ASSESSING IMPACT OF RIDGE TO VALLEY SCENARIOS ON SOIL AND WATER PROCESSES IN RELATION TO LAND COVER SEASONALITY

By

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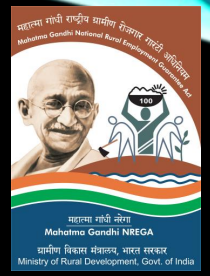
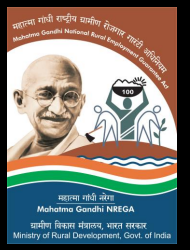
INTRODUCTION



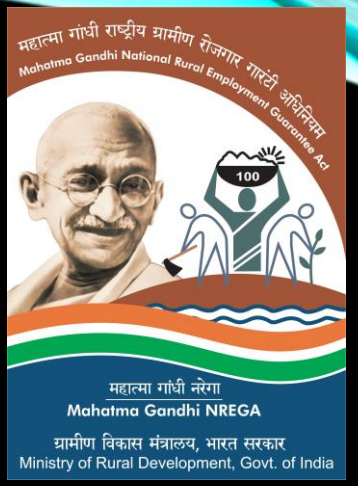
- **Ministry Of Rural Development (MoRD) aims to develop geospatial information oriented Natural Resources Management (NRM) plans under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA).**
- **Water resources management and watershed conservation play a key role in NRM plans.**
- **Involve the construction of check dams, farm ponds, percolation tanks and other related works.**
- **Among 155 NRM activities, IWMP(Integrated Watershed Management Programme) is an ongoing scheme and its main objective is to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water.**

NEED OF THE STUDY



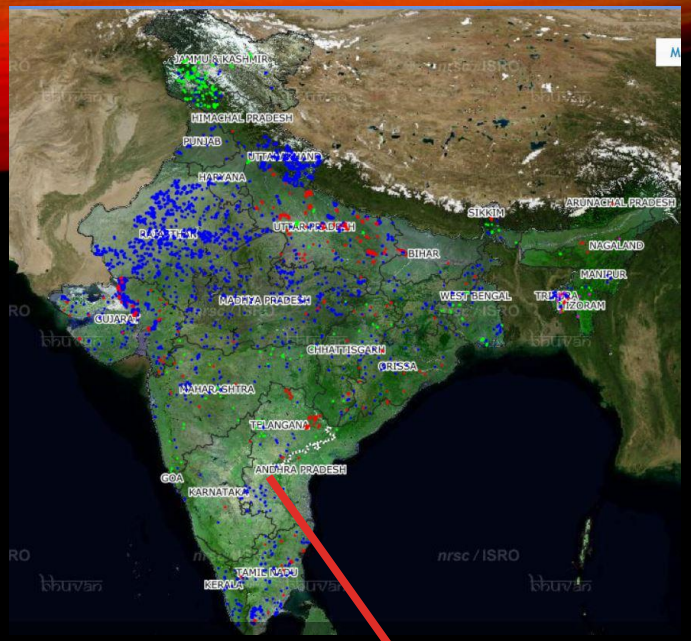
- The conservation activities are carried out but there is a limited understanding about the impact of these activities in the ecosystem of the rural areas.
- Need to know the significance of these structures on the hydrological parameters to understand the actual conservation occurring in terms of water.
- This can be achieved by the hydrological process models.

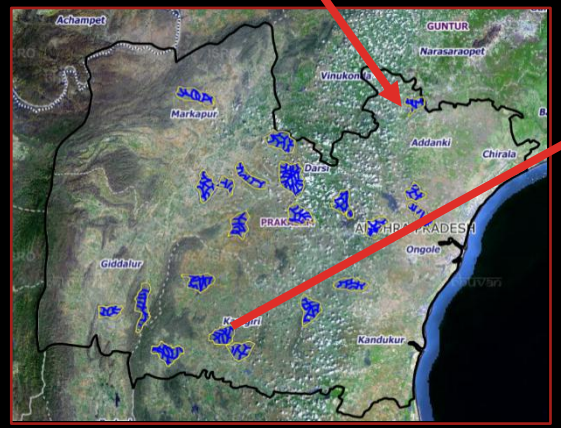
OBJECTIVES



- To plan ridge to valley treatment for water conservation using check dams, percolation ponds, farm ponds as per MWC Standards.
- To map the seasonality of crop cover and to study the seasonal variations in the runoff values using hydrological process modeling.

STUDY AREA





- The study area is Prakasam/IWMP-36/2011-12 in Paleru basin of Prakasam district.
- The total area is 5686.71 ha nearly 2.56% of Paleru basin.
- The major crops grown are Paddy, Redgram, Black gram, Ragi and Bajra.
- The average population is nearly 10,400 and average rainfall is 736 mm.
- The max and min elevation are 265 m and 14 m.
- The major soil types are clayeyloam and clay.

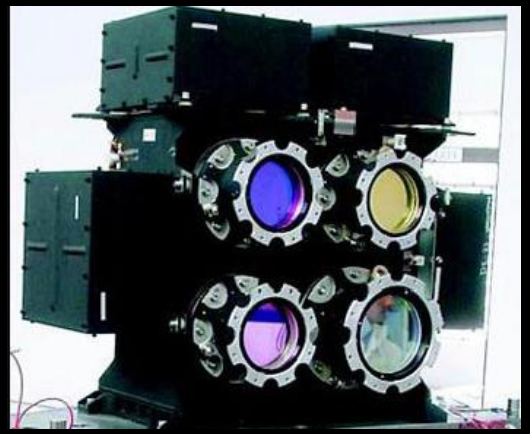
Land Cover change in the Kanigiri area observed near the study site (2014 and 2016).

- Increase in water cover due to conservation activities are clearly seen in the landscape, which is adopted as model inputs in the study site.
- Latest water conservation activities in the nearby village Chilamkur is considered.
- From a technical manual SAMARTHYA, guidelines are taken for these interventions.
- The Geo-MGNREGA Geotagged assets in panchayats of Prakasam/IWMP-36/2011-12 are Cheerladinne 632, Guravajipeta 491, Vangapadu 362, Jammalamadaga 108, Vangapadu 362.

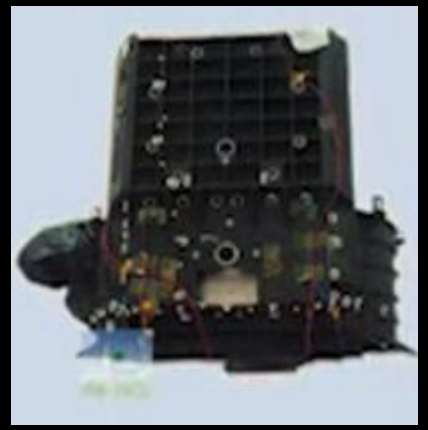
INPUT DATA

- **Satellite Data involves the** CartoDEM , LISS IV data of the study area in the year 2013-2014, Land use and Land cover 1:250 K database using AWiFS, Soil Map is taken from SWAT Indian Datasets.
- **Meteorological data** is taken from the NRSC Regular Datasets, Daily Rainfall data taken and Daily minimum and maximum temperature data for each crop season from 2013 to 2014.
- The input data is taken for IWMP-36/2011-12 a Sub basin of total Paleru Basin.
- The meteorological is provided by CDAS (Climate Data Analysis System) by NRSC, ISRO.

