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Research Paper :

Water budget assessment of Agricultural University Akola Campus

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ABSTRACT

The study was carried out to know the water resource potential and demand of the Dr.Panjabrao Deshmukh Agricultural University campus, Akola to assess the need of water conservation measures in order to maintain water need of the campus. The water potential of the campus was 453564.98 m^3/yr, which comprised of surface run off (325616.1 m^3/yr) and extractable ground water of 127948.88 m^3/yr (75% of ground water recharge of 170598.5 m^3/yr). On the other hand, the water demand of the campus was estimated as 188217.99 m^3/yr that includes water demand of students and peoples (42887.5 m^3/yr), animals (1980.49 m^3/yr) and agriculture water need (143350 m^3/yr) of the campus. It was observed that, water potential is more than the water need of the campus. Even then, due to lack of water conservation measures, the runoff water is getting out of the campus and creating a water shortage of 60269.11 m^3/yr.

Key words : Water conservation, Antecedent moisture condition, Surface runoff, Watershed

Soil and water are the two major natural resources essential for crop production. Efficient management and utilization of these resources is very important to increase the crop production and productivity per unit. One of the main objects of soil and water conservation measure is to conserve maximum possible rainwater in the soil to make efficient use of it and increasing the storage capacity of the profile to conserve the rainwater (Gawande *et al.*, 1997). A reduction in the huge runoff losses from land area will automatically means that more water will become available for retention as soil moisture. In Akola district, only 500 ha area (14%) is irrigated which is very low and most of the area (86%) under rainfed. The next alternative, therefore, is to concentrate on the best use of rainfall through water harvesting. The future of Indian agriculture lies in the better management of water and *in situ* conservation of moisture.

The availability and demand of water vary with time and space. One of the major requirements for water resources development and management is analysis of water availability and demand in the area. The spatial variation necessitates, selecting a suitable hydrological unit in terms of area in which water availability is uniform. Watershed is a hydrological unit since it has defined boundaries and can be taken as unit for water balance studies (Giraldez and Ayuso, 1988). Also, watershed based water management is being advocated as most appropriate approach, since in this approach, emphasis is being given to meet the total water demand in the watershed from available resources. This approach sounds well and scientific, as it offers a possibility of matching the demand with the availability on temporal scale. Keeping the above necessities in view, a project was undertaken for computation of water needs in the Dr. PDKV campus and available water potential.

METHODOLOGY

Location and climate of watershed:

The watershed that is under study was delineated on contour map (Scale 1:5000 cm). Akola is located between 19^{0}51' and 21^{0}16' N latitude and 56^{0}33' and 77^{0}44' E longitude. Watershed area is about 265 ha. Nala is flowing in the direction from North to Southwest.

The mean monthly temperature of Akola ranges from 20.5 to 30.5^{0}C with recorded minimum and maximum temperature of 11.8^{0}C and 48.5^{0}C in the month of December and May, respectively. Akola district falls in assured rainfall zone of Maharashtra state having an average annual rainfall (a.a.r.) of 790 mm. Rainfall occurs mainly during South West monsoon originating from Arebian Sea. Onset of monsoon is normally during the second week of June and gradually reduces in month of October. About 90% annual rainfall occurs between June to September.

Analysis of daily rainfall data:

The daily rainfall data were collected from the meteorological department of Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola. To estimate the runoff, the eleven years (1992-2002) daily rainfall data were considered for the study. The collected daily rainfall data were analysed for deciding the antecedent moisture

condition (AMC) of the soil at the particular rainfall event to compute the runoff from the watershed area. AMC condition of the soil is determined by taking the sum of five days rainfall (Table 1).

