RESERVOIR OPERATION SIMULATION (EXTENDED) SYSTEM

- ROSES - Version 3.00

User Manual

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FORWARD

As part of a consultancy project undertaken by IIMI for the participatory Rural Development Project in the N.C.P. assisted by the International Fund for Agricultural Development, IIMI has developed a Reservoir Operation Simulation Model called "Reservoir Operation Simulation (Extended) System - ROSES".

This software package is designed to simulate the operation of water systems on a daily basis. The objective of the system is to provide a tool for water resources experts to use in analysing irrigation and hydrological aspects of river basins.

The simulation model was applied to more than 100 cascades (sub-watersheds) in the N.C.P. IIMI has now developed a users' manual for the simulation model. The users' manual has been prepared by Mr. Thejaka Usgoda Arachchi and his colleagues to train the irrigation professionals working in the N.C.P. The users' manual will be useful for others who may wish to use this simulation model.

Dr. Douglas J. Merrey
Leader, Sri Lanka National Program

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Research based study on development of a water resource simulation model for Area Development Project - North Central Province

Reservoir Operation Simulation (Extended) System - ROSES 3.00

User Manual

1.0 Introduction

The Reservoir Operation Simulation (Extended) System (ROSES) is a software package designed to simulate the operation of water resource systems on a daily basis. The version 3.00 has all the capabilities of earlier versions and the new version is a much improved with more capabilities. The software model was developed on the findings of a research based study carried out for the Area Development Project in the North Central Province. The objective of developing this system is to provide a tool for the water resource experts which could be used in analyzing the hydrological and irrigation aspects of water resource systems.

The system has been designed to handle the following 3 major functional areas in water resource systems analysis.

1. Isolated Tank Watershed Analysis
2. Cascade Watershed Analysis
3. Basin Watershed Analysis (Integrated Cascade Operation)

1.1 Isolated Tank Watershed Analysis

The operation of a single reservoir is analyzed under given operational situations. Various inflows to the reservoir, outflows from reservoir as well as all forms of water losses from reservoir are calculated using basic input data given to the system. The water balance of the particular reservoir is calculated at each time step.

1.2 Cascade Watershed Analysis

The model has the capability to analyze the system of reservoirs operating in cascade. The model could be used to analyze cascade systems with no limitations to the number of reservoirs and their physical characteristics. The integrated operation of the system is analyzed at each time step and for any time period. By calculating various inflows, outflows and losses to each reservoir the water balance of each reservoir is calculated in order to obtain the resultant status of reservoirs at each time step. In cascade operation the surplus water spilled through the spillways and the feeder canal releases from a particular reservoir are input to the down stream reservoir.

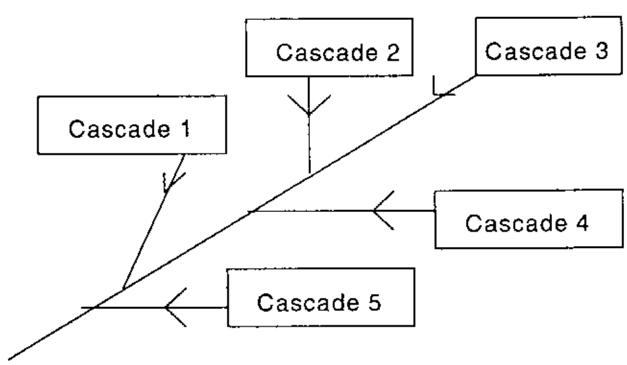
In analyzing such a cascade system the whole system of reservoirs is treated one by one in a determined order to obtain the water balance of each reservoir considering their interactive operation.

In this process, as an obvious rule built into the software system, any reservoir is analyzed only after analyzing all the upstream reservoirs which contribute water through waterways to the particular reservoir.

1.3 Basin Watershed Analysis

Several cascades can be combined to form a complete basin. In otherwords, the basins could be sub divided into several sub cascade systems. These sub cascade systems could be analyzed separately to obtain the reservoir operation status as well as water outflows from such cascades. Then these cascades can be combined resulting in a complete basin watershed. Therefore in this form of analysis, the resultant status of component sub systems which forms the basin, is used in analyzing the combined cascade (basin) watershed.

The analysis procedure is similar to the procedure used in isolated cascade watershed analysis, except that several such cascades are treated separately in a determined order with defined interactions between them.



The status of each reservoir in the basin system is obtained. The subdivision is only a method used to simplify the process. As an alternative method to this, the whole basin could be considered as a single cascade. But this method will complicate the process, since all the reservoirs in the basin should be defined to a single model resulting in increased number of nodes and links in the model. A description about the node-link model is given in in the next section.

2.0 Input to ROSES

2.1 Modeling method

The widely accepted node-link modeling method of water resource simulation is used. Each hydrologically important structure is a node in the model. The water conveyance system such as canals, streams are considered as links. A link connects two nodes. The model could consists of following node types.

1. Start node (hypothetical)
2. Reservoirs
3. Diversions
4. Confluences
5. Cross regulators
6. Lateral feeders
7. End (Terminating) nodes (hypothetical)

The start node is a hypothetical structure used in the node-link model to account for the virgin flows or lumped flows into a particular cascade.

Also the hypothetical node named end (terminating) node is used to associate the final outflows from the extreme end of the cascade. The nodes and links are numbered for reference purposes.

The initial step of modeling a cascade system is the translation of the physical system to the node-link model used in the software system. In this translating process, it is important to identify all the nodes and links of the physical system. After identifying all the nodes and links, numbering of nodes and links should be done. Node numbers are used to define nodes and there is no order of numbering nodes. Each link is reprecented by a number. After numbering all the nodes and links, the data related to each node and link in the model should be input to the software system. Data required to define a node in the model differs depending on the type of the node.

In addition to the sequential numbering the nodes and links, more descriptive ids and descriptions of each node should be given as inputs to represent other characteristic and parametric data.

Out of the node types 1 - 7 listed above, the reservoir node the most important node type in the model, requires a higher number of input data items.

Refer the sample node link model given in annexure I.

2.2 Method of feeding data into ROSES

Each cascade has a separate node link structure. Each cascade must be fed into the system separately and must be saved in different file names.

Note :

To make a basin from relevant cascades there are some interactions maintained in-between cascades and it is described under Interaction Data topic.

Input data of a cascade is organized in the following order.

Nodes data	-	All data related to the nodes of the node link structure.
Links data	-	Data about links which are connecting nodes.
Interaction data	-	Data about interactions in-between cascades.
Rainfall data	-	Data about rainfall measuring stations.
Reserv. curves	-	Reservoir curves for each reservoir.
Gauging stations	-	Data about gauge measuring stations.
Daily data	-	Collected daily data. (E.g. rainfall data, gauge readings)
Crop water table	-	Crop water requirement table.
Eva-trans. table	-	Each month evapotranspiration coefficients.
Eva-coefficients	-	Each month evaporation coefficients.
XY coordinates	-	X Y coordinates for each node.
Yield cal.method	-	Yield calculation method for all reservoirs in the model.

2.2.1 Nodes data

This contains all data related to the nodes of the node link structure of the current cascade. There are seven types of nodes.

Start node
Reservoir
Diversion
Flow confluence
Lateral feeder
Cross regulator
End node

2.2.1.1 Start node

Start node is a hypothetical structure used in the node link model. Following data can be input for start nodes.

a). Node number
b). Node Id.
c). Node description
d). Virgin or feeder inflow
e). Inflow gauge id

Note :

d) and e) are used only when there are virgin flows or lumped inflows from the start node to the cascade.

2.2.1.2 Reservoir node

Reservoir node is the most important node type in the node link model. Following data can be input for reservoir nodes.

a). Node number
b). Node type
c). Node id
d). Node description
e). Reservoir curve definition (formula / discrete)
f). Formula for direct rainfall

Format : coefficient * (rainfall station no.)

E.g. : The formula to get the half of the rainfall from the rainfall station no. 1 is 0.5*(1) g). Inflows

These are used only when inflows to the reservoir are measured with using gauges or otherwise keep them as blanks.

h). Operating levels (ft)
FSL (full supply level)
MDL (minimum draw down level)

i). Storage levels (Acft)
FSL (full supply level)
MDL (minimum draw down level)

j). Initial level (ft)
Starting level of the reservoir.

k). Spill gauge id

Only if spill is measured with using a gauge and gauge measures are available, otherwise keep it as a blank.

l). Command area (Ac)

m). Reservoir level gauge id.