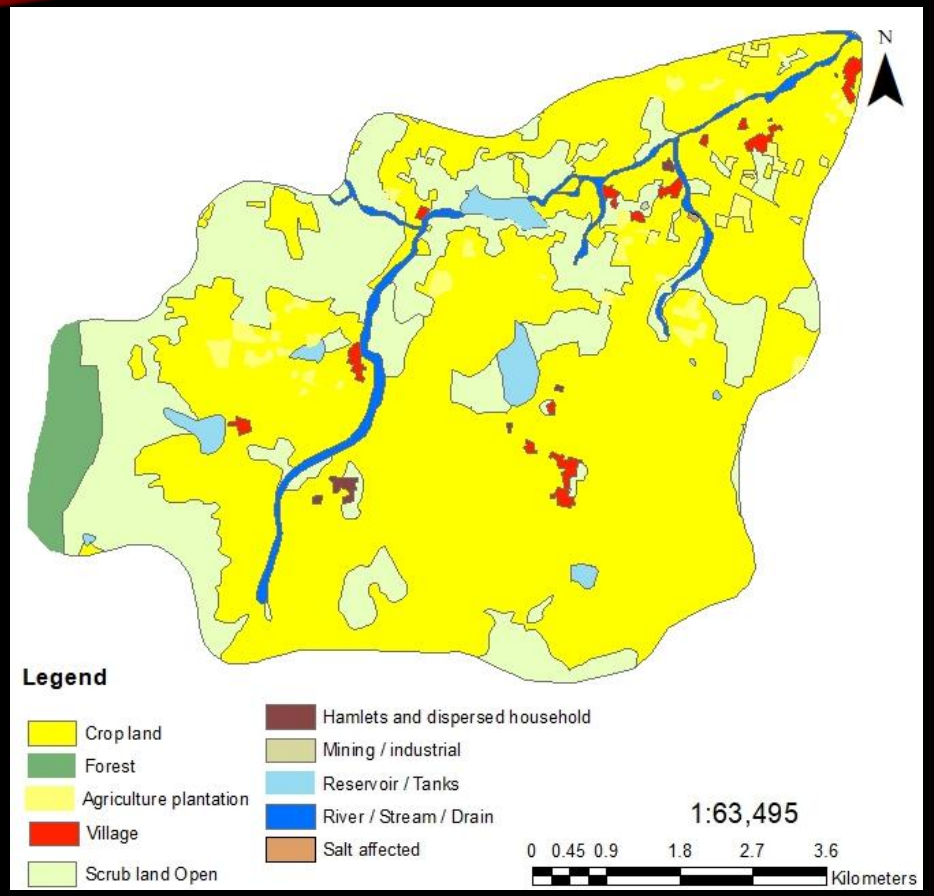
AWIFS



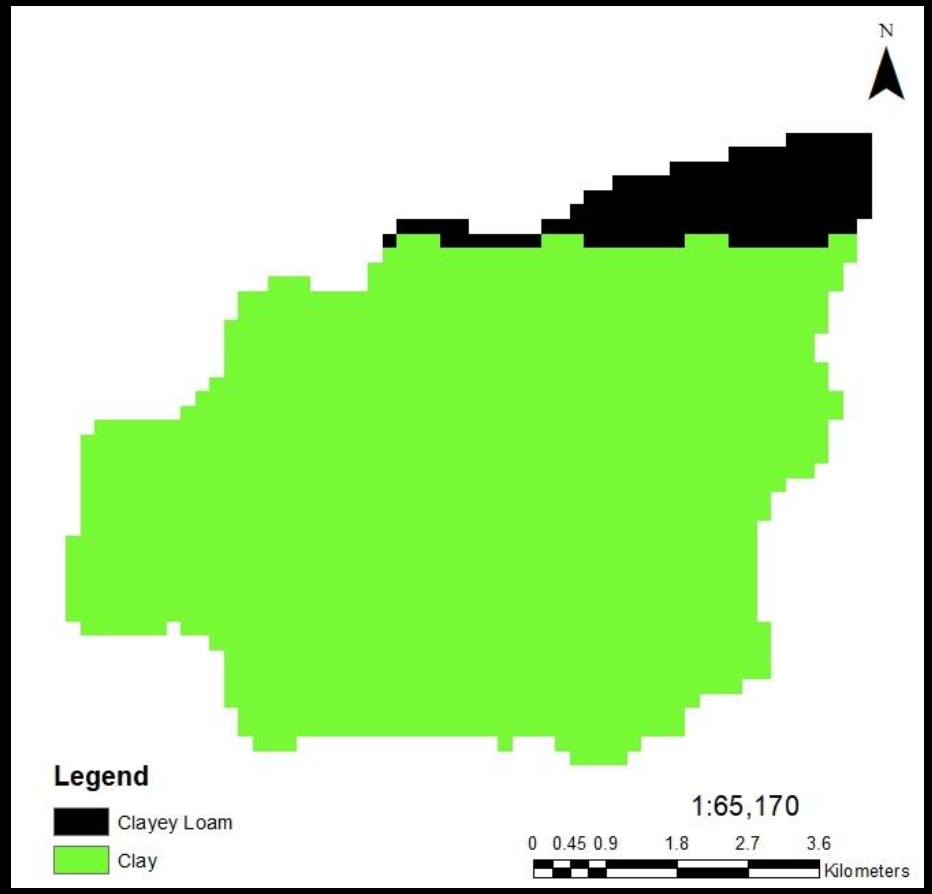
LISS IV



Carto 1 PAN

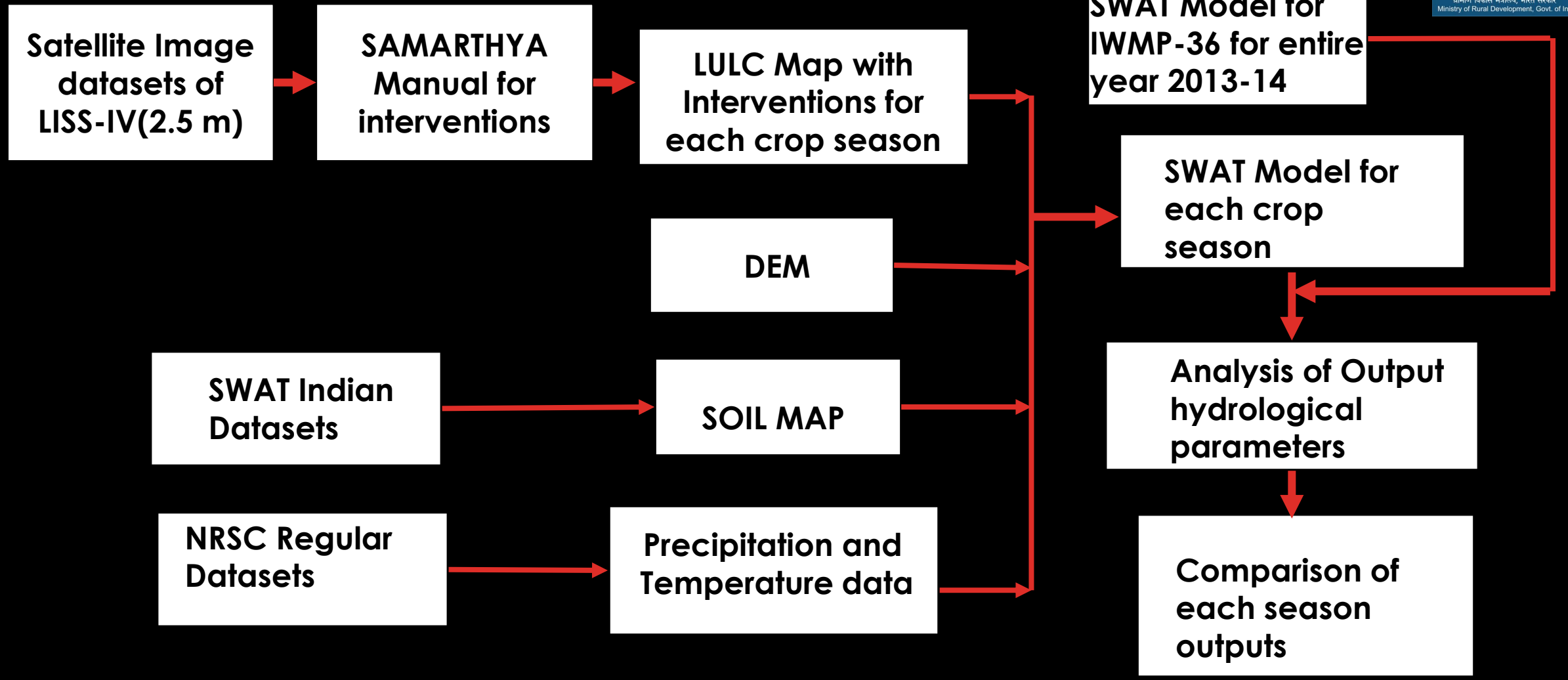


Land Use and Land Cover Map of IWMP-36 for year 2013-14 , Prakasam district taken from NRSC Regular Datasets

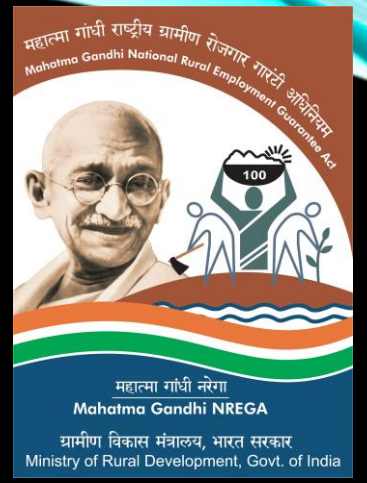


Soil map of study area Prakasam-IWMP-36/2011-12 (source: swat indian datasets)

METHODOLOGY



PLANNING OF INTERVENTIONS



- Water Budgeting of the study area is calculated.
- Water availability and requirements statistics are takem from SAMARTHYA, a technical Manual by MoRD.

Water Availability

Avg annual rainfall= 5680*0.736=4180.48

- Ground water(9%) = 376.24
- Runoff(40%) = 1672.2
- Soil Moisture(10%) = 418.05
- EvapoTranspiration(41%) = 1713.997
- Volume of water bodies = 319.575

Total Water Available for study area = 1113.87 Ha m.

