Field work update

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12th August 2020

- Field work objectives
- Methodology
  - Water balance equation and its components
  - Validating water balance at catchment level
  - Scale – pointwise to regional
  - Use of GSDA framework
- Execution
  - Regional runoff
    - Concept – stage-discharge relationship for CNB at outlet of catchment
    - Design and construction of stilling well – for measuring water flowing over the CNB
    - Current meter readings
  - Regional GW recharge
    - GSDA methodology – WTF; selection of wells in the catchment; monitoring water levels at frequent intervals
    - Baseflows – water flows during lean periods
  - Farm level soil moisture – soil moisture tests at regular intervals
  - Farm level runoff – farmer narratives; photos; event-wise documentation of rain events
  - AET – farmer narratives and crop growth status; application of protective irrigation
  - Farm level GW recharge – well behavior, time for rise in levels after events etc.
- Field work status
- Results till now
- Planned work

- Field work objectives
  - To devise validation plan for PoCRA water balance model
  - To select clusters, catchments for validation during monsoon of 2020; and to set up required infrastructure and logistics for the validation

  - To collect and monitor data and analyze
  - To document farmer narratives and various phenomena on the field (such as ponding, baseflows etc.)
  - To formulate water balance for the selected catchments with the observed data

  - To compare the observed results with daily model, hourly model and GSDA results
  - To recommend refinements in the model based on observations in the field

- Validation methodology

Core water balance equation for the kharif (monsoon) season

Rainfall = runoff + GW + AET + del SM

(del SM is the change in soil moisture stock)

- If individual components are measured at the catchment level and the equation is satisfied, the model is validated

But,

- SM and AET are essentially farm level entities
- Runoff and GW are regional entities

So, Validation plan would to

- Validate runoff and GW at catchment level
- Validate SM and AET at sampled points in the catchment

- Validation plan

Component	Scale	Measurable on field?	Proxy	How?
Runoff	Regional	Yes		Measuring discharge at the outlet of the selected catchment
GW recharge	Regional	No	Well levels	GSDA Water table fluctuation method
Soil moisture	Farm level	Yes		Soil moisture measurement for selected points at regular intervals
AET	Farm level	No	Farmer narratives + crop height	Was there need to irrigate the crop during dry spell? Did the crop suffer stress? Is crop growth adequate? What is the expected yield?
GW recharge	Farm level	No	Farmer narratives and well levels	Well levels in the individual fields
Runoff	Farm level	No	Farmer narratives	Was runoff generated on the field? How long did it last? Was there any ponding? etc.

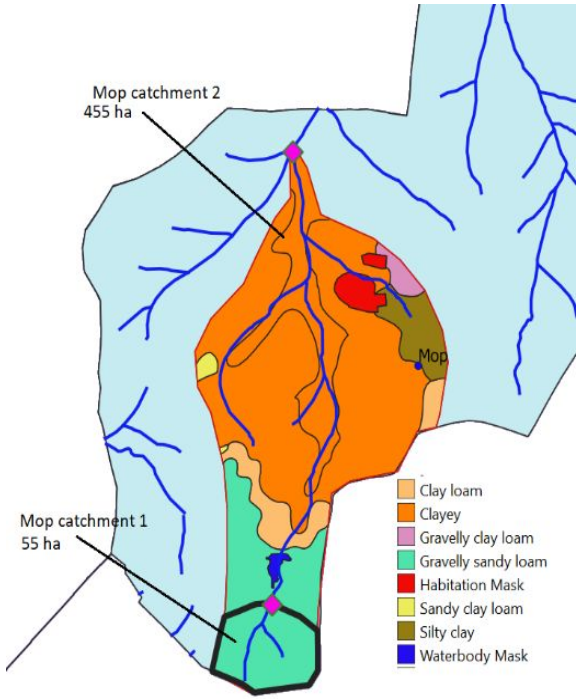
- Selection of clusters – based on
  - Study completed by GSDA and report submitted
  - Rainfall
  - Soil types
  - Land use
  - Slopes
  - Logistics (especially because of limitations on travel during lockdown)

