1. **Upper Wardha Optimization for RCP-4.5 for Case 1**

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /56000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/



Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
```

```
*_____________________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
*                 STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                 STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                 INISTO         INITIAL RESERVOIR STORAGE
                 PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                 EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                 RELMAX(T)      RELEASE RATE CONSTRAINT
                 RELMIN(T)      MINIMUM RELEASE RATE
                 MINRES(T)      MINIMUM RESERVOIR STORAGE
                 MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                 OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;

*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___

FILE Release /UW45ReleaseC1.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*

FILE Storage /UW45StorageC1.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

2. Upper Wardha Optimization for RCP-4.5 for Case 2

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /56000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/



Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
```

```
*_____________________________________________________________________
___
EQUATIONS          MASSBAL(T)      MASS BALANCE FOR EACH PERIOD
*                   STOMAX(T)       UPPER LIMIT OF RESERVOIR
STORAGE
*                   STOMIN(T)       LOWER LIMIT OF RESERVOIR
STORAGE
                   INISTO          INITIAL RESERVOIR STORAGE
                   PRECIP(T)       VOLUMETRIC DAILY PRECIPITATION
                   EVAPOR(T)       VOLUMETRIC DAILY EVAPORATION
                   RELMAX(T)       RELEASE RATE CONSTRAINT
                   RELMIN(T)       MINIMUM RELEASE RATE
                   MINRES(T)       MINIMUM RESERVOIR STORAGE
                   MAXRES(T)       MAXIMUM RESERVOIR STORAGE
                   OBJECTIVE       OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;

*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___

FILE Release /UW45ReleaseC2.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*

FILE Storage /UW45StorageC2.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

3. Upper Wardha Optimization for RCP-4.5 for Case 3

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /112000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha45in1.xlsx o=parQ.inc
$include parQ.inc
;
*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
*                 STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
```

```
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________
___
FILE Release /UW45ReleaseC3.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /UW45StorageC3.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________
___
```

4. Upper Wardha Optimization for RCP-4.5 for Case 4

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /112000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/



Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
```

```
*_____________________________________________________________________
___
EQUATIONS         MASSBAL(T)      MASS BALANCE FOR EACH PERIOD
*                  STOMAX(T)       UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)       LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO          INITIAL RESERVOIR STORAGE
                  PRECIP(T)       VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)       VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)       RELEASE RATE CONSTRAINT
                  RELMIN(T)       MINIMUM RELEASE RATE
                  MINRES(T)       MINIMUM RESERVOIR STORAGE
                  MAXRES(T)       MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE       OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;

*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___

FILE Release /UW45ReleaseC4.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*

FILE Storage /UW45StorageC4.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

5. Upper Wardha Optimization for RCP-8.5 for Case 1

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /56000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/



Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
```

```
*_____________________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
*                 STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                 STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                 INISTO         INITIAL RESERVOIR STORAGE
                 PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                 EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                 RELMAX(T)      RELEASE RATE CONSTRAINT
                 RELMIN(T)      MINIMUM RELEASE RATE
                 MINRES(T)      MINIMUM RESERVOIR STORAGE
                 MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                 OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;

*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___

FILE Release /UW85ReleaseC1.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*

FILE Storage /UW85StorageC1.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

6. Upper Wardha Optimization for RCP-8.5 for Case 2

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /56000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha85in1.xlsx o=parQ.inc
$include parQ.inc
;
*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /UW85ReleaseC2.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /UW85StorageC2.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

7. Upper Wardha Optimization for RCP-8.5 for Case 3

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /112000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);
*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /UW85ReleaseC3.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /UW85StorageC3.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

8. Upper Wardha Optimization for RCP-8.5 for Case 4

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /504000000/

*Maximum allowable storage- 90% of the capacity of the Upper
Wardha Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /112000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /470000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=upperwardha85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /UW85ReleaseC4.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /UW85StorageC4.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

9. Isapur Optimization for RCP-4.5 for Case 1

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /96000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID45ReleaseC1.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID45StorageC1.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

10. Isapur Optimization for RCP-4.5 for Case 2

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /96000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID45ReleaseC2.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID45StorageC2.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

11. Isapur Optimization for RCP-4.5 for Case 3

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /192000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID45ReleaseC3.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID45StorageC3.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

12. Isapur Optimization for RCP-4.5 for Case 4

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /192000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur45in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID45ReleaseC4.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID45StorageC4.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

13. Isapur Optimization for RCP-8.5 for Case 1

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /96000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID85ReleaseC1.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID85StorageC1.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

14. Isapur Optimization for RCP-8.5 for Case 2

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /96000000/

*Minimum allowable storage will be 10% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID85ReleaseC2.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID85StorageC2.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

15. Isapur Optimization for RCP-8.5 for Case 3

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /192000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I3');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID85ReleaseC3.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID85StorageC3.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```

16. Isapur Optimization for RCP-8.5 for Case 4

