INSTITUTE of HYDROLOGY

St. Lucia

Rainfall Runoff Model

Institute of Hydrology

(1986)

St. Lucia Rainfall Runoff Model
Institute of Hydrology (1986)

Explanation of program usage

The model used in this package is a 9 parameter rainfall runoff model. It is described in the appendix.

There are two programs in this package, namely OPTIDMOD and PREDMOD. The optimisation program (OPTIDMOD) requires full months of continuous daily rainfall, flow and evaporation values in mm over the catchment, as well as starting values for the model parameters. The user can then optimise the parameter values by the suggested procedure described in the appendix .

These optimised parameters can then be used with daily rainfall and evaporation to predict flows using the prediction program (PREDMOD). Both OPTIDMOD and PREDMOD can be run by inputting information from a parameter file or from the console. They both require the data to be input from a data file set up before the program is run and residing on the disk drive A:. These files should be created and updated using the editor available on your system.

Model input files

The parameter input files for the two programs can be identical. The program used will abstract only the data it requires. An example of a parameter file is shown below called A:CDSAC.DAT

A:CDSAC.DAT			EXPLANATION
SS	0	3.1	-
RC	4	0.7	|
RDEL	0	0.2	|
RX	0	2.6	|
RK	0	0.1	|-Model optimisation order and parameters
FC	2	0.7	| (see below)
GSU	0	90.4	| (9X,I1,F10.4)
GSP	3	1.7	|
GDEL	1	0.5	-

The first column of numbers specifies the order of optimisation required and is only necessary when OPTIDMOD is run in interactive mode. We suggest that you only optimise 4 parameters at a time as excessive numbers of parameters causes extremely long and inefficient optimisation. For all other executions of OPTIDMOD or PREDMOD this column will be ignored. The second column describes the parameter values. These are explained in the appendix together with suggested limits to their values.These parameter values must be contained in a 10 character wide field starting at the 10th character from the extreme left.

The data files for the two programs can also be the same but OPTIDMOD requires rainfall, flow and evaporation whereas PREDMOD only requires rainfall and evaporation data. An example of the start of an OPTIDMOD data file is shown below called

A:LUCIA.DAT

```
  DATA                                EXPLANATION
0985                    Month of data (MM.YY)
  30                    Number of days in month
 8.3     1.43    4.96   Rain,flow & evaporation (3f7.4)
 6.1     1.37    4.96
  .       .       .
  .       .       .
 etc
```

The values should be catchment average daily rainfall (mm)
catchment daily river flow (mm)
daily evaporation (mm)

The field specification "f7.4" means that the data must be contained within a field of seven characters. As long as a decimal point is present the number input need not have four places of decimal. For example , the following :

```
     .......................
     5642.9032.1       5.62
would be read as 5642.9, 32.1, 5.62
```

PREDMOD can use the same file, otherwise the data should be as follows:-

```
  DATA                                EXPLANATION
0985                    As above
  30                      "
 8.3             4.96   Rain,flow and evaporation (F7.4,7x,F7.4)
 6.1             4.96
  .               .
  .               .
  etc
```

N.B. These data must be continuous. Additional months may be added to the end of this file as they become available.

Running the model

Both the optimisation and prediction models can be run inputting information from a parameter file, as described above, or by interactive input. The option is chosen once the program has been started.

The running of PREDMOD is described first as this program will be most often used.

A - Prediction mode
Load the disk supplied in the drive 'B:'and ensure your data files are available on disk drive A: together with files TEMP and OUT (these two files will be created by the program if they do not exist on your disk). You may wish to copy the example data files from the disk onto your A: disk.
Type 'B:PREDMOD'
<ENTER>
An example of the console questions and answers follows, <ENTER> is required after each command

PREDICTION MODE READING FROM CONSOLE

```
PREDICTION   PROGRAM

SPECIFY PARAMETER INPUT TYPE
         0=FROM FILE
         1=FROM CONSOLE
         1

Input Catchment Name ?   (<13 Characters)
CUL-DE-SAC

Input Starting month (MMYY)  0985

Input End month      (MMYY)  0186


Input Output Control Selection
           0 ....  Daily values and monthly totals
           1 ....  Monthly totals

     Selection ? 0



SPECIFY BASEFLOW REQUIRED

     1=HIGH BASEFLOW
     2=MEDIUM BASEFLOW
     3=LOW BASEFLOW
     2
```

MODEL REQUIRES 9 PARAMETERS
PLEASE TYPE VALUES UNDER TITLE

	PARAMETER
SS	3.1141
RC	0.7303
RDEL	0.2001
RX	2.5910
RK	0.0229
FC	0.6858
GSU	90.4261
GSP	1.6945
GDEL	0.5287

INPUT DATA ARE AS FOLLOWS:

```
**************************************************************************
**************************************************************************
***                  INSTITUTE OF HYDROLOGY                            ***
***                St. Lucia Modelling Package                         ***
***                                                                    ***
***           LOCATION/CATCHMENT-**** CUL-DE-SAC  ****                 ***
***             DURATION OF DATA-**** 9 85-- 1  86****                 ***
***               DATA FREQUENCY-       DAILY                          ***
**************************************************************************
**************************************************************************
```

SS	0	3.1141
RC	0	0.7303
RDEL	0	0.2001
RX	0	2.5910
RK	0	0.0229
FC	0	0.6858
GSU	0	90.4261
GSP	0	1.6945
GDEL	0	0.5287

PLEASE TYPE 0=RE-ENTER DATA
1=CONTINUE
2=CONTINUE (NO HARD COPY OF ABOVE)
YOUR CHOICE =1

PRINTER COPYING PARAMETER VALUES

The name of the data file to be used is requested by the program. This should be answered by the operator with a filename of a file which resides on the A: disk and should be in the form : A:LUCIA.DAT. An error message at this point could indicate that the data file is not in the correct format or that the years requested by the parameter input section are not available in the data file.

```
NAME OF DATA FILE PLEASE ????????.DAT
THIS DATA FILE SHOULD CONTAIN RAINFALL, RUNOFF (IF ANY)
AND EVAPORATION INFORMATION
 A:LUCIA.DAT
```

THE PRINTER WILL RESPOND WITH

INPUT FILE CHOSEN =

**A:LUCIA.DAT **

MEDIUM BASE FLOW CHOSEN

```
**************************************************************************
**************************************************************************
***                  INSTITUTE OF HYDROLOGY                            ***
***               St. Lucia Modelling Package                          ***
***                                                                    ***
***          LOCATION/CATCHMENT-**** CUL-DE-SAC  ****                  ***
***            DURATION OF DATA-**** 9 85-- 1  86****                  ***
***              DATA FREQUENCY-       DAILY                           ***
**************************************************************************
**************************************************************************
```

PARAMETER VALUES

SS	0	3.1141
RC	0	0.7303
RDEL	0	0.2001
RX	0	2.5910
RK	0	0.0229
FC	0	0.6858
GSU	0	90.4261
GSP	0	1.6945
GDEL	0	0.5287

MONTH: 985

DAY	RAIN	EVAP	EPRED	BSTORE	RUNOFF
1	8.3	5.0	5.2	80.38	0.8
2	6.1	5.0	5.2	79.56	0.8
3	1.1	5.0	5.2	78.76	0.8
4	4.9	5.0	5.2	77.97	0.8
5	0.0	5.0	5.2	77.19	0.8
6	3.0	5.0	5.2	76.42	0.8
7	10.5	5.0	5.2	75.67	0.7
8	1.3	5.0	5.3	74.93	0.7
9	2.6	5.0	5.2	74.20	0.7
10	0.5	5.0	5.2	73.49	0.7
11	8.8	5.0	5.2	72.79	0.7
12	27.8	5.0	5.3	72.09	9.6
13	31.1	5.0	5.2	71.41	13.7
14	15.0	5.0	5.2	72.64	3.5
15	6.9	5.0	5.2	76.91	0.8
16	4.2	5.0	5.2	82.31	0.9
17	0.4	5.0	5.2	85.36	0.9
18	0.4	5.0	3.9	85.88	1.0
19	0.0	5.0	3.6	84.97	1.0
20	1.5	5.0	4.3	84.07	0.9
21	1.9	5.0	5.2	83.18	0.9
22	6.2	5.0	5.2	82.32	0.9
23	8.9	5.0	5.2	81.46	0.9
24	8.3	5.0	5.2	80.63	0.9
25	0.5	5.0	5.2	79.80	0.8
26	4.2	5.0	5.2	78.99	0.8
27	14.4	5.0	5.2	78.20	1.0
28	2.6	5.0	5.2	77.42	1.0
29	3.9	5.0	5.2	76.83	0.9
30	8.6	5.0	5.2	76.07	0.9
TOTAL	193.9	148.8	153.5		49.515

