URBS Training Course – Day 1

- Morning
  - URBS+ Upper Murray Data Install
  - URBS refresh – lexicon/structure
  - UM Model structure
  - UM event data generation
  - Rainfall data generation exercise
- Afternoon
  - UM URBS ControlCentre
    - Running the Model
  - UM Calibration Exercise
  - Review and Q&A

URBS Training Course – Day 2

- Morning
  - Modelling Results
  - Recommended Parameters
  - Operational Considerations
  - FEWS-URBS integration
  - Q&A Discussion
- Afternoon
  - Meeting with MDBA and FEWS experts re operational issues

Input/Output – Files & Naming

- File locations
- Model files
  - Vector/rainfall
- Input Files
  - Static
  - Dynamic
- Output files
  - Static
  - Dynamic

Model Files

- Catchment definition file or URBS vector file
  - .u, .cdf, .vec
  - Catchment Data files - .cat
- Rainfall definition file
  - .rai, .rdf
- But Suffixes are flexible – to suit local preferences
- Most use .vec & .rdf

File Locations (default is run directory)

- URBS' File Locator Variables
  - URBS_RAIN=directory
    - where pluviograph files are located
  - URBS_RATS=directory
    - where rating table files are located.
  - URBS_GAUG=directory
    - where gauging station files are located.
  - URBS_INFS=directory
    - where inflow hydrograph files are located
  - URBS_RUNF=directory
    - Where rainfall-runoff files are located.
  - URBS_RETS=directory
    - where to place results.

Using the Ini Files to set Environment variables

[Real Time Parameters]
URBS_BF=25
URBS_BASF=FALSE
URBS_REAL=FALSE
[URBS Directories]
URBS_RATS=d:\urbs\upper_murray\calibration\ratings
URBS_RAIN=d:\urbs\upper_murray\calibration\201203\data
URBS_GAUG=d:\urbs\upper_murray\calibration\201203\data
URBS_INFS=d:\urbs\upper_murray\calibration\201203\data
DARTMOUTH=471.31
HUME=185.77

URBS Model File Naming Convention

Four file types

- Static Files
- Dynamic Files
- Output Files
- Run Log Files

Static Files – Created by the user

- Catchment vector file (*file.u*)
  - (can be created using CatchmentSim)
  - Optional catchment data file (*file.cat*)
- Rainfall definition file (*file.rdf*)
- Rating curve file(s) – (*StationName.rat*)
  - 1 file for each water level station
- Dam storage data file(s) (*DamName.els*)
  - 1 file for each dam in the catchment

Note 1:

The last 2 files are required only if water level stations and dams are contained in the catchment vector file

Note 2:

The names of the gauging station file, rating curve file and the name in the catchment vector file must be the same

Dynamic Files – Created by Special Utilities

- Rainfall data files – 1 file for each sub area in a model (*basinID+subAreaID.r*)
- Discharge and water level data files – 1 file for each discharge and water level station (for discharge – *StationNameq.g*; for water level – *StationName.g*) up to 16 characters
- Hot start File (*file.hst*) – explain later
- External inflow file (*ForecastAreaName.i*)
- Batch files to run model (eg *run_catch.bat*)

Common Output Files – Created by the model

- '.csv' file
- '.prm' file
- '.o' file
- '.p' file
- '.q' file
- '.hst' file
- '.a' file
- '.e' file
- 'DamName_cal.o' file
- '.vbf' file
- '.cc' file
- '.h' file
- '.pqh' file
- '.hc' file
- '.osd' file
- '.fs' file
- _a.csv file (TuFlow)
- _e.csv file (TuFlow)
- _r.csv file (TuFlow)
- _i.csv file (TuFlow)

Run Log Files – Created by the ControlCentre

- *urbsout.log* – contains on screen messages transmitted by the model
- *urbserr.txt* – contains error and warning messages given by the model

Note: Look at these before you look at results

Static Input Files – more details

- Rating Table Files (.rat)
- Storage-Discharge files (.sq)
- Storage Elevation files (.els)
- Catchment Data files (.dat)

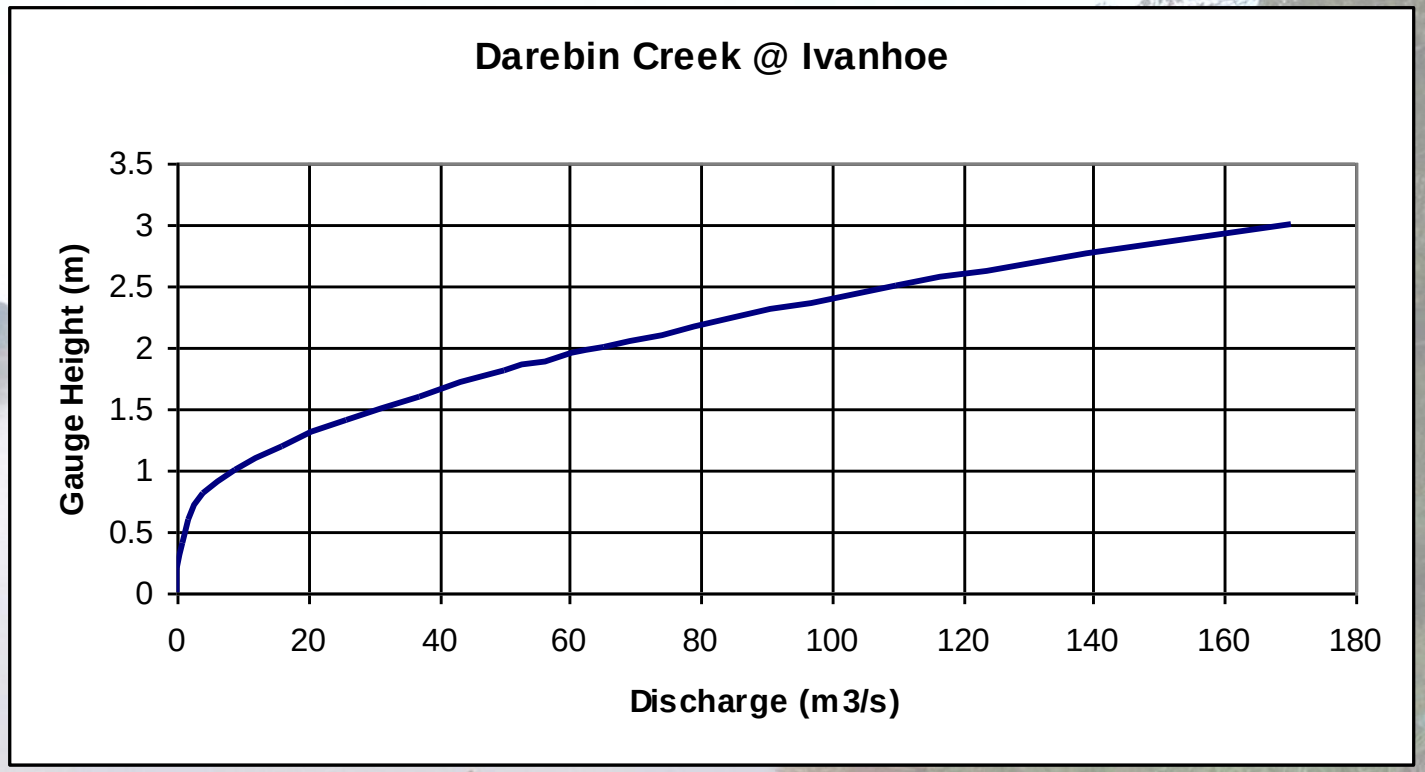
Rating Table Files (.rat)

- Header Line
- [/ *dslocation* = *h*]
- [k = *kk*]
- *n* PAIRS:
- h_1 q_1
- h_2 q_2
- ..
- ..
- h_n q_n

Rating Curve Files - Example

DAREBIN CREEK, IVANHOE
*** AWRC: 229403**
*** Table: 3.01**
*** Modified**
13 PAIRS:

0.0	**0**
0.2	**0.17**
0.4	**0.72**
0.6	**1.62**
0.8	**3.99**
1.0	**8.85**
1.2	**16.2**
1.4	**26**
1.6	**37**
1.8	**50**
2.0	**65**
2.5	**110**
3.0	**170**



Storage Discharge Files (.sq)

- Title/Header
- n No of Storage-Discharge pairs
- S_1 q_1
- S_2 q_2
- ..
- ..
- S_n q_n

The unit for storage values is ML.

