CS/AR-4/2004

WATER BALANCE FOR DHASAN BASIN IN MADHYA PRADESH

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NATIONAL INSTITUTE OF HYDROLOGY
JALVIGYAN BHAWAN
ROORKEE-247 667 (UTTARAKHAND)

2004

DIRECTOR
Dr. K.D. Sharma

HEAD & CO-ORDINATOR
Dr. A.K. Bhar

STUDY GROUP
L.N. Thakural
T. Thomas
Surjeet Singh

PREFACE

The scarcity of the available land and water resources, which is an outcome of the growing population, has necessitated it proper planning and management. The planning and management of water resources is also imperative due to the regional imbalances of the available water. Sooner than later, water will be a very scarce resource and therefore needs to be harnessed in a most scientific and efficient manner. The complexity of today's environmental problems suggests, even more than before, the need to understand the natural systems and how our actions affect them. Water budgeting is imperative for the assessment of the available water resources and also for proper management of the precious resource in a judicious and optimal way so as to meet the needs of the various users without any conflict of interest. The water balance provides quantitative individual contribution of sources of water in the system over different time periods and establishes the degree of variation in water regime due to changes in components of the system. The water balance method is a powerful tool to determine water deficiency for irrigation. This approach is useful for practicing scientific irrigation, which offers a firm basis for appraising the problems in the planning for timely sowing, how much water to apply in order to satisfy water requirements of crops without profligate waste and crop varieties in an area based on availability of water. Even though being lumped in nature it still helps one to understand the overall scenario of the water resources system. Planning for agriculture, industry, hydropower and domestic demands may be planned accordingly well in advance without any risk of failures to meet the expected demands from various user agencies.

This report titled *"Water Balance for Dhasan Basin"* has been prepared with an aim to determine the climatic water balance for Dhasan basin using the popular Thornthwaite's and Mather concept of potential evapotranspiration. This report has been prepared by Sh. L. N. Thakural, *Sr. Research Assistant*, Sh. T. Thomas, *Scientist 'B'* and Dr. Surjeet Singh, *Scientist 'C'* from Ganga Plains South Regional Centre of National Institute of Hydrology, Sagar under guidance of Dr. A.K. Bhar, Scientist 'F', NIH, Roorkee.

K. D. Sharma
Director

ABSTRACT

The estimation of water balance is necessary in the water resources development not only for economic appraisal of the project but also for checking the reliability and general pattern of the availability of water from month to month. As the planning, development and operation of the water resources projects in a river basin is very much dependent upon the availability of water, in required quantities, the water balance study is imperative. Therefore, water balance study in different time periods and its dependability has to be carried to conceive water resources development projects and ascertain its success for long term operation for a particular purpose for which it is meant. The water balance is useful for determining or predicting some of human impacts on the hydrologic cycle. The water deficit and the water surplus in the basin will eventually be evaluated from the water balance study, which is an essential part to be carried out before deciding an irrigation project.

The present study involves the evaluation of water balance components for Dhasan basin in Sagar district, Madhya Pradesh. The catchment area under the study is 2049 sq. km. and extends on both sides of Dhasan river. Thornthwaite and Mather method (1957) has been used for computation of various components of water balance like water surplus, water deficit runoff etc. The study reveals that the on normal basis, the basin has a annual water requirement of 1770 mm whereas the rainfall is 1149 mm and actual evapotranspiration is 821 mm. Computations have revealed a water surplus of 327 mm during monsoon months of July, August and September whereas the water deficit during the remaining period is 948 mm. The water deficit actually starts from the month of October, i.e. soon after the withdrawal of the monsoon from the basin and generally increases with onset of the summer season. Since the wheat is the major crop being sown during rabi season in the catchment area, irrigation has to be planned accordingly for the crops. Moreover, since the annual water deficit is much more than annual water surplus, the basin may be considered to be drought prone. This study will be useful to the Water Resources Department, Govt. of Madhya Pradesh to assess the availability of water in the basin and plan the water resources projects accordingly so as to obtain optimum yield from the crops by providing timely irrigation.

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1.0 INTRODUCTION

The balance between supply and demand for water is a delicate one, marked over time by political and environmental conflicts, the impacts of natural disasters and human actions, and the day-to-day demands for a multiplicity of uses for this most vital resource. Although a renewable resource, water is always neither available to a thirsty nation when and where it is needed, nor it is always of suitable quality for the intended use. Water must be considered as a finite resource that has limits and boundaries to its availability and suitability for use. Many of the existing sources of water are being stressed by withdrawals from aquifers and diversions from rivers and reservoirs to meet the needs of homes, cities, farms and industries. Increasing requirements to leave water in the streams and rivers to meet environmental, fish and wildlife, and recreational needs further complicate the matter.

The Indian society is mainly agrarian with about 75% of the people depending on agriculture. The total geographical area of India is about 328 million hectares. In India about 68% of total sown area of the country is drought prone. The scarcity of available land and water resources, which is outcome of the growing population, has necessitated its proper planning and management. Inadequate and uneven distribution of available water resources results in frequent crop failures and shortage of fodder and drinking water. Hydrologist have made attempts to make predictions of water availability to overcome the problems created due to temporal and spatial variations in precipitations The water balance studies are conducted to evaluate the net available water quantity and to assess the existing water utilization pattern and practices, which helps in planning the optimal and sufficient management of water resources in a region. The water balance is useful for predicting some of human impacts on the hydrologic cycle. The hydrologic effects of weather variation or changes of vegetation cover can be quickly estimated at a very early stage in the planning. Although the predictions may be approximate, they are sufficiently accurate to indicate whether a scheme is sound or not. The water balance can be refined to meet the most sophisticated design needs if sufficient time and money for instrumentation are available. Finally the method is valuable for helping to phrase precise questions about the chances of success, mode of operation, and environmental impact of proposed changes. It is therefore a valuable tool in the analysis of water problems in a region.

