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Hyper Temporal Image Analysis for Crop Mapping and Modelling using High-Resolution Hydrological Model Parameter Dataset

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Abstract

This study contributes to addressing some important issue, focusing on-i) Mapping cropland areas using agricultural mask from LULC map and LAI (1km resolution) 8 day composite image data layer by ISODATA clustering technique. ii) Preparing model input parameters for different vegetation types and LAI profile of those classes to investigate its effect on the simulation of evapotranspiration and stream flow using Variable Infiltration Capacity hydrology model for Mahanadi river basin. iii) Estimate the irrigation consumption using experimental satellite-based evapotranspiration estimation system integrated with VIC hydrology model, so that for agricultural water resource management we investigate the potential of satellite data. VIC hydrology model with an integrated irrigation model successfully applied for Mahanadi river basin to estimate evapotranspiration under irrigated, non-irrigated scenario and stream flow. Model results shows ET is more for Rice-02 and low for Rice-01 because of their vegetation cover percentage for Mahanadi river Basin. ET based on VIC irrigation model agree closely with satellite-based estimates as well as the model gives a better output in irrigated condition rather that non-irrigated condition. Irrigation water demand more for July to September in case of Mahanadi river basin and estimated stream flow indicates a good match with observed stream flow.

Introduction

For monitoring and planning of agriculture resources at local, regional and continental levels agricultural land use mapping is required. For estimating and mapping cropland area remote sensing has become a valuable tool.LAI is functionally linked to the canopy spectral reflectance. Many investigations and studies in recent years have prompted by its retrieval from remote sensing data.Changes in cropping systems, cropping intensity, cropping patterns and cropping calendars by season using vegetation indices such as LAI data MODIS satellite images are suitable.For monitoring the spatial and temporal variability of LAI remote sensing provides a potential solution.Hydrological processes in many way influenced by vegetation cover or land cover. There is a linkage between LULC and hydrology at spatial and temporal scales. LULC changes alter energy fluxes that affect the climate. These changes effects availability of water spatially and temporal scales (Aggarwal et al., 2013).In present study vegetation parameter file as a input to VIC hydrology model was prepared using NRSC, ISRO LULC data of 56 m resolution for whole India for 0.25 degree resolution and the vegetation parameter, vegetation library file was modified to implement an irrigation scheme for VIC hydrology model as done by Lettenmaier D.P et al. (2009). Variable Infiltration capacity hydrology model was run in water balance mode using climate dataset like maximum temperature, minimum temperature, rainfall (1951-2011) and land cover dataset such as vegetation as well as soil data at a daily time step for the Mahanadi river basin to simulate the daily run-off potential and ET for each grid cell and estimating the Irrigation water demand. The main objective of this paper to investigate effect of vegetation and climatic factors on evapotranspiration under irrigation and non-irrigation scenarios,validation of long term model derived discharge with field data and calculate Irrigation water demand.

Study Area

In the present study as a study area we consider Mahanadi River Basin. The Mahanadi Basin is located within geographical co-ordinates of 80°30´to 86°50´East longitudes and 19°20´ to 23°35´North latitudes as shown in Fig.1.The total catchment area of the basin is 1,41,600 km^2. The average elevation of the drainage basin is 426 m with a maximum of 877 m and a minimum of 193 m. (Dadhwal *et al*., 2010).

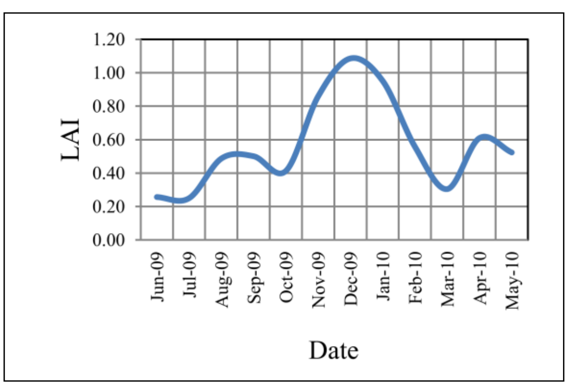
Figure 1 Mahanadi River Basin

It is bounded on the north by the Central India hills, on the South, East by the Eastern Ghats and on the West by the Maikala range. The Mahanadi is one of the major east flowing peninsular rivers draining into Bay of Bengal. The total length of the river from origin to its outfall into Bay of Bengal is 851 km of which 357 km lies in

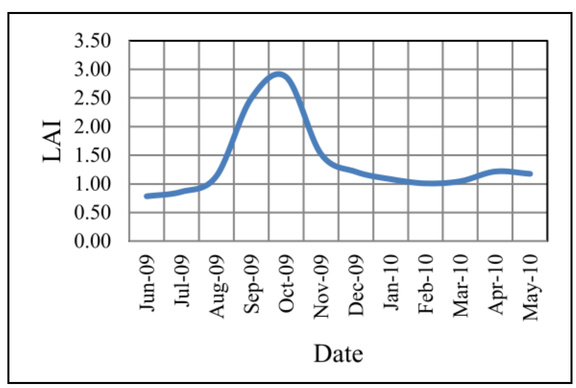
Chhattisgarh and 494 km in Orissa. The climatic setting is tropical with hot and humid monsoonal climate. Mahanadi is mainly rain-fed and the water availability undergoes large seasonal fluctuations. The Basin is vulnerable to flood and has been affected by catastrophic flood disasters almost annually. (Asokan *et al*., 2008).

