

Hydrological Assessment for Renovation of tanks using Geo-informatics

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Abstract : Runoff is one of the most important hydrologic variables used in most of the applications of water resources. Reliable prediction of quantity and rate of runoff from land surface into streams / rivers is difficult and time consuming to obtain for un-gauged tank catchments. Space Remote sensing technology in association with geographical information system (GIS) can supplement the conventional methods to an immense amount in hydrological studies. An attempt is made to estimate average monthly/annual run-off from catchment areas of nine tanks in Manjeera river catchment, which is a tributary of Godavari basin covering in Nizambad and Medak districts of Andhra Pradesh. The hydrological assessment for the tanks has been carried out for renovation using Soil Conservation Service (SCS) curve method. Average annual rainfall of the area is 870 mm. Land use / land cover and soils resource information generated from remote sensing data and daily rainfall data of 40 years (1965 to 2005) have been used. The estimated run-off in the area varies from 6.86 mcft to 11.70 mcft per sq.km. Finally, a protocol was developed in a graphical form. It is found that good correlation ($R^2 = 0.97$) was observed between the runoff and catchment area. The protocol is useful for assessment of runoff and prioritize the tanks for renovation as well as for optimum utilization of water resources in the Manjeera river catchment.

INTRODUCTION

A tank catchment is the area covering the land that contributes surface runoff to tank. It is a natural physiographic or ecological unit composed of interrelated parts and functions. In India, the availability of accurate information on runoff is scarcely available in few selected sites. Runoff is one of the vital hydrologic variables used in construction of any hydraulic structure and planning of water resources. There are a number of physical characteristics of catchments that affect the amount and/or rate of runoff. With the advent of space borne remote sensing data coupled with GIS techniques would help to generate terrain inputs for estimation of runoff in un-gauged tank/reservoir catchments. The information extracted from remote sensing and other sources can be stored as a geo-referenced database in geographical information system (GIS). The system provides efficient tools for data input into database, retrieval of selected data items for further processing. Several researchers (Rao

et al., 1996; Chadramohan and Durbude, 2001; Dilip D Durbude et al., 2001; Sharma and Kumar, 2002; Ashish Pandey and Dabral, 2004) have used SCS model for the estimation of runoff and tested for un-gauged catchments. This method involves various types of information related to hydrologic soil group, vegetation and antecedent moisture condition of the catchment.

An attempt is made to develop a protocol for the Manjeera catchment covering in Medak and Nizambad districts of Andhra Pradesh based on estimation of run-off in the catchment areas of nine tanks.

STUDY AREA

Nine tank catchments were selected for the study. It spreads in Medak and Nizambad districts of Andhra Pradesh covering in the part of Manjeera river basin(10,372 sq.km in A.P. The total catchment area of the nine tanks is about 375.79 sq.km. It receives rainfall from SW and NE monsoon with an average annual rainfall ranging

from 660mm and 956mm. The location and catchment area details of the nine tanks are given in table -1.

DATA USED

Topographic maps (56 K/2, 56G/13, 56 J/8, 56 K/1 & 56 J/3) of Survey of India on 1: 50,000 scale has been used for demarcation of catchment area of each tank. IRS P6 LISS-III data of 23rd November 2005 and 8th & 27th Feb. 2006 is used for generating land use / land cover theme. Soils information is extracted from published data of National Bureau of Soil Survey and Land Use Planning (NBSS&LUP, 1996) and updated using IRS P6 LISS-III data of 2005. The daily rainfall data from 1965 to 2005 has been collected from Department of Economics and Statistics, Govt. of A.P. / India Meteorological Department (IMD). The information about hydraulic particulars of the tanks is collected from Irrigation and Command area Department, Govt. of A.P.

METHODOLOGY

The catchment areas of nine tanks were delineated using Survey of India toposheets. Digital data of IRSP6 LISS-III of kharif (Oct/Nov.,2005) and Rabi

(Feb/March,2006) season was geo-referenced and used for preparation of land use / land cover map. Ground truth information is also used for finalization of land use / land cover map. Hydrological soil group map has been prepared based on soils resources information. The daily rainfall data of available rain gauges in and the around study area is collected for the period 1965 to 2005. Daily average rainfall for each catchment has been estimated using thessien polygon method. Soil Conservation Services (SCS) Curve Number model modified for Indian conditions has been used for estimation of surface run-off. This method involves relationship between land use/ land cover and hydrologic soil group. The curve number value for each unique parcel of unit was assigned based on combination of land use / land cover and hydrologic soil group. The extent of different LU/LC class and hydrological soil group combinations were estimated and accordingly CN (Curve-Number) values were assigned. Then, weighted value of CN(II) for AMC-II of the catchment of each tank was worked out. The CN(II) values of AMC-II condition is converted in to CN values for AMC-I and AMC-III condition by using CN(I) & CN(III) respectively. The weighted average curve number was estimated.