Thus the water balance is a powerful tool used for computing seasonal and geographic patterns of irrigation demand, the soil moisture stresses under which crop and natural vegetation can survive, a point of utmost importance to a country like India where water conservation is urgent and need for irrigation is omnipresent. The water balance calculated for any basin is an itemized account, which refers to the balance between incoming of water in form of precipitation and outflow of water by evapotranspiration, ground water storages and stream flow occurring within specified period of time.

In agricultural planning detailed information on soil moisture conditions i.e. its seasonal variation, period, duration and magnitude of moisture deficit and surplus are important in suitable scheduling of irrigation and estimating the amount of water to apply in each irrigation. A simple accounting method by Thornthwaite and Mather (1957) may be effectively employed for mutual comparison of precipitation and potential evapotranspiration for the evaluation of water balance for quantitatively assessing the adequacy of precipitation as water supply in relation to potential evapotranspiration as water need.

The present study is taken with an objective to determine the climatic water balance components of Dhasan basin using the popular concept of Thornthwaite and Mather (1957), which are fundamentally required in decision-making process. This technique uses long-term average monthly rainfall, long-term average potential evapotranspiration and soil and vegetation characteristics for computing the components of hydrologic cycle.

2.0 REVIEW OF LITERATURE

Scientists have worked over the years on the problem of how to express the daily or seasonal water budget of a place or area. The studies were advanced significantly in the 1940s by the work of C. W. Thornthwaite in the United States, H. L. Penman in England and M.I. Budyko in the USSR. The approaches of these major contributors to the water balance climatology are all quite different, the myriad of modifications of each of schemes that these and other scientist produced later have resulted in innumerable variations on the basic techniques. Water budgeting schemes and models has contributed to the understanding of our environmental water relations. Thornthwaite, (1948) developed a climatic water budget utilising a book keeping system of accounting for increments of water supply and loss on either daily or a monthly basis and later modified by Thornthwaite and Mather, (1957) to make it more useful under a wide range of soil and vegetation conditions.

This approach of computing the water balance was carried out by Subrahmanyam et. al, (1970) for Godavari river basin computing water surplus, water deficit and actual evapotranspiration for entire basin by utilising precipitation and temperature data of 56 stations. Similar study was done by Nale and Correia, (1983) for weekly water balance of Udaipur by employing this technique. Sudheer et. al, (1999) used SWRRB model, for simulating various components of water balance in Tambrapani river basin with daily precipitation and daily temperature data. A similar study is done by Kumar (2001) on monthly basis for Krishnai river basin and revealed that the basin is free from drought.

While we utilise the Thornthwaite and Mather, (1957) approach in the present instance, our major concern is for an understanding of the overall value of a water budget at a particular place, its usefulness and applicability, and its function in clarifying the water resources relationships of a place or a river basin.

3.0 STUDY AREA

The river Dhasan is an interstate river flowing between Madhya Pradesh and Uttar Pradesh with total length of 365 km. The Dhasan river rises in Raisen district of Madhya Pradesh at an elevation of 721 m. above mean sea level at latitude 23°26'00" and longitude 78°33'00". The river flows 240 km. in Madhya Pradesh and 71 km. in Uttar Pradesh and besides this forms a common boundary of 54 km. between Madhya Pradesh and Uttar Pradesh. It joins Betwa river at an elevation of 135 m. near Deer village in Jhansi district of Uttar Pradesh. The Dhasan river has five major tributaries out of which two are completely in M. P. and three lie partly in M.P.

Dhasan basin up to Patan village which extends from east longitude 78°22'30" to 79°00'00" and north latitude 23°26'00" to 24°16'00" and lies in Sagar district with a catchment area of 2049 sq. km. has been selected for carrying out the study. The study area lies at the southern eastern edge of great Malwa plateau. Most of the area shows more or less undulating topography having hills extended from southwest to northeast direction. The index map of the area is shown in Fig. 1. and the location map of the study area is given as Fig. 2.

3.1 Climate

The area enjoys a pleasant climate in the subtropical climate zone. Moderate to extreme heat is observed during the summer season in the area. The average maximum and minimum and mean daily temperatures for 25 years for Sagar district are as below:

Maximum	:	45.6 °C
Minimum	:	1.1 °C
Mean daily	:	23.3 °C

3.2 Rainfall

The southwest monsoon happens to be the larger contributor of monsoon rains which breaks by second week of June and lasts till the end of September. About 90% of the rainfall occurs during the month of June to September and the balance 10% is distributed in the winter and summer months. Broadly speaking, the district enjoys three distinct seasons viz. winter, summer and rainy. The average monthly rainfall in the Dhasan Basin is given shown in Table 1.