Discharge values are in cumecs.

Storage-Elevation Files (.els)

- EL,A,V
- *nn.nn, nn.nn, nn.nn*
- *nn.nn, nn.nn, nn.nn*
-
- etc.
-

EL specifies the elevation in metres.

A specifies the storage area in hectares.

V specifies the storage volume in megalitres

Storage Elevation File - Example

El,A,V

315,0,0

325,0,1

326,1,4

327,2,17

328,5,50

329,7,111

330,11,202

Dynamic Input Files – More Details

- Pluviograph files (.r)
- Rainfall runoff files (.rrf)
- Gauging Station files (.g)
- Flow files (.f)
- Inflow files (.i)

File format

- Pluviograph/Rainfall Runoff
- *heading line*
- *comment line*
- *comment line*
- *comment line*
- t_{start} t_{inc} n
- v_1
- v_2
- ..
- ..
- v_n

Definitions …

t_{start}=the Unix starting time (SECONDS)

t_{inc}= the time increment (in SECONDS)

n = the number of values

Note the first value will be the rainfall that fell between the starting time and the next timestep

ie between t_{start} *and* $t_{start} + t_{inc}$

Values are in mm

Example Pluviograph file

Station: awrc 401012 rainfall
StartTime = Mon Feb 27 2012 09:00
EndTime = Tue Mar 13 2012 09:00
Created from file 401012p.raw on the Mon Jan 25 13:52:18 2016
1330297200 3600 360
0.00
0.00
0.00
0.00
1.60
1.60
0.20

Gauging Station/Inflow files

- *heading line*
- *comment line*
- *comment line*
- *comment line*
- t_{start} t_{inc} n
- v_0
- v_1
- v_2
- ..
- ..
- v_n

Definitions …

t_{start}=the Unix starting time (SECONDS)

t_{inc}= the time increment (in SECONDS)

n = the number of values

Values are in

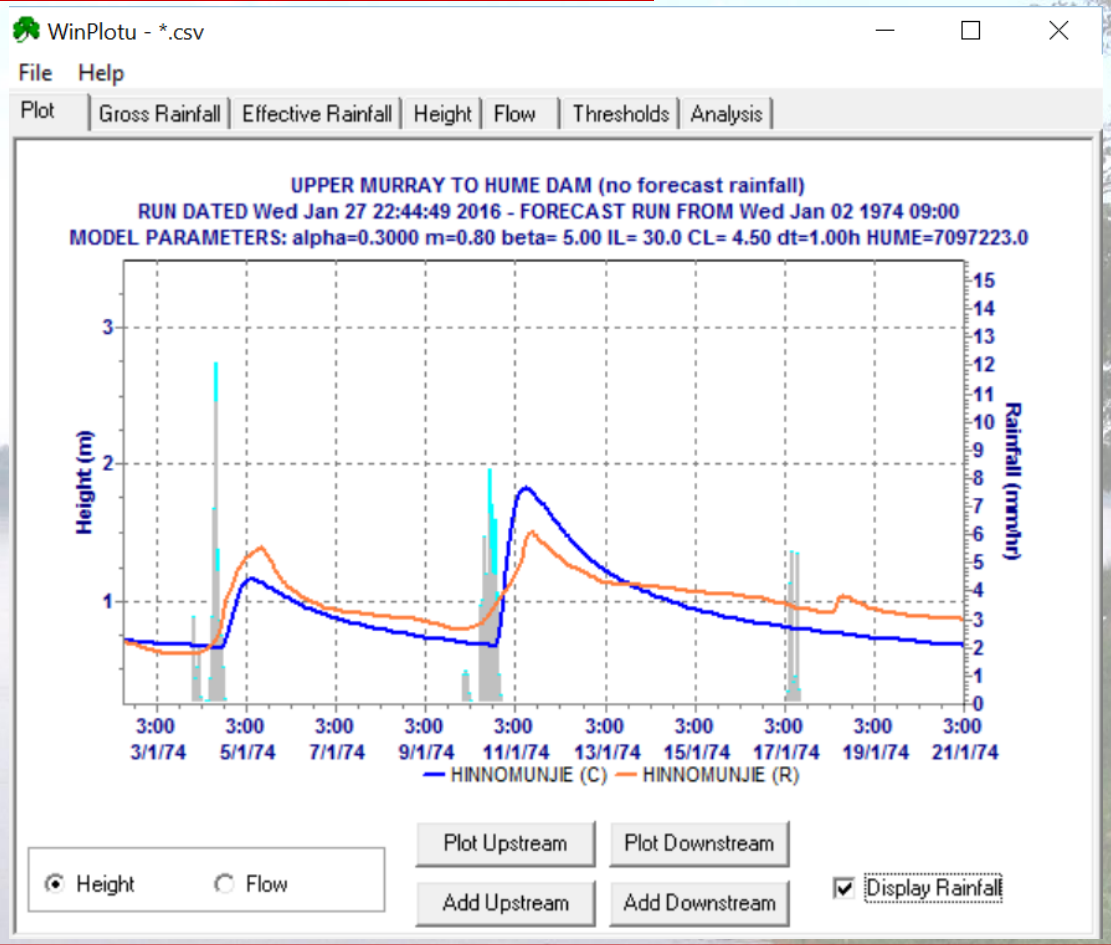
metres for gauging stations

cumecs for inflow files

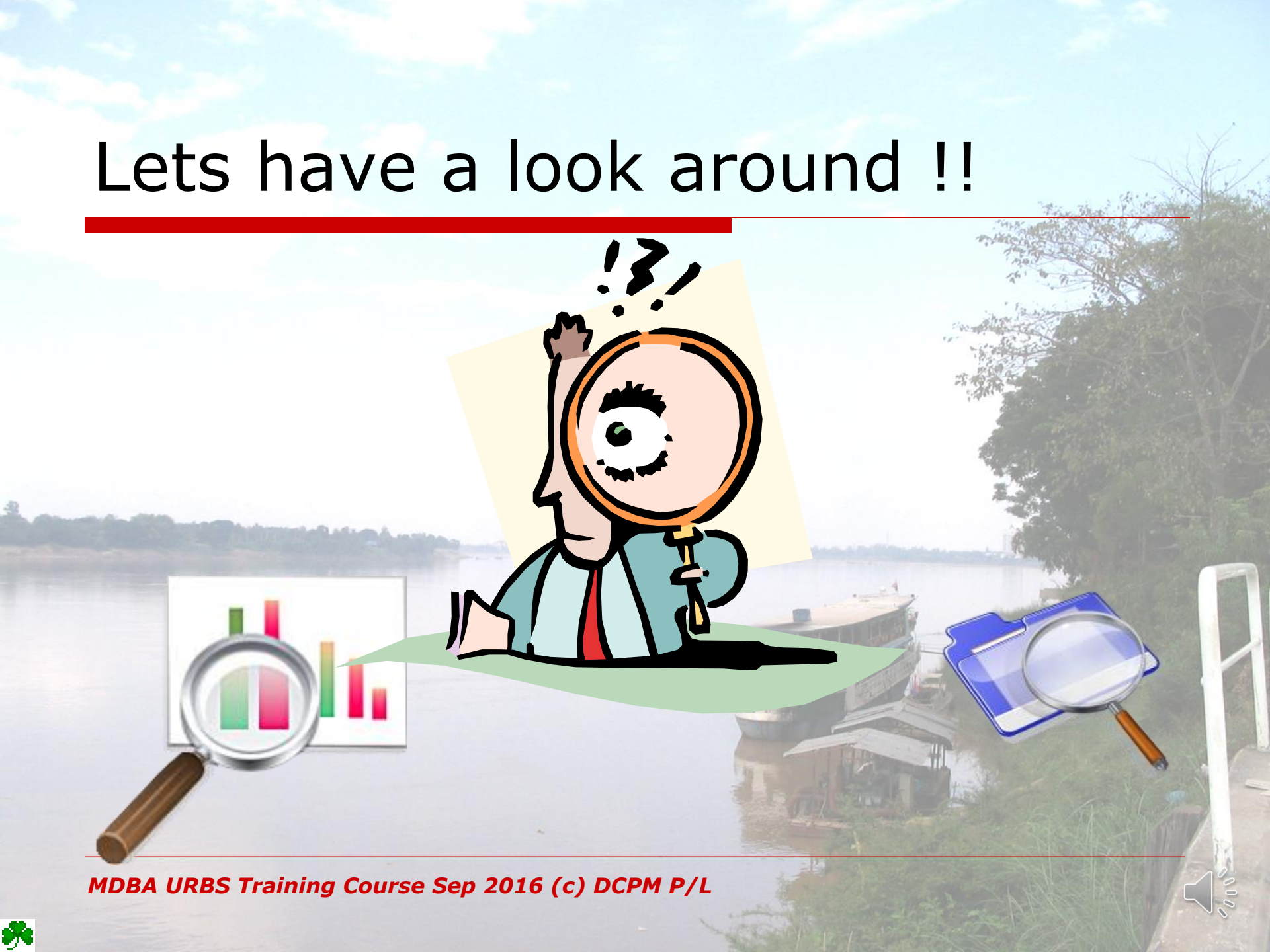
Example Gauging Station File

Station: site 401204 mitta mitta river @ tallandoon
StartTime = Mon Feb 27 2012 09:00
EndTime = Tue Mar 13 2012 09:00
Created from file 401204h.raw on the Mon Jan 25 13:52:26 2016
1330297200 3600 361
1.51
1.51
1.52
1.52
1.53
1.53
1.53
1.54
1.54
1.55
1.57
1.58
1.60

Example CSV plot



Lets have a look around !!