Water Requirements

- Crops grown = 1126.64
- Population (3 Ha m per 1000) = 31.2
- Livestock, Poultry and others = 1.976

Total water Requirements = 1160

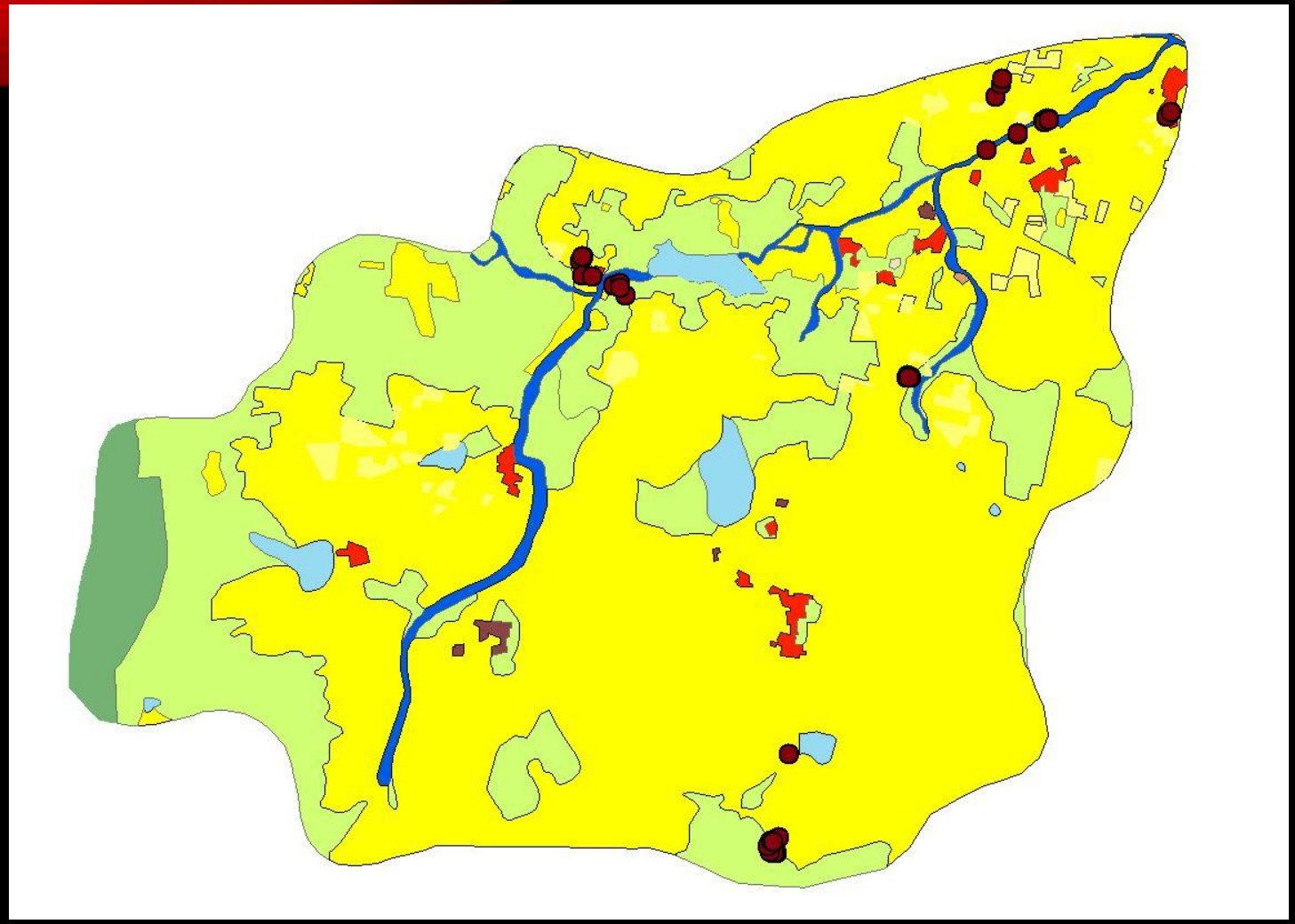
Deficit = 1160-1113.87 = 46.13 Ha m

- To balance the deficit certain conservation structures are planned to save the water.
- A farm ponds, Check dams, Percolation Tanks, Earthen Bunds etc total 155 categories of structures are planned to be constructed by MoRD under MGNREGA.
- A 62 Geotags of planned interventions are found in the study area.

Type of Structure	Dimensions (metres)	Volume(cubic metres)	Kharif crop season	Rabi crop season	Zaid crop season
Farm Ponds	12.8*6.3	300	269	334	500
Check dams	15*15	1500	44	47	70
Percolation Tanks	23*23	3000	15	24	60

Table showing the Interventions that are proposed to be planned in respective seasons for study area.

Land use land cover overlain with IWMP proejct related conservation Interventions



IWMP activities that are implemented for study area

- The brown color cricles shows the geotags of places where interventions are carried out.
- These involve

  Dug out pits – 13

  Farm Ponds - 6

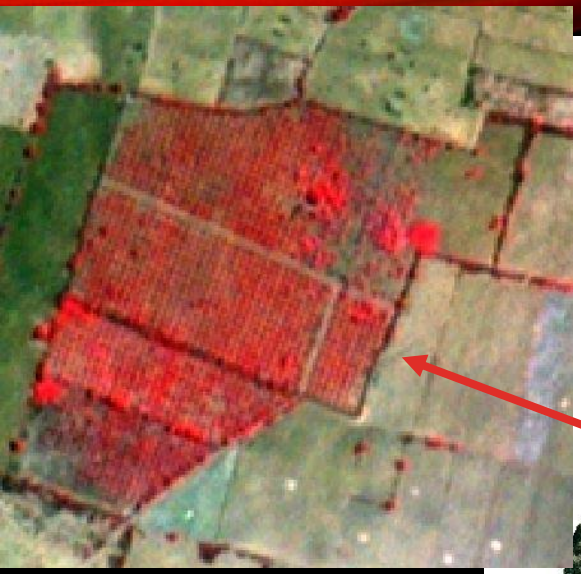
  Horticulture – 9

  Percolation Tank – 1

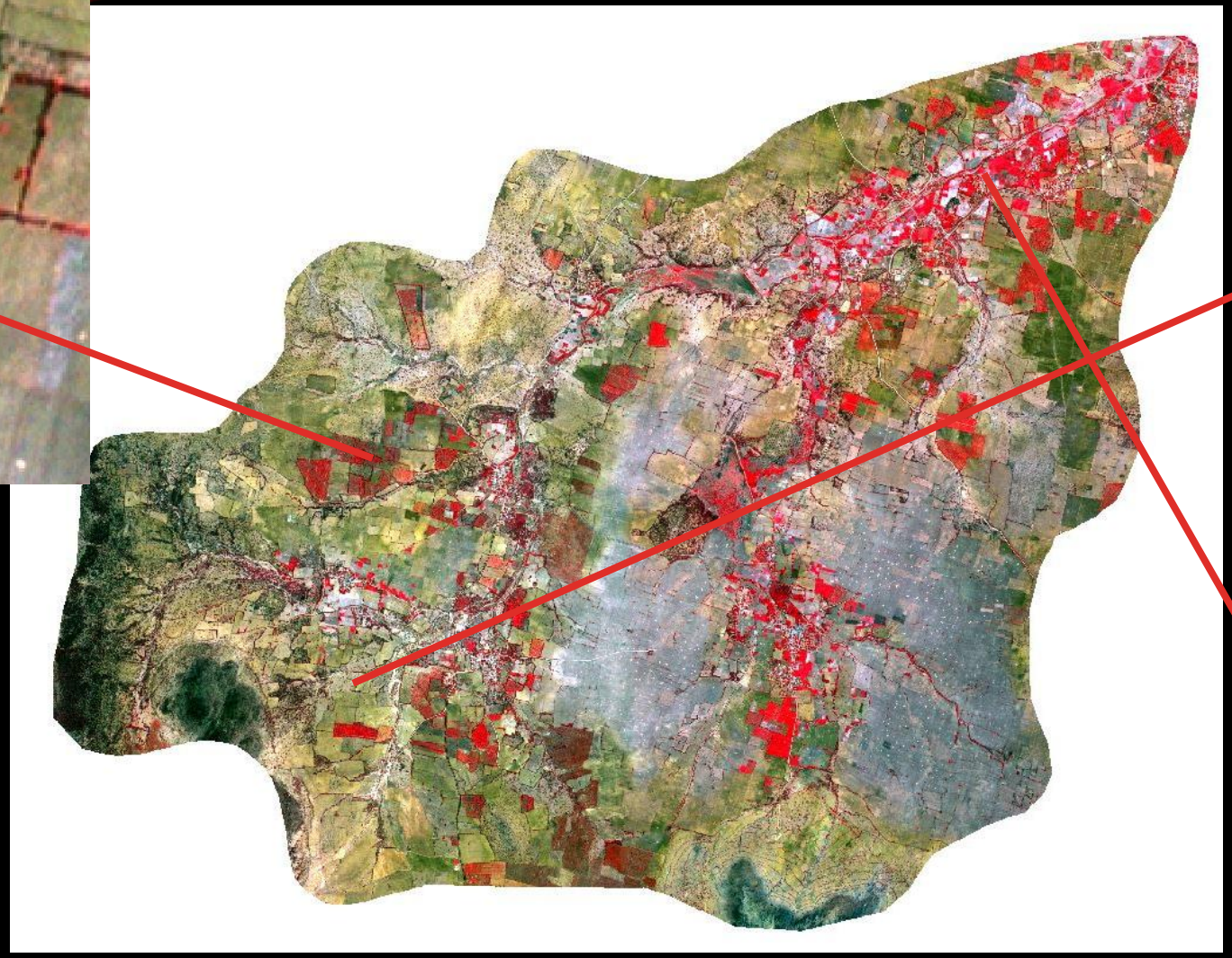
  Vermi Compost – 10

  Others - 23

Land use land cover overlain with IWMP project related conservation Interventions