Only if level is measured with using a gauge and gauge measures are available, otherwise keep it as a blank.

n). Release calculation method
One from the following list
Cropwater
Target
Actual

o). Release outlets (irrigation)

If release calculation method is cropwater, only one release is considered and no need to fill release outlets. If release calculation method is target, release outlets must be filled with target gauge ids and priority levels. If release calculation method is actual, release outlets must be filled with actual gauge ids.

Note :

Refer calculation procedure for more details.

p). Feeder releases

If release calculation method is actual or target then, actual or target gauge ids should be specified with priority order respectively.

Note :

Refer calculation procedure for more details.

q). Evaporation loss coefficient

r). Seepage loss coefficient

s). Yield calculation method
One from the following list
Iso-yield opproach
Maha kanamulla research study
Thirappane study
Walagambahuwa study
DANIDA study
Nachchaduwa / Kalawewa study
User define

t). Unknown variable

Selection of the unknown variable from the water balance equation variables.

$$Inflow1 + Inflow2 + Inflow3 + Rainfall = Outflow1 + Outflow2 + Outflow3 + Release1 + Release2 + Release3 + Storage$$

u). Crop pattern table (planned)

This table contains area (Acft) irrigated and starting date of irrigation upstream and down stream of reservoir for each crop.

v). Catchment area table

Catchment areas (Acft) for the reservoir and their influence coefficients.

2.2.1.3 Diversion

Following data can be input for diversion nodes.

a). Node number
b). Node type
c). Node id
d). Node description
e). Diversion factor
f). Release gauge id
g). Right link gauge id
h). Left link gauge id

2.2.1.4 Flow confluence

Following data can be input for flow confluence nodes.

a). Node number
b). Node type
c). Node id
d). Node description
e). Inflows to node

Only when inflows to the node are controlled using gauges and gauge readings are available.

f). Release flow (MCM) and release gauge id
g). Total outflow and outflow gauge id

Note :

f) and g) are used only when these gauges are available and are measured.

2.2.1.5 Lateral feeder

Lateral Feeder node is used to measure feeder flows. Following data can be input for lateral feeder nodes.

a). Node number
b). Node type
c). Node id
d). Node description
e). Lateral feeder gauge id

Only when this gauge is available and is measured.

2.2.1.6 Cross regulator

Following data can be input for cross regulator nodes.

a). Node number
b). Node type
c). Node id
d). Node description
e). Release gauge id
    Gauge which measures the releases.
f). Lateral feeder gauge id

2.2.1.7 End node

End node is a hypothetical structure used in the node link model to associate the final outflows from the extreme ends of the cascades. Following data can be input for end nodes.

a). Node number
b). Node type
c). Node id
d). Node description

2.2.2 Links data

Links data contains data about connections in-between nodes of the current cascade. Each link definition has following data.

a). Link number
b). Link id
c). Link description
d). Start (left) node number
e). End (right) node number
f). Maximum capacity (Acft)
    Default value is zero.
g). Flow correction factor
    Default value is zero.
h). Time delay through link
    Default value is zero.
I). Category
    This can take 0,1,2,3 values which are effecting the color of the current link in the model diagram. This feature can be used to mark special links.
    0 - Blue color
    1 - green color
    2 - White color
    3 - Black color

2.2.3 Interaction data

Interaction data contains interactions between current cascade and others in the basin. Only inflow interactions are considered for the current cascade. Each interaction contains following data.

a). To Node no.
    The start node number of the current cascade which is having interaction connecting to end node.

b). From Cascade id and Node no.
The linking cascade id and the linking end node number.

c). Analyze (Y/N)
Y - Need to analyze the linked cascade before analyze the current cascade.
N - No need to analyze the linked cascade, use outputs from the previous process of the linked cascade.

2.2.4 Rainfall data

Rainfall data contains data of rainfall stations for the cascade. Each rainfall station definition has following data.

a). Station no.
b). Station id.
c). Description
d). Rainfall station coverage area

Note :
d) is not necessary.

2.2.5 Reservoir curves

Reservoir curves can be as formula or table (discrete) format. There is a separate curve for each reservoir. Curve type can be defined at reservoir node definition.

Formula type

There are two types of formulas.

Polynomial - A(h -h0)^B + C
Linear - A(h -h0)+B

All A,B,C,h,h0 must be supplied.

Table type

The table is used to make the relationship between height, area and capacity. Therefore it consists of 3 columns.

Height, Area, Capacity.

2.2.6 Gauging stations

Gauging stations for the cascade can be defined if they are available.
Each gauge has

Station no
Station id
Station description

Each gauge may cover several openings. There are 5 types of openings.

Circular gated
Square gated
Radial gated
weir gated
overflow structure

2.2.7 Daily data

Daily data for a cascade contains data collected daily from the field. Those data are of 3 types.

Rainfall data
Gauge data
Target data

2.2.7.1 Rainfall data

Rainfall data contains daily rainfall for each station in millimeters.

2.2.7.2 Gauge data

Gauge data contains daily readings of gauges. Each data set has the following data items.

a). Observation date
b). Gauging station id
c). Opening number
d). Height - meter reading (mm)
e). Upstream water level (mm)
f). Downstream water level (mm)
g). Time

2.2.7.3 Target data

These data contains daily targets of gauges for irrigation releases. Each data set has following data items.

a). Observation date
b). Gauging station id
c). Opening number
d). Flow (Acft)

2.2.8 Crop water table

Crop water table contains crop water requirement details for each crop which are cultivated in the current cascade. For each crop the following data items are required.

Initial stage	-	Days and Kc value
Develop stage	-	Days and Kc value
Mid stage	-	Days and Kc value
Late stage	-	Days and Kc value

2.2.9 Evapo-transpiration table

Evapo-transpiration table contains ET0 coefficients for each month for the current cascade.

2.2.10 Evaporation coefficient table

Evaporation coefficient table contains evaporation coefficients for each month for the current cascade.

2.2.11 X Y Coordinates

X Y Coordinates are used to represent the cascade in graphical form according to the node link structure drawn for the cascade.

This table contains,

Node number

XY coordinate values

2.2.12 Yield calculation method

This can be used to change the yield calculation method of all reservoirs in the cascade. One from the following list can be selected.