Table 1 : Rainfall limits for estimating antecedent moisture condition

Antecedent moisture condition	5 days total antecedent rainfall, mm	
	Dormant season	Growing season
AMC I	<12	<35
AMC II	12.5 to 27.5	35 to 52.5
AMC III	> 27.5	> 52.5

The runoff calculated from the daily rainfall data using the Curve Number Technique method (Gilley *et al*., 1995, Kumbhare and Rastogi, 1992 and Shrivastava and Rao, 1993). In order to calculate the runoff, following steps were involved. (a) First hydrological soil group of the catchment was determined according to infiltration rate of the soil. (b) CN for AMC II was determined according to land use, treatment given, hydrological condition and hydrological soil group. (c) CN for AMC I and AMC III have been obtained from the graph. (d) Potential maximum retention (S) was determined by using following equation;

$$CN = \frac{25400}{254 + S} \quad (1)$$

Then runoff (Q) was determined by using following formula.

$$Q = \frac{(P - 0.2S)^2}{P + 0.8S} \quad (2)$$

where,
Q = runoff, mm
P = rainfall, mm
S = potential maximum retention

Estimation of water demand for domestic and irrigation purpose:

The total population was estimated by collecting information about students, the working staff *i.e.* academic, non academic, working labours etc. from the respective colleges and respective offices, hostels including boys and girls' hostel, quarters, library etc. The water demand for public purpose which includes residential and non-residential persons in the campus was estimated based on the total population and per capita requirement for the population of Dr. PDKV, Akola university campus under normal condition. Irrigation requirement was estimated based on cultivated area and requirement of water in m^3/ ha per year for the season.

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been summarized under following heads:

Estimation of surface runoff from watershed:

Using curve number technique total surface runoff from watershed during monsoon was estimated. According to the type of land, treatments applied and hydrological soil group, CN for AMC II was found to be 80. The CN for AMC III and AMC I were obtained from the graph. Thus CN from the graph for AMC III and I were found to be 60 and 90, respectively. From these CN numbers, potential maximum retention (S) was calculated for three AMC conditions which were worked out to be 169.33, 63.5 and 28.22 mm. for AMC I, AMC II and AMC III, respectively. For every rainstorm above 12.50 mm, AMC was determined using five-day antecedent moisture condition and then runoff was estimated using equation 2. The average monthly rainfall, runoff and percentage contribution of rainfall towards runoff are presented in Table 2. The average surface runoff from watershed area during June, July, August and September was found to be 38.774, 46.34, 23.92 and 13.84 mm, respectively (Table 2). It shows that monthly runoff was more in the months of June and July in comparison to August and September months. It is observed from the Table 2 that total runoff in the watershed was about 18.90 per cent of total rainfall during monsoon season. Month wise per cent runoff from the period of June to September was 25.21, 26.74, 12.71 and 10.27 per cent, respectively. Total average seasonal runoff was 122.874 mm taking only runoff events into consideration. Therefore, the amount of surface runoff was estimated as 3,25,616.1 m^3 from the watershed area of 265 ha.

Table 2 : Average monthly runoff during the monsoon season (1992- 2002)

Months	Rainfall, mm	Runoff, mm	% of runoff with respect to rainfall
June	153.8	38.774	25.21
July	173.28	46.34	26.74
August	188.11	23.92	12.71
September	134.72	13.84	10.27
Total	649.91	122.874	18.90

Ground water recharge:

The ground water recharge from rainfall was estimated using infiltration method taking normal monthly rainfall and infiltration factor equal to 9 per cent. The results pertaining to ground water recharge are presented in Table 3. The average ground water recharge from rainfall in the month of June, July, August and September were about 13.842, 15.595, 16.929 and 12.124 mm, respectively. So the total ground water recharge from rainfall for watershed area 265 ha. was estimated as 154998.5 m^3.

Table 3 : Month wise ground water recharge from rainfall

Month	Rainfall (mm)	Recharge (mm)
June	153.8	13.842
July	173.28	15.595
Aug	188.11	16.929
September	134.72	12.124

According to the soil conditions seepage rate was considered as 2.5 mm/h *i.e.* 0.06 m/day. The combined daily seepage from nala and stream was estimated on the assumption that the nala and stream are flowing for 10 days. The results of recharge rates from nala and stream are presented in Table 4. It is revealed from table 4 that, the total seepage for both nala and stream was estimated as 1560 m^3/day. Considering 10 rainy days during which nala and stream flows, total recharge was estimated as 15600 m^3 during the season.