Table 1. Location and catchment areas of nine tanks

S.No.	Name of the tank	District	Latitude (N)	Longitude (E)	Catchment area (Sq.km)
1	Nalla Cheruvu	Medak	17 ^o 12' 30"	78 ^o 07' 45"	16.54
2	Malkapur cheruvu	Medak	17 ^o 25' 00"	78 ^o 01' 50"	139.03
3	Laxminarayana cheruvu	Medak	17 ^o 54' 24"	77 ^o 54' 36"	4.23
4	Pothangalvagu	Nizambad	18 ^o 09' 12"	78 ^o 03' 40"	22.76
5	Goutampur tank	Medak	17 ^o 51' 21"	77 ^o 54' 36"	4.75
6	Rayanpally project	Medak	18 ^o 05' 30"	78 ^o 21' 30"	94.17
7	Pedda cheruvu	Medak	18 ^o 01' 30"	78 ^o 18' 30"	22.19
8	Pedda-chinna cheruvu	Medak	17 ^o 59' 10"	78 ^o 02' 50"	21.70
9	Masanapalli	Medak	17 ^o 54' 20"	78 ^o 03' 30"	50.67

Finally, the daily runoff of each tank catchment was calculated. The monthly and yearly runoff values have been arrived and catchment areas of the respective tanks were plotted on log-log graph.

RESULTS AND DISCUSSION

The total catchment area of nine tanks is 375.79 sq.km. Of which, the predominant land use classes are un-irrigated crop (50%), double crop (14%), dense forest (11%), land with scrub (8%), barren rocky area (3%) and water bodies (3.1%). As the catchment area of Manjeera river covered by black soils, the major hydrological soil groups are falling under D category - very low infiltration rate (81%) and under C category – low infiltration rate (11%).

The drainage, land use / land cover and hydrological soil group maps of three tanks catchments are shown in Fig. 1. The average

weighted curve number, annual rainfall and runoff of the nine tank catchments is given in Table-2. The annual rainfall Vs runoff from 1965 to 2005 is depicted in Fig.2. The log values of catchment area against runoff have shown in Fig.3. The results reveal that the correlation between catchment area and runoff is about 0.97, which shows good fit.

CONCLUSION

It demonstrates the generation of hydrological parameters based on remote sensing data for runoff estimation in un-gauged catchments. The protocol will help to predict runoff in the tank catchments for proper planning of water resources, screening of tanks for renovation as well as for construction of suitable hydraulic structures in the catchment.

Table 2. Weighted CN, avg. Annual Rainfall and runoff of Nine tank catchments

S.No	Name of the tank	District	Weighted curve number (CN)	Average annual rainfall (mm)	Catchment area in Sq.km.	Average annual runoff (MCM)
1	Nalla Cheruvu	Medak	85	850	16.54	3.70
2	Malkapur cheruvu	Medak	85	810	139.03	27.01
3	Laxminarayana cheruvu	Medak	85	911	4.23	1.22
4	Pothangalvagu	Nizambad	76	956	22.76	4.57
5	Goutampur tank	Medak	85	903	4.75	1.35
6	Rayanpally project	Medak	70	830	94.17	19.59
7	Pedda cheruvu	Medak	72	660	22.19	4.39
8	Pedda-chinna cheruvu	Medak	87	864	21.7	6.57
9	Masanapalli	Medak	88	886	50.67	16.79

