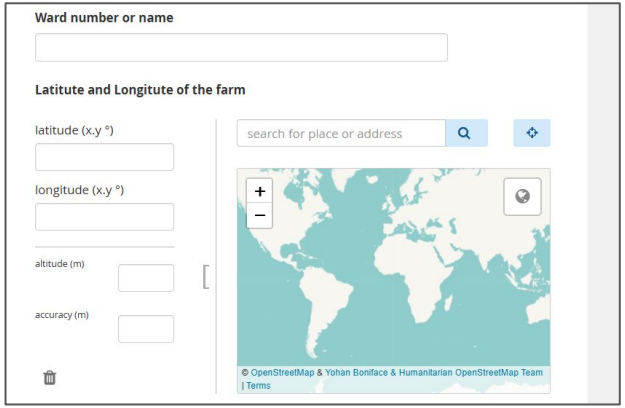


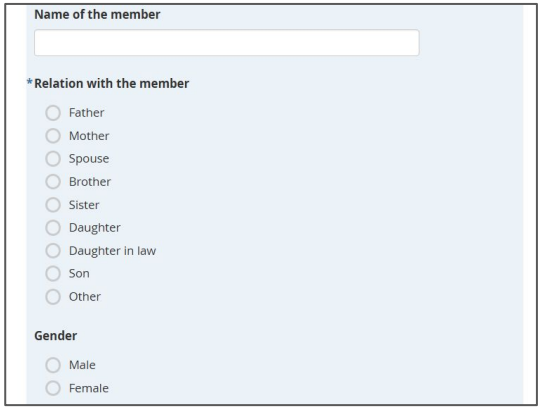
Farmer survey table

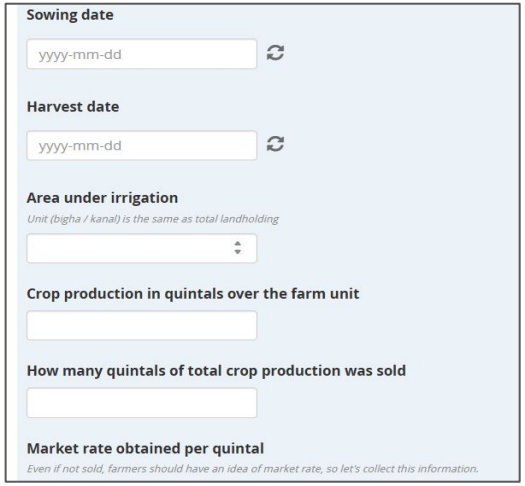
District	Gram Panchayat	No of habitations	No. of households	No.of farmers surveyed
Hamirpur	Pathliyar	6	441	33
Una	Chowki Khas	15	496	30
Kangra	Khart Khas	19	270	30
Kullu	Chanon	29	454	38
Kullu	Pangan	16	486	31
Mandi	Mandal	7	585	36
Mandi	Ropa	12	218	34
Chamba	Sadal	29	344	33
Sirmaur	Chokar	16	485	31
solan	Jangeshu	15	107	30
	Total	**164**	**3886**	**326**

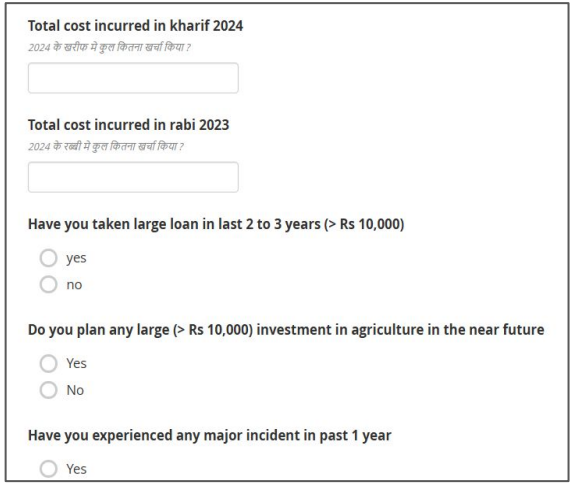
Farmer interview - KOBO tool

- Location info
- Surveyor Info
- Household Information as gathered from interviewee
- Family member details
- Infrastructure and assets of the household
- Crops and yields per farm unit
- Financial details



