UM-14

APPLICATION OF TANK MODEL FOR DAILY RUNOFF ANALYSIS

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ABSTRACT

Tank model is a simple conceptual rainfall-runoff model developed in Japan by Sugawara (1967). This model is used for daily runoff analysis for both humid and non humid basins with continuous dail data generally for a period of three to four years. Tank model for daily runoff analysis can also be used with snowmelt component. The structure of tank model applicable to humid basin consists of four tanks laid vertically in series. However, 4 x 4 tank model is used for non-humid basins by dividing them into four zones depending on soil moisture content. First initial set of parameter values of the model is finalised based on the procedure stated in this user manual for computer programme of the model. The parameters along with the daily storm data are supplied as input. The programme simulates outflow hydrographs. Six hydrographs are plotted simultaneously viz., observed discharge, output from the fourth tank, sum of outputs from third and fourth tanks, sum of output from second, third and fourth tanks, sum of output from all the four tanks and final simulated discharge in log scale against time in natural scale. These hydrographs are compared with observed discharge hydrograph to find which runoff component plays main role in the particular period. Calibration of parameters may be performed by trial and error procedure. Values of each of the parameters are successively changed and from comparison of fit of simulated hydrograph with observed one, best fit parameter values are ascertained. The parameters calibrated in this way lead

to final model strucutre.

The programme has been implemented and tested on VAX-11/780 system at National Institute of Hydrology, Roorkee. The input and output specifications for the programme have been described with an illustrative example. The programme can be run on computers other than VAX-11/780 system having FORTRAN compiler after making suitable software modifications.

This programme can be used for daily analysis of runoff for humid basin. However, some modifications in the programme are required in order to use it for non-humid basin.

1.0 INTRODUCTION

Different rainfall-runoff models are in use in India and various countries abroad for simulation of runoff. Tank model is a simple conceptual rainfall-runoff model developed in Japan by Sugawara (1967). The tank model for daily analysis considers four tanks with a structure of soil moisture at the bottom of the top tank. This model was used by Sugawara to simulate the daily flow from humid basins of Japan, where rainfall is high and distributed almost throughout the year so that the soil always remains in near saturated condition. But in India conditions differ widely ranging from arid to very humid. The rainfall is not uniformly distributed through out the year. The 4 x 4 tank model structure developed by Sugawara is capable of considering such variation of soil moisture in non-humid basin expreriencing long dry period by dividing the basin generally into four zones.

1.1 Purpose and Capabilities

The purpose of this user's manual is to provide guidelines for the users in order to run the computer programme of tank model for daily analysis. The programme has been developed in FORTRAN IV language. It has been successfully implemented and tested on VAX-11/780 system. This programme can be used for the humid or non humid basin with or without snowy region. The parameters of the model are calibrated by trial and error method. The daily runoff can be predicted for the given rainfall and daily evapotranspiration values using the calibrated parameters.

1.2 Definitions of terminology

α	Decreasing ratio
T	Time constant
X	Storage
Y	Discharge
E	Evaporation
A0	Coefficient for bottom outlet of top tank (measure of infiltration rate from top strata)
A1,A2	Coefficient for first and second side outlets of top tank (measure of surface runoff rate from top tank)
B0	Coefficient for bottom outlet of second tank
B1	Coefficient for side outlet of second tank
C0	Coefficient for bottom outlet of third tank
C1	Coefficient for side outlet of third tank
D1	Coefficient for side outlet of fourth tank
HA1,HA2	Head for first and second side outlets of top tank (Measure of initial losses)
PS	Saturation capacity of primary zone
SS	Saturation capacity of secondary zone
XP	Initial storage in primary zone
XS	Initial storage in secondary zone
XA,XB,XC,XD	Initial storage of top tank, second tank, third tank and fourth tank respectively
T1	Transfer velocity of water from lower strata to fulfil the primary soil moisture under capillary action

T2	Transfer velocity of water from primary to secondary soil moisture
1,Y2,Y3,Y4	Discharges respectively from top tank, second tank, third tank and bottom tank
1,S2,S3,S4	Ratio of area of different zones of the basin
CP	Weight of precipitation
WE	Weight of Discharge

1.3 Scope

The tank model programme for daily flow analysis requires the observed daily rainfall at each ORG stations, corresponding stations weights, daily Evaporation values etc. as input. The programme estimates the following components and stores in a disk file TANKDH.OUT.

i) Various input data

ii) Storage amounts of each tank and the snow deposit depths of each zones (if snow option is used)

iii) Storage amount of each snow deposit tanks (if ISTANK=1)

iv) The free water (XF), primary soil moisture (XP), Secondary soil moisture (XS), Observed monthly discharge (Q) and calculated monthly discharge (QE)

v) Line printer output of the hydrographs where each symbol corresponds as follows :

*	observed daily discharge
+	calculated daily discharge
.	sum of outputs from second,third and fourth tank
,	Sum of output from third and fourth tanks
-	output from the fourth tank
I	Scale point

vi) Observed mean daily discharge (MQ) and calculated mean daily discharge (mm)

vii) Monthly plot of MQ,MQE and DQ. DQ is calculated as

$$DQ = \log_e (MQE) - \log_e (MQ)$$

Each symbol in the plot corresponds as follows:

.	DQ
*	MQ
+	MQE
I	Scale points

Viii) SUM OF MQ and MQE in a year

ix) Total sum of MQ and MQE for every year

2.0 TANK MODEL FOR DAILY FLOW ANALYSIS

2.1 General Description

2.1.1 For humid basin

Tht tank model is a simple conceptual rainfall-runoff model developed by Sugwara (1967) to simulate the runoff of a basin. The tank model, which was used by Sugawara for daily analysis, is composed of several tanks laid vertically in series representing soil moisture and groundwater in different soil strata of the basin as shown in Figure 1. Each tank has one side outlet and one bottom outlet except the top tank which has two side outlets and the bottom tank which does not have any bottom outlet. The top tank corresponds to structure of ground surface and the discharge through side outlets (Y1 = YA1 + YA2) represents the surface flow, while the discharge through bottom outlet represents infiltration. Similarly, discharges through side outlets of second, third and fourth tanks represent interflow (Y2), sub-base flow (Y3) and base flow (Y4) respectively. The sum of outflows through side outlets of four tanks (Y = Y1 +Y2 +Y3+ Y4) represents total runoff from the basin. The HA1 and HA2 represent the heads (threshold levels) of two side outlets of top tank and are measures of initial losses. Similarly, HB and HC are heads (threshold levels) of side outlets of second and third tanks respectively. A1,A2,B1,C1 and D1 are

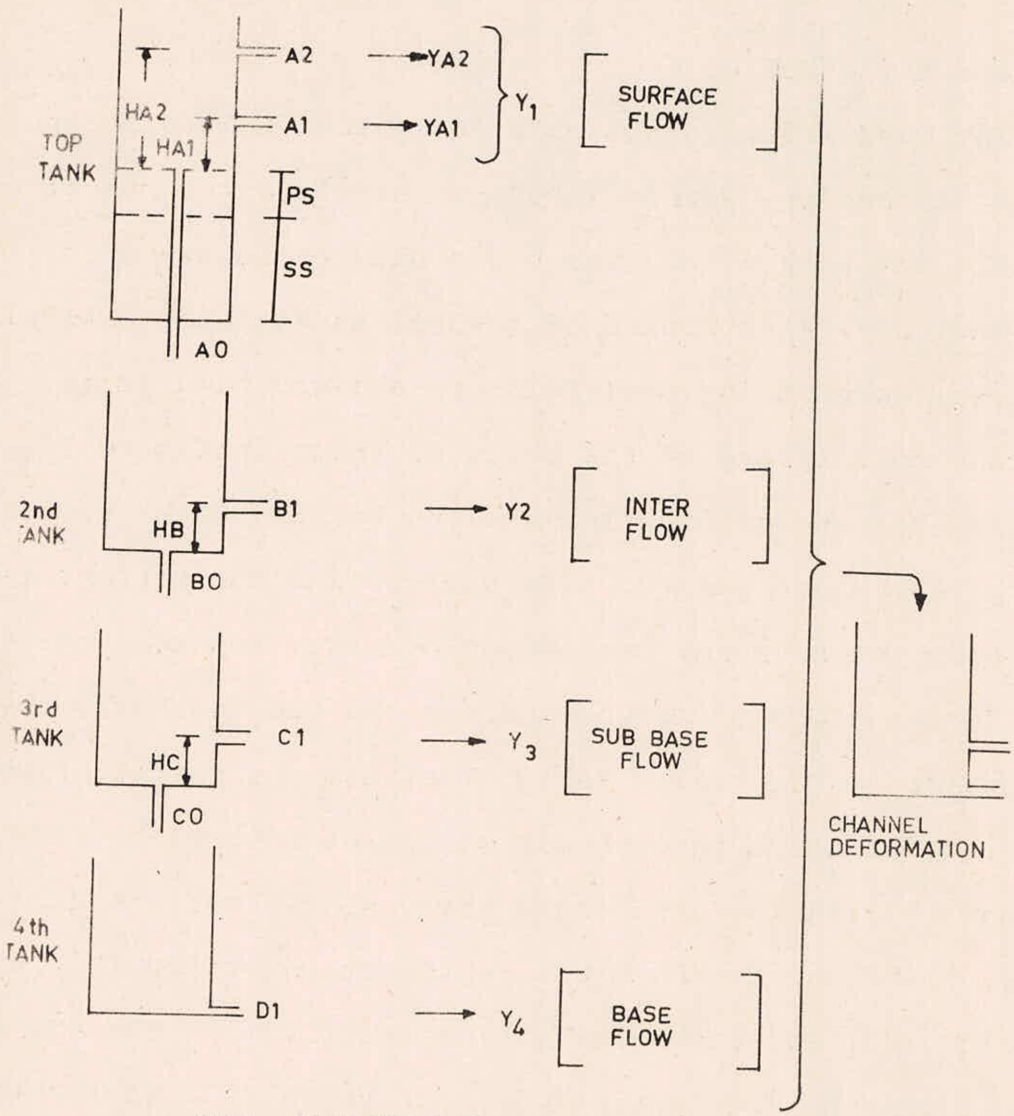

FIG.1— TANK MODEL STRUCTURE

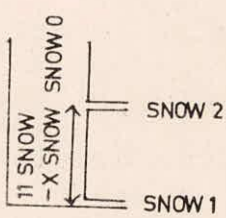

FIG 2 SNOW DEPOSIT TANK

discharge coefficients of bottom outlets of top, second and third tank respectively.

Rainfall is the input to the top tank. Water in all the three tanks from top moves both horizontally and vertically. Discharges through bottom outlet of the top tank is the inflow to the second tank. Similarly, discharges throug bottom outlets of second and third tanks are the inflows to the third tank and fourth tanks respectively. The model is based on the assumption that the runoff at any instant from each tank depends on the storage in the tank at that instant and follows an exponential function.

If the basin is snowfed, the precipitation input is modified in the programme to consider the snowmelt. However in some basins, at the beginning of snowmelt in early snowmelt season, the calculated hydrograph reflects a small peak but in observed hydrograph this small peak does not appear. The explanation of this fact is that the snowmelt water is stored in a snow deposit and it is not supplied to ground surface. A simple simulation of .ter storage 'n snow deposi will be an incomplete integral with long time constant. However, such storage effect becomes unncessary soon after the beginning of snowmelt, and we can get good results by putting snowmelt directly into the tank model. Therefore, the time constant of the incomplete short integral must change after a short while. This can be represented by a tank model as shown in Figure 2. The important different point of this model from the usual ones is that the position of the upper outlet is variable i.e. it is proportional to the amount of snow deposit. That means, when snow deposit is dry, snowmelt water is stored in snow deposit and the water supply to ground surface is very slow, but when snow deposit becomes wet, i.e. ratio of water storage to solid snow deposit exceeds some limit, water supply to ground surface becomes rapid. To make such a model, SNOW1 must be small and (SNOW1 + SNOW2) must be nearer to 1 (Figure 2).

The user of this program must set ISTANK to 1, if this snow deposit tank is used, otherwise ISTANK must be set to zero.

In this program, SNOW0, SNOW1, and SNOW2 are represented by W0, W1 and W2 respectively. XSNOW is represented by Xw user may completely omit snow option by setting ISNOW=0 in the programme.

2.1.2 For Non-humid basin

For non humid basins which experience long dry periods, the 4 x4 tank model is used for daily rainfall-runoff analysis. Some part of such basins remain dry while the area near the river remains wet. Percentage of dry area and wet area of such basins do not remain constant all throughout the year. As the dry season continues, the percentage of dry area to the whole basin area continues to increase. When the rainy season begins, the wet area that remained near the river courses at the end of dry period starts to increase and continues to grow till the rainy season contiues. Surface runoff occurs only in wet area while in dry area all the rainfall gets absorbed as soil moisture. Evaporation from the basin also varies depending on the variation of wet area. To take into account such variations, the basin is devided into number of zones and variation is accounted in steps. Generally the basin is devided in four zones,S1,S2,S3 and S4 as shown in Figure 3. For each zone four linear tanks in series are considered to represent surface flow, intermediate flow, sub-base flow and base flow. Schematically, 4 x 4 tank model structure along slopping ground of a basin is shown in Figure 4. Left side is the mountain side and right side is the river side. Details of 4 x 4 tank model strucutre is shown in Figure 5. Each zone is represented for simultation by series of four tanks laid vertically with soil moisture structure at the bottom of the tank. Series of four tanks of first zone S1 is in parallel with that of the other three zones S2,S3,S4. The top tank of four zones are of identical structure, similarly structure of all second tanks, structure of all third tanks, structure of all fourth tanks are identical. The only difference in the structure of four zones that may occur is in the structure of soil moisture (PS and SS values may be different) and zonal areas.

In this model free water moves in two directions; horizantally and vertically. Each tank receives water from the upper tank of the same zone or from the mountain side tank of the same strata and transfer water to the lower tank of the same zone or to the river side tank of the same strata. The top tank of each zone receives rainwater as input. Another important water transfer is transfer to soil moisture from lower free water by capillary action.

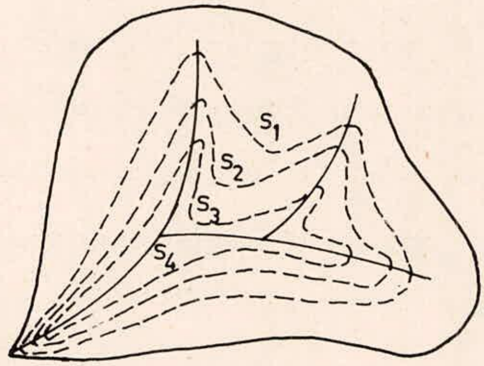

FIG. 3 - NON-HUMID BASIN DIVIDED INTO FOUR ZONES

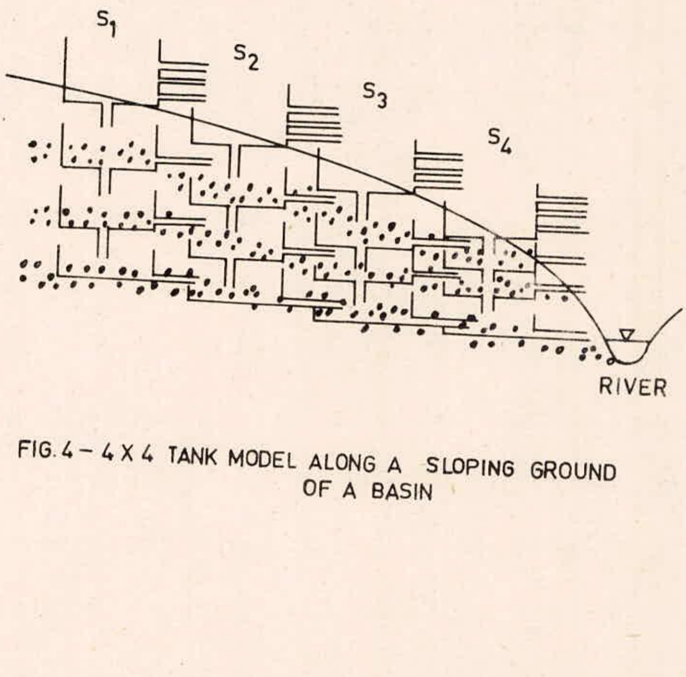

FIG. 4 - 4 X 4 TANK MODEL ALONG A SLOPING GROUND OF A BASIN

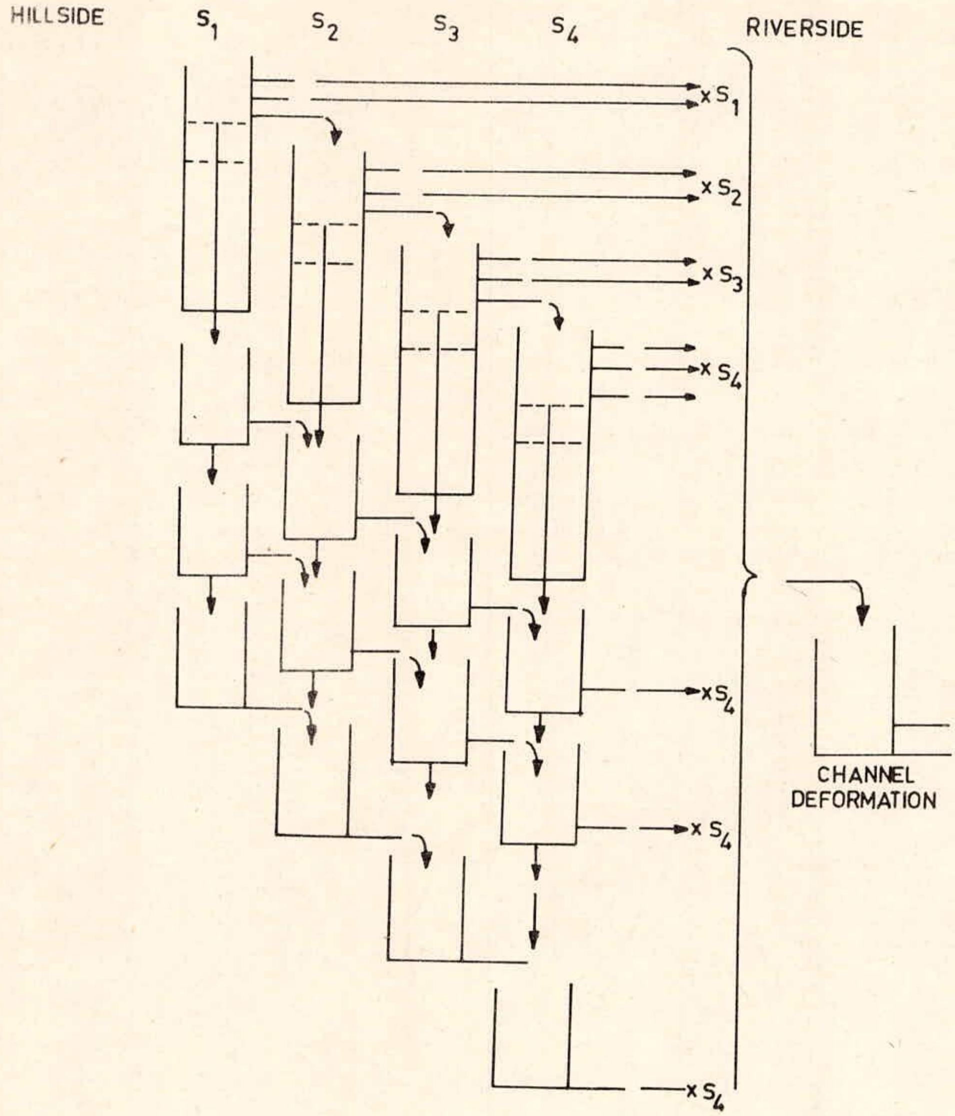

FIG. 5 – 4 X 4 TANK MODEL STRUCTURE FOR NON HUMID BASIN

When the dry season comes, free water of the highest zone decreases faster than that of the other zones due to water transfer to lower zones. After depletion of free water, soil moisture begins to decrease. Due to these depletions, the highest zone becomes dry earliest and then the second zone, the third zone and fourth zone. When the rainy season comes, in the opposite way the lowest zone becomes saturated first and then the second zone, the third zone and fourth zone.