Iso yield curve method

Maha kana mulla method

Thirappane study method

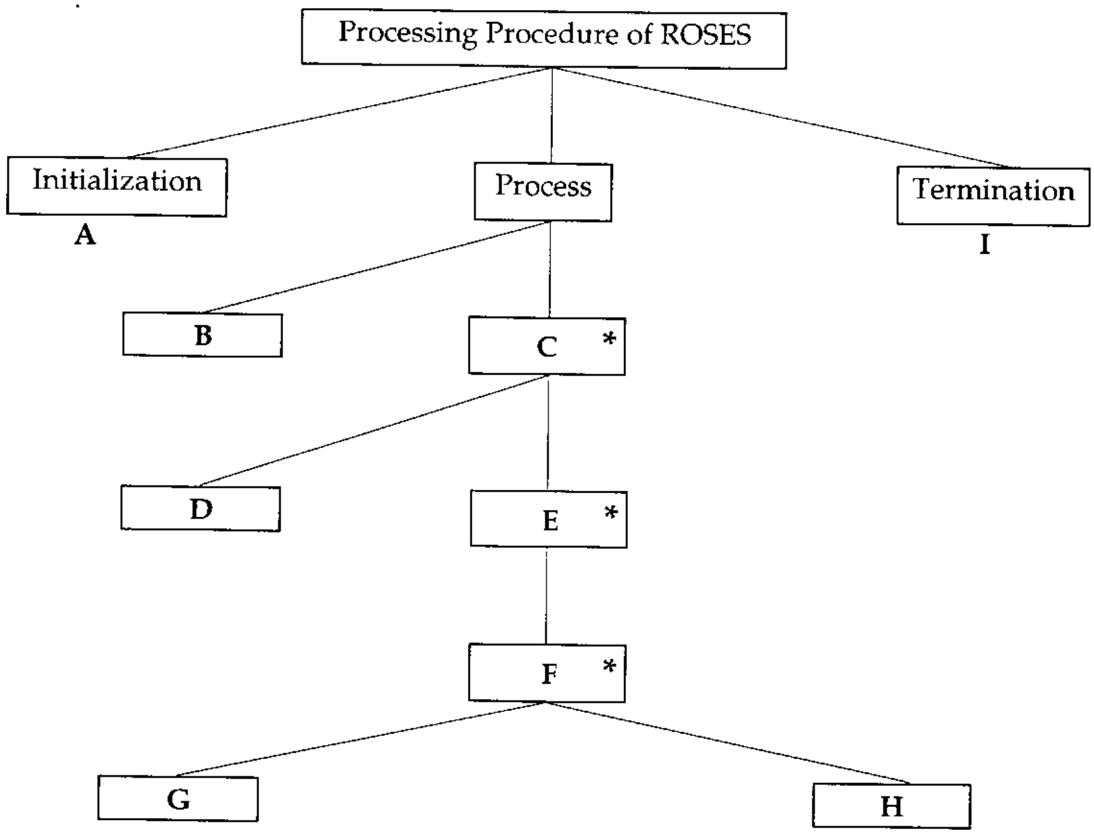
Walagambauwa study method

DANIDA study method

Nach / Kalawewa study method

User define method

3.0 Processing Procedure of ROSES



Functional List

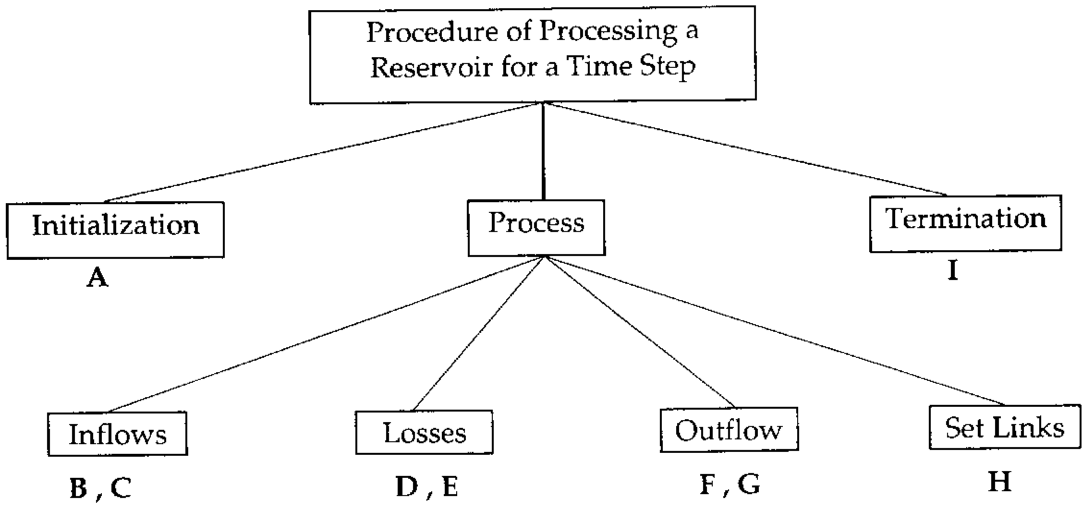
- A - Getting the name of the cascade to be processed and the date range.
- B - Setting the order of cascades to be processed according to the interactions with other cascades.
- D - Setting the order of the nodes to be processed for the current cascade.
- G - Process the node for the day.
- H - Record the input and output data for the node and for the day.
- I - Reorganize output to readable format.

Conditional List

- C - Select the cascades one by one in the order until the end of the list, for the given date range.
- E - Increase date, day by day from the start date until reach the end date.
- F - Select the nodes one by one according to the order until end of the list.

* - Asteric represents repetitive computation process.

3.1 Procedure of processing a Reservoir node for a time step



Functional List

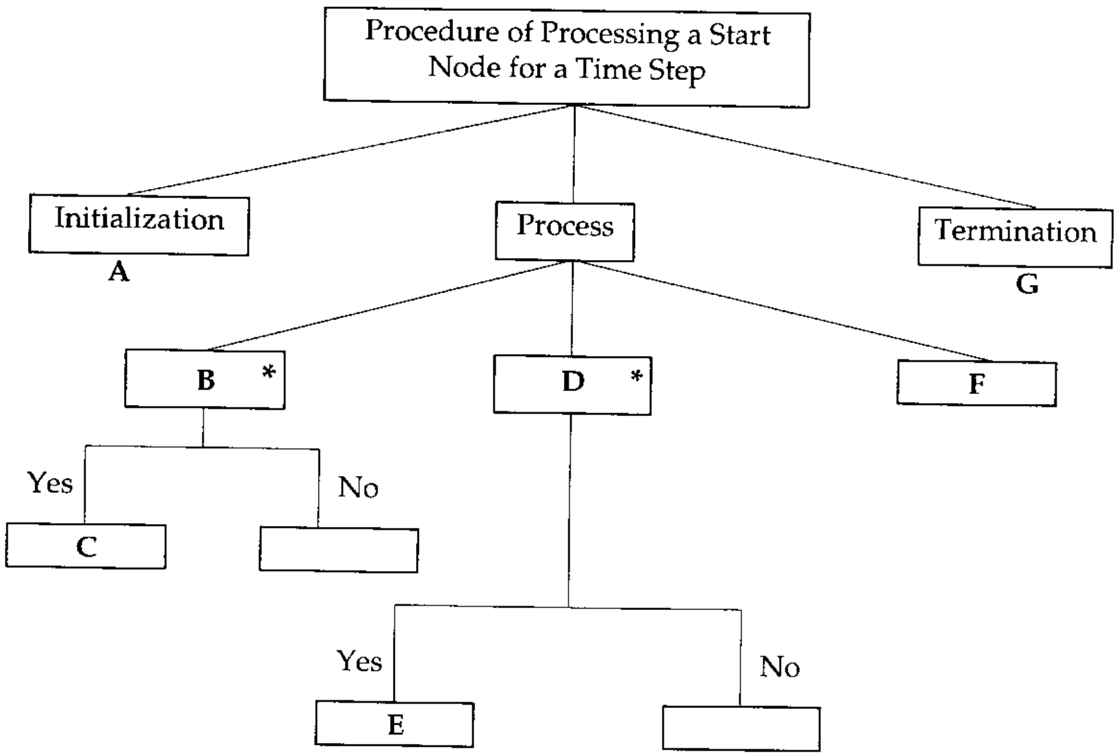
A - Set the start storage level of the reservoir.
B - Calculate inflows to the reservoir
  - Feeder inflows (3 nos. max.).
  - Runoff (Calculated in any of 6 different methods).
  - Direct rainfall contribution.
  - Drainage input from upstream reservoirs.

C - Add total inflow volume to the start storage.
D - Calculate losses
  - Seepage loss - given percentage of the water volume of the reservoir.
  - Evaporation loss - using the given evaporation coefficient and water spread area.

E - Reduce losses from the storage.
F - Calculate outflows in following priority order
  - Spillage when occurred.
  - Irrigation releases (3 nos. max.).
  - Feeder releases (3 nos. max.).

G - Reduce outflows from the storage to get the storage for the end of the time step. This storage will be used as the start storage for the next time step.
H - Set the flows of the connecting links.
I - Record all calculated data for the reservoir and connecting links for current time step.

3.2 Procedure of processing a Start node for a time step



Functional List

A - Set the start flow of the connecting link to zero.

C - Get the flow of the connected end node from the linked cascade.

E - Read the gauge flow of the current time step.

F - Add all flows and set the flow of the connecting link.

G - Record all calculated data for the start node and the link for current time step.

Conditional list

B - Is there an interaction with some other cascade.

D - Is there a Virgin flow.

3.3 Procedure of processing a Lateral Feeder node for a time step

Lateral Feeder is used to measure feeder flows.

1. According to the lateral feeder gauge reading for the time step, it is calculating the flow of the link.
2. Record all calculated data for the lateral feeder node and link for current time step.

3.4 Procedure of processing a Cross Regulator node for a time step.

1. Calculate feeder canal flow for the time step by reading the gauge data of the lateral feeder gauge for the time step.
2. Calculate the release canal flow and set the flow of the link which is going out from the node.
3. Record all calculated data for the cross regulator node and the links for the time step.

3.5 Procedure of processing a Diversion node for a time step.

1. Devide the flow according to diversion factor or gauge readings for the time step.
2. Add the calculated flows to the relevant links.
3. Record all calculated data for the diversion node and the links for the time step.

3.6 Procedure of processing a Flow Confluence node for a time step.

1. Calculate inflows.
   - If there are gauges, calculate from the gauge reading for the time step.
2. Add the total inflow amount to the flow of the link which is going out from the node.
3. Record all calculated data for the flow confluence node and the links for the time step.

3.7 Procedure of processing a End node for a time step.

Record the flow coming into the end node for the time step.

4.0 Output from ROSES

Roses gives outputs in graphical and tabular forms.

4.1 Tank water balance and tank evaluation indicators reports

4.1.1 Tank water balance report

This report includes the following data items.

Tank name
Beginning storage
Catchment inflow
Direct rainfall
Spill water inflow from upstream tank
Drainage return flow
Spillage volume
Irrigation release
Losses
End storage

4.1.2 Evaluation indicators report

This report includes following data items.