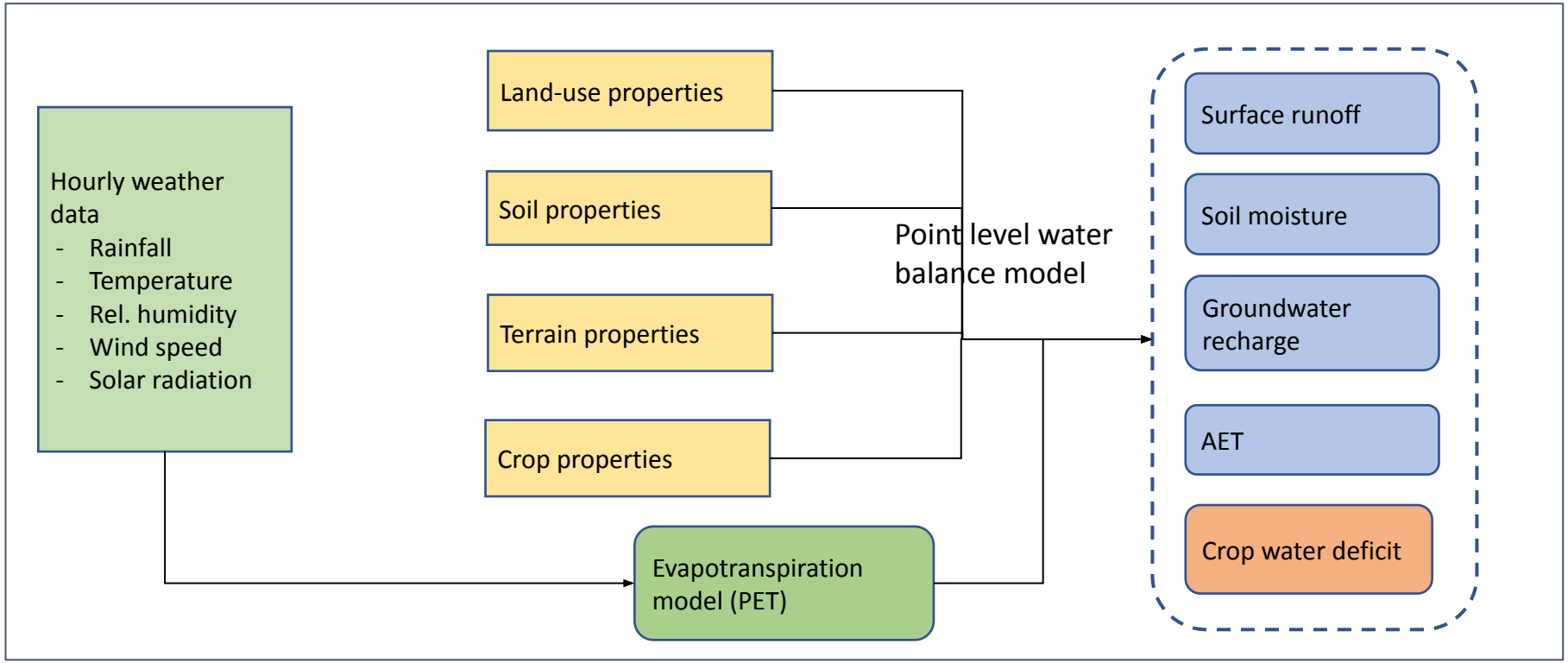






Demand side quantification - SWAT model

Science: SWAT and FAO based soil water balance model

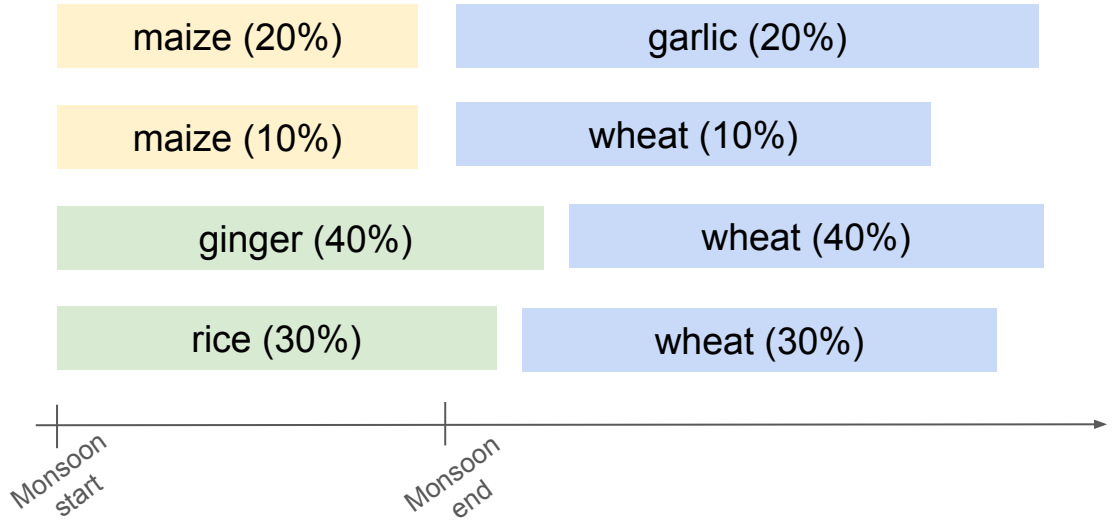


Cropping pattern - the key demand side input

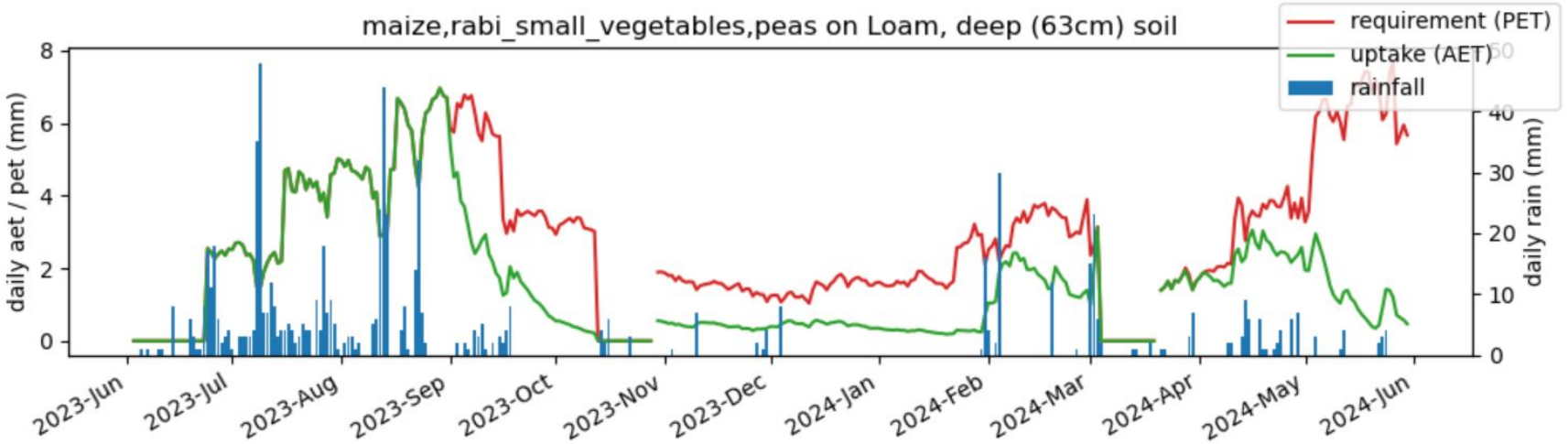
- **Crop sequence** - the key input to the point model
- **Cropping pattern** collected by the field team to **crop calendar** to **crop sequence** - transforms habitation-level cropping pattern to crop-calendar and finally input for point-model

Tharugadh, Jangeshu, 2024

Crop	Season	Area
maize	kharif	30%
rice	long kharif	30%
ginger	long kharif	40%
wheat	rabi	80%
garlic	rabi	20%



Crop AET - PET plots - different crops, different rainfall patterns



Hinner GP : मक्की , सब्जी , मटर 2023

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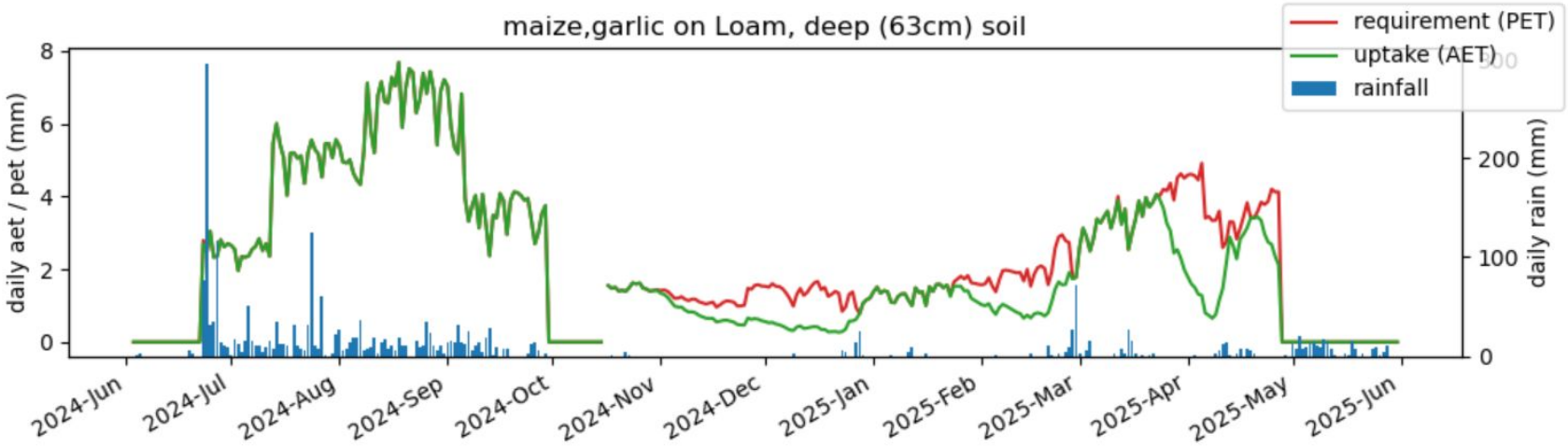


