MoU IV Inception report - Water

IIT Bombay
24th Sept 2021

MoU IV components

A. Model Validation - consolidation, incorporating with ponding and aquifer depth

B. Community Extension - providing templates for extension

C. Model Improvements - integrating regional flows - vulnerability and GW

D. Rabi Planning Framework - guiding villages to sustainable and profitable rabi

E. PMU and IT Support - Providing timely support and eventual transfer

A. Model Validation (In 4 clusters, 1 catchment per cluster, for Kharif and Rabi seasons)

| Model Component	Scale	Method to be used	Number
Runoff	Point/ Farm	V notch with sensor	Total 7 farms to be monitored
Runoff	Regional	Water Level Sensors on CNB	20 sensors to be installed at sub-catchment and catchment levels (+ 1 at Percolation tank)
Soil Moisture	Point	Soil Moisture Sensor	2 locations per farm, total 5 farms to be monitored
Groundwater recharge	Regional	Monitoring of well water levels throughout Kharif and Rabi seasons	About 15 wells per catchment
AET (Indirect)	Point	Detailed interviews with farmers	About 15 farmers per catchment
Post monsoon water availability (GW + SM + Surface water)	Regional (cluster)	Farmer interviews, cropping pattern, GW extraction measurements, Baseflow measurements, GW level monitoring	About 10 farmers per village in the cluster

Loha Cluster
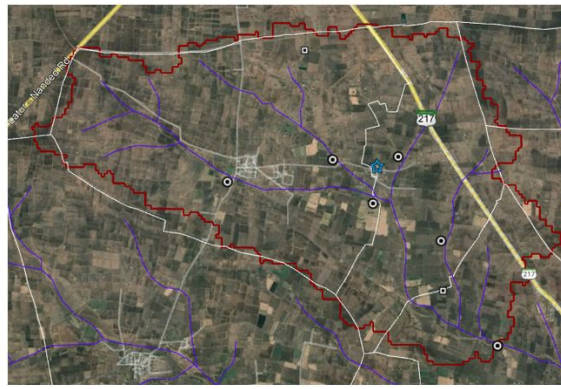
Ahmedpur Cluster

★ Rain gauge
▣ V-notch and soil moisture sensors
⊙ Water level sensor on CNB
● Water level sensor in Percolation Tank

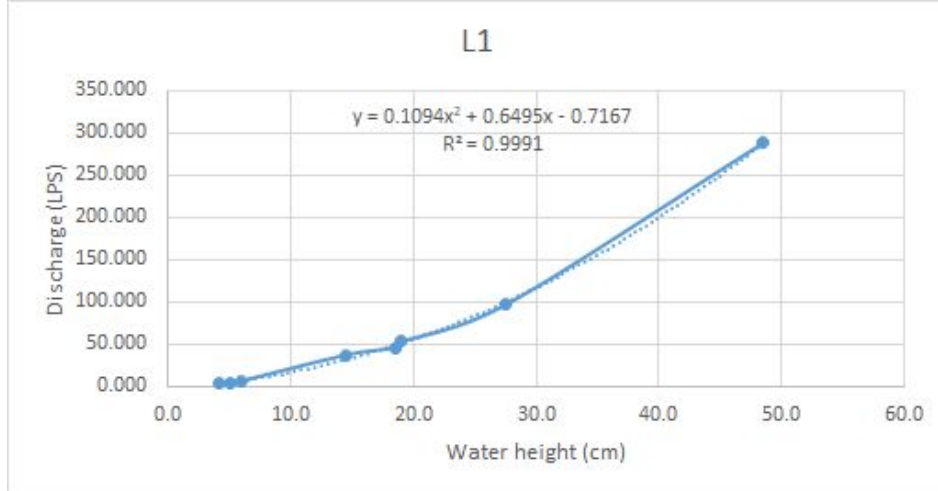# Selected clusters and sensor locations
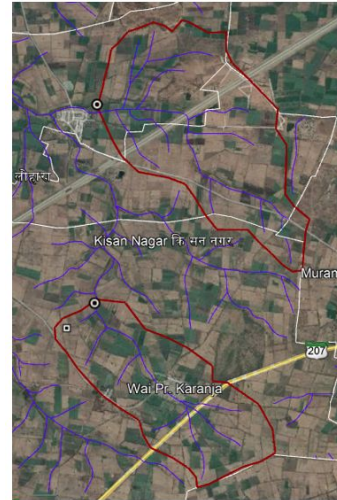
Karanja Cluster
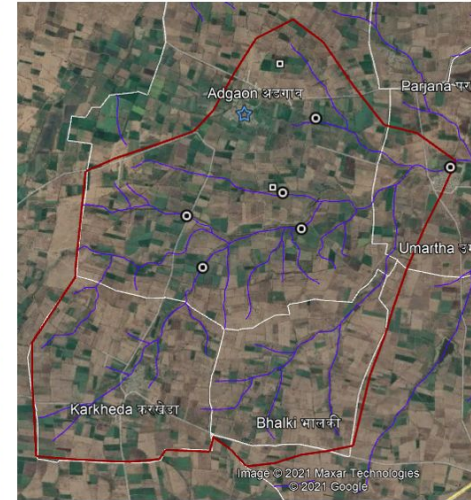
Ner Cluster