Catchment Schematisation

- Typical catchment
- Catchment Definition file (Vector)
  - Overall format
  - Keywords
- Rating Curves
- Gauging Stations
- Pluviograph assignment

Reminder - URBS Syntax

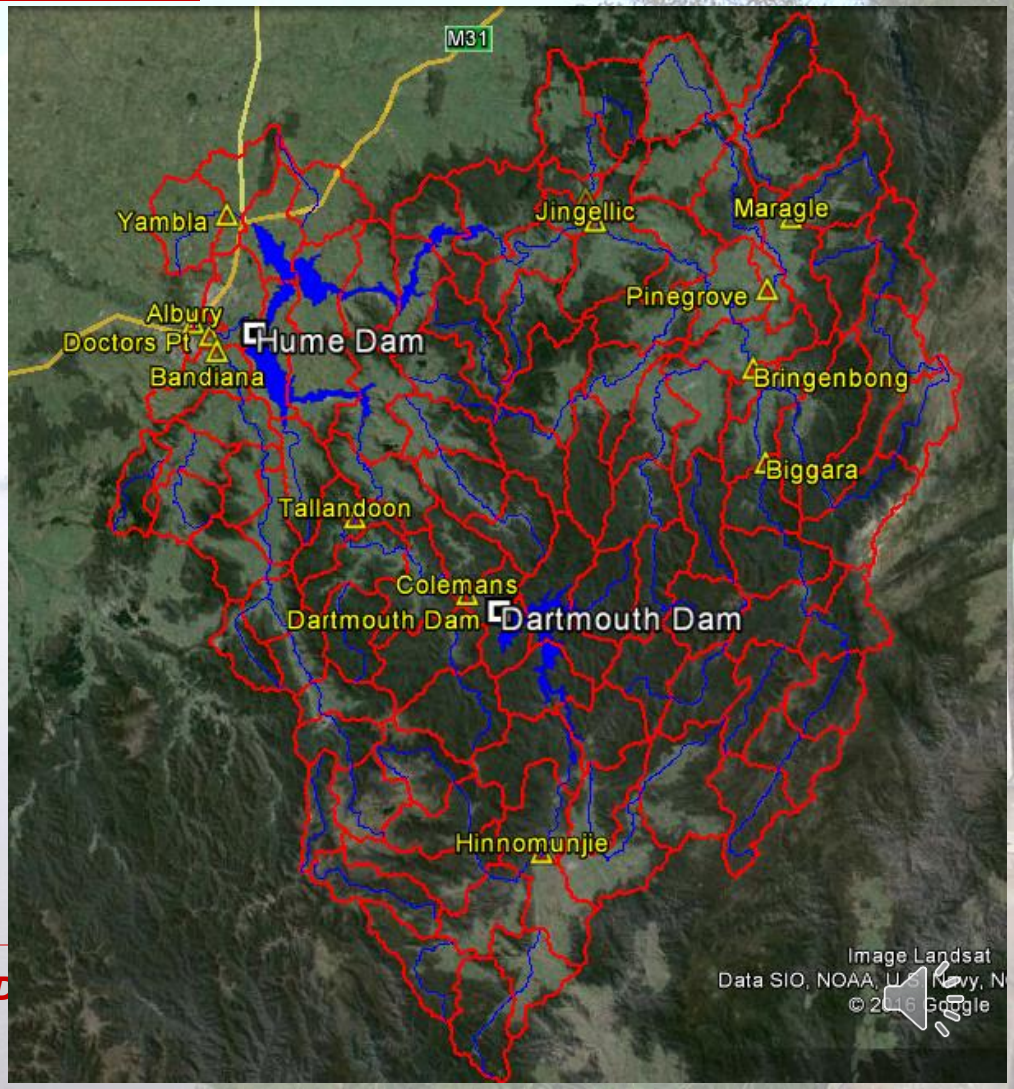
- Place . after
  - Print, Input, store, get
  - location, end
- Place : after
  - no of items
  - Model, Uses, store
- Comments are within { }
- Otherwise free field

Reminder URBS Syntax - Files

- Dynamic file have a header + 3 comment lines + data in free format
- Rating curve - specify the number of pairs
- ELS files - uses commas to separate variables and values
- Case-insensitive