AT END OF MONTH 985

CUMULATIVE VALUES ARE: RUNOFF = 49.5

STORE CONTENTS ARE: CS= 3.11 DC= 3.3 GS= 75.3

CUMULATIVE VALUE OF: RAIN = 193.9 EVAP = 148.8 EPRED = 153.5

PREDICTION MODE READING FROM PARAMETER FILE

```
PREDICTION   PROGRAM

SPECIFY PARAMETER INPUT TYPE
         0=FROM FILE
         1=FROM CONSOLE
         0
```

The program will prompt for the name of the parameter file to be used. This should be input in the form A:CDSAC.DAT.This file should exist on the A: drive and should be in the same format as the example 'A:CDSAC.DAT' above. You may wish to copy the example data file from the disk provided.

If an error message occurs check that the parameter file specified exists on the disk A: and check that the data required are on that parameter file in the format specified above.

```
NAME_OF_PARAMETER FILE  ????????.DAT
A:CDSAC.DAT

Input Catchment Name ?   (<13 Characters)
CUL-DE-SAC

Input Starting month (MMYY)  0985

Input End month      (MMYY)  0186


Input Output Control Selection
           0 ....  Daily values and monthly totals
           1 ....  Monthly totals

     Selection ? 1


SPECIFY BASEFLOW REQUIRED

    1=HIGH BASEFLOW
    2=MEDIUM BASEFLOW
    3=LOW BASEFLOW
    2
```

INPUT DATA ARE AS FOLLOWS:

```
**********************************************************************
**********************************************************************
***                  INSTITUTE OF HYDROLOGY                        ***
***                St. Lucia Modelling Package                     ***
***                                                                ***
***           LOCATION/CATCHMENT-**** CUL-DE-SAC  ****             ***
***             DURATION OF DATA-**** 9 85-- 1  86****             ***
***               DATA FREQUENCY-       DAILY                      ***
**********************************************************************
**********************************************************************

 SS     0        3.1141
 RC     2        0.7303
 RDEL   0        0.2001
 RX     4        2.5910
 RK     0        0.0229
 FC     1        0.6858
 GSU    0       90.4261
 GSP    3        1.6945
 GDEL   0        0.5287


PLEASE TYPE 0=RE-ENTER DATA
            1=CONTINUE
            2=CONTINUE (NO HARD COPY OF ABOVE)
YOUR CHOICE =2


  NAME OF DATA FILE PLEASE ????????.DAT
  THIS DATA FILE SHOULD CONTAIN RAINFALL, RUNOFF (IF ANY)
  AND EVAPORATION INFORMATION

    A:LUCIA.DAT


                    THE PRINTER WILL RESPOND WITH


                          INPUT FILE CHOSEN =

                          **A:LUCIA.DAT **



  MEDIUM BASE FLOW CHOSEN
```

MONTH	RAIN	EVAP	EPRED	RUNOFF	CS	DC	GS			
985	193.9	148.8	153.5	49.5	3.11	3.3	75.3	193.9	148.8	153.5
MONTH	RAIN	EVAP	EPRED	RUNOFF	CS	DC	GS			
1085	344.9	144.5	148.1	137.6	3.11	-3.2	136.1	538.8	293.3	301.6
MONTH	RAIN	EVAP	EPRED	RUNOFF	CS	DC	GS			
1185	317.5	130.8	135.7	152.3	1.60	-3.0	184.0	856.3	424.1	437.3
MONTH	RAIN	EVAP	EPRED	RUNOFF	CS	DC	GS			
1285	141.6	126.8	137.6	83.2	3.11	-0.8	126.4	997.9	550.9	574.9
MONTH	RAIN	EVAP	EPRED	RUNOFF	CS	DC	GS			
186	160.2	131.1	143.5	61.3	3.11	9.5	99.3	1158.1	682.0	718.4

STOP

B - Optimisation mode
Load disk into disk drive 'B:' and your data file disk into A: again containing TEMP and OUT.
Type 'B:OPTIDMOD'
<ENTER>
A worked example is attached.
The automatic selection carries out the full optimisation process described in the appendix. The interactive version allows the operator to decide which parameters will be optimised and in what order.

```
                    OPTIDMOD IN AUTOMATIC MODE


 OPTIMISATION PROGRAM

 TYPE OF OPTIMISATION REQUIRED ?
     1=AUTOMATIC PARAMETER SELECTION
     2=INTERACTIVE PARAMETER SELECTION

      1


SPECIFY PARAMETER INPUT TYPE
         0=FROM FILE
         1=FROM CONSOLE
         0

NAME OF PARAMETER FILE  ????????.DAT
A:CDSAC.DAT

Input Catchment Name ?    (<13 Characters)
CUL-DE-SAC

Input Starting month (MMYY)  0985

Input End month      (MMYY)  0186


          INPUT DATA ARE AS FOLLOWS:

    ************************************************************************
    ************************************************************************
    ***                  INSTITUTE OF HYDROLOGY                          ***
    ***              CONCEPTUAL MODELLING PACKAGE                        ***
    ***                                                                  ***
    ***           LOCATION/CATCHMENT-**** CUL-DE-SAC  ****               ***
    ***             DURATION OF DATA-**** 9 85-- 1  86****               ***
    ***               DATA FREQUENCY-       DAILY                        ***
    ************************************************************************
    ************************************************************************

 SS    4        3.1141
 RC    3        0.7303
 RDEL  0        0.2001
 RX    0        2.5910
 RK    0        0.0229
 FC    1        0.6858
 GSU   0       90.4261
 GSP   2        1.6945
 GDEL  0        0.5287
```

```
PLEASE TYPE 0=RE-ENTER DATA
            1=CONTINUE
            2=CONTINUE (NO HARD COPY OF ABOVE)
YOUR CHOICE =1


    ***PRINTER COPYING PARAMETER VALUES***

  NAME OF DATA FILE PLEASE ????????.DAT

    A:LUCIA.DAT


                    THE PRINTER WILL RESPOND WITH

    ************************************************************************
    ************************************************************************
    ***                  INSTITUTE OF HYDROLOGY                          ***
    ***               CONCEPTUAL MODELLING PACKAGE                       ***
    ***                                                                  ***
    ***          LOCATION/CATCHMENT-**** CUL-DE-SAC  ****                ***
    ***            DURATION OF DATA-**** 9 85-- 1  86****                ***
    ***              DATA FREQUENCY-       DAILY                         ***
    ************************************************************************
    ************************************************************************


  PARAMETER VALUES


            LOWER      UPPER      PARAMETER      OPTIMISING
            LIMIT      LIMIT        VALUE         SEQUENCE

SS           1.5570     4.6712      3.1141           4
RC           0.3652     1.0954      0.7303           3
RDEL                                0.2001
RX                                  2.5910
RK                                  0.0229
FC           0.3429     1.0287      0.6858           1
GSU                                90.4261
GSP          0.8472     2.5418      1.6945           2
GDEL                                0.5287


                              INPUT FILE CHOSEN =

                              **A:LUCIA.DAT **
```