★ Rain gauge
▣ V-notch and soil moisture sensors
⊙ Water level sensor on CNB

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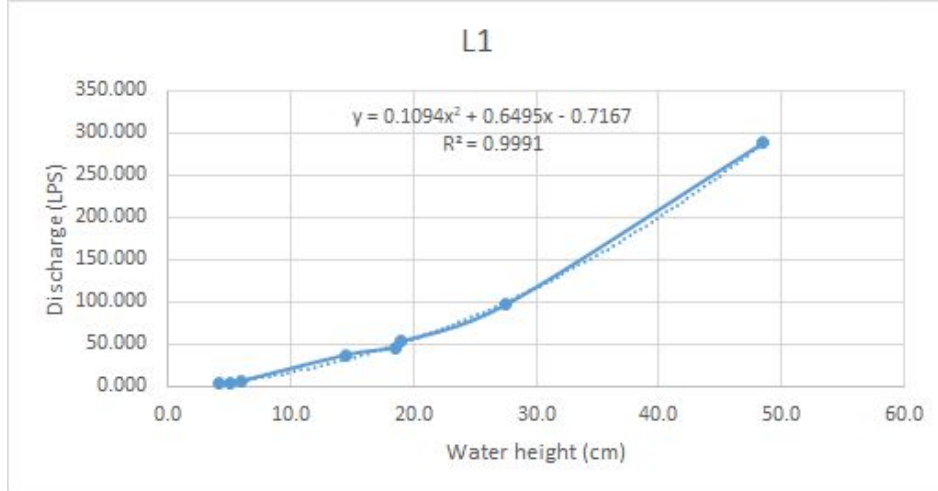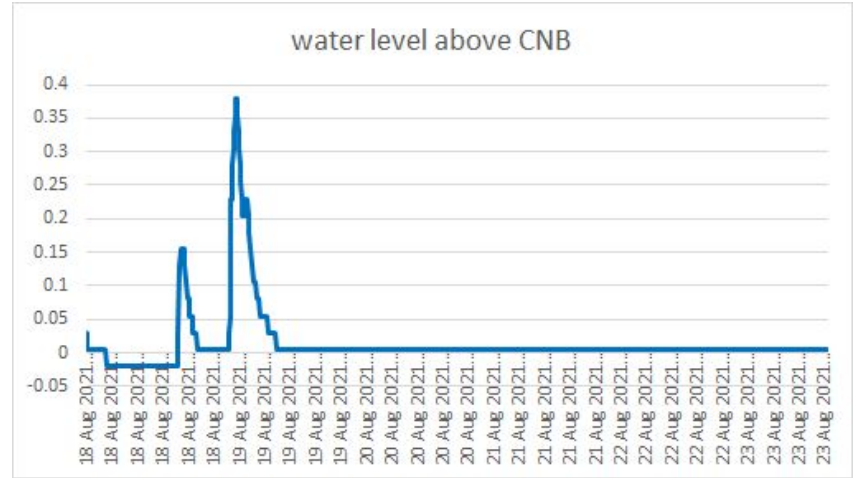
Sample sensor data for an event

Water height Vs Discharge relation for CNB (L1)

Sample sensor
data for an event

water level above CNB

L1

$y = 0.1094x^2 + 0.6495x - 0.7167$
$R^2 = 0.9991$

Water height Vs Discharge relation
for CNB (L1)

Work to be done (expected deliverables, planned activities, schedule)