Materials and Methods

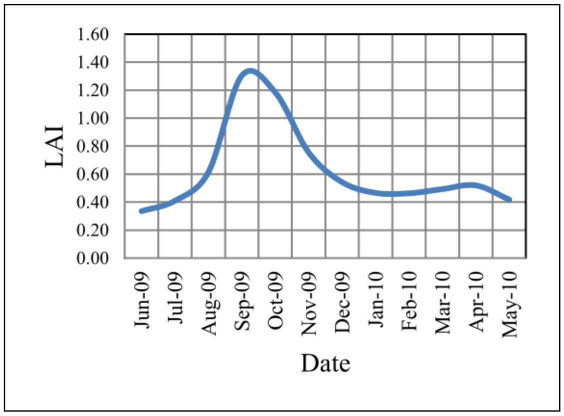
Using the agricultural mask from LULC map a ten spectral classes were generated from ISODATA clustering algorithm by ERDAS IMAGINE software, LULC map (56m) from NRSC and LAI (1km resolution) 8 day composite image data layer (MCD15A2.MRTWEB.A2007129.005).The stacked LAI time series was categorized into multiple classes representing spatially and temporally varying LAI profiles.ISODATA is an unsupervised classification technique, which calculates class means evenly distributed in the data space and iteratively clusters pixels using the minimum distance rule (Tou and Gonzalez, 1974).Digital LULC map had sixteen spectral classes (build up, kharif only, rabi only, zaid only, double/triple, current fallow, plantation/orchard, evergreen forest, deciduous forest, scrub/deg. forest, littoral swamp, grassland, other wasteland, gullied, scrubland, and water bodies). From four crop classes like kharif only, rabi only, zaid only and double/triple tenspectral classes like rice-wheat,maize,jowar,coconut,rice-01,rice-02,rice-03,rice-rice,soyabean and ragi were generated.Spectral signatures were created using training sites selected based on information from LAI and LULC thematic map. The profiles generated is representation of all the classes.Fig.2 depicts samples of spectral signature of each spectral class. For vegetation types evergreen broadleaf and deciduous broadleaf we find highest LAI values and for scrubland the LAI values are lowest.There is considerable variation in behaviour between profiles. When comparing the general shapes of the curves the difference in cover types seen is significant. A key for effective monitoring of the spectral signature of different land cover types is on the basis of their behaviour in time, heights and the regions of India where they are considered as major crops.After comparing field district/state agricultural statistics we relate LAI classes with agriculture crop dominant areas and a major/dominant crop type map was generated from entire agriculture area.The Maize and coconut has highest LAI values than other crop types. Double crops have the strongest seasonal variation.