VARIANCE, FLOW AND ACTIVE PARAMETERS
****

SUM = 529.9701

F	SUMP	SUMP-SUM	FC	GSP	RC	SS
2479.8040	514.5983	-15.3718	0.6858	1.6945	0.7303	3.1141
2259.1240	519.6285	-10.3416	0.6966	1.6945	0.7303	3.1141
2274.7664	513.3919	-16.5782	0.7127	1.6945	0.7303	3.1141
2264.2478	516.7434	-13.2266	0.7040	1.6945	0.7303	3.1141
2250.4609	520.0114	-9.9586	0.6966	1.7211	0.7303	3.1141
2237.3083	520.5495	-9.4205	0.6966	1.7610	0.7303	3.1141
2217.3000	521.2781	-8.6920	0.6966	1.8205	0.7303	3.1141
2186.9656	522.2072	-7.7629	0.6966	1.9084	0.7303	3.1141
2141.8999	523.2787	-6.6913	0.6966	2.0356	0.7303	3.1141
2079.2858	524.3210	-5.6490	0.6966	2.2092	0.7303	3.1141
2007.1308	525.0729	-4.8972	0.6966	2.4123	0.7303	3.1141
1963.2931	525.3546	-4.6155	0.6966	2.5415	0.7303	3.1141
2048.2158	524.6943	-5.2757	0.6966	2.2957	0.7303	3.1141
1963.2191	525.3550	-4.6151	0.6966	2.5417	0.7303	3.1141
1867.5427	525.7453	-4.2247	0.6966	2.5417	0.7418	3.1141
1728.0906	526.3414	-3.6287	0.6966	2.5417	0.7589	3.1141
1528.7844	527.2571	-2.7130	0.6966	2.5417	0.7846	3.1141
1254.5405	528.6719	-1.2981	0.6966	2.5417	0.8225	3.1141
903.7820	530.8502	0.8802	0.6966	2.5417	0.8773	3.1141
533.4627	533.1975	3.2275	0.6966	2.5417	0.9521	3.1141
260.2466	535.9756	6.0056	0.6966	2.5417	1.0397	3.1141
186.4549	537.8907	7.9207	0.6966	2.5417	1.0954	3.1141
394.8337	534.3512	4.3812	0.6966	2.5417	0.9894	3.1141
186.7557	537.8717	7.9016	0.6966	2.5417	1.0948	3.1141
184.7793	536.1054	6.1354	0.6966	2.5417	1.0954	3.1630
184.5447	533.4811	3.5110	0.6966	2.5417	1.0954	3.2363
189.5708	529.6425	-0.3275	0.6966	2.5417	1.0954	3.3456
184.5035	534.5579	4.5878	0.6966	2.5417	1.0954	3.2057

1 ITERATIONS OF OPTIMISATION COMPLETED
28 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 184.503510
****

184.3938	534.5069	4.5369	0.6966	2.5417	1.0954	3.2063
184.2741	534.4282	4.4581	0.6968	2.5414	1.0954	3.2073
184.1999	534.3055	4.3354	0.6969	2.5405	1.0953	3.2087
184.3329	534.1106	4.1406	0.6972	2.5382	1.0947	3.2109
184.1993	534.2968	4.3267	0.6969	2.5404	1.0953	3.2088
185.4647	535.0730	5.1030	0.6950	2.5404	1.0953	3.2088
183.2028	533.5212	3.5512	0.6989	2.5404	1.0953	3.2088
182.1257	532.3637	2.3936	0.7018	2.5404	1.0953	3.2088
181.6688	530.6288	0.6587	0.7061	2.5404	1.0953	3.2088
183.5903	528.0295	-1.9406	0.7126	2.5404	1.0953	3.2088
181.6481	530.9259	0.9558	0.7053	2.5404	1.0953	3.2088
189.3361	530.7618	0.7917	0.7040	2.5343	1.0865	3.2201
182.7304	530.7443	0.7743	0.7066	2.5166	1.0908	3.1975
181.1344	530.8980	0.9279	0.7058	2.5350	1.0951	3.2046
182.2972	530.1572	0.1871	0.7058	2.5350	1.0951	3.2259
179.9308	531.6600	1.6899	0.7058	2.5350	1.0951	3.1833
178.5573	532.8124	2.8424	0.7058	2.5350	1.0952	3.1513
177.7818	534.5422	4.5721	0.7058	2.5350	1.0952	3.1033
178.9634	537.1279	7.1578	0.7058	2.5350	1.0952	3.0314
177.7773	534.7494	4.7794	0.7058	2.5350	1.0952	3.0976

2 ITERATIONS OF OPTIMISATION COMPLETED
48 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 177.777320
****

OPTIMISED PARAMETER VALUES

FC	0.7058
GSP	2.5350
RC	1.0952
SS	3.0976

	LOWER LIMIT	UPPER LIMIT	PARAMETER VALUE	OPTIMISING SEQUENCE
SS			3.0976	
RC			1.0952	
RDEL	0.1001	0.3002	0.2001	3
RX	1.2955	3.8865	2.5910	1
RK	0.0114	0.0344	0.0229	2
FC			0.7058	
GSU	45.2131	135.6392	90.4261	4
GSP			2.5350	
GDEL			0.5287	

VARIANCE, FLOW AND ACTIVE PARAMETERS
****

SUM = 529.9701

F	SUMP	SUMP-SUM	RX	RK	RDEL	GSU
2006.8047	534.7495	4.7794	2.5910	0.0229	0.2001	90.4261
2026.5692	534.7567	4.7867	2.6317	0.0229	0.2001	90.4261
1991.4746	534.7418	4.7718	2.5503	0.0229	0.2001	90.4261
1975.2049	534.7297	4.7597	2.4894	0.0229	0.2001	90.4261
1944.3099	532.9982	3.0281	2.3984	0.0229	0.2001	90.4261
2144.4602	530.4461	0.4761	2.2639	0.0229	0.2001	90.4261
1951.6885	533.5376	3.5676	2.4224	0.0229	0.2001	90.4261
1945.6249	533.1252	3.1552	2.3984	0.0233	0.2001	90.4261
1943.0640	532.8707	2.9006	2.3984	0.0225	0.2001	90.4261
1943.7266	532.6787	2.7086	2.3984	0.0220	0.2001	90.4261
1942.5582	532.8167	2.8466	2.3984	0.0224	0.2001	90.4261
1932.0598	532.7828	2.8127	2.3984	0.0224	0.2032	90.4261
1916.9558	532.7321	2.7620	2.3984	0.0224	0.2079	90.4261
1895.8000	532.6564	2.6863	2.3984	0.0224	0.2150	90.4261
1867.5602	532.5445	2.5745	2.3984	0.0224	0.2254	90.4261
1833.1520	532.3827	2.4127	2.3984	0.0224	0.2404	90.4261
1798.4052	532.1619	2.1918	2.3984	0.0224	0.2609	90.4261
1775.6897	531.9035	1.9334	2.3984	0.0224	0.2849	90.4261
1771.3055	531.7390	1.7690	2.3984	0.0224	0.3001	90.4261
1786.3604	532.0518	2.0817	2.3984	0.0224	0.2711	90.4261
1771.3190	531.7429	1.7729	2.3984	0.0224	0.2998	90.4261
1771.2686	531.9097	1.9396	2.3984	0.0224	0.3001	91.8463
1771.2253	532.1593	2.1893	2.3984	0.0224	0.3001	93.9735
1771.1849	532.5197	2.5497	2.3984	0.0224	0.3001	97.1480
1771.1697	533.0281	3.0580	2.3984	0.0224	0.3001	101.8420
1771.2244	533.7176	3.7476	2.3984	0.0224	0.3001	108.6265
1771.1696	532.9632	2.9932	2.3984	0.0224	0.3001	101.2292

1 ITERATIONS OF OPTIMISATION COMPLETED
27 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 1771.169600
****

1772.2919	533.0249	3.0549	2.4027	0.0224	0.3000	100.9911
1771.0037	532.9036	2.9335	2.3941	0.0224	0.3001	101.4669
1773.2611	532.8180	2.8479	2.3877	0.0224	0.2999	101.8228
1770.4904	532.9258	2.9557	2.3957	0.0224	0.3001	101.3775
1780.7839	532.4046	2.4346	2.3673	0.0224	0.3001	101.3632
1778.1320	533.4818	3.5117	2.4243	0.0224	0.3001	101.3918
1771.0016	532.9657	2.9957	2.3978	0.0224	0.3001	101.3786
1770.8115	532.9535	2.9835	2.3957	0.0225	0.3001	101.3790
1770.8677	532.8981	2.9280	2.3957	0.0223	0.3001	101.3761
1770.5032	532.9269	2.9568	2.3957	0.0224	0.3001	101.3776
1770.5038	533.1344	3.1643	2.3957	0.0224	0.3001	103.3603
1770.4851	532.7102	2.7402	2.3957	0.0224	0.3001	99.3721
1770.5148	532.3734	2.4033	2.3957	0.0224	0.3001	96.3307
1770.4854	532.7633	2.7932	2.3957	0.0224	0.3001	99.8614