Areal ratio of zones S1:S2:S3:S4 is an important parameter in this model. These ratios can be determined if the detailed information regarding hydrological, topographical and geological characteristics of the basin are available. If no such information is available, the ratio can be determined by trial and error method.

2.2 Data Requirements

Following inputs are necessary for running the computer programme of daily analysis model.

(a) Data for the storm

(1) Year and month of beginning and end of data Number of rainfall stations

(2) Catchment area in sq.km.

(3) Name of basin

(4) Observed discharge value of first year

(5) Daily evapotranspiration data of first year (If option IEVAP=1)

(6) Observed precipitation values for first year for first

station, second station and so on. Serial (4),(5) and (6) are repeated for subsequent years.

(7) Monthly mean of daily evapotranspiration value (If option IEVAP=0)

(b) Initial Parameter values

(1) Primary and secondary soil moisture depth (PS & SS)

(2) Coefficient of discharge and initial loss heads of top tank, second tank, third tank and fourth tank.

(3) CP,WE and LAG of each rainfall station.

(4) Transfer velocity of water T1 and T2

(5) Initial storage dor each tank

(c) Following are to be defined for the output

(1) Number of graphs to be plotted, number of scale points, range of plot, maximum and minimum value to be plotted

(2) Scale points to define

(3) Output format to be supplied

2.3 Analysis

2.3.1 Daily analysis procedure using Tank Model for humid basin

Following are main points to be followed for analysis and selecting initial parameter values for first trial run to start the calibration process of the tank model for daily analysis.

(1) Length of data - A minimum of three to four years continuous daily discharge, rainfall and evapotranspiration

data are necessary. A period of ten years continuous data containing both wet year and dry year is a good choice.

(2) Hydrograph plotting- observed discharge data are plotted in logarithmic scale against time in natural scale. A rough estimation of time constant of runoff, TC, is made from recession slope of the flow hydrographs.

(3) Initial Tank model parameters- Decreasing ratio α is calculated as 1/TC. From the value of α the discharge coefficients and initial losses are calculated for top tank, second tank and third tank using the equations :

$$A0 = A1 = A2 \quad \ldots\ldots \quad = \alpha/2$$

$$B0 = B1 = \alpha/10$$

$$C0 = C1 = \alpha/50$$

The values of initial losses are selected from the following ranges.

$$HA1 = 0 \sim 15 \text{ (mm)}, HA2 = 15 \sim 40 \text{ (mm)}$$

$$HA3 = 40 \sim 60 \text{ (mm)}, HB = 5 \sim 15 \text{ (mm)}$$

$$HC = 5 \sim 15 \text{ (mm)}$$

(4) Input precipitation- weighted mean values of the rainfall stations for the basin are generally considered .For simplicity simple mean of rainfall stations may also be considered.

(5) Time Lag (LAG)- Unit of time lag is one day. Initi time lag is considered to be zero.

(6) Evapotranspiration (E) - If observed evaporation data are available from number of stations within the basin or near the basin, then mean daily evapotranspiration values are computed and used for analysis. If no such data are available for the period under consideration monthly mean of daily evapotranspiration value for that region may be used.

(7) Initial storage (XA,XB,XC,XD) - Initial amount of storage of the fourth tank can be decided from long duration of dry period. For first trial, initial value of storage for other tanks may be set to zero.

(8) Correction Factor for Precipitation - For initial trial, the values of correction factors (CP & WE) are usually considered as 1.0

Main steps to be followed in calibration are as follows:

(i) Observing and comparing the calculated and observed hydrographs, if it is found that nth runoff component takes the main part then the parameter of nth tank is adjusted.

(ii) If the parameter of side outlet is increased and that of bottom outlet is decreased of the nth tank keeping their sum unchanged then the amount of discharge increases without changing the form of the hydrograph and vice versa.

(iii) If both the parameters of side outlet and bottom outlet of nth tank are increased then the recession slope corresponding to nth tank becomes steeper.

(iv) If the parameter of top side outlet of top tank is decreased and that of lower outlet is increased then hydrograph of large flood becomes steeper whereas for smaller flood it becomes smoother.

(v) The positions of the side outlets ,determined by the parameters HA1,HA2,HA3,HB and HC ,are useful for representing initial losses of surface flow, interflow and baseflow.

(vi) After obtaining fairly good result by adjusting the above stated parameters, calibration of the weights of rainfall station begins.

(vii) When there are no. of rainfall stations and data of each rainfall stations are considered as a part of the input, then on comparing the simulated hydrograph with observed one suitable time lags are provided to the stations depending on the distance of rainfall stations from the observed discharge site.

(viii) Usually same amount of initial storages are considered But depending on antecedent rainfall and soil moisture condition different initial storages may be considered subject to further adjustment.

(ix) Correction factor for the precipitation is provided when the depth of calculated discharge differs considerably from the observed one. Generally same value of correction factor is provided to all precipitation stations. But in some cases, it becomes necessary to provide different correction factors to different precipitation stations depending on its topographic location, orographic effect etc.

(x) Correction factor for channel deformation is also provided depending on the situation. (Channel deformation is not considered in this programme).

(xi) During calibration it is very important to keep in min that parameters are to be changed and adjusted one by one in successive trials. Usually it is better to adjust the top tank first, then the second tank, the third tank and so on. But in case of significant difference between calculated and actual base discharge, the parameter corresponding to fourth tank requires to be adjusted first.

(xii) It is important to make a well balanced general outline first and then fine adjustments are to be made.

2.3.2 Daily Analysis procedure using tank model for non-humid basin

Daily analysis for non-humid basin is performed using 4 x 4 tank model for which the analysis procedure is quite similar to that of daily analysis model for humid basin as stated in 2.3.1. Additional points to be followed are :

(i) Different values of primary and secondary soil moisture may be considered for each zone depending on the situation.

(ii) Aerial ratio of zones S1:S2:S3:S4 is an important parameter in this model. These ratios can be determined if the detailed informations, regarding drainage area, topography vegetation and soil of the basin are available. If no such informations are available, the ratio can be determined by trial and error. Usually for convenience of taking different trials, the ratios of areas are assumed to be in geometrical progression.

2.4 Advantages and limitations

Main advantages of the Tank Model are :

(i) It is simple in its form and to some extent it has reasonably physical meaning corresponding to the zonal structure of ground water.

(ii) It can represent the non-linear character of surface runoff.

(iii) It can represent several components of runoff, each of the components having its own half life but from non linear character of this model the values of the half periods are not definite.

(iv) Input (rainfall) is distributed to each of the components automatically by this non linear structure.

(v) Runoff components from lower tanks are smoothened in shape and the time lags are given to them automatically.

(vi) Data requirements are comparatively small and

(vii) The model can also suitably be applied to basins experiencing snowmelt runoff.

There are some limitations for using this programme. These limitations are as follows:

(i) Number of rainfall stations (NP) are less than 11.

(ii) Number of zone (IZONE) are less than 7.

(iii) Basin name (ANAME) are less than 40 characters.

(iv) Rainfall station name (PNAME) are less than 16 characters. Only first 8 characters is output.

(v) Number of scale points in the hydrograph plotting are less than 6.

(vii) No. of printing positions in the line printer are less than 132.

(ix) No. of graphs in the hydrographs plotting are less than 6.

3.0 RECOMMENDATIONS

The programme TANKDH.FOR can be used for daily flow analysis using tank model for humid or snowfed basins with no consideration for river channel deformations. The programe was developed by Sugawara in Japan and it has been implemented and tested at National Institute of Hydrology, Roorkee on VAX-11/780 Computer system which is a 32-bit machine. The programme occupies the larger part of the computer storage due to data represented by DIMENSION P (366,10), TMIN(366,10), and TMAX(366,10). If the user of this programme want to decrease the required storage capacity, decrease the number of rainfall stations at first, if possible. In case more than 10 stations are to be used, user may accordingly modify the DIMENSION statements. The execution time for the programme is different due to the number of rainfall stations (NP) and the number of years of data (NYEAR). The programme may run on other computer system, having FORTRAN compiler, after suitable modifications as per the software requirements of the system.

The programme may also be used for non-humid basin with some modifications.

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DETAILS OF COMPUTER PROGRAMME FOR TANK MODEL FOR DAILY FLOW ANALYSIS

A. DESCRIPTION OF COMPUTER PROGRAMME

The computer programme TANKDH.FOR is developed in FORTRAN - IV language and it has been implemented and teste on VAX-11/780 computer system. The programme consists main programme and ten subroutines. The subroutines are called within the main programme whenever they are required.

I. Main Programme: (A) The daily flow analysis using this programme is performed in the following steps.

1. File reference numbers, 5 and 6, are set for input and output.
2. An intermediate file SCR.DAT is created for storing various input information at file reference number DSC. As soon as the execution is over, this file is deleted. "DATAFL" is the subroutine which inputs various data from the file TANKDH.DAT(5) and stores these data into the file ARC.DAT.

   Various parameters are input from the file TANKDH.DAT and printed in file TANKDH.OUT in order to check.

   Percent ratios (WE(K))for the weights for the rainfall stations are obtained.

   IF NIVL is equal to 1, NITR is set to 4 (Tank model calculation is done three times before normal calculations in order to get initial storages for four tanks).

7. Various data are initialized to zero.

8. Number of years (NY) from FYEAR are calculated.

9. Leap year consideration is done

10. Observed discharge data for one year are read

11. If IEVAP=1 , daily evapo(transi)pration data for one year are read

12. Precipitation data(one year) for NP stations are read

13. If ISNOW=1, daily maximum and minimum temperature data (one year) for NP stations are read

14. Tail data of QA,QB,QC and QD are transmitted to the beginning of array in order to cope with time lag.

15. Various data are initilized to zero.

16. Write Headings. IF NM(NR) is not equal to NITR,this writing is skipped.

17. Consideration in case that the first month is not equal to 1 or the last month is not equal to 12 is done.

18. Thawing constant at first day of each month and value for interpolation are obtained.

19. Precipitation is adjusted using rainfall station weight.

20. IF ISNOW=1, steps (21) to (22) are skipped.

21. Snowmelt calculation with or without snow deposit tank is done calling the subroutine ' ZONES' or "ZONE"

22. Thawing constant for next day is obtained. Snow deposits are accummulated.

23. Evapotranspiration is subracted through the subroitine "EVPTRW"

24. Tank model calculation for one day is performed through subroutines "TANKSM" and "TANKB" and output discharge

from each outlet is obtained.

25. Irrigation effect, if any, is considered using the subroutine " IRRIG".

26. Weighted discharge value from each outlet is calculated.

27. Steps (19) to (26) are repeated for NP times.

28. Monthly discharge data are obtained

29. Steps (19) to (28) are repeated for one month

30. Various results are printed, and monthly and yearly data are obtained. If NM is not equal to NITR, these are skipped.

31. Step (18) to (30) are repeated for 12 months.

32. Yearly data and various hydrographs are printed. The hydrographs are plotted with the help of a subroutine " HYDRGR". If NM is not equal to NITR, this printing is skipped.

33. Step (8) to (32) are repeated for (LYEAR- FYEAR+1) times.

34. If INVL=1 and NM is not equal to NITR the initial storages for every tanks are obtained using the subroutine "INVAL3"

35. Step (7) to (34) are repeated for NITR times

36. Monthly data are plotted using the subroutine "PLOTM"

B. Desecriptions of the variables used in the programme:-
Various variable/ constants used in the programme are described below:

VARIABLE	DESCRIPTION
FMONTH	First Month
FYEAR	First Year
LMONTH	Last month
LYEAR	Last year

NP	No. of rainfall stations
ISNOW	Switch for snow consideration
IEVAP	Switch for evapotranspiration data type
AREA	Catchment area (Km ** 2)
ANAME	Basin area name
YEAR	Year
Q	A vector containing daily observed discharge values in m**3/S during one year
PNAME	Rainfall station name
P	A matrix containing daily observed precipitation for different rainfall stations during different years.
TMAX	A matrix containing daily observed maximum temperature for different stations during different years
TMIN	A matrix containing daily observed maximum temperature for different stations during different years
EVAP	A vector containing the evapotranspiration values during a year.
S1	Primary soil moisture Depth
S2	Secondary soil Moisture Depth
HA1	First side outlet height of top tank
HA2	Second outlet height of top tank
A0	Infiltration coefficient of top tank
A1	Discharge coefficient for HA1
A2	Discharge coefficient for HA2
HB1	Side outlet height of second tank

B0	Infiltration coefficient of second tank
B1	Discharge coefficient for HB1
HC1	Side outlet height of third tank
C0	Infiltration coefficient of third tank
C1	Discharge coefficient for HC1
HD1	Side outlet height of fourth tank
D0	Infiltration coefficient of fourth tank
D1	Discharge coefficient for HD1
E	Vector containing daily evapotranspiration values for each month (If IEVAP is equal to zero)
K1	Water supply rate from lower tanks to primar soil moisture
K2	Water exchange rate between primary and secondary soil moisture
CP(K)	Weight for precipitation of Kth rainfall station
WE(K)	Weight for discharge of kth rainfall station
LAG(K)	Time lag for Kth rainfall station
INVL	SWITCH in order to use the subroutine INVAL3 (If INVAL=1, use the subroutine INVAL3,otherwise set INVL=0)
ISTANK	If snow deposit tank is used =1,otherwise=0
QO	Adding constant for logarithmic calculation of data which have zero value
IZONE	Number of zone (If ISNOW=1)
SMLT(M)	Thawing constant for each month (If ISNOW=1)
CM(M)	Weight for precipitation of Mth month(If ISNOW=1)

PD(IZ,K)	WEIGHT for precipitation of IZth zone in Kth rainfall station (If ISNOW=1)
ZA(IZ,K)	Area of IZth zone in Kth rainfall station (If ISNOW=1)
TW(K)	Weights in formula TW(K) * TMAX + (1-TW(K))*TMIN (If ISNOW=1)
TO(K)	Temperature correction factor TO in formula TI = T - (IZ-1) *TD+T0 (If ISNOW=1)
TD(K)	Temperature decreasing constant TD of above formula(If ISNOW=
XW(IZ,K)	Initial storage of snow deposit tank for IZth zone in Kth station
W0	Coefficient for determining height of second outlet in snow deposit tank
W1	Discharge coefficient of first outlet in snow deposit tank
W2	Discharge coefficient of second outlet in snow deposit tank
NPLOT	Number of Graphs plotted
NSCAL	Number of scale point
LY	Number of characters in one line
YMIN	Minimum value to be plotted
YMAX	Maximum value to be plotted
SCAL(NX)	Plotting value for NXth scale point
GRFMT	Format specification for plotting
IRMS	First month for Irrigation
IRME	Last month for Irrigation

(a) SUBROUTINE DATAFL (MT,DSC)

This subroutine is used for storing data into temporary disk file SCR.DAT from the other disk file TANKDH.DAT. The main programme extracts the input from the file SCR.DAT during the execution. As soon as execution is over the file SCR.DAT is deleted. Here arguments are file reference nos.

The data read from disk file TANKDH.DAT are as follows:

NO.	INPUT LIST	FORMAT
1.	FYEAR,FMONTH,LYEAR,LMONTH,NP, ISNOW,IEVP	10I8
2.	AREA	F10.0
3.	ANAME	10A 4
4.	YEAR	16X,I8
5.	(Q(I),I=IS,IE)	10 F8.1
6.	(E(I),I=1,366	(2(10F6.1/),11F6.1)
7.	(PNAME(J,K),J=1,4),K=1,NP) YEAR	4A4,I8
8.	(P(I),I=IS,IE)	(2(10F6.1/),11F6.1)
9.	YEAR	16X,I8
10.	(T(I),I=IS,IE)	(2(10F6.1/) ,11F6.1)

NOTE: (i) IF IEVAP is equal to zero, the input lists correspon-ding to Sl.No.6 will be skipped

(ii) IF ISNOW is equal to zero, the input lists correspondi to Sl.No.9 and 10 will be skipped.

The data stored into temporary disk file SCR.DAT are as follows:

No	OUTPUT LIST	FORMAT
1.	(Q(I),I=1,366)	FREE
2.	(E(I),I=1,366)	FREE
3.	(P(I),I=1,366)	FREE
4.	(T(I),I=1,366)	FREE

NOTE: (i) If IEVAP is equal to zero, the output lists corresponding to Sl.No.2 will not be stored in the file SCAR.DAT

(ii) If ISNOW is equal to zero, the output lists corresponding to Sl.No.4 will not be stored in the file SCAR.DAT

(iii) In case, if there is some thing wrong in the data, a message " Some thing wrong in data" will be written in the file TANKDH.OUT and execution of the programme will be stopped.

(b) SUBROUTINE EVAPTRW(EV,K1,K2,S1,S2,XA,XS,XB,XC,XD)

This subroutine extracts evapotranspiration and calculates the transfer values from lower tank to upper tank and between primary and secondary soil moistures, the variables used as arguments are:

K1 Water supply rate from lower tanks to primary soil moisture

K2 Water exchanges rate between primary and secondary soil moisture

S1 Primary soil moisture depth

S2 Secondary soil moisture depth

XA,XB,XC,XD Initial storage of top tank,second tank,third tank and fourth tank respectively

XS Initial storage of secondary soil moisture

(c) SUBROUTINE TANKSM (P,XA,Y2,Y1,Y0,HA1,HA2,S1,A0,A1,A2)

This subroutine is used for the computation of the tc tank with soil moisture structure. The variables used as arguments are :

P	Average precipitation for a day
XA	Initial storage of top tank
Y2	Discharge from the second side outlet of top tank
Y1	Discharge from the first side outlet of the top tank
Y0	Infiltration from the first tank
HA1	First side outlet height of top tank
HA2	Second side outlet height of top tank
S1	Primary soil moisture depth
A0	Infiltration coefficient of top tank
A1	Discharge coefficient for HA1
A2	Discharge coefficient for HA2

(d) SUBROUTINE TANKB (P,X,Y,Y0,H1,B0,B1)

This subroutine is used for calculation of 2nd,3rd and 4th tanks which has only one side outlet. The variables used as arguments are:

P	Infiltration from the first tank
X	Storage of second tank
Y	Discharge from the side outlet of second tank
Y0	Infiltration from the second tank
H1	Side outlet height of second tank
B0	Coefficient of discharge through bottom outlet of second tank (measure of percolation)

B1 Ceofficient of discharge through side outlet of second tank (measure of percolation)

NOTE: The SUBROUTINE TANKB is also used for the calculation of third and fourth tank.