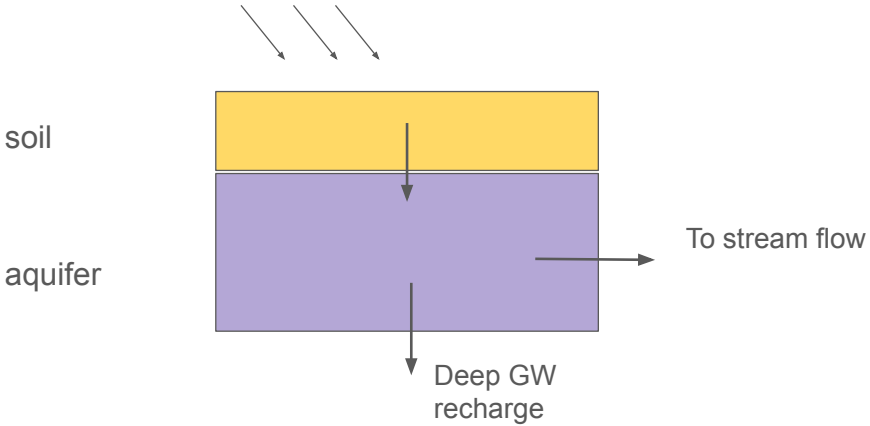
Deedag GP : मक्की , लसन , 2024

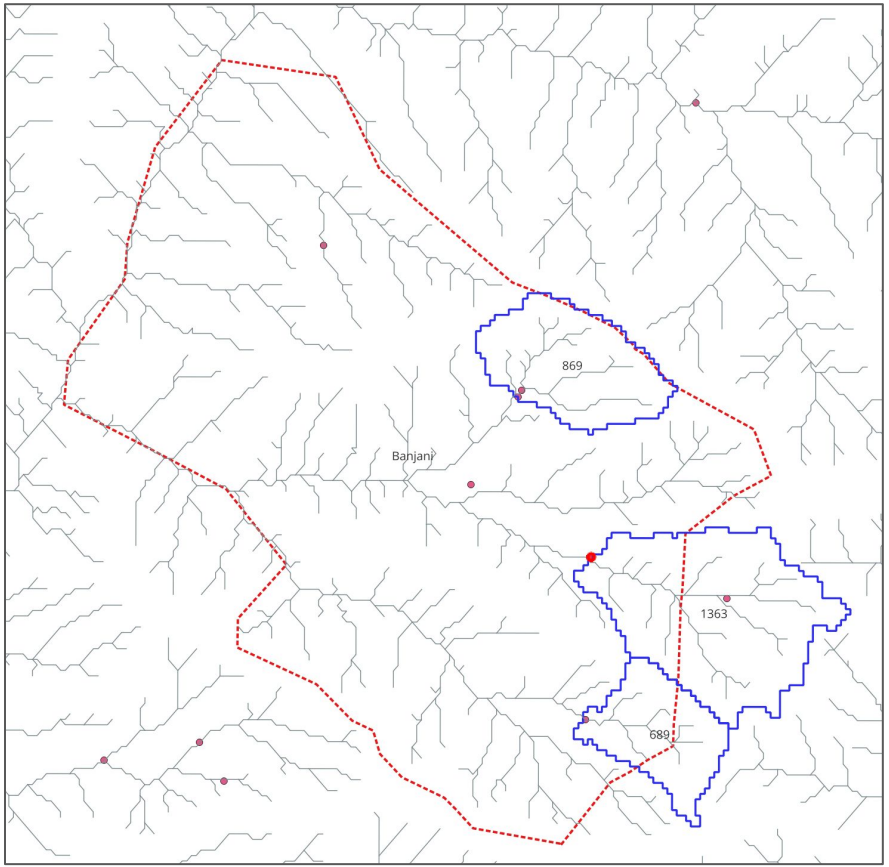
Demand-side parameters: crop cycles, cropping scenarios, habitation-wise weekly/daily crop and **Unmet demand in LPM,**

Supply side

Key question: how much is the flow (in lpm) ?

- at any point on the stream
- on any day in post monsoon season

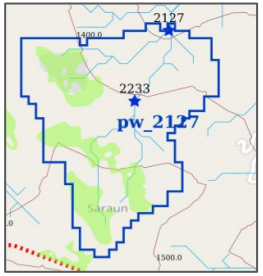




Baseflow model

Identifying pickup points [from field / PMIS]

Delineate watershed for the pickup point



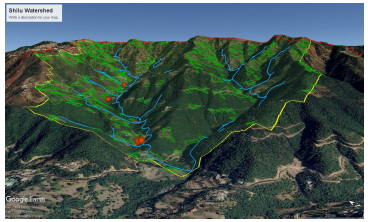
LULC

Aquifer

Soils

Terrain

Characterize watershed

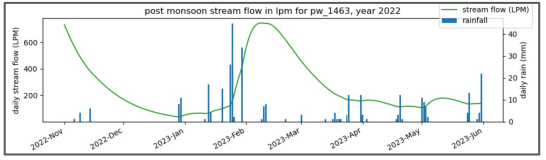


Compute baseflow coefficients

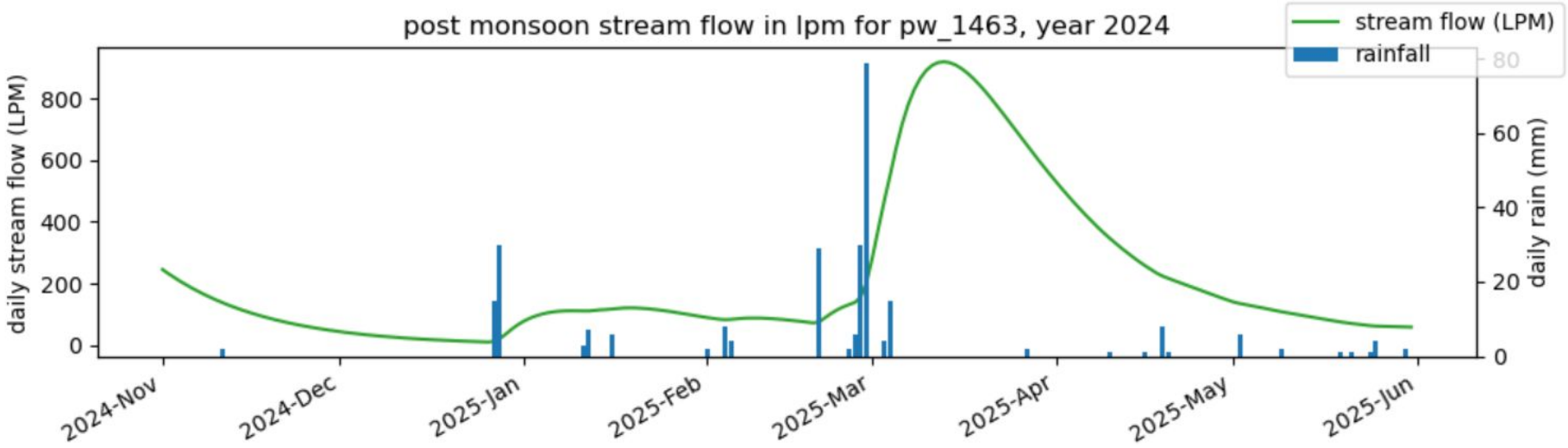
delay factor,
deep recharge factor,
recession constant

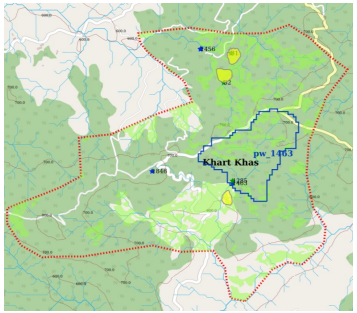
Water budget, daily gw recharge from model