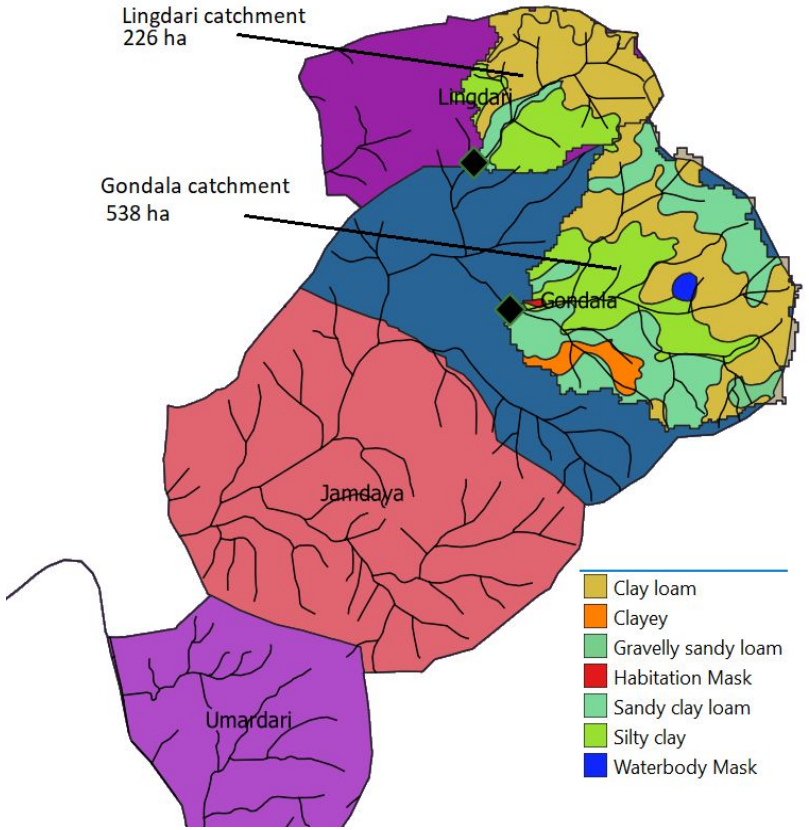
- Selected clusters

Cluster	District	Taluka		

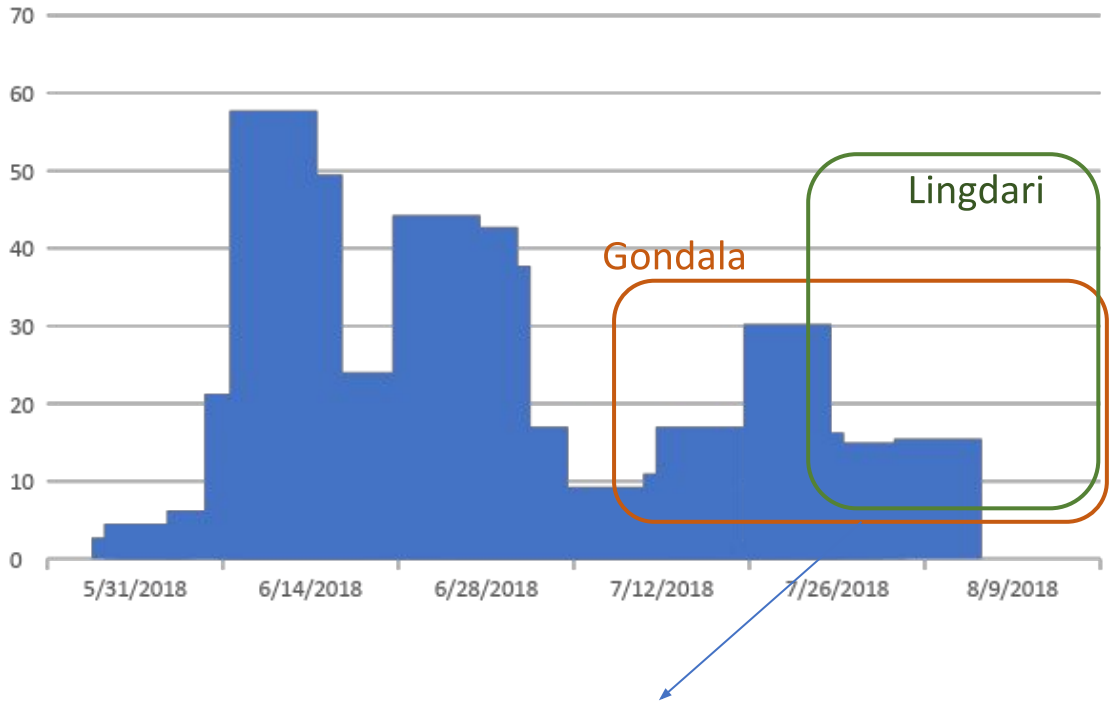
Village	Catchment size ha	Agri. Area ha	Forest area.	Dominant soil types	Terrain	Dominant vegetation
Lingdari	224	100	126	Clay loam-shallow	Slopes	Scrub, soyabean
Gondala	538	250	228	Clay loam-shallow, sandy clay loam-shallow	Slopes	Scrub forest, soyabean
Mop	55	50	0	Gravelly sandy loam, shallow	Gentle slope	Soyabean
Mop	455	455	0	Clayey-deep	Flat	Soyabean