(e) SUBROUTINE IRRIG (W,Y,XC)

This subroutine treats the irrigatior effect. The variables as arguments are:

W Irrigation data for a day

Y Net daily discharge after substracting the irrigation water

XC Storage water in third tank

(f) SUBROUTINE PLOTM (FYEAR,FMONTH,LYEAR,LMONTH,NY,MQ, MQE,DQ,Q0) :- This subroutine is used for the plotting of monthly data. The variables as arguments are :

FYEAR	FIRST YEAR
FMONTH	FIRST MONTH
LYEAR	LAST YEAR
LMONTH	LAST MONTH
NY	No. of years
MQ	Observed mean daily discharge (mm) in a month of a year
MQE	Calculated mean daily discharge (mm) in a month of a year
DQ	It is calculated as log (MQE) - log (MQ)
Q0	Adding constant for logarithmic calculation of data which have zero value

(g) SUBROUTINE INVAL3(N,NP,XA,XS,XB,XC,XD)

This subroutine determines the initial storage of four tanks and of secondary soil moisture. The variables used as arguments are :

N	Dummy constant
NP	No. of rainfall stations
XA	Storage of top tank
XS	Storage of secondary soil moisture
XB	Storage of second tank
XC	Storage of third tank
XD	Storage of fourth tank

(h) SUBROUTINE ZONES (IZONE,SMELT,PX,TMAX ,TIMIN,TW,T0,TD, CM,PD,ZA,SNOW,PY,SK,W0,W1,W2,XW)

This is the subroutine for computing the precipitation modified by melted snow and the snow deposit with snow deposit tank. The variables used as arguments are:

IZONE	Number of zone
SMELT	Thawing constant for each month
PX	Weighted precipitation
TMAX	Observed maximum temperature
TMIN	Observed minimum temperature
TW	Weights in formula TW * TMAX + (1-TW)*TMIN
T0	Temperature correction factor
TD	Temperature decreasing constant
CM	Weight for precipitation for a month
PD	Matrix containing the values of precipitation' of different zone at different rainfall stations

ZA	A matrix containing area of different zones at different rainfall station
SNOW	Snow deposit of each zone for each rainfall station.
PY	Input quantity into first tank
SK	Accumulated snow deposit
W0	Coefficient of determining height between second outlet and first outlet in snow deposit tank
W1	Coefficient of discharge of second outlet
W2	Coefficient of discharge of first outlet
XW	Storage of snow deposit tank for each zone and each rainfall station

(i) SUBROUTINE ZONE (IZONE,SMELT,PX,TMAX,TMIN,TW,T0,TD, CM,PD,ZA,SNOW,PY,SK)

This is the subroutine for calculating the precipitation modified by melted snow and the snow deposit tank. The variables used as arguments are already described as for SUBROUTINE ZONES

(j) SUBROUTINE HYDRGR (ISNOW,YEAR,MS,ME,Q,QA,QB,QC,QD, ST,NP,P,IEVAP,E,Q0)

This subroutine is used for graph plotting of daily discharge hydrograph and other data. The variables used as arguments are:

ISNOW	Switch for snow consideration
YEAR	Year
MS	Starting month
ME	End Month
Q	Daily observed discharge values during the year
QA	Storage for top tank

QB	Storage for second tank
QC	Storage for third tank
QD	Storage for **fourth** tank
ST	Weighted snow deposits
NP	No. of rainfall stations
P	Observed precipitation
IEVAP	Switch for evapotranspiration data type
E	Daily evaporation
Q0	Adding constant for logarithmic calculation of data which has zero value.

B. INPUT SPECIFICATIONS

The input lists and their specifications which are to be suplied through an input file TANKDH.DAT are:

NO	INPUT LISTS	FORMAT	REMARK
1	FYEAR,FMONTH,LYEAR,LMONTH,NP,ISNOW,IE-VAP	10I8	
2	AREA	F10.0	
3	ANAME	10A4	
4	YEAR	16X,I8	
5	(Q(I),I=IS,IE)	10F8.1	
6	(E(I),I=IS,IE)	(2(10F6.1/),11F6.1)	
7	((PNAME(J,K),J=1,4),K=1,NP),YEAR	4A4,I8	
8	(P(I),I=IS,IE)	(2(10F6.1/),11F6.1)	
9	YEAR	16X,I8	Skip input lists
10	(T(I),I=IS,IE)	(2(10F6.1/),11F6.1)	from no.9 to 10
11	S1,S2	10F8.0	if ISNOW=0.Repeat
12	HA1,HA2,A0,A1,A2	10F8.0	no. 4 to 10 for
13	HB1,B0,B1	10F8.0	each year
14	HC1,C0,C1	10F8.0	
15	HD1,D0,D1	10F8.0	
16	(E(M),M=1,12)	12F6.0	Skip input list
17	K1,K2	10F8.0	no.16 if IEVAP is
18	(CP(K),K=1,NP)	10F8.0	not equal to zero
19	(WE(K),K=1,NP)	10F8.0	
20	(LAG(K),K=1,NP)	10I8	
21	INVL,ISTANK	10I8	
22	Q0	10F8.0	
23	IZONE	10I8	Skip input lists
24	(SMLT(M),M=1,12)	12F6.0	from no.23 to 30
25	(CM(M),M=1,12)	12F6.0	if ISNOW=0
26	((PD(IZ,K),IZ=1,IZONE),K=1,NP)	10F8.0	
27	((ZA(IZ,K),IZ=1,IZONE),K=1,NP)	10F8.0	
28	(TW(K),TO(K),TD(K),K=1,NP)	10F8.0	
29	((XW(IZ,K),IZ=1,IZONE),K=1,NP)	10F8.0	
30	W0,W1,W2	10F8.0	
31	(XA(K),XS(K),XB(K),XC(K),XD(K),K=1,NP)	10F8.0	
32	((SNOW(IZ,K),IZ=1,IZONE),K=1,NP)	10F8.0	Skip input list no. 32 if ISNOW is not
33	NPLOT,NSCAL,LY,YMIN,YMAX	3I8,2F8.0	equal to 1

34	(SCAL(NX),NX=1,NSCAL)	10F8.0	
35	GRFMT		
36	IRMS,IRME,FMTR	2I8,4X,4A4	Skip input list no.
37	(AM(M),(RR(I,M),I=1, IE)	FMTR	36 and 37 if irrisat ion is not considered

NOTE:-

(i) The input lists no.1 to 10 are in SUBROUTINE DATAFL
(ii) The input lists no.11 to 37 are in MAIN PROGRAMME

C. OUPUT SPECIFICATIONS

The output file TANKDH.OUT consists the values of the following output lists in the specified format:

NO.	OUPUT LISTS	FORMAT	REMARK
1	ANAME,INVL,QO,ISTANK	1H1,10A4//,6X,'INVL',I10,8X,'QO',F10.3,4X,'ISTANK',I10	
2	FYEAR,FMONTH,LYEAR,LMONTH,NP,ISNOW,IEVAP,AREA	///,1H ,5X,'FYEAR',4X,'FMONTH',5X,'LYEAR',4X,'LMONTH',8X,'NP',5X,'ISNOW',5X,'IEVAP',8X,'AREA'/1H ,7I10,F12.2	
3	S1,S2,HA1,HA2,A0,A1,A2	1H0,8X,'S1',8X,'S2',7X,'HA1',7X,'HA2',8X,'A0',8X,'A1',8X,'A2'/1H ,4F10.0,3F10.4	
4	HB1,B0,B1,HC1,C0,C1,HD1,D0,D1	1H0,7X,'HB1',8X,'B0',8X,'B1',7X,'HC1',8X,'C0',8X,'C1',7X,'HD1',8X,'D0',8X,'D1'/3(1H ,F10.0,2F10.4)	
5	(AM(M),M=1,12),(E(M),M=1,12)	1H0,7X,12(5X,A3)/6X,'E',12F8.2	No.5 ouput lists will be skipped if IEVAP is not equal to zero
6	K1,K2	1H0,8X,'K1',8X,'K2'/1H ,2F10.1	
7	(CP(K),K=1,NP)	1H0,8X,'CP'/(5X,10F10.2)	
8	(WE(K),K=1,NP)	1H0,8X,'WE'/(5X,10F10.2)	
9	(LAG(K),K=1,1NP)	1H0,7X,'LAG'/1H 10I10	
10	IZONE	IH0,5X,'IZONE',5X,I10	The output lists from no.10 to 18 will be skipped if ISNOW=0
11	(AM(M),M=1,12),(SMLT(M),M=1,12)	1H0,7X,12(5X,A3)/4X,'SMLT',12F8.2	
12	Title	1H0,8X,'PD',38X,'ZA',43X,'TW',8X,'TO',8X,'TD'	
13	(PD(IZ,K),IZ=1,IZONE)	7X,4F8.2	The ouput list no.13 to 15 will be repeated for K=1 to NP
14	(ZA(IZ,K),IZ=1,IZONE)	1H+,46X,4F8.2	
15	(TW(K),TO(K),TD(K))	1H+,86X,3F10.2	
16	Title	1H0,8X,'XW'	The output lists from no.16 to 18 will be skipped if ISTANK=0
17	((XW(IZ,K),IZ=1,IZONE),K=1,NP)	7X,4F8.2	
18	W0,W1,W2	1H0,5X,'W0',F8.2,2X,'W1',F8.2,2X,'W2',F8.2	
19	Title	1H0,8X,'XA',8X,'XS',8X,'XB',8X,'XC',8X,'XD',10X,'SNOW'	
20	(XA(K),XS(K),XB(K),XC(K),XD(K),K=1,NP)	1H ,5F10.0	
21	((SNOW(IZ,K),IZ=1,IZONE),K=1,NP)	1H+,60X,6F8.0	The output list no. 21 will be skipped

22	NPLOT,NSCAL,LY,YMIN, YMAX,(SCAL(NX),NX=1, NSCAL)	1H0,5X,'NPLOT',5X,'NSCAL', 8X,'LY',6X,'YMIN',6X, 'YMAX',14X,'SCAL'/1H ,3I10 ,2F10.2,12X,5F8.2	if ISNOW is not equal to one
23	GRFMT	1H0,5X,'GRFMT'/9X,10A4	
24	Title	1H0,'IRRIGATION'	The output list no. 24 and 25 will be skipped if irrig ation option is not used
25	(AM(M),(RR(I,M),I=1, IE),M=IRMS,IRME)	1H0,4X,A3,4X,20F5.2/12X	
26	ANAME,YEAR	1H1,10A4/1H0,I4,5X,'Q', 5X,'QE',13X,'XF',3X,'XP' ,3X,'XS',3X,'XB',4X,'XC' ,4X,'XD',4X,'XW',3X,'SNOW'	The output list no.26 will be skipped if ISTANK =0
27	ANAME,YEAR	1H1,10A4/1H0,I4,5X,'Q', 5X,'QE',13X,'XF',3X,'XP' ,3X,'XS',3X,'XB',4X,'XC' ,4X,'XD',3X,'SNOW'	The output list no.27 will be skipped if ISTANK is not equal to zero
28	AM(M),SQ,SQE	2X,A3,2F7.1	The output list no.28 will be printed for M= 1 to ME
29	(PNAME(J,K),J=1,2), XF,XP,XS(K),XB(K), XC(K),XD(K)	1H,20X,2A4,4F5.0,14F6.0	The output list no. 29 will be skipped if ISNOW =1
30	(PNAME(J,K),J=1,2), XF,XP,XS(K),XB(K), XC(K),XD(K),(SNOW(I, K),I=1,IZONE)	1H,20X,2A4,4F5.0,14F6.0	The output list no. 30 will be skipped if ISNOW NE 1 and ISTANK EQ 1
31	(PNAME(J,K),J=1,2), XF,XP,XS(K),XB(K), XC(K),XD(K),XW(K), (SNOW(J,K),J=1, IZONE)	1H,20X,2A4,4F5.0,14F6.0	The output list no. 31 will be skipped if ISNOW NE 1 and ISTANK NE 1
32	YQ,YQE	1H0,4X,2F7.1	The output list no. 29 to 31 will be printed for K=1 to NP
33	IYR	1H ,I4	
34	AM,(IPREC(K),K=1,NP) ,E(J),(PLOT(I),I=1, 2),IST,(GBUF(L),L= 1,LY)	GRFMT	The ouput list no. 34 will be skipped if ISNOW=0 or IEVAP=0
35	AM,(IPREC(K),K=1,NP) ,(PLOT(I),I=1,2) ,IST,(GBUF(L),L= 1,LY)	GRFMT	The ouput list no. 35 will be skipped if ISNOW=0 or IEVAP NE 0

36	AM,(IPREC(K),K=1,NP) ,E(J),(PLOT(I),I=1, 2),(GBUF(L),L= 1,LY)	GRFMT	The ouput list no. 36 will be skipped if ISNOW NE 0 or IEVAP=0 and ISNOW=(
37	AM,(IPREC(K),K=1,NP) ,(PLOT(I),I=1,2), ,(GBUF(L),L=1,LY)	GRFMT	The ouput list no. 37 will be skipped if ISNOW NE 0 or IEVAP NE 0 and ISNOW=0 The ouput list no. 34 to 37 will be printed for J=NS tc NE
38	Title	1H1 ,/13X,'MQ',5X,'MQE', 4X,'DQ'/	
39	AM(MON),MQ(M,N), MQE(M,N),DQ(M,N), (GBUF(L),L=1,LE)	6X,A3,3F7.2,100A1	The output list no. 39 will be skipped if DQ(M,N)=-999
40	AM(MON),(GBUF(L), L=1,LE)	6X,A3,' * * * * ',100A1	The ouput list no. 40 will be skipped if DQ(M,N) NE -999
41	YEAR	1H+,I4	
42	SMQ,SMQE	5X,'YEAR',2F7.2/	
43	SSMQ,SSMQE	1H0,3X,'TOTAL',2F7.2	

NOTE:-

(i) Output lists no. 1 to 32 are in MAIN PROGRAMME

(ii) Output lists no.33 to 37 are in SUBROUTINE HYDRGR

(iii) Output lists no.38 to 43 are in SUBROUTINE PLOTM

(iv) Output files created at files reference no.2 and 20 are utilized for intermediate computations.As soon as the execution is over these files are automatically deleted.