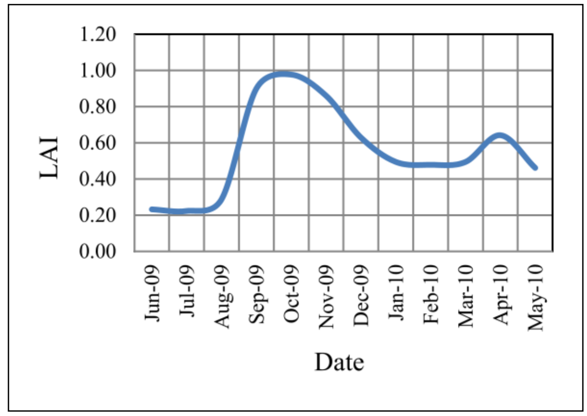
a) Cocunut



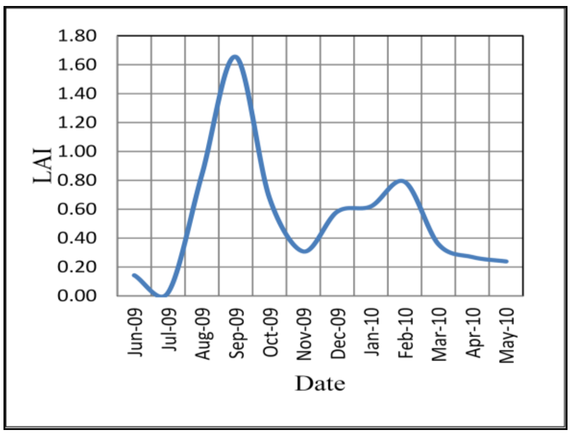
b) Maize



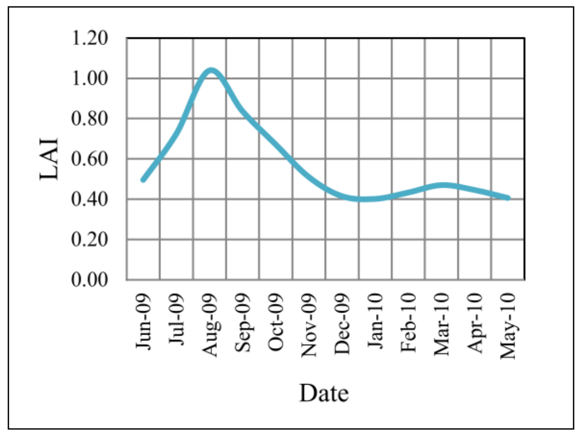
c) Jowar



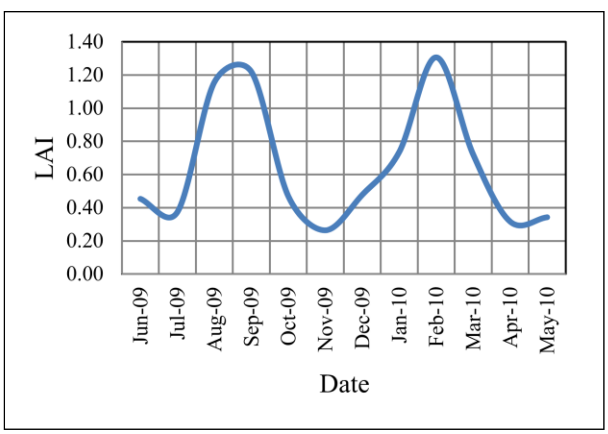
d) Rice-02



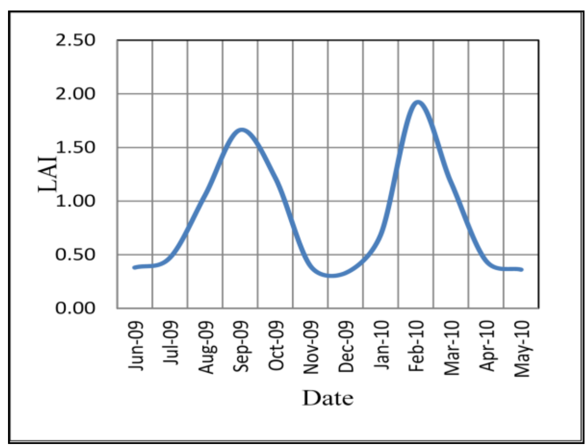
e) Rice-Wheat-02



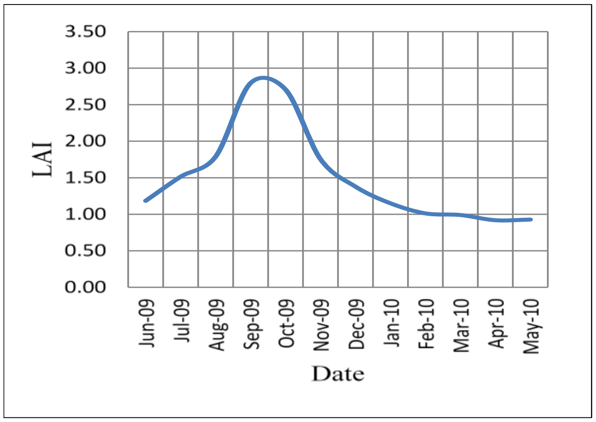
f) Ragi



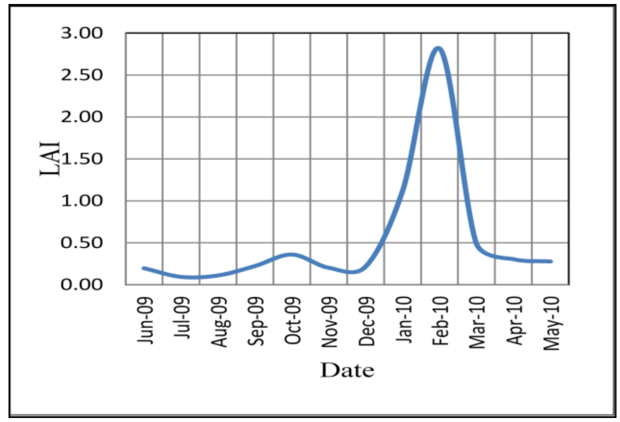
g) Rice_Rice



h) Rice 01



i) Rice 03



j) Soyabean

Figure 2. Twenty two LAI profile generated for Mahanadi River Basin

Table 1 : Classification of production by agro-ecosystem in India

No.	Agroecosystem	Crop production System	States
1	Coastal	Rice and groundnuts	Andhra, Tamil Nadu, and Orissa
		Coconut and rice	Karnataka, Kerala, Goa, Maharashtra, and Tamil Nadu
2	Irrigated	Rice and wheat	Bihar, Haryana, Punjab, Uttar Pradesh, and West Bengal
3	Rain-fed	Rice	Assam, Bihar, Madhya Pradesh, Maharashtra, Orissa, and West Bengal
		Coarse cereals	Karnataka and Maharashtra

Source: National Centre for Agricultural Economics and Policy Research, New Delhi, India 2001.

The duration of the growing season is closely related to agro-climatic consideration. Growing season too is related to the temperature, light and the moisture availability.Table 1 showing classification of production by agro-ecosystem in India(G. Mythili, 2008).Rice-Wheat system is the widely adopted cropping system for the states of Uttar Pradesh, Punjab, Haryana, Bihar, West Bengal and Madhya Pradesh.Rice-rice is the popular cropping system of Orissa, Tamil Nadu, Andhra Pradesh, Karnataka and Kerala. (Das.P.,2006). Table 2 showing the sowing and harvesting period for different crops for India. Heights of different crops are in Table 3.In table 4 there are different crops with their time period, LAI height and region of India.

Table 2: Growing Season of Different crops of Indian Agro-climatic Region

Crops	Duration	Time Period
1. Jowar	Last week of June to first week of July depending upon onset of monsoon. In Deccan plateau areas sowing of this winter or rabi crop is done in 2nd fortnight of September to middle of October.	100-120 days duration after which they are harvested.
2. Maize	Kharif season. Its sowing is done with the onset of monsoon. 1.North-Eastern hilly areas:Early March 2. North-Western hilly areas: April-May 3. Plateau India: May-June 4. Indo-Gangetic plains: End of June to middle of March. In Bihar, Andhra Pradesh, Tamil Nadu and Karnataka sowing is done from the end of October to middle of March.	Kharif-August November Rabi-January-April
3. Coconut	During May with the 00- set of pre-monsoon shower	Coconuts become mature in about 12 months after the opening of the spathe.
4. Rice	Autumn-March-August Winter-June-October Summer-November-February	Autumn-June December Winter-November-April Summer-March-June
5. Ragi	Rain-fed- April or early May Kharif season- May or June	September-October

Source-Agricultural Meteorology: ANTS – 2 (BookletNo.521, 145, 055, 130, 132, 128, 098, 084, 097)

Table 3: Heights of Different crops

Crops	Height(cm)
Maize	175-210,230-270
Wheat	60-180
Rice	100-160
Jowar	Up to 180,60-120
Ragi	60-120
Coconut	300

Preparation of crop map

From the behavior of spectral signature of LAI, information on followed crop calendars was extracted. On the basis of the number of crops grown sequentially within one year the records were then grouped by LAI class. The LAI classes were described in more details by combining the information from signature of crop varieties and the grouped LAI class record cultivated in specific cropping seasons. All LAI classes were explained based on tabulated information on region, cropping pattern during various season and height. Annual averaged LAI profiles that are almost similar were combined to reduce the number of classes and inter-annual differences within that time period also removed by this process. The derived LAI-curves should be to the crop calendars. High profiles represent green cover and reduced LAI values indicates harvest period. During August to October there is a best difference between LAI values of profiles. Like Maize LAI profile is high during September. Jowar has a very low LAI profile during September. Moreover some crop types are predominant in some areas. After identifying different crop types from spectral signature we do supervised classification of LULC 56m resolution map with aoi of different crop land. Then converting the LULC to shapefile we merge the different crop typesshapefile created from supervised classification. Again after merging we create a final raster map of LULC class. Figure 4 shows the resulting land unit map plus its legend.

Table 4: Classification of various crops depending on behaviour of spectral signature with time and region

Crop Types	Time Period	LAI_Height	Region of India
Coconut	Middle August-October	1.10	South
Jowar	Aug-October	1.30	West and South
Rice-02	September-October	0.95	South and West
Maize	August-October	2.80	North and East
Rice-Wheat	August-September and December-February	1.70 and 0.80	Uttranchal
Ragi	July-August	1.10	North and East
Rice-01	August-September and January-February	1.60 and 1.80	North and East
Rice-02	August-October and March-April	0.90 and 0.70	South and West
Rice-03(1(s))	July-September and January-February	1.30 and 1.35	North
Rice-04(1(t))	August-September	1.30	South
Rice-05(1(u))	August-October	2.80	South
Rice-06(1(v))	August-October	1.70	East

Description about VIC hydrology model

VIC hydrology model is a grid based semi-distributed hydrology model. It run in Linux and written in C programming language. We use global parameter, vegetation parameter, vegetation library, soil parameter and forcing file to run VIC hydrology model. After compiling C programme we get an exe file VicNl. We run VIC hydrology model by command vicNl –g global parameter file name. In global parameter file the time period to run the model, it's state of running (Irrigated, Non-Irrigated, Energy balance and Water balance etc.) and path of different parameter file are included. For routing another exe file generated and that is rout. We use the command rout to run routing model. For running routing model we need four parameter files and they are flow direction, flow accumulation, unit hydrograph and rout input file. The rout input file contain the path of these files and the time period to run the model (Lohmann *et al*.,1998). For VIC irrigation model there are some changes in C programme according to some condition given in vegetation parameter file to consider Irrigation and Irrigation free condition.For estimating ET under irrigated and non-irrigated scenario two extra lines are included in global parameter file- IRRIGATION FALSE/TRUE and IRRIGATION_FREE FALSE/TRUE. If IRRIGATION-TRUE we run the VIC hydrology model in irrigation mode and if IRRIGATION_FREE-FALSE we run the model in without irrigation mode.After running VIC hydrology model the output parameters are precipitation, Evapotranspiration, soil moisture, base flow, snow depth and snow cover etc.