Jalna catchment
to be added

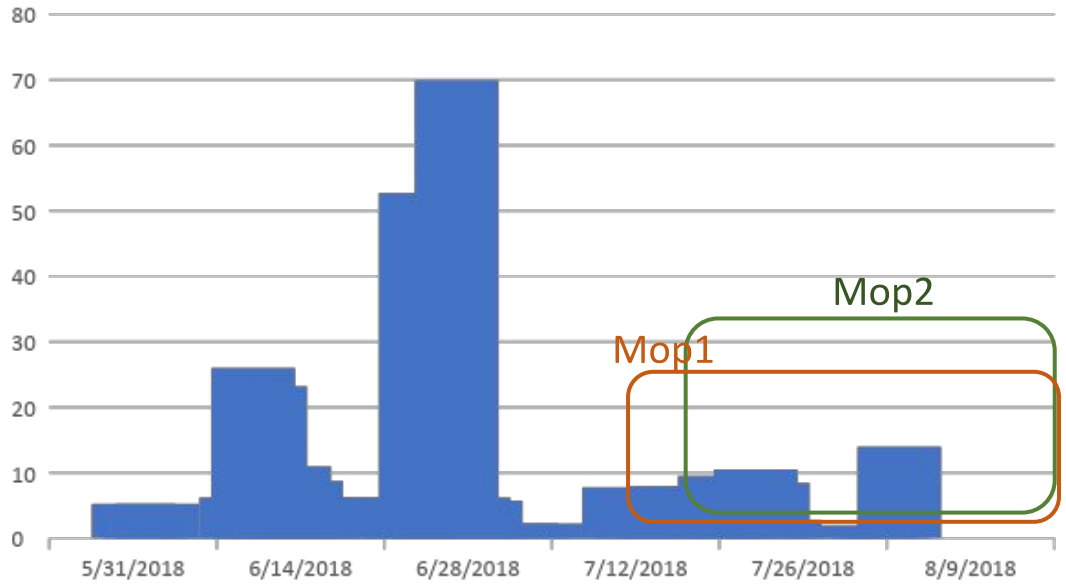




Rainfall till 4th Aug 2020



Sensors functional



Installation of water level sensors

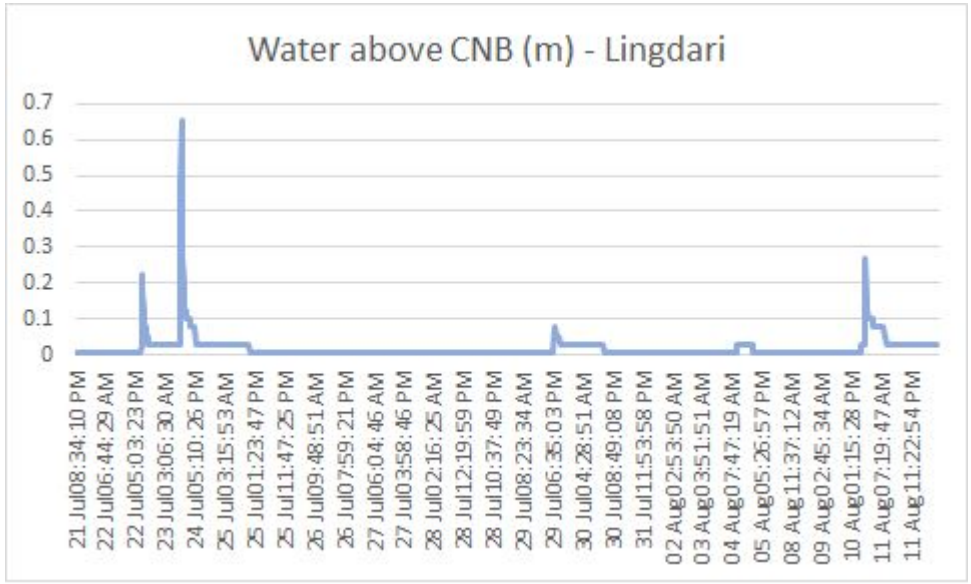
Gondala sensor

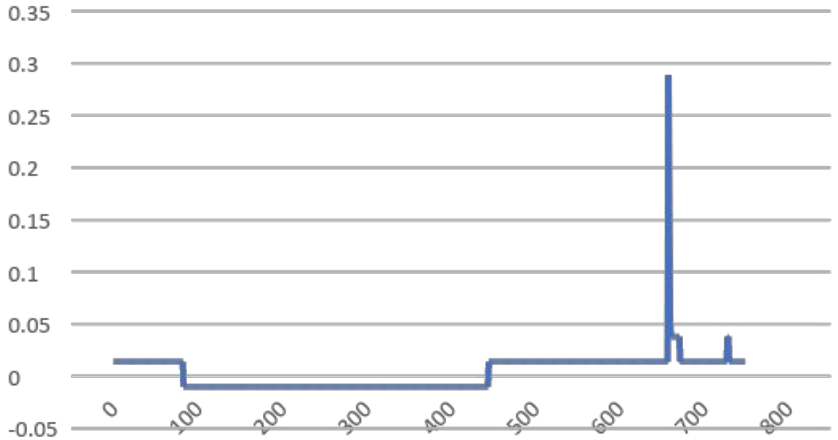
Lingdari sensor

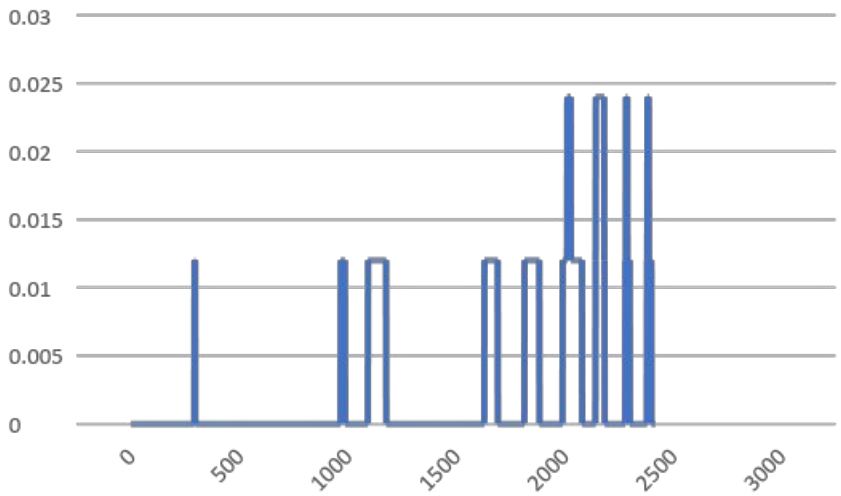
Mop sensor 1

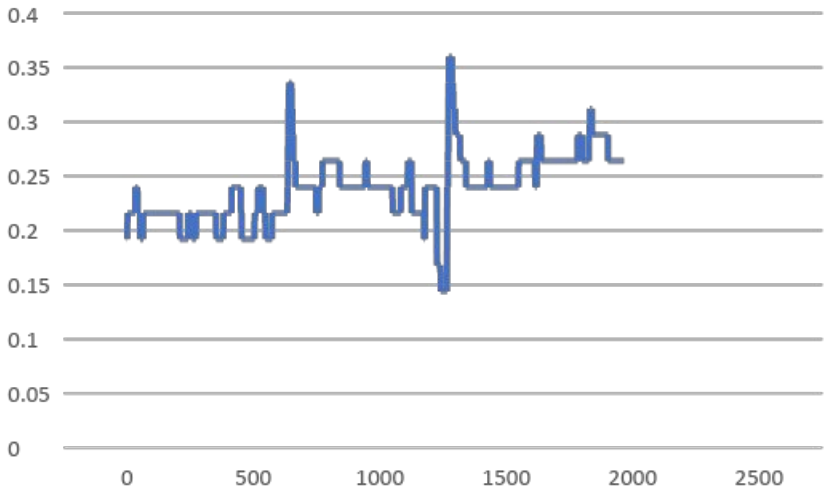
Mop sensor 2

Sensor readings









Water balance (daily and hourly) for the 4 catchments upto 4th Aug 2020

Catchment	Rainfall mm	Runoff mm daily	Runoff mm hourly	GW mm daily	GW mm hourly	AET mm daily	AET mm hourly	SM mm daily	SM mm hourly
Lingdari	531	232	151	83	158	158	158	57	64
Gondala	531	232	149	99	176	148	148	52	58
Mop1	334	90	33	109	167	115	113	20	20
Mop2	334	96	58	29	56	148	148	61	73