Horticultural Plantations

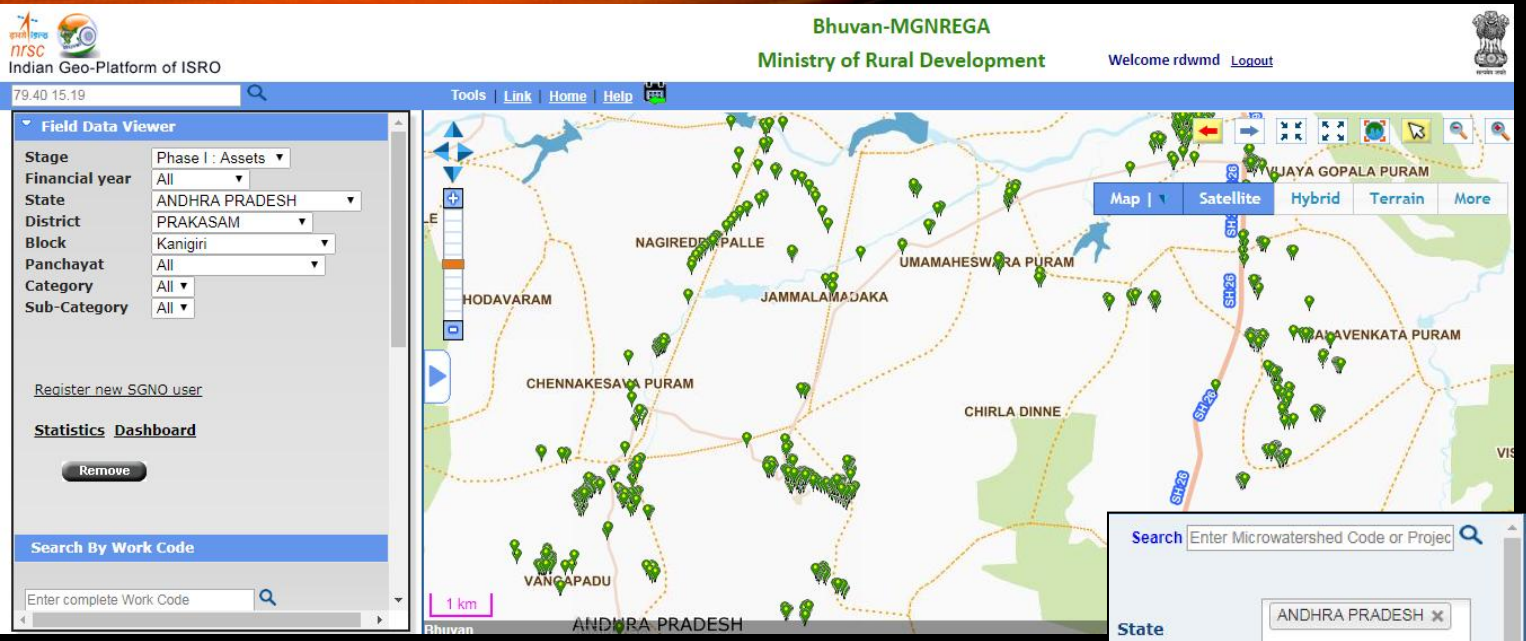


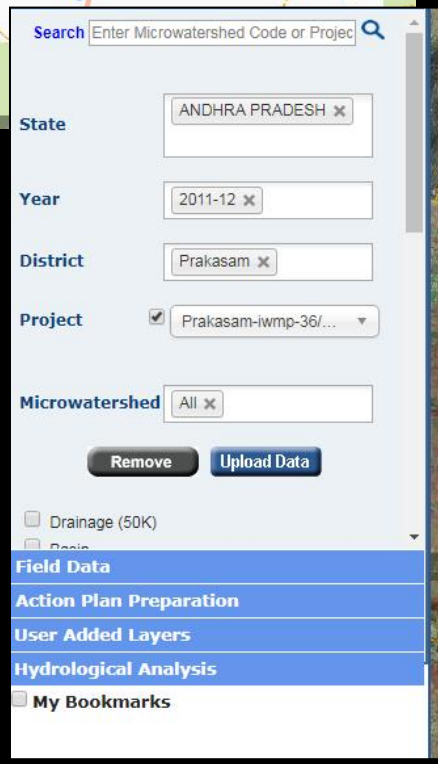
LISS IV Image of the study area

Farm Ponds

Agricultural Lands

The Bhuvan Web Portal where these interventions are placed as geotags

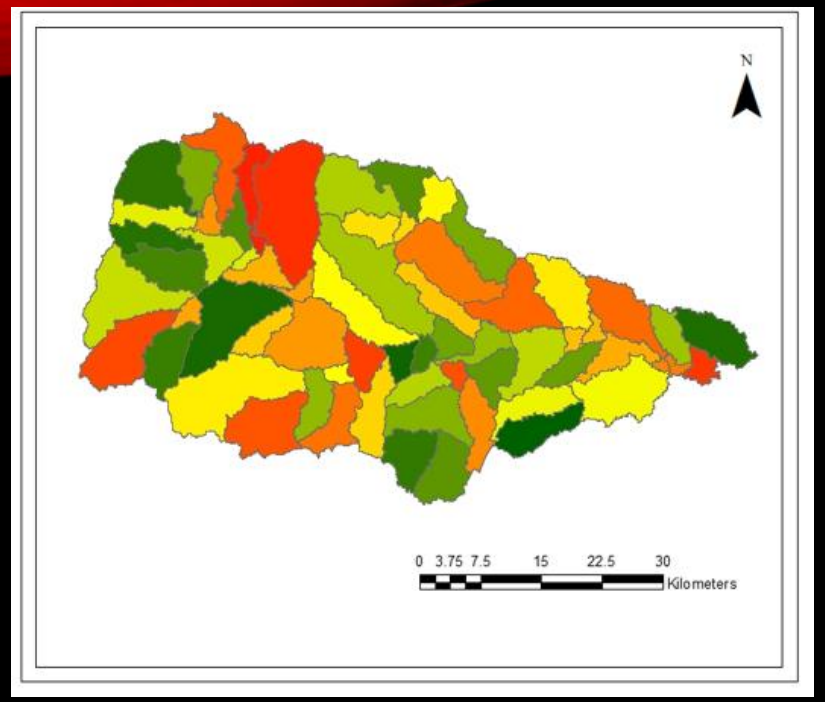




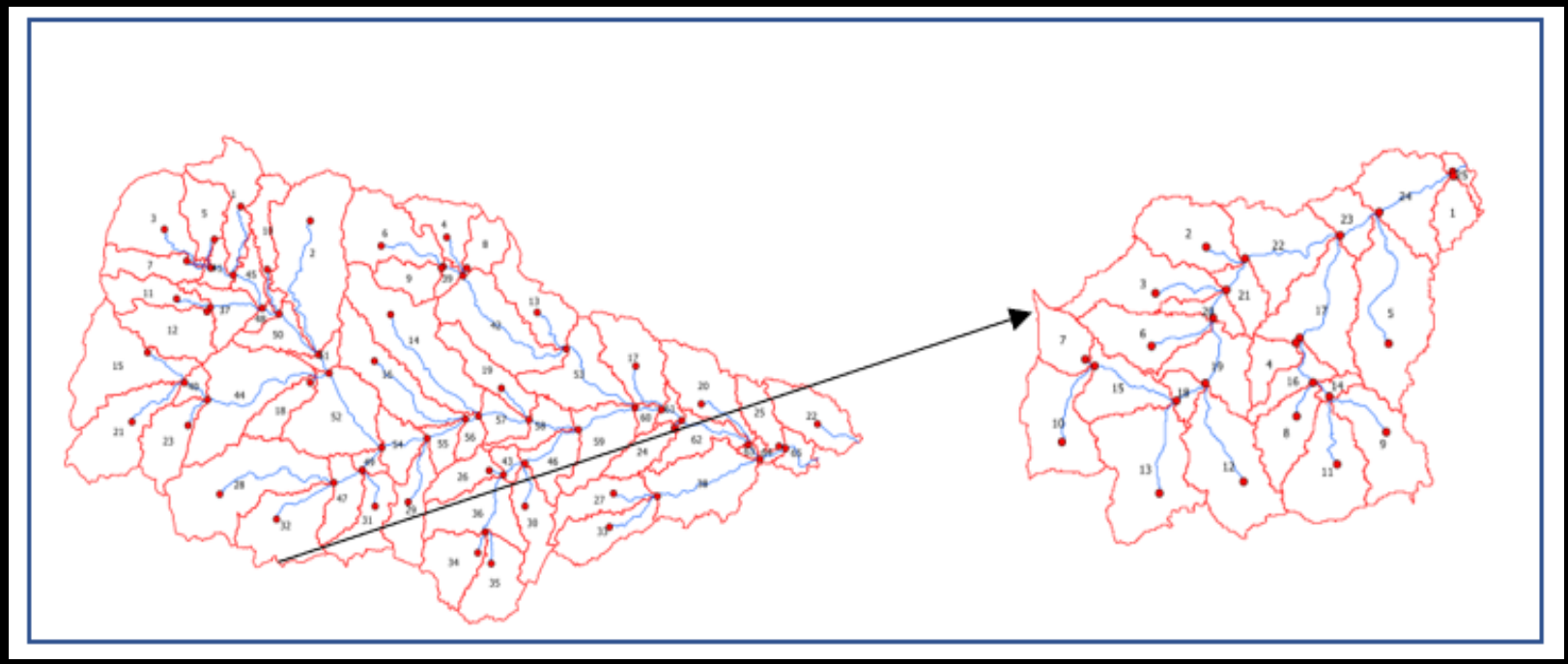
MGNREGA and IWMP Web GIS showing the study site

