IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 14, Issue 5 Ver. II (Sep. - Oct. 2017), PP 15-19
www.iosrjournals.org

An Estimation of Runoff of a Catchment by Spatial and Analytical Approach

*B N Suma[1], C.V.Srinivasa[2]
[1]*(Department of Civil Engineering, Global Academy of Technology, Ideal Home Township, Rajarajeshwarinagar, Bangalore-98, Karnataka, India)*
[2]*(Department of Civil Engineering, Global Academy of Technology, Ideal Home Township, Rajarajeshwarinagar, Bangalore-98, Karnataka, India)*
Corresponding Author: B N Suma

Abstract: *The study area encompassed between 76°40'0"to 77º0'0"E and 13°13'0" to 14º0'0''N. The river systems consist of tributaries of Cauvery and Krishna. The study area consists of Hassan, Chickmagalur and Chitradurga district. The thematic maps were generated to study the geomorphological characteristics, land use land cover pattern, other major geological hydrological information's which are retrieved from the RS and GIS studies. The runoff generated from the watershed is analyzed using both SCSCN method and Stranges Tables Method to get the reliable results.*

Keywords: *Runoff, RS&GIS, SCSCN, Stranges Table, Vedavathy*.

Date of Submission: 05-09-2017 Date of acceptance: 20-09-2017

I. Introduction

Water resource development and management in a catchment requires the quantification of water resource potential. This is usually achieved by the estimation of hydrological & geological characteristics of the basin using observed data to carryout statistical estimate.

For many years hydrologists have been facing the problem of prediction of runoff over the catchments since it involves many factors to evaluate the runoff predictions, which is complex in nature. Hence there is an important need to develop a rainfall-runoff model or SCSCN model to evaluate the runoff. A watershed is usually a complex heterogeneous system. Hydrologic processes vary both in space and time. Empirical method of analysis is site specific and it takes time generate results Hence. Using modern tools of geospatial technology as it is possible to achieve the objectives of representative as well as more accurate spatial rainfall and concurrent runoff.

A paper explains the calculation of runoff depth in the Sheonath river upper sub-basin of Chhattisgarh State of India. A paper [1] represents the remote sensing and GIS tool is effectively Estimate the runoff using SCSCN method from the basin of similar hydro geological characteristics.

II. Methodology

2.1 Study Area:

The study area covers Vedavathy river basin. River it consists of 5 watersheds namely Gundihalla 1, Gundihalla2, Kodi dodddahalla and Vedavathy 1&2 watershed. The study area consists of Vedavathy 1&2 watershed which includes Hassan, Chickmagalur, Chitrdurga District. It consists of 3 taluks of chickmagalur which are Chickmagalur, kadur and Tarikere, Belur and Arasikere of Hassan and Holalkere and Hosadurga of Chitradurga district respectively. It comprises of total 43 Zilla Panchayat. Hence the field study was carried out at these taluks to ascertain the effectiveness of rainwater harvesting structures which were constructed to increase the ground water level for the project area along with these field study supplementary information's from Remote sensing and GIS tools with Rainfall data from NRDMS helps to determine the runoff from both SCSCN model and Strange table method.

The thematic maps for the entire Vedavathy basin was studied to know the suitability of land for the RWH structures and also the data is required for the estimation of runoff from the catchment which requires many thematic factors for the study .The spatial analysis includes data gathered from the Remote sensing and GIS tools which is empirically solved using SCSSN method.

The analytical approach includes comparison of the results obtained from Stranges table method which is applicable to State of Karnataka and Maharashtra with the SCSCN method.

The following maps represent the catchments details as below.