Current meter readings and flow over broad crested weir

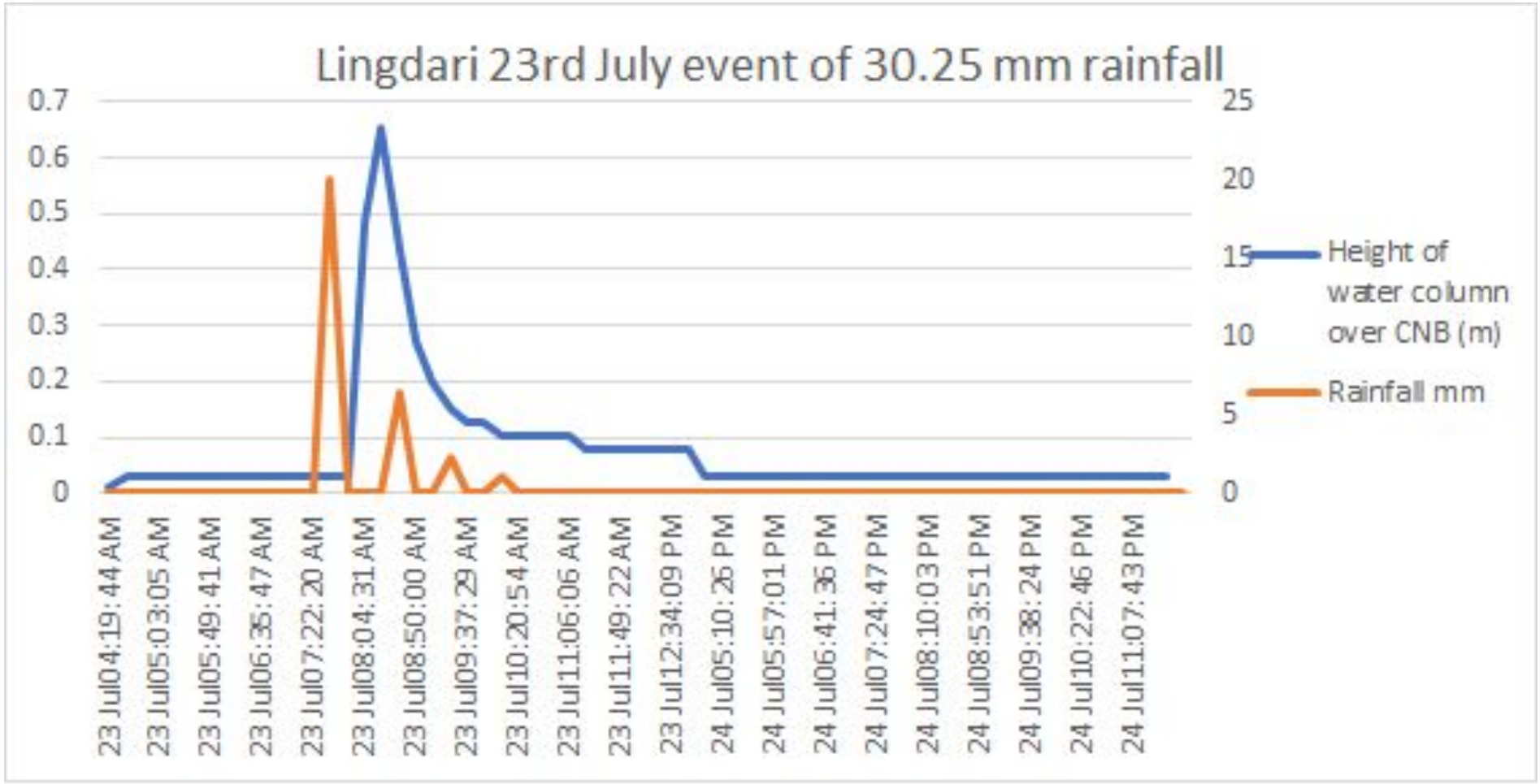
For sensor	Water column over CNB (cm)	Discharge downstream of CNB (lps) Measured by current meter	As per formula for broad crested weir (lps)
Gondala	1	12	21
Gondala	5	272	236
Gondala	7	430	391
Lingdari	1		10.5
Lingdari	4	61.4	84

Flow over broad crested weir – 1.715 x 0.62 x L x (H^1.5)

Runoff measured at the outlet of the catchment (sensor readings)