2 ITERATIONS OF OPTIMISATION COMPLETED
41 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 1770.485190
****

OPTIMISED PARAMETER VALUES

RX	2.3957
RK	0.0224
RDEL	0.3001
GSU	99.3721

	LOWER LIMIT	UPPER LIMIT	PARAMETER VALUE	OPTIMISING SEQUENCE
SS			3.0976	
RC	0.5476	1.6428	1.0952	4
RDEL			0.3001	
RX			2.3957	
RK			0.0224	
FC	0.3529	1.0587	0.7058	2
GSU			99.8614	
GSP	1.2675	3.8024	2.5350	3
GDEL	0.2644	0.7930	0.5287	1

VARIANCE, FLOW AND ACTIVE PARAMETERS

****

SUM = 529.9701

F	SUMP	SUMP-SUM	GDEL	FC	GSP	RC
1770.4853	532.7633	2.7932	0.5287	0.7058	2.5350	1.0952
1770.4938	532.7541	2.7841	0.5370	0.7058	2.5350	1.0952
1770.4762	532.7723	2.8022	0.5204	0.7058	2.5350	1.0952
1770.4646	532.7859	2.8159	0.5080	0.7058	2.5350	1.0952
1770.4454	532.8060	2.8359	0.4894	0.7058	2.5350	1.0952
1770.4182	532.8357	2.8657	0.4620	0.7058	2.5350	1.0952
1770.3811	532.8786	2.9086	0.4223	0.7058	2.5350	1.0952
1770.3300	532.9366	2.9666	0.3681	0.7058	2.5350	1.0952
1770.2743	533.0039	3.0339	0.3047	0.7058	2.5350	1.0952
1770.2403	533.0463	3.0762	0.2644	0.7058	2.5350	1.0952
1770.3060	532.9654	2.9953	0.3411	0.7058	2.5350	1.0952
1770.2406	533.0464	3.0764	0.2644	0.7058	2.5350	1.0952
1770.5032	528.6448	-1.3253	0.2644	0.7169	2.5350	1.0952
1770.2563	537.4772	7.5071	0.2644	0.6947	2.5350	1.0952
1770.2092	535.0034	5.0334	0.2644	0.7009	2.5350	1.0952
1770.2010	534.8294	4.8594	0.2644	0.7009	2.5748	1.0952
1770.2020	534.5738	4.6038	0.2644	0.7009	2.6344	1.0952
1770.2002	534.7174	4.7474	0.2644	0.7009	2.6007	1.0952
1824.4887	535.5119	5.5419	0.2644	0.7009	2.6007	1.1124
1722.7824	533.9446	3.9745	0.2644	0.7009	2.6007	1.0780
1657.0115	532.8276	2.8576	0.2644	0.7009	2.6007	1.0522
1570.5633	531.2389	1.2688	0.2644	0.7009	2.6007	1.0138
1489.8321	529.0399	-0.9302	0.2644	0.7009	2.6007	0.9569
1429.2153	526.1471	-3.8229	0.2644	0.7009	2.6007	0.8747
1430.9579	522.6597	-7.3103	0.2644	0.7009	2.6007	0.7625
1418.1198	524.3370	-5.6331	0.2644	0.7009	2.6007	0.8184

1 ITERATIONS OF OPTIMISATION COMPLETED
26 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 1418.119810

****

1423.9680	525.3263	-4.6437	0.2744	0.7017	2.5900	0.8605
1425.0572	523.4729	-6.4971	0.2713	0.7001	2.6115	0.7785
1418.0934	524.3764	-5.5936	0.2645	0.7009	2.6003	0.8202
1418.1844	524.2886	-5.6815	0.2645	0.7009	2.6013	0.8163
1418.1190	524.4657	-5.5043	0.2645	0.7010	2.5993	0.8241
1418.0888	524.4013	-5.5687	0.2645	0.7010	2.6000	0.8213
1418.0880	524.3673	-5.6028	0.2645	0.7011	2.6000	0.8213
1418.0864	524.3160	-5.6540	0.2645	0.7012	2.6000	0.8213
1418.0840	524.2393	-5.7308	0.2645	0.7014	2.6000	0.8213
1418.0810	524.1242	-5.8458	0.2645	0.7016	2.6000	0.8212
1418.0766	523.9516	-6.0184	0.2645	0.7020	2.6000	0.8212
1418.0700	523.6924	-6.2776	0.2645	0.7027	2.6000	0.8212
1418.0634	523.3041	-6.6660	0.2645	0.7036	2.6000	0.8212
1418.0570	522.7211	-7.2490	0.2645	0.7050	2.6000	0.8211
1418.0576	521.8467	-8.1234	0.2645	0.7070	2.6000	0.8211
1418.0560	522.3278	-7.6422	0.2645	0.7059	2.6000	0.8211
1420.4937	527.8570	-2.1130	0.2645	0.6934	2.7660	0.8277
1416.7121	516.7347	-13.2353	0.2645	0.7184	2.4329	0.8146
1416.6693	508.2768	-21.6932	0.2645	0.7370	2.1865	0.8048
1421.1657	495.5031	-34.4669	0.2645	0.7648	1.8453	0.7905
1416.3832	512.3724	-17.5977	0.2645	0.7280	2.3043	0.8095

2 ITERATIONS OF OPTIMISATION COMPLETED
47 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 1416.383230
****

OPTIMISED PARAMETER VALUES

GDEL	0.2645
FC	0.7280
GSP	2.3043
RC	0.8095

MONTH: 985

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	8.3	5.0	5.4	2.8	116.7	1.430	1.443	0.9
2	6.1	5.0	5.4	-0.1	115.3	1.370	1.403	2.4
3	1.1	5.0	5.4	-0.7	113.9	1.150	1.365	18.7
4	4.9	5.0	5.4	1.9	112.9	0.890	1.335	50.0
5	0.0	5.0	5.4	2.4	111.6	0.810	1.302	60.7
6	3.0	5.0	5.3	4.8	110.3	0.760	1.267	66.7
7	10.5	5.0	5.4	7.1	109.1	0.710	1.234	73.8
8	1.3	5.0	5.4	2.0	107.8	1.120	1.202	7.3
9	2.6	5.0	5.4	4.3	106.6	0.730	1.171	60.5
10	0.5	5.0	5.4	6.6	105.5	0.740	1.142	54.3
11	8.8	5.0	5.4	8.9	104.3	1.130	1.114	-1.4
12	27.8	5.0	5.4	5.5	103.2	21.250	7.492	-64.7
13	31.1	5.0	5.4	-4.6	102.2	6.060	16.498	172.2
14	15.0	5.0	5.4	-11.2	105.2	4.340	6.627	52.7
15	6.9	5.0	5.4	-13.0	109.9	3.330	1.315	-60.5
16	4.2	5.0	5.4	-8.0	115.2	1.710	1.439	-15.9
17	0.4	5.0	5.4	-2.8	117.8	1.310	1.521	16.1
18	0.4	5.0	4.1	1.9	117.7	1.240	1.531	23.4
19	0.0	5.0	3.8	5.3	116.3	1.060	1.493	40.8
20	1.5	5.0	4.5	8.3	114.8	1.090	1.447	32.7
21	1.9	5.0	5.4	10.6	113.5	1.040	1.403	34.9
22	6.2	5.0	5.4	12.9	112.1	1.320	1.362	3.2
23	8.9	5.0	5.4	12.1	110.8	1.730	1.323	-23.5
24	8.3	5.0	5.4	8.6	109.5	1.570	1.286	-18.1
25	0.5	5.0	5.4	5.7	108.3	1.120	1.251	11.7
26	4.2	5.0	5.4	8.0	107.1	1.280	1.217	-4.9
27	14.4	5.0	5.4	9.2	105.9	2.170	1.319	-39.2
28	2.6	5.0	5.4	1.7	104.8	1.390	1.317	-5.2
29	3.9	5.0	5.4	4.0	103.7	1.320	1.255	-4.9
30	8.6	5.0	5.4	5.5	102.6	1.940	1.204	-38.0
TOTAL	193.9	148.8	158.2			67.110	66.276	-1.2

AT END OF MONTH 985

CUMULATIVE VALUES ARE: FLOW= 67.1 PREDICTED= 66.3
VARIANCE= 311.10 EFFICIENCY= 0.244

STORE CONTENTS ARE: CS= 3.10 DC= 5.5 GS= 101.5

CUMULATIVE VALUE OF: RAIN = 193.9 EVAP = 148.8 EPRED = 158.