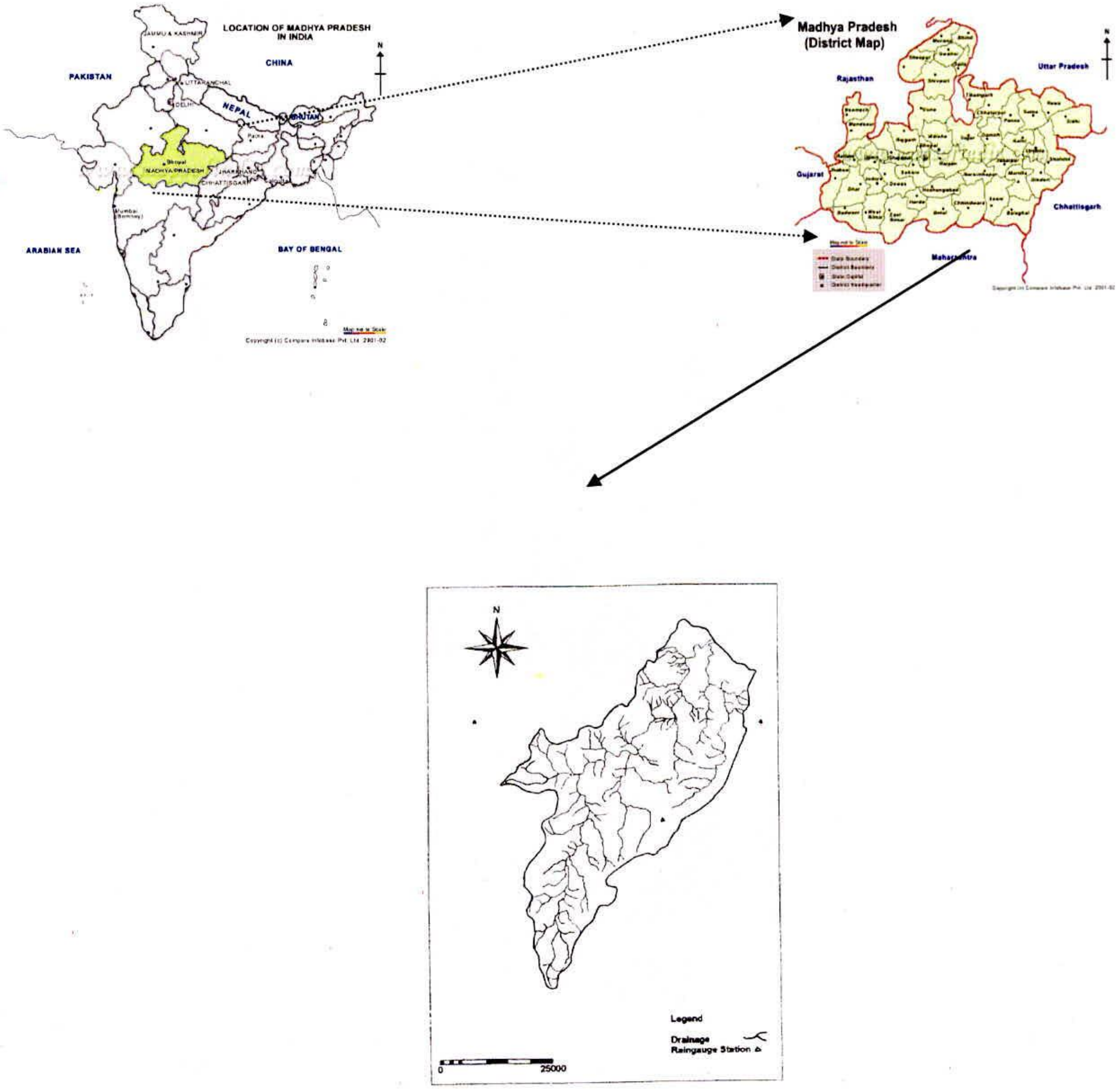

Fig. 1: Index map of study area

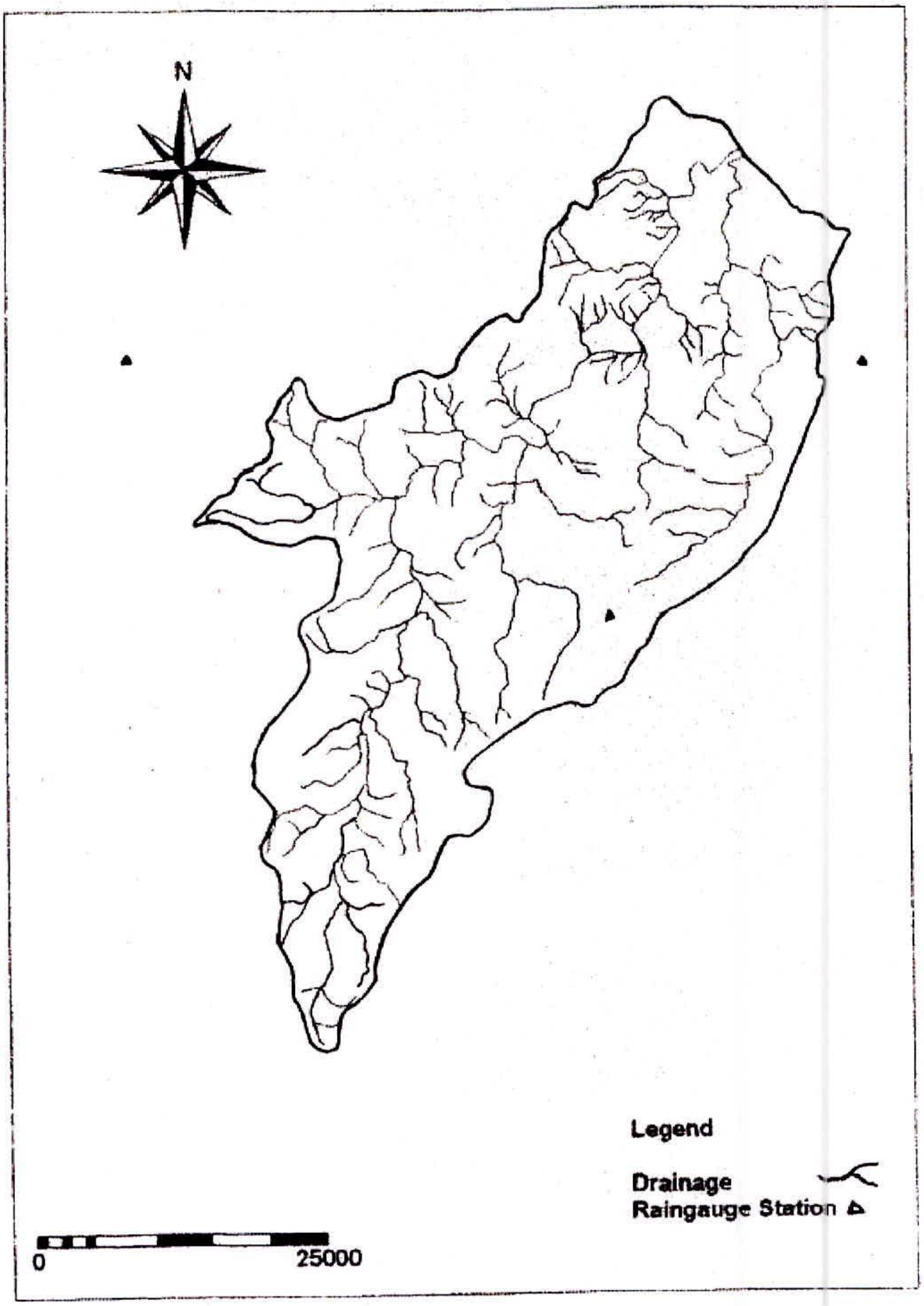

Fig 2: Location map of study area

3.3 Soils

The basin area is predominantly covered by clay and clayey loam type of sois. These soils are generally black coloured and are deep to very deep and spread on nearly leveled to gently sloping plains.

3.4 Geology

Various geological formations are exposed from east to west in the basin. The area is covered by Deccan Trap, which is basaltic lava flow and is made up of horizontal basalt. Sandstones are spread in northern part of the basin.

3.5 Agriculture

Wheat and pulses are the major crops cultivated in most of the area of basin in Rabi season. Kharif season crops are mainly oilseeds, pulses, jowar, maize and paddy. Double cropping is being practiced under the rainfed cultivation, which indicates that much higher cropping intensities can be achieved with proper irrigation. and application of fertilizers and manures.

4.0 MATERIALS AND METHODOLOGY

4.1 Materials

Survey of India toposheet no.'s 54 L and 55 I, scale (1:2,50,000) were used for digitizing the catchment boundary, rivers and location of rain gauge stations.

4.2 Data Used

In the present study daily rainfall data of three rain gauge stations namely Sagar, Banda and Khurai maintained by India Meteorological Department for the period of 11 years i.e. from 1985 to1995 has been used. The maximum and minimum daily temperature data of the Sagar station for the period of 11 years i.e. from 1985 to 1995 has also been used for the analysis.

4.3 Software's Used

ILWIS 3.0 has been used for preparation of thematic maps like basin map, soil map, land use map, location of rain gauge stations, drainage and computing the area of the basin. ILWIS 3.0 was used for generating the Thiessen polygon map for the basin.

4.4 Methodology

4.4.1 Estimation of average rainfall

In the hydrologic analysis it is required to have the aerial distribution of precipitation. The rainfall data of the three rain gauge stations, namely Sagar, Banda and Khurai has been considered in the present study. The Thiessen polygon for these rain gauge stations has been drawn from point interpolation using ILWIS and presented in Fig. 3 and the weight of each station was computed. The Thiessen weights are given in Table-2.