Upper Murray River to Albury

CatchmentSim output for Upper Murray Based on: 3” SRTM DEM data



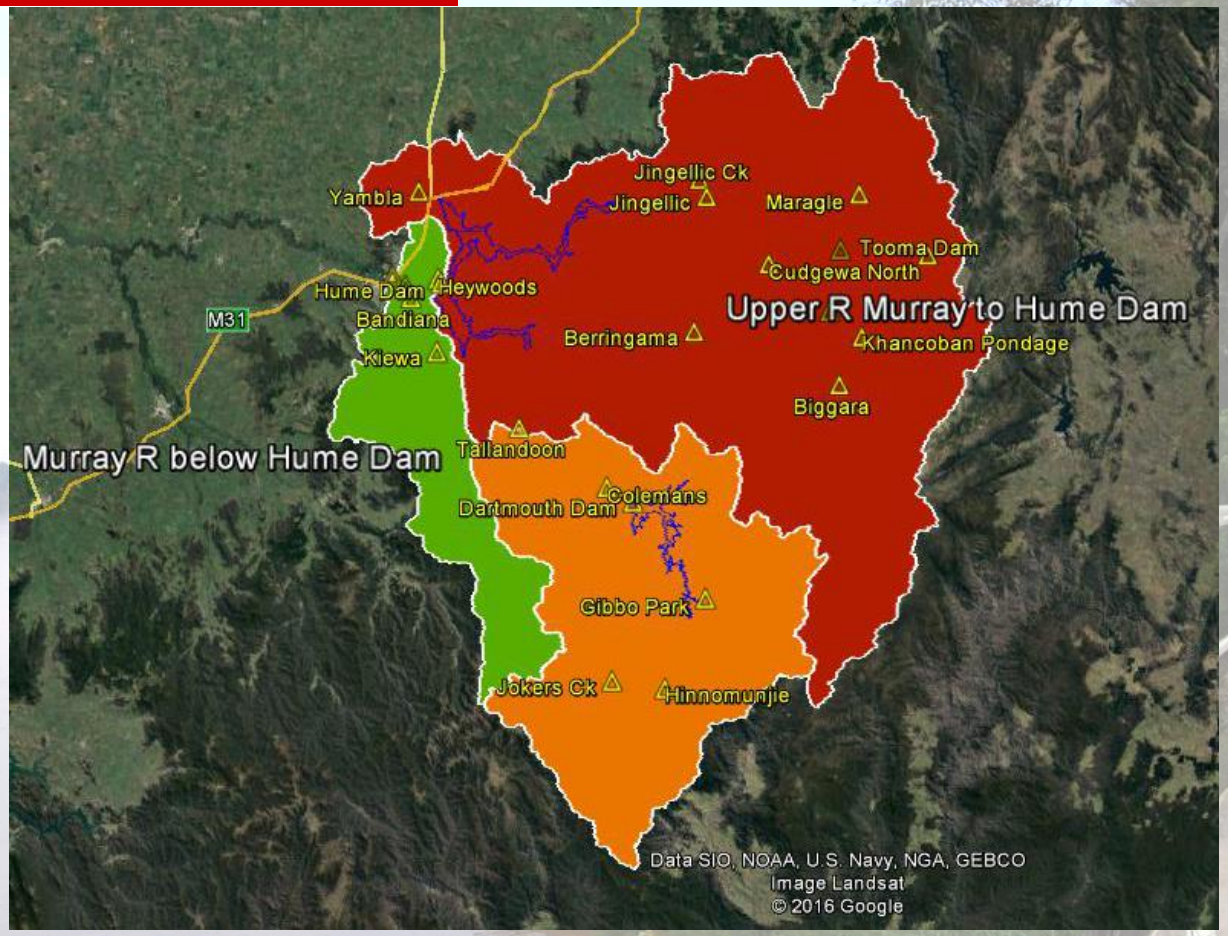
Upper Murray River to Albury

3 Sub-catchments

Upper Murray

Mitta Milta

Below Hume



URBS Vector File Excerpt - Upper

```
Upper Murray to Hume Dam
MODEL: SPLIT
{Developed using CatchmentSIM by Terry Malone on 18-07-2016}
{Baseflow factors revised and McCallums added TM 20-08-2016}

USES: L, I
{The default parameters are for information only}
DEFAULT PARAMETERS: alpha = 0.3 m = 0.8 beta = 2.5 n = 1 x = 0.25
CATCHMENT DATA FILE = ..\..\vectors\upper.dat
RAIN #16 L = 12.40
STORE.
RAIN #17 L = 8.34
GET.
ROUTE THRU #19 L = 1.69
......

INPUT. MITTA : A=4741
PRINT.TALLANDOON :B0=0 BR=0.95 BC=0.05 BM=1
......
{Drowned reach}
FACTOR=0.5
ROUTE THRU #2 L = 0.48
ADD RAIN #2 L = 0.48
{HUME DAM 1929}
baseflow=1
PRINT.HD_INFLOW  :B0=0 BR=0.95 BC=0.05 BM=1
{The normal fsl is 192.06.  for dams with known outflows, the fsl should be the dam crest which should also be reflected in the sq curve}
{To generate a reverse routed inflow, first put an asterisk after the location hume, subsequent calibration runs should exclude the asterisk}
DAM ROUTE FSL=220 datafile=hume.els il=HUME location=hume REL=hd_outflow.g file=hume.sq
PRINT.HD_OUTFLOW
END OF CATCHMENT DATA.
```

URBS Vector File Upper Excerpt (2):

95 PLUVIOGRAPHS:
LOCATION. upper002
1 SUBAREAS: 2
.....
.....
LOCATION. upper096
1 SUBAREAS: 96
END OF PLUVIOGRAPH DATA.

11 RATING CURVES:
LOCATION. BIGGARA
LOCATION. BRINGENBONG
LOCATION. MARAGLE
LOCATION. PINEGROVE
LOCATION. BERRINGAMA
LOCATION. CUDGEWA_NORTH
LOCATION. R_JINGELLIC
LOCATION. CK_JINGELLIC
LOCATION. MCCALLUMS
LOCATION. TALLANDOON
LOCATION. YAMBLA
END OF RATING CURVE DATA.

URBS Vector File Upper Excerpt (3):

14 GAUGING STATIONS:
LOCATION. BIGGARA
LOCATION. KHANCOBAN *
LOCATION. BRINGENBONG
LOCATION. MARAGLE
LOCATION. PINEGROVE
LOCATION. BERRINGAMA
LOCATION. CUDGEWA_NORTH
LOCATION. R_JINGELLIC
LOCATION. CK_JINGELLIC
LOCATION. YAMBLA
LOCATION. MCCALLUMS
LOCATION. TALLANDOON
LOCATION. HD_INFLOW
LOCATION. HD_OUTFLOW
END OF GAUGING STATIONS.

URBS Vector File Excerpt - Mitta

```
Mitta Mitta River to Tallandoon
{Pre Dartmouth Dam}
MODEL: SPLIT
{Developed using CatchmentSIM by Terry Malone on 18-07-2016}
USES: L
{The default parameters are for information only}
DEFAULT PARAMETERS: alpha = 0.3 m = 0.8 beta = 2.5 n = 1 x = 0.25
CATCHMENT DATA FILE = ..\..\VECTORS\mitta.dat
RAIN #29 L = 9.00
STORE.
RAIN #30 L = 19.51
GET.
ROUTE THRU #5 L = 0.38
ADD RAIN #5 L = 0.38
PRINT.JOKERS_CK :B0=0 BR=0.95 BC=0.05 BM=1

.....
.....
{DARTMOUTH DAM 1979}
baseflow=1
PRINT.DD_INFLOW :B0=0 BR=0.95 BC=0.05 BM=1
{To generate a reverse routed inflow, first put an asterisk after the location dartmouth, subsequent calibration
runs should exclude the asterisk}
DAM ROUTE FSL=486.0 datafile=dartmouth.els location=dartmouth il=DARTMOUTH file=dartmouth.sq
PRINT.DARTMOUTH_DAM
.....
.....
PRINT.TALLANDOON :B0=0 BR=0.95 BC=0.05 BM=1
END OF CATCHMENT DATA.
```

URBS Vector File Mitta Excerpt (2):

51 PLUVIOGRAPHS:
LOCATION. mitta001
1 SUBAREAS: 1
.....
LOCATION. mitta051
1 SUBAREAS: 51
END OF PLUVIOGRAPH DATA.

6 RATING CURVES:
LOCATION. JOKERS_CK
LOCATION. HINNOMUNJIE
LOCATION. GIBBO_PK
LOCATION. DARTMOUTH_DAM
LOCATION. COLEMANS
LOCATION. TALLANDOON
END OF RATING CURVE DATA.

7 GAUGING STATIONS:
LOCATION. JOKERS_CK
LOCATION. HINNOMUNJIE
LOCATION. GIBBO_PK
LOCATION. DD_INFLOW
LOCATION. DARTMOUTH_DAM
LOCATION. COLEMANS
LOCATION. TALLANDOON
END OF GAUGING STATIONS.

URBS Vector File Excerpt - Below

```
Murray R - Hume Dam to Albury
{with operate dam}
MODEL: SPLIT
{Developed using CatchmentSIM by Terry Malone on 18-07-2016}
USES: L
{The default parameters are for information only}
DEFAULT PARAMETERS: alpha = 0.3 m = 0.8 beta = 2.5 n = 1 x = 0.25
CATCHMENT DATA FILE = ..\..\vectors\below.dat
RAIN #7 L = 17.72
STORE.
RAIN #8 L = 15.69
GET.
ROUTE THRU #10 L = 1.28
.......
.......
........
INPUT. UPPER : A=15260
PRINT.HEYWOODS * :B0=0 BR=0.95 BC=0.025 BM=1
ROUTE THRU #14 L = 5.79
ADD RAIN #14 L = 5.79
GET.
PRINT.DOCTORS_PT :B0=0 BR=0.95 BC=0.025 BM=1
ROUTE THRU #2 L = 3.70
ADD RAIN #2 L = 3.70
PRINT.ALBURY :B0=0 BR=0.95 BC=0.025 BM=1
END OF CATCHMENT DATA.
```

URBS Vector File Below Excerpt (2):

13 PLUVIOGRAPHS:
LOCATION. below002
1 SUBAREAS: 2
LOCATION. below014
.....
1 SUBAREAS: 14
END OF PLUVIOGRAPH DATA.

5 RATING CURVES:
LOCATION. HEYWOODS
LOCATION. KIEWA
LOCATION. BANDIANA
LOCATION. DOCTORS_PT
LOCATION. ALBURY
END OF RATING CURVE DATA.

5 GAUGING STATIONS:
LOCATION. HEYWOODS
LOCATION. KIEWA
LOCATION. BANDIANA
LOCATION. DOCTORS_PT
LOCATION. ALBURY
END OF GAUGING STATIONS.

