Incorporation of Ponding in Water Balance Framework

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Date 11-08-2020

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Types of Ponding Observed

1. Ponding in furrows

Types of Ponding Observed

2. Ponding near bund

Types of Ponding Observed

3. Ponding due to natural depression

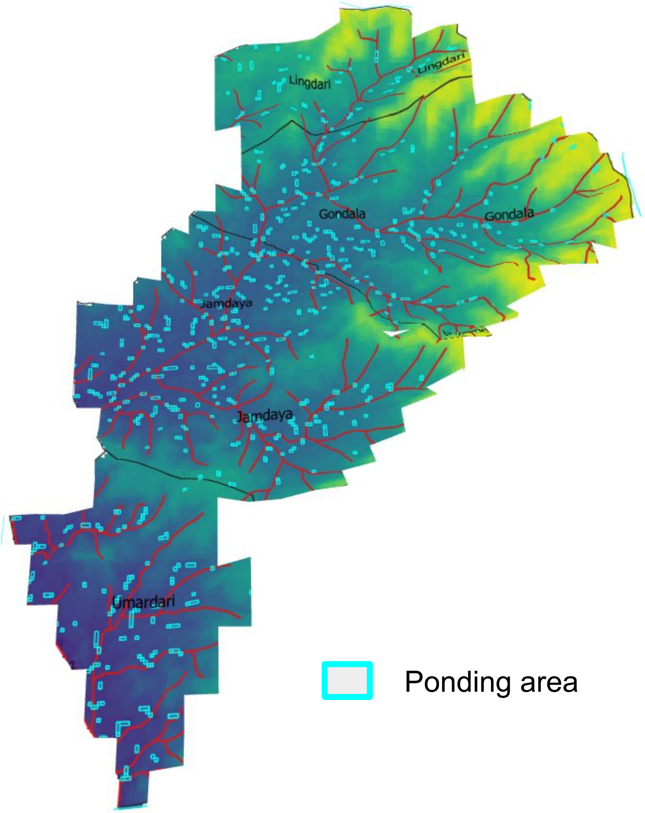
Incorporation of the ponding into the water balance framework:-

Steps for incorporation

1. Identifying possible areas of ponding
2. Computation of ponding constant
3. Incorporation of ponding constant in present water balance

1. Identifying Ponding areas

- Identification of possible ponding areas can be done using sink detection algorithm from QGIS
- Sink are the areas where runoff can be accumulated.
- Usually sinks are removed from DEM while computing watershed/drainage network
- DEM errors can affect identification, but we can increase resolution to cross verify ponding areas



2. Computation of Ponding Constant

1 Based on Furrow depth and Farmers interview

- Detailed survey can be conducted to understand relation between farm machinery used, soil depth and crop.
- List of factors to be gathered and analyze from farmers interview.

Farm slope, slope direction and furrow depth,furrow direction, Bund Height, Soil Depth, furrow machinery used

Field Observations

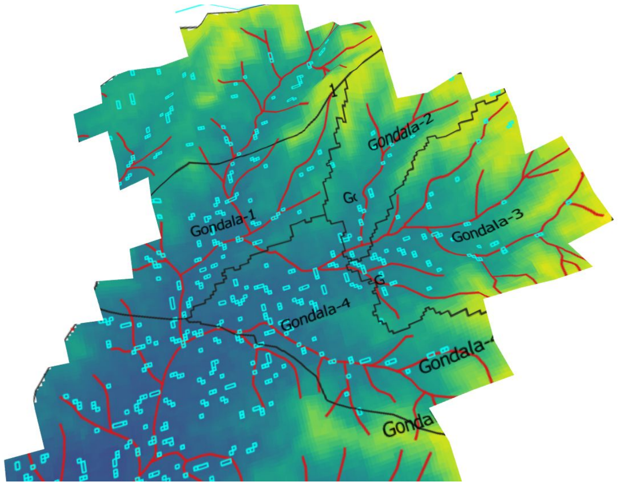
- Change is furrow depth is significant in first 2-3 rainfall events
- In Hingoli region, furrow depth for soybean and tur crop is near about 15 cm which can vary depending up on soil depth as well as land management practices
- For turmeric, in case of raised bed furrow depth is about 1 ft/ 30 cm.
- Maximum furrow depth is always limited by depth of farm machinery/plough

2. Computation of Ponding Constant

2 Based on Sink Volume in cluster area

$$Ponding\ constant(mm) = \frac{Vmax1\ (m3) + Vmax2\ (m3) + Vmax3\ (m3) + .. + Vmax1n(m3)}{Zone\ area(m2)} * 1000$$

- Based on sink algorithm, location and area of the local ponding areas can be computed.
- Further, with the help of DEM, volume can be computed.
- This volume is then further normalized over zone area to find ponding constant of the zone.