MONTH: 1085

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	0.0	4.7	5.2	2.1	101.5	1.170	1.159	-1.0
2	0.0	4.7	3.4	5.5	100.5	0.940	1.119	19.0
3	13.7	4.7	5.2	7.6	99.5	1.000	1.183	18.3
4	13.8	4.7	5.2	-0.1	98.5	1.730	1.329	-23.2
5	34.2	4.7	5.2	-7.6	97.6	21.870	15.387	-29.6
6	13.3	4.7	5.2	-13.2	102.5	4.570	7.174	57.0
7	2.8	4.7	5.2	-14.1	108.1	2.220	1.171	-47.3
8	5.4	4.7	5.2	-5.0	114.0	1.600	1.321	-17.4
9	36.5	4.7	5.2	-2.7	115.1	4.900	15.309	212.4
10	0.0	4.7	5.2	-11.0	117.4	3.260	7.407	127.2
11	0.0	4.7	3.4	-2.1	121.4	1.450	1.538	6.1
12	0.0	4.7	3.4	2.3	120.9	1.190	1.558	30.9
13	0.0	4.7	3.4	5.7	119.4	3.350	1.521	-54.6
14	1.7	4.7	4.4	8.4	117.9	4.800	1.477	-69.2
15	6.5	4.7	5.2	10.5	116.4	1.510	1.434	-5.0
16	19.1	4.7	5.2	9.2	115.0	3.730	2.231	-40.2
17	27.9	4.7	5.2	0.5	113.6	19.040	13.231	-30.5
18	18.6	4.7	5.2	-8.6	113.4	8.360	6.973	-16.6
19	7.7	4.7	5.2	-12.3	117.0	4.930	2.111	-57.2
20	6.6	4.7	5.2	-8.7	121.7	4.610	1.986	-56.9
21	8.8	4.7	5.2	-5.7	124.4	3.980	1.957	-50.8
22	3.4	4.7	5.2	-6.5	125.6	4.260	1.932	-54.7
23	4.4	4.7	5.2	-1.5	127.2	2.640	1.928	-27.0
24	7.1	4.7	5.2	0.1	126.2	2.950	1.882	-36.2
25	3.7	4.7	5.2	-1.9	124.5	3.210	1.809	-43.6
26	7.2	4.7	5.2	0.6	123.7	2.320	1.759	-24.2
27	7.4	4.7	5.2	-1.5	122.1	5.730	1.701	-70.3
28	67.0	4.7	5.2	-2.9	121.2	42.890	33.632	-21.6
29	19.5	4.7	5.2	-14.1	126.3	7.650	16.382	114.1
30	1.4	4.7	5.2	-15.1	132.3	4.590	2.765	-39.8
31	7.2	4.7	5.2	-5.5	137.9	5.020	2.580	-48.6
TOTAL	344.9	144.5	152.8			181.470	154.945	-14.6

AT END OF MONTH 1085

CUMULATIVE VALUES ARE: FLOW= 248.6 PREDICTED= 221.2
VARIANCE= 755.07 EFFICIENCY= 0.717

STORE CONTENTS ARE: CS= 3.10 DC= -2.7 GS= 138.6

CUMULATIVE VALUE OF: RAIN = 538.8 EVAP = 293.3 EPRED = 311.0

MONTH: 1185

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	14.1	4.4	5.0	-5.0	138.6	4.550	2.765	-39.2
2	0.0	4.4	5.0	-10.3	139.1	2.400	2.683	11.8
3	0.3	4.4	3.3	-2.1	142.0	1.930	2.595	34.5
4	0.0	4.4	3.3	2.0	140.8	1.630	2.496	53.1
5	0.0	4.4	3.2	5.2	138.6	1.490	2.366	58.8
6	0.1	4.4	3.2	8.3	136.5	1.380	2.249	63.0
7	2.0	4.4	4.4	10.6	134.4	1.540	2.148	39.5
8	13.4	4.4	5.0	12.5	132.5	6.800	2.137	-68.6
9	12.0	4.4	5.0	4.7	130.5	3.040	2.069	-31.9
10	17.0	4.4	5.0	-2.3	128.7	3.730	2.919	-21.7
11	33.8	4.4	5.0	-9.2	128.5	19.330	17.254	-10.7
12	6.1	4.4	5.0	-14.3	133.3	5.480	8.343	52.2
13	5.4	4.4	5.0	-8.3	138.5	3.060	2.078	-32.1
14	0.0	4.4	5.0	-4.6	140.5	2.040	2.178	6.8
15	0.0	4.4	3.2	0.9	140.6	1.760	2.199	24.9
16	7.0	4.4	5.0	2.8	138.4	6.340	2.142	-66.2
17	16.1	4.4	5.0	0.7	136.3	4.320	2.257	-47.8
18	18.9	4.4	5.0	-7.6	134.2	2.430	4.138	70.3
19	0.0	4.4	5.0	-12.0	136.6	1.780	3.567	100.4
20	23.2	4.4	5.0	-4.1	140.6	19.440	8.939	-54.0
21	45.8	4.4	5.0	-10.7	141.5	13.790	25.987	88.4
22	13.8	4.4	5.0	-16.1	147.8	20.610	11.415	-44.6
23	38.0	4.4	5.0	-15.8	153.5	6.800	17.697	160.2
24	8.0	4.4	5.0	-18.0	161.1	7.350	9.384	27.7
25	7.3	4.4	5.0	-12.0	167.1	3.540	3.204	-9.5
26	0.0	4.4	5.0	-8.3	169.8	2.560	3.366	31.5
27	17.3	4.4	5.0	-2.3	170.6	8.420	3.810	-54.7
28	10.9	4.4	5.0	-9.2	168.8	4.350	3.802	-12.6
29	5.4	4.4	5.0	-10.5	170.0	3.900	3.703	-5.0
30	1.6	4.4	5.0	-5.7	171.9	2.460	3.710	50.8
TOTAL	317.5	130.8	139.9			168.250	163.600	-2.8