Upper Murray Rainfall Assignment

- Use Utility SUBRAIN to assign a virtual pluviograph for each subarea (this is is preferred approach for flood forecasting)
- (FEWS will do this in real time)
- Steps outside of FEWS: - 3 steps
  - Generate '.raw' files
  - Convert to URBS .r and .g station files using C2U
  - Assign rainfall to each subarea using SUBRAIN

RAW Data Files – Pluviograph Data

AWRC 401009 Rainfall
Source: NSW Water Information
1/01/2010 0:00 0.0
1/01/2010 1:00 0.0
1/01/2010 2:00 0.0
1/01/2010 3:00 0.0
1/01/2010 4:00 0.0
1/01/2010 5:00 0.0
1/01/2010 6:00 0.0
1/01/2010 7:00 0.0
1/01/2010 8:00 0.2
1/01/2010 9:00 0.2
1/01/2010 10:00 0.2
1/01/2010 11:00 0.2
1/01/2010 12:00 0.2
1/01/2010 13:00 0.2

RAW Data Files – Daily Rainfall Data

Station: 71042
Source: BoM Climate Information Pack:
01/02/2011 09:00:00 0.00
02/02/2011 09:00:00 0.00
03/02/2011 09:00:00 27.00
04/02/2011 09:00:00 31.00
05/02/2011 09:00:00 54.00
06/02/2011 09:00:00 68.40
07/02/2011 09:00:00 69.40
08/02/2011 09:00:00 69.40
09/02/2011 09:00:00 69.40
10/02/2011 09:00:00 69.40
11/02/2011 09:00:00 71.40
12/02/2011 09:00:00 100.40
13/02/2011 09:00:00 100.40

RAW Data Files – Gauging Station data

AWRC 401001h Water Level
Source: NSW Water
28/02/2012 1:00 1.173
28/02/2012 2:00 1.171
28/02/2012 3:00 1.17
28/02/2012 4:00 1.171
28/02/2012 5:00 1.184
28/02/2012 6:00 1.205
28/02/2012 7:00 1.209
28/02/2012 8:00 1.228
28/02/2012 9:00 1.233
28/02/2012 10:00 1.226
28/02/2012 11:00 1.22
28/02/2012 12:00 1.215
28/02/2012 13:00 1.215
28/02/2012 14:00 1.21

Conversion to URBS Files

```
rem Batch file to generate urbs data files

set /p start=
set /p end=

rem Set start/end dates
set URBS_DATE=%start%
set URBS_TIME=09:00:00
set END_DATE=%end%
set END_TIME=09:00:00

rem Remove old files
rem del *.g, *.r

rem Regenerate urbs data files
d:\urbs\bin\c2u daily.stns -l -i24 -2 -e
d:\urbs\bin\c2u pluvio.stns -l -i1 -2 -e
d:\urbs\bin\c2u river.stns -l -i1 -2 -e
```

Example Station File (.stns)

401012.raw,BIGGARA.g
401549.raw,BRINGENBONG.g
401009.raw,MARAGLE.g
401014.raw,PINEGROVE.g
401201.raw,R_JINGELLIC.g
401013.raw,CK_JINGELLIC.g
401015.raw,YAMBLA.g
401203.raw,HINNOMUNJIE.g
401224.raw,DARTMOUTH.g
401224.raw,DARTMOUTH_DAM.g
401211.raw,COLEMANS.g
401204.raw,TALLANDOON.g
401027.raw,HUME.g
401027.raw,HUME_DAM.g
HD_OUTFLOW.raw,HD_OUTFLOW.g

409016.raw,HEYWOODS.g
402205.raw,BANDIANA.g
409017.raw,DOCTORS_PT.g
409001.raw,ALBURY.g
401208.raw,BERRINGAMA.g
401229.raw,CUDGEWA_NORTH.g
401217.raw,GIBBO_PK.g
402222.raw,KIEWA.g
401216.raw,JOKERS_CK.g
401220.raw,MCCALLUMS.g

Assign rainfall to each Subarea - SUBRAIN

1. Prepare a network file
2. Prepare a subarea file
3. Using SUBRAIN Generate the virtual subarea pluviographs (VSAP's)
4. Examine results incl. KML's –
   Omit faulty stations
5. Repeat until satisfied

Using SubRain

- Used as follows

SUBRAIN filename.net filename.sub

Followed by switches

- Net file
  - Contains lists of stations that you want considered in the analysis
- Sub file
  - Contains subarea details – in particular the lat/long of subarea centroid

SubRain Switches

- **-3 for triangulation interpolation**
- **-b for the BoM net file format**
- -c<n.n> continuing loss
- -d<directory for all data input and output files>
- **-e use URBS starttime and endtime variables environment**
- -i<n.n> data interval in hours
- **-l<label> label for output rainfall files**
- **-n<nn> -> use the nn nearest stations**
- **-m<nn> -> 1 for row method (default) and 2 for col method**
- -o<output file name>
- -p<project file name>
- -r<rainfall Directory with input raw data>
- -s<n.n> run Scale
- -t<n.n> iniTial loss
- -u<Urbs catchment definition file name>
- -w<rainfall directory for output rainfall data>

Using SubRain - Tips

- Always Always check the results file
- Comment out suspect stations
- Rerun until satisfied
- Rainfall not right – no amount of modelling will give you an accurate answer

Network file – one file for all subs

UPPER MURRAY RIVER
217 RAINFALL STATIONS:
070217 COOMA AIRPORT AWS 1485821 -361739 p -99
071010 KIANDRA CHALET 1483000 -355300 p -99
071029 SPENCERS CREEK 1482100 -362600 p -99
071032 THREDBO AWS 1481709 -362929 p -99
071034 GUTHEGA POWER STATION 1482445 -362106 p -99
071035 MOONBAH (RIVERVIEW) 1483300 -362900 p -99
071042 INGEBYRA (GROSSES PLAINS) 1482804 -363608 p -99
072023 HUME RESERVOIR 1470158 -360614 p -99
……
……
83084 FALLS CREEK 1471632 -365215 d -99
83085 MOUNT HOTHAM 1470803 -365836 d -99
83090 OMEO 1473603 -370606 d -99
83095 ANGLERS REST (BUNDARRAH VALLEY) 1472440 -370001 d -99
END OF RAINFALL STATIONS.

Subarea file – one file for each sub

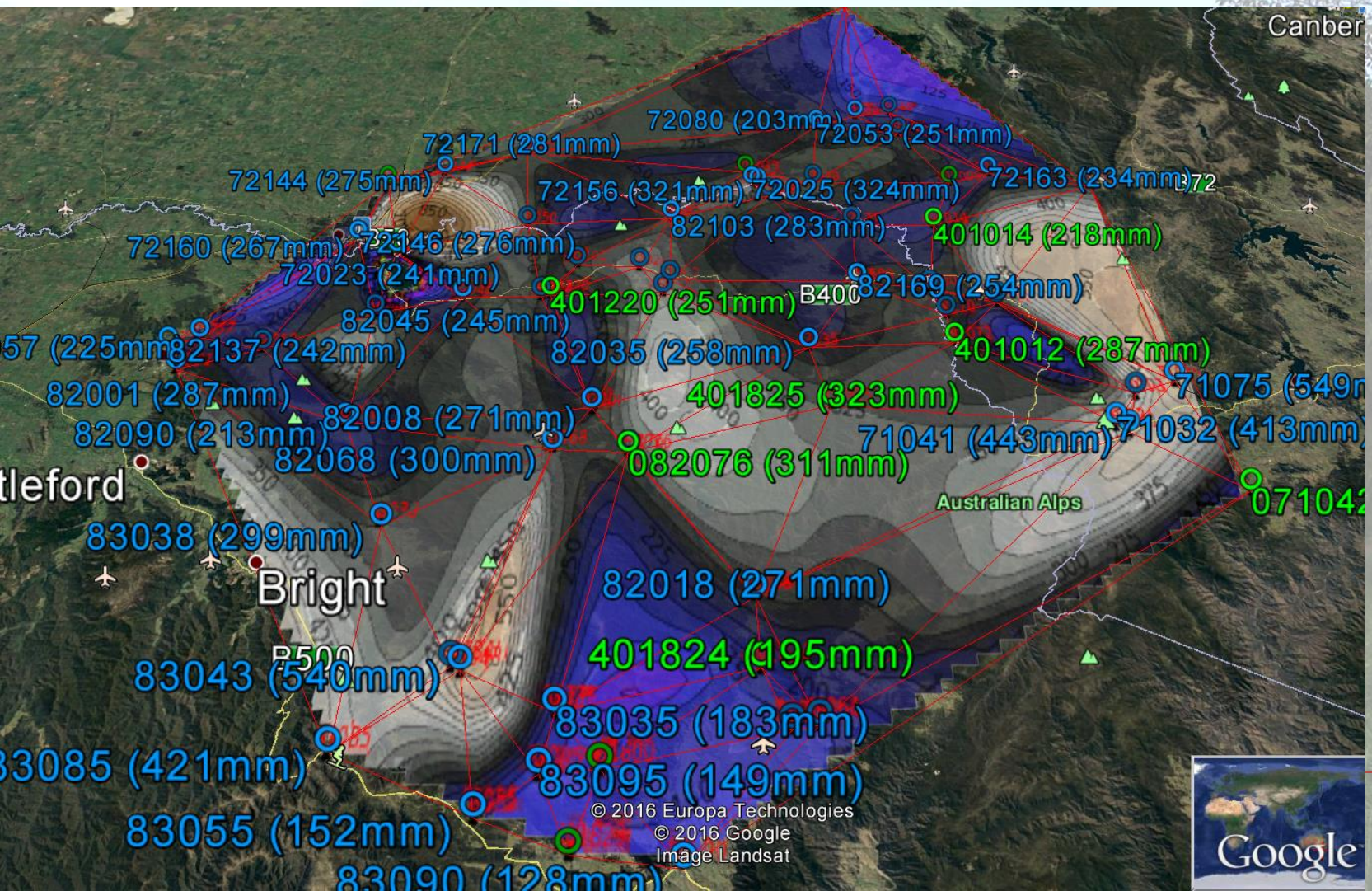
Upper Murray to Hume Dam
95 SUBAREAS:
2 1470157 -360644
3 1480219 -362402
4 1480612 -361328
5 1480322 -361348
6 1480559 -355457
7 1480351 -360122
8 1481717 -360556
…..
…..
93 1471502 -361646
94 1471553 -360952
95 1472127 -361450
96 1472434 -361039
END OF SUBAREAS.