Compute daily baseflow for the watershed



Supply curves: Khart Khas, Baroh, Kangra: pickup point 1463

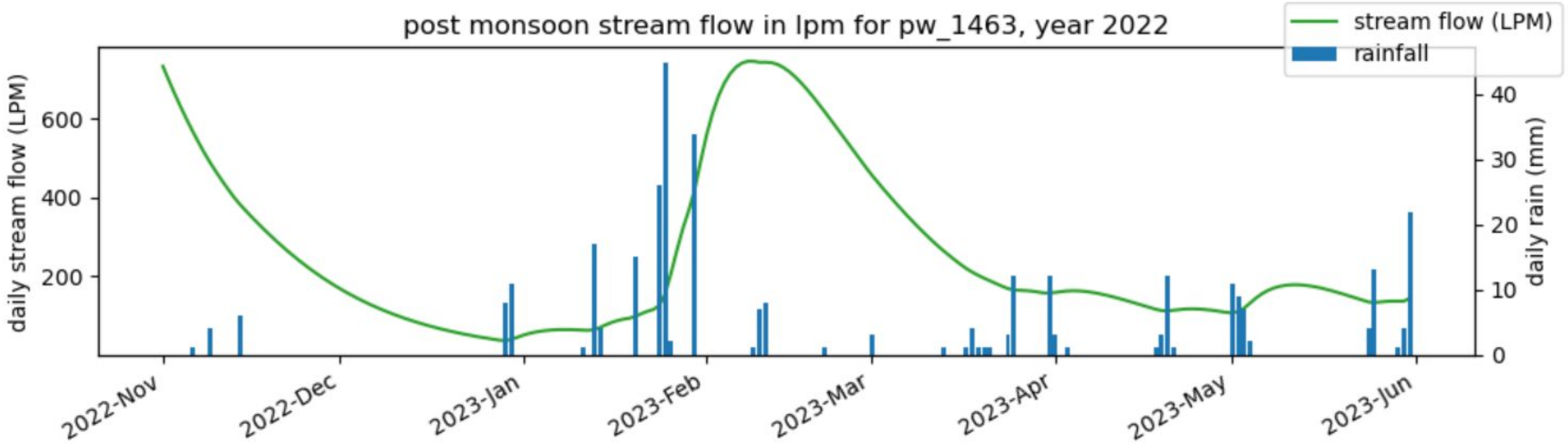


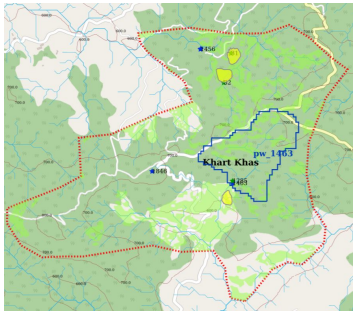


Area: 56.51 ha
Year: 2024

80% confidence
flow: 61.98 LPM

Supply curves Khart Khas, Baroh, Kangra: pickup point 1463





Area: 56.51 ha
Year: 2022

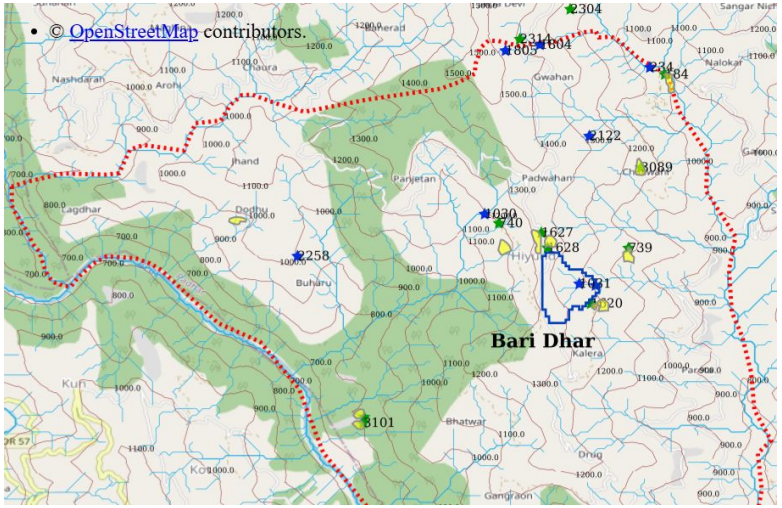
80% confidence
flow: 105.34 lpm

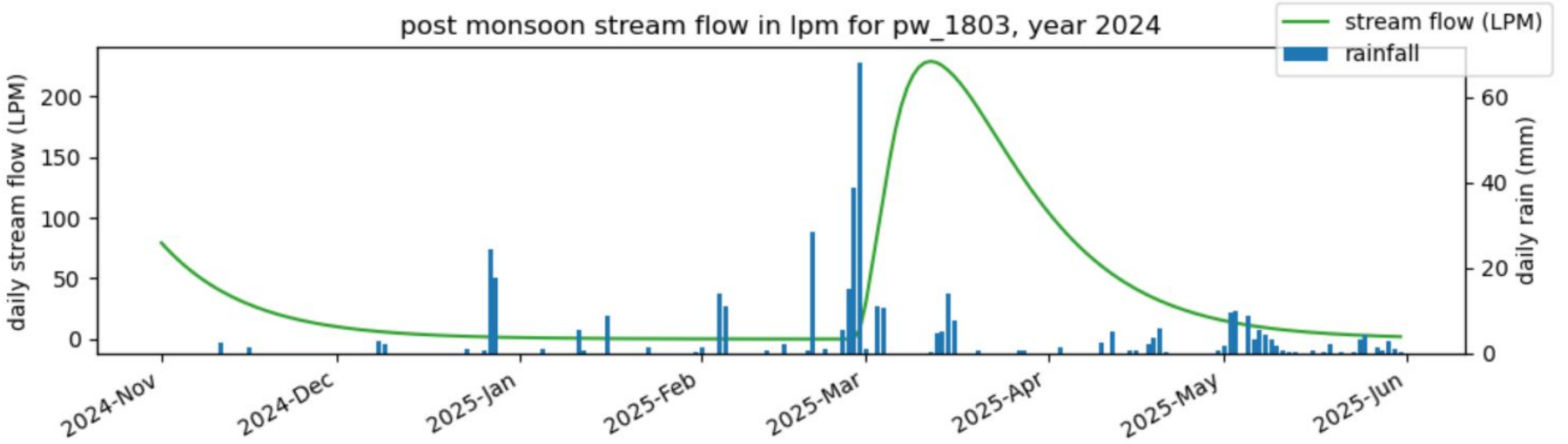
Linking supply and demand

The supply side

Bari Dhar GP, Mandi
Gharat Magaru nallah: pickup point 1803

Watershed area: 18.62 ha

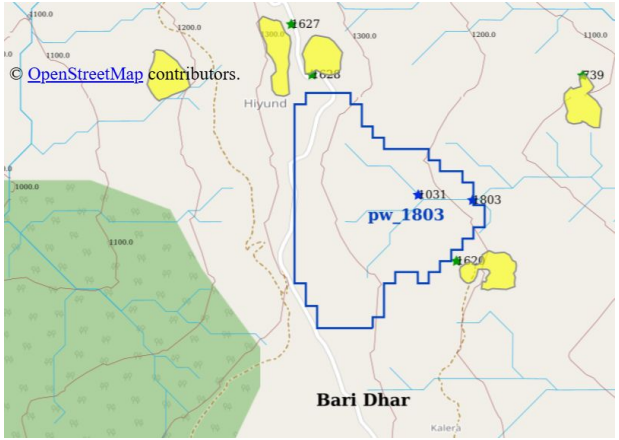


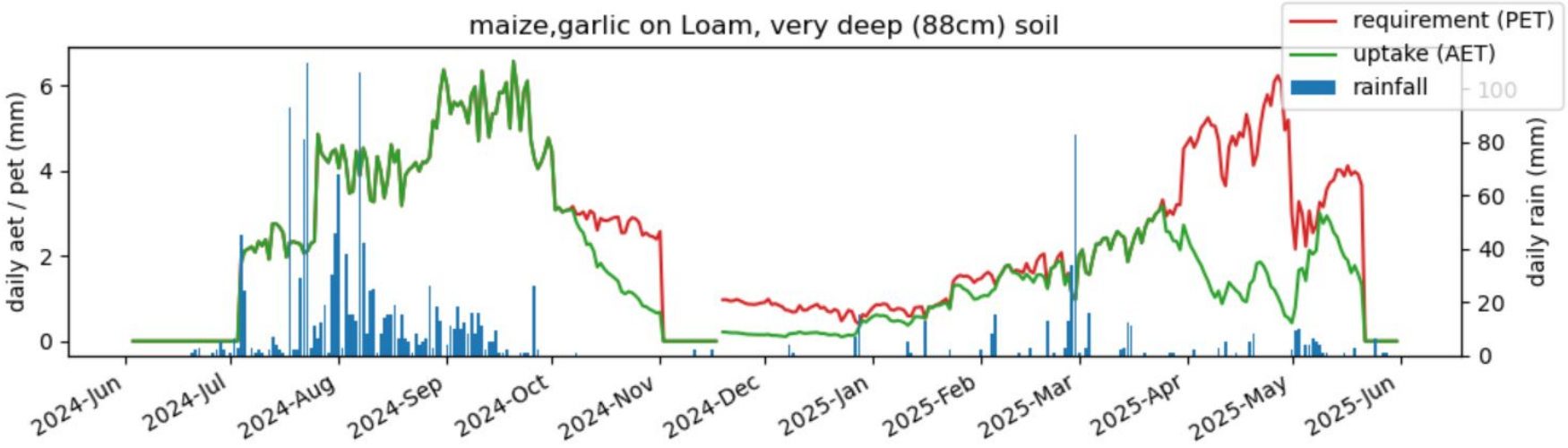


The demand side

Kalera tank
Agri area: 9085 sq m (~ 10 bigha)