AT END OF MONTH 1185

CUMULATIVE VALUES ARE: FLOW= 416.8 PREDICTED= 384.8
VARIANCE= 1316.81 EFFICIENCY= 0.634

STORE CONTENTS ARE: CS= 1.60 DC= -2.9 GS= 171.2

CUMULATIVE VALUE OF: RAIN = 856.3 EVAP = 424.1 EPRED = 450.9

MONTH: 1285

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	0.6	4.1	4.3	-0.8	171.2	2.110	3.663	73.6
2	2.8	4.1	4.8	1.3	168.2	1.840	3.518	91.2
3	0.2	4.1	4.7	3.0	164.9	1.670	3.346	100.3
4	0.5	4.1	3.4	5.7	161.7	1.600	3.185	99.0
5	0.0	4.1	3.3	8.4	158.6	1.550	3.038	96.0
6	8.6	4.1	4.8	10.1	155.7	1.700	2.902	70.7
7	11.4	4.1	4.8	6.3	153.0	2.330	2.777	19.2
8	2.1	4.1	4.8	-0.4	150.3	2.560	2.661	3.9
9	10.9	4.1	4.8	1.5	147.9	2.030	2.558	26.0
10	10.3	4.1	4.8	-4.6	145.4	1.730	2.458	42.1
11	5.0	4.1	4.8	-7.8	145.4	2.010	2.426	20.7
12	6.3	4.1	4.8	-4.2	146.9	1.410	2.465	74.8
13	1.8	4.1	4.8	-3.6	146.6	1.290	2.467	91.2
14	0.0	4.1	4.0	0.4	145.9	1.340	2.442	82.3
15	0.0	4.1	3.0	3.4	143.5	1.260	2.367	87.9
16	6.3	4.1	4.8	5.1	141.2	1.110	2.279	105.3
17	3.2	4.1	4.8	3.5	139.0	1.120	2.196	96.0
18	0.0	4.1	4.8	5.1	136.9	2.180	2.117	-2.9
19	18.9	4.1	4.8	6.8	134.8	2.530	3.257	28.7
20	0.0	4.1	4.8	-2.2	132.8	1.140	3.028	165.6
21	6.5	4.1	4.8	0.5	132.0	1.880	2.491	32.5
22	6.3	4.1	4.8	-1.2	130.1	3.900	2.247	-42.4
23	5.1	4.1	4.8	-2.1	128.8	1.580	2.098	32.8
24	3.2	4.1	4.8	-1.4	128.1	1.380	2.005	45.3
25	4.1	4.1	4.8	0.9	127.0	1.330	1.931	45.2
26	3.4	4.1	4.8	1.5	125.3	1.450	1.850	27.6
27	0.0	4.1	4.8	2.9	123.6	1.140	1.775	55.7
28	2.5	4.1	4.4	4.8	122.0	1.100	1.707	55.2
29	2.8	4.1	4.8	6.5	120.4	1.410	1.645	16.7
30	15.6	4.1	4.8	8.2	118.8	1.380	2.001	45.0
31	3.2	4.1	4.8	-0.2	117.3	1.230	1.970	60.1
TOTAL	141.6	126.8	141.5			52.290	76.869	47.0

AT END OF MONTH 1285

CUMULATIVE VALUES ARE: FLOW= 469.1 PREDICTED= 461.7
VARIANCE= 1349.81 EFFICIENCY= 0.645

STORE CONTENTS ARE: CS= 3.10 DC= -0.1 GS= 116.0

CUMULATIVE VALUE OF: RAIN = 997.9 EVAP = 550.9 EPRED = 592.

MONTH: 186

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	2.3	4.2	4.9	1.6	116.0	1.100	1.776	61.4
2	18.3	4.2	4.9	3.3	114.6	5.020	3.325	-33.8
3	5.5	4.2	4.9	-5.5	113.2	1.520	2.771	82.3
4	0.1	4.2	4.9	-3.4	114.6	1.170	2.014	72.1
5	4.3	4.2	4.9	0.1	114.9	1.320	1.804	36.7
6	3.5	4.2	4.9	0.7	113.5	1.140	1.662	45.7
7	2.5	4.2	4.9	2.0	112.2	1.050	1.554	48.0
8	2.3	4.2	4.9	3.8	110.9	1.060	1.471	38.8
9	3.8	4.2	4.9	5.6	109.6	1.240	1.404	13.2
10	4.0	4.2	4.9	6.7	108.4	1.140	1.347	18.2
11	10.3	4.2	4.9	7.5	107.2	1.930	1.297	-32.8
12	2.6	4.2	4.9	2.1	106.0	1.160	1.252	8.0
13	8.4	4.2	4.9	3.9	104.8	1.310	1.212	-7.5
14	2.6	4.2	4.9	0.3	103.7	1.210	1.175	-2.9
15	2.2	4.2	4.9	2.1	102.6	1.280	1.140	-10.9
16	5.9	4.2	4.9	3.9	101.6	3.290	1.108	-66.3
17	15.7	4.2	4.9	2.9	100.5	2.430	1.461	-39.9
18	3.1	4.2	4.9	-5.4	99.5	1.850	1.463	-20.9
19	16.0	4.2	4.9	-1.0	101.2	6.850	2.156	-68.5
20	2.5	4.2	4.9	-8.5	101.0	1.680	1.965	16.9
21	4.4	4.2	4.9	-2.5	104.3	1.460	1.622	11.1
22	0.7	4.2	4.9	-0.8	104.4	1.130	1.476	30.6
23	1.0	4.2	4.1	2.0	103.7	6.960	1.370	-80.3
24	5.1	4.2	4.9	3.8	102.6	1.230	1.286	4.5
25	0.6	4.2	4.9	3.5	101.5	1.120	1.220	8.9
26	0.1	4.2	3.5	6.3	100.5	0.960	1.166	21.4
27	0.6	4.2	3.5	9.1	99.5	0.900	1.120	24.4
28	5.5	4.2	4.9	10.9	98.5	1.140	1.080	-5.3
29	0.1	4.2	4.9	10.2	97.5	1.000	1.044	4.4
30	3.1	4.2	4.9	12.0	96.6	1.030	1.012	-1.7
31	23.1	4.2	4.9	13.8	95.6	5.170	4.933	-4.6
TOTAL	160.2	131.1	147.5			60.850	50.683	-16.7

AT END OF MONTH 186

CUMULATIVE VALUES ARE: FLOW= 530.0 PREDICTED= 512.4
VARIANCE= 1416.38 EFFICIENCY= 0.643

STORE CONTENTS ARE: CS= 3.10 DC= 11.8 GS= 94.7

CUMULATIVE VALUE OF: RAIN = 1158.1 EVAP = 682.0 EPRED = 739.8

MONTH 985 TO MONTH 186 INC.

TOTAL RAINFALL (MM) 1158.100

TOTAL FLOW (MM)	OBSERVED	529.97004
	PREDICTED	512.37237
MAX FLOW (MM)	OBSERVED	42.89000
	PREDICTED	33.63205
	DATE -	281085
	PREDICTED	33.63205
	OBSERVED	42.89000
	DATE -	281085
MIN FLOW (MM)	OBSERVED	0.71000
	PREDICTED	1.23386
	DATE -	7 985
	PREDICTED	1.01230
	OBSERVED	1.03000
	DATE -	30 186

ERROR IN TOTAL DISCHARGE = -3.321%

INITIAL VARIANCE = 3970.874
FINAL VARIANCE = 1416.383
EFFICIENCY-EXPLAINED VARIANCE = 0.6433
COEFFICIENT OF VARIATION = 0.878
CORRELATION COEFFICIENT = 80.206%

TOTAL EO = 681.980 TOTAL EPRED = 739.842

OPTIDMOD IN INTERACTIVE MODE

```
 OPTIMISATION PROGRAM

 TYPE OF OPTIMISATION REQUIRED ?
     1=AUTOMATIC PARAMETER SELECTION
     2=INTERACTIVE PARAMETER SELECTION

     2


SPECIFY PARAMETER INPUT TYPE
         0=FROM FILE
         1=FROM CONSOLE
         0

NAME OF PARAMETER FILE  ????????.DAT
A:CDSAC.DAT

Input Catchment Name ?    (<13 Characters)
CUL-DE-SAC

Input Starting month (MMYY)  0985

Input End month      (MMYY)  0186


Input Output Control Selection
           0 ....  Daily values and monthly totals
           1 ....  Monthly totals

     Selection ? 0


NUMBER OF PARAMETERS TO BE OPTIMISED = ? (<9)
                                       4


TIME UNIT FOR OPTIMISATION = ?
    0= DAILY
    2= MONTHLY
    =2
```

```
**********************************************************************
**********************************************************************
***                  INSTITUTE OF HYDROLOGY                        ***
***               CONCEPTUAL MODELLING PACKAGE                     ***
***                                                                ***
***           LOCATION/CATCHMENT-**** CUL-DE-SAC  ****             ***
***             DURATION OF DATA-**** 9 85-- 1  86****             ***
***               DATA FREQUENCY-       DAILY                      ***
**********************************************************************
**********************************************************************

 SS     0        3.1141
 RC     2        0.7303
 RDEL   0        0.2001
 RX     4        2.5910
 RK     0        0.0229
 FC     1        0.6858
 GSU    0       90.4261
 GSP    3        1.6945
 GDEL   0        0.5287


PLEASE TYPE 0=RE-ENTER DATA
            1=CONTINUE
            2=CONTINUE (NO HARD COPY OF ABOVE)
YOUR CHOICE =2


  NAME OF DATA FILE PLEASE ????????.DAT

    A:LUCIA.DAT


                    THE PRINTER WILL RESPOND WITH


          LOWER      UPPER      PARAMETER      OPTIMISING
          LIMIT      LIMIT        VALUE         SEQUENCE

 SS                               3.1141
 RC        0.3652     1.0954      0.7303            2
 RDEL                             0.2001
 RX        1.2955     3.8865      2.5910            4
 RK                               0.0229
 FC        0.3429     1.0287      0.6858            1
 GSU                             90.4261
 GSP       0.8472     2.5418      1.6945            3
 GDEL                             0.5287


                          INPUT FILE CHOSEN =

                          **A:LUCIA.DAT **
```