Generate VSAP's using SUBRAIN

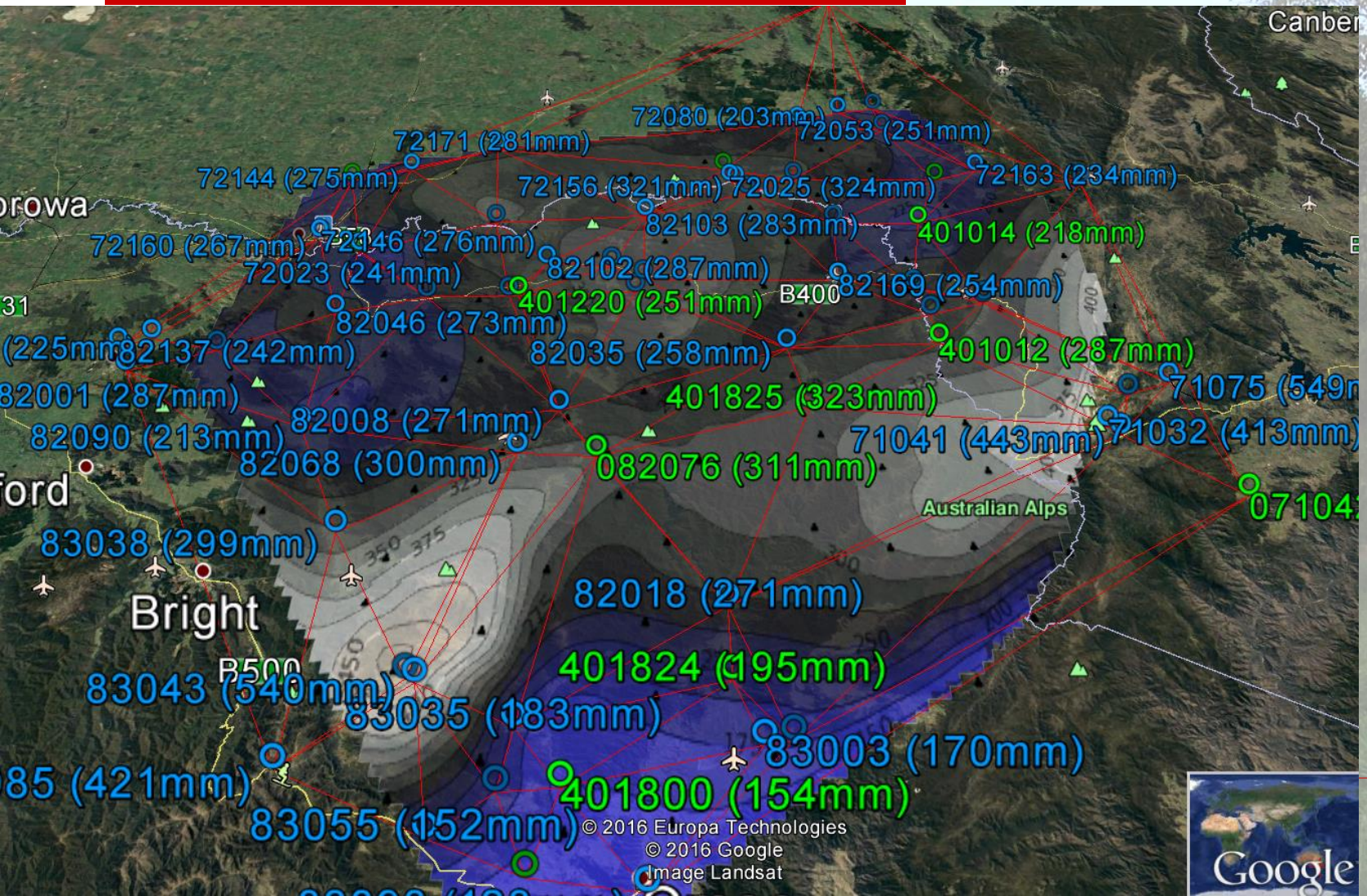
```
echo off
del *.res
set /p start=
set /p end=
set /p event=

rem Set start/end dates
set URBS_DATE=%start%
set URBS_TIME=09:00:00
set END_DATE=%end%
set END_TIME=09:00:00

d:\urbs\bin\subrain.exe upper_m.net mitta.sub -lmitta -b -e -3
d:\urbs\bin\subrain.exe upper_m.net upper.sub -lupper -b -e -3
d:\urbs\bin\subrain.exe upper_m.net below.sub -lbelow -b -e -3
```

Interpolation Methodology - Triangulation

Interpolation Methodology – Triangulation Station Contours



Interpolation Methodology – Triangulation SubArea Contours



SUBRAIN 'res' file

```
UPPER MURRAY RIVER
217 RAINFALL STATIONS:
"070217       COOMA AIRPORT AWS        1485821    -361739    p    -99.0
"071010       KIANDRA CHALET           1483000    -355300    p    -99.0
"071029       SPENCERS CREEK           1482100    -362600    p    -99.0
"071032       THREDBO AWS              1481709    -362929    p    -99.0
"071034       GUTHEGA POWER STATIO     1482445    -362106    p    -99.0
"071035       MOONBAH (RIVERVIEW)      1483300    -362900    p    -99.0
"071042       INGEBYRA (GROSSES PL     1482804    -363608    p    -99.0
 072023       HUME RESERVOIR           1470158    -360614    p    210.4
"072056       BLOWERING DAM            1481449    -352341    p    -99.0
"072060       KHANCOBAN SMHEA          1480835    -361331    p    -99.0
…..
…..
"83071        FALLS CREEK              1471700    -365200    d    -99.0
"83081        MOUNT HOTHAM             1470852    -365900    d    -99.0
 83084        FALLS CREEK              1471632    -365215    d    236.4
 83085        MOUNT HOTHAM             1470803    -365836    d    269.6
 83090        OMEO                     1473603    -370606    d    107.0
 83095        ANGLERS REST (BUNDAR     1472440    -370001    d    121.6
END OF RAINFALL STATIONS.
```

Exercise ...