D. COMPUTER PROGRAMME

```
C
C
C     THIS IS THE DAILY RUNOFF ANALYSIS PROGRAM BASED ON THE SERIES
C     STORAGE-TYPE MODEL WHICH IS CALLED 'TANK MODEL'.
C
C     THIS PROGRAM IS FOR THE ARID (OR SEMI-ARID) AND SNOWY  REGION,
C     SO CONSIDERS SNOW-MELT AND SOIL-MOISTURE.
C
C     AT FIRST, CHANGE DATA SET REFERENCE NUMBERS TO APPROPRIATE
C     NUMBERS FOR YOUR INSTLATION.
C     AND CHECK THE DIFFERENCE OF THE INTERNAL CHARACTER
C     REPRESENTATION, ESPECIALLY NUMBER OF BITS PER CHARACTER, BETWEEN
C     YOUR COMPUTER AND THIS COMPUTER (VAX-11/780).
C     (VAX-11/780 1 WORD CONSISTS FOUR CHARACTERS)
C
C     THE OBSERVED PRECIPITATION, DISCHARGE AND TEMPERATURE ARE STORED
C     ON THE DISK THROUGH A FILE.  USUAL SETUP IN THIS FILE IS AS FOLLOWS:
C       * FYEAR (FIRST YEAR), FMONTH (FIRST MONTH), LYEAR (LAST YEAR),
C           LMONTH (LAST MONTH), NP (NUMBER OF RAINFALL STATIONS),
C           ISNOW (SWITCH FOR SNOW CONSIDERATION),
C           IEVAP (SWITCH FOR EVAPOTRANSPIRATION DATA TYPE)  (7I8)
C       * AREA (CATCHMENT AREA (KM**2))  (F10.0)
C       * ANAME (BASIN AREA NAME)  (10A4)
C
C       * YEAR (YEAR)   (16X,I8)
C           (FOR FIRST YEAR)
C       * Q (OBSERVED DISCHARGE (M**3/SEC))  (2(10F6.2/),11F6.2)
C           (FOR FIRST YEAR)
C       * EVAP (DAILY EVAPOTRANSPIRATION) (2(10F6.2/),11F6.2)
C           (FOR FIRST YEAR)  (IF IEVAP=1)
C       * PNAME (RAINFALL STATION NAME), YEAR  (4A4,I8)  (FOR FIRST
C           STATION, FIRST YEAR)
C       * P (OBSERVED PRECIPITATION)  (2(10F6.1/),11F6.1)  (FOR FIRST
C           STATION, FIRST YEAR)
C       * PNAME, YEAR (FOR SECOND STATION)
C       * P (FOR SECOND STATION)
C           .
C           .
C           .
C       * PNAME, YEAR  (FOR LAST STATION)
C       * P (FOR LAST STATION)
C       ** YEAR  (16X,I8)  (FOR FIRST STATION, FIRST YEAR)
C       ** TMAX (OBSERVED MAXIMUM TEMPERATURE)  (2(10F6.1/),11F6.1)
C           (FOR FIRST STATION, FIRST YEAR)
C       ** TMIN (OBSERVED MINIMUM TEMPERATURE)  (2(10F6.1/),11F6.1)
C           (FOR FIRST STATION, FIRST YEAR)
C       ** YEAR  (16X,I8)  (FOR SECOND STATION)
C       ** TMAX  (FOR SECOND STATION)
C       ** TMIN  (FOR SECOND STATION)
C           .
```

```
C          .
C          .
C      ** YEAR  (FOR LAST STATION)
C      ** TMAX  (FOR LAST STATION)
C      ** TMIN  (FOR LAST STATION)
C      * YEAR  (FOR SECOND YEAR)
C      * Q  (FOR SECOND YEAR)
C      * EVAP  (FOR SECOND YEAR)  (IF IEVAP=1)
C      * PNAME, YEAR  (FOR FIRST STATION, SECOND YEAR)
C      * P  (FOR FIRST STATION, SECOND YEAR)
C          .
C          .
C          .
C      ** YEAR  (FOR FIRST STATION, SECOND YEAR)
C      ** TMAX  (FOR FIRST STATION, SECOND YEAR)
C      ** TMIN  (FOR FIRST STATION, SECOND YEAR)
C          .
C          .
C          .
C      * PNAME, YEAR  (FOR LAST STATION, LAST YEAR)
C      * P  (FOR LAST STATION, LAST YEAR)
C          .
C          .
C          .
C      ** YEAR  (FOR LAST STATION, LAST YEAR)
C      ** TMAX  (FOR LAST STATION, LAST YEAR)
C      ** TMIN  (FOR LAST STATION, LAST YEAR)
C      FILE MARK
C      * FYEAR, ...  (NEXT FILE FOR OTHER BASIN)
C          .
C          .
C          .
C
C      NOTES.  (1) THE DATA FOR EACH MONTH CONSIST OF THREE CARDS.
C              (2) IF YOU WANT TO SET THE DAILY EVAPOTRANSPIRATION FOR
C                  EACH DAY IN EACH YEAR, SPECIFY IEVAP=1.  IF YOU WANT
C                  TO SET THE DAILY EVAPOTRANSPIRATION FOR EACH MONTH,
C                  SPECIFY IEVAP=0.
C              (3) IF YOU WANT TO CALCULATE ABOUT SNOW, SPECIFY ISNOW=1.
C              (4) IF ISNOW=0, THESE DATA WHICH ARE SPECIFIED BY DOUBLE
C                  ASTERISK MUST NOT BE APPEARED.
C
C     USUAL DATA SETUP FROM CARD READER (OR SYSTEM INPUT) IS AS FOLLOWS:
C        * VARIOUS TANK MODEL PARAMETERS
C        * VARIOUS PARAMETERS FOR GRAPH PLOTTING
C        * IRRIGATION DATA
C
C
      REAL MQ(12,10),MQE(12,10),DQ(12,10),K1,K2
      INTEGER MONTH(12),FYEAR,FMONTH,YEAR,DSC
```

```
      DIMENSION QNAME(4)
      DIMENSION E(12), LAG(10), CP(10), WE(10), XA(10), XS(10), XB(10),
     1     XC(10), XD(10), SNOW(6,10), CM(12), TW(10), TO(10),
     2     TD(10), PD(6,10), ZA(6,10), SMLT(13), XW(6,10)
      DIMENSION RR(31,12), FMTR(4), AM(12)
      DIMENSION Q(366),EVAP(366), P(366,10),TMAX(366,10),
     2     TMIN(366,10),
     1     QA(370), QB(370), QC(370), QD(370), ST(366)
      DATA AM / 'JAN', 'FEB', 'MAR', 'APR', 'MAY', 'JUN',
     1          'JUL', 'AUG', 'SEP', 'OCT', 'NOV', 'DEC' /
      DATA MONTH /31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31/
      DATA IRMS, IRME /2*0/
C
      COMMON // FYEAR, FMONTH, LYEAR, LMONTH, NP, ISNOW, IEVAP, AREA,
     1     ANAME(10), PNAME(4,10), ISTANK
      COMMON /HYGR/ NPLOT, NSCAL, LY, YMIN, YMAX, SCAL(5), GRFMT(10)
      MT=5
        DSC=2
        DEFINE FILE 20 (30,3660,U,ID20)
        OPEN (UNIT=MT,FILE='TANKDH.DAT',STATUS='OLD')
        OPEN (UNIT=6,FILE='TANKDH.OUT',STATUS='NEW')
        OPEN (UNIT=DSC,FILE='SCR.DAT',STATUS='SCRATCH',FORM='UNFORMATTED')
C
C                   STORING DATA INTO DATA SET DSC
C                   FROM DATA SET MT
      CALL DATAFL (MT, DSC)
C
C                   READING VARIOUS TANK MODEL PARAMETERS
C                     S1 :  PRIMARY SOIL MOISTURE DEPTH
C                     S2 :  SECONDARY SOIL MOISTURE DEPTH
C                     HA1 :  FIRST SIDE OUTLET HEIGHT OF TOP TANK
C                     HA2 :  SECOND OUTLET HEIGHT OF TOP TANK
C                     A0 :  INFILTRATION COEFFICIENT OF TOP TANK
C                     A1 :  DISCHARGE COEFFICIENT FOR HA1
C                     A2 :  DISCHARGE COEFFICIENT FOR HA2
C                           AND SO ON
C                     E(M) :  DAIRY EVAPOTRANSPIRATION FOR M-TH
C                             MONTH (IF IEVAP IS     EQUAL TO ZERO)
C                     K1 :  WATER SUPPLY RATE FROM LOWER TANKS
C                           TO PRIMARY SOIL MOISTURE
C                     K2 :  WATER EXCHANGE RATE BETWEEN PRIMARY
C                           AND SECONDARY SOIL MOISTURE
C                     CP(K) :  WEIGHT FOR PRECIPITATION OF
C                              K-TH RAINFALL STATION
C                     WE(K) :  WEIGHT FOR DISCHARGE OF
C                              K-TH RAINFALL STATION
C                     LAG(K) :  TIME LAG FOR K-TH RAINFALL STATION
C                     INVL : IF SUBROUTINE INVAL3 IS USED
C                            IN ORDER TO GET INITIAL
C                            STORAGE FOR EACH TANK,
```

```
C                                 SPECIFY INVL=1, OTHERWISE
C                                 SET INVL=0
C                         ISTANK : IF SNOW DEPOSIT TANK IS USED,
C                         =1, OTHERWISE, =0
C                         Q0 : ADDING CONSTANT FOR LOGARITHMIC
C                              CALCULATION OF DATA WHICH
C                              HAVE ZERO VALUE
C                         IZONE :  NUMBER OF ZONE  (IF ISNOW=1)
C                         SMLT(M) : THAWING CONSTANT FOR EACH
C                                   MONTH (IF ISNOW=1)
C                         CM(M) :  WEIGHT FOR PRECIPITATION OF
C                                  M-TH MONTH  (IF ISNOW=1)
C                         PD(IZ,K) :  WEIGHT FOR PRECIPITATION OF
C                                   IZ-TH ZONE IN K-TH RAINFALL STATION
C                                   (IF ISNOW=1)
C                         ZA(IZ,K) :  AREA OF IZ-TH ZONE IN
C                                   K-TH RAINFALL STATION  (IF ISNOW=1)
C                         TW(K) :  WEIGHTS IN FORMULA
C                                   TW(K)*TMAX+(1-TW(K))*TMIN
C                                   (IF ISNOW=1)
C                         TO(K) :  TEMPERATURE CORRECTION FACTOR TO IN
C                                  FORMULA   TI=T-(IZ-1)*TD+TO
C                                   (IF ISNOW=1)
C                         TD(K) :  TEMPERATURE DECREASING CONSTANT TD
C                                   OF ABOVE FORMULA  (IF ISNOW=1)
C                         XW(IZ,K) : INITIAL STORAGE OF SNOW
C                                    DEPOSIT TANK FOR IZ-TH ZONE
C                                    IN K-TH STATION
C                         WO : COEFFICIENT FOR DETERMINING
C                             HEIGHT OF SECOND OUTLET IN
C                              SNOW DEPOSIT TANK
C                         W1 : DISCHARGE COEFFICIENT OF FIRST
C                              OUTLET IN SNOW DEPOSIT TANK
C                         W2 : DISCHARGE COEFFICIENT OF SECOND
C                              OUTLET IN SNOW DEPOSIT TANK
      READ (5,11) S1, S2
      READ (5,11) HA1, HA2, A0, A1, A2
      READ (5,11) HB1, B0, B1
      READ (5,11) HC1, C0, C1
      READ (5,11) HD1, D0, D1
C
C                       READING DAILY EVAPOTRANSPIRATION VALUE FOR
C                       EACH MONTH (E(M)), IF IEVAP = 0
C
      IF  (IEVAP .EQ. 0)   READ (5,12) (E(M), M=1,12)
      READ (5,11) K1, K2
      READ (5,11) (CP(K), K=1,NP)
      READ (5,11) (WE(K), K=1,NP)
      READ (5,10) (LAG(K), K=1,NP)
      READ (5,10) INVL, ISTANK
```

```
      READ (5,11) QO
C
C                          SKIPPING READING VARIOUS PARAMETERS RELATED
C                          TO SNOW, IF ISNOW = 0
      IF  (ISNOW .EQ. 0)   GO TO 155
C
      READ (5,10) IZONE
      READ (5,12) (SMLT(M), M = 1, 12)
      SMLT(13) = SMLT(1)
      READ (5,12) (CM(M), M=1,12)
      DO 150 K = 1, NP
  150 READ (5,11) (PD(IZ,K), IZ=1,IZONE)
      DO 151 K = 1, NP
  151 READ (5,11) (ZA(IZ,K), IZ=1,IZONE)
      DO 152 K = 1, NP
  152 READ (5,11) TW(K), TO(K), TD(K)
      IF (ISTANK .EQ. 0) GO TO 155
      DO 153 K = 1, NP
  153 READ(5,11) (XW(IZ, K), IZ = 1, IZONE)
      READ (5,11) WO, W1, W2
  155 CONTINUE
C
C                          READING INITIAL STORAGE OF EACH TANK AND
C                          INITIAL SNOW DEPOSIT OF EACH ZONE FOR
C                          EACH RAINFALL STATION
      DO 156 K = 1, NP
      READ (5,11) XA(K), XS(K), XB(K), XC(K), XD(K)
      IF  (ISNOW .EQ. 1)   READ (5,11) (SNOW(IZ,K), IZ=1,IZONE)
  156 CONTINUE
C
C                          READING PARAMETERS FOR GRAPH PLOTTING
C                            NPLOT :  NUMBER OF GRAPHS PLOTTED
C                            NSCAL :  NUMBER OF SCALE POINT
C                            LY :  NUMBER OF CHARACTERS IN ONE LINE
C                            YMIN :  MINIMUM VALUE TO BE PLOTTED
C                            YMAX : MAXIMUM VALUE TO BE PLOTTED
C                            SCAL(NX) :  PLOTTING VALUE FOR NX-TH SCALE
C                                           POINT
C                            GRFMT :  FORMAT SPECIFICATION FOR PLOTTING
      READ (5,14) NPLOT, NSCAL, LY, YMIN, YMAX
      READ (5,11) (SCAL(NX), NX=1,NSCAL)
      READ (5,15) GRFMT
C
   10 FORMAT (10I8)
   11 FORMAT (10F8.0)
   12 FORMAT (12F6.0)
   14 FORMAT(3I8,2F8.0)
   15 FORMAT (10A4)
C
C                          WRITING VARIOUS PARAMETERS FOR CHECKING
```

```
      WRITE (6,20) ANAME, INVL, QO, ISTANK
      WRITE (6,21) FYEAR, FMONTH, LYEAR, LMONTH, NP, ISNOW, IEVAP, AREA
      WRITE (6,22) S1, S2, HA1, HA2, A0, A1, A2
      WRITE (6,23) HB1, B0, B1, HC1, C0, C1, HD1, D0, D1
      IF  (IEVAP .EQ. 0)   WRITE (6,24) (AM(M), M=1,12), (E(M), M=1,12)
      WRITE (6,25) K1, K2
      WRITE (6,26) (CP(K), K=1,NP)
      WRITE (6,27) (WE(K), K=1,NP)
      WRITE (6,28) (LAG(K), K=1,NP)
C
      IF  (ISNOW .EQ. 0)   GO TO 165
C
      WRITE (6,29) IZONE
      WRITE(6,45) (AM(M), M = 1, 12), (SMLT(M), M = 1, 12)
   45 FORMAT (1H0,7X,12(5X,A3)/4X,'SMLT',12F8.2)
      WRITE (6,30) (AM(M), M=1,12), (CM(M), M=1,12)
      WRITE (6,31)
      DO 160 K = 1, NP
      WRITE (6,32) (PD(IZ,K), IZ=1,IZONE)
      WRITE (6,33) (ZA(IZ,K), IZ=1,IZONE)
  160 WRITE (6,34) TW(K), TO(K), TD(K)
      IF (ISTANK .EQ. 0) GO TO 165
      WRITE (6,46)
      DO 161 K = 1, NP
  161 WRITE (6,47) (XW(IZ, K), IZ = 1, IZONE)
   46 FORMAT (1H0,8X,'XW')
   47 FORMAT (7X,4F8.2)
      WRITE (6,48) W0, W1, W2
   48 FORMAT(1H0,5X,'W0',F8.2,2X,'W1',F8.2,2X,'W2',F8.2)
  165 CONTINUE
C
      WRITE (6,35)
      DO 166 K = 1, NP
      WRITE (6,36) XA(K), XS(K), XB(K), XC(K), XD(K)
      IF  (ISNOW .EQ. 1)   WRITE (6,37) (SNOW(IZ,K), IZ=1,IZONE)
  166 CONTINUE

      WRITE (6,38) NPLOT, NSCAL, LY, YMIN, YMAX, (SCAL(NX), NX=1,NSCAL)
      WRITE (6,39) GRFMT

   20 FORMAT (1H1,10A4//,6X,'INVL',I10,8X,'QO',F10.3,
     1      4X,'ISTANK',I10)
   21 FORMAT(///,1H ,5X,'FYEAR',4X,'FMONTH',5X,'LYEAR',4X,'LMONTH',
     1      8X,'NP',5X,'ISNOW',5X,'IEVAP',8X,'AREA'/1H ,7I10,F12.2)
   22 FORMAT (1H0,8X,'S1',8X,'S2',7X,'HA1',7X,'HA2',8X,'A0',8X,'A1',
     1      8X,'A2'/1H ,4F10.0,3F10.4)
   23 FORMAT(1H0,7X,'HB1',8X,'B0',8X,'B1',7X,'HC1',8X,'C0',8X,'C1',
     1      7X,'HD1',8X,'D0',8X,'D1'/3(1H ,F10.0,2F10.4))
   24 FORMAT (1H0,7X,12(5X,A3)/6X,'E ',12F8.2)
   25 FORMAT (1H0,8X,'K1',8X,'K2'/1H ,2F10.1)
```

```
   26 FORMAT(1H0,8X,'CP'/(5X,10F10.2))
   27 FORMAT(1H0,8X,'WE'/(5X,10F10.2))
   28 FORMAT(1H0,7X,'LAG'/1H 10I10)
   29 FORMAT(1H0,5X,'IZONE',5 X,I10)
   30 FORMAT (1H0,7X,12(5X,A3)/6X,'CM',12F8.2)
   31 FORMAT(1H0,8X,'PD',38X,'ZA',43X,'TW',8X,'TO',8X,'TD')
   32 FORMAT(7X,4F8.2)
   33 FORMAT(1H+,46X,4F8.2)
   34 FORMAT(1H+,86X,3F10.2)
   35 FORMAT (1H0,8X,'XA',8X,'XS',8X,'XB',8X,'XC',8X,'XD',10X,'SNOW'
   36 FORMAT (1H ,5F10.0)
   37 FORMAT (1H+,60X,6F8.0)
   38 FORMAT(1H0,5X,'NPLOT',5X,'NSCAL',8X,'LY',6X,'YMIN',6X,
     1      'YMAX',14X,'SCAL'/1H ,3I10,2F10.2,12X,5F8.2)
   39 FORMAT(1H0,5X,'GRFMT'/9X,10A4)
C
C                       READING, WRITING AND STORING IN RR DATA FOR
C                       IRRIGATION,
C                          IRMS:  FIRST MONTH FOR IRRIGATION
C                          IRME:  LAST MONTH FOR IRRIGATION
C                          FMTR:  FORMAT FOR WATER QUANTITIES IN MM.
C
C                       NOTE:  IF IRRIGATION IS NOT CONSIDERED,
C                              IRMS MUST BE ZERO.
      READ(5,16,END=170) IRMS, IRME, FMTR
   16 FORMAT (2I8,4X,4A4)
      WRITE (6,40)
      DO 169 M = IRMS, IRME
      IE = MONTH(M)
      READ (5,FMTR) (RR(I,M), I=1,IE)
      WRITE (6,41) AM(M), (RR(I,M), I=1,IE)
  169 CONTINUE
   40 FORMAT (1H0,'IRRIGATION')
   41 FORMAT (1H0,4X,A3,4X,20F5.2/12X,11F5.2)
  170 CONTINUE
C
C                       NORMALIZING THE WEIGHT FOR DISCHARGE
      SWE = 0.
      DO 180 K = 1, NP
  180 SWE = SWE + WE(K)
      DO 190 K = 1, NP
  190 WE(K) = WE(K)/SWE
C
C                        IF INVL IS EQUAL TO 1, TANK MODEL
C                        CALCULATION IS DONE THREE TIMES IN
C                        ORDER TO GET INITIAL STORAGES BEFOR
C                        NORMAL CALCULATION
      ID20=1
      DO 1001 J=1,4
      QNAME(J)=ANAME(J)
```

```
 1001 CONTINUE
      WRITE (20'ID20) QNAME,AREA,FYEAR,FMONTH,LYEAR,LMONTH,QO
      NITR = 1
      IF (INVL .EQ. 1) NITR = 4
C
      DO 420 NR = 1, NITR
      NM = NR
C
C                           INITIALIZING VARIOUS STORAGES TO ZERO
      DO 200 J = 366, 370
      QA(J) = 0.
      QB(J) = 0.
      QC(J) = 0.
  200 QD(J) = 0.
C
      REWIND DSC
C
C                           BEGINNING OF YEAR LOOP
      DO 400 YEAR = FYEAR, LYEAR
C
      IY =YEAR
      NY = YEAR - FYEAR + 1
C                           SETTING FOR LEAP YEAR
      MONTH(2) = 28
      IF  (MOD(YEAR, 4) .EQ. 0)   MONTH(2) = 29
C
C                           READING OBSERVED DISCHARGE FOR ONE YEAR
      READ (DSC) Q
C
C                           IF IEVAP IS EQUAL TO 1, READ DAILY
C                           EVAPOTRANSPIRATION DATA FOR ONE YEAR
C
      IF  (IEVAP .EQ. 1)   READ (DSC) EVAP
C
      DO 300 K = 1, NP
C                           READING PRECIPITATION (ONE YEAR)
C                           FOR ONE STATION
  300 READ (DSC) (P(J,K), J=1,366)
C
C                           SKIPPING THE READING OF TMAX AND TMIN,
C                           IF ISNOW = 0
      IF  (ISNOW .EQ. 0)   GO TO 320
C
      DO 310 K = 1, NP
C                           READING MAXIMUM TEMPERATURE AND MINIMUM
C                           TEMPERATURE (ONE YEAR) FOR ONE STATION
      READ (DSC) (TMAX(J,K), J=1,366)
      READ (DSC) (TMIN(J,K), J=1,366)
  310 CONTINUE
  320 CONTINUE
```

```
C
C                      TAIL DATA OF QA, QB, QC AND QD ARE TRANSMITTED
C                      TO THE BEGINNING OF ARRAYS IN ORDER TO COPE
C                      WITH TIME LAG.
      JLAG = 366
      IF  (MOD(YEAR-1, 4) .EQ. 0)  JLAG = 367
      DO 330 J = 1, 4
      QA(J) = QA(JLAG)
      QB(J) = QB(JLAG)
      QC(J) = QC(JLAG)
      QD(J) = QD(JLAG)
  330 JLAG = JLAG + 1
C
C                      INITIALIZING VARIOUS STORAGES TO ZERO
      DO 340 J = 5, 370
      QA(J) = 0.
      QB(J) = 0.
      QC(J) = 0.
      QD(J) = 0.
  340 ST(J-4) = 0.
      YQ = 0.
      YQE = 0.
C
C                      SKIP WRITING, IF NM IS NOT EQUAL TO NITR
      IF (NM .NE. NITR) GO TO 341
      IF (ISTANK .EQ. 0) GO TO 344
      WRITE (6,50) ANAME, YEAR
      GO TO 341
  344 WRITE (6,51) ANAME, YEAR
  341 CONTINUE
C
C                      CALCULATION OF TANK MODEL FOR ONE YEAR
      MS = 1
      ME = 12
      IF  (YEAR .EQ. FYEAR)   MS = FMONTH
      IF  (YEAR .EQ. LYEAR)   ME = LMONTH
      JE = 0
      DO 390 M = 1, ME
C
      SQ = 0.
      SQE = 0.
      DAY = 0.
C
C                      GETTING THAWING CONSTANT AT FIRST DAY
C                      OF EACH MONTH AND VALUE FOR INTERPOLATION
      DSML = (SMLT(M+1) - SMLT(M))/FLOAT(MONTH(M))
      SMELT = SMLT(M)
C
C                      CALCULATION OF TANK MODEL FOR ONE MONTH
      JS = JE + 1
```

```
      JE = JE + MONTH(M)
      IF  (M .LT. MS)   GO TO 390
      DO 370 J = JS, JE
C
      DO 360 K = 1, NP
C
C                        ADJUSTING PRECIPITATION USING RAINFALL
C                        STATION WEIGHT
      PX = P(J,K) * CP(K)
      PY = PX
C
C                        SKIPPING SNOW MELT CALCULATION, IF ISNOW = 0
      IF  (ISNOW .EQ. 0)   GO TO 350
C
C                        SNOW MELT CALCULATION WITH OR WITHOUT SNOW
C                        DEPOSIT TANK
      IF (ISTANK .EQ.0) GO TO 342
      CALL ZONES(IZONE, SMELT, PX, TMAX(J,K), TMIN(J,K), TW(K), TO(K),
     1     TD(K), CM(M), PD(1,K), ZA(1,K), SNOW(1,K), PY, SK,
     2     WO, W1, W2, XW(1,K))
      GO TO 343
  342 CALL ZONE (IZONE, SMELT, PX, TMAX(J,K),TMIN(J,K), TW(K),
     1     TO(K), TD(K), CM(M), PD(1,K), ZA(1,K), SNOW(1,K), PY, SK)
  343 CONTINUE
C
C                        GETTING THAWING CONSTANT FOR NEXT DAY
      SMELT = SMELT + DSML
C
      ST(J) = ST(J) + SK * WE(K)
C
C                        SUBTRACTING EVAPOTRANSPILATION.
C
  350 EV = E(M)
      IF  (IEVAP .EQ. 1)   EV = EVAP(J)
      CALL EVPTRW (EV, K1, K2, S1, S2, XA(K), XS(K), XB(K),
     1     XC(K), XD(K))
C
C                        TANK MODEL CALCULATION FOR ONE DAY
C
      CALL TANKSM (PY, XA(K), Y2, Y1, YAO, HA1, HA2, S1, AO, A1, A2)
      CALL TANKB (YAO, XB(K), YB, YBO, HB1, BO, B1)
      CALL TANKB (YBO, XC(K), YC, YCO, HC1, CO, C1)
      CALL TANKB (YCO, XD(K), YD, YDO, HD1, DO, D1)
C
      YA = Y1 + Y2
      Y = YA + YB + YC + YD
C
C                        CALCULATING IRRIGATION EFFECT
C
      IF  (M .LT. IRMS  .OR.  M .GT. IRME)   GO TO 355
```

```
      IDAY = J - JS + 1
      CALL IRRIG (RR(IDAY,M), Y, XC(K))
  355 CONTINUE
C
C                       CALCULATING WEIGHTED DISCHARGE VALUE
C                       FROM EACH TANK
      JL = J + LAG(K)
      QD(JL) = QD(JL) + YD * WE(K)
      QC(JL) = QC(JL) + (YD + YC) * WE(K)
      QB(JL) = QB(JL) + (YD + YC + YB) * WE(K)
      QA(JL) = QA(JL) + Y * WE(K)
C
  360 CONTINUE
C
C                       CALCULATING MONTHLY DISCHARGE
      IF  (Q(J) .LT. 0.)   GO TO 370
      SQ = SQ + Q(J)
      SQE = SQE + QA(J)
      DAY = DAY + 1.
C
  370 CONTINUE
C
C                       SKIP MONTHLY
C                       RESULT WRITEING, IF NM(NR) IS NOT EQUAL
C                       NITR, THAT IS, IF NOT FINAL LOOP
      IF (NM .NE. NITR) GO TO 53
C
C                       PRINTING MONTHLY DISCHARGE
      WRITE (6,60) AM(M), SQ, SQE
C
   53 DO 382 K = 1, NP
C
      XF = 0.
      XP = XA(K)
      IF  (XA(K) .LE .S1)   GO TO 380
      XF = XA(K) - S1
      XP = S1
C
C                       SKIP RESULT WRITING, IF NM IS NOT EQUAL TO NITR
  380 IF (NM .NE. NITR) GO TO 382
C
C                       WRITING VARIOUS DATA
      IF  (ISNOW .EQ. 1)   GO TO 381
      WRITE (6,70) (PNAME(J,K), J=1,2), XF, XP, XS(K), XB(K),
     1     XC(K), XD(K)
      GO TO 382
C
  381 IF (ISTANK .EQ. 1) GO TO 384
      WRITE (6,70) (PNAME(J,K), J=1,2), XF, XP, XS(K), XB(K),
     1     XC(K), XD(K), (SNOW(I,K), I=1,IZONE)
```

```
      GO TO 382
  384 WRITE (6,70) (FNAME(J,K), J=1,2), XF, XP, XS(K), XB(K),
     1      XC(K), XD(K), (XW(J,K),SNOW(J,K), J=1,IZONE)
  382 CONTINUE
C
   50 FORMAT(1H1,10A4/1H0,I4,5X,'Q',5X,'QE',13X,'XF',3X,'XP',3X,'XS',3X,
     1      'XB',4X,'XC',4X,'XD',4X,'XW',3X,'SNOW'/)
   51 FORMAT(1H1,10A4/1H0,I4,5X,'Q',5X,'QE',13X,'XF',3X,'XP',3X,'XS',3X,
     1      'XB',4X,'XC',4X,'XD',3X,'SNOW'/)
   60 FORMAT(2X,A3,2F7.1)
   70 FORMAT(1H ,20X,2A4,4F5.0,14F6.0)
C
C                          SKIP YEARLY CALCULATION, IF NM IS NOT EQUAL
C                          TO NITR
      IF (NM .NE. NITR) GO TO 390
C
C                          CALCULATING YEARLY DISCHARGE
      YQ = YQ + SQ
                + SQE
C
      MQ(M,NY) = 0.
      MQE(M,NY) = 0.
      DQ(M,NY) = -999.
      IF  (DAY .EQ. 0)   GO TO 390
C
C                          CALCULATING MEAN DISCHARGE IN A MONTH
      MQ(M,NY) = SQ / DAY
      MQE(M,NY) = SQE / DAY
C
      DQ(M,NY) = 0.
      IF  (SQ .EQ. 0.  .OR.  SQE .EQ. 0.)   GO TO 390
C
C                          CALCULATING A EVALUATING CRITERION
      DQ(M,NY) = ALOG(MQE(M,NY)) - ALOG(MQ(M,NY))
  390 CONTINUE
C
C                          SKIP PRINTING, IF NM IS NOT EQUAL TO NITR
      IF (NM .NE. NITR) GO TO 400
C
C                          PRINTING YEARLY DISCHARGE
      WRITE (6,80) YQ, YQE
   80 FORMAT(1H0,4X,2F7.1)
C
C                          GRAPH PLOTTING FOR DAILY DATA
      WRITE (20'ID20) (Q(J),J=1,366)
      WRITE (20'ID20) (QA(J),J=1,366)
      CALL HYDRGR (ISNOW, IY,   MS, ME, Q, QA, QB, QC, QD, ST,
     1              NP, P, IEVAP, E, Q0)
C
  400 CONTINUE
```

```
C
C                   GETTING INITIAL STORAGE BY USING
C                   SUBROUTINE INVAL3
      IF (INVL .EQ. 0) GO TO 383
      IF (NM .EQ. NITR) GO TO 383
      CALL INVAL3 (NM, NP, XA, XS, XB, XC, XD)
  383 CONTINUE
C
  420 CONTINUE
C
C                   GRAPH PLOTTING FOR MONTHLY DATA
      NYEAR = LYEAR - FYEAR + 1
      CALL PLOTM (FYEAR, MS, LYEAR, ME, NYEAR, MQ, MQE, DQ, QO)
C
500     CLOSE(UNIT=20,DISP='DELETE')
      STOP
      END
C
C
C        SUBROUTINE FOR STORING DATA INTO DATA SET DSC FROM DATA SET MT
C
      SUBROUTINE DATAFL (MT,DSC)
C
      COMMON // FYEAR, FMONTH, LYEAR, LMONTH, NP, ISNOW, IEVAP, AREA,
     1    ANAME(10), PNAME(4,10), ISTANK
      DIMENSION Q(366), P(366), T(366), E(366)
      INTEGER FYEAR, FMONTH, YEAR, DSC, MONTH(12)
      DATA MONTH /31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31/
C
C                   READING FIRST YEAR (FYEAR),
C                   FIRST MONTH (FMONTH),
C                   LAST YEAR (LYEAR), LAST MONTH (LMONTH),
C                   NUMBER OF RAINFALL STATION (NP),
C                   ISNOW  :  =1  IF SNOW MELT IS CONSIDERED
C                             =0  IF NOT,
C                   IEVAP  :  =1  DAILY EVAPOTRANSPIRATION IS
C                                 SET FOR EACH DAY
C                             =0  DAILY EVAPOTRANSPIRATION IS
C                                 SET FOR EACH MONTH,
C                   CATCHMENT AREA (KM**2) AND BASIN AREA NAME
C
      READ (MT,10) FYEAR, FMONTH, LYEAR, LMONTH, NP, ISNOW, IEVAP
      READ (MT,12) AREA
      READ (MT,11) ANAME
   10 FORMAT (10I8)
   11 FORMAT (10A4)
   12 FORMAT (F10.0)

                    CALCULATING COEFFICIENT TO CONVER FROM
                    M**3/SEC TO MILIMETER
```

```
      AR = 86.4 / AREA
      IEE = 0
C
      REWIND DSC
C
C                             BEGINNING OF YEAR LOOP
      DO 400 IY = FYEAR, LYEAR
C
C                             INITIALIZING Q, P AND T TO ZERO
      DO 100 I = 1, 366
      Q(I) = 0.
      P(I) = 0.
      T(I) = 0.
      E(I) = 0.
  100 CONTINUE
C
C                             READING YEAR
      READ (MT,20) YEAR
    ) FORMAT (16X,I8)
C
C                             IF YEAR IS SOMETHING WRONG,
C                             PRINT THIS FACT AND STOP
      IF (YEAR .EQ. IY) GO TO 22
      IYY = IY
      IEE = 1
      GO TO 600
C
C                             TETTING FOR LEAP YEAR
   22 MONTH(2) = 28
      IF  (MOD(YEAR,4) .EQ. 0)   MONTH(2) = 29
C
      MS = 1
      ME = 12
      IF  (YEAR .EQ. FYEAR)   MS = FMONTH
      IF  (YEAR .EQ. LYEAR)   ME = LMONTH
C
C                             READING OBSERVED DISCHARGE FOR ONE YEAR
      IE = 0
      DO 110 M = 1, ME
      IS = IE + 1
      IE = IE + MONTH(M)
      IF  (M .LT. MS)   GO TO 110
      READ (MT,21) (Q(I), I=IS,IE)
   21 FORMAT (10F8.1)
  110 CONTINUE

                              CONVERTING TO MILIMETER FROM M**3/SEC, AND SET
                              TO -999., IF OBSERVED DISCHARGE IS MISSING
      DO 120 I = 1, IE
      Q(I) = Q(I) * AR
```

```
      IF  (Q(I) .LE. 0.)   Q(I) = -999.
  120 CONTINUE
C
C                       WRITING OBSERVED DISCHARGE (ONE YEAR) TO
C                       DATA SET DSC
      WRITE (DSC) (Q(I), I=1,366)
C
C                       IF IEVAP EQUAL TO ZERO, SKIP TO 140
      IF  (IEVAP .EQ. 0)   GO TO 140
C
C                       READING AND WRITING EVAPOTRANSPIRATION DATA
C                       (ONE YEAR) TO DATA SET DSC
      IE = 0
      DO 130 M = 1, ME
      IS = IE + 1
      IE = IE + MONTH(M)
      IF  (M .LT. MS)   GO TO 130
      READ (MT,40) (E(I), I=IS,IE)
  130 CONTINUE
      WRITE (DSC) (E(I), I=1,366)
  140  CONTINUE
C
C                       READING AND WRITING PRECIPITATION FOR
C                       EACH RAINFALL STATION
      DO 210 K = 1, NP
C                       READING RAINFALL STATION NAME
C                       (MAXIMUM NUMBER OF CHARACTER = 16) AND YEAR
      READ (MT,30) (PNAME(J,K), J=1,4), YEAR
   30 FORMAT (4A4,I8)
C
C                       IF YEAR IS SOMETHING WRONG,
C                       PRINT THIS FACT AND STOP
      IF (YEAR .EQ. IY) GO TO 60
      IYY = IY
      IEE = 2
      GO TO 600
C
C                       READING PRECIPITATION FOR ONE YEAR
   60 IE = 0
      DO 200 M = 1, ME
      IS = IE + 1
      IE = IE + MONTH(M)
      IF  (M .LT. MS)   GO TO 200
      READ (MT,40) (P(I), I=IS,IE)
   40 FORMAT (2(10F6.1/),11F6.1)
  200 CONTINUE
C
C                       WRITING PRECIPITATION (ONE STATION, ONE YEAR)
C                       TO DATA SET DSC
      WRITE (DSC) (P(I), I=1,366)
```

```
  210 CONTINUE
C
      IF  (ISNOW .EQ. 0)   GO TO 400
C
C                         READING AND WRITING TMAX, TMIN FOR
C                         EACH RAINFALL STATION
      DO 320 K = 1, NP
      READ (MT,20) YEAR
C
C                         IF YEAR IS SOMETHING WRONG,
C                         PRINT THIS FACT AND STOP
      IF (YEAR .EQ. IY) GO TO 70
      IYY = IY
      IEE =3
      GO TO 600
C
   70 DO 310 J = 1, 2
      IE = 0
      DO 300 M = 1, ME
      IS = IE + 1
      IE = IE + MONTH(M)
      IF  (M .LT. MS)   GO TO 300
      READ (MT,40) (T(I), I=IS,IE)
  300 CONTINUE
C
C                         WRITING TMAX AND TMIN FOR EACH RAINFALL STATION
C                         TO DATA SET DSC
  310 WRITE (DSC) (T(I), I=1,366)
  320 CONTINUE
C
  400 CONTINUE
C
C
      RETURN
C
  600 WRITE (6,80) IEE, IYY
   80 FORMAT (1H ,'SOMETHING WRONG IN DISK FILE TANKDH.DAT DATA',
     1           2X, 'IEE=', I2,3X,'IYY=',I5)
      STOP
      END
C
C
C     SUBROUTINE FOR EXTRACTING EVAPOTRANSPIRATION AND FOR
C     CALCULATION OF TRANSFER VALUE FROM LOWER TANK TO UPPER TANK
C
C     NOTE.  THIS SUBROUTINE IS FOR THE ARID OR SEMI-ARID REGION
C
      SUBROUTINE EVPTRW (EV, K1, K2, S1, S2, XA, XS, XB, XC, XD)
C
      REAL K1, K2
```

```
C
C                         EXTRACTING EVAPOTRANSPIRATION FROM FIRST TANK
C                         (PRIMARY SOIL MOISTURE) ONLY
      XA = XA - EV
C
C                         IF QUANTITY OF FIRST TANK BECOMES LESS THAN
C                         ZERO, IT IS SET TO ZERO, AND EVEN IN THIS CASE,
C                         EXTRACTION FROM LOWER TANK IS NOT OCCURRED.
      IF  (XA .LT. 0.)  XA = 0.
      XP = XA
      IF  (XA .GT. S1)  XP = S1
C
C                         CALCULATION OF TRANSFER VALUE (T1) FROM
C                         LOWER TANK TO PRIMARY SOIL MOISTURE AND
C                         TRANSFER VALUE (T2) FROM PRIMARY SOIL MOISTURE
C                         TO SECONDARY SOIL MOISTURE.
C                         AFTER SUBTRACTING T1 FROM XB, IF XB IS LESS
C                         THAN ZERO, REMAINED QUANTITY IS SUBTRACTED
C                         FROM LOWER TANKS.
      T1 = K1 * (1. - XP/S1)
      T2 = K2 * (XP/S1 - XS/S2)
C
      XA = XA + T1 - T2
      XS = XS + T2
      XB = XB - T1
C
      IF  (XB .GE. 0.)  RETURN
C
      XC = XC + XB
      XB = 0.
      IF  (XC .GE. 0.)  RETURN
C
      XD = XD + XC
      XC = 0.
      IF  (XD .GE. 0.)  RETURN
C
      XA = XA + XD
      XD = 0.
      RETURN
      END
C
C
C     SUBROUTINE FOR CALCULATION OF TOP TANK WITH SOIL MOISTURE
C     STRUCTURE
C
      SUBROUTINE TANKSM (P, XA, Y2, Y1, Y0, HA1, HA2, S1, A0, A1, A2)
C
      XA = XA + P
C
      Y2 = 0.
```

```
      Y1 = 0.
      Y0 = 0.
C
C                        IF XA IS EQUAL TO OR LESS THAN S1,
C                        ANY OUTPUT FROM THIS TOP TANK DOES NOT OCCUR.
      IF  (XA .LE. S1)   RETURN
C
C                        FREE WATER QUANTIRY IS OBTAINED.
      XF = XA - S1
C
C                        EVERY OUTPUTS AND STORAGE QUANTITY ARE
C                        CALCULATED.
      IF  (XF .LE. HA1)   GO TO 100
      Y1 = (XF - HA1) * A1
C
      IF  (XF .LE. HA2)   GO TO 100
      Y2 = (XF - HA2) * A2
C
  100 Y0 = XF * A0
C
      XA = XA - Y0 - Y1 - Y2
C
      RETURN
      END
C
C
C       CALCULATION OF 2ND,3RD AND 4TH TANK
C
C
      SUBROUTINE TANKB (P, X, Y, Y0, H1, B0, B1)
C
      X = X + P
      Y = 0.
      IF  (X .GT. H1)   Y = (X - H1) * B1
      Y0 = X * B0
      X = X - Y0 - Y
C
      RETURN
      END
C
C
C     TREATMENT OF IRRIGATION EFFECT
C
C     IRRIGATION WATER IS SUBTRUCTED FROM DAILY DISCHARGE,
C     AND ADDED TO STORAGE WATER IN THIRD TANK.
C
      SUBROUTINE IRRIG (W, Y, XC)
C
      Y = Y - W
      XC = XC + W
```

```
      IF  (Y .GE. 0.)   RETURN
      XC = XC + Y
      Y = 0.
      RETURN
      END
C
C
C        GRAPH PLOTTING FOR MONTHLY DISCHARGE
C
      SUBROUTINE PLOTM(FYEAR,FMONTH,LYEAR,LMONTH,NY,MQ,MQE,DQ, Q0)
      COMMON/HYGR/ NPLOT,NSCAL,LY,YMIN,YMAX,SCAL(5),GRFMT(10)
      INTEGER FYEAR,FMONTH,YEAR
      REAL MQ(12,NY),MQE(12,NY),DQ(12,NY),PLOT(2)
      INTEGER AM(12),GBUF(100),C(2),ISCAL(8)
      INTEGER CHAA,CHAB,CHAC
      DATA CHAA,CHAB,CHAC/'I',' ','.'/
      DATA ISCAL/1,21,41,0,0,0,0,0/
      DATA LE, LO, LYMQ, DYDQ / 100, 41, 60, 20. /
      DATA C/'+','*'/
      DATA AM/'JAN','FEB','MAR','APR','MAY','JUN',
     1        'JUL','AUG','SEP','OCT','NOV','DEC'/
      DATA LP/6/
C
C                          SETTING MAXIMUM AND MUNIMUM PRINTING
C                          VALUE IN LOGARISMIC SCALE
      AMIN=ALOG10(YMIN+Q0)
      AMAX=ALOG10(YMAX+Q0)
C
C                          SETTING VALUE FOR ONE CHARACTER SPACE
      DYMQ=IFIX(FLOAT(LYMQ-1)/(AMAX-AMIN))
C
C                          SETTING POSITIONS OF SCALE POINTS
      DO 100 K=1,NSCAL
      KK=K+3
      ISCAL(KK)=(ALOG10(SCAL(K)+Q0)-AMIN)*DYMQ+FLOAT(LO)
      IF (ISCAL(KK).GT.LE) ISCAL(KK)=LE
      IF (ISCAL(KK).LT.LO) ISCAL(KK)=LO
  100 CONTINUE
      KSCAL=NSCAL+3
C
      SSMQ  = 0.
      SSMQE = 0.
C
      DO 300 N=1,NY
C
      SMQ  = 0.
      SMQE = 0.
      YEAR=FYEAR+N-1
      IF (FMONTH.GT.1) YEAR=YEAR+1
```

```
      IF  (MOD(N,4) .EQ. 1)   WRITE (LP,10)
   10 FORMAT (1H1,/13X,'MQ',5X,'MQE',4X,'DQ'/)
C
      DO 200 M=1,12
C
C                        CONSIDERATION WHEN FMONTH IS NOT EQUAL 1
      MON=M+FMONTH-1
      IF (MON.GT.12) MON=MON-12
C
C                        INITIALIZATION TO BLANK FOR GBUF
      DO 110 L=1,LE
  110 GBUF(L)=CHAB
C
      IF  (M .NE. 1)   GO TO 140
C
C                        PREPARATION FOR PRINTING OF SCALE POINTS
      DO 120 K=1,KSCAL
      IP=ISCAL(K)
  120 GBUF(IP)=CHAA
C
C                        PREPARATION FOR PRINTING OF EACH GRAPH
C                        AND SETTING PRINT POSITION IP FOR GRAP
C                        OF DQ AND SETTING APPROPRIATE CHARACTER
C                        IN IP POSITION OF GBUF
  140 IF (DQ(M,N).EQ.-999.) GO TO 180
      SMQ  = SMQ  + MQ (M,N)
      SMQE = SMQE + MQE(M,N)
      IP=(DQ(M,N)+1.)*DYDQ+1.
      IF (IP.LT.1) IP=1
      IF (IP.GT.LO) IP=LO
      GBUF(IP)=CHAC
      PLOT(1)=MQE(M,N)
      PLOT(2)=MQ(M,N)
C
C                        SETTING PRINT POSITIONS FOR MQ  AND
C                        MQE, AND SETTING APPROPRIATE CHARACTER
C                        IN IP POSITION OF GBUF
      DO 170 NX=1,2
      IF (PLOT(NX).GT.YMIN) GO TO 150
      IP=LO
      GO TO 160
  150 IP=(ALOG10(PLOT(NX)+QO)-AMIN)*DYMQ+FLOAT(LO)
      IF (IP.LT.LO) IP=LO
      IF (IP.GT.LE) IP=LE
  160 GBUF(IP)=C(NX)
  170 CONTINUE
C
C                        PRINTING EACH VALUE
      WRITE (LP,30) AM(MON),MQ(M,N),MQE(M,N),DQ(M,N),(GBUF(L),L=1,LE)
      GO TO 190
```

```
   30 FORMAT (6X,A3,3F7.2,100A1)
C
  180 WRITE (LP,31) AM(MON),(GBUF(L),L=1,LE)
   31 FORMAT (6X,A3,'    *      *      *  ',100A1)
C
  19  CONTINUE
      IF  (MON .GT. 1)   GO TO 200
      WRITE (LP,20) YEAR
   .0 FORMAT (1H+,I4)
C
      IF  (N .EQ. NY  .AND.  MON .EQ. LMONTH)   GO TO 210
  200 CONTINUE
C
  210 WRITE (LP,40) SMQ, SMQE
   40 FORMAT (5X,'YEAR',2F7.2/)
C
      SSMQ  = SSMQ  + SMQ
      SSMQE = SSMQE + SMQE
  300 CONTINUE
C
      WRITE (LP,41)  SSMQ, SSMQE
   41 FORMAT (1H0,3X,'TOTAL',2F7.2)
C
      RETURN
      END
C
C     SUBROUTINE FOR DETERMINING INITIAL STORAGE
C
      SUBROUTINE INVAL3 (N,NP,XA,XS,XB,XC,XD)
      DIMENSION XA(NP),XS(NP),XB(NP),XC(NP),XD(NP)
      DIMENSION XA1(30),XB1(30),XC1(30),XD1(30),XS1(30)
      DIMENSION XA2(30),XB2(30),XC2(30),XD2(30),XS2(30)
C
      FX(X1,X2,X3)=X1+(X2-X1)**2/(2.*X2-X1-X3)
,
      GO TO (100,200,300), N

  100 DO 110 K=1,NP
      XA1(K)=XA(K)
      XS1(K)=XS(K)
      XB1(K)=XB(K)
      XC1(K)=XC(K)
      XD1(K)=XD(K)
  110 CONTINUE
      RETURN
C
  200 DO 210 K=1,NP
      XA2(K)=XA(K)
      XS2(K)=XS(K)
      XB2(K)=XB(K)
```

```
      XC2(K)=XC(K)
      XD2(K)=XD(K)
  210 CONTINUE
      RETURN
C
  300 DO 350 K=1,NP
      IF (XA1(K).EQ.XA2(K)) GO TO 310
      XA(K)=FX(XA1(K),XA2(K),XA(K))
      IF (XA(K).LT.0.) XA(K)=0.
C
  310 IF (XS1(K).EQ.XS2(K)) GO TO 320
      XS(K)=FX(XS1(K),XS2(K),XS(K))
      IF (XS(K).LT.0.) XS(K)=0.
C
C
  320 IF (XB1(K).EQ.XB2(K)) GO TO 330
      XB(K)=FX(XB1(K),XB2(K),XB(K))
      IF (XB(K).LT.0.) XB(K)=0.
C
  330 IF (XC1(K).EQ.XC2(K)) GO TO 340
      XC(K)=FX(XC1(K),XC2(K),XC(K))
      IF (XC(K).LT.0.) XC(K)=0.
C
  340 IF (XD1(K).EQ.XD2(K)) GO TO 350
      XD(K)=FX(XD1(K),XD2(K),XD(K))
      IF (XD(K).LT.0.) XD(K)=0.
  350 CONTINUE
      RETURN
      END
C
C
C        CALCULATION OF PRECIPITATION MODIFIED BY MELTED SNOW
C        AND OF SNOW DEPOSIT  WITH SNOW DEPOSIT TANK
C
      SUBROUTINE ZONES  (IZONE, SMELT, PX, TMAX, TMIN, TW, TO, TD,
     1      CM, PD, ZA, SNOW, PY, SK, WO, W1, W2, XW)
C
      DIMENSION PD(IZONE), ZA(IZONE), SNOW(IZONE), XW(IZONE)
C
      PY = 0.
      SK = 0.
C
C                            GETTING MEAN TEMP. FOR LOWEST ALTITUDE
C                            ZONE
      TI = TMAX*TW + TMIN*(1.-TW) + TO
C
      DO 150 I = 1, IZONE
C
C                            GETTING ZONE PRECIPITATION MODIFIED BY
C                            ZONE FACTOR (PD) AND MONTH FACTOR (CM)
```

```
      PN = (1.+PD(I)*CM) * PX
C
C                             IF MEAN TEMP. (TI) IS LESS THAN
C                             OR  EQUAL TO ZERO,
C                             PRECIPITATION AT EACH ZONE IS CONVERTED
C                             INTO SNOW DEPOSIT AT EACH ZONE, OTHERWISE
C                             QUANTITY OF WATER DUE TO MELTED SNOW BY
C                             HEAT (TEMP. (TI)) AND BY RAINFALL (PN)
C                             IS CALCULATED.
C                             AT LATER CASE, IF SNOW DEPOSIT AFTER
C                             SUBTRACTING SNOW MELT (SM) BECOMES
C                             LESS THAN ZERO, SNOW DEPOSIT IS SET
C                             TO ZERO AND QUANTITY OF MELTED SNOW
C                             IS ADJUSTED.
      IF  (TI .GT. 0.)   GO TO 100
      SNOW(I) = SNOW(I) + PN
      PW = 0.
      GO TO 120
C
  100 SM = (SMELT*TI) + (0.0125*PN*TI)
      SNOW(I) = SNOW(I) - SM
      IF  (SNOW(I) .GE. 0.)   GO TO 110
      SM = SM + SNOW(I)
      SNOW(I) = 0.
C
C                             INPUT QUANTITY (PW) INTO SNOW DEPOSIT
C                             TANK IS OBTAINED.
  110 PW = PN + SM
C
C                             SNOW DEPOSIT TANK CALCULATION
  120 HW = W0*SNOW(I)
      XW(I) = XW(I) + PW
      YW = XW(I)*W1
      IF  (XW(I) .GT. HW)   YW = YW + (XW(I)-HW)*W2
      XW(I) = XW(I) - YW
C
C                             OUTPUTS FROM EVERY ZONES ARE
C                             ACCUMULATED.
      PY = PY + YW*ZA(I)
C
C                             GETTING ACCUMULATED SNOW DEPOSIT
C                             FROM EVERY ZONES.
      SK = SK + SNOW(I)*ZA(I)
C
C                             GETTING MEAN TEMP. FOR NEXT HIGHER ZONE
      TI = TI - TD
  150 CONTINUE
      RETURN
      END
C
```

```
C       CALCULATION OF PRECIPITATION MODIFIED BY MELTED SNOW
C       AND OF SNOW DEPOSIT WITHOUT SNOW DEPOSIT TANK
C
      SUBROUTINE ZONE (IZONE, SMELT, PX, TMAX, TMIN, TW, TO, TD,
     1       CM, PD, ZA, SNOW, PY, SK)
      DIMENSION PD(IZONE), ZA(IZONE), SNOW(IZONE)
C
      PY = 0.
      SK = 0.
C
C                             GETTING MEAN TEMP. FOR LOWEST ALTITUDE
C                             ZONE
      TI = TMAX * TW + TMIN * (1.-TW) + TO
C
      DO 150 I = 1, IZONE
C
C                             GETTING ZONE PRECIPITATION MODIFIED BY
C                             ZONE FACTOR (PD) AND MONTH FACTOR (PCM)
      PN = (1. + PD(I) *  CM) * PX
C
C                             IF MEAN TEMP. (TI) IS LESS THAN
C                             OR  EQUAL TO ZERO,
C                             PRECIPITATION AT EACH ZONE IS CONVERTED
C                             INTO SNOW DEPOSIT AT EACH ZONE, OTHERWISE
C                             QUANTITY OF WATER DUE TO MELTED SNOW BY
C                             HEAT (TEMP. (TI)) AND BY RAINFALL (PN)
C                             IS CALCULATED.
C                             AT LATER CASE, IF SNOW DEPOSIT AFTER
C                             SUBTRACTING SNOW MELT (SM) BECOMES
C                             LESS THAN ZERO, SNOW DEPOSIT IS SET
C                             TO ZERO AND QUANTITY OF MELTED SNOW
C                             IS ADJUSTED.
      IF  (TI .GT. 0.)   GO TO 100
      SNOW(I) = SNOW(I) + PN
      GO TO 120
C
  100 SM = (SMELT * TI) + (0.0125 * PN * TI)
      SNOW(I) = SNOW(I) - SM
      IF  (SNOW(I) .GE. 0.)   GO TO 110
      SM = SM + SNOW(I)
      SNOW(I) = 0.
C
C                             OUTPUTS FROM EVERY ZONES ARE
C                             ACCUMULATED.
  110 PY = PY + (PN + SM) * ZA(I)
C
C                             GETTING ACCUMULATED SNOW DEPOSIT
C                             FROM EVERY ZONES.
  120 SK = SK + SNOW(I) * ZA(I)
C
```

```
C                              GETTING MEAN TEMP. FOR NEXT HIGHER ZONE
      TI = TI - TD
  150 CONTINUE
      RETURN
      END
C
C
C        GRAPH PLOTTING FOR DAILY DISCHARGE
C
      SUBROUTINE HYDRGR (ISNOW, YEAR, MS, ME, Q, QA, QB, QC, QD,
     1     ST, NP, P, IEVAP, E, Q0)
      COMMON /HYGR/ NPLOT,NSCAL,LY,YMIN,YMAX,SCAL(5),GRFMT(10)
      DIMENSION Q(366),QA(366),QB(366),QC(366),QD(366),ST(366),
     1     E(366),P(366,NP),IPREC(10)
      DIMENSION MONTH(12)
      DIMENSION GBUF(120),ISCAL(5),CM(12,3),CHAR(5),PLOT(5)
      INTEGER YEAR
      DATA MONTH /31,28,31,30,31,30,31,31,30,31,30,31/
      DATA CM /'J','F','M','A','M','J','J','A','S','O','N','D',
     2        'A','E','A','P','A','U','U','U','E','C','O','E',
     3        'N','B','R','R','Y','N','L','G','P','T','V','C'/
      DATA CHAR / '*', '+', '.', ',', '-' /,
     1     CHAB, CHAI /' ', 'I'/
C
C                        SETTING MAXIMUM AND MUNIMUM PRINTING
C                        VALUE IN LOGARISMIC SCALE
      AMIN=ALOG10(YMIN+Q0)
      AMAX=ALOG10(YMAX+Q0)
C
C                        SETTING VALUE FOR ONE CHARACTER SPACE
      DY=IFIX(FLOAT(LY-1)/(AMAX-AMIN))
C
C                        SETTING POSITIONS OF SCALE POINTS
      DO 100 N=1,NSCAL
      ISCAL(N)=(ALOG10(SCAL(N)+Q0)-AMIN)*DY+1.
      IF (ISCAL(N).LT.1)  ISCAL(N)=1
      IF (ISCAL(N).GT.LY) ISCAL(N)=LY
  100 CONTINUE
C
C                        LEAP YEAR CONSIDERATION
      IYR=YEAR
      IF (MS.GT.2) IYR=IYR+1
      MM=ME
      IF (ME.LT.MS) MM=ME+12
      MONTH(2)=28
      IF (MOD(IYR,4).EQ.0) MONTH(2)=29
C
      JE=0
      DO 300 MON=1,MM
C
```

```
C                      CONSIDERATION WHEN FMONTH IS NOT EQUAL 1
      M=MON
      IF (M.GT.12) M=M-12
      IF (MOD(MON-MS,2).EQ.0) WRITE (6,60)
      IF (M.NE.1) GO TO 109
      IYR=YEAR
      IF (MS.GT.1) IYR=IYR+1
      WRITE (6,61) IYR
   60 FORMAT(1H1,I4)
   61 FORMAT(1H ,I4)
  109 CONTINUE
C
      JS=JE+1
      JE=JE+MONTH(M)
C
      IF (MON .LT.MS) GO TO 201
      DO 200 J=JS,JE
C
C                      INITIALIZING TO BLANK FOR GBUF
      DO 120 L=1,LY
  120 GBUF(L)=CHAB
C
C                      PREPARATION FOR PRINTING OF MONTH
      AM=CHAB
      JDAY=J-JS+1
      IF (JDAY.GT.3) GO TO 140
      AM=CM(M,JDAY)
      IF (JDAY.NE.1) GO TO 140
C
C                      PREPARATION FOR PRINTING OF SCALE POINTS
      DO 130 N=1,NSCAL
      IP=ISCAL(N)
  130 GBUF(IP)=CHAI
C
C                      PREPARATION FOR PRINTING OF EACH GRAPH
  140 PLOT(1)=Q(J)
      PLOT(2)=QA(J)
      PLOT(3)=QB(J)
      PLOT(4)=QC(J)
      PLOT(5)=QD(J)
C
      NX=NPLOT
  150 IF (PLOT(NX).EQ.-999.) GO TO 171
      IF (PLOT(NX).GT.YMIN) GO TO 160
      IP=1
      GO TO 170
C
C                      SETTING PRING POSITION(IP) FOR EACH GRAPH
C                      AND APPROPRIATE CHARACTER IN IP POSITION OF
C                      GBUF
```

```
  160 IP=(ALOG10(PLOT(NX)+Q0)-AMIN)*DY+1.
      IF (IP.LE.0) IP=1
      IF (IP.GT.LY) IP=LY
  170 GBUF(IP)=CHAR(NX)
  171 NX=NX-1
      IF (NX.GT.0) GO TO 150
C
C                            PRINTING EACH VALUE
      DO 180 K=1,NP
  180 IPREC(K)=P(J,K)+0.5
C
      IF (ISNOW.EQ.0) GO TO 190
C
      IST=ST(J)+0.5
C
      IF (IEVAP.EQ.0) GO TO 185
      WRITE (6,GRFMT) AM, (IPREC(K),K=1,NP), E(J), (PLOT(I),I=1,2), IST
     1      , (GBUF(L),L=1,LY)
      GO TO 200
  185 WRITE (6,GRFMT) AM, (IPREC(K),K=1,NP), (PLOT(I),I=1,2), IST
     1      , (GBUF(L),L=1,LY)
      GO TO 200
C
  190 IF (IEVAP.EQ.0) GO TO 195
      WRITE (6,GRFMT) AM, (IPREC(K),K=1,NP), E(J), (PLOT(I),I=1,2)
     1      , (GBUF(L),L=1,LY)
      GO TO 200
  195 WRITE (6,GRFMT) AM, (IPREC(K),K=1,NP), (PLOT(I),I=1,2)
     1      , (GBUF(L),L=1,LY)
C
  200 CONTINUE
  201 CONTINUE
  300 CONTINUE
C
      RETURN
      END
```