Component	Pre-Phase II (May - Sept)	Phase II	Phase III	Phase IV	Phase V
Review of validation methodology, field work, initial report	Methodology, Field work	Initial report			
Data processing, analysis, documentation of observations, insights for model improvements, kharif report	consolidation and cleaning of sensor data	data analysis, comparison with water budget model results	Kharif validation report		
Data processing and analysis in rabi season			Field work, data collection, farmer interviews	data analysis, comparison with water budget model results	Rabi validation and Closure report
Analytical comparison of water budget results for earlier years to understand year-to-year dependence.			Collecting all required data	Data analysis	Report writing and delivery

Component B: Community Extension

The key objective will be to demonstrate easy-to-understand village level exercises and develop protocols which will feed into the information comprehension and collective action based extension framework.

1. **Kharif Extension activities:** kharif yields, vulnerability, protective irrigation, investments, solutions basket etc.

2. **Rabi Extension activities:** rabi yield curves, rabi water stress, groundwater competition, uncertainty in access to water, investments, benefits, impacts of NRM works,

Deliverables as Field visits and Actionable and Reproducible reports in the clusters selected for model validation

Design and conduct of farmer surveys in the selected clusters, design of data collection formats, which may be used by the VCRMC and extension agents

Conduct of village-level meetings to present key problems faced by the median farmers, and aid in better targeting of benefits and NRM works

Farmer surveys, questionnaire design, conduct of village meeting

Component	Key information to be collected
Vulnerability	- Soil types, farm location (stream proximity or non-proximity), - Cropping pattern in kharif and rabi season during good and bad years - Maximum, minimum and average yields achieved in the last 10 years for major kharif and rabi crops - crop stress during dry spell in this monsoon, waterings required, and provided
Access to water and energy	- Existing assets and sources of water - wells, borewells, farm pond, drip, pipeline etc. - Ability to provide protective irrigation at crucial times during kharif and rabi seasons - Seasonal water availability - When do wells go dry in the post-monsoon season? - Access to electricity during crucial times, number of DT failures per year, major concerns
Farmer investments and aspirations	- What are the major investments in the last 5 years on assuring access to water / energy? Cost-benefit analysis of the investments - What are the major investments, or crop choices planned in the next one or two years?
PoCRA benefits	- Application history and status - impacts and outcomes of the benefits as per farmer's narrative and whether the benefit was able to reduce vulnerability to some extent

Farmer surveys in four villages in the selected clusters planned in October

Rabi extension activities - to be carried out in Nov, Dec

Farmers narratives on: GW availability, access and its seasonality, Waterings provided to different crops in different soil types, irrigation deficit if any to fetch maximum yield and average yield, yield loss due to deficit and rationing practices

Measurements: Water provided during each irrigation for combination of different crops (wheat, gram, cotton) for different soil types (good and poor soils) and irrigation method (furrow, sprinkler and drip)

Work to be done (expected deliverables, planned activities, schedule)

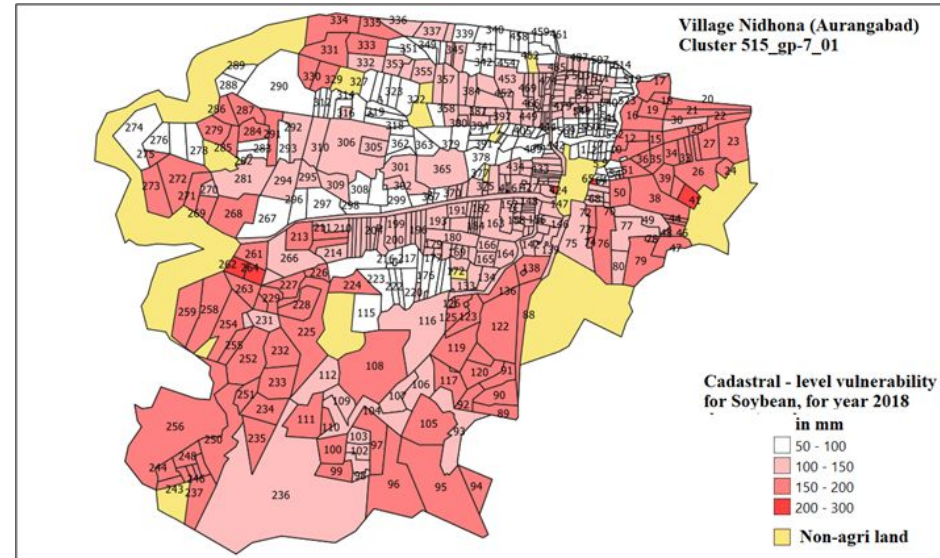| Component	Phase II	Phase III	Phase IV	Phase V	Phase VI
B1 - Kharif Extension activities	Conceptualization, Field work, conduct of meetings	Documentation, training material, reporting	solutions space analysis, PMU support		
B2 - Rabi Extension activities		Conceptualization, Field work	Data analysis, documentation of key observations, conduct of village meetings	Documentation, training material, reporting	