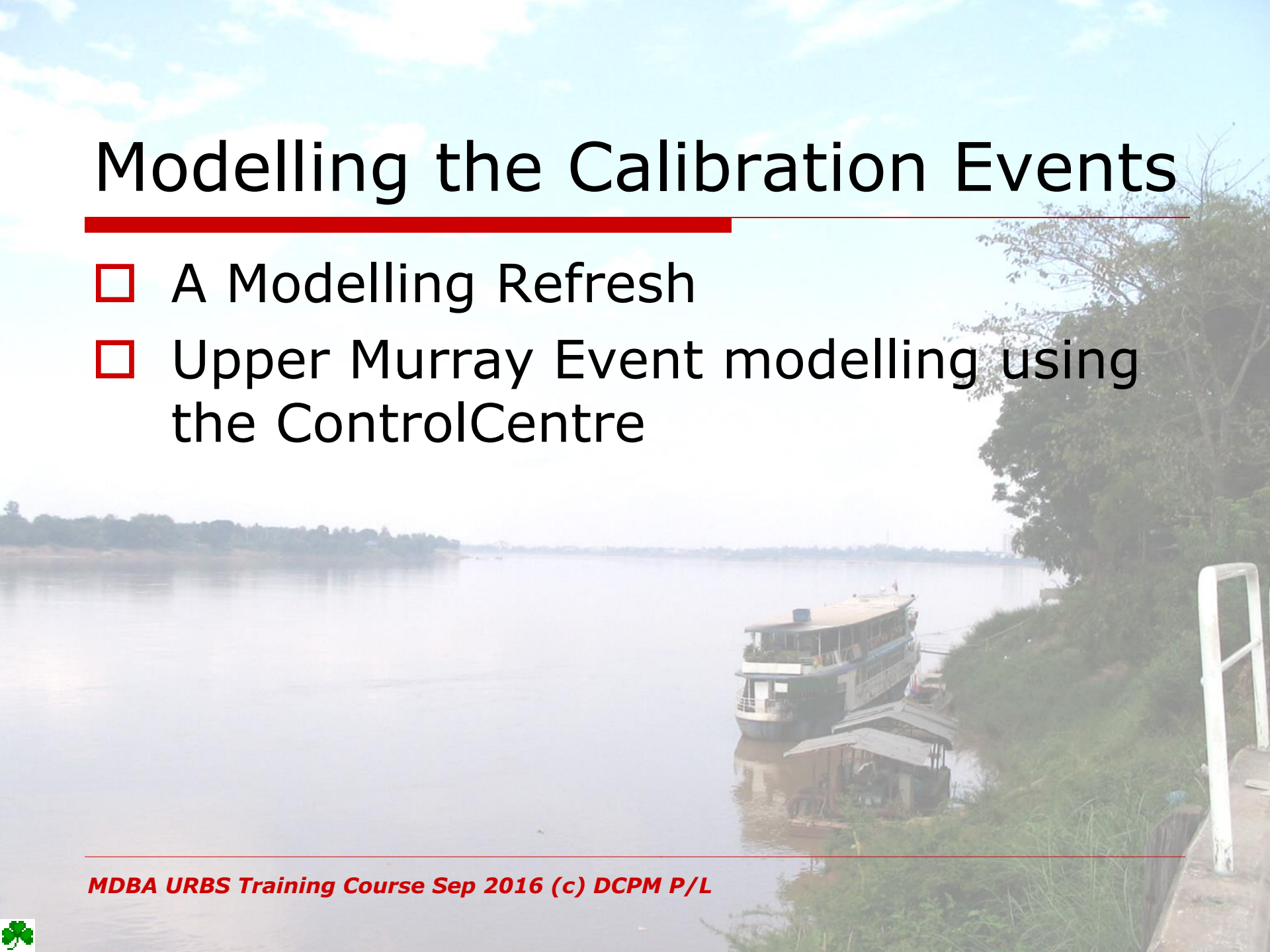
Objective:

To be able to run the SUBRAIN utility and assess changes in subarea rainfall depths due to: (a) omission of stations and (b) rainfall interpolation methodology.

- Go to 201203 sub-directory
- Open the KML file/Res files and view
- Edit the network file and omit McCallums (401220)
- Compare res and KML files
- Change Interpolation technique to nearest 3 stations
- Compare results
- Discussion

Modelling the Calibration Events

- A Modelling Refresh
- Upper Murray Event modelling using the ControlCentre



Runoff Routing Models

- SPLIT MODEL
  - Catchment routing
    - Lag proportional to √ Area
    - Rainfall assumed to be routed to centroid of sub-catchment
    - Usually assumed non-linear response
  - Channel routing
    - Lag proportional to River Length (or surrogate)
    - Usually assumed linear (Muskingum)

Catchment Routing

- Storage Equation

$$S_{catch} = \left\{ \frac{\beta \sqrt{A}(1+F)^2}{(1+U)^2} \right\} Q^m$$

- Note – if not assessing urbanization or de-forestation U=0 and F=0

Catchment Routing

- Parameters
  - Beta : lag parameter (1-9)
  - m : non-linearity parameter (0.6-1)
  - U : fraction Urbanised (0 – 1)
  - F : fraction forested (0 – 1)

Channel Routing - Muskingum

- Storage Equation

$$S_{chnl} = \alpha f \frac{L}{\sqrt{S_c}} (xQ_u + (1 - x)Q_d)^n$$

Channel Routing

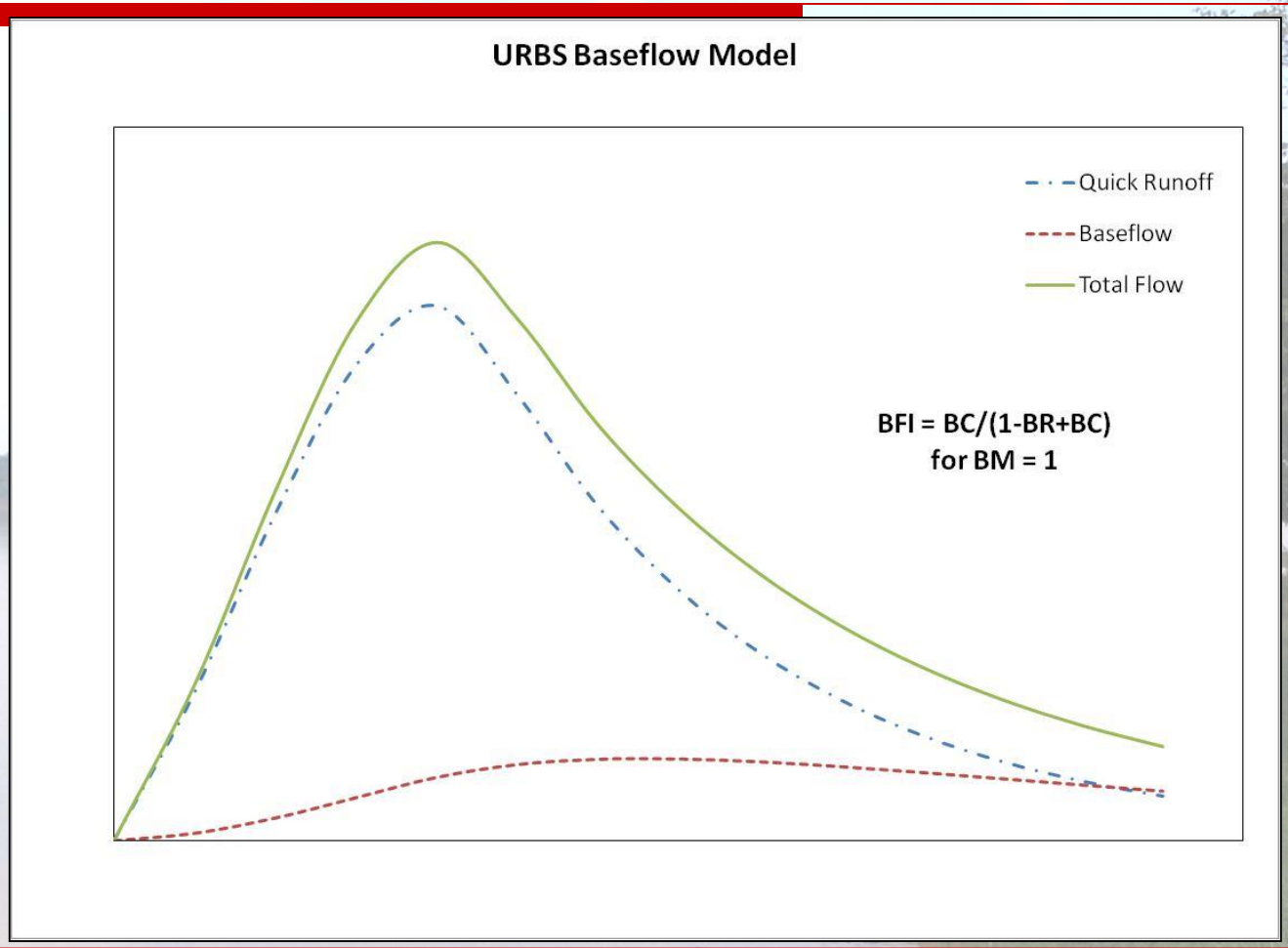
- Parameters
  - Alpha : lag Parameter (.1 – .5)
  - n : Non-linearity parm (0.8-1.2)
  - f : Reach length factor (0.3 - 3)
  - x : Muskingum x parameter (0-0.5)