Tank name
Target release (IWD)
Net runoff volume (RO)
Tank capacity (C)
Ratio RO/IWD
Ratio RO/C

4.2 Graphical outputs

There are seven types of graphical outputs.

Reservoir storages
Reservoir spills
Reservoir levels
Link flows
Actual and target releases
Model diagram
Comparison

4.2.1 Reservoir storage

Reservoir storage graph is used to plot the storage variation of a selected reservoir against a selected time period.

4.2.2 Reservoir spills

Reservoir spills graph is used to plot the spill volume of a selected reservoir against a selected time period.

4..2.3 Reservoir levels

Reservoir levels graph is used to plot the water level of a selected reservoir against a selected time period.

4.2.4 Link flows

Link flows graph is used to plot the discharge volume of a selected link against a selected time period.

4.2.5 Actual and target releases

Actual and target releases graph is used to compare target releases and actual releases volumes for a selected reservoir against a selected time period.

4.2.6 Model diagram

Model diagram is a graphical preview of the node link structure according to the XY coordinates of the current cascade.

4.2.7 Comparison

Comparison graph is used to preview the impact of rehabilitation for a reservoir. This graph is comparing releases of a selected reservoir on, before and after rehabilitation processes, for a given time period. And target releases graph also included in the same.

4.3 Table outputs

Table outputs are categorized into two types, Data and Results.

4.3.1 Data

Data outputs are about source data entered for the current cascade
E.g. structure data of the current cascade.

4.3.2 Results

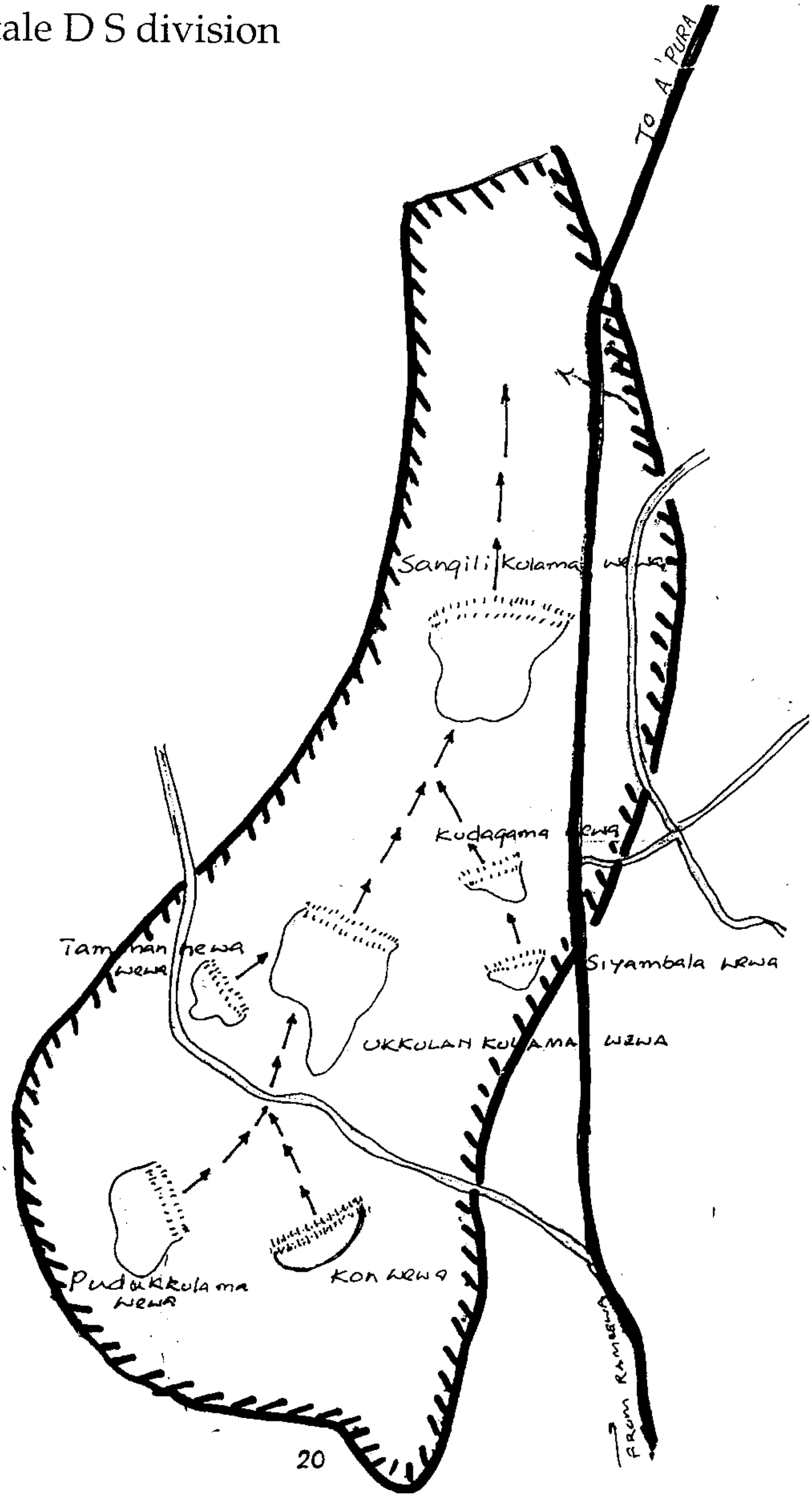
Result outputs of the current cascade for the last process are listed under following report headings.

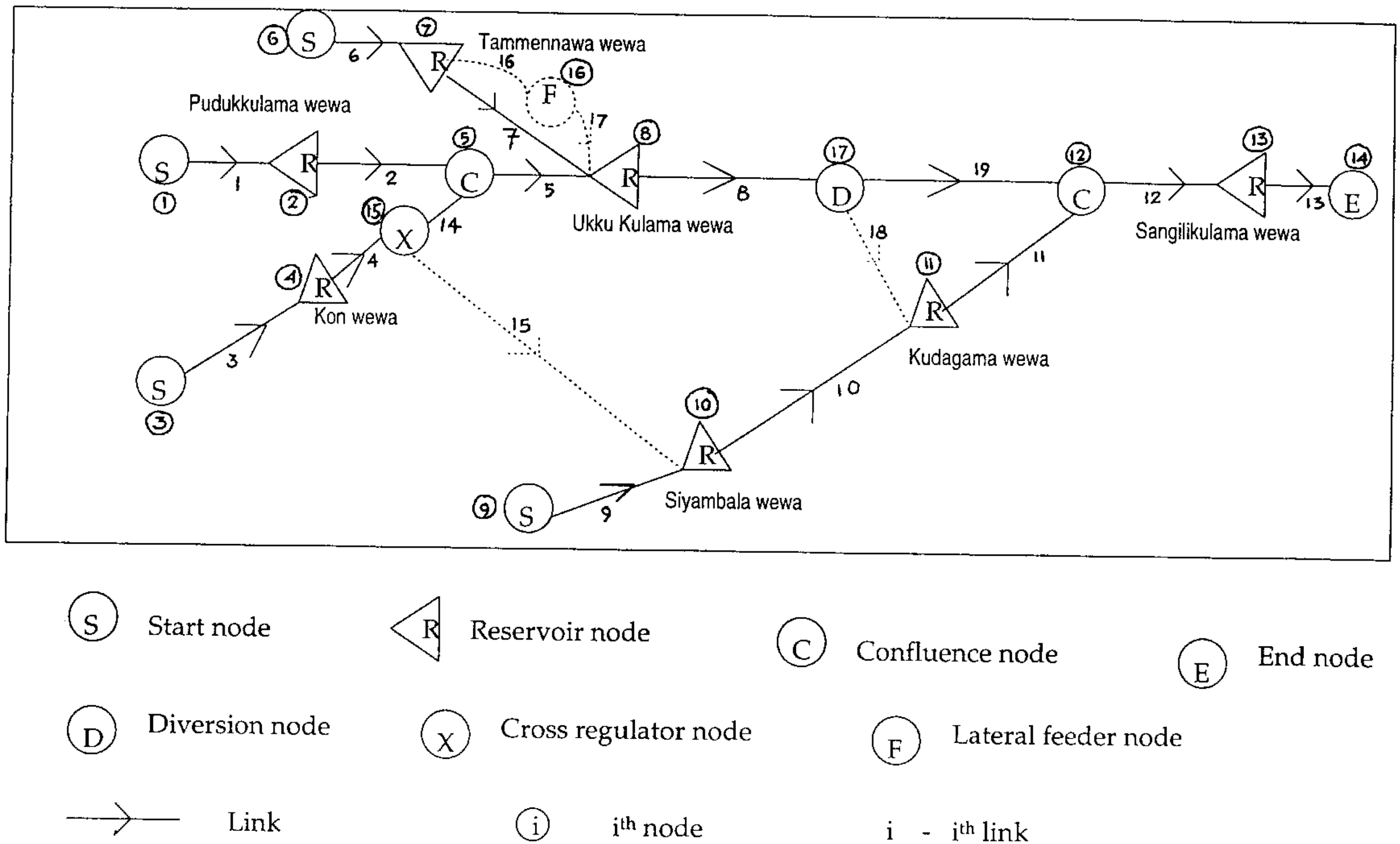
Reservoir status
Releases
Flows in links
Run off figures
Volume losses
End node flows