Catchment	Start date	End date	Rainfall in the period mm	Flow out of the catchment (TCM)	Flow out of the catchment (mm)	Flow during lean period (baseflows) mm	Runoff as per model in same period
Lingdari	21-Jul-20	10-Aug-20	134	68.96	30.5	3.04	25
Gondala	21-Jul-20	10-Aug-20	134	114.19	21.74	5.2	19.5
Mop1	11-Jul-20	6-Aug-20	73	2.08	3.8	0	0

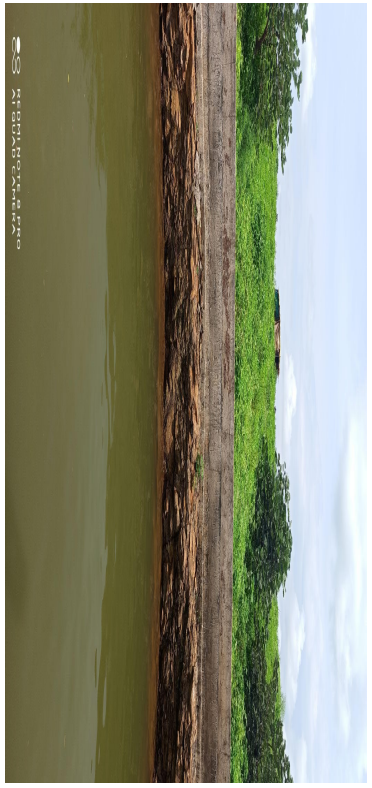
Baseflows were observed to be significant. Water flows over the CNBs in Lingdari and Gondala even during dry patches with no rainfall.