Preparation of of vegetation parameter file for VIC hydrology model

VIC hydrology model vegetation files consist of two files and they are Vegetation Parameter file and Vegetation Library file. A MATLAB program was written to prepare vegetation parameter file from Root Library file and Vegetation Fraction file. Root library file has six rows and they are root zone thickness and fraction of root in the current root zone for three soil layers and vegetation fraction file has percentage of area covered by each vegetation type in each grid cell. Vegetation Library file has following fields like LAI, Albedo, Roughness length, displacement height and other parameters (http://www.hydro.washington.edu). The vegetation files are in ascii format. In each 0.25 degree grid the fraction of each type of land use is obtained using the LULC data layer for 2007-08.A sample Vegetation parameter and Vegetation library file is given below in Figures 3 and 5.

```
6 3
23 0.072652 0.15 0.1 0.35 0.3 1 0.6
24 0.78101 0.15 0.1 0.35 0.3 1 0.6
27 0.14634 0.15 0.3 0.35 0.6 1 0.1
```

Figure 3. 0.25 degree Vegetation parameter file for VIC hydrology model where 6 is number grid cells, 3 is number of vegetation classes, 23, 24 and 27 are the vegetation classes, 0.072652, 0.78101 and 0.14634 are the fraction of area of the vegetation classes covered the grid cell, 0.15, 0.1 and 0.35 are root zone thickness (sum of depths is total depth of root penetration) of three soil layers and 0.3,1 and 0.6 are fraction of root in the current root zone.