Crop :
Maize (monsoon) - Garlic (post-monsoon)
Total demand : 180 mm





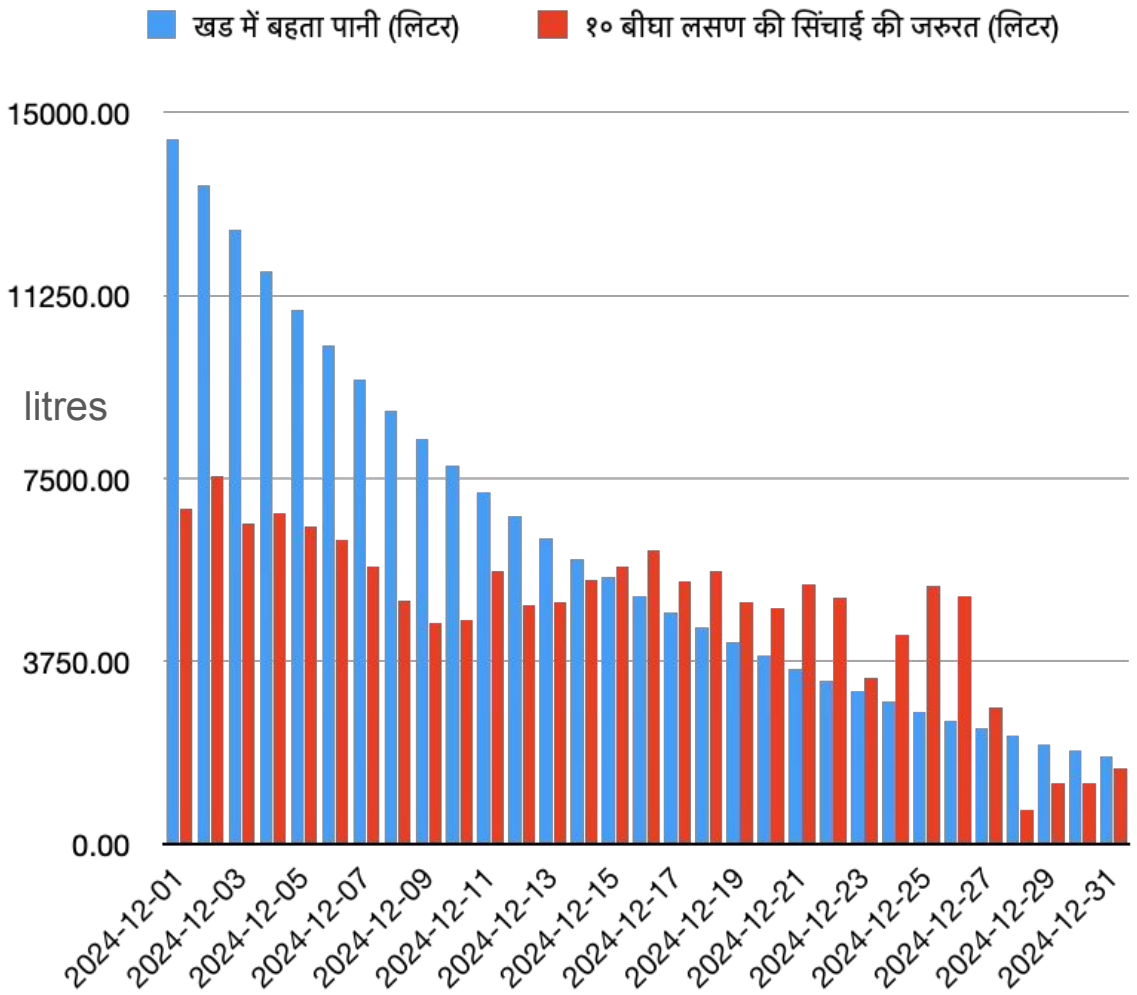
Demand - supply matching

Dec 2024

Target area: 10 bigha

Crop: garlic

90% irrigation demand in Dec satisfied from stream flow



Demand - supply matching

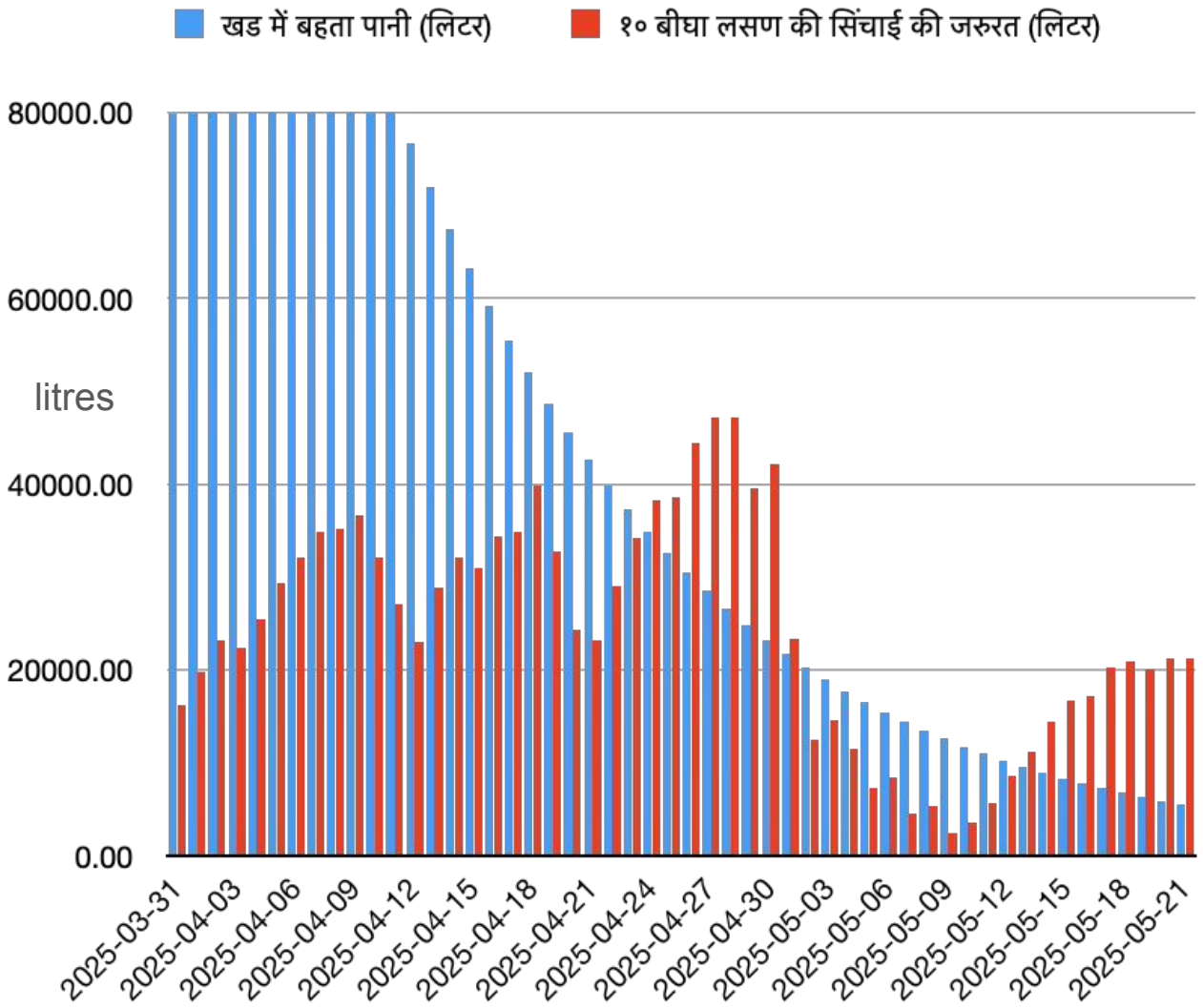
April - May 2025

Target area: 10 bigha

Crop: garlic

64% irrigation demand in May satisfied from stream flow

90% demand in April satisfied from stream flow



Demand - supply matching

- Supply Scarcity
- Demand Scarcity
- Allocation scarcity

CCA	0.9 ha
Crop	Garlic
Secondary tank pondage	40000 litres
Total crop demand	1858 cum
Total natural crop uptake	994 cum
Total deficit	864 cum
Satisfied by IDP structures on streams	671 cum
Supply shortfall days	58

Bari Dhar GP - Kalera Tank - Gharat Magaru Nallah

Supply shortfall days

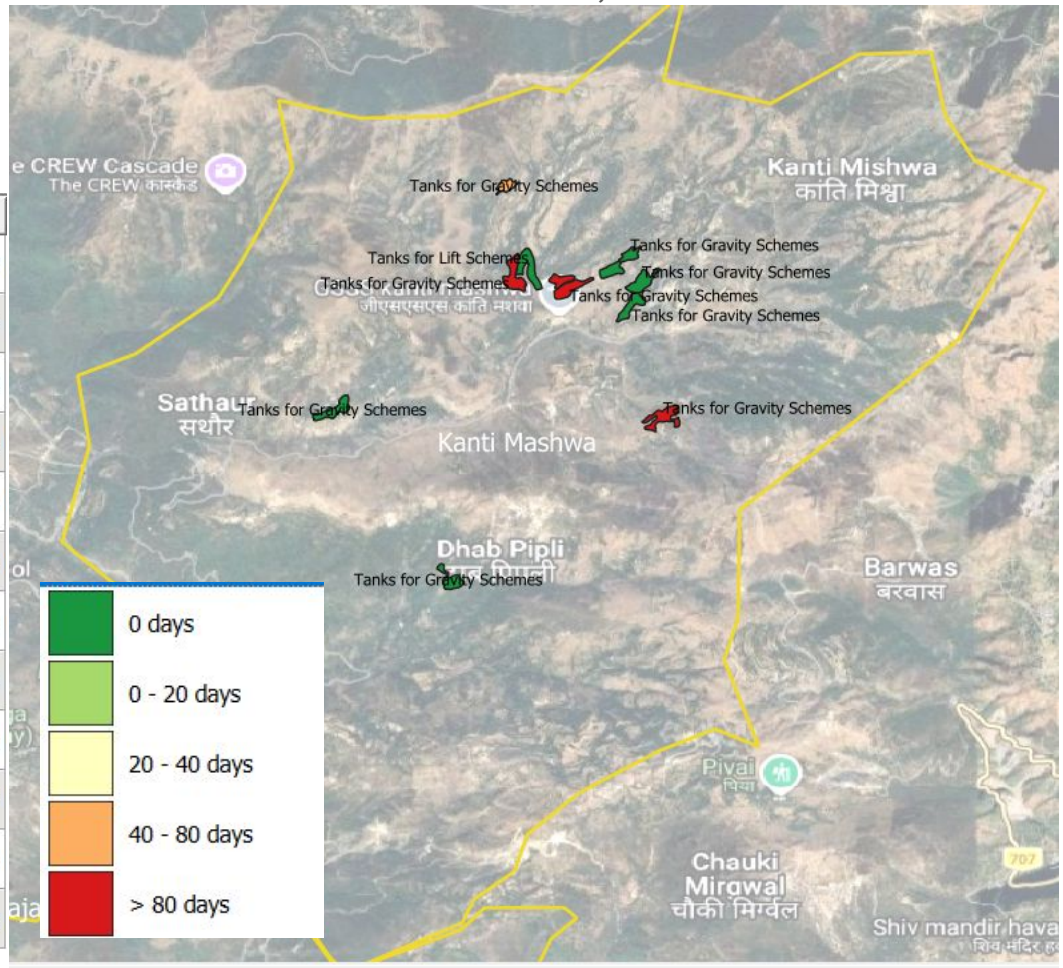
pre-IDP uptake

post-IDP uptake

Year 2023

_gp_name	id	AET_PET	nAET_PET
Kanti Mashwa	3163	0.505	0.837
Kanti Mashwa	3159	0.504	0.723
Kanti Mashwa	607	0.507	0.717
Kanti Mashwa	2755	0.507	1
Kanti Mashwa	2753	0.507	1
Kanti Mashwa	2756	0.51	1
Kanti Mashwa	2108	0.507	1
Kanti Mashwa	2105	0.504	0.888
Kanti Mashwa	1227	0.507	1
Kanti Mashwa	2760	0.506	1
Kanti Mashwa	2754	0.51	1
Kanti Mashwa	2111	0.507	0.817

Kanti Mashwa GP, Sirmaur



Translating all this Into Key Charts