A sample geotag content shown for farm pond constructed

SWAT MODEL FOR PALERU BASIN



SWAT process model output of sub basins of Prakasam-Paleru Basin



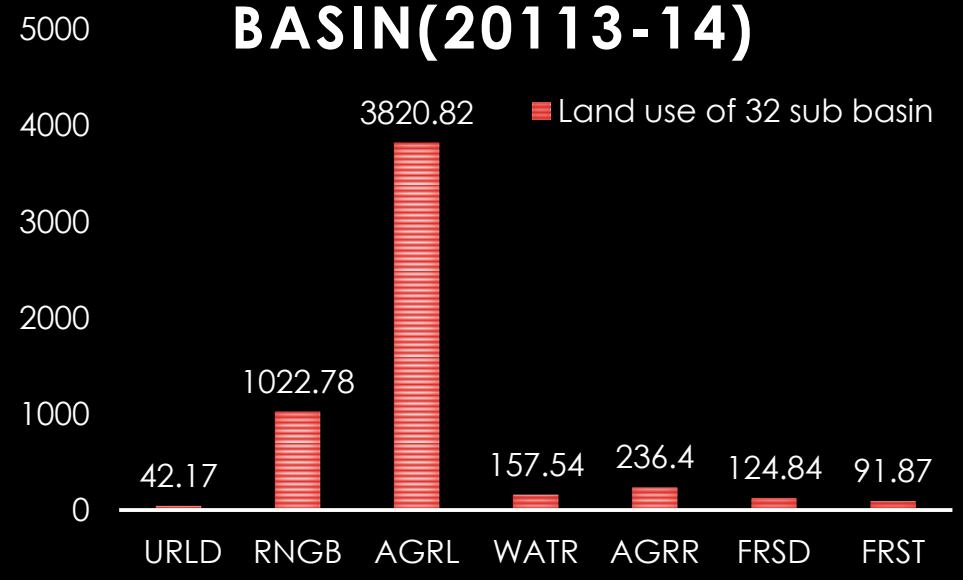
Prakasam-IWMP-36/2011-12 as a subbasin of Paleru watershed

- A total of of 65 sub basins created with a total HRU count of 601.
- The total area of the basin is nearly 2300 sq kms and discharge values of Bitrigunta Anicut are considered for calibration.
- The sub basin 32 of the watershed is our study area IWMP-36
- This occupies nearly 2.56% of the entire watershed with an area of 5686.71 ha and of 10 HRU's numbering from 302 to 312.

	Area [ha]		%Watershed		%Subbasin	
Subbasin 32	5686.71		2.56			
Landuse						
URLD	42.17	(42.17)	0.02	(0.02)	0.74	(0.74)
RNGB	1022.78	(1022.69)	0.46	(0.46)	17.99	(17.98)
AGRL	3820.82	(3820.49)	1.72	(1.72)	67.19	(67.18)
WATR	157.54	(157.52)	0.07	(0.07)	2.77	(2.77)
AGRR	236.40	(236.84)	0.11	(0.11)	4.16	(4.16)
FRSD	124.84	(124.83)	0.06	(0.06)	2.20	(2.20)
FRST	91.87	(91.86)	0.04	(0.04)	1.62	(1.62)
Soil						
Vc43-3ab-3861	5037.26	(5036.84)	2.27	(2.27)	88.58	(88.57)
Lc76-2b-3782	459.14	(459.57)	0.21	(0.21)	8.07	(8.08)
Slope						
0-9999	5496.41	(5496.41)	2.48	(2.48)	96.65	(96.65)
HRUs:						
302 URLD/Vc43-3ab-3861/0-9999	28.42		0.01		0.50	
303 URLD/Lc76-2b-3782/0-9999	13.75		0.01		0.24	
304 RNGB/Vc43-3ab-3861/0-9999	1011.08		0.46		17.78	
305 RNGB/Lc76-2b-3782/0-9999	11.70		0.01		0.21	
306 AGRL/Vc43-3ab-3861/0-9999	3416.48		1.54		60.08	
307 AGRL/Lc76-2b-3782/0-9999	404.34		0.18		7.11	
308 WATR/Vc43-3ab-3861/0-9999	128.18		0.06		2.25	
309 WATR/Lc76-2b-3782/0-9999	29.35		0.01		0.52	
310 AGRR/Vc43-3ab-3861/0-9999	236.40		0.11		4.16	
311 FRSD/Vc43-3ab-3861/0-9999	124.84		0.06		2.20	
312 FRST/Vc43-3ab-3861/0-9999	91.87		0.04		1.62	

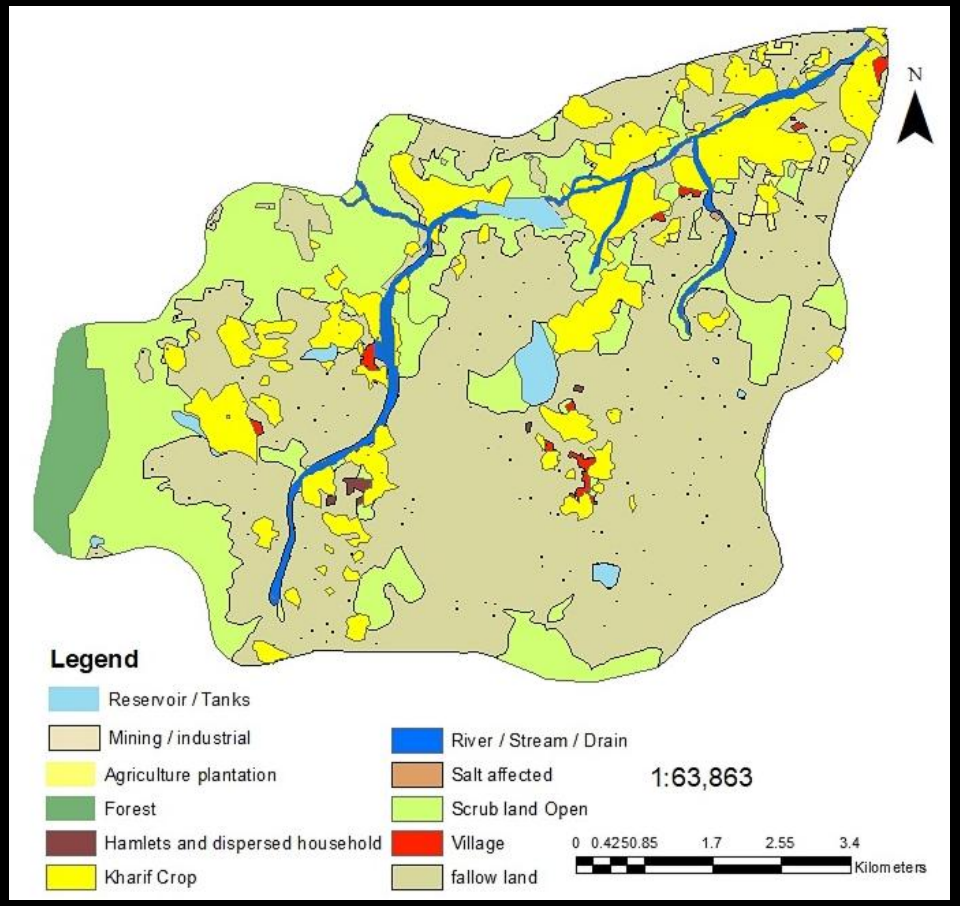
The characteristics of Sub basin 32 of Paleru basin, Prakasam district

LAND USE OF 32 SUB BASIN(20113-14)



Land use classes and area occupied by each class

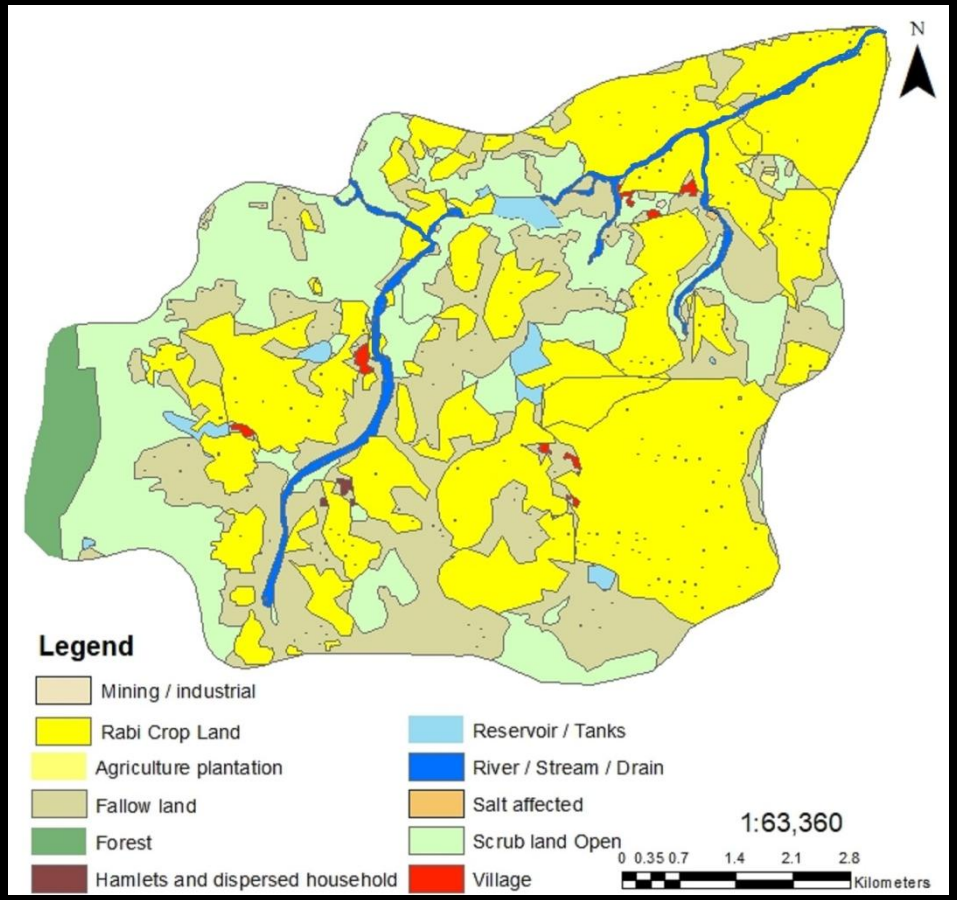
LULC MAP AND SWAT MODEL RESULTS FOR KHARIF CROP SEASON



The LULC Map for Kharif season of 2013-14

- A total of 131 HRU's created for 25 sub basins.
- The total area of Kharif crop is nearly 884.74 ha which is 15.32% of total watershed.
- An area of 86.48 ha which is 1.5% of total watershed which is under agriculture Plantations for kharif season.
- An area of 1132.26 ha is not under agricultural which is fallow land which is 19.61% of entire watershed.