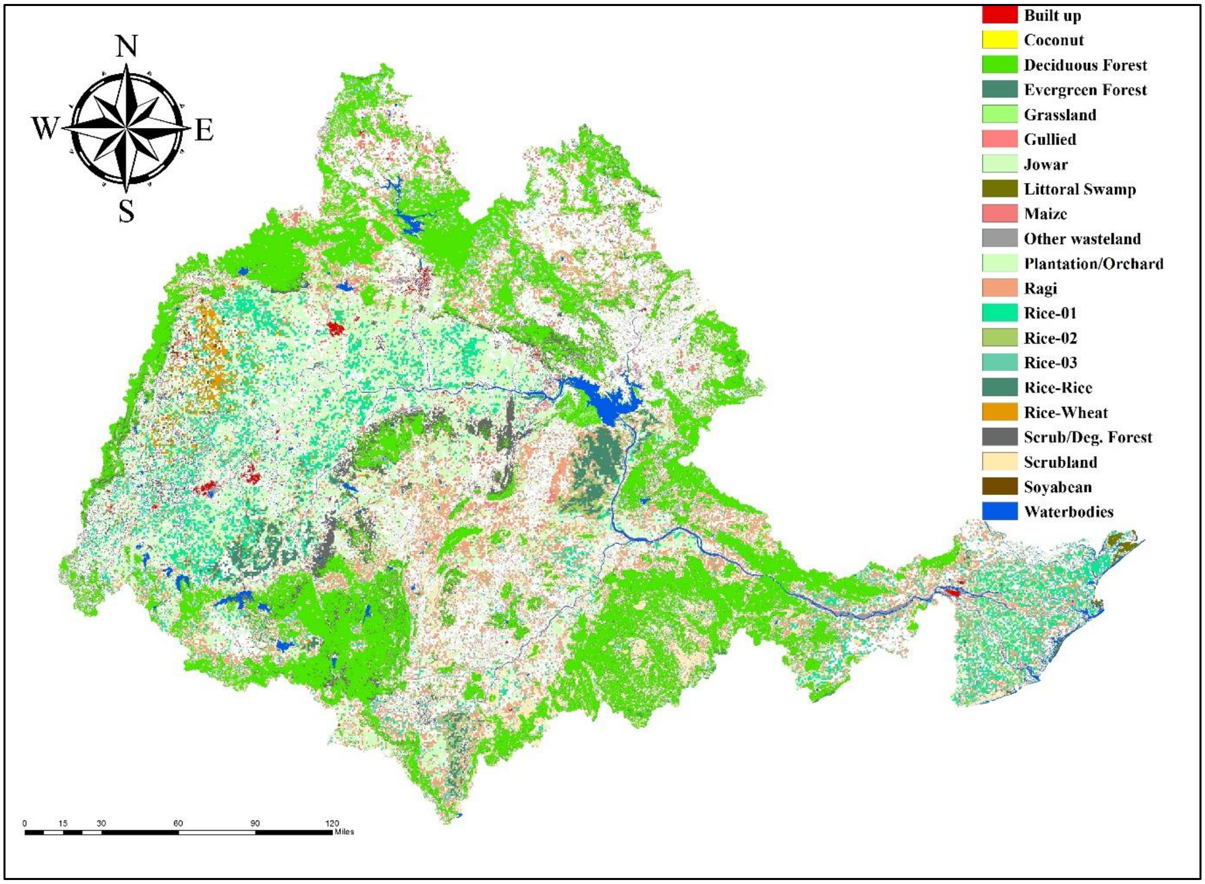


Figure 4 Crop map for Mahanadi River Basin

Class	OvrStry	Rarc	Rmin	JUN-LAI	JUL-LAI	AUG-LAI	SEP-LAI	OCT-LAI	NOV-LAI	DEC-LAI
	JAN-LAI	FEB-LAI	MAR-LAI	APR-LAI	MAY-LAI	JUN-ALB	JUL-ALB	AUG-ALB	SEP-ALB	OCT-ALB
	NOV-ALB	DEC-ALB	JAN-ALB	FEB_ALB	MAR-ALB	APR-ALB	MAY-ALB	JUN-ROU	JUL-ROU	AUG-ROU
	SEP-ROU	OCT-ROU	NOV-ROU	DEC-ROU	JAN-ROU	FEB-ROU	MAR-ROU	APR-ROU	MAY-ROU	JUN-DIS
	JUL-DIS	AUG-DIS	SEP-DIS	OCT-DIS	NOV-DIS	DEC-DIS	JAN-DIS	FEB-DIS	MAR-DIS	APR-DIS
	MAY-DIS	WIND_H	RGL	rad_atten		wind_atten		truck_ratio		COMMENT
1	0	25	80	0.53	0.84	1.48	1.41	0.89	0.60	0.33
	0.31	0.56	0.53	0.34	0.33	0.135	0.125	0.120	0.120	0.120
	0.140	0.135	0.130	0.125	0.120	0.125	0.135	0.022	0.036	0.107
	0.172	0.172	0.101	0.000	0.037	0.092	0.135	0.123	0.000	0.120
	0.194	0.582	0.938	0.938	0.550	0.550	0.201	0.503	0.737	0.670
	0.670	3.25	100	0.5	0.5	0.2				

Figure 5. Vegetation library file for VIC hydrology model where the LAI, Albedo, architectural resistance, minimum stomatal resistance, vegetation roughness length, displacement length, overstry, wind height, radiation attenuation and wind attenuation information is given for different vegetation types (http://www.hydro.washington.edu).

Preparation of vegetation parameter file for Irrigation model of VIC hydrology model:

VIC irrigation model has described by Haddeland *et al* (2006). For VIC irrigation model we have to make a change in our vegetation parameter file. There should be one extra 1 on the first line and information on percent irrigated area per month on last line. The last line is the cropping calendar, i.e. how much of the area equipped for irrigation is actually irrigated that month. It should not go below 1 percent or above 99 percent on the last line. An example of a cell in the vegetation parameter file cell with irrigated vegetation can be seen below in Figure.6.

```
20378 6 1
1 0.0410 0.30 0.30 0.70 0.70
4.8780 4.8780 4.8780 4.8780 4.8780 4.8780 4.8780 4.8780 4.8780 4.8780 4.8780
4.8780
6 0.0608 0.30 0.60 0.70 0.40
0.3380 0.3630 0.3630 0.3750 0.7880 2.1250 3.1500 2.6370 1.4620 0.6250 0.3870
0.3870
7 0.2061 0.30 0.60 0.70 0.40
0.4630 0.6500 0.9880 1.9380 3.3630 3.2370 2.6630 1.8120 1.9250 1.1380 0.6130
0.3380
10 0.0230 0.30 0.80 0.70 0.20
0.2250 0.3250 0.4750 0.8370 2.4000 3.1380 2.9380 2.1250 1.7000 1.0500 0.4500
0.2500
11 0.5719 0.30 0.50 0.70 0.50
0.1080 0.1560 0.2470 0.5410 2.1790 3.6170 3.1640 1.2390 0.9970 0.6120 0.3250
0.1750
114 0.6487 0.30 0.50 0.70 0.50
5
0.1000 0.1000 0.1000 0.1000 0.2230 0.9340 2.2950 2.4310 1.0530 0.1000 0.1000
0.1000
114 0.6487 0.30 0.50 0.70 0.50
0.1000 0.1000 0.1000 0.1000 0.2230 0.9340 2.2950 2.4310 1.0530 0.1000 0.1000
0.1000
10.0 10.0 10.0 10.0 80.0000 80.0 80.0 80.0 80.0 10.0 10.0 10.0
```

Figure 6. 0.25 degree Vegetation parameter file for VIC irrigation model where 20378 is number grid cells, 6 is number of vegetation classes, 1, 6,7,10,11 and 114 are the vegetation classes , 0.0410, 0.0608,0.2061,0.0230,0.5719 and 0.6487 are the fraction of area of the vegetation classes covered the grid cell. 0.30, 0.30, 0.70 and 0.70 are root zone thickness (sum of depths is total depth of root penetration) of three soil layers.1 represent the presence of irrigated cell. If 114 is the irrigated cell the it again repeat and 10.0,10.0,10.0,10.1,80.080.0,80.0,80.0,80.0,10.0 and 10.0 are the percentage irrigated area of the grid cell.

Number of vegetation types is, as we can see, only 6, although there may seem to be information on 7 types listed. The vegetation type "114" is irrigated vegetation. The percentage tells the model how much of the area equipped for irrigation within that cell (0.0687+0.6487) that is actually irrigated that month (information taken from e.g. FAO).

Results

In this study main aim is to find the effect of vegetation as well as climate on model ET,discharge in the form of vegetation parameter, vegetation library and forcing file used in VIC hydrology model and calculate irrigation water demand. We run VIC hydrology model for Mahanadi river basin for irrigated and non-irrigated scenarios for estimating ET under these two scenarios. For estimating ET by VIC irrigation model we need soil parameter, vegetation parameter, vegetation library and forcing (Maximum temperature, Minimum temperature and rainfall) files. Figure 7 and 8 showing the spatial plotting of Evapotranspiration for monsoon, pre-Monsoon and post-Monsoon season using GMT 5.1 derived using VIC hydrology model and MODIS observed ET(MOD16 (mean monthly) for the time period of 2000-2007.