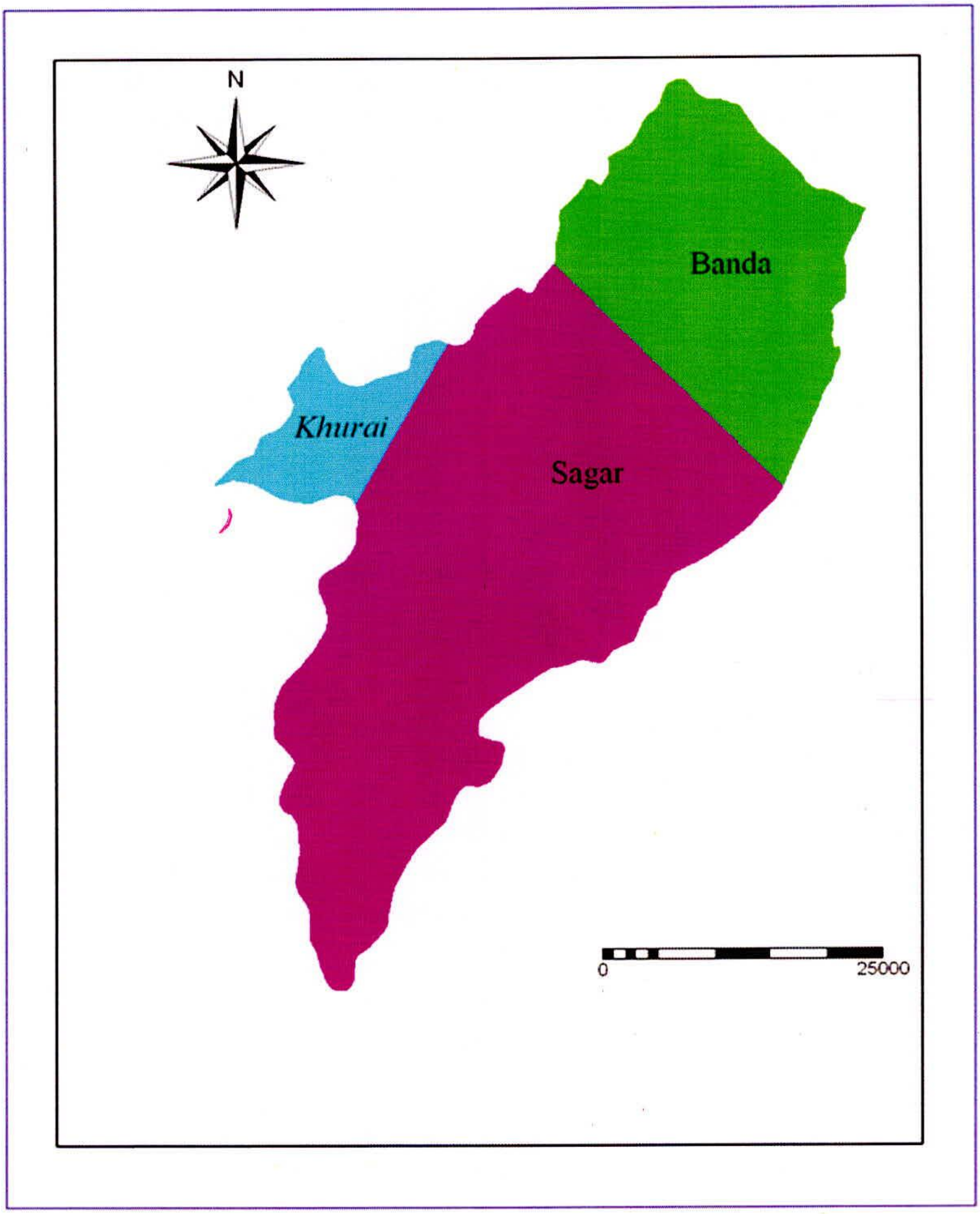

Fig 3: Thiessen polygon map of Dhasan basin

The average rainfall for the entire basin was computed using these weights of individual representing rain gauge stations. The average rainfall variation during the year 1985 to 1995 is shown in Fig. 4.

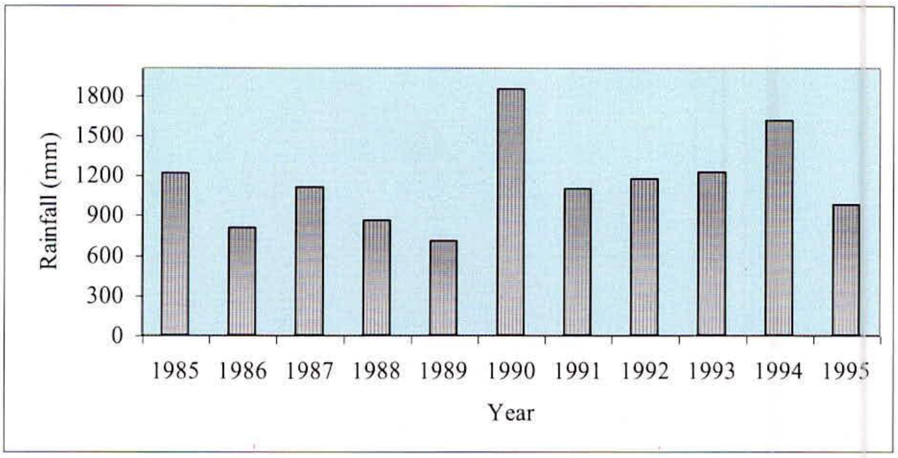

Fig 4: Rainfall variation in Dhasan basin during 1985-1995

4.4.2 Potential evaporation calculation

Thornthwaite (1948) developed a complex empirical formula for calculating potential evapotranspiration as a function of climatic average monthly temperature and day length. This method estimates potential evapotranspiration with assumption that an exponential relationship existed between mean monthly temperature and mean monthly consumptive use. The relationship was based largely on experience in the central and eastern United States.

Meteorological data for the study has been obtained from India Meteorological department, Pune, Maharashtra. The mean monthly air temperature is being used for calculation of potential evapotranspiration. Thornthwaite proposed the following formula:

$$ET = 1.6La\left(10\frac{Tn}{I}\right)^3 \qquad \ldots\ldots (3.1)$$

where,

ET = Monthly PET in cm

La = factor, to correct for unequal day length between months related to6 the latitude of the place.

Tn = Mean monthly air temperature in degree Celsius.

a = an empirical constant

$$= (675 * 10^{-9})J^3 - (771 * 10^{-7})J^2 + (179 * 10^{-4})J + 0.492$$

J = Total of 12 monthly values of heat index j

j = Monthly heat index $= \left(\frac{Tn}{5}\right)^{1.514}$

4.4.3 Computing the water balance components

The soil water balance was computed by following procedure by Thornthwaite and Mather method (1957)

The initial climatological data required for the purpose are:

1. Mean Monthly rainfall (in mm)
2. Mean Monthly temperature (°C)
3. Monthly potential evapotranspiration (PET) (in mm)
4. Field capacity moisture (storage capacity) (mm)

The procedure to be followed is as follows:

1. Average Monthly precipitation data (P) from processed rainfall data.
2. Calculated PET on monthly basis
3. Estimation of quantitative water excess as (+) and water deficit as (-) over PET. where P: precipitation. PET: potential evapotranspiration for each month.

4. Computation of accumulated values of (P-PET) for each month to account for gross potential deficit and gross potential surplus.

5. Computation of storage of soil moisture for each month. The release of soil moisture is an exponential function given by

$$St = AWC * \exp\left(Ac \frac{(P - PET)}{AWC} \right)$$

where,

St- Actual storage of soil moisture

AWC – Storage capacity of soil moisture

Ac (P-PET) – Accumulated values of (P-PET

6. Computation of change in storage (δSt)

δSt – is the change of actual storage from month to month. When the storage remains at capacity level the St=0; when St reaches values of less than the capacity, then St is calculated as the subtraction St from the actual month from St of the previous month.

δSt – can be negative and implies subtraction of water from the storage to be used for evapotranspiration.

δSt – can be positive which implies infiltration of water in the soil and its addition to the soil moisture storage

7. When δSt negative Actual Evapotranspiration (AET) is:

AET = δSt + P, when δSt is positive AET=PET

8. Once the soil moisture deficit has been developed, it is reduced when precipitation is stored in the soil at the beginning of the wet season. The soil moisture will eventually attain field capacity; however further precipitation excess must leave the soil by gravitational drainage. The amount of water stored (excess from SM) is moisture supply.

9. The moisture surplus drains out to the ground water body to streams. It cannot drain out in same month, however and certain proportion remains in the soil and carried over into later months.

10. Thornthwaite and Mather advised as for large catchments approximately 50% of surplus water that is available for runoff in any months actually runs off. The rest of the surplus is detained in the subsoil, ground water, small lakes and canals and is available for runoff during the next month.. The methodology described here is shown in flow chart in Fig. 5.