Annexure I

Sample node-link model

Ukkulankulama Cascade
of Mihintale D S division





Node-link model diagram for the Ukkulankulama cascade

Node link model connectivity data for Ukkulankulama cascade

Link no.	Link id.	Description	From node no.	To node no.
1	L1	Link 1	1	2
2	L2	Link 2	2	5
3	L3	Link 3	3	4
4	L4	Link 4	4	15
5	L5	Link 5	5	8
6	L6	Link 6	6	7
7	L7	Link 7	7	8
8	L8	Link 8	8	17
9	L9	Link 9	9	10
10	L10	Link 10	10	11
11	L11	Link 11	11	12
12	L12	Link 12	12	13
13	L13	Link 13	13	14
14	L14	Link 14	15	5
15	L15	Link 15	15	10
16	L16	Link 16	7	16
17	L17	Link 17	16	8
18	L18	Link 18	17	11
19	L19	Link 19	17	12

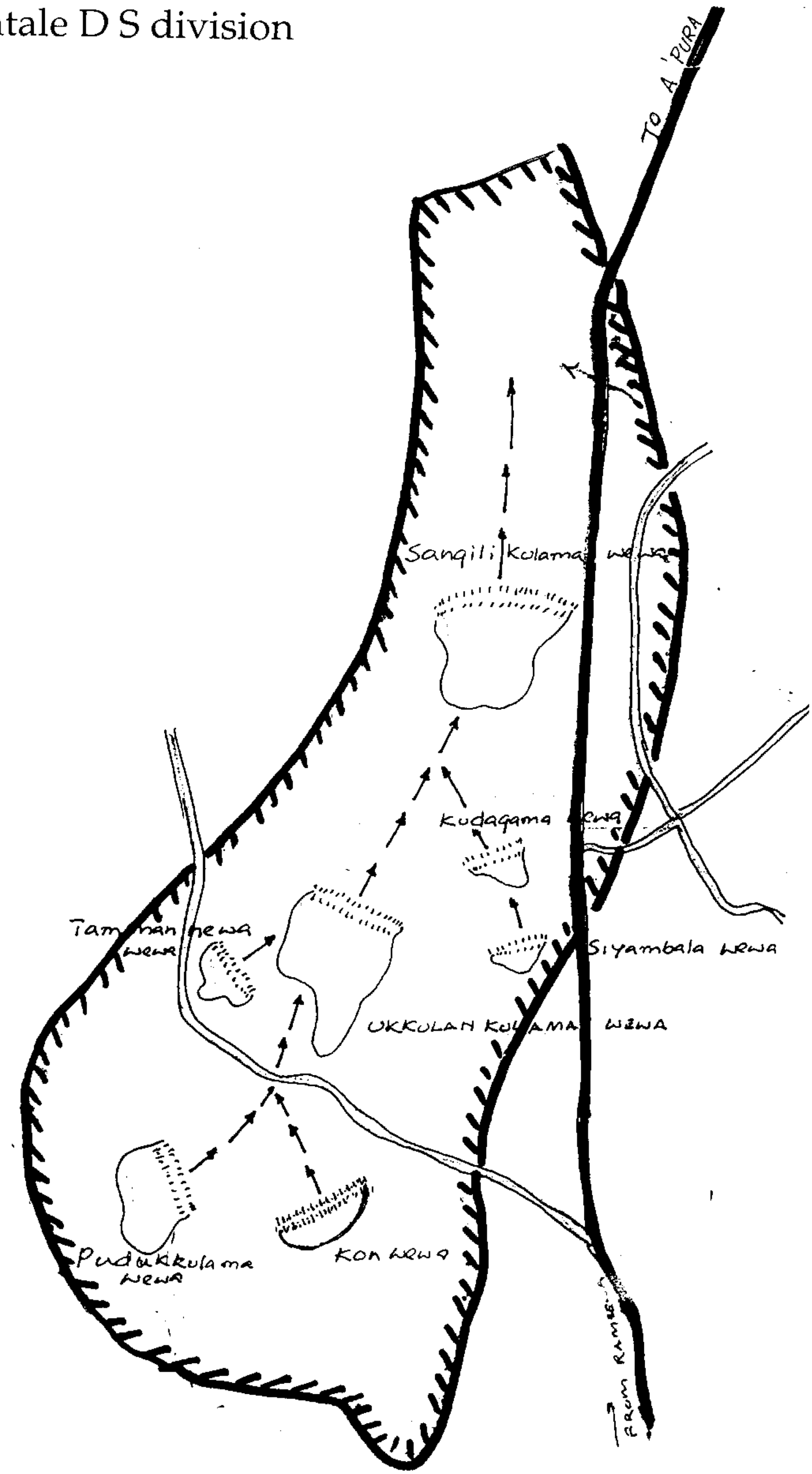
Annexure II

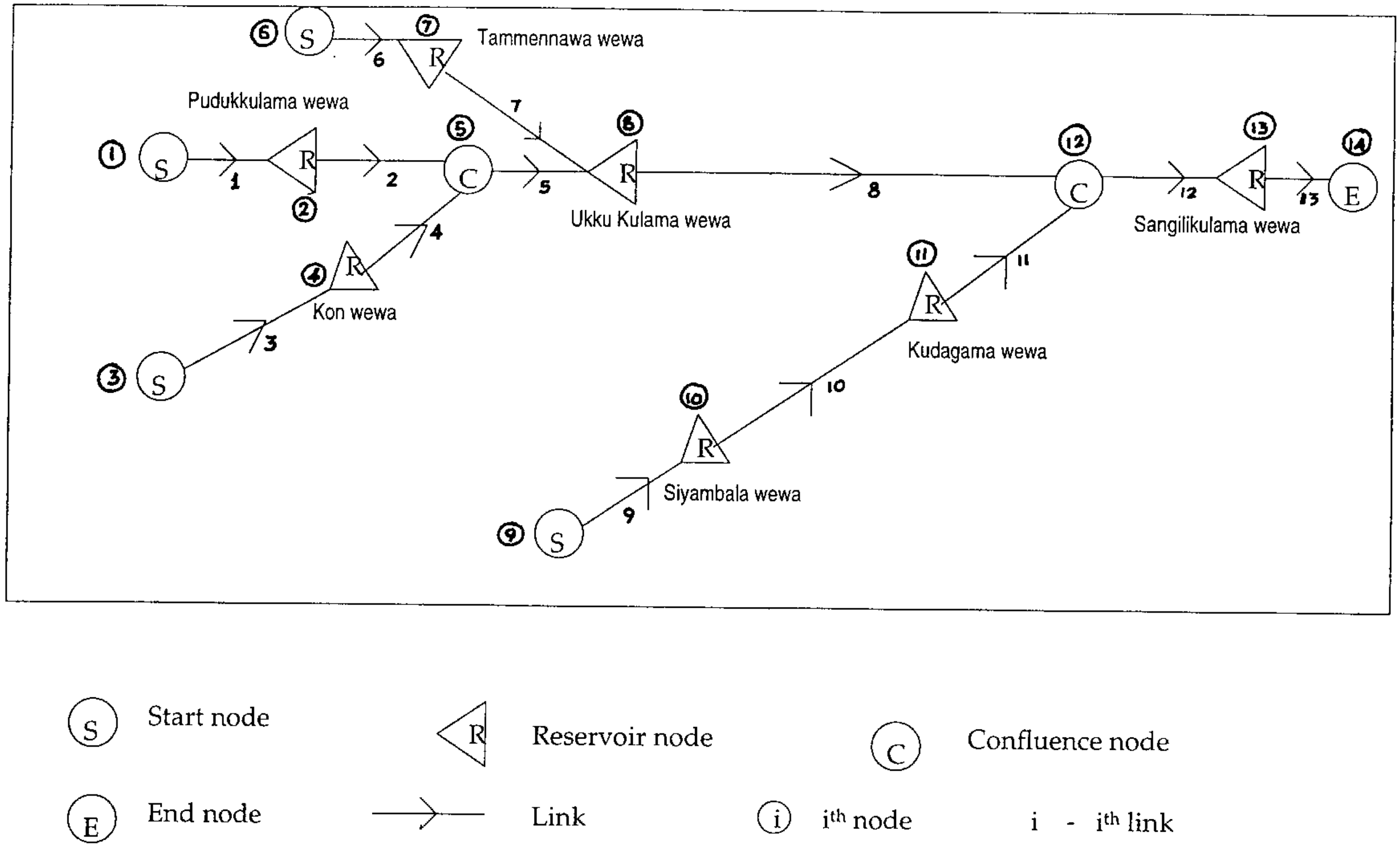
Processed Example -

Ukkulankulama cascade of
Mihintale D S division

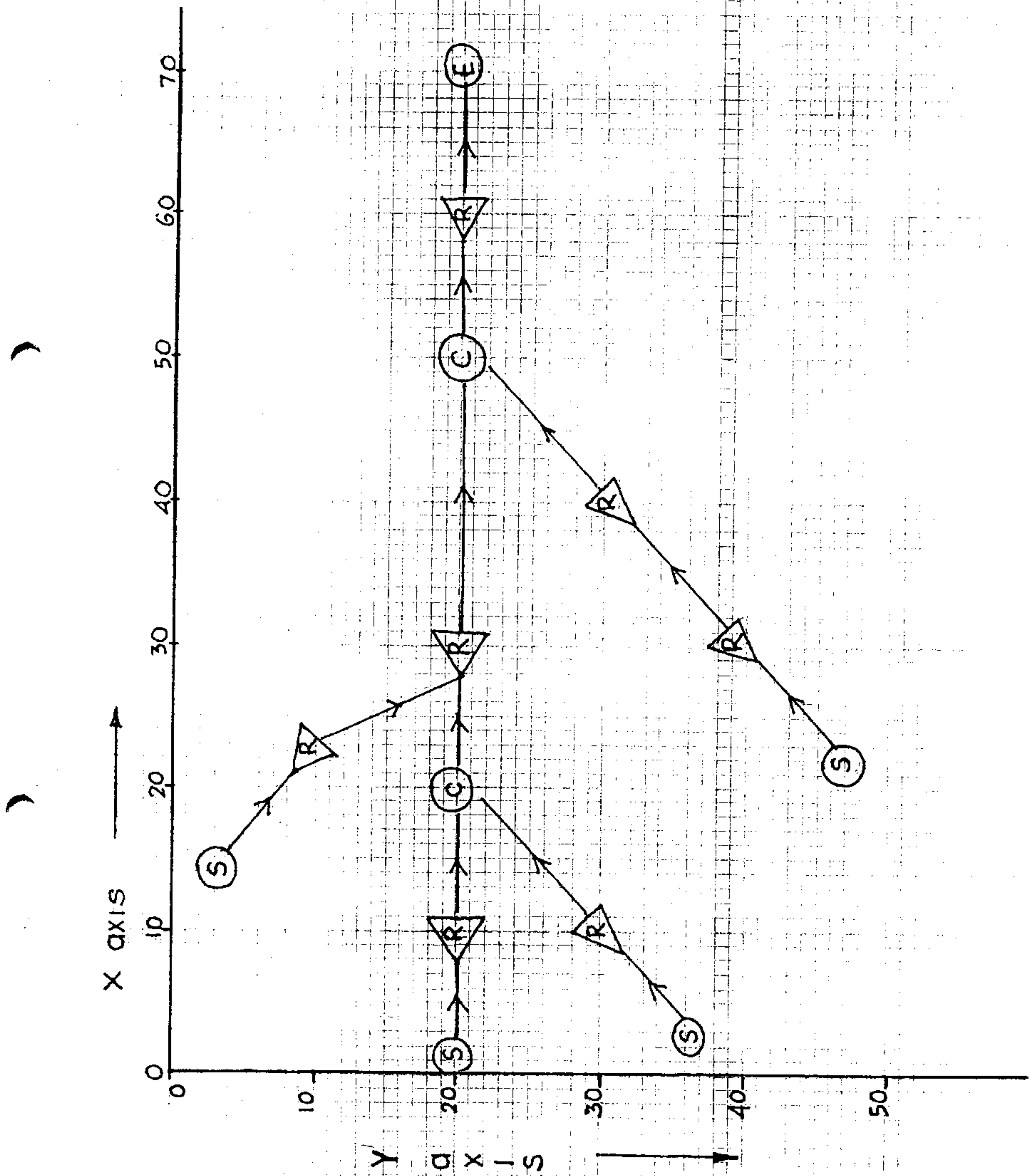
Input data

Ukkulankulama Cascade
of Mihintale D S division





Node-link model diagram for the Ukkulankulama cascade


X axis
Y axis
0
10
20
30
40
50
60
70
S
R
C
E

Node link model connectivity data for Ukkulankulama cascade

Link no.	Link id.	Description	From node no.	To node no.
1	L1	Link 1	1	2
2	L2	Link 2	2	5
3	L3	Link 3	3	4
4	L4	Link 4	4	5
5	L5	Link 5	5	8
6	L6	Link 6	6	7
7	L7	Link 7	7	8
8	L8	Link 8	8	12
9	L9	Link 9	9	10
10	L10	Link 10	10	11
11	L11	Link 11	11	12
12	L12	Link 12	12	13
13	L13	Link 13	13	14

Node link model coordinate data for Ukkulankulama cascade

Node no.	X coordinate	Y coordinate
1	0	20
2	10	20
3	3	37
4	10	30
5	20	20
6	14	4
7	23	10
8	30	20
9	22	47
10	30	39
11	40	30
12	50	20
13	60	20
14	70	20

1.0 Nodes data

1.2 Reservoir data

Tank no.	Name of the tank	Tank area (Ac)	Micro catchment area (Ac)	Micro catch. gross area (Ac)	Command area (Ac)	Height at FSL (ft)	Storage at FSL (Acft)