Basic supply, demand and intervention data along with surplus/deficits.

Source	Discharge (LPM)	Harvested (LPM)	Spare (LPM)
P1	9	9	0
P2	22	12	10
P3	63	40	23
P4	125	30	95
Spare discharge as on 15th February			128

Principal Cropping Demand

	Crop	Non-command (Ha.)	Command (Ha.)	Actual Demand	Met Demand	Gap
1	Wheat	80	12	84	20	64
2	Maize	20	10	70	20	50
3	Cauliflower	0	4	50	50	0
	Total gap as on 25th February, 2025					114

Secondary

Storage	Capacity KL	Flow	Area (Ha)	Farmers
S1	100	10	2	5
S2	100	10	2	6
S3	100	20	3	10

Translating the above Into K

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inter
surpl

Basis of extension:

How to understand the supply and demand and and how to improve allocation

- Engineering,
- Water user associations, collective action
- Crop choices, irrigation methods

Sourc e	Discharge (LPM)	Harvest ed (LPM)	Spare (LPM)
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	22	12	10
	63	40	23
	125	30	95
re discharge as on 15th ruary			128

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Training workshops - objectives and purpose

- For farmers - crop choices, key locations, existing good and bad practices,
- For SEOs and AEOs - for reaching all habitations, collecting cropping data
- For FEOs - identifying key sources, existing irrigation structures, possible engineering solutions
- Our software and web interface: How to analyze supply and demand, and decide feasibility