VARIANCE, FLOW AND ACTIVE PARAMETERS
****

SUM = 529.9701

F	SUMP	SUMP-SUM	FC	RC	GSP	RX
2479.8037	514.5983	-15.3717	0.6858	0.7303	1.6945	2.5910
2259.1233	519.6285	-10.3415	0.6966	0.7303	1.6945	2.5910
2274.7673	513.3919	-16.5782	0.7127	0.7303	1.6945	2.5910
2264.2479	516.7434	-13.2266	0.7040	0.7303	1.6945	2.5910
2130.8504	520.3051	-9.6649	0.6966	0.7418	1.6945	2.5910
1945.7803	521.3332	-8.6369	0.6966	0.7589	1.6945	2.5910
1685.4126	522.9012	-7.0688	0.6966	0.7846	1.6945	2.5910
1335.8606	525.2968	-4.6733	0.6966	0.8225	1.6945	2.5910
906.6062	528.9263	-1.0437	0.6966	0.8773	1.6945	2.5910
470.1426	533.3205	3.3505	0.6966	0.9521	1.6945	2.5910
189.9576	538.5828	8.6127	0.6966	1.0397	1.6945	2.5910
147.1225	542.1248	12.1547	0.6966	1.0954	1.6945	2.5910
319.5919	535.5215	5.5514	0.6966	0.9894	1.6945	2.5910
146.7442	541.9887	12.0186	0.6966	1.0933	1.6945	2.5910
146.7636	541.8224	11.8524	0.6966	1.0933	1.7211	2.5910
146.8445	542.1585	12.1885	0.6966	1.0933	1.6679	2.5910
146.7376	541.9321	11.9620	0.6966	1.0933	1.7035	2.5910
149.8560	541.9394	11.9694	0.6966	1.0933	1.7035	2.6317
143.9369	541.9245	11.9545	0.6966	1.0933	1.7035	2.5503
140.1024	541.9125	11.9424	0.6966	1.0933	1.7035	2.4894
150.2220	540.1501	10.1801	0.6966	1.0933	1.7035	2.3984
140.2760	541.9131	11.9431	0.6966	1.0933	1.7035	2.4922

1 ITERATIONS OF OPTIMISATION COMPLETED
22 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 140.102371
****

139.9639	541.9072	11.9371	0.6967	1.0938	1.7036	2.4883
139.7599	541.8882	11.9182	0.6969	1.0945	1.7037	2.4866
139.4380	541.8356	11.8656	0.6971	1.0952	1.7040	2.4842
138.8714	541.7015	11.7314	0.6975	1.0954	1.7043	2.4805
137.8631	541.3765	11.4065	0.6981	1.0937	1.7048	2.4750
138.9060	540.3804	10.4103	0.6990	1.0869	1.7055	2.4668
137.6288	541.2765	11.3064	0.6982	1.0930	1.7049	2.4737
139.0371	541.8386	11.8685	0.6967	1.0930	1.7049	2.4737
136.3602	540.7155	10.7455	0.6998	1.0930	1.7049	2.4737
134.7269	539.8753	9.9053	0.7021	1.0930	1.7049	2.4737
132.8819	538.6179	8.6478	0.7056	1.0930	1.7049	2.4737
131.4554	536.7386	6.7686	0.7108	1.0930	1.7049	2.4737
132.4473	533.9261	3.9561	0.7185	1.0930	1.7049	2.4738
131.3538	536.0741	6.1040	0.7126	1.0930	1.7049	2.4737
136.5403	535.4123	5.4422	0.7126	1.0931	1.7073	2.4469
133.0565	536.0915	6.1214	0.7126	1.0930	1.7025	2.5006
131.7798	536.0786	6.1085	0.7126	1.0930	1.7043	2.4805
131.3558	536.0732	6.1031	0.7126	1.0930	1.7050	2.4738
131.3516	536.0751	6.1050	0.7126	1.0930	1.7047	2.4737
131.3486	536.0766	6.1065	0.7126	1.0930	1.7045	2.4737
131.3443	536.0789	6.1088	0.7126	1.0930	1.7043	2.4736
131.3378	536.0822	6.1121	0.7126	1.0930	1.7038	2.4735
131.3278	536.0872	6.1172	0.7126	1.0930	1.7031	2.4734
131.3135	536.0947	6.1247	0.7126	1.0930	1.7021	2.4732
131.3518	536.1001	6.1301	0.7126	1.0930	1.7006	2.4729
131.3140	536.0943	6.1243	0.7126	1.0930	1.7022	2.4732

2 ITERATIONS OF OPTIMISATION COMPLETED
48 FUNCTION CALCULATIONS SO FAR
FUNCTION VALUE IS NOW 131.313517
****

OPTIMISED PARAMETER VALUES

FC	0.7126
RC	1.0930
GSP	1.7021
RX	2.4732

MONTH: 985

DAY	RAIN	EVAP	EPRED	DEF	GSTORE	RUNOFF	PRUN	ERROR %
1	8.3	5.0	5.4	2.7	111.4	1.430	1.443	0.9
2	6.1	5.0	5.4	-0.2	110.0	1.370	1.412	3.0
3	1.1	5.0	5.4	-0.9	108.7	1.150	1.382	20.2
4	4.9	5.0	5.4	1.8	107.7	0.890	1.358	52.6
5	0.0	5.0	5.4	2.3	106.4	0.810	1.334	64.7
6	3.0	5.0	5.3	4.6	105.1	0.760	1.306	71.8
7	10.5	5.0	5.4	6.8	103.8	0.710	1.279	80.1
8	1.3	5.0	5.4	1.6	102.5	1.120	1.252	11.8
9	2.6	5.0	5.4	3.9	101.3	0.730	1.226	68.0
10	0.5	5.0	5.3	6.1	100.1	0.740	1.201	62.3
11	8.8	5.0	5.4	8.4	98.9	1.130	1.177	4.2
12	27.8	5.0	5.4	4.9	97.7	21.250	14.431	-32.1
13	31.1	5.0	5.4	-0.9	96.6	6.060	20.614	240.2
14	15.0	5.0	5.4	-6.5	95.5	4.340	5.347	23.2
15	6.9	5.0	5.4	-10.4	97.5	3.330	1.318	-60.4
16	4.2	5.0	5.4	-6.7	101.5	1.710	1.338	-21.8
17	0.4	5.0	5.4	-2.2	103.7	1.310	1.374	4.9
18	0.4	5.0	4.0	2.1	103.5	1.240	1.375	10.9
19	0.0	5.0	3.8	5.5	102.3	1.060	1.345	26.9
20	1.5	5.0	4.4	8.4	101.0	1.090	1.307	19.9
21	1.9	5.0	5.4	10.6	99.8	1.040	1.271	22.3
22	6.2	5.0	5.4	12.8	98.7	1.320	1.239	-6.1
23	8.9	5.0	5.4	12.0	97.5	1.730	1.209	-30.1
24	8.3	5.0	5.4	8.5	96.4	1.570	1.180	-24.8
25	0.5	5.0	5.4	5.5	95.2	1.120	1.153	2.9
26	4.2	5.0	5.4	7.7	94.2	1^C		

etc.