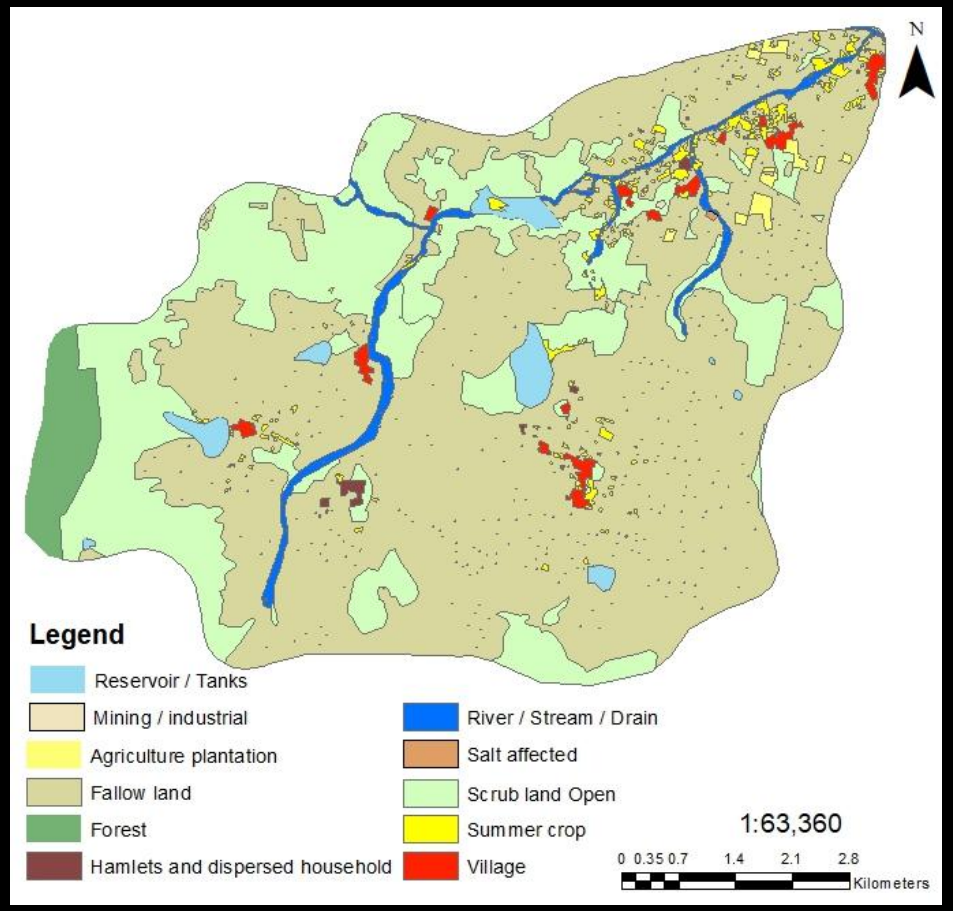
LULC MAP AND SWAT MODEL RESULTS FOR RABI CROP SEASON



The LULC Map for Rabi Season of 2013-14

- A total of 120 HRU's created for 25 sub basins.
- The total area of Rabi crop is nearly 2423.5 ha which is 41.98% of total watershed.
- An area of 72.17 ha which is 1.25% of total watershed which is not under agriculture for Rabi season.
- An area of 0.65 ha is under agricultural plantations which is 0.01% of entire watershed.
- The study area is Rabi dominated cropping pattern.

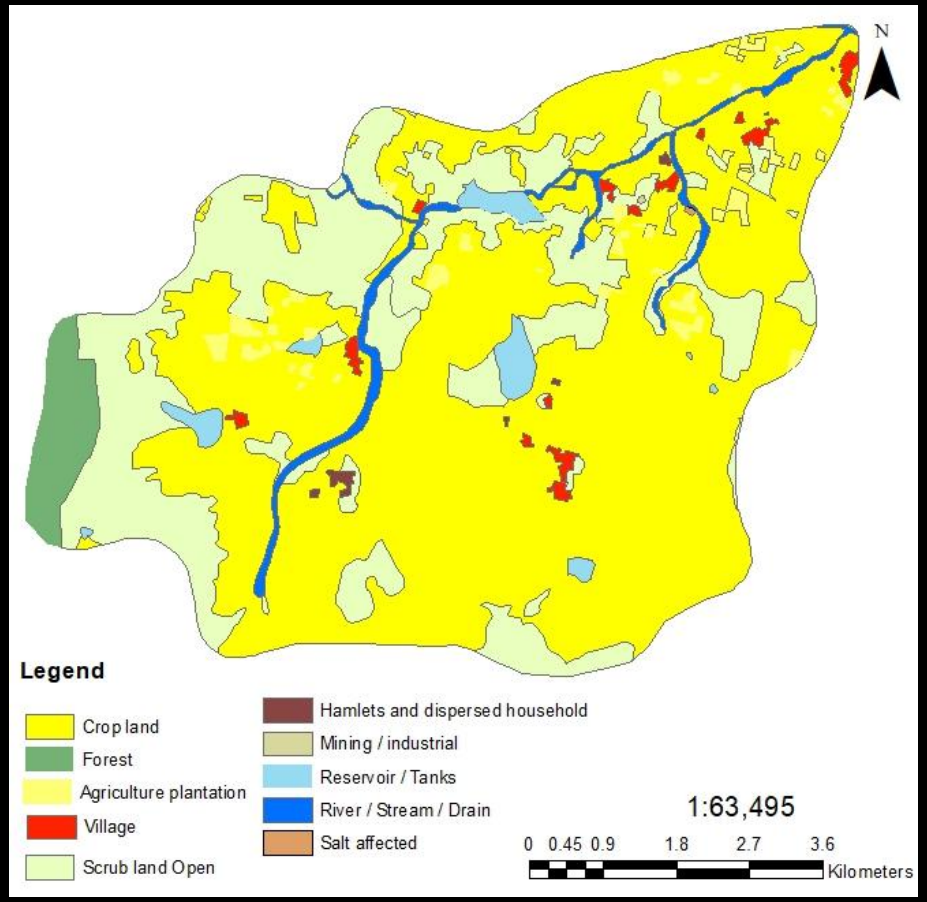
LULC MAP AND SWAT MODEL RESULTS FOR ZAID CROP SEASON



The LULC Map for Zaid Season of 2013-14

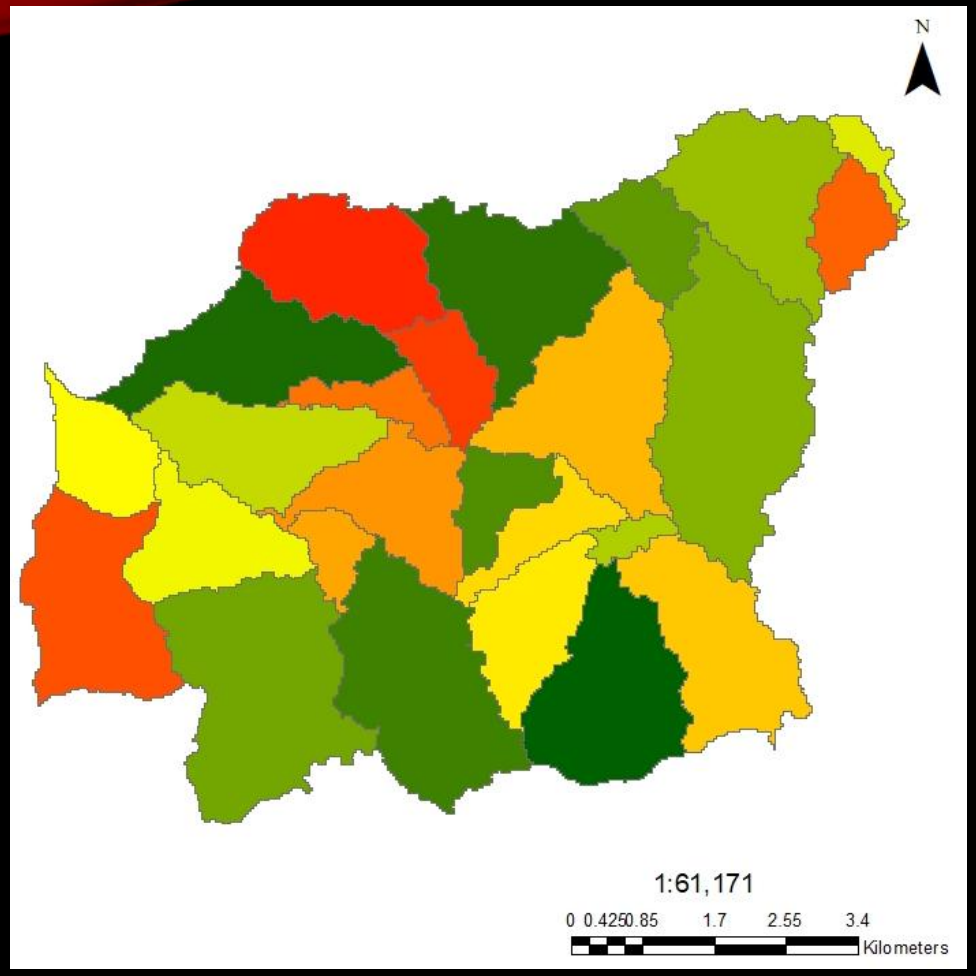
- A total of 145 HRU's created for 25 sub basins.
- The total area of summer crop is nearly 229.6 ha which is 3.9% of total watershed.
- An area of 0.65 ha is under agricultural plantations which is 0.01% of entire watershed.
- It is observed that 1279.39 ha of agricultural land is observed as Fallow land which is 22.14% of watershed in 2014.