INPUT DATA

```
  1978      6   1979      12       1       0       0
 16576.0
NARMADA RIVER (JAMTARA SUB-BASIN)
                 1978
    4.9     4.9     4.3     4.3     4.3     4.3     4.2     4.2     4.1     4.1
    5.9    11.5     9.7     7.0    11.5    10.9    10.4    10.4     9.2     9.9
    9.9   241.4   313.0   295.6   306.2   307.6   191.7   205.8  1043.7   650.2
  103.6  1099.1   490.8   265.9   272.5   469.5   784.0   312.4   288.2   784.0
  599.5   373.4   249.6   355.5   511.0   200.6   108.4   134.2   410.5   145.3
   89.7    72.8  1931.5   694.8   646.3   543.4   610.9   346.2   180.6   137.6
  168.8
  400.9   719.5   439.4   288.2   694.5  3021.6  1162.3   565.3   490.1   479.6
  610.8   532.5   355.4   249.6   707.1  1432.3  2164.3   963.8   449.4   288.2
  500.4   490.1   837.4   796.9  1931.2  1008.3   744.8   978.7   878.4   920.9
  610.8
  391.7   320.9   373.4   321.0   420.1   364.4   249.8   168.3   123.6   103.6
   85.4    68.9    65.1    76.9    54.2    47.5    38.3    76.9    68.9   103.6
  200.6   200.6   181.2   128.8    89.7    94.3    54.2    47.5    47.5    38.3
   27.6    20.7    18.6    14.8    13.1    11.4     9.9     9.8     8.4     8.5
    5.9     5.9     4.8     4.8     3.8     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0     0.0
    0.0
 JAMTARA         1978
  0.0  0.0  0.0  0.0  0.0  1.8  5.2  0.0  8.4  0.0
  7.5  4.6  2.3  0.0 13.1  4.1  0.2  0.1  0.1  4.3
 17.4 11.0 13.8 16.9  7.0  3.2  6.3 28.3 12.6  5.8
 38.8 23.1 17.2 10.0  4.4 30.9 10.3  7.9 15.4 26.4
  7.4 16.6 16.6  6.7  3.4  0.8  3.4  3.7  3.9  3.6
 14.4 14.8 26.4 10.2 13.8 16.1  3.9  3.3  6.4 17.6 11.4
 12.5  1.9 16.3 19.7 41.7  9.6  6.6  3.7 10.1 13.0
  5.0  1.3  5.4  9.1 30.9 28.3 28.4  0.1  5.7 10.9
 13.8  2.6 18.1 26.3 23.9  8.8 17.2 22.2 20.9  7.1  2.6
  3.6  8.4  8.0  6.4  2.7  0.1  0.0  0.0  0.0  0.2
  0.0  3.1  0.0  0.0  0.0  0.2 11.3  5.8  3.7  4.0
 15.4  4.3  4.9  5.4  0.9  2.6  5.4  0.2  0.0  0.0
  0.0  0.0  0.0  0.0  2.3  0.0  1.7  0.2  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  1.9  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  2.3  7.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
1979

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0									
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0									
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0									
28.0	28.0	28.0	23.0	22.0	19.0	20.0	22.0	19.0	19.0
21.0	21.0	21.0	17.0	18.0	20.0	20.0	18.0	16.0	38.0
27.0	25.0	23.0	23.3	52.0	77.6	58.6	45.8	42.7	119.3
74.2	111.8	131.4	78.3	54.5	43.2	35.1	29.8	27.4	28.9
44.8	161.1	113.5	450.7	609.7	818.8	384.7	243.8	198.1	278.6
193.8	167.0	154.3	120.1	191.7	227.3	215.8	231.9	155.3	173.0
183.33									
243.8	219.3	347.9	409.3	660.1	611.6	559.5	1677.8	11391.8	5139.7
2500.0	1225.0	708.3	583.4	340.8	340.8	290.3	251.1	229.6	201.4
173.0	151.5	134.0	119.3	107.8	97.7	88.8	82.4	76.2	70.9
66.5									
68.4	88.1	92.4	99.2	111.1	167.0	114.3	84.5	67.7	58.6
53.9	56.2	70.9	65.8	138.5	116.8	105.4	101.5	86.6	91.7
81.7	85.2	98.5	103.1	102.3	88.8	73.5	66.5	62.7	69.0
100.7	83.8	63.4	51.2	44.8	41.7	39.3	36.0	33.3	31.5
30.3	28.9	27.7	26.5	25.7	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0									
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0									

JAMTARA(MEAN) 1979

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	6.5	14.1	
6.5	0.0	1.8	0.0	0.0	0.0	0.0	20.6	7.4	0.0	0.0
10.4	1.2	0.0	0.0	0.0	5.7	30.2	0.1	0.0	0.0	