```
SETS     T TIME INDEX   /T1*T18264/
         I INPUT INDEX  /I1*I3/
* INDEX I1 = DAILY INFLOW TO THE RESERVOIR (M^3/DAY)
*       I2 = DAILY PRECIPITATION (M/DAY)
*       I3 = DAILY EVAPORATION RATE (M/DAY)
*_____________________________________________________________
___
SCALAR STU  UPPER LIMIT OF RESERVOIR STORAGE IN M^3 /768000000/

*Maximum allowable storage- 80% of the capacity of the Isapur
Reservoir

       STL  LOWER LIMIT OF RESERVOIR STORAGE IN M^3 /192000000/

*Minimum allowable storage will be 20% of the capacity of the
reservoir

       K    INITIAL RESERVOIR STORAGE IN M^3        /680000000/

Table Q(T,I) DAILY FORCING (M^3 per DAY)
$call =xls2gms r=A1:D18264 i=isapur85in1.xlsx o=parQ.inc
$include parQ.inc
;

*_____________________________________________________________
___
VARIABLES ST(T)   STORAGE OF RESERVOIR AT TIME T (M^3)
          R(T)    DAILY EXCESS RELEASE (M^3)
          ELE(T)  WATER SURFACE ELEVATION (M)
*          SA(T)   RESERVOIR SURFACE AREA (M^2)
          P(T)    VOLUMETRIC DAILY PRECIPITATION (M^3)
          E(T)    VOLUMETRIC DAILY EVAPORATION (M^3)
          OBJ     OBJECTIVE: SUM OF ALL RELEASES   ;

POSITIVE VARIABLE        ST(T);
POSITIVE VARIABLE        R(T);
POSITIVE VARIABLE        ELE(T);
POSITIVE VARIABLE        SA(T);
POSITIVE VARIABLE        P(T);
POSITIVE VARIABLE        E(T);

*_____________________________________________________________
___
EQUATIONS        MASSBAL(T)     MASS BALANCE FOR EACH PERIOD
```

```
*                  STOMAX(T)      UPPER LIMIT OF RESERVOIR
STORAGE
*                  STOMIN(T)      LOWER LIMIT OF RESERVOIR
STORAGE
                  INISTO         INITIAL RESERVOIR STORAGE
                  PRECIP(T)      VOLUMETRIC DAILY PRECIPITATION
                  EVAPOR(T)      VOLUMETRIC DAILY EVAPORATION
                  RELMAX(T)      RELEASE RATE CONSTRAINT
                  RELMIN(T)      MINIMUM RELEASE RATE
                  MINRES(T)      MINIMUM RESERVOIR STORAGE
                  MAXRES(T)      MAXIMUM RESERVOIR STORAGE
                  OBJECTIVE      OBJECTIVE FUNCTION;

MASSBAL(T)..ST(T+1)=L=ST(T)+Q(T,'I1')-R(T)+P(T)-E(T);
INISTO..ST('T1')=E=K;
PRECIP(T)..P(T)=E=0;
EVAPOR(T)..E(T)=E=0;
RELMAX(T)..R(T)=L=Q(T,'I2');
RELMIN(T)..R(T)=G=0;
MINRES(T)..ST(T)=G=STL;
MAXRES(T)..ST(T)=L=STU;
OBJECTIVE..SUM(T,R(T))=E=OBJ;
*_____________________________________________________________________
___
MODEL MAXRELEASE /ALL/;
SOLVE MAXRELEASE USING LP maximizing OBJ;
*_____________________________________________________________________
___
FILE Release /ID85ReleaseC4.csv/
PUT Release
*PUT 'Daily Release (m^3/day)', PUT/
LOOP(T, PUT R.l(T), PUT/)
*
FILE Storage /ID85StorageC4.csv/
PUT Storage
*PUT 'Daily Precipitation (m^3)', PUT/
LOOP(T, PUT ST.l(T), PUT/)
*_____________________________________________________________________
___
```