Table 4 : Ground water recharge from nala and stream

Type of flow	Mean wetted perimeter, m	Length, m	Wetted area, m^2	Ground water recharge rate m/day	Recharge, m^3/day
Nala	10.0	2300	23000	0.06	1380
Stream	5.00	600	3000	0.06	180
		Total		1560	

Water demand of public and animals:

Total population estimated in university campus was about 2700. In the hostels about 650 - 700 students were living. In quarters considering four persons in each quarter, total population was estimated to be 884 – 900. Remaining population was from academic, non-academic staff and working labour in university through out the year. It was considered that water used at the rate of 70 lit/day for domestic and civic purposes for residential persons and 5 lit/day for non-residential persons.

Water demand for animals was estimated on the basis of daily water requirement for different animals, which was estimated in lit/day. Animals including bullocks, cows, buffaloes, calves, broilers, layers consumed water as their daily requirement. The population of these animals and birds varies through the year. So, some constant population was taken into consideration on the basis of the information taken at present condition. The total water demand by human beings and animals are presented in Table 5. For human beings it was estimated as 117500 lit/day (42887.50 m^3). This demand includes domestic and civic purposes, which was estimated on basis of requirement of total population and per capita requirement. The total water requirement for animals was estimated as 5426 lit/day (1980.49m^3). Thus total water requirement on daily water use basis was 122926 lit/day. Therefore, the whole water requirement per year was estimated as 44867.99 m^3/year.

Table 5 : Daily water requirement for public and animals

Category	Population	Water use	Total requirement (lit/day)
Public			
Residential	1600	70	1120000
Non Residential	1100	5	5500
Bullock	6	70	420
Cow	25	50	1250
Buffalo	25	80	2000
Calves	34	40	1360
Broiler	256	60 lit/100 day	156
Layer	400	60 lit/100 day	240
Total		122926	

Water demand for irrigation of horticultural crops and agronomical crops:

In horticultural crops Sapota, Guava, Mango, Orange, Mosumbi and Ber are included. The water requirement for horticultural crops is estimated on the basis of the land under cultivation and water requirement of different crops in m^3/ha-year. Total water requirement by the horticultural and agronomical crops are presented in Table 6. From Table 6, it is revealed that the total water

Table 6 : Water demand for irrigation of horticultural crops and agronomical crops

Water demand for different crops	Area under cultivation, ha	Total requirement, m^3/year
Horticultural crops	13.07	120950
Agronomical crops	2.8	10400
Garden and Lawns	1.2	12000
Total		143350

requirement per year was accounted to 143350 m^3 for the horticultural, agronomical and garden and lawns.

Analysis of water resources potential availability and demand:

The total annual fresh water potential of the watershed was estimated as 453564.98 m^3 which comprised of different sources *i.e.* surface runoff (325616.1 m^3) and extractable ground water (127948.88 m^3 *i.e.*75 % of ground water recharge of 170598.5 m^3). The total water demand in the university campus is 188217.99 m^3, which includes water demand for students and peoples (42887.5 m^3), animals (1980.49 m^3) and for agriculture (143350 m^3). It is observed that water availability is more than the water needed. However, only ground water through wells was utilized in the university campus since there was no provision to tap the surface runoff and as such it goes as waste. Surface runoff was also very temporarily during the season. The extractable ground water availability was only 127948.88 m^3 which was too less to fulfill the requirement of total water demand of 188217.99 m^3. Available potential of the water source was not adequate since all the runoff was not conserved and accounting for shortage of 60269.11 m^3 of water per year. Therefore, proper conservation of runoff water was needed. The constructions of permanent water harvesting structures are very much essential for rainfed areas (Verma and Sharma, 1990). The water shortage was experienced since complete water potential was not tapped and conserved. If the total water potential is conserved, it will suffice the water need of human beings, animals and agriculture in watershed for which master conservation plan is to be prepared and implemented. However, with recent construction of 5 farm ponds (Wardha, Vena, Pranhita, Morna and Purna) and one nala bund, it was able to tap 7987.5 m^3 and 14070 m^3/yr of water, respectively. Even then, it is leading to a shortage of 38211.61 m^3 of water annually. So, with these findings, it clearly indicates the need of more water conservation structures in the campus to meet the water demand.

Conclusion:

Due to lack of water conservation measures, the runoff water is getting out of the Agricultural University Akola campus and creating a water shortage of 60269.11 m^3/yr.

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