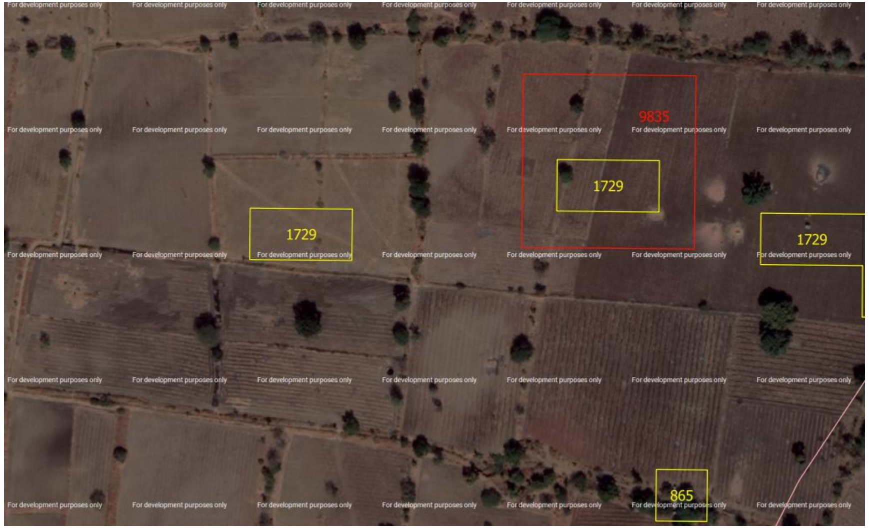
2. Computation of Ponding Constant

3 As per SWAT Theory Documentation 2009

$$V = V_{stored} + V_{flowin} - V_{flowout} + V_{pcp} - V_{evap} - V_{seep}$$

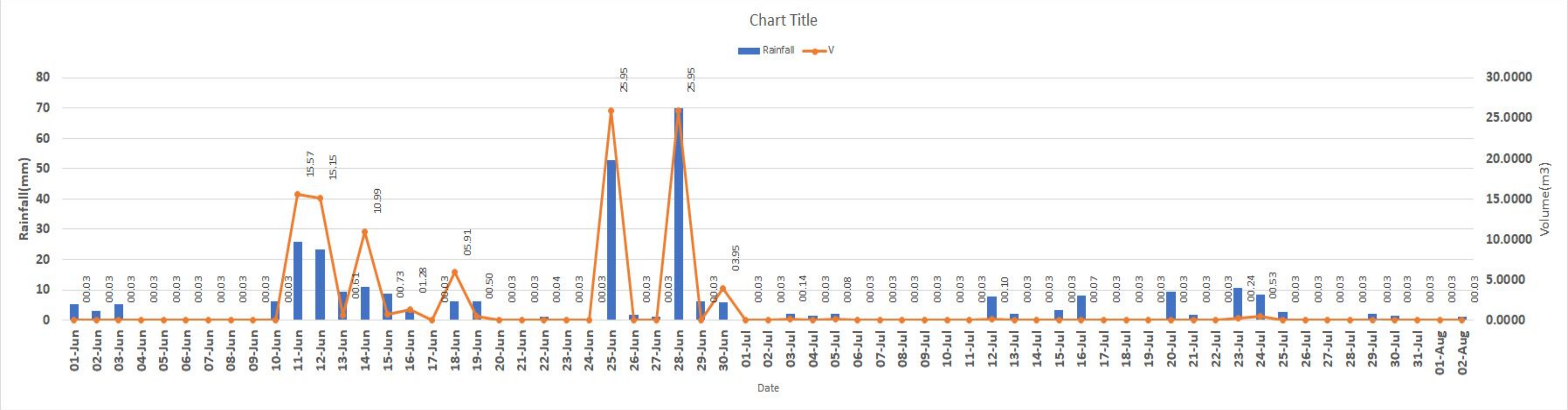
- V = volume of water in the impoundment at the end of the day (m3 H2O)
- V_{stored}=volume of water stored in the water body at the beginning of the day (m3 H2O)
- V_{flowin}=volume of water entering the water body during the day (m3 H2O)
- $V_{flowout}$=volume of water flowing out of the water body during the day (m3 H2O)
- V_{pcp}=volume of precipitation falling on the water body during the day (m3 H2O)
- V_{evap}=volume of water removed from the water body by evaporation during the day (m3 H2O)
- V_{seep}=volume of water lost from the water body by seepage (m3 H2O)

Mop:- Wetland case



- Surface Area of wetland=**1729m^2**
- Basin Area of wetland = **9835m^2**
- Soil Texture:- **Clay loam**
- Ksat:-**2.7 mm/hour**

Mop:- Wetland case



Summary since 1 June to 2 Aug with assumed max depth of 0.03 m

Vpcp(TCM)	Vflowin_Runoff(TCM)	Vseep(TCM)	Vevp(TCM)	Voutflow(TCM)
0.0289	0.2797	0.1582	0.0136	0.1367

