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ESTIMATION OF GROUND WATER RECHARGE FROM PRECIPITATION IN RAJASTHAN

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At times, it becomes necessary to take up preliminary and quick ground water evaluation for a basin or region. This can be done only on the basis of available data on metereology and hydrogeology of the region. The author presents a method of estimating annual groundwater recharge by using rainfall and potential evapo-transpiration data. An attempt has been made to estimate approximately annual groundwater recharge for the State of Rajasthan by adopting the values of rainfall, runoff co-efficient and potential evepo-transpiration calculated on the basis Penman's method.

INTRODUCTION

Ground water budgeting of a basin includes an analysis of the total water loss due to evaporation and transpiration from all surfaces of a basin. Evapo-transpiration is, therefore, the combined loss of water vapour to atmosphere in the form of evaporation from water and soil, surfaces and transpiration from the plants. This loss depends on the availability of moisture and the ability of the atmosphere to supply energy to vaporise water and transport vapour. If supply of water is unlimited, the loss of water in the form of evaporation and transpiration will depend on the atmospheric conditions and the loss is termed as "potential evapo-transpiration". (P.E)

METHODS FOR ESTIMATING POTENTIAL EVAPO-TRANSPIRATION

The relation of evapo-transpiration to climatic factors, geographic location and vegetation has been studied by many Hydrologists and has led to the development of various formulae for estimating potential evapo-transpiration. These are mostly emperical and contain one or more climatological factors such as temperature, solar radiation, dew points, and wind speed. The most commonly used methods for estimating potential evapo-transpiration from climatological data are:

(1) Thornthwaite method, (2) Penman's method, (3) U.S. Weather Bureau method (a modification of Penman's method), (4) Lowry — Johnson method (5) Blaney — Criddle method, (6) Lane's method, (7) Hamon's method.

Without going in details of each method, the author adopts the values of potential evapo-transpiration as calculated by Rao, George and Ramasastri (1971) of India Meteorological Department based on Penman's method (1948), which is considered more appropriate for the different stations of Rajasthan. They have prepared contour maps showing the potential evapo-transpiration for every month for the

country, taking into account of values at the adjoining States and a few stations of Pakistan.

Distribution of Potential Evapo-transpiration In Rajasthan

Some of the important features observed in P.E. distribution over Rajasthan are worth mentioning. The P.E. is observed maximum in the month of June throughout the State and is highest around Jaiselmer (317.4) and the lowest in Udaipur district (178.7 mm) (excluding Mount Abu, which is a Hill Station). The values of P.E. gradually decrease onwards and are relatively low during monsoon period. It is only during the month of August that P.E. is low as compared to precipitation particularly in the eastern and sourthern Rajasthan. The P.E. generally decreases up to the month of December and there is a gradual increase from January to June. The lowest values are for the month of December, when Ganganagar is lowest with 40.4 mm., and Barmer is the highest having 77.1 mm.

Method for Estimating Groundwater Recharge

It is well known fact that when a basin receives precipitation, a part is lost as run-off, depending on the terrain characteristic, vegetation cover, type of soils etc. The run-off co-efficients can be calculated for every basin by recording the rainfall in the catchment area and the amount of water collected in reservoirs. The author has, however, broadly classified the terrain characteristics of the States and has assigned average values of run-off co-efficients on the basis of available data of important water reservoirs (Table I). After allowing the necessary allowance for run-off, the remaining balance of precipitation is utilised as potential evapo-transpiration in a particular basin. In case, if the monthly loss as P.E. is more than the remaining balance of the precipitation, it leaves no possibilities of any contribution towards ground water recharge.