- For DPOs, APOs – link demand-supply planning to funds availability
- For PMU - cost benefit analysis, impact evaluation

Training workshops - dates and venues

Date	Location	Districts Covered
2nd March 2026	Solan	Solan, Sirmaur, Shimla
5th March 2026	Sundarnagar	Mandi, Kullu, Bilaspur
7th March 2026	Dharamshala	Kangra, Chamba, Hamirpur, Una

Participants: DPOs, APOs, FEOs, AEOs, SEOs, farmers

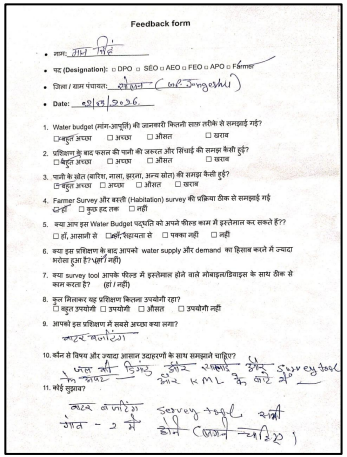
Brief agenda for the workshop

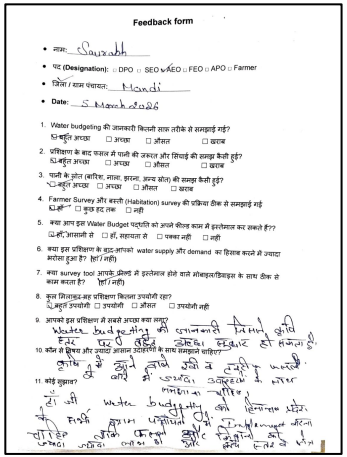
Time	Session
10:15 – 10:45	Agenda for the day, the key objectives, Introduction to water budgeting
10:45 – 12:00	Demand side: field insights, datasets, model
12:00 – 13:15	Supply side: field insights, datasets, model
13:15 – 14:00	Lunch Break
14:00 – 15:00	Demonstration of the Web Interface, Demand–supply matching for intervention planning
15:00 – 15:45	Use of KoBoToolbox for demand and supply side surveys
15:45 – 16:15	Feedback and discussion

Feedback from the participants

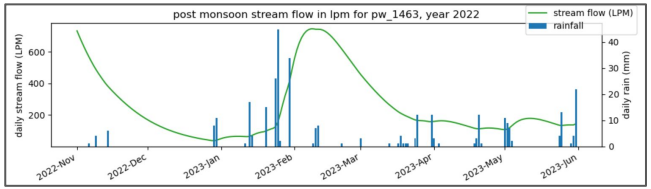
- such workshops **should have been conducted earlier**, as the concepts and tools introduced are highly useful for on-ground planning
- very easy and **clear understanding of the water budget concepts** in terms of demand-supply and practical applications of water budgeting.
- such planning tools (the kobo tool and the demand-supply tool) should be **introduced right from the start** of the project in the future
- Many participants expressed **interest in having hands-on field training sessions** in the future to gain practical experience in data collection and implementation of the water budgeting framework.

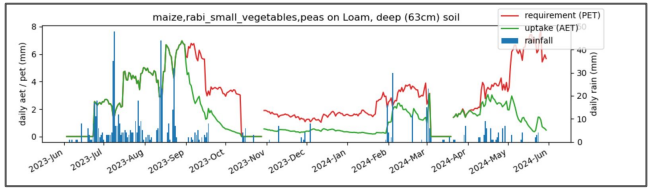
Dharamshala



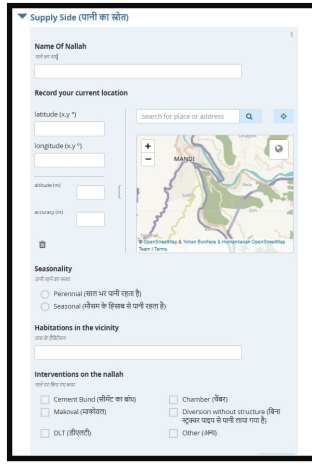


Feedbacks





Demand supply curves



Kobo tool

Sundar nagar

Solan

Few Learnings from the workshops

- Habitation as the smallest unit of survey. Each habitation in the GP needs to be reached

- Importance of the demand and supply assessment before planning starts
- The structured tool, and focused questions required - the kobo tool
- Need for maps, charts, mobile-based planning devices for the local staff for planning interventions

- Need for planning dashboards for the PMU, DPOs
- Smarter SoPs for the local staff

What are the benefits of such a framework

- Enables demand-side planning
- Easy computation of returns on investments
- Easy to adapt to changing cropping patterns
- Displays coverage and access
- Allows easy thumb-rules which connects rainfall, landuse etc. with flow profile
- Better planning and management for WUAs
- Trainable and scalable for village as a unit

Contents required:

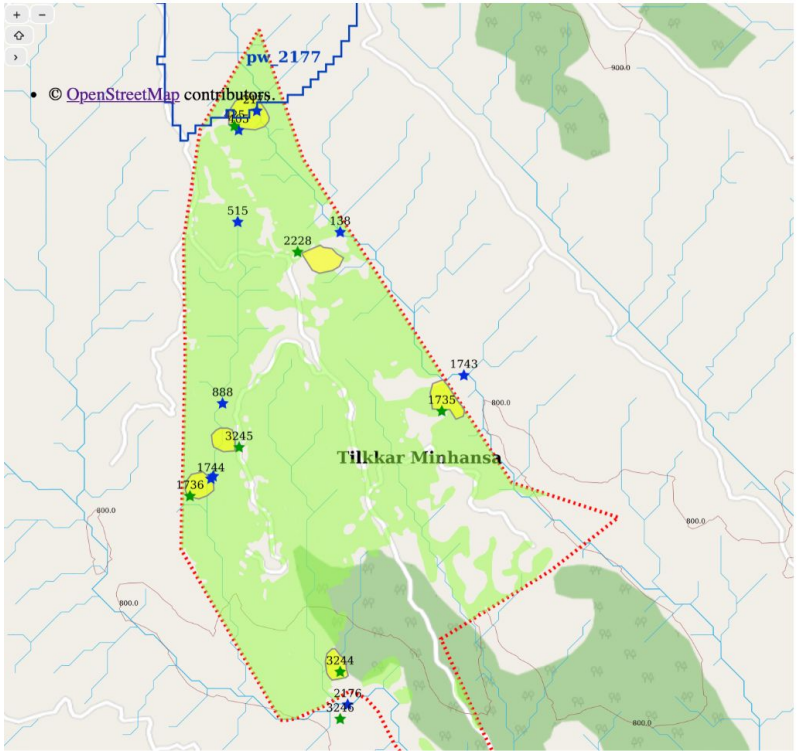
- Base maps - village boundary, cadastral, stream network, important contours
- Location of key baudis and pickup points and their discharge table
- Irrigation systems and beneficiary units
- Demand calendar (water)
- Water user association details

The web interface http://34.131.193.102/gpview/

HP-IDP Gram Panchayat Planner

A prototype to illustrate supply-demand-allocation based planning framework at Gram Panchayat level. Built by IIT Bombay, in collaboration with HP-IDP.

जिला हमीरपुर तहसिल Bhoranj ग्राम पंचायत Tilkkar Minhansa Watershed pw_2177 (72.53 ha) Year 2023



PWHS activity: Sump Wells (4.15(2)x3.20x0.74 mtr.)/Tank (3.00(2)x1.50x2.17mtr.)