LULC MAP AND SWAT MODEL FOR IWMP-36 FOR 2013-14



The LULC Map for entire year of 2013-14

- A total of 133 HRU's created for 25 sub basin.
- An area of 256 ha which is 2.71% of total watershed which is under agriculture Plantations.
- An area of 1263 ha is Scrub Lands which is 21.8% of entire watershed.
- It is observed that 3185 ha of agricultural land is observed as crop land which is 53.4% of watershed in 2014.



The sub basins map of a typical crop season with 25 sub basins

- This is the sub basins map for IWMP-36 study area which is run by changing Land cover Seasonality.
- The Soil layer is kept constant for entire work.
- The complete work is a scenario based model development and analysis.
- The planned interventions are verified by field work and are proposed to be constructed.

COMPARISION OF OUTPUTS OBTAINED

Hydrological Outputs (mm)	Kharif Season	Rabi Season	Zaid Season	Entire Year 2013-14	Average Parm for season wise run	Change by Times
Evaporation and Transpiration	1070.70	687.50	1128.20	338.80	962.13	-1.84
PET	1983.80	1797.00	2034.60	1637.60	1938.47	-0.18
Surface Runoff	109.24	225.69	141.87	349.89	158.93	0.55
Lateral Flow	0.78	0.61	0.45	1.09	0.61	0.44
Return Flow	18.13	27.24	5.54	34.58	16.97	0.51
Revap from shallow aquifer	32.93	20.35	7.33	23.50	20.20	0.14
Percolation to shallow aquifer	14.03	45.57	9.59	51.66	23.06	0.55
Recharge to deep aquifer	1.65	2.28	0.48	2.58	1.47	0.43

Runoff has halved as model output when seasonal patterns are used for modeling

Last column indicates times by which value has decreased in season wise run as against Entire year run

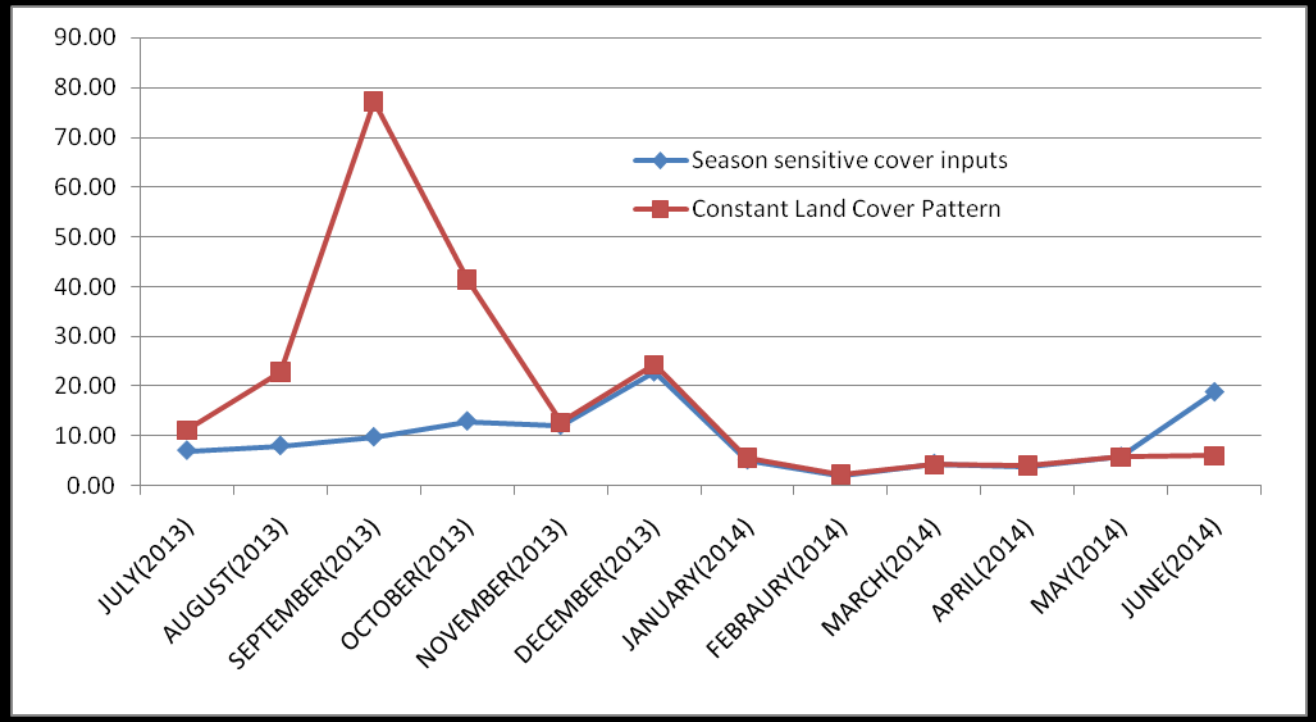
Percolation to shallow aquifer has decreased as an average (51.66 & 23.06), but in Rabi it has increased distinctly

Flow Out trends with respect to seasonality of land cover patterns

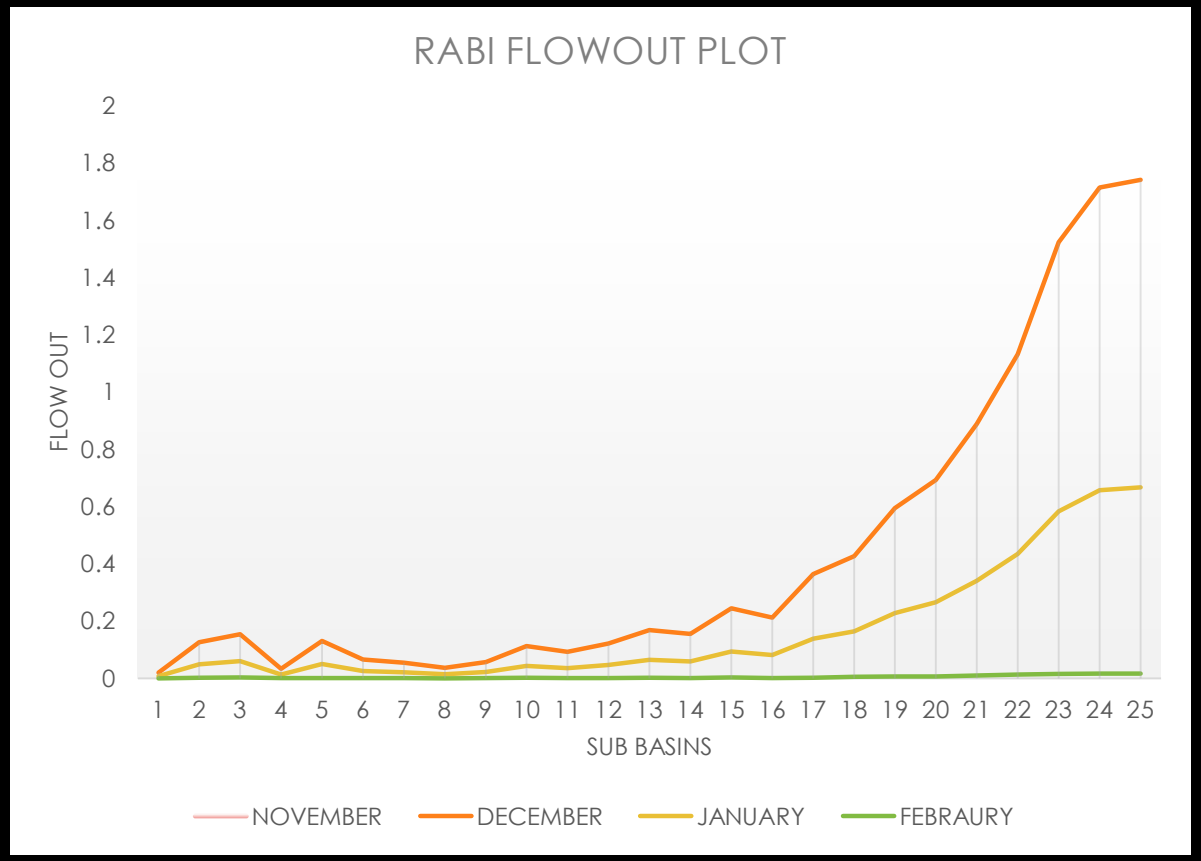
Reduction in Kharif extent clearly have influenced the flow out values and hence seasonal cover pattern is key for improving model application