Table I

Range of Values for run-off co-efficients for Rajasthan

Physical characters of the catchment	Range	Average
Hills, devoid of culturable land and rural population	25 - 50	35
Undulating Hills, with patches of agricultural lands, forests and pedimont plains	20 - 40	25
Undulating peneplained hills with thin sandy loam mantle	10 - 25	15
Undulating plains mostly of clayey soil	10 - 20	15
Undulating plains mostly of sandy loam soil	8 - 13	10
Undulating plains mostly of sandy soil	3 - 7	5
Undulating sand dunes	0	0

TABLE II

Estimation of groundwater recharge from precipitation at different stations of Rajasthan

Months	Rainfall (mm)	Balance of rainfall after deducting run-off-allowance	P. E.	Balance available for groundwater recharge (mm)
1	2	3	4	5
1. Run-off allowance — Nil				
(i) GANGANAGAR				
July	68.70	68.70	236.30	—
Aug.	76.80	76.80	193.70	—
Sept.	49.50	49.50	161.40	—
(ii) BIKANER				
July	86.80	86.80	288.20	—
Aug.	104.50	104.50	196.60	—
Sept.	45.70	45.70	177.70	—
(iii) JAISALMER				
July	89.50	89.50	247.60	—
Aug.	85.80	85.80	210.70	—
Sept.	13.90	13.90	192.00	—
(vi) BARMER				
July	87.40	87.40	178.10	—
Aug.	139.10	139.10	152.30	—
Sept.	33.10	33.10	163.60	—
(v) SIKAR				
July	155.20	155.20	155.90	—
Aug.	126.00	126.00	133.00	—
Sept.	43.00	43.10	134.40	—
2. Run-off allowance — 5%				
(i) PHALODI				
July	72.10	68.50	225.10	—
Aug.	93.20	88.64	185.50	—
Sept.	23.70	22.52	186.00	—
(i) JODHPUR				
July	121.80	119.71	184.00	—
Aug.	145.50	138.23	145.20	—
Sept.	47.40	40.29	156.10	—

TABLE II (*Contd.*)

1	2	3	4	5
3. **Run-off allowance — 10%**				
(i) JAIPUR				
July	193.20	173.88	161.70	12.18
Aug.	239.00	215.10	126.40	88.70
Sept.	89.80	80.82	144.80	—
				100.88
4. **Run-off allowance — 15%**				
(i) AJMER				
July	187.40	159.88	155.80	4.08
Aug.	174.60	148.41	128.30	20.11
Sept.	71.00	60.35	142.10	—
				24.19
(ii) KOTA				
July	308.60	262.31	138.60	123.71
Aug.	267.90	227.72	120.60	107.12
Sept.	132.20	112.37	138.30	—
				230.83
5. **Run-off allowance 25%**				
(i) UDAIPUR				
July	197.30	149.98	119.50	30.48
Aug.	206.90	155.18	102.30	52.88
Sept.	120.40	90.30	115.30	—
				83.36
(ii) JHALAWAR				
July	356.60	267.45	140.80	126.65
Aug.	326.70	245.03	125.80	119.23
Sept.	168.50	126.38	129.60	—
				245.88

There may be some stations where the precipitation may be more than the monthly potential evapo-transpiration and this amount, therefore, can be regarded as available for groundwater recharge. This surplus quantity can be computed for a basin and an approximate assessment of groundwater recharge from precipitation can be made.

CONCLUSIONS

The author has worked out the hydrologic balance study for all the I.M.D. Stations and of Rajasthan (Table II) and it is observed that after allowing the contribution for the run-off, all the area lying east of Aravalli axis gets considerable recharge directly from the precipitation (Plate). The ground water recharge is maximum in Rajakhera-Dholpur area of Bharatpur district, south-eastern part of Jhalawar district and Kushanpur block of Banswara district (Over 300 mm.). The contours of groundwater recharge almost take a NE-SW trend and percentage of groundwater recharge from precipitation gradually increases towards east. It is also inferred that the area west of Jodhpur, Ajmer and Sikar has no possibilities of groundwater recharge from precipitation.

Although, this approach provides only an approximate estimation of ground water recharge from precipitation, can be adopted safely for preliminary and quick groundwater resource evaluation.

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