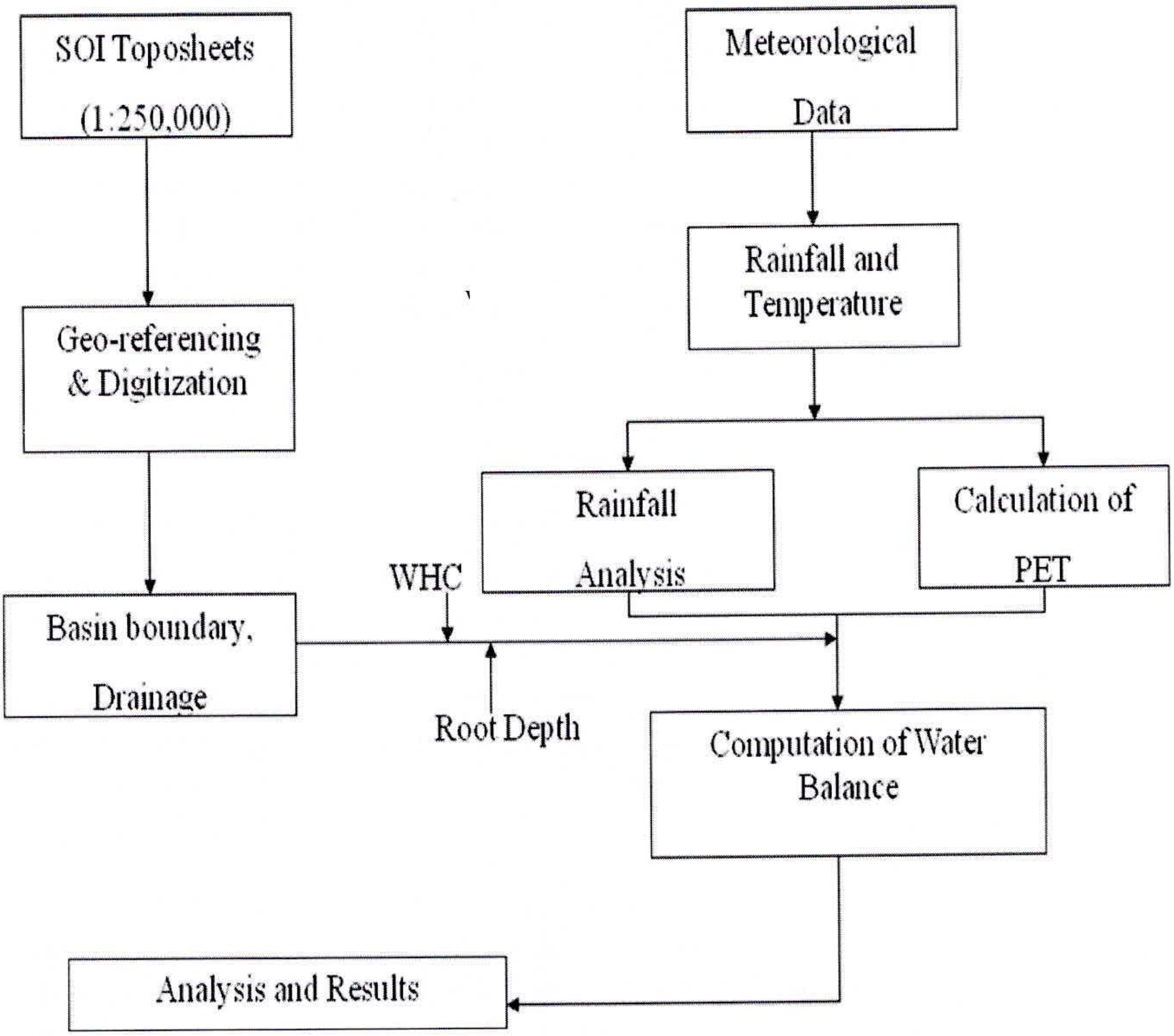

Fig. 5: Flowchart of the methodology

5.0 RESULTS AND DISCUSSION

In the present study the technique suggested by Thornthwaite and Mather (1957) have been used to compute the climatic water balance for the Dhasan basin for which mean monthly rainfall and temperature data for a period of 10 years from 1985 to 1995 has been used input variables. The average annual rainfall for the study area is 1148 mm, which is slightly less than the district average rainfall of 1245 mm. The variation of the annual average rainfall over the study area is presented in Table-3. The variation of rainfall over the basin under the observed period shows that below average rainfall was experienced during 1986, 1987, 1988, 1989, 1991 and 1995 and the range of deficit was from -3% to –38%. Similarly above average rainfall occurred during 1985, 1990, 1993 and 1994 and the variation was from 2% to 60%.

Potential evapotranspiration has been estimated with the help of Thornthwaite (1948) method using the temperature data for the Sagar district. The mean monthly maximum, mean monthly minimum and mean monthly average temperature are shown in the Fig. 6. The minimum temperature in the basin varies between 11.8°C in January to 26.06°C during May whereas the maximum temperature varies between 25.7°C in December to 41.08°C in May.

The estimation of all the normal water balance components has been presented in Table-4. The field capacity of the soil is assumed to be 150 mm. The computations for the water balance starts from the month of June and ends by the month of May. It is observed that the precipitation starts to increase from the month of June and reaches highest in the month of August. As the PET for June is greater than the actual rainfall therefore the basin is water deficit in the month of June by about 150 mm. However in July, August and September the basin is water surplus as the rainfall is greater than the PET; August being the month having a maximum surplus of 261 mm. This is indicative of the fact that proper storage structures can be envisaged for the judicious use of this surplus water for the water deficit months. Also as soyabean is the major kharif crop in the study area, it can be seen that additional irrigation water is not required during the monsoon months except in situations of weak monsoon. It is revealed that potential evapotranspiration exceeds precipitation for the remaining months indicating the dry season with water deficit in all the months accumulating to a total deficit of 948 mm. The soil moisture remains at field capacity of 150 mm during July to September and thereafter it starts reducing. The soil moisture ultimately becomes a negligible during the months of April to June. Also the soil moisture during the rabi season is rather very insignificant thereby indicating the need for providing irrigation water to the crops i.e. mainly wheat. The major runoff occurs during the months of July, August and September, amounting to a total of 328 mm, which can be tapped effectively by constructing small irrigation structures. The study identifies the wet season to be from July to August and the remaining months are dry season.