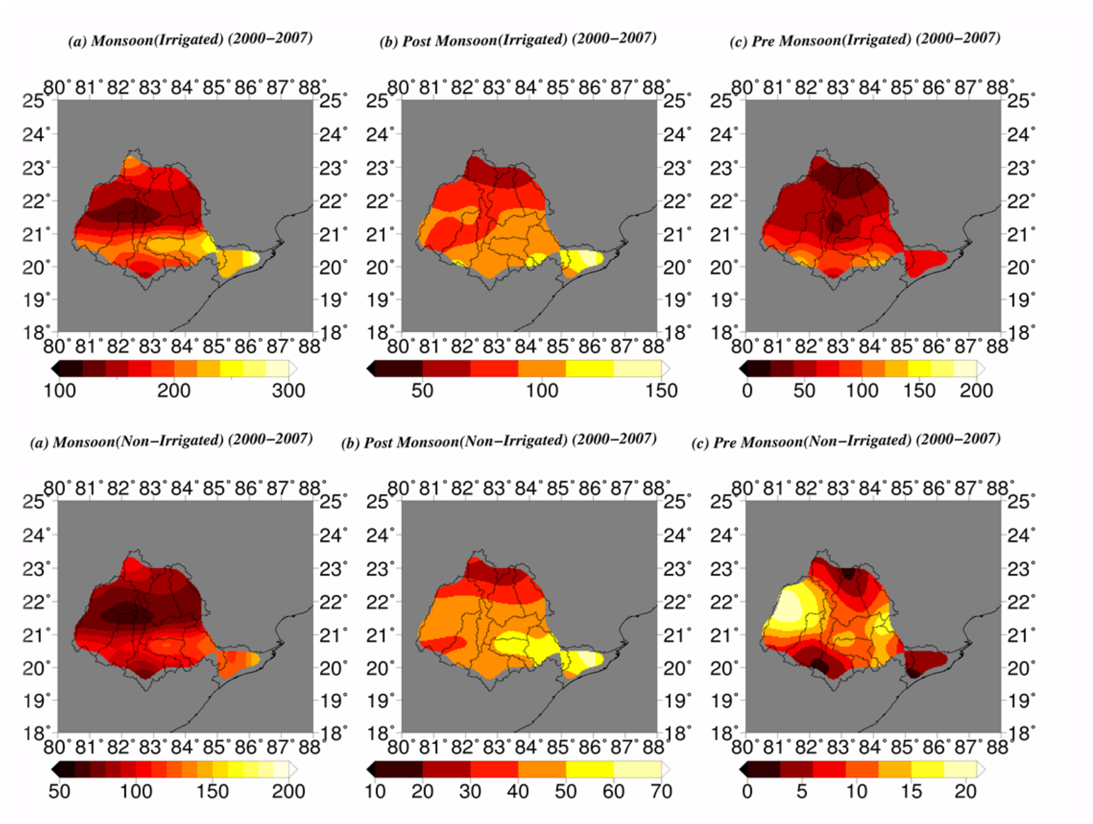


Figure 7. Spatial plotting of Mean Evapotranspiration derived from VIC hydrology model 2000-2007 during Monsoon season, Post Monsoon and Pre Monsoon season under irrigated and non-Irrigated Scenario.

Figure 9 shows time series of monthly ET for Mahanadi river basin from 2000-2007.ET under irrigation condition is higher than non-irrigated condition as well as matching with observed ET.Scatter plot of monthly Observed and Simulated ET (Irrigation_scenario) for Mahanadi is shown in Figure 10. There is a good match between observed and simulated evapotranspiration. We adopt accuracy measures such as root-mean-squared-error (RMSE), correlation coefficient (R) and Nash-Sutcliffe (E).For our study the values are coming 0.89, 0.87 and .95. Before numerical simulations to be performed VIC hydrology model is needed to be calibrated. The three calibration parameters in the ARNO subsurface flow parameterization (D_m, D_s and W_s). And the parameters that affect evapotranspiration are the depths of three soil layers (D1, D2 and D3). According to Myburgh et al. there is a positive respond of vegetative growth and physiological activities to increasing soil depth under dry land irrigated conditions compared to non-irrigated treatments of corresponding depths. We change the soil depths from 1.5 to 3m during calibration to check it's effect on ET. The increasing soil depth has a positive response on ET.

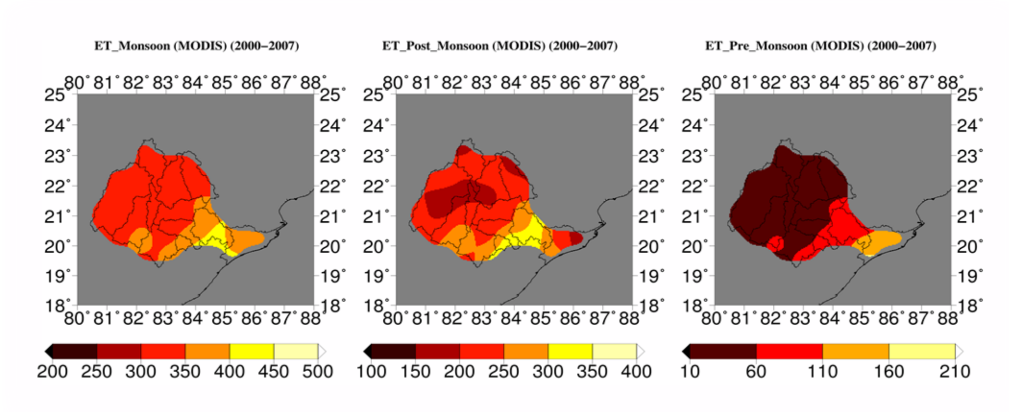


Figure 8. Spatial plotting of Mean Evapotranspiration derived from MODIS_ET (2000-2007) during Monsoon, Post Monsoon and Pre Monsoon season.

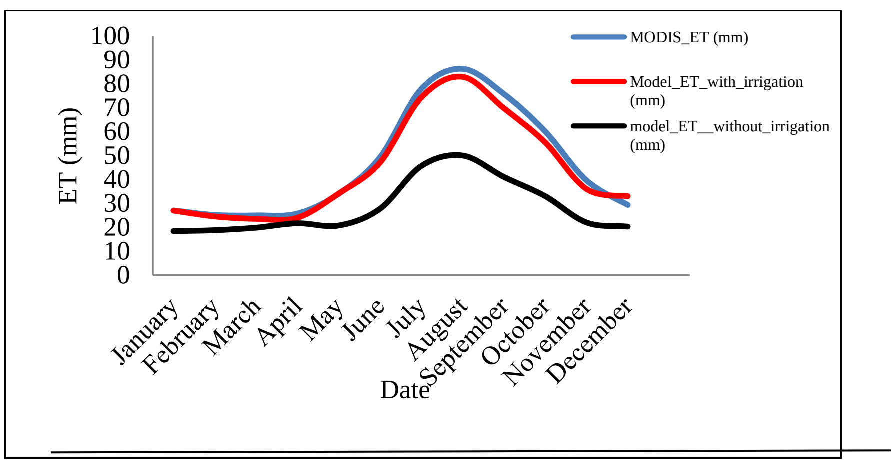


Figure 9. Comparison of monthly Observed and Simulated ET for Mahanadi for Irrigated and non-Irrigated scenario.