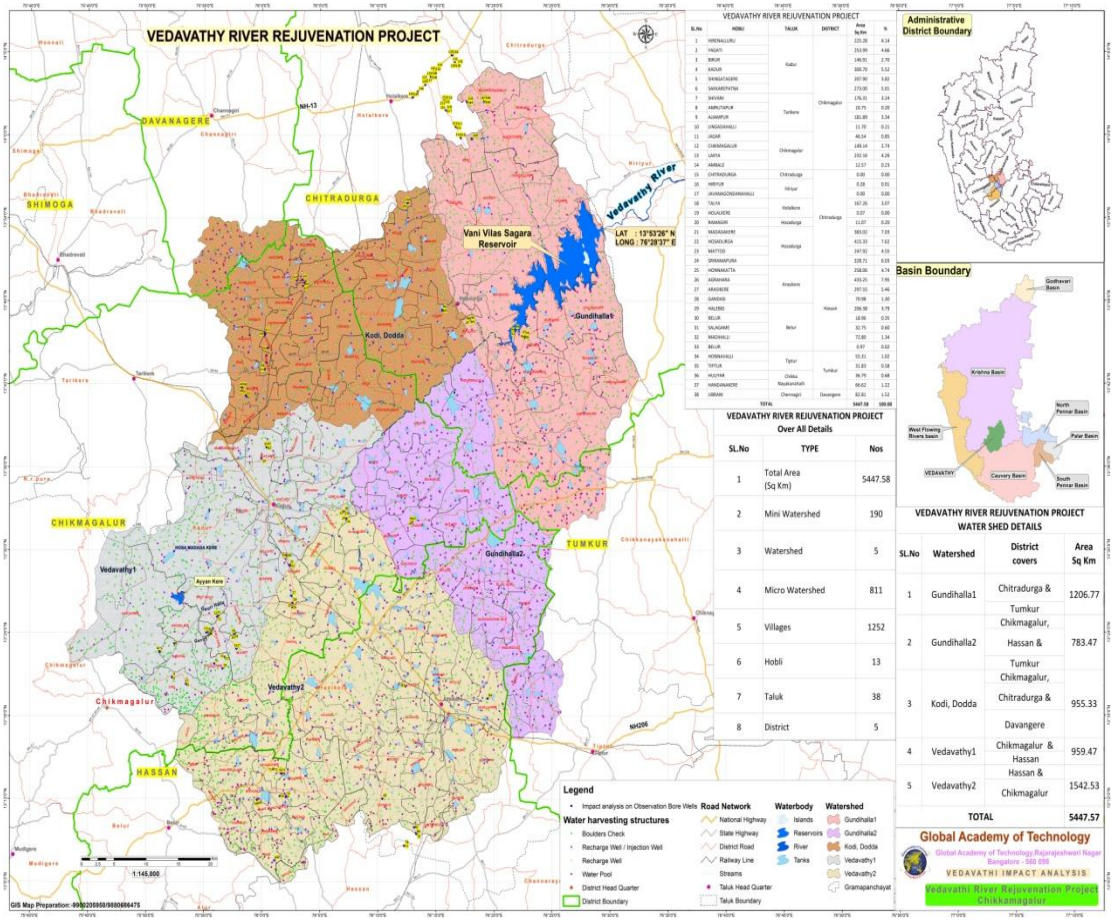

Fig.1 Vedavathy River Basin and its watersheds

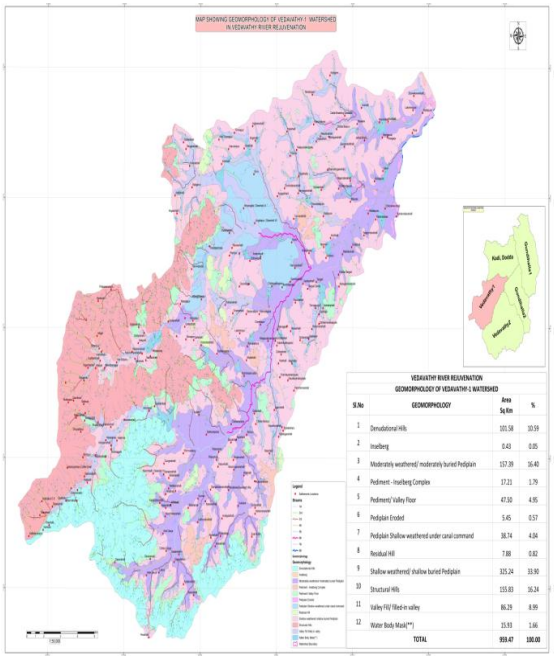

Fig.2 Geomorphology map Vedavathy 1

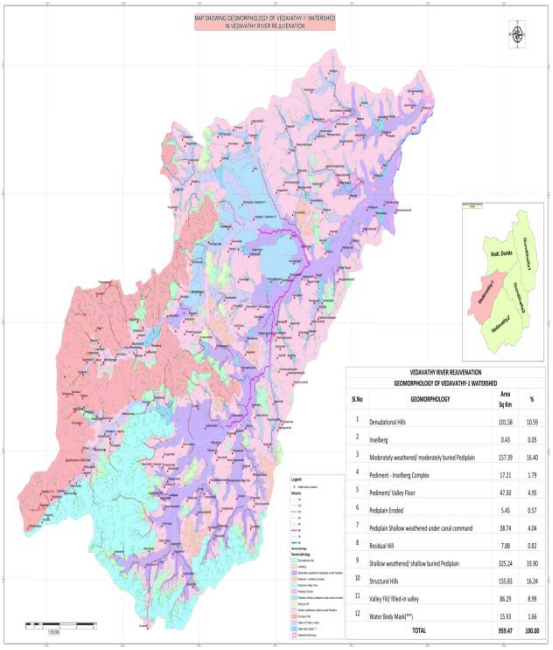

Fig.3 Groundwater prospectus map Vedavathy 1

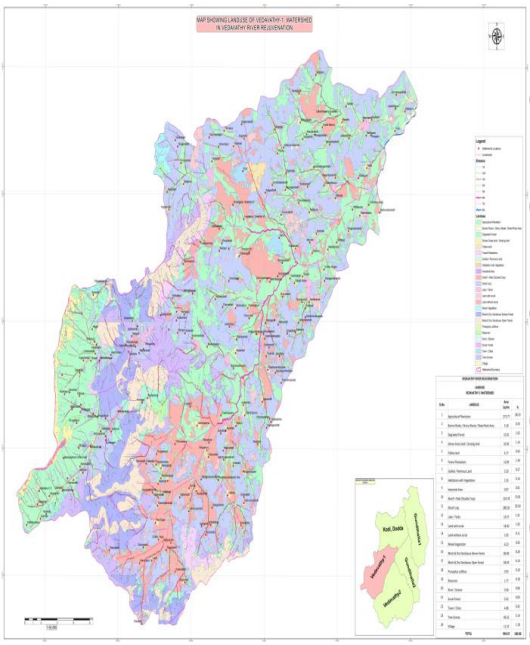

Fig.4 Geomorphology Map Vedavathy 2

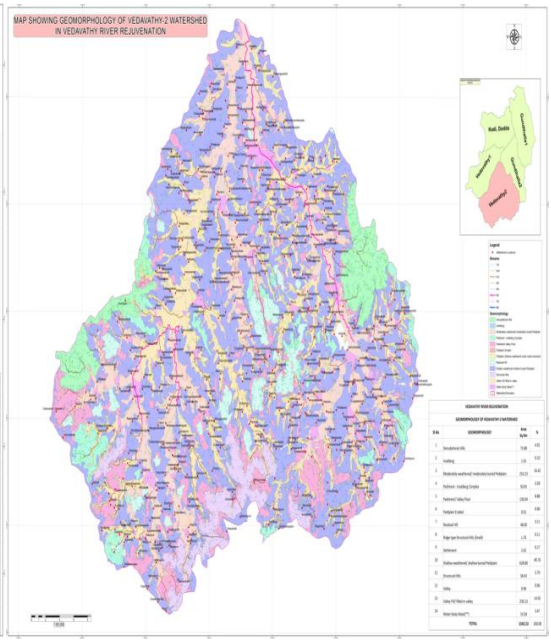

Fig .5 Landuse landcover Map vedavathy 1