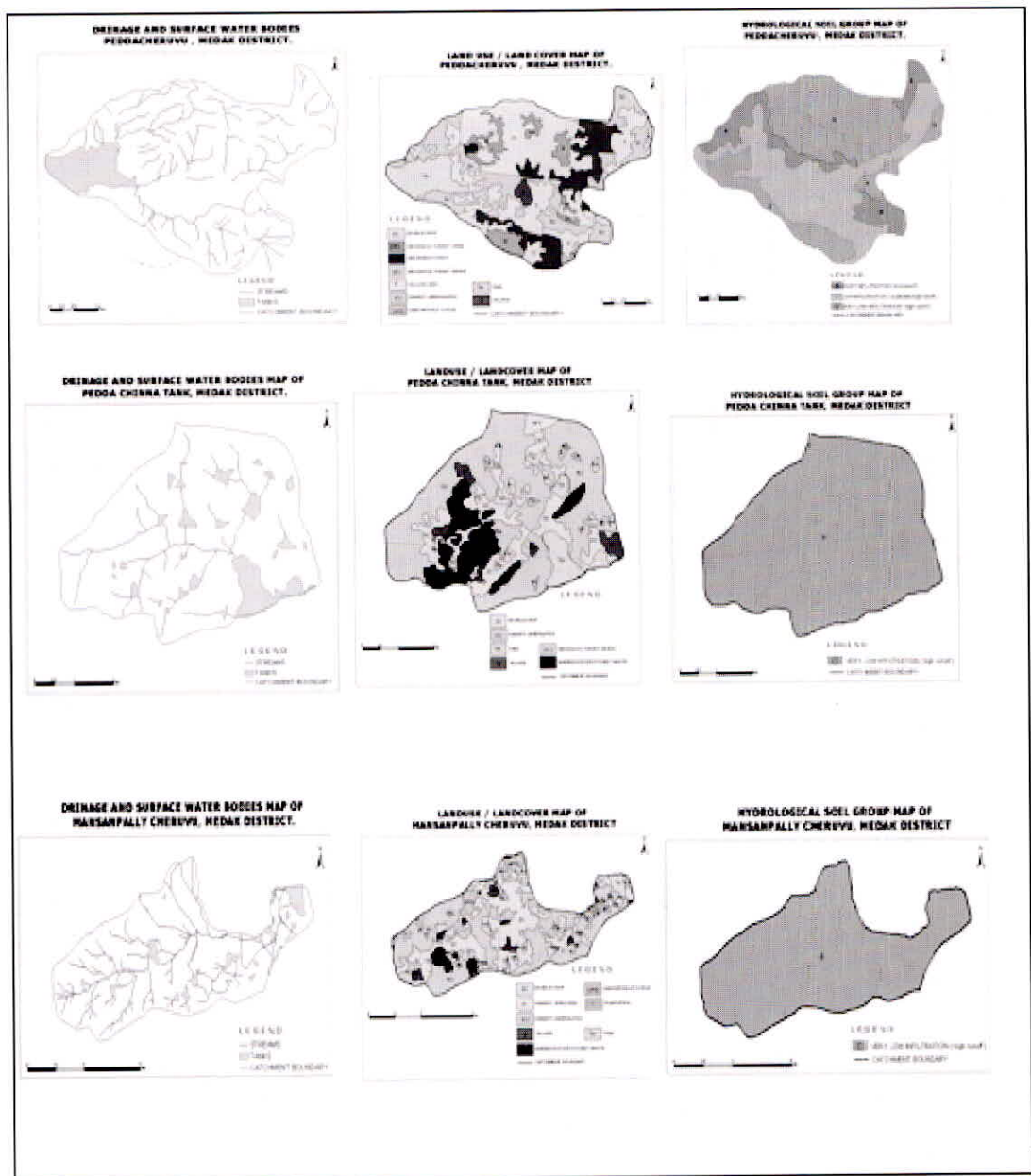


Fig. 1. Drainage, land use / land cover and hydrological soil group maps

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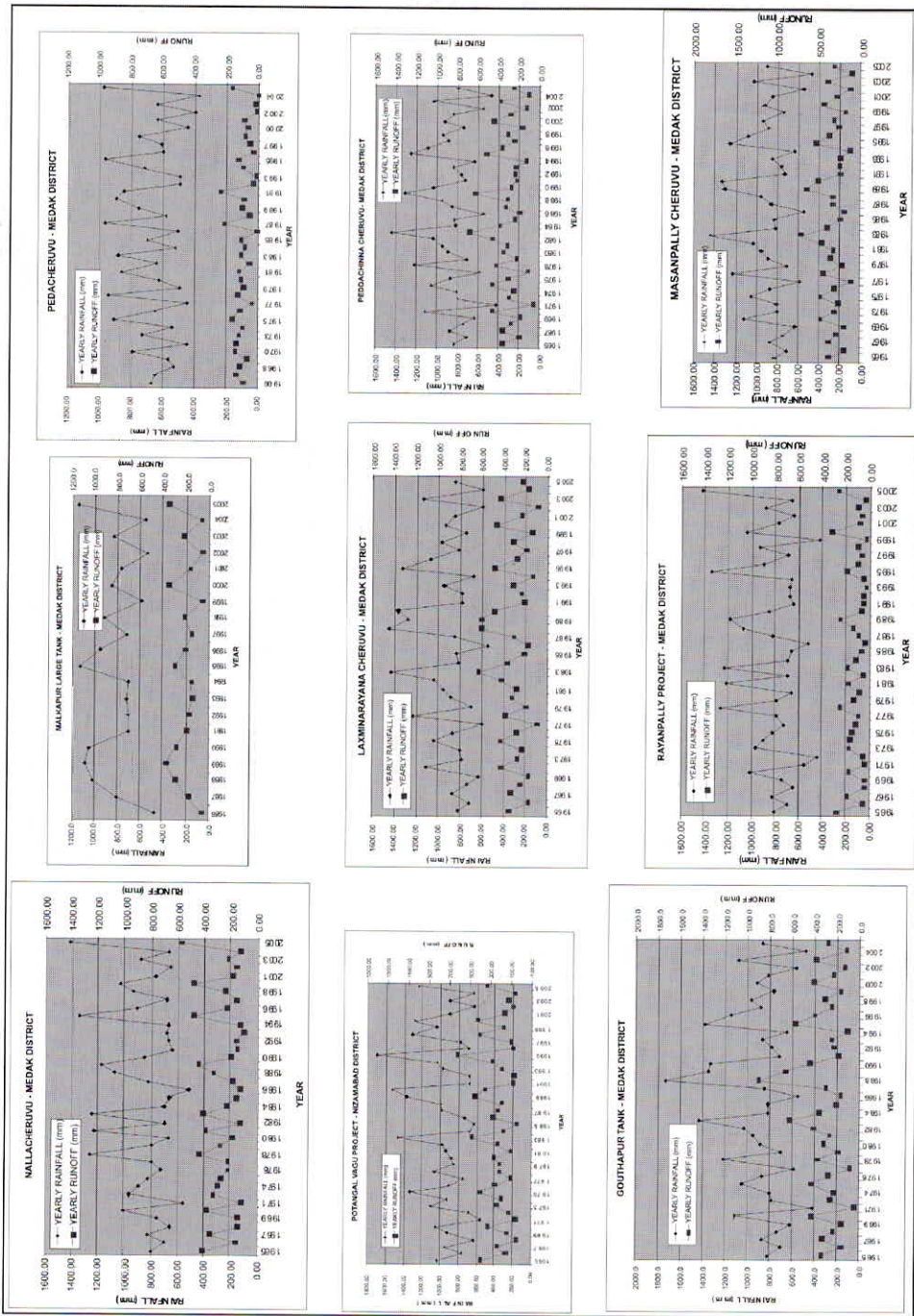