Component C: Model changes and improvement

- Improvements in point model
  - Incorporating farm-level phenomena such as ponding, water-logging etc.
  - Incorporating hydrogeological attributes such as aquifer depth, specific yield for better computation of GW recharge
- Implementing regional geography GIS framework
  - Zone numbering and ordering
  - Delineation and addition of new stream-proximity-zones layer
  - Integrating the regional geography on to the PMU IT stack
- Use of regional geography to compute regional flows
  - Within zone - from non-stream-proximity to stream-proximity
  - Across zones - from upstream to downstream zones through stream-proximity
  - Integrate GW and SW flows into existing model

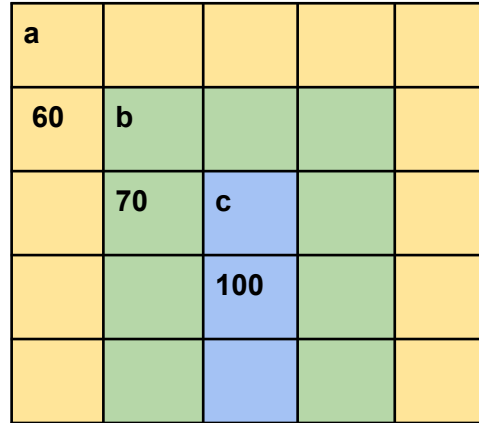# Dynamic computation of water budget - space-time interchange

- Allows for water budget at village and farm level on any day during ongoing monsoon season

- Computation of stress and availability of surface, and groundwater

Vulnerability module

•**Indicates vulnerability based on crop stress in Kharif season**

•Vulnerability depends on soil types, slopes and rainfall pattern (dry spells)

•Useful in identifying regions which need protective irrigation during kharif season

Village Nidhona (Aurangabad)
Cluster 515_gp-7_01

Cadastral - level vulnerability for Soybean, for year 2018 in mm

- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 300
- Non-agri land

Incorporation of groundwater flows and groundwater endowment zones

stock at specific grid points, extraction (mm/day, region, days): (0.6, a, 100) (0.6, b, 100) (0.6, c, 100)
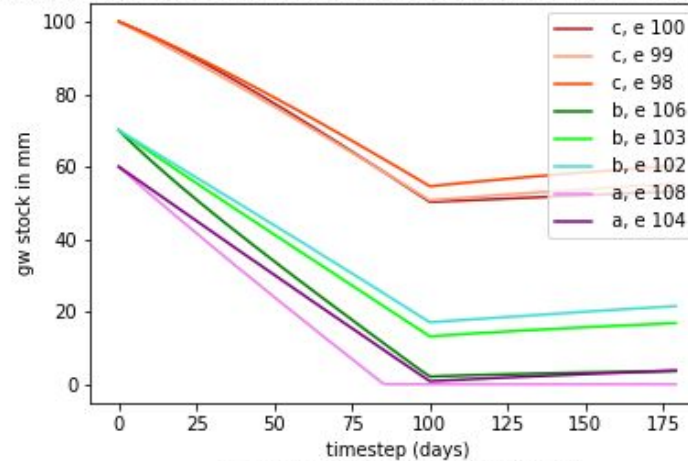
flow (m3) from region a to b: 21167.98
flow (m3) from region b to c: 12216.11

Regime	Rabi C	Rabi B	Rabi A	AET C	AET B	AET A
Rabi in c	180 mm	0	0	180 mm	0	0
Rabi in b,c	120 mm	60 mm	00	120 mm	60 mm	0
Rabi in all	60 mm	60 mm	60 mm	60 mm	60 mm	48 mm