```
0.0   0.0   0.0   0.0   -4.0   9.6  13.5   2.5   1.0   4.7
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   1.3   0.0   2.1   0.0   4.7   9.0   8.5
5.6  11.0  13.1   7.7   5.2  10.5  22.1   6.7  27.4  12.8
0.7   1.3   0.0   0.0   0.0   0.0   4.2   2.5  19.4  14.7
23.5  31.5  32.7  35.4  12.1   5.6   9.1  14.3  10.4   2.8
4.2   0.4   3.1   1.4  16.4  13.7   0.0   3.2   7.1  10.6   2.1
4.2   7.4  12.2  25.7  25.5  19.2  50.7  37.6  46.8   7.0
0.1   0.0   1.2   2.0   1.5   6.1   0.6   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   3.1   0.0   0.0
7.8   1.5  15.6  12.4   0.0   0.0   0.0   0.0   0.0   0.0
7.5   6.0  12.3   4.2   9.6   0.0   0.0   0.7  10.3   4.7
5.5  15.2   0.0   0.0   0.6   2.6   3.0   3.6   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.7   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0  13.4   6.7   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0  19.6   5.3
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   1.3   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  50.    250.
 15.0    40.0   0.115   0.115   0.115
 15.0   0.023   0.023
 15.0   0.005   0.005
  0.0     0.0   0.001
2.3   3.3   4.5   5.6   6.6   5.5   3.3   3.3   3.5   3.5   2.6   2
  2.0    20.0
  1.0
  1.0
   0
   1       0
 0.0
 0.0      0.0      0.0      0.0      0.0
   5        3      100    0.001      10.
 0.01     0.1      1.0
(1H A1,I4,F6.1,1X,2F6.2,100A1)
```

F. OUTPUT