1	Puddukkulama wewa	24.96	151.97	-	43.98	7.55	75.33
2	Kon wewa	16.06	244.88	-	9.88	6.56	42.14
3	Tammannawa wewa	8.90	109.96	-	15.07	5.91	21.02
4	Ukkulan Kulama wewa	52.88	362.01	556.73	120.09	9.84	208.06
5	Siyambala wewa	4.94	20.02	-	3.95	1.97	3.89
6	Kudagama wewa	6.92	56.09	24.96	7.41	3.61	9.99
7	Sangilikulama wewa	49.91	404.02	477.90	64.99	8.20	163.64

Release calculation method is Cropwater method.

Losses :
Evaporation coefficient is 0.12.
Seepage coefficient is 0.01.

Yield calculation method is Iso Yield Curve method.
Yield for Yala is 60.00.
Yield for Maha is 500.00.

Crop pattern :
Paddy for total command area starting from 15/10/93.

Catchment area table
Full catchment area.

Take rainfall as full rainfall of (R1) station.

Reservoir curves are discrete.

Storages are unknown for all reservoirs.

2.0 Interaction data

No interactions with other cascades.

3.0 Rainfall data

Rainfall station is Rainfall_Station1 (R1)

4.0 Reservoir curves

Puddukkulama wewa

Height	Area	Capacity
0.00	0.00	0.00
0.84	0.31	0.10
1.68	1.23	0.83
2.52	2.77	2.79
3.36	4.93	6.63
4.19	7.70	12.91
5.03	11.09	22.31
5.87	15.09	35.43
6.71	19.71	52.90
7.55	24.95	75.35

Kon wewa

Height	Area	Capacity
0.00	0.00	0.00
0.73	0.20	0.06
1.46	0.79	0.46
2.19	1.78	1.56
2.92	3.17	3.70
3.64	4.96	7.22
4.37	7.14	12.48
5.10	9.72	19.83
5.83	12.69	29.59
6.56	16.06	42.14

Tammannawa wewa

Height	Area	Capacity
0.00	0.00	0.00
0.66	0.11	0.03
1.31	0.44	0.23
1.97	0.99	0.78
2.63	1.76	1.85
3.28	2.74	3.59
3.94	3.95	6.23
4.60	5.38	9.90
5.25	7.02	14.74
5.91	8.89	21.02

5.0 Gauging stations

No gauging stations.