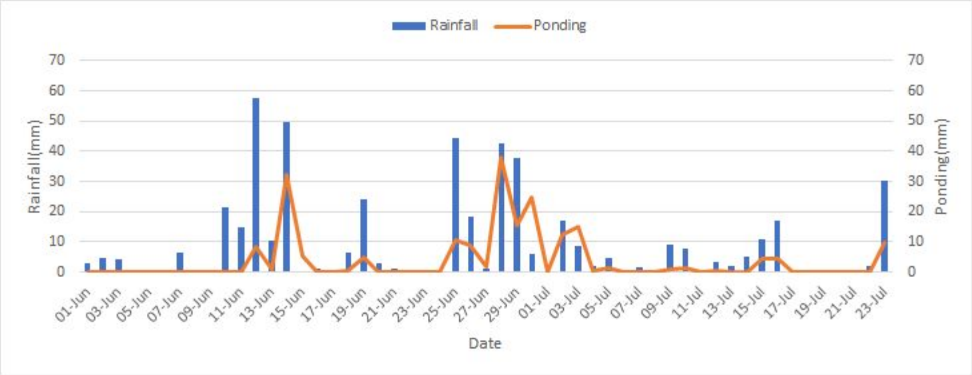
3. Incorporation of ponding constant in model

- if (pri_runoff + sec_runoff) >= Ponding_Constant then
  Ponding_Depth = Ponding_Constant
  Else
  Ponding_Depth = (pri_runoff + sec_runoff))

- If new runoff generated =

  pri_runoff + sec_runoff) - Ponding_Depth

- present time step rainfall= previous time step's Ponding_Depth + present time step’s rainfall



Hourly Model Simulation and Field Obs

2020-07-23 07-11 A.M

2020-07-23 07-38 A.M

2020-07-23 07-55 A.M

2020-07-23 08-11 A.M

2020-07-23 08-41 A.M

2020-07-23 08-51 A.M

2020-07-23 01-29 A.M

2020-07-24 07-52 A.M

Hourly Model Simulation and Field Obs

23rd july event		clayey v.deep ponding=10mm			clayey v.deep ponding=4mm			clayey v.deep ponding=0mm		
Time	Rain	pri+sec ru	ponding	new_runo	pri+sec ru	ponding	new_runo	pri+sec ru	ponding	new_runoff
23-07-2018 05:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 06:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 07:00	20	10.72	10	0.72	10.58	4	6.58	9.77	0	9.77
23-07-2018 08:00	6.5	8.98	8.98	0	4.11	4	0.11	1.29	0	1.29
23-07-2018 09:00	2.25	5.37	5.37	0	1.68	1.68	0	0.02	0	0.02
23-07-2018 10:00	0.5	1.8	1.8	0	0.06	0.06	0	0	0	0
23-07-2018 11:00	1	0.31	0.31	0	0	0	0	0	0	0
23-07-2018 12:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 13:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 14:00	0	0	0	0	0	0	0	0	0	0
	30.25	27.18	26.46	0.72	16.43	9.74	6.69	11.08	0	11.08

Clayey

23rd july event		clay loam mod. deep ponding=10mm			clay loam mod. deep ponding=4mm			clay loam mod. deep ponding=0mm		
Time	Rain	pri+sec runoff	ponding	new_run off	pri+sec runoff	ponding	new_run off	pri+sec runoff	ponding	new_runoff
23-07-2018 05:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 06:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 07:00	20	9.45	9.45	0	9.45	4	5.45	9.36	0	9.36
23-07-2018 08:00	6.5	7.18	7.18	0	3.26	3.26	0	1.02	0	1.02
23-07-2018 09:00	2.25	3	3	0	0.79	0.79	0	0	0	0
23-07-2018 10:00	0.5	0.22	0.22	0	0	0	0	0	0	0
23-07-2018 11:00	1	0	0	0	0	0	0	0	0	0
23-07-2018 12:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 13:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 14:00	0	0	0	0	0	0	0	0	0	0
	30.25	19.85	19.85	0	13.5	8.05	5.45	10.38	0	10.38

Clay Loam

Hourly Model Simulation and Field Obs

23rd july event		g. clay loam shallow ponding=10mm			g. clay loam shallow ponding=4mm			g. clay loam shallow ponding=0mm		
Time	Rain	pri+sec runoff	ponding	new_run off	pri+sec runoff	ponding	new_run off	pri+sec runoff	ponding	new_runoff
23-07-2018 05:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 06:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 07:00	20	9.55	9.55	0	9.55	4	5.55	9.46	0	9.46
23-07-2018 08:00	6.5	7.34	7.34	0	3.31	3.31	0	1.04	0	1.04
23-07-2018 09:00	2.25	3.14	3.14	0	0.83	0.83	0	0	0	0
23-07-2018 10:00	0.5	0.27	0.27	0	0	0	0	0	0	0
23-07-2018 11:00	1	0	0	0	0	0	0	0	0	0
23-07-2018 12:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 13:00	0	0	0	0	0	0	0	0	0	0
23-07-2018 14:00	0	0	0	0	0	0	0	0	0	0
	30.25	20.3	20.3	0	13.69	8.14	5.55	10.5	0	10.5

G.Clay Loam