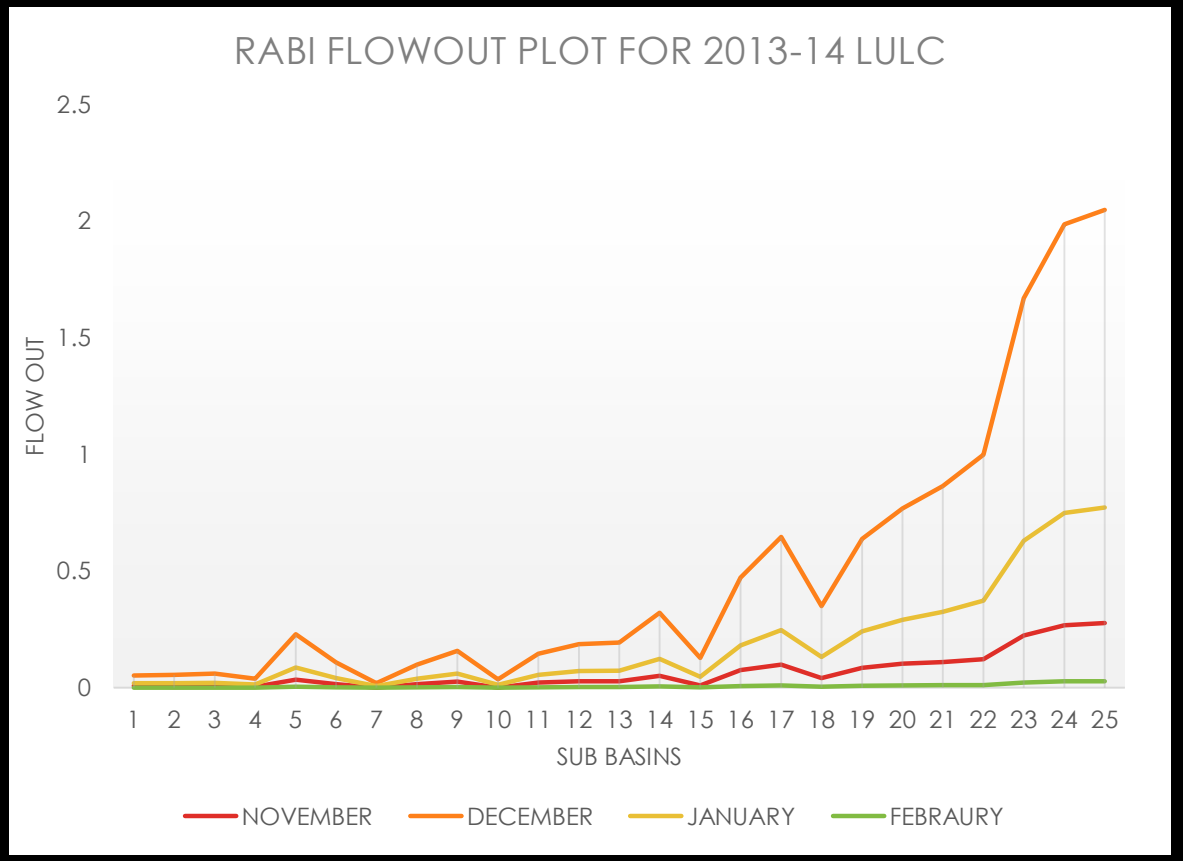
Table showing the Total Flow out values for each month of every crop season in the year 2013-14

MONTH	Season sensitive cover inputs	Constant Land Cover Pattern
JULY(2013)	7.09	11.13
AUGUST(2013)	8.05	22.81
SEPTEMBER(2013)	9.78	77.17
OCTOBER(2013)	12.99	41.32
NOVEMBER(2013)	12.12	12.66
DECEMBER(2013)	22.86	24.27
JANUARY(2014)	5.16	5.64
FEBRAURY(2014)	2.11	2.17
MARCH(2014)	4.42	4.15
APRIL(2014)	4.00	4.00
MAY(2014)	5.83	5.68
JUNE(2014)	18.83	6.00



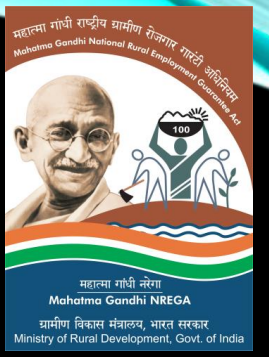
- The Mean Flow out values for kharif season are 0.3645 with standard deviation of 1.652
- The Mean Flow out values for Rabi season are 0.406 with standard deviation of 1.467
- The Mean Flow out values for Rabi season are 0.318 with standard deviation of 0.946





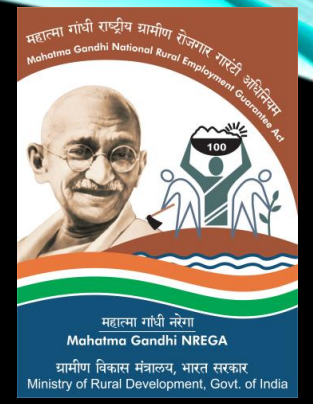
FLOW OUT PLOTS FOR RABI SEASON LULC AND FOR 2013-14 LULC MAP

MAJOR OBESRVATIONS



- Evaporation and Transpiration is less for Rabi season and the Kharif season which is the influence of crop cover.
- PET is more for summer crop and then Kharif crop season with values 2034.6 mm and 1983.8.
- The Surface Runoff is more for Rabi season with $1284*10^7$ litres of water where as in the entire year $1989.73*10^7$ litres of water is produced as runoff.
- The variations in the Crop land and fallow land has considerable significance in the Runoff values.

CONCLUSIONS



- This study revealed the **impact of interventions in LULC layer on hydrological outputs.**
- **A seasonal study is made which draws a clear approach of influence of interventions on crop seasons.**
- The ridge to valley interventions are therotically tested by running a process model to **analyse the runoff values.**
- The **real time assessment** of the influence of water conservation works on the hydrology of the study area is carried out by using process models.
- This plays a crucial role in rural development as a **clear approach of development is obtained in terms of hydrology.**
- The current study helps to support and plan the rural development since we can measure, monitor, model and demonstrate as well as develop policy suggestions.

FUTURE SCOPE

- Develop the Models without interventions for each season.
- To compare the each model with interventions and without interventions.
- This enables a clear understanding of the impact of ridge to valley scenarios on the Hydrological outputs.

REFERENCES

- A K Gosain, S Rao and D Basuray, 2006. “Climate change impact assessment on hydrology of Indian river basins”, *CURRENT SCIENCE*, VOL. 90, NO. 3
- C N Tripathi and A K Gosain, 2013. “Micro Watershed Modeling in India Using GIS Technologies and Agricultural Policy Environmental Extender (APEX) Model. A Case Study”, *International Journal of Engineering Research and Application*,Vol. 3, Issue 2, pp.1640-1648
- C Sombat, M K Goel, and C K Singh, 2016. Application of Inflow Model for Weir Irrigation System without Upstream Dam, World Journal of Engineering and Technology, 4, 1-6.
- http://www.sciencedirect.com/science/article/pii/S1642359315000749.
- K E Schilling, M K Jha, Y K Zhang, P W Gassman, Laura, M Normana and R Niraula, 2016. “Model Analysis of check dam impacts on long-term sediment and water budgets in Southeast Arizona, USA”, *Journal of Ecohydrology and Hybridology-94*,
- M E Mohammad , N A Ansari and S Knutsson, 2012,”. Application of SWAT Model to Estimate the Runoff and Sediment Load from the Right Bank Valleys of Mosul Dam Reservoir”, *ICSE6* , Paris - August 27-31, 2012.
- M P Tripathi , R K Panda, S Prardhan , S Sudhakar, 2002,” Runoff Modelling of a Small Watershed Using Satellite Data and GIS” Journal of the Indian Society of Remote Sensing, Vol. 30, No. 1&2, 2002.
- M Sánchez, A Lopez, V Acuna, and G Ziv, 2015. “Sensitivity analysis of a sediment dynamics model applied in a Mediterranean river basin: Global change and management implications”, Science of the Total Environment 502, 602–610.
- N M Vinayak, J Umesh ,2013,” Watershed Planning and Development Plan by Using Rs and GIS of Khultabad Taluka of Aurangabad District, International Journal of Information and Computation Technology,ISSN 0974-2239 Volume 3, Number 10 (2013), pp. 1093-1100.
- P Shirisha, K Venkata Reddy, Deva Pratap, 2015,” EXPERIMENTAL WATERSHED FOR REAL TIME FLOW SIMULATION*”, IJRET: International Journal of Research in Engineering and Technology*,Volume 04, Special Issue 11 , 2319-1163
- R S Dwivedi, K V Ramana, S P Wani, and P Pathak, Use of Satellite Data for Watershed Management and Impact Assessment, National Remote Sensing Agency (NRSA), Department of Space, Balanagar, Hyderabad, India.
- R Srinivasan, A theory on Check Dam, Colorado Department of Transportation, Unpublished SWAT Calibration Instructions for Best Management Practices.
- SAMARTHYA, Technical Training Manual, 2015, A Module on MNNREGA

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