OPTIDMOD, INTERACTIVE MODE, READING FROM CONSOLE

```
 OPTIMISATION PROGRAM

 TYPE OF OPTIMISATION REQUIRED ?
     1=AUTOMATIC PARAMETER SELECTION
     2=INTERACTIVE PARAMETER SELECTION

     2


SPECIFY PARAMETER INPUT TYPE
          0=FROM FILE
          1=FROM CONSOLE
          1

Input Catchment Name ?    (<13 Characters)
CUL-DE-SAC

Input Starting month (MMYY)  0985

Input End month      (MMYY)  0186


Input Output Control Selection
            0 ....  Daily values and monthly totals
            1 ....  Monthly totals

      Selection ? 1


NUMBER OF PARAMETERS TO BE OPTIMISED = ? (<9)
                                       4


TIME UNIT FOR OPTIMISATION = ?
     0= DAILY
     2= MONTHLY
     =0
```

```
MODEL REQUIRES 9 PARAMETERS WITH THEIR ORDER OF OPTIMISATION (N)
TYPE VALUES UNDER TITLES

        N     PARAMETER

SS      0      3.1

RC      4     0.7

RDEL    0      0.2

RX      0   2.6

RK      0     0.1

FC      2     0.7

GSU     0      90.4

GSP     3     1.7

GDEL    1 0.5


            INPUT DATA ARE AS FOLLOWS:

     **********************************************************************
     **********************************************************************
     ***                  INSTITUTE OF HYDROLOGY                        ***
     ***               CONCEPTUAL MODELLING PACKAGE                     ***
     ***                                                                ***
     ***           LOCATION/CATCHMENT-**** CUL-DE-SAC  ****             ***
     ***             DURATION OF DATA-**** 9 85-- 1  86****             ***
     ***               DATA FREQUENCY-       DAILY                      ***
     **********************************************************************
     **********************************************************************

  SS     0        3.1000
  RC     4        0.7000
  RDEL   0        0.2000
  RX     0        2.6000
  RK     0        0.1000
  FC     2        0.7000
  GSU    0       90.4000
  GSP    3        1.7000
  GDEL   1        0.5000


PLEASE TYPE 0=RE-ENTER DATA
            1=CONTINUE
            2=CONTINUE (NO HARD COPY OF ABOVE)
YOUR CHOICE =2


   NAME OF DATA FILE PLEASE ????????.DAT

     A:LUCIA.DAT
```

THE PRINTER WILL RESPOND WITH

	LOWER LIMIT	UPPER LIMIT	PARAMETER VALUE	OPTIMISING SEQUENCE
SS			3.1000	
RC	0.3500	1.0500	0.7000	4
RDEL			0.2000	
RX			2.6000	
RK			0.1000	
FC	0.3500	1.0500	0.7000	2
GSU			90.4000	
GSP	0.8500	2.5500	1.7000	3
GDEL	0.2500	0.7500	0.5000	1

INPUT FILE CHOSEN =

**A:LUCIA.DAT **

VARIANCE, FLOW AND ACTIVE PARAMETERS
****

SUM = 529.9701

F	SUMP	SUMP-SUM	GDEL	FC	GSP	RC
1368.7644	510.1229	-19.8471	0.5000	0.7000	1.7000	0.7000
1362.0774	519.3023	-10.6677	0.5079	0.7000	1.7000	0.7000
1362.1863	519.2741	-10.6960	0.5196	0.7000	1.7000	0.7000
1362.1307	519.2885	-10.6815	0.5136	0.7000	1.7000	0.7000

etc.

APPENDIX

The Model

A general introduction to the use of this type of conceptual model and its calibration is given by Blackie and Eeles (1985). The model which has been mounted in this package is a daily version of the larger model described by them, and it has the number of parameters reduced to nine for simplicity of operation. The number of stores in the model conceptual structure is four: the vegetation and surface detention store, the soil store, groundwater and channel routing stores. The model is an abstraction and so a simplification of the real world processes of the basin being simulated. Therefore the absolute values of the store contents and parameters should be regarded with caution.For irrigation purposes the changes in soil moisture deficit are probably a reasonable guide to the behaviour of the depth of the soil profile over the basin, but do not refer to any particular depth or point within the basin.

The contents of the groundwater store are used in an expression to represent the storage release of an aquifer if present in the basin, or, if not, possibly a secondary storage within the soil profile. However, this store does tend to accumulate the residual errors associated with the other stores, and its output would need comparison with base flow from the catchment over a number of years if any reliance were to be placed on it.

The model is so designed that for reasonable results all runs must be started in a dry period. This allows the interception and channel routing stores to be initially empty, the soil moisture deficit to be positive, and the simulated basin outflow to be in recession with only the baseflow component. This is particularly important for short periods of data as the starting conditions will considerably influence the first two or three months of prediction. For longer data sets (of greater than one year) the starting conditions are of much less importance.

Model Parameters

SS : Size of the vegetation interception and surface detention store in mm...(>0, approx 2) < 5

FC : Penman open water evaporation factor...(<1, approx 0.7) > 0.3

RC : Surface runoff partitioning factor...(<1) > 0

RX : Channel routing store index...(>1)

RK : Channel routing store factor. > 0 ≤ 1

RDEL : Channel routing delay in days. ≥ 0

GSU : Denominator of groundwater store contents in runoff expression. > 30

GSP : Power to which the above fraction is raised...(>1)

GDEL : The groundwater runoff delay...( ) >0

The values in brackets provide necessary bounds to the parameters and, in some cases, suggested approximate values for the parameters. These values should be born in mind when optimising.

Optimisation of the model parameters

The calibration of the model is carried out in three stages after the initial selection of likely parameter values. The optimisation strategy is that the first of these stages is carried out using the model in a 'monthly' mode to obtain a good estimate of flow. This mode is the summation of daily values over the month. Its use is to set a realistic model structure for the second stage which is undertaken at the daily frequency to optimise the parameters for shaping the predicted hydrograph. The final optimisation run acts as a 'fine tuning' of the volume parameters at the daily frequency. The parameters fitted in these three stages are shown below :-

OTIMISATION ORDER	MONTHLY DATA	DAILY DATA	DAILY DATA
1	FC	RX	GDEL
2	GSP	RK	FC
3	RC	RDEL	GSP
4	SS	GSU	RC

If the "AUTOMATIC" option is chosen in OPTIDMOD this sequence of runs is carried out without operator intervention.

The optimisation algorithm is based on the Rosenbrock rotation of axes technique, and it is fully discussed in Blackie and Eeles(1985). The parameters are scaled using a sine squared function, the amplitude of which is determined by using upper and lower bounds. These constraints are obtained by multiplication of the parameter initial value by an upper or lower factor. The convergence of the algorithm is reached when the scaled value of each parameter is changed by less than one percent.Each iteration is dependent on the success in obtaining a new 'low' in the objective function on each axis. The objective function used is the sum of squares obtained by:-

Summation of n values of (Qo-Qp)squared

where Qo is the observed flow
Qp is the predicted flow
n is the number of days in the calibration period.

Additional notes

PREDMOD requires values of the baseflow prior to the prediction period to provide starting values for the store contents. There is a choice of 'HIGH', 'MEDIUM' or 'LOW'. Ideally the prediction should be started in the low flow season and the low baseflow should be chosen, but if the starting date is at any other time the operator must choose a baseflow representative of the likely conditions.OPTIDMOD ignores this value which specifies the type of baseflow recession expected just prior to a prediction run.

This is merely to provide a starting value for the model stores. The prediction runs should be started in the dry season with the low baseflow input. Optimisation should be carried out on a minimum of one water year of data.

Contents of Disk

The disk provided contains the files:

OPTIDMOD.EXE
PREDMOD.EXE
CDSAC.DAT
LUCIA.DAT
MANUAL.DOC

OPTIDMOD and PREDMOD are executable versions of the programs. CDSAC.DAT and LUCIA.DAT are example data files which you may wish to copy to a disk for use on the A: disk drive. The files TEMP and OUT will be used on disk drive A:. If they do not allready exist the program will create them.A: disk drive. 'TEMP' is used as work space for the optimisation program and 'OUT' will contain the daily flows when the prediction program is used.

MANUAL.DOC is a wordstar document file which contains the text parts of the manual provided. It does not contain the worked examples.You can obtain copies using your own version of wordstar.

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The Institute of Hydrology is a component establishment of the Natural Environment Research Council