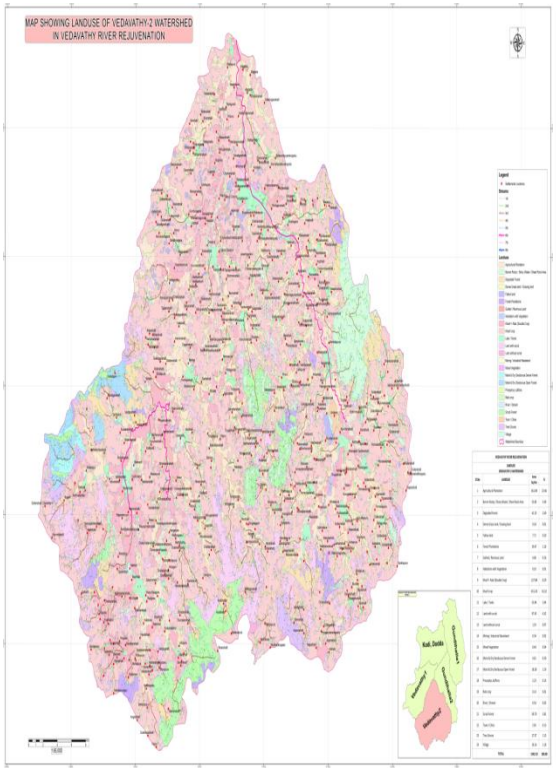

Fig.6 Groundwater Prospectus Map Vedavathy 2

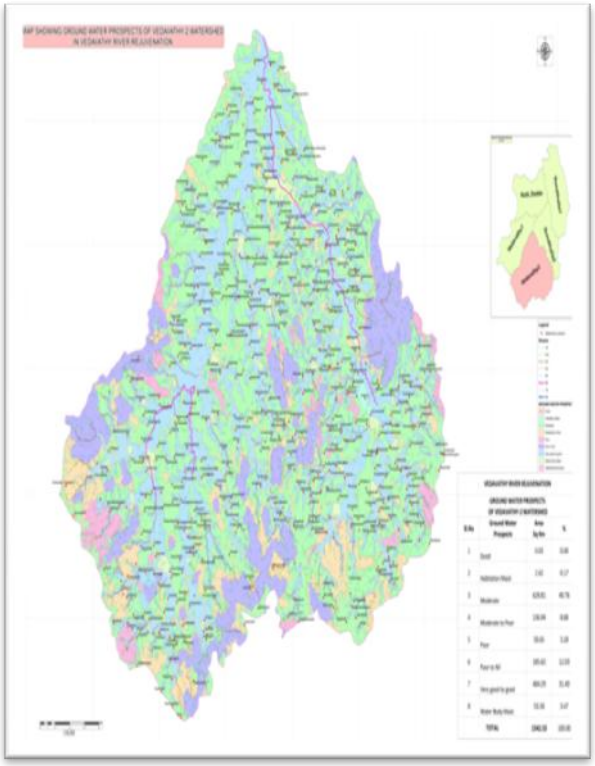

Fig.7 Landuse Landcover Map Vedavathy 2

III. Result and Discussion:

3.1 Procedure used for estimating runoff from SCSCN and Stranges Table method

1. Land use/cover information of the catchment under study is derived based on interpretation of multi-seasonal satellite images. It is highly advantageous if the GIS database of the catchment is prepared and land use/cover data is linked to it.
2. The soil information of the catchment is obtained by using soil maps prepared by National Bureau of Soil Survey and Land use planning (NBSS & LUP) (1996). Soil data relevant to the catchment is identified and appropriate hydrological soil classification is made and the spatial form of this data is stored in GIS database.