6.0 Daily data - Rainfall data

Rainfall date	Station Id	Rainfall (inches)
1/10/93	R1	0.09
2/10/93	R1	0.50
3/10/93	R1	0.30
4/10/93	R1	0.03
5/10/93	R1	0.46
6/10/93	R1	0.01
7/10/93	R1	0.45
8/10/93	R1	0.21
9/10/93	R1	0.07
10/10/93	R1	0.28
11/10/93	R1	0.19
12/10/93	R1	0.30
13/10/93	R1	0.27
14/10/93	R1	0.37
15/10/93	R1	0.46
16/10/93	R1	0.21
17/10/93	R1	0.19
18/10/93	R1	0.01
19/10/93	R1	0.22
20/10/93	R1	0.34
21/10/93	R1	0.36
22/10/93	R1	0.11
23/10/93	R1	0.41
24/10/93	R1	0.09
25/10/93	R1	0.14
26/10/93	R1	0.33
27/10/93	R1	0.39
28/10/93	R1	0.07
29/10/93	R1	0.35
30/10/93	R1	0.16
31/10/93	R1	0.39

7.0 Crop water tale

Crop	Initial stage		Develop stage		Mid stage		Late stage	
	Days	Kc	Days	Kc	Days	Kc	Days	Kc
Chilly	2	0.65	25	0.85	75	1.00	25	0.90
Paddy	30	1.00	40	1.15	45	1.20	20	0.90

8.0 Evapo_transpiration table

Month	Coefficient
October	6.20
November	4.30
December	4.50
January	4.70
February	5.00
March	6.20
April	5.90
May	6.40
June	6.90
July	7.50
August	7.60

9.0 Evaporation coefficients table

Month	Coefficient
October	0.35
November	0.29
December	0.31
January	0.32
February	0.36
March	0.49
April	0.41
May	0.42
June	0.44
July	0.45
August	0.49

Process

Ukkulankulama cascade is processed during the date range 01/10/93 to 30/09/95 and got the following outputs.

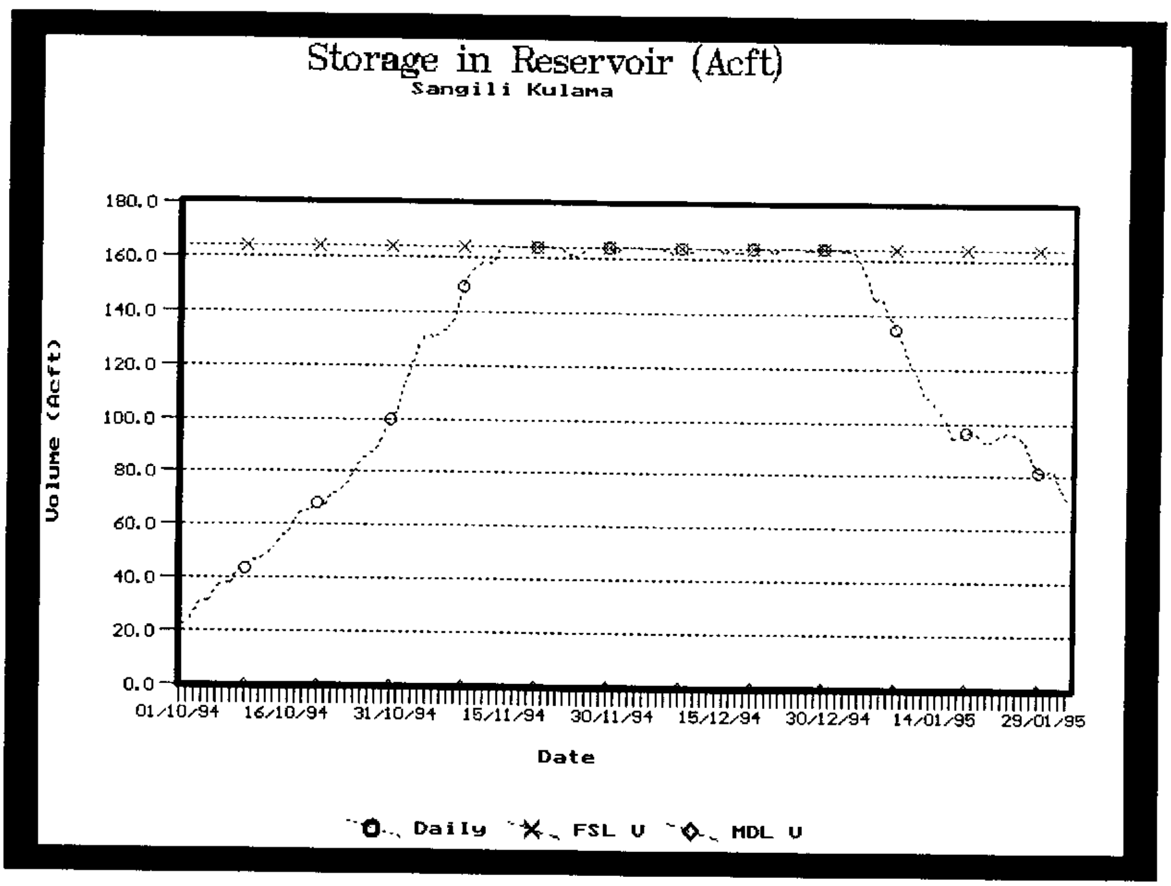
Outputs

Some of the outputs for the process are given below.

1.0 Graphical outputs

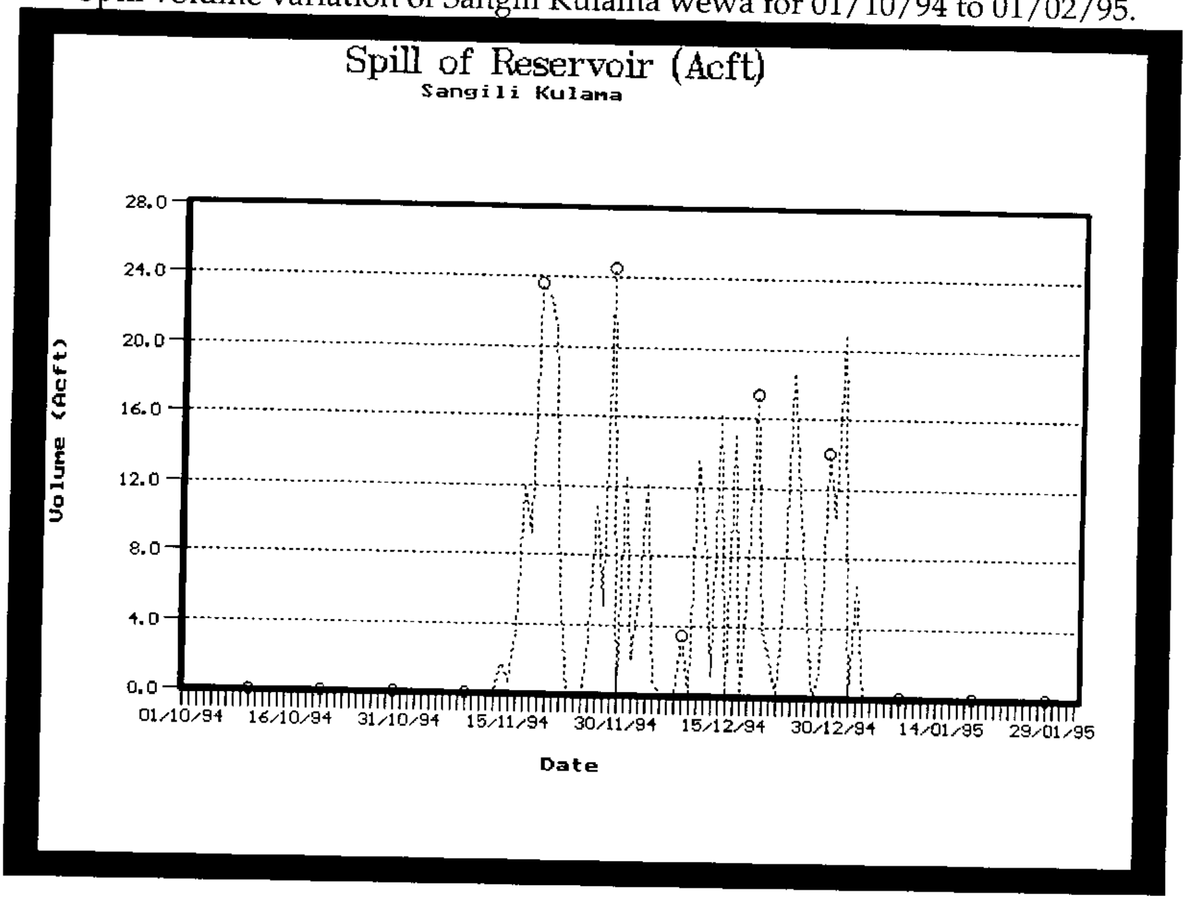
1.1 Reservoir storages

Storage variation of Sangili Kulama wewa for 01/10/94 to 01/02/95.



