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Studies on Water Balance and Groundwater Budgeting in Godawari-Purna Sub-basin

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Abstract

The Godawari-Purna sub basin is located between 76°36' to 77°59' E and 19°07' to 19°17' N with an area of 34413.87 ha falls in assured rainfall region. The basin boundary was updated using the updated drainage and terrain information from high resolution satellite data of LISS-IV using GIS tool. Based on the last 30 years rainfall records, the runoff potential was estimated using SCS curve number method. Marathwada region of Maharashtra state has always been a water deficit area which calls for immediate remedial measures to address the critical water resources situation in the region. The entire Godawari-Purna sub basin (GP sub basin) is hard rock terrain. It suffers from growing water scarcity, which is aggravated by frequent droughts. The various water balance components *viz*. soil moisture storage, ground water recharge and surface storage were estimated for the GP basin. Similarly, the input from the rainfall was also worked out. The various losses such as runoff, evaporation from water bodies were estimated and accordingly the water available in the basin was estimated. The estimated values of ground water recharge were considered for water balance analysis. The surface water storage in each sub basin was estimated considering the water storage area as per satellite image and thus the storage volume was estimated. Combining the soil moisture storage, surface water storage and ground water recharge, water availability was estimated for each sub basin. The surface runoff was estimated by water balance method considering the rainfall volume and losses in each sub basin. Water balance study reflected that sub-catchment No. I, IV, VI and VIII of GP sub basin are under total water deficit and require urgent attention for water management to meet out the water deficit

Key words : Catchment, Curve number, Evaporation, Groundwater, Hydrological soil group, Rainfall, Runoff, soil moisture.

Water is a prime natural resource and considered as a precious national asset. It is also a basic need for agricultural planning and development.Water resource planning based on water balance study is an important issue for sustainable development. The scientific and technological development has been conspicuously evident during this century in the major field of engineering and Remote Sensing and GIS. Surface and ground water are an important and a dependable source of water supplies in all climatic regions including both urban and rural areas. Unfortunately, lowering of groundwater table and aquifer depletion due to over exploitation and increasing population are threatening our ecosystem and even the life of our future generation. Marathwada region of Maharashtra state has always been a water deficit area which calls for immediate remedial measures to address the critical water resources situation in the region.

Materials and Methods

The study on water balance and water budgeting was conducted Godawari-Purna sub basin (GP sub basin), located between 76036' to 77°59'E and 19°07' to 19°17'N. The geographical area of the basin is 34413.87 ha. The rainfall data of last 30 years were collected from Department of Agricultural Meteorology, VNMKV, Parbhani and the rainfall data of the

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normal rainfall year was used to estimate the surface runoff potential using SCS curve number technique. The SCS curve number techniques is based on recharge capacity of the basin. (Mishra *et al*. 2006). The recharge capacity was determined by antecedent moisture condition and by physical characteristics of the watershed. Antecedent moisture condition (AMC) was used as an index of basin wetness. The selection of curve numbers was based on various hydrologic soil cover, land use, treatment or cultivation practices, hydrological condition of the area and hydrological soil group.

Water Balance Studies : An equation that describes the annual water budget of a natural system like watershed states that water input (I) equals discharge (D) plus or minus changes in water in storage (S):

I (water entering system) = D (water leaving system) + ΔS. .....(1)

In natural systems, water enters the system as precipitation (P) and leaves the system as stream flow (SF) (surface runoff plus ground-water discharge to streams) and evapotranspiration (ET):

P = SFΔS + ET ....(2)

where, P =precipitation, SF=stream flow leaving the watershed, S=change in storage, and ET=evapotranspiration.

The input from the rainfall was also worked out. The various losses such as runoff, evaporation from water bodies were estimated and accordingly the water available in the basin was estimated. Further, the water availability was compared with total water demand (crop and population) and thus the water deficit or surplus in each sub basin was estimated.

Estimation of water balance components : The various water balance components *viz*. soil moisture storage, ground water recharge and surface storage were estimated for the GP basin. Soil moisture storage was estimated considering the average soil moisture percentage, bulk density and root zone depth of the soil. The estimated values of ground water recharge were considered for water balance analysis. The surface water storage in each sub basin was estimated considering the water storage area as per satellite image and thus the storage volume was estimated. Combining the soil moisture storage, surface water storage and ground water recharge, water availability was estimated for each sub basin. Similarly, the evapotranspiration from the area of each sub-basin was also estimated and compared with the water availability to determine the water deficit / surplus. The surface runoff was estimated by water balance method considering the rainfall volume and losses in each sub basin.

Results and Discussions

Estimation of water balance components for GP sub basin : The various water balance components *viz*., soil moisture storage, ground water recharge, surface storage and evapotranspiration of the each sub catchment of GP basin watershed were estimated and the data is presented in Table 1.

The water availability in each sub catchment was estimated by adding soil moisture storage, groundwater recharge and surface storage and then compared with the evapotranspiration to determine the water deficit / surplus. Water balance estimation indicates that, sub catchment No. I, IV, VI and VIII are found water deficit and rest of the sub catchment were found in water surplus. These estimates will be helped in planning for various water harvesting structures particularly in water deficit sub-catchments of GP basin.