Total rainfall – 30.25 mm (between 7 and 10 am 23rd July)
Runoff as measured – 8.4 mm (measured till 24th July afternoon i.e. including delayed flows OR baseflows)
Runoff by model – 5 mm

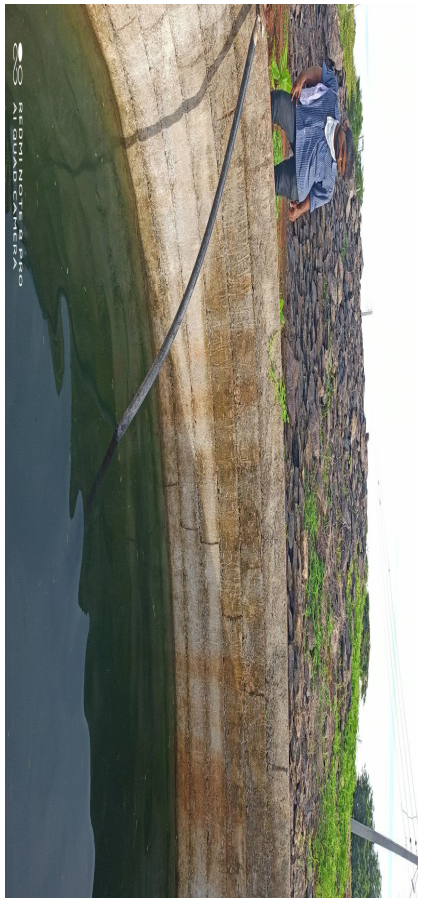
Almost all wells are full everywhere

Gondala wells



Lingdari wells

GSDA recharge, graph



Mop well

Overall Observations

- Runoff as measured by the sensors roughly matches with the hourly-model estimates. (preliminary findings)
- Calibration of sensor readings need to be done further. This will require more current meter readings during different rainfall events. – To be done in August
- GW recharge by GSDA methodology,
  - Water table fluctuation during monsoon (As observed in Lingdari and Gondala) = 7 m i.e. 56 mm GW recharge with 0.8 % specific yield as estimated by GSDA.
- GW recharge by hourly model
  - Around 160 mm – i.e. too high. – but all wells were full
  - Explanation for this high recharge may be given through two observations
    - Significant Baseflows during monsoon season (on days when there is no rainfall i.e. CNBs overflow throughout the monsoon season) this can account for 30-40 mm of GW recharge which flows out as baseflows during monsoon
    - Kharif season extraction – Many farmers gave one watering to soyabean and turmeric around 10^{th} to 12^{th} July when there was a small dry spell. This may account for 5-10 mm of GW recharge.
    - Rest needs to be accounted. This would require further investigation in to Ksat used for soils such as sandy clay loam, gravelly sandy loam etc.
- AET – crop height and growth (for soyabean) was seen to be varying with different soils. This roughly matches with the AET predicted by the model

Planned work

- Farmer narratives – this would include detailed interviews regarding crop growth status, protective irrigation, expected and actual yields, changes in groundwater levels etc.
- Soil moisture measurements – Few farmers in each catchment will be selected for measuring soil moisture at regular intervals between 15th August and 15th September
- New sensor to be installed in Goregaon cluster – sensor in transit currently; will be installed in the next week
- More current meter readings to be taken at the outlet of all catchments to form a robust relationship between stage and discharge.

Preliminary recommendations for model refinements

- Incorporating baseflows
  - This will require limiting of GW recharge into the aquifers using aquifer thickness and specific yields. These parameters may be taken from GSDA for all clusters.
- Ponding
  - AS per the observations in the field, ponding of runoff occurs during heavy rainfall events. i.e. Some of the runoff never leaves the field. This may further reduce the runoff which adds to the stream channels. This needs to be incorporated in the model using a constant MAX_PONDING_DEPTH. The value of this constant needs to be estimated from farmer interviews and identifying depressions using DEM analysis.
- GW recharge in hourly water balance model in soils with thin layers and high saturated hydraulic conductivity need to be investigated further to understand why so much recharge occurs. NBSS may be consulted to get Ksat values for local soil types.