```
NARMADA RIVER (JAMTARA SUB-BASIN)

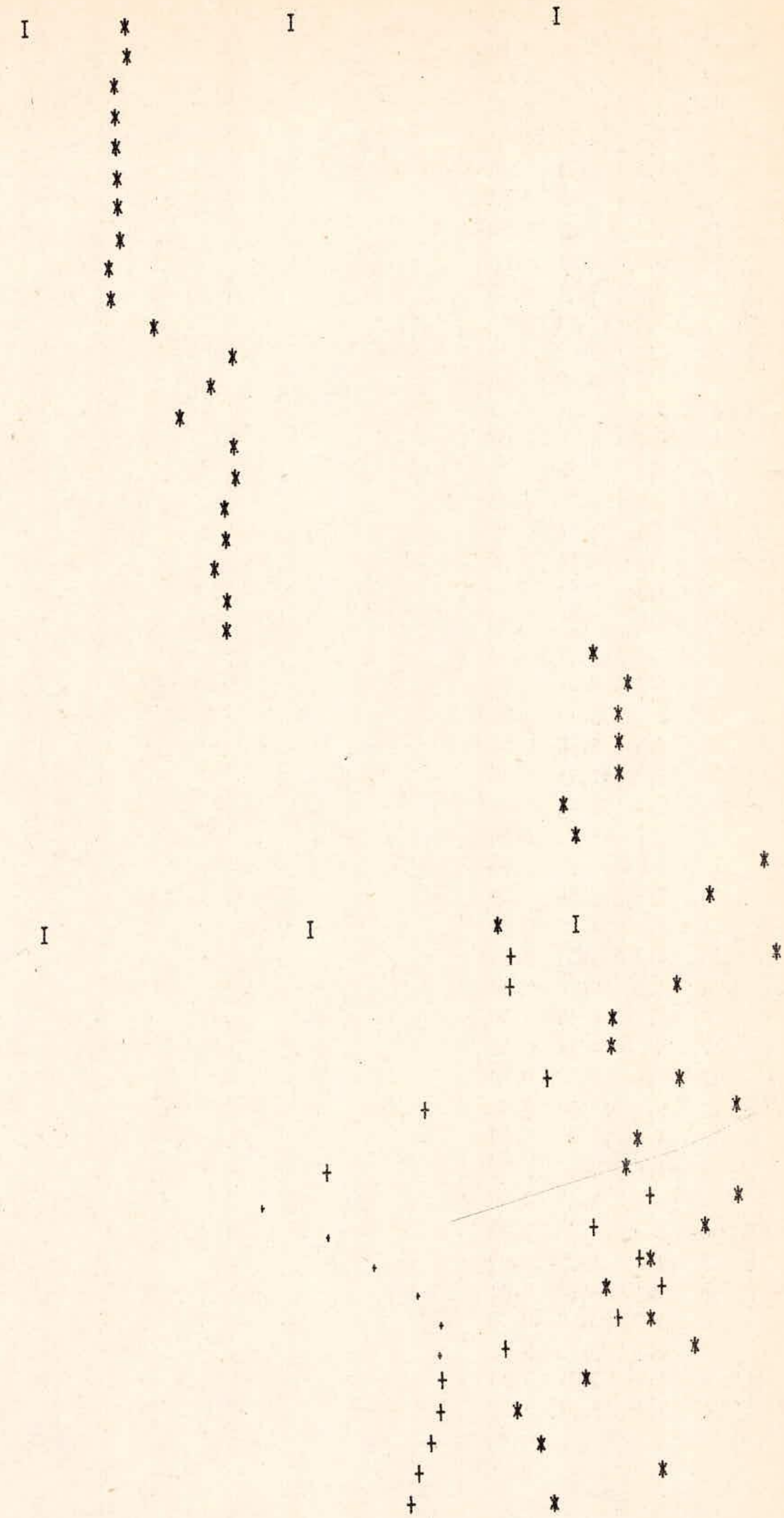
     INVL        1       Q0     0.000    ISTANK        0