3. Available rainfall data of various rain gauge stations in and around the catchment is collected, screened for consistency and accuracy and linked to the GIS database. For reasonable estimate of catchment yield it is desirable to have a rainfall record of at least 25 years duration.
4. Thiess polygons are established for each identified rain gauge station.
5. For each Thiessen cell, appropriate area weighted CNII value is established by adequate consideration of spatial variation of land use and/cover and soil types. Further, for each cell, corresponding CNI and CNIII values are determined by using equations.
6. Using the relevant SCS-CN equations sequentially with the rainfall data, the corresponding daily runoff series is derived for each cell. From this, the needed weekly/monthly/annual runoff time series is derived. Further, by combining the results of various cells constituting the catchment, the corresponding catchment runoff time series is obtained.
7. Appropriate summing of the above time series, yields seasonal/annual runoff volume series and from this the desired dependable catchment yield can be estimated.

TABLE 1. Summary Of Calculation Using Scs Cn Method:

REGION	**AVERAGE RAINFALL mm**	**Runoff Depth mm**	**TOTAL RUNOFF(Mm3)**
KADUR	76.05	31.88	6.3353
HOSADURGA	70.19	24.32	3.5611
CHENNAGIRI	69.967	24.53	0.1084
HOLALKERE	69.60	24.43	2.078
CHIKMAGALUR	103.9	56.21	2.9739
TARIKERE	88.375	44.91	1.1417
HASSAN	69.12	21.60	0.31122
BELUR	87.741	41.47	1.642
ARSIKERE	69.60	26.25	2.8933
TIPTUR	77.7	36.24	0.8077
CK HALLI	83.49	42.50	1.048

Table 2. Summary of calculation using Strange's table method

Area	Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chitradurga	Total Monsoon Rainfall mm	812.9	336.2	687.4	538.6	689	557.1	276.5	451	706.5	706.5	439.7
	Total Monsoon runoff mm	173.14	19.23	158.1	66.35	118.78	71.75	14.35	42.79	125.96	125.96	39.5
	Runoff Mm3	3.76	0.41	3.43	1.44	2.58	1.56	0.31	0.93	2.73	2.73	0.85
Holalkere	Total Monsoon Rainfall mm	677.1	370	557.3	561.4	654.4	589.6	414.5	280.6	617.4	617.4	536.7
	Total Monsoon runoff mm	114.36	22.97	71.83	73.47	105.68	82.36	43.98	11.22	91.62	91.62	64.99
	Runoff Mm3	2.48	0.49	1.56	1.59	2.29	1.76	2.42	0.24	1.99	1.99	0.79
Chickmagular	Total Monsoon Rainfall mm	778.4	346.9	833	596	1344.6	1117.4	596.9	348	477.5	477.5	847.3
	Total Monsoon runoff mm	158.17	42.69	181.59	113.42	523.31	351.96	111.62	20.88	46.8	46.8	190.82
	Runoff Mm3	3.44	0.92	3.94	2.46	11.38	7.56	2.42	0.45	1.01	1.01	13.74
Kadur	Total Monsoon Rainfall mm	538.1	263.4	581.2	510	621.8	616	349.04	313	423.2	423.2	532.6
	Total Monsoon runoff mm	66.26	9.22	80.14	58.19	94.45	91.1	20.09	14.67	34.77	34.77	63.74
	Runoff Mm3	1.44	0.2	1.74	1.26	2.05	1.98	0.45	0.1	0.75	0.75	0.14
Tarikere	Total Monsoon Rainfall mm	947.6	651.7	817.5	821	859.8	795.9	624.38	406.6	773.5	773.5	699.4
	Total Monsoon runoff mm	245.62	104.27	177.15	179.14	197.49	166.9	59.51	31.55	156.32	156.32	122.95
	Runoff Mm3	2.34	2.26	3.85	24.17	4.29	3.63	1.29	0.68	3.39	3.39	1.84
Arasikere	Total Monsoon Rainfall mm	606.9	329.5	681.5	490.9	573.6	644.5	363.12	172.5	613	613	437.7
	Total Monsoon runoff mm	88.12	17.52	115.85	254.04	76.28	100.99	59.51	2.39	92.05	92.05	38.95
	Runoff Mm3	1.91	0.38	2.51	5.52	1.65	2.19	1.29	0.05	2	2	0.336
Hassan	Total Monsoon Rainfall mm	1219.2	653.1	966.9	963.6	688.3	838.2	499.5	281.5	845	845	463.2
	Total Monsoon runoff mm	264.54	100.44	256.13	254.04	116.95	186.08	55.8	11.28	253.59	253.59	45.34
	Runoff Mm3	5.75	2.44	5.57	5.52	2.54	4.04	1.21	0.24	5.51	5.51	3.08