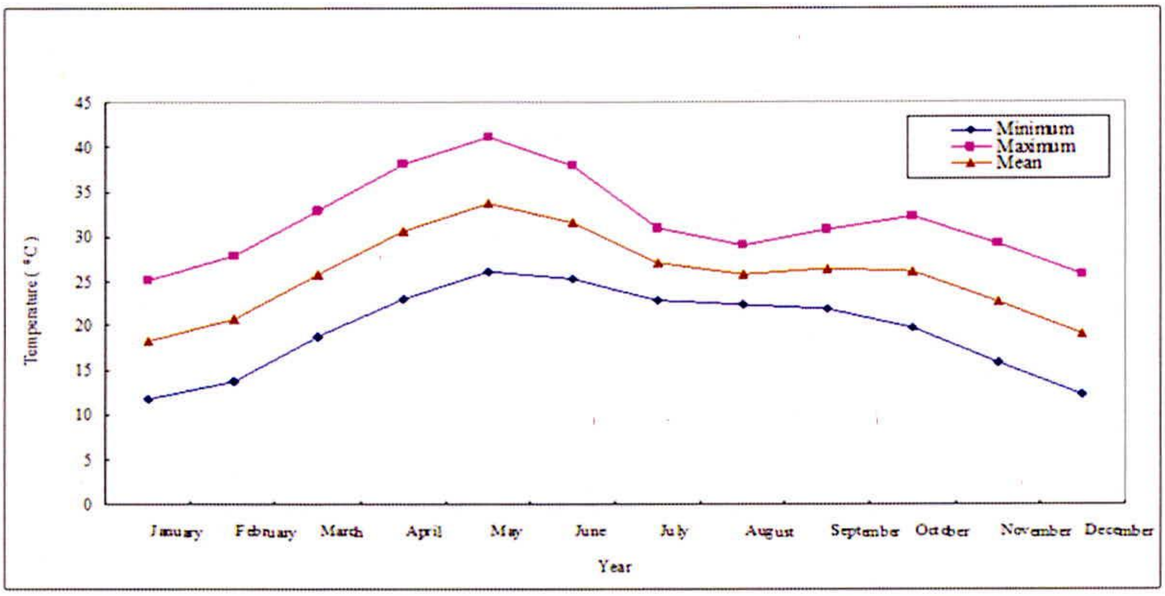

Fig 6: Temperature variation in Dhasn Basin

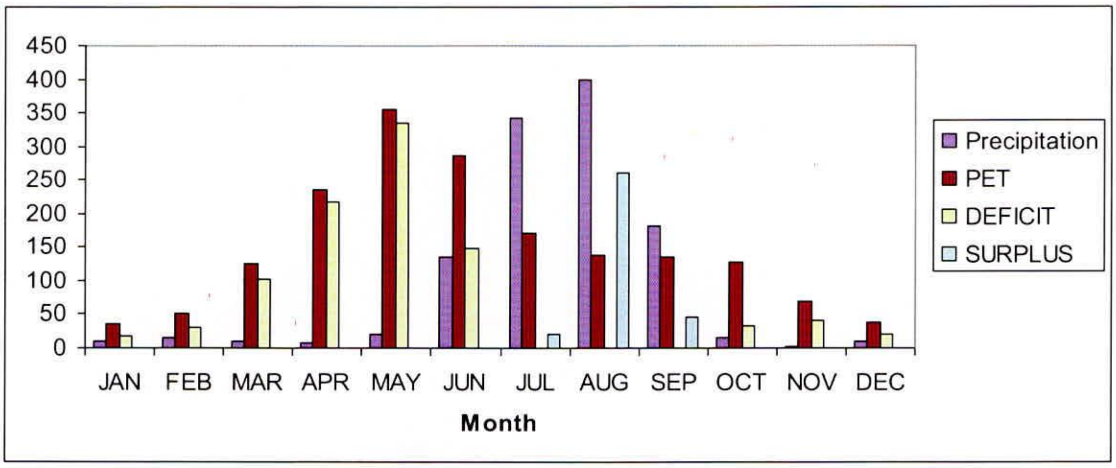

Fig. 7: Normal water balance for Dhasan basin

6.0 CONCLUSIONS

An attempt has been made to apply the Thornthwaite and Mather's technique of water balance computations for Dhasan basin in Sagar district. The study provides an insight into the hydrology of Dhasan river basin through the use of monthly water balance. Even though the water balance technique is lumped in nature but it still provides an insight into the various components interacting within the system and helps us to quantify the same with a fair degree of accuracy. One of the most important aspects in planning of an irrigation project is to assess the availability of water and its time distribution. The water balance method of determining water deficiency is a powerful tool for irrigation which not only can indicate when moisture is needed, but it also provides information on how much to apply in order to satisfy the needs without unnecessary wastage.

The following conclusions can be drawn from the study. The water balance of Dhasan basin illustrates that the basin is water deficit for most parts of the year except during July to August when there is ample water surplus amounting to 327 mm. The water deficit is observed during the rabi season when there is no rainfall or surface water irrigation available for the crops, especially wheat. The total water deficit in the basin is in the order of 948 mm, which is a matter of great concern. The surplus water in the basin can be harnessed by planning suitable water resources projects in the basin thereby providing a scope for bringing greater area under planned irrigation. The water balance study can also be used to determine the effect of global climatic changes on the volumes of water that is cycled under various hydrological processes in the basin. Such an analysis could be valuable to the various agencies involved in the water sector towards the water resources planning and management in the basin.