Fig. 2. Annual Rainfall Vs Runoff of nine Catchment areas

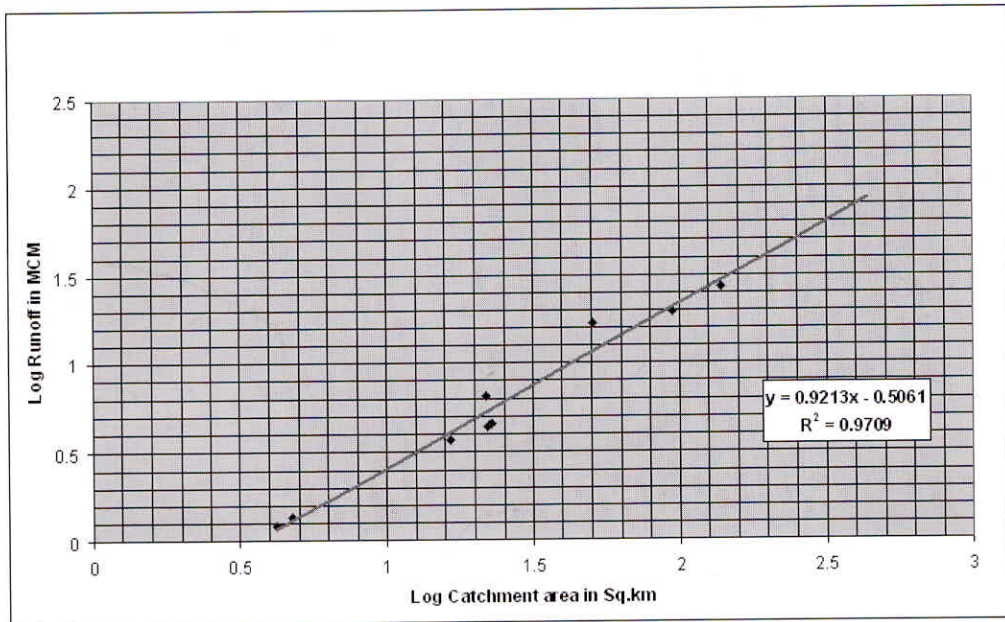


Fig. 3. Catchment area Vs Estimated Runoff

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