Ground-water budgeting of sub watersheds : Based on the ground water

recharge in each sub catchment, the input from ground water was determined. The total ground water requirement was worked out including both ground water requirement for irrigating crops and groundwater requirement for population and the data is presented in Table 2. Based on this data, the groundwater deficit / surplus for each sub catchments were determined. Ground water budgeting of basin indicated that, out of the 11 sub catchments of

Table 1. Estimation of water balance components in GP basin

Sub catchment number	Input from rainfall, (000' Cu.M.)	Soil moisture storage	Ground-water recharge	Surface storage	Water available (3+4+5)	ET	Runoff (Water balance method) {1-(6+7)}	Water deficit / surplus (6-7)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
I	46890.27	4520.01	8920.19	920	14360.2	14985.45	17544.62	-625.25
II	45912.99	4425.81	12597.00	21	17043.81	15718.45	13150.73	1325.36
III	22055.22	2126.03	5002.82	27	7155.85	5090.55	9808.82	2065.3
IV	47001.38	4530.73	8163.87	15	12709.6	13234.95	21056.83	-525.35
V	20653.95	1990.95	3302.49	87	5380.44	5039.97	10233.54	340.47
VI	38934.89	3753.15	5658.18	24	9435.33	10933.69	18565.87	-1498.36
VII	18597.32	1792.70	4298.72	92	6183.42	5285.57	7128.33	897.85
VIII	27996.73	2698.76	4001.31	37	6737.07	6859.55	14400.11	-122.48
IX	18667.76	1799.49	3503.24	18	5320.73	4918.37	8428.66	402.36
X	22348.27	2154.27	5489.14	11	7654.41	7588.17	7105.69	66.24
XI	19387.19	1868.84	5528.11	09	7405.95	6616.74	5364.50	789.21
Total	328445.97	31660.74	66465.07	1261	99386.81	96271.46	132787.7	3115.35

Table 2. Ground-water budgeting of sub catchments of GP sub basin

Sub catchment number	Input from groundwater (000' Cu.M.)	Water requirement of population from groundwater,	Water requirement for irrigation, 000'Cu.M.	Total water requirement from ground water, 000'Cu,M.	Groundwater deficit/surplus, 000'Cu.M.
1	**2**	**3**	**4**	**(3+4)=5**	**(2-5)=6**
I	8920.19	272.40	8814.07	9086.47	-166.28
II	12597.00	231.58	11907.76	12139.34	457.66
III	5002.82	4077.69	1375.04	5452.73	-449.91
IV	8163.87	293.06	8208.92	8501.98	-338.11
V	3302.49	39.81	1866.29	1906.1	1396.39
Vi	5658.18	918.77	5435.92	6354.69	-696.51
VII	4298.72	132.87	3784.22	3917.09	381.63
VIII	4001.31	178.70	3891.21	4069.91	-68.6
IX	3503.24	76.31	3278.34	3354.65	148.59
X	5489.14	107.26	5331.80	5439.06	50.08
XI	5528.11	87.34	4947.87	5035.21	492.9
Total	66465.07	6415.79	58841.44	65257.23	1207.84

GP sub basin, the ground water deficit was observed in five sub catchments No. III, IV, VI and VIII. The lowest water deficit was observed in sub catchment No. VIII i.e. 68.6 TCM. However the highest ground water deficit was observed in sub catchment No. III as it covers the most of the part of Parbhani city and thus the domestic water requirement of the population from ground water is higher. The higher surplus of groundwater was observed in sub catchment No. V due to scarce population and hence the domestic water requirement from groundwater is less. The surplus of ground water was observed in sub catchment No. II due to the percolation of water from the percolation tank near Jamb village. The sub catchment No. IX, X and XI are located towards the confluence point of the GP sub basin and hence the surplus groundwater was observed in these sub catchments. This information was found to be helpful in deciding the suitable locations for water harvesting structures and thereby for enhancing the groundwater potential to meet out the water deficit.

Conclusion

Water balance study reflected that sub basin No. I, IV, VI and VIII are under water deficit and require urgent attention for water management to meet out the water deficit.

References

Agarwal, A. K. Mohan, R. and Yadav, S. K. S. 2004. An integrated approach of remote sensing, GIS and geophysical techniques for hydrological studies in Rajpura block, Budaun district, Uttar Pradesh, Indian J PRVD, Jan-Feb : 35-40.

Jha, M. K., Chowdhury, A., Chowdary, V. M. and Peifer, S. 2007. Groundwater management and development by integrated remote sensing and geographic information systems: prospects and constraints. Water Resour. Manage, 21(2) : 427-467.

Mishra, S. S. and Nagarajan, R. 2010. Morphometric analysis and prioritization of sub watersheds using GIS and Remote Sensing techniques : a case study of Odisha, India. International Journal of Geomatics and Geosciences, 1(3) : 501-510.

Pawar, A. S. 2015 Water budget of Bhad river watershed, Panzara river basin, Dhule District of Maharashtra State, International Journal of Engineering and Innovative Technology, Vol. 4(10), pp. 53-58.