7.0 ACKNOWLEDGEMENTS

To mention the names of a few petals which together as a flower, scented with an elegant fragrance. It is opulent occasion for us to express our deep sense of gratitude to the Director, National Institute of Hydrology, Roorkee. We are grateful to Dr. A. K. Bhar, Scientist 'F', Head & Coordinator, RC Sagar for his full support and cooperation at every time step during the study.

We express my deep sense of gratitude to Shri Ravi Galkate, Scientist, 'C', for his incessant and indefatigable guidance, advice, constant encouragement, full support and co-operation at every step.

We acknowledge following organizations/offices for their valuable support during data /literature collection:

- India Metrological Department, Pune.
- Water Resources Department, Sagar

REFERENCES

Chow, V.T. (1964). Handbook of Applied Hydrology. McGraw Hill, New York.

Hema Malini B., Sarma V.V.L.N., Murli Krishna G., Naqvi S.A.S., and Nageaswara Rao K., Impact of human land use practices on the occurrence of droughts- A case study of Godavari Delta Region, Journal of Applied Hydrology

Jensen, M.E., and Wright, J.L. (1978), "The role of evapotranspiration models in irrigation scheduling". Transactions of the ASAE, 21(1): 82-87

K.H.V. Durga Rao, Roshn Pradhan, "Remote Sensing and GIS in Hydrological Modelling of Ungauged watersheds", International conference on watershed Management and Conservation, 8-10 December 1998, New Delhi, pp-402-409

Kogan FN, 1990, Remote sensing of weather impacts on vegetation in non- homogeneous areas, International Journal of Remote sensing.0200

Kumar, S.R., "Water Balance study of Krishnai river Basin According to Thornthwaite's concept of Potential Evapotranspiration" CS/Ar-2/2000-01.

Mather, J.R., " The Climatic Water Budget in Environmental Analysis".

Michael, A.M., " Book on Irrigation Theory and Practices".

Pandey R.P., and Ramasastri K.S., 2002. Incidence of droughts in different climatic regions, Hydrolgical Sciences Journal

Penman, H.L.(1956), "Estimating evaporation. Trans, Amer. Geophys. Un., Vol. 37, No1, pp. 43-56

Rao, K.N., George, C.J., and Ramasastri, K.S. (1971), "Potential evapotranspiration over India". Proceedings of the symposium on water resources, Indian Institute of Science, Banglore, India 1:A2-1-14

Rasamee Suwanwerakamtorn, (1994), "GIS and hydrological modeling for the management of small watersheds", ITC journal, 4, 343-348.

Robins, J.R., Pruitt, W.O., and Gardener, W.H. (1954). "Unsaturated flow of water in field soils and its effect on soil moisture investigation". Soil science society of America proceedings, 18:344-347

Salih, A.M.A., and Sendil, U. (1984), "Evapotranspiration under extremely arid climates". Journal of Irrigation and drainage engineering, American society of civil engineers. 110(3): 289-303

Sudheer, K.P., "Estimating Hydrological Parameters for Water Balance studies in Tamarapani River Basin, Tamil Nadu", CS (AR) 23/98-99.

Thornthwaite, C.W. (1948), An approach toward a rational classification of climate. Geogr. Rev., Vol. 38, No.1, pp. 55-94.

Thornthwaite, C.W. (1952), "The water balance in arid and semi- arid climates. Proceedings International Symposium on Desert Research, Jerusalem.

Thornthwaite, C.W. and Mather, J.R. (1957), Instructions and tables for computing potential evapotranspiration and water balance, laboratory of Climatology, Publication No. 10, Centerton, NJ.

World Metrological Organisation (1966), "Measurement and estimation of evaporation and evapotranspiration". WMO technical note no.83.

Table-1: Average Monthly Rainfall in Dhasan Basin

Months	Average Rainfall (mm)
January	10.83
February	14.45
March	11.33
April	8.09
May	19.82
June	136.73
July	341.82
August	398.46
September	180.50
October	14.90
November	2.29
December	9.36

Table-2: Thiessen weights of influencing rain gauge stations

S.No	Name of the rain gauge station	Thiessen weights
1	Sagar	0.649
2	Banda	0.282
3	Khurai	0.069

Table-3: Variation of the annual average rainfall

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Rainfall	1213	806	1112	858	711	1849	1095	1176	1225	1610	979	1149
% Deviation	6	-30	-3	-25	-38	61	-5	2	7	40	-15	

Table 4 : Water Balance by Thorthwaite - Mather Model for Dhasan Basin

Components	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Precipitation	10.83	14.45	11.33	8.09	19.82	136.73	341.82	398.46	180.50	14.90	2.29	9.36	1149
PET	34.65	51.20	125.62	235.64	356.47	286.31	171.48	137.54	134.70	126.79	70.21	38.94	1770
P-PET	-24	-37	-114	-228	-337	-150	170	261	46	-112	-68	-30	-621
ACC.POT.WL	-233	-270	-384	-612	-948	-1098	0	0	0	-112	-180	-209	
SM	32	25	12	3	0	0	150	150	150	71	45	37	
CHANGE_SM	-5	-7	-13	-9	-2	0	150	0	0	-79	-26	-8	
AET	16	21	25	17	22	137	171	138	135	94	28	17	821
DEFICIT	18	30	101	219	334	149	0	0	0	33	42	21	948
SURPLUS	0	0	0	0	0	0	20	261	46	0	0	0	327
TOT.AV.RUNOFF	11	5	2	1	0	0	20	270	180	89	44	21	
RO	6	3	1	1	0	0	11	136	91	45	23	11	328
DETENTION	5	2	1	0	0	0	9	134	89	44	21	10	

Available water capacity in soil is 150mm. All values are given in mm.