Work to be done (expected deliverables, planned activities, schedule)

Component	Phase II	Phase III	Phase IV	Phase V	Phase VI
C1 - Point model changes	Dynamic wb computation, updated plugin	Incorporation of field insights, code changes	Point model changes for GW recharge	Note on MLP improvements	
C2 - Implementation of Regional geography framework	code changes, documentation	zone ordering, delineation of stream proximity, changes to IT stack	PMU support		
C3 - Computation of regional flows	Conceptualization	Code changes, documentation	zonal module for reallocation of water within and across zones		Note on Chart improvements

D. Rabi Planning Framework

- Objectives
  - To provide better grounds for GW regulation based on entitlements and endowments
  - To facilitate village-level crop planning
  - To identify low-endowment zones for NRM interventions

- Deliverable: Stand-alone module (plug-in) : may be incorporated in MLP app

  To be used for village-level Rabi planning meeting

- Inputs
  - Zone map with (improved) rabi water availability at the start of the rabi season
  - This will require kharif cropping data entered, zone-wise water budget files ready and zone-level water reallocation done
  - Crop data table with watering, yield, market rate, income ready for all LK, annual, rabi and summer crops
  - List of probable crops to be sown in rabi – to be entered by the community

- Output - *cropping pattern scenarios for profit maximization as well as equity maximization*
  - Probable area under all rabi crops
  - Possible zone-level cropping pattern scenarios considering crop yield curves, incomes, profits etc.
  - Possible regions for NRM interventions

Man-months 10

Work planned, schedule

| Component	Phase II	Phase III	Phase IV	Phase V	Phase VI
Design of rabi planning framework for crop planning and diversification.		conceptualization	note on conceptual framework		
Designing energy and irrigation practices as a joint constraint.		incorporating insights from field, documentation			
Designing cropping scenarios through Linear Programming (LP) model.		preparation and coding of prototype LP model	Field work, interactions with farmers, documenting various cropping pattern scenarios	testing and strengthening of LP model through coding and field work	stand-alone rabi planning module for pilot villages
Addition of required datasets to IT stack (market rates, P1, P2, P3 definitions, crop hierarchies).			Identifying key datasets such as market rates, crop hierarchy, yield curves through field work	Documentation and design of database schema through interactions with PMU	PMU support for integration into MLP

Component E: PMU and IT support

Well beneficiary prioritization module

Use of vulnerability maps to aid the process of of beneficiary selection

Implementable in GIS framework through spatial joins between Vulnerability maps, LULC maps and DBT data

Output - a template containing map which highlights high-priority Gat nos.for granting of wells, along with guiding rules for the AA to select beneficiaries
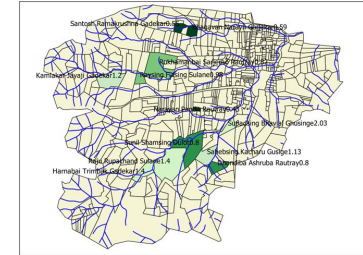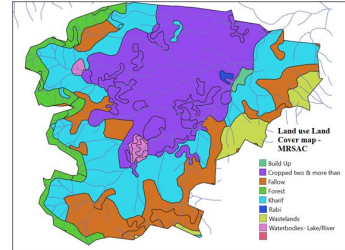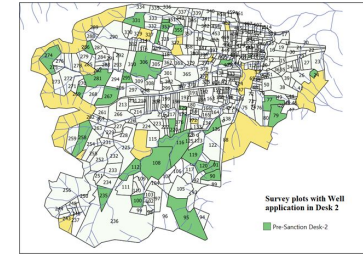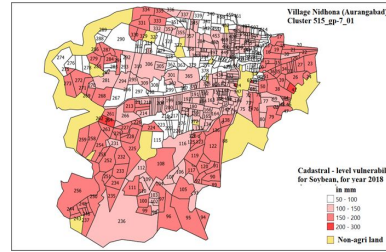
Possible guiding rules to be considered along with vulnerability maps

- **Priority to farmers with wells (in family or in any other Gat) to be given higher priority. This indicates no prior access to groundwater**
- **Considering previous year's cropping pattern and yields**
- **Considering Stream proximity, Proximity to existing NRM works such as CNBs, MNBs, Pazar Talav etc.**
- **Tentative plan for transfer of water to other Gat (suggesting increase in rabi area)**