Water budget for watershed pw_2177 (72.53 ha)

Season	Rain (mm)	Runoff (mm)	AET (mm)	PET (mm)	Groundwater recharge (mm)	Available soil moisture (mm)
monsoon: 01 Jun to 08 Oct	776	128	336	401	290	23
postmonsoon: 31 Oct to 30 May	229	3	169	339	46	43

Land use by area percent in watershed pw_2177 (72.53 ha)

Dense forest (%)	Sparse forest (%)	Grassland / scrubland (%)	Agriculture crops (%)	Horticulture plantation (%)
0.27	0.00	16.83	76.48	0.00

Topography in watershed pw_2177 (72.53 ha)

Minimum elevation (m asl)	Maximum elevation (m asl)	Gentle slope area (%)	Moderate slope area (%)	Steep slope area (%)
847	941	83.96	15.90	0.00

Lithology and soil in watershed pw_2177 (72.53 ha)

Dominant soil group	Soil storage capacity	Soil hydraulic conductivity	Domniant aquifer group	Aquifer storativity	Aquifer hydraulic conductivity
	high	low		high	high

For the next MoU :)

Stabilizing the model

Calibration of key parameters
- FC, WP, KSat, specific yield, hydraulic cond. Etc.
- ET models for Forests, orchards etc.
- Calibration and validation of baseflow model

Incorporation of
- Snowfall, snowmelt
- Springs

Preparing the thumb rules

- Irrigation requirements
- Translating flows into LPM / bigha
- Secondary tank design and management

- Formats for habitation and farmer surveys
- Training of field staff
- SoPs for field staff

Scale-up

Taking to all GPs in the state

Public Inventory of Key datasets at district level
- Crop data, soil maps, aquifer maps, LULC, revenue maps, farmer data etc.

Planning dashboard for district planners
Mobile devices for GP planners

For the next MoU :)

Stabilizing the model

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- ET mode… orchards
- Calibrati… validatio… model

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Scale-up

Taking to all GPs in the state

…y of Key …rict level
…oil maps, aquifer …, revenue maps, …etc.

Planning dashboard for district planners
Mobile devices for GP planners

Doing this with the district relevant departments:
Forest, Agriculture, IT, Disaster and so on..

Working with 2 or 3 sample districts:
With district administration for extension, training

IDP water budgeting can be taken to other hilly states

- Stream flows, baseflows, springs
- Drinking water and crop demands
- Climate resilient agriculture
- Forest management
- Disaster and extreme climate event management

Meghalaya preliminary visit Sept-Oct 2024
Visited 6 villages under MegLIFE project

How to do this… MoUs.

Institutionalization at the top..

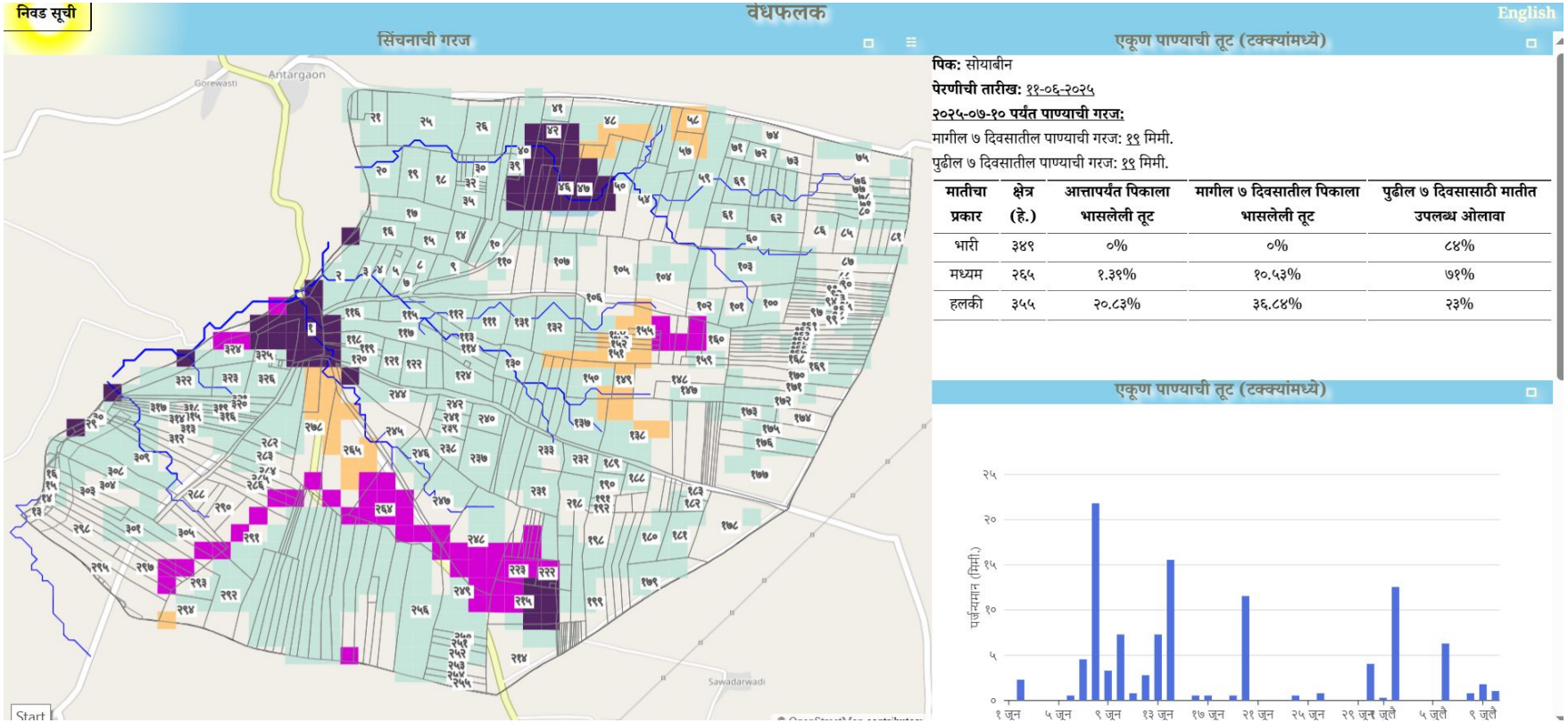
- Work at the state level
- Newer protocols, new job positions
- Collaborate with Agri. universities, academic institutes

Institutionalization at the middle..

- MoUs with the district magistrate, district agri. office,
- Work on tools for the day-to-day planning


भारतीय गैर-न्यायिक
एक सौ रुपये
Rs. 100
रु. 100
ONE HUNDRED RUPEES
भारत INDIA
INDIA NON JUDICIAL
महाराष्ट्र MAHARASHTRA
2025
50AB 452971
15 MAY 2025
MEMORANDUM OF UNDERSTANDING
BETWEEN
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
AND
COLLECTOR & DM OFFICE, DHARASHIV & DISTRICT SUPERINTENDING AGRICULTURE OFFICE, DHARASHIV
This Agreement is made and entered into as of 3rd June, 2025 by and between Collector & DM Office, Dharashiv along with District Superintending Agriculture Office, Dharashiv, Maharashtra having its registered office at Dharashiv hereinafter referred to as FIRST PARTY which expression, unless repugnant to the context shall mean and include its successors and assigns, of the FIRST PARTY,
AND
Indian Institute of Technology Bombay (through Prof. Milind Sohoni of CSE Department), a research and educational institution in science, technology and engineering disciplines, established by a special act of Parliament of Republic of India, the institute is recognized as an Institution of Eminence by Government of India and known worldwide for the high-quality education that it imparts and for undertaking cutting-edge research in various areas of science, engineering, design, management and humanities, having its office at Powai, Mumbai-400 076,
Page 1 of 12
REDMI NOTE 8 PRO
AI QUAD CAMERA

The Dharashiv dashboard



https://test.dharashiv-aio.in/district/talukas/4237/villages/561171/irrigation_requirement?crop=soybean&date=2025-07-10

…. and institutionalization at the bottom!