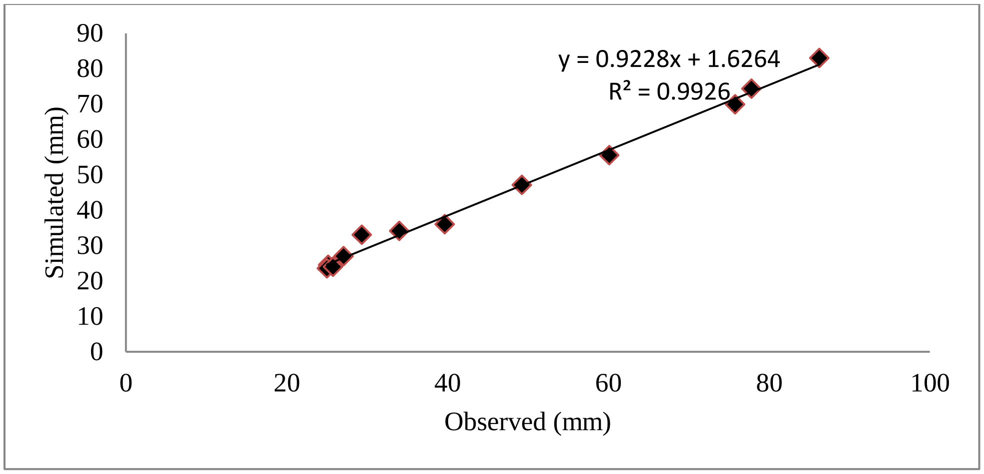


Figure 10. Scatter plot of monthly Observed and Simulated ET (Irrigation_scenario) for Mahanadi.

We run the model for Mahanadi river basin for the period 1980-2007 and compared the simulated discharge with field discharge for different locations named Simga (lon-82°47′27″, lat-21°43′18″) (Fig.11), Kesinga (lon-82°47′27″, lat- 21°43′18″) (Fig.12) and Kurubhata ((lon-82°47′27″, lat- 21°43′18″) (Fig.13).Table 5. showing the Nash-Sutcliffe Efficiency of these three stations. The NSE showing a good match between observed and simulated discharge.

The Net irrigation consumption was determined by substituting the ET estimated by running VIC hydrology model in irrigation mode that is ET_{irr} and the hypothetical ET estimated by conventional VIC model for ET that is ET_{actual} (Eq. 1) as decribed by Lettenmaier *et al.*, (2009).

$$Con_{irr}=ET_{actual}-ET_{natural} \quad 1$$

ET_{actual} is the actual ET for irrigated conditions and $ET_{natural}$ is the hypothetical ET under natural conditions in irrigable lands. Satellite-based and conventional model-based estimates of ET is MOD_{irr} whereas the differences between VIC irrigation model and conventional VIC model estimates are the VIC_{irr}. Both VIC_{irr} and MOD_{irr} show reasonable agreement in most months. The net irrigation consumption is more in summer and less in winter (Fig.14).

Table 5: Nash-Sutcliffe Efficiency of three stations of Mahanadi river Basin

Station	Nash-Sutcliffe Efficiency
Simga	0.84
Kesinga	0.90
Kurubhata	0.89

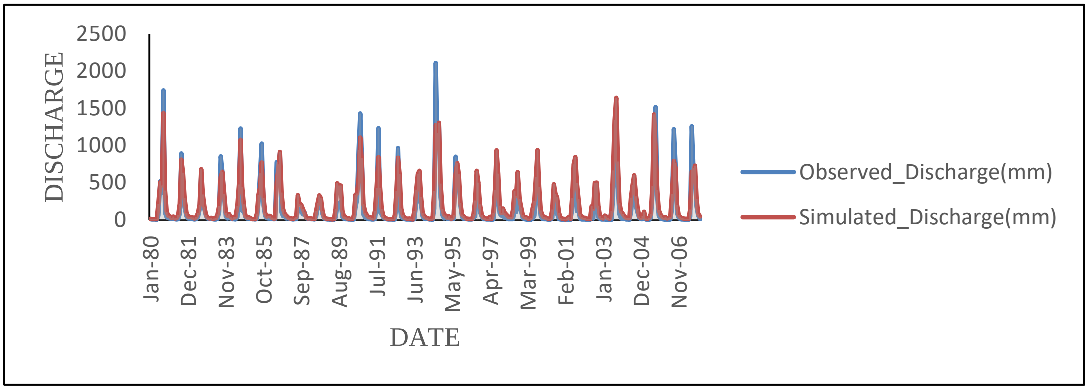


Figure 11. Observed monthly runoff vs. VIC simulated monthly runoff for Simga (1980-2007)

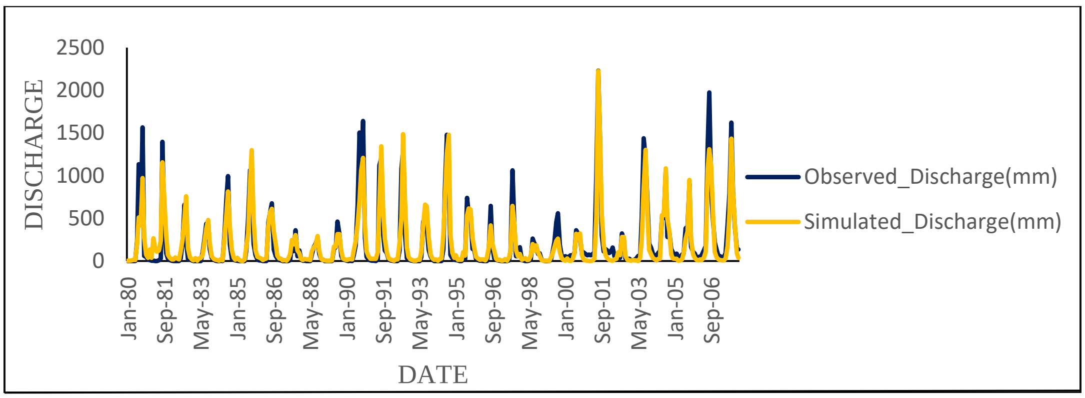


Figure 12. Observed monthly runoff vs. VIC simulated monthly runoff for Kesinga (1980-2007)