     FYEAR    FMONTH     LYEAR    LMONTH        NP     ISNOW     IEVAP       AREA
      1978         6      1979        12         1         0         0   16576.00
0       S1        S2       HA1       HA2        A0        A1        A2
       50.      250.       15.       40.    0.1150    0.1150    0.1150
0      HB1        B0        B1       HC1        C0        C1       HD1         D0        D1
       15.    0.0230    0.0230       15.    0.0050    0.0050        0.     0.0000    0.0010
0            JAN       FEB       MAR       APR       MAY       JUN       JUL       AUG       SEP       OCT       NOV       DEC
     E      2.30      3.30      4.50      5.60      6.60      5.50      3.30      3.30      3.50      3.50      2.60      2.10
0       K1        K2
       2.0      20.0
0       CP
      1.00
0       WE
      1.00
0      LAG
         0
0       XA        XS        XB        XC        XD          SNOW
        0.        0.        0.        0.        0.
0    NPLOT     NSCAL        LY      YMIN      YMAX               SCAL
         5         3       100      0.00     10.00               0.01      0.10      1.00
0    GRFMT
       (1H A1,I4,F6.1,1X,2F6.2,100A1)
```

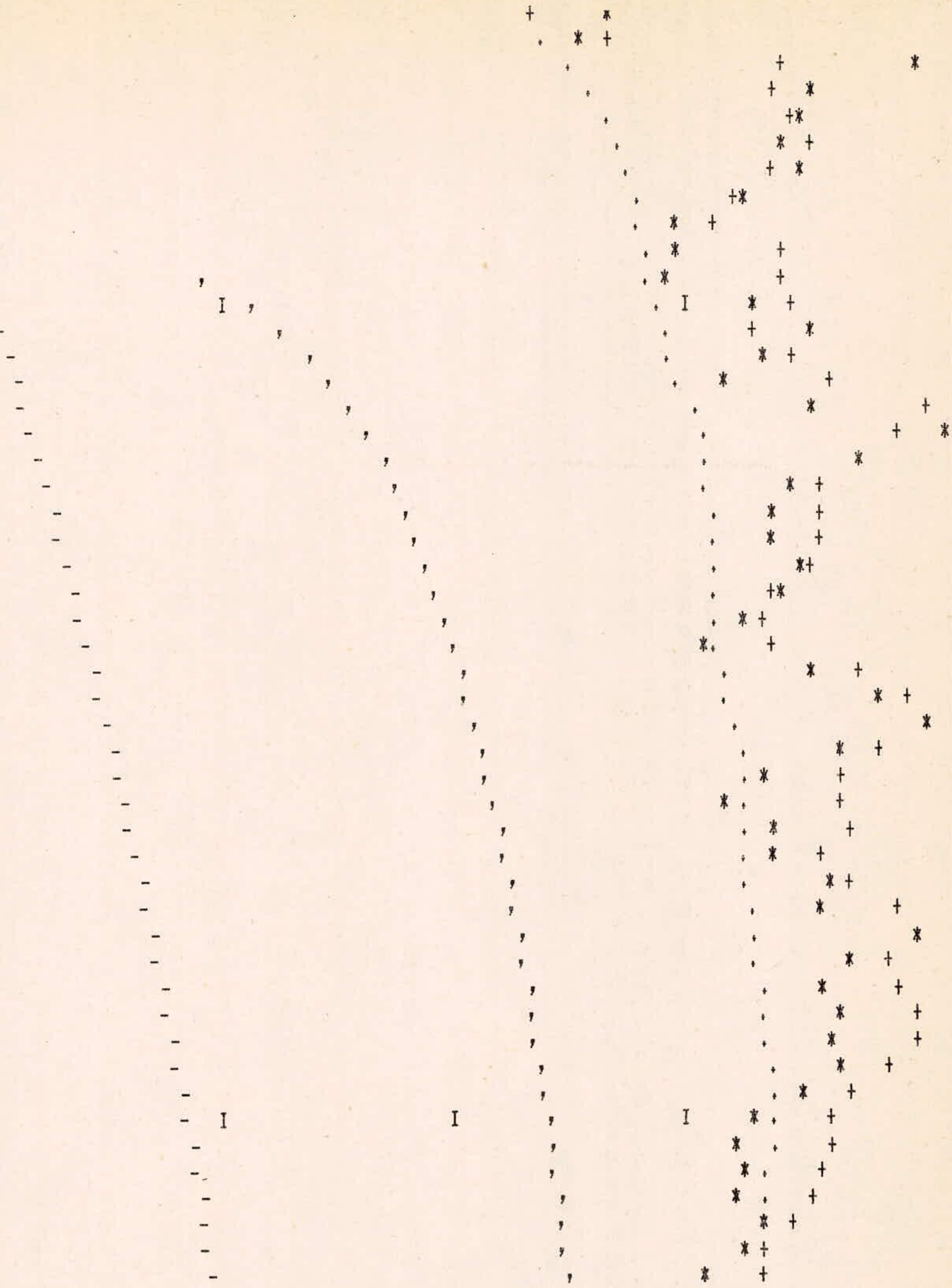
NARMADA RIVER (JAMTARA SUB-BASIN)

01978	Q	QE		XF	XP	XS	XB	XC	XD	SNOW
JUN	19.3	0.0								
			JAMTARA	0.	34.	91.	0.	0.	0.	
JUL	70.0	35.8								
			JAMTARA	27.	50.	235.	45.	16.	1.	
AUG	134.0	190.9								
			JAMTARA	32.	50.	249.	104.	64.	7.	
SEP	24.0	58.2								
			JAMTARA	0.	46.	241.	42.	91.	19.	
OCT	0.9	11.2								
			JAMTARA	0.	40.	171.	4.	81.	32.	
NOV	0.0	0.0								
			JAMTARA	0.	26.	134.	0	42	40	
DEC	0.0	0.0								
			JAMTARA	0.	22.	108.	0.	2.	42.	
0	248.2	296.2								
1979										

J	0	0.0	0.00	0.00
U	0	0.0	0.00	0.00
N	0	0.0	0.00	0.00
	0	0.0	0.00	0.00
	0	0.0	0.00	0.00
	2	0.0	0.00	0.00
	5	0.0	0.00	0.00
	0	0.0	0.00	0.00
	8	0.0	0.00	0.00
	0	0.0	0.00	0.00
	8	0.0	0.00	0.00
	5	0.1	0.00	0.00
	2	0.1	0.00	0.00
	0	0.0	0.00	0.00
	13	0.1	0.00	0.00
	4	0.1	0.00	0.00
	0	0.1	0.00	0.00
	0	0.1	0.00	0.00
	0	0.0	0.00	0.00
	4	0.1	0.00	0.00
	17	0.1	0.00	0.00
	11	1.3	0.00	0.00
	14	1.6	0.00	0.00
	17	1.5	0.00	0.00
	7	1.6	0.00	0.00
	3	1.6	0.00	0.00
	6	1.0	0.00	0.00
	28	1.1	0.00	0.00
	13	5.4	0.00	0.00
	6	3.4	0.00	0.00
J	39	0.5	0.00	0.00
U	23	5.7	0.61	0.00
L	17	2.6	0.57	0.00
	10	1.4	0.00	0.00
	4	1.4	0.00	0.00
	31	2.4	0.78	0.00
	10	4.1	0.27	0.00
	8	1.6	0.00	0.00
	15	1.5	0.12	0.00
	26	4.1	1.88	0.00
	7	3.1	1.12	0.00
	17	1.9	1.66	0.00
	17	1.3	2.15	0.00
	7	1.9	1.43	0.00
	3	2.7	0.52	0.00
	1	1.0	0.31	0.00
	3	0.6	0.30	0.00
	4	0.7	0.28	0.00
	4	2.1	0.26	0.00
	4	0.8	0.23	0.00



	14	0.5	0.23	0.00
	15	0.4	0.47	0.00
	26	10.1	2.67	0.00
	10	3.6	2.53	0.00
	14	3.4	2.88	0.00
	16	2.8	3.49	0.00
	4	3.2	2.50	0.00
	3	1.8	1.71	0.00
	6	0.9	1.47	0.00
	18	1.0	2.61	0.00
	11	0.9	2.81	0.00
A	13	2.1	3.12	0.00
U	2	3.8	2.14	0.00
G	16	2.3	3.07	0.00
	20	1.5	4.62	0.00
	42	3.6	11.41	0.00
	10	15.7	8.51	0.00
	7	6.1	5.93	0.00
	4	2.9	3.89	0.00
	10	2.6	3.86	0.00
	13	2.5	4.18	0.00
	5	3.2	3.51	0.00
	1	2.8	2.55	0.00
	5	1.9	2.29	0.00
	9	1.3	2.51	0.00
	31	3.7	6.16	0.00
	28	7.5	9.60	0.00
	28	11.3	11.93	0.00
	0	5.0	6.94	0.00
	6	2.3	4.96	0.00
	11	1.5	4.87	0.00
	14	2.6	5.50	0.00
	3	2.6	4.05	0.00
	18	4.4	5.34	0.00
	26	4.2	8.76	0.00
	24	10.1	10.49	0.00
	9	5.3	8.15	0.00
	17	3.9	8.57	0.00
	22	5.1	10.04	0.00
	21	4.6	10.73	0.00
	7	4.8	8.01	0.00
	3	3.2	5.22	0.00
S	4	2.0	4.36	0.00
E	8	1.7	4.25	0.00
P	8	1.9	4.12	0.00
	6	1.7	3.82	0.00
	3	2.2	3.15	0.00
	0	1.9	2.31	0.00
	0	1.3	2.19	0.00



	0	0.9	2.12	0.00
	0	0.6	2.04	0.00
	0	0.5	1.96	0.00
	0	0.4	1.88	0.00
	3	0.4	1.80	0.00
	0	0.3	1.73	0.00
	0	0.4	1.65	0.00
	0	0.3	1.58	0.00
	0	0.2	1.52	0.00
	11	0.2	1.47	0.00
	6	0.4	1.43	0.00
	4	0.4	1.38	0.00
	4	0.5	1.34	0.00
	15	1.0	1.33	0.00
	4	1.0	1.31	0.00
	5	0.9	1.29	0.00
	5	0.7	1.28	0.00
	1	0.5	1.25	0.00
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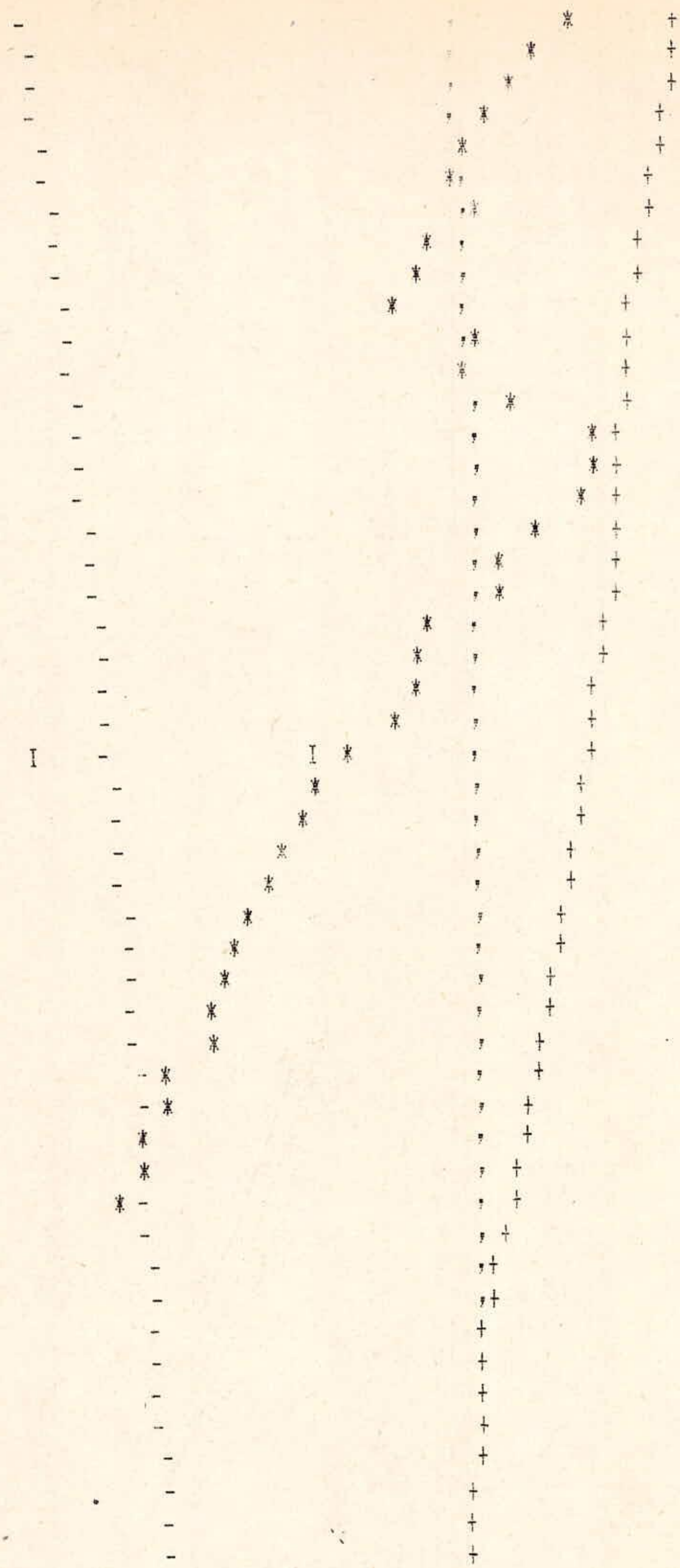

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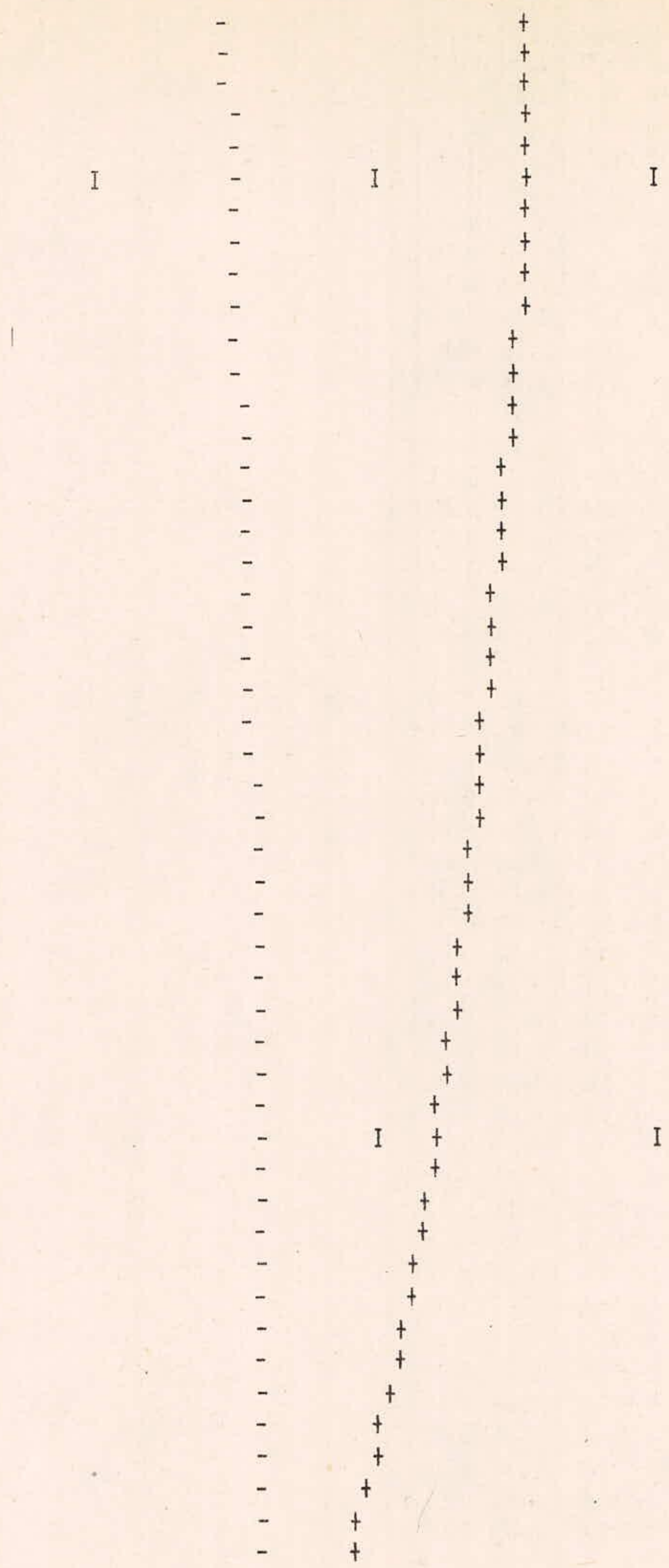

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APR	0.0	0.0	JAMTARA	0.	0.	2.	0.	0.	0.
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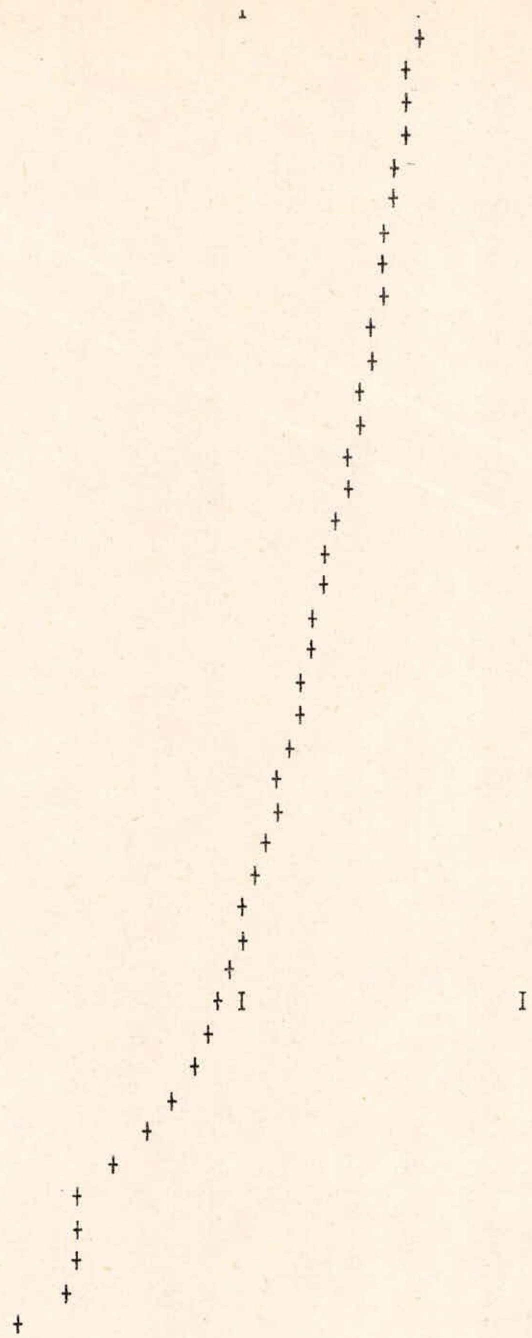

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	11	0.4	0.00	0.00
	22	0.3	0.00	0.00
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	27	0.2	0.00	0.00
	13	0.6	0.00	0.00
J	1	0.4	0.00	0.00
U	1	0.6	0.00	0.00
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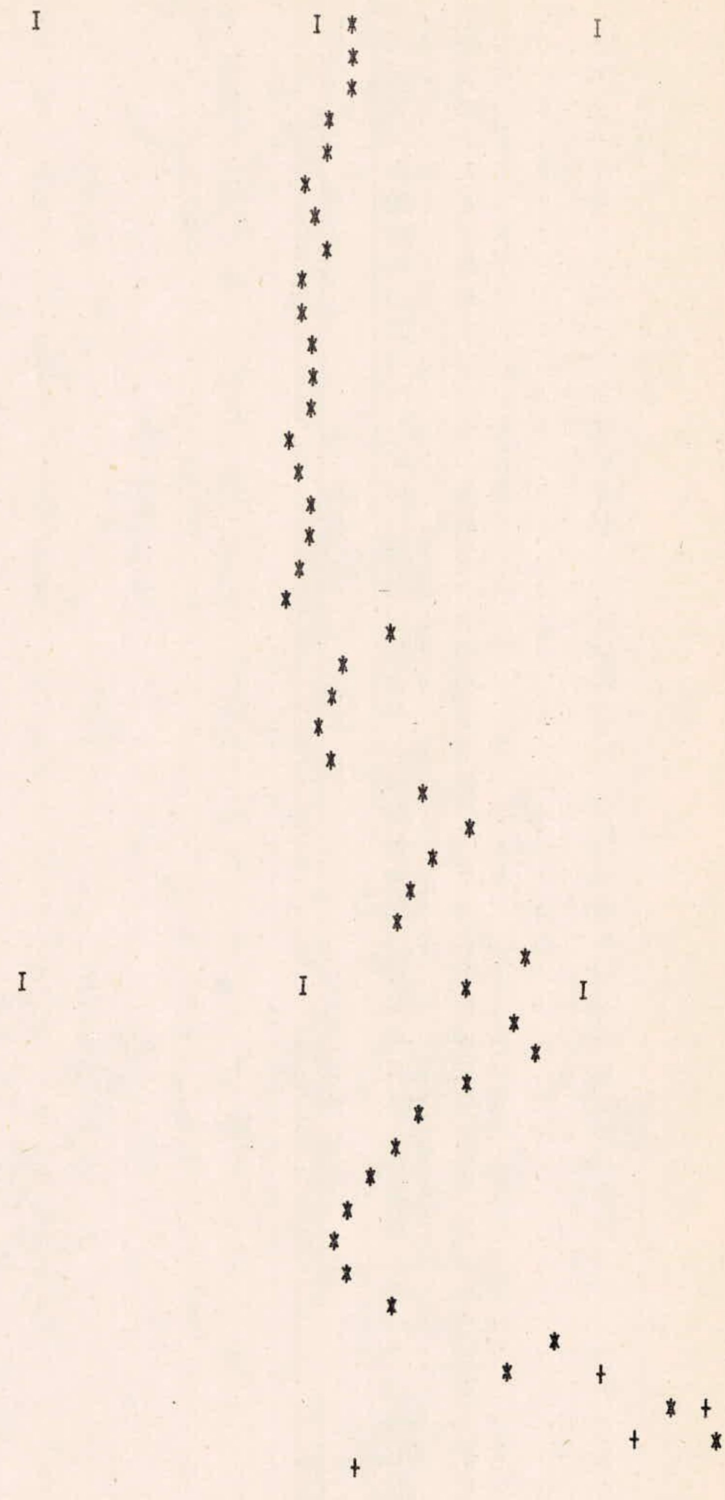

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	3	0.8	0.00	0.00
	1	0.6	0.00	0.00
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	14	1.2	0.00	0.00
	0	1.1	0.00	0.00
	3	1.2	0.00	0.00
	7	0.8	0.00	0.00
	11	0.9	0.00	0.00
	2	1.0	0.00	0.00
A	4	1.3	0.00	0.00
U	7	1.1	0.00	0.00
G	12	1.8	0.00	0.00
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	19	3.2	3.67	0.00
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	0	6.4	3.26	0.00
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	2	1.8	1.03	0.00
	6	1.8	1.01	0.00
	1	1.5	0.98	0.00
	0	1.3	0.94	0.00
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	0	0.9	0.79	0.00
	0	0.8	0.75	0.00
	0	0.7	0.70	0.00
	0	0.6	0.66	0.00
	0	0.6	0.62	0.00
	0	0.5	0.58	0.00
	0	0.5	0.54	0.00
	0	0.4	0.50	0.00
	3	0.4	0.46	0.00
	0	0.4	0.43	0.00
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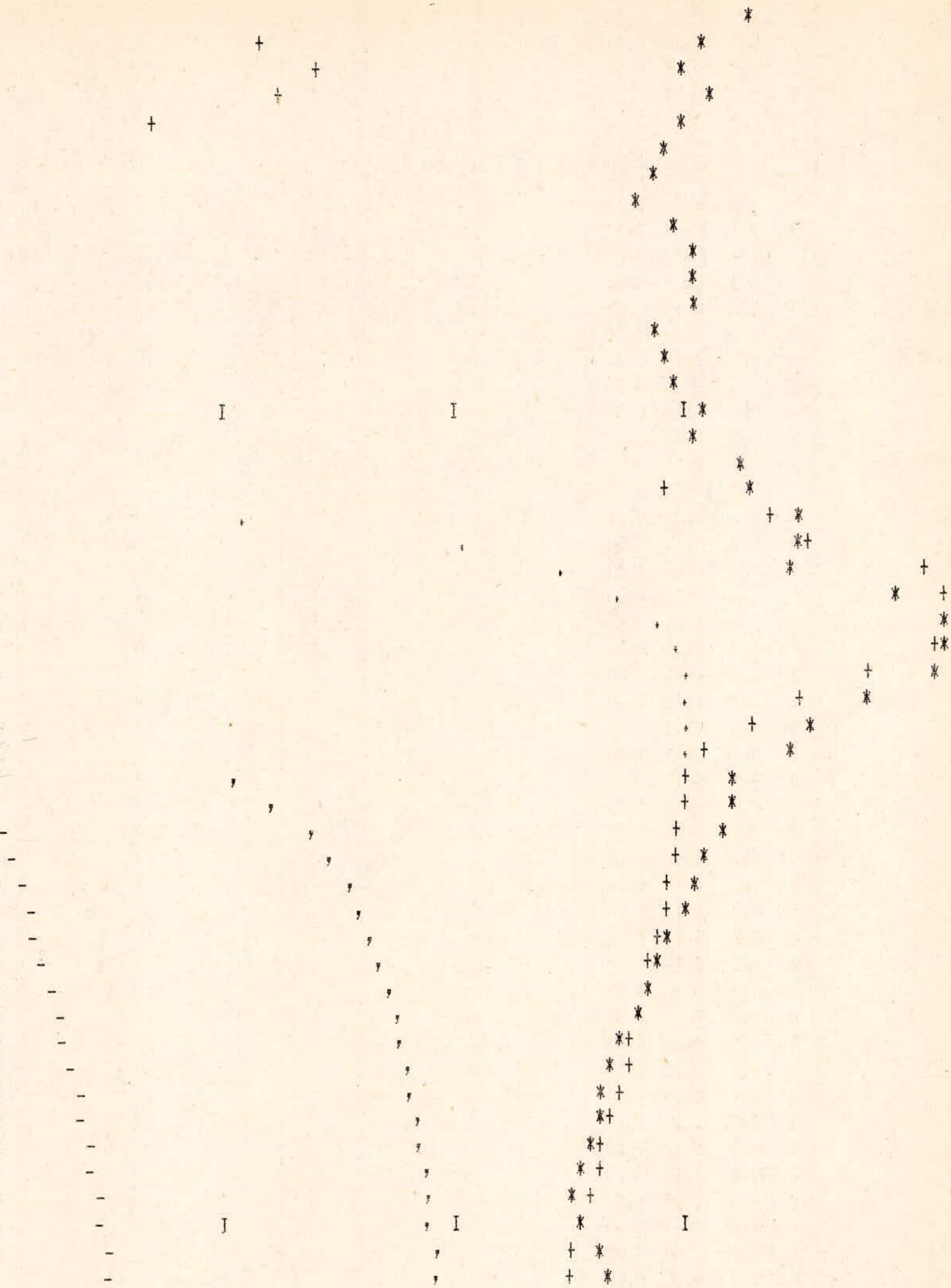
P	16	0.5	0.33	0.00



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	0	0.4	0.28	0.00
	0	0.4	0.25	0.00
	0	0.3	0.23	0.00
	8	0.3	0.20	0.00
	6	0.3	0.18	0.00
	12	0.4	0.19	0.00
	4	0.3	0.19	0.00
	10	0.7	0.19	0.00
	0	0.6	0.18	0.00
	0	0.5	0.17	0.00
	1	0.5	0.15	0.00
	10	0.5	0.14	0.00
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	6	0.4	0.13	0.00
	15	0.4	0.15	0.00
	0	0.5	0.15	0.00
	0	0.5	0.15	0.00
	1	0.5	0.13	0.00
	3	0.5	0.12	0.00
	3	0.4	0.11	0.00
	4	0.3	0.11	0.00
	0	0.3	0.11	0.00
	0	0.4	0.11	0.00
O	0	0.5	0.11	0.00
C	0	0.4	0.11	0.00
T	0	0.3	0.11	0.00
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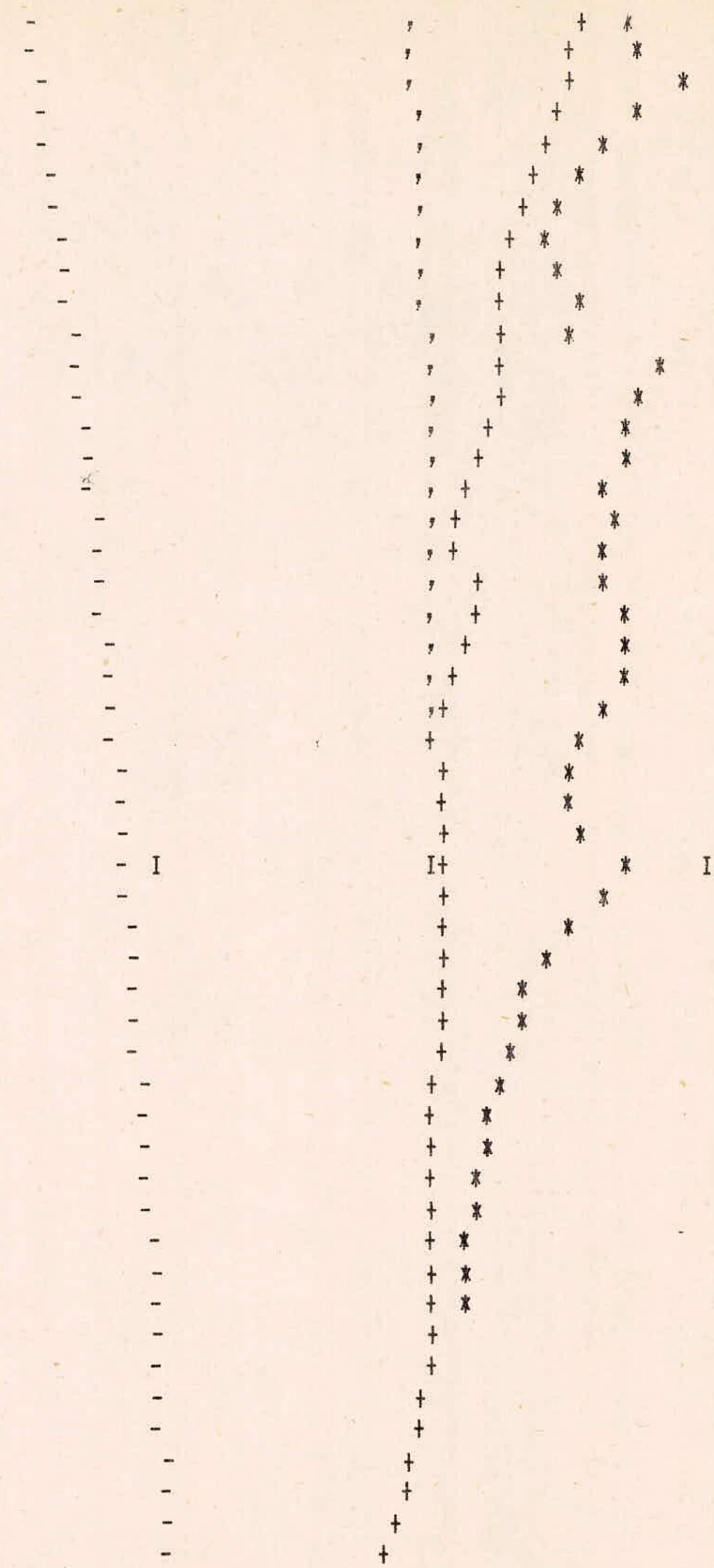

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    0-999.0   0.04  0.00                        -             +
    0-999.0   0.04  0.00                        -
N   0-999.0   0.03  0.00                       I-          +           I                       I
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V   0-999.0   0.03  0.00                        -       +
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    0-999.0   0.01  0.00                       +
    0-999.0   0.01  0.00                      +
    0-999.0   0.01  0.00                     +
    0-999.0   0.01  0.00                    +
    0-999.0   0.01  0.00                   +
    0-999.0   0.01  0.00                 +
    0-999.0   0.01  0.00               +
   20-999.0   0.00  0.00             +
    5-999.0   0.00  0.00            +
D   0-999.0   0.00  0.00           +          I                        I                       I
E   0-999.0   0.00  0.00         +
C   0-999.0   0.00  0.00      +
    0-999.0   0.00  0.00 +
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
    0-999.0   0.00  0.00
```

0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
1-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00
0-999.0	0.00	0.00

		MQ	MQE	DQ
	JAN	0.00	0.00	0.00I
+1978				
	FEB	0.00	0.00	0.00
	MAR	0.00	0.00	0.00
	APR	0.00	0.00	0.00
	MAY	0.00	0.00	0.00
	JUN	0.64	0.00	0.00
	JUL	2.26	1.16	-0.67
	AUG	4.32	6.16	0.35
	SEP	0.80	1.94	0.89
	OCT	0.06	0.75	2.55
	NOV	*	*	*
	DEC	*	*	*
	YEAR	8.08	10.01	
	JAN	*	*	*
+1979				
	FEB	*	*	*
	MAR	*	*	*
	APR	*	*	*
	MAY	*	*	*
	JUN	0.16	0.00	0.00
	JUL	1.00	0.21	-1.57
	AUG	4.89	2.90	-0.52
	SEP	0.46	0.20	-0.82
	OCT	0.23	0.11	-0.73
	NOV	*	*	*
	DEC	*	*	*
	YEAR	6.75	3.42	
0	TOTAL	14.83	13.43