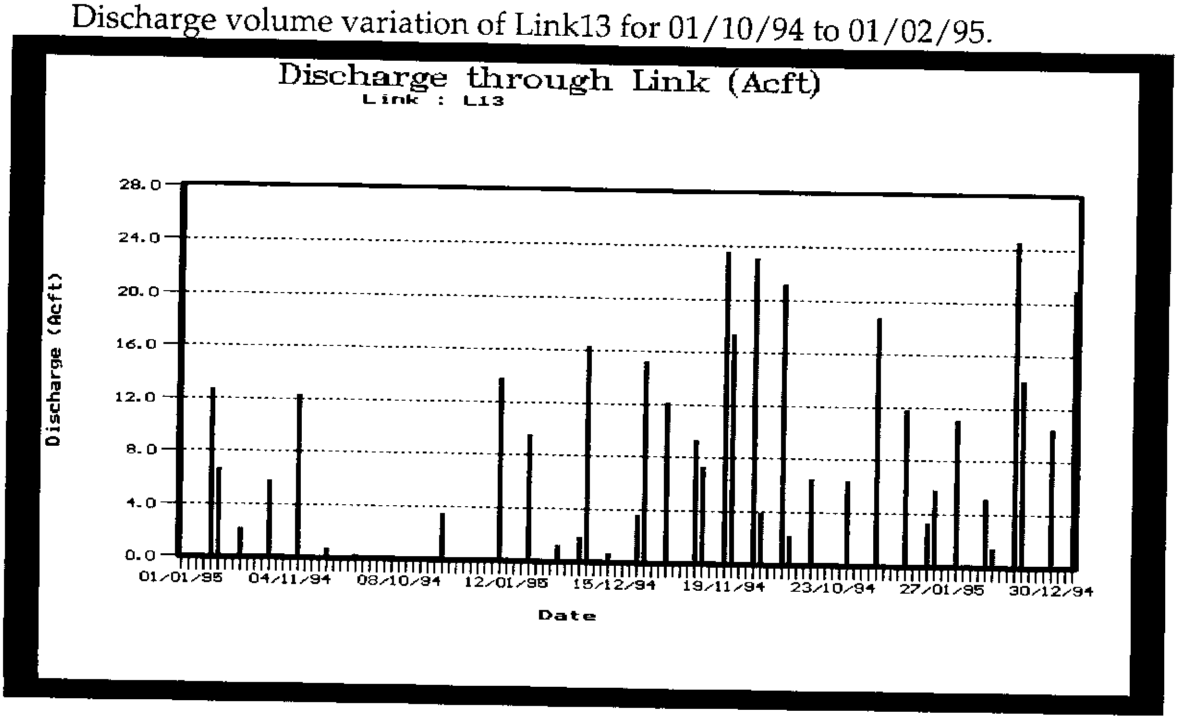
1.2 Reservoir spills

Spill volume variation of Sangili Kulama wewa for 01/10/94 to 01/02/95.



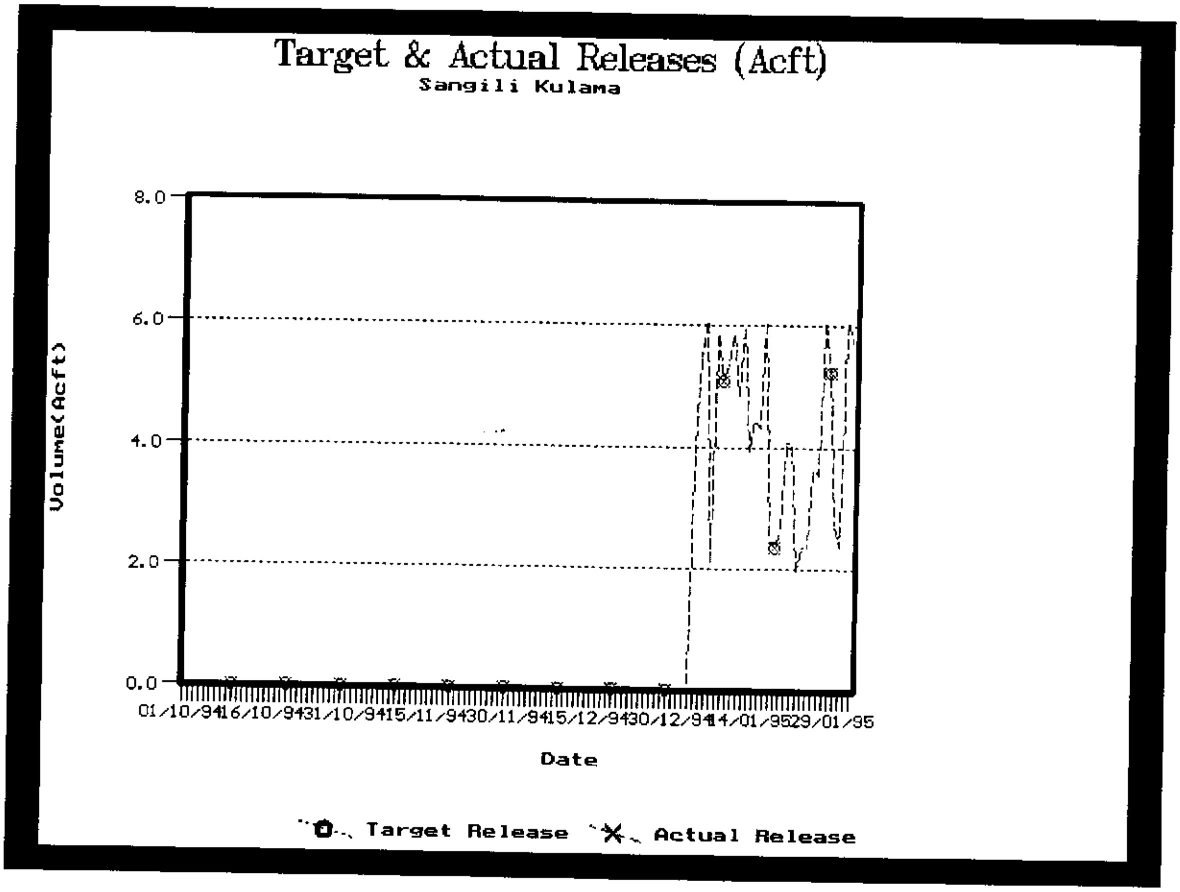
1.3 Link flows

Discharge volume variation of Link13 for 01/10/94 to 01/02/95.



1.4 **Actual and target releases**

Comparison of actual and target release volumes for Sengili Kulama wewa for 01/10/94 to 01/02/95.



2.0 Other outputs.

2.1 End node flows

End node flow of node no. 14 of the cascade for 01/10/94 to 01/02/95 is 365.01 Acft.

3.0 Annual tank water balances and Tank evaluation indicators reports

3.1 Annual tank water balances report

Tank name	Begin storage	Catchment inflow	Direct rainfall	Spill inflow from up tank	Drainage return flow	Spillage volume	Irrigation release	Losses	End storage
Pudukkulama wewa	0	133.10	18.47	0.00	0.00	0.00	99.41	48.93	3.13
Kon wewa	0	214.11	45.39	0.00	0.00	67.96	34.89	150.67	6.25
Tammannawa wewa	0	96.24	19.08	0.00	0.00	12.39	49.59	51.05	2.32
UkkulanKulama wewa	0	511.34	86.00	80.32	9.93	0.00	397.77	274.90	14.96
Siyambala wewa	0	17.58	7.30	0.00	0.00	1.01	10.41	12.87	0.45
Kudagama wewa	0	57.76	15.75	1.01	2.08	14.26	24.94	36.36	1.29
Sangili Kulama wewa	0	520.65	108.85	14.26	0.00	44.73	227.07	356.54	15.33

3.2 Annual tank evaluation indicators report

Tank name	Target release (IWD)	Net runoff volume (RO)	Tank capacity (C) Acres	Ratio RO/IWD	Ratio RO/C
Pudukkulama wewa	153.78	102.64	75.35	0.67	1.36
Kon wewa	34.89	108.83	42.14	3.12	2.58
Tammannawa wewa	52.51	64.27	21.02	1.22	3.06
UkkulanKulama wewa	419.45	412.69	208.06	0.98	1.98
Siyambala wewa	13.96	12.01	3.89	0.86	3.09
Kudagama wewa	26.26	40.24	9.99	1.53	1.03
Sangili Kulama wewa	227.07	287.22	163.64	1.26	1.76