Strange (1892) studied the available rainfall and runoff and runoff in the border areas of present-day Maharashtra and Karnataka and has obtained yield ratios as functions of indication representing catchment characteristics. Catchments are classified as good, average, and bad according to the relative magnitude of yield they give. For example, catchments with good forest/vegetal cover and having soils of high permeability would be classified as bad, while catchments having soils of high permeability and having little or no vegetal cover is termed as good.

The estimated surface runoff is used to plan for proper water and land management in the study area. In this direction, rainfall – runoff analysis will help in knowing the amount of runoff so that the alternate cropping pattern can be suggested for the available water.

- The result from surface runoff helps us to provide water conservation measure by some of the popular engineering management practices are terrace construction, channel diversion, gully plugs, farm ponds, and provision of gabions, recharge pits, etc. Similarly, vegetative measures include seeding and fertilizing of pastures, strip cropping, afforestation measures, fruit trees, shrubs, etc.
- For the proposed construction of weir or barrage in the given study area proper Watershed development and planning of water resources is done effectively.
- In SCN Curve number method Antecedent moisture condition of soil plays very important role because CN number varies according to water content present in the soil and that is considered while estimating runoff depth.
- From the above runoff calculations it is found that strange table method, shows very low runoff and SCN Curve number method results shows very high runoff as compare to STRANGE'S TABLE method.(Irrigation Department recommends SCSCN method than Stranges table Method)
- The catchment area consists of first order, second order, third order, and fourth order upto 7th order stream network. The catchment area has medium infiltration capacity .It consist of various land use and land cover pattern. The majority of the area is under agricultural area .Hence in the catchment artificial recharge structures are constructed at micro watershed to mini watershed in the basin.
- The proposed structures are injection well, recharge well, farm pond, and Boulder checks. These structures are helps as recharging the ground water to considerable level. The ground water prospectus is moderately good as it has good water bearing strata.

IV. Conclusion

- It is evident from the thematic maps that catchment has good water bearing stratum. The soil is having moderate infiltration capacity. Geomorphology studies shows that catchment characteristics are favourable for proposing the suitable rain water harvesting structures.
- The runoff calculation shows that SCS-CN yields better results than the Stranges Tables Methods. Hence it is shows that runoff value is higher in SCSCN method then the Stranges table method.
- Hence it can be concluded that by constructing the recharge structures runoff could be effectively utilized for recharging the ground water. Thereby it helps in rejuvenating the Groundwater and its utilization for agricultural purposes.

References

[1] Ishtiyaq Ahmad 1, Vivek Verma 2, and Mukesh Kumar Verma 3 Application of Curve Number Method for Estimation of Runoff Potential in GIS Environment 2015 2nd International Conference on Geological and Civil Engineering IPCBEE vol. 80 (2015) © (2015) IACSIT Press, Singapore

[2] M Latha., etal Comparison of GIS based SCS-CN and Strange table Method of Rainfall-Runoff Models for Veeranam Tank, Tamil Nadu, and India. International Journal of Scientific & Engineering Research, Volume 3, Issue 10, October-2012 1 ISSN 2229-5518

[3] Arun W. Dhawale "Runoff Estimation for Darewadi Watershed using RS and GIS" International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-1, Issue-6, January, 2013

[4] J.P. Patila, A. Sarangia, A.K. Singha, T. Ahmadb "Evaluation of modified CN methods for watershed runoff

B N Suma. "An Estimation of Runoff of a Catchment by Spatial and Analytical Approach." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 14, no. 5, 2017, pp. 15–19.