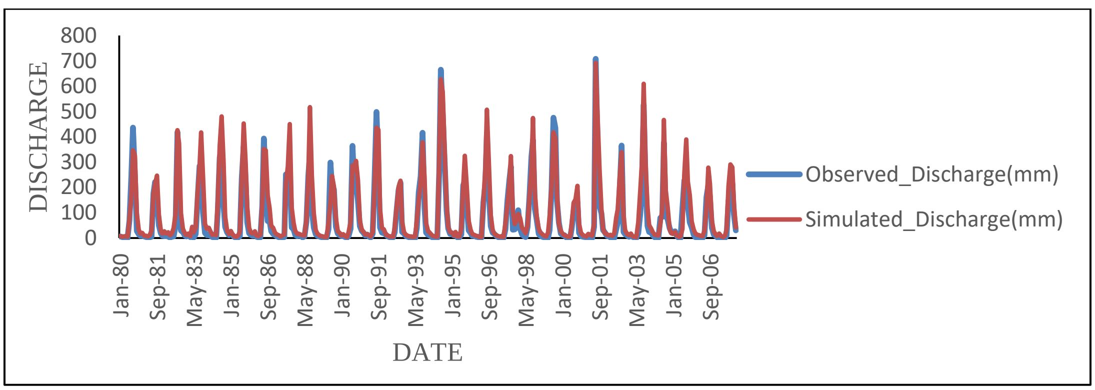


Figure 13. Observed monthly runoff vs. VIC simulated monthly runoff for Kurubhata (1980-2007)

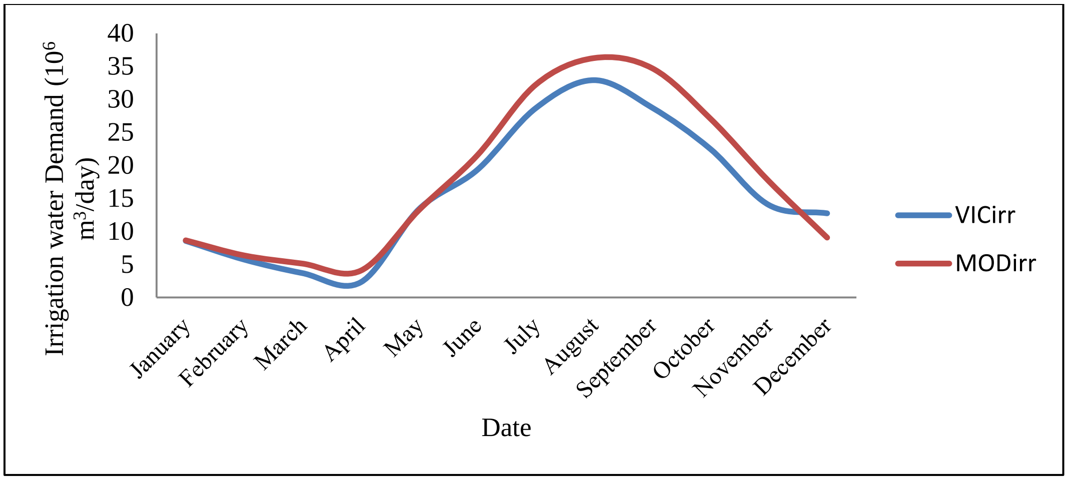


Figure 14. Mean monthly comparison of VIC_{irr} and MOD_{irr} for the period 2000-2007

Table 6. gives the brief information about sites. We consider a few land cover types for our site as follows Jowar, Ragi, Rice-01, Rice-02, Deciduous forest, Grassland, Scrub/Deg forest and Rice-Wheat-02. The sites are located across the Mahanadi river basin. VIC hydrology model partition the rainfall into infiltration and surface runoff. (Wood *et al*., 1992).ET is calculated using the Penman-Monteith equation (Monteith and Unsworth, 1990). Maximum ET is for Rice-02 as well as ET shows a lower value for Rice-01.The low ET is mainly a result of low temperature and vegetation cover.Rice-01 has low vegetation cover for Mahanadi river basin where Rice-02 has a higher vegetation cover followed by grassland and deciduous forest.

Table 6: Comparison of annual evapotranspiration (ET) values for different vegetation types

Lat-lon	Vegetation types	Annual ET (mm)
21.875,82.375	Jowar	16855.00
22.375,83.625	Ragi	19926.45
21.625,82.125	Rice-01	16754.21
21.125,83.625	Rice-02	24035.21
20.375,83.875	Deciduous Forest	20216.95
21.625,83.625	Grassland	22917.22
21.125,82.125	Scrub/Deg Forest	17111.47
21.875,81.375	Rice-Wheat-02	16844.22

Discussions and Conclusion

This paper demonstrate that in classifying land use for heterogeneous and highly intensive crop areas the hyper-temporal LAI analysis approach is very effective. Temporal LAI-profiles differences are related to differences in land cover because of phenology differences of natural vegetation. A total twenty two vegetation classes used to create vegetation parameter file. The VIC hydrology model requires three types of parameter files, which are vegetation, soil and forcing parameter files as well as it has inbuilt functions by which model automatically calculate the effect of solar radiation for calculating ET. Estimations of actual evapotranspiration based on hydrological cycle simulations are of great significance to the water resources adaptive management under changing environment. In this paper ET was estimated using VIC hydrology model by the penman-monteith ET estimation approach.ET variation generally effected by weather, crop characteristics, crop practices, water management, length of growth season and magnitude of solar radiation (Alberto *et al*.,2011;Bezerra *et al*.,2012).After successful implementation of VIC hydrology model we compare the ET value for specific vegetation type at selected sites and it gives an expected result with a variation of ET for under variation of vegetation cover. We are not elaborating much about effect of LAI on ET as well as seasonal variation of different parameters as the main objective of our paper is crop mapping and modelling using temporal LAI variation.Result showed thathighest ET occurred in the period of July to August with 86 .80 mm/month, relating to adequate precipitation and fully developed vegetation canopy as well as high downward radiation fluxes.ET under irrigation condition matches well with the observed ET because of irrigation is a one of the most efficient water management practice as we know that where the evaporating surface is the soil surface the amount of water available at the soil surface is the main source of ET. According to Tang *et al*., 2009 the conventional VIC hydrology model used to compute evapotranspiration in absence of irrigation withdrawal whereas Irrigation model implemented for VIC hydrology model estimate the actual evapotranspiration in presence of irrigation withdrawal. Measurement of irrigation withdrawals is estimated by difference of crop water use (ET) of hypothetical VIC model output and VIC model output with irrigation model. The irrigation water demand is high for July and august with $34.45*10^6 m^3$/day as a result of higher ET during this period. Influence of evapotranspiration on catchment runoff is an interesting and not very often studied hydrological phenomenon. Water use by riparian vegetation is closely linked to stream flow diurnal variability.According to Cadol *et al*. (2012) across multiple temporal scales ET exerts influence on stream discharge. In this study we found a good correlation between observed discharge and model discharge which indicate a good fit of all model parameters to estimate the discharge.

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