BaseFlow Modelling

- Baseflows are accumulated along drainage network
- Baseflow values can be overwritten
- Baseflow can vary over time:

$$Qb_i = B0 + BR\,(Qb_{i-1} - B0) + BC\,(Qr)^{BM}$$

Baseflow Modelling



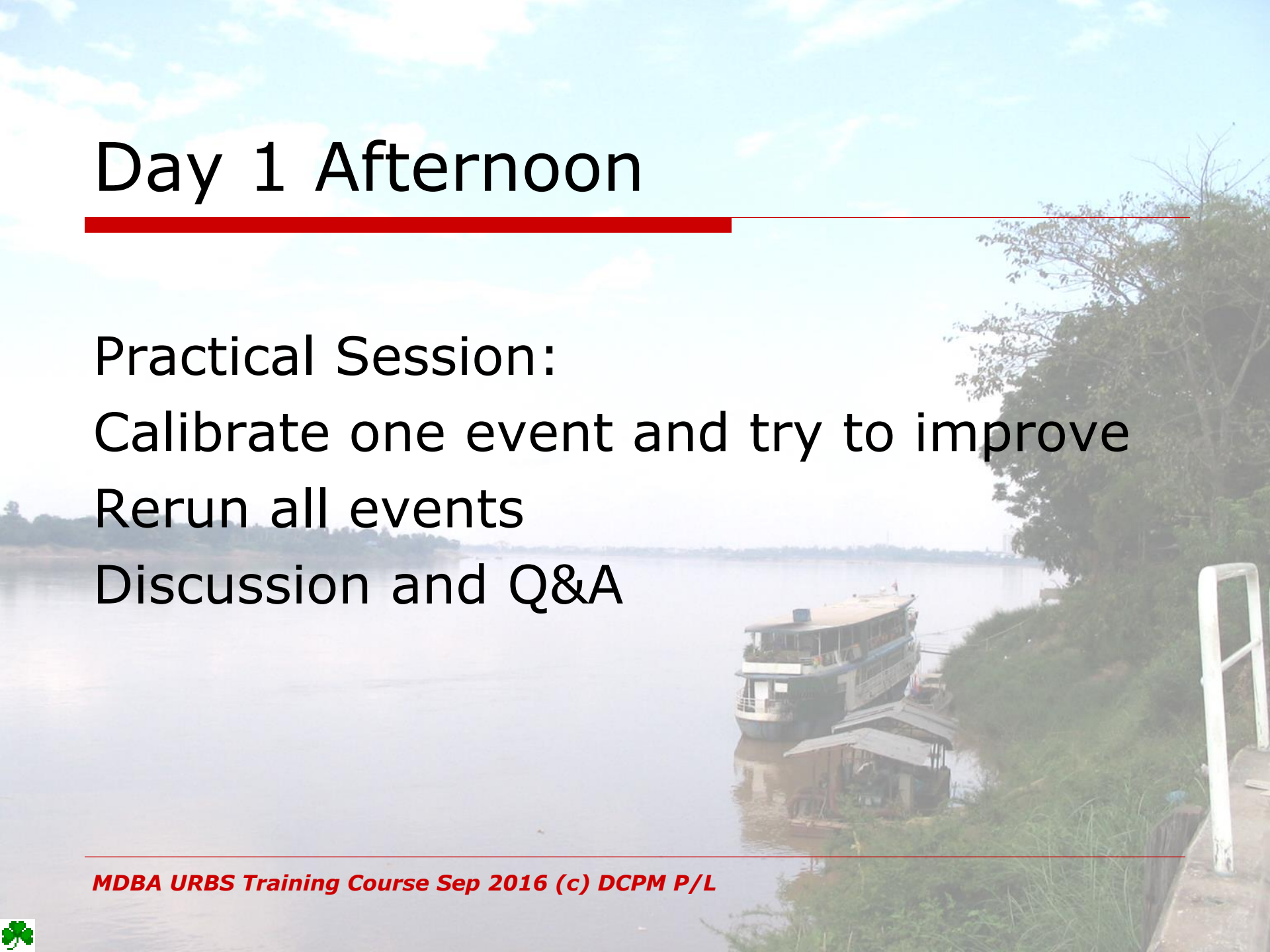
Day 1 Afternoon

Practical Session:

Calibrate one event and try to improve

Rerun all events

Discussion and Q&A



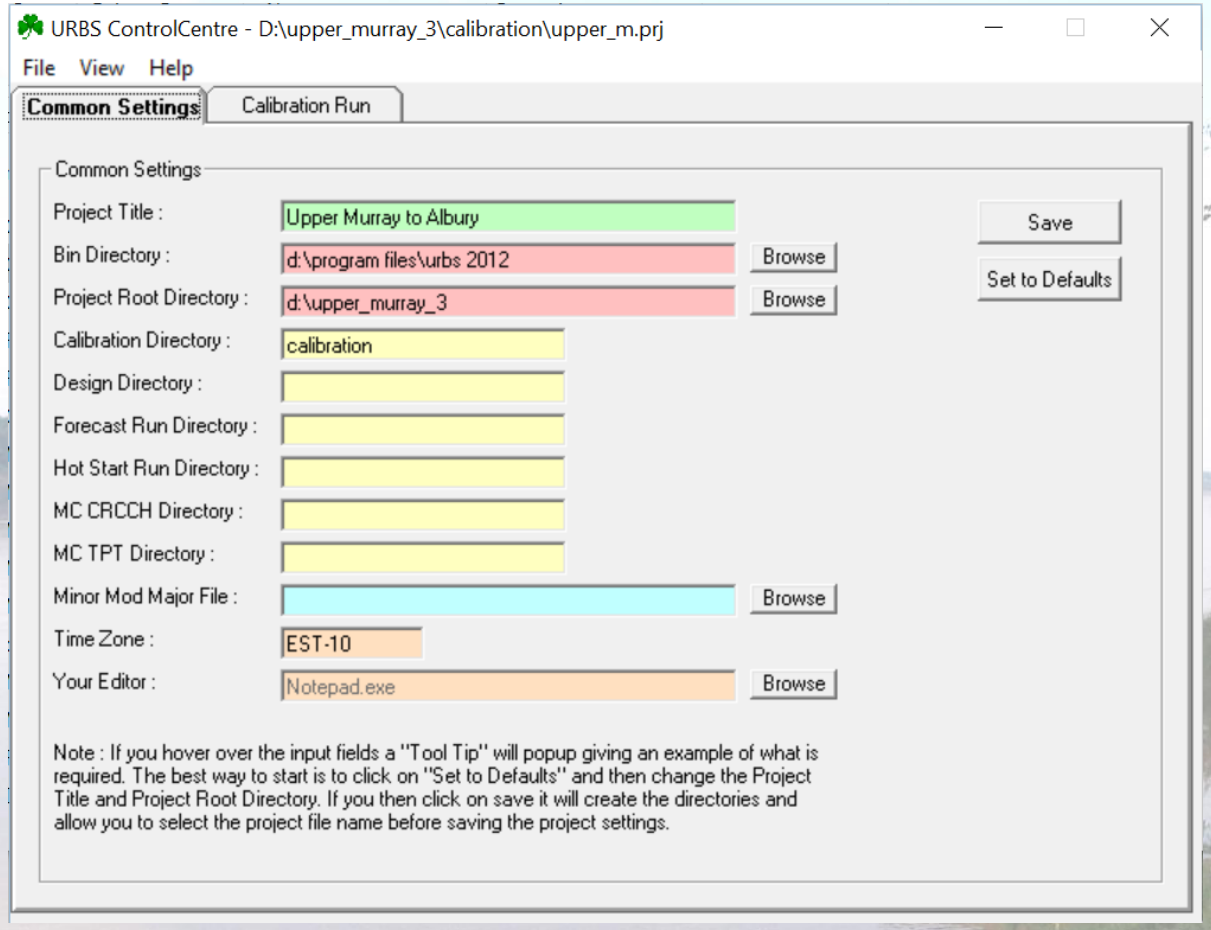
Day 1 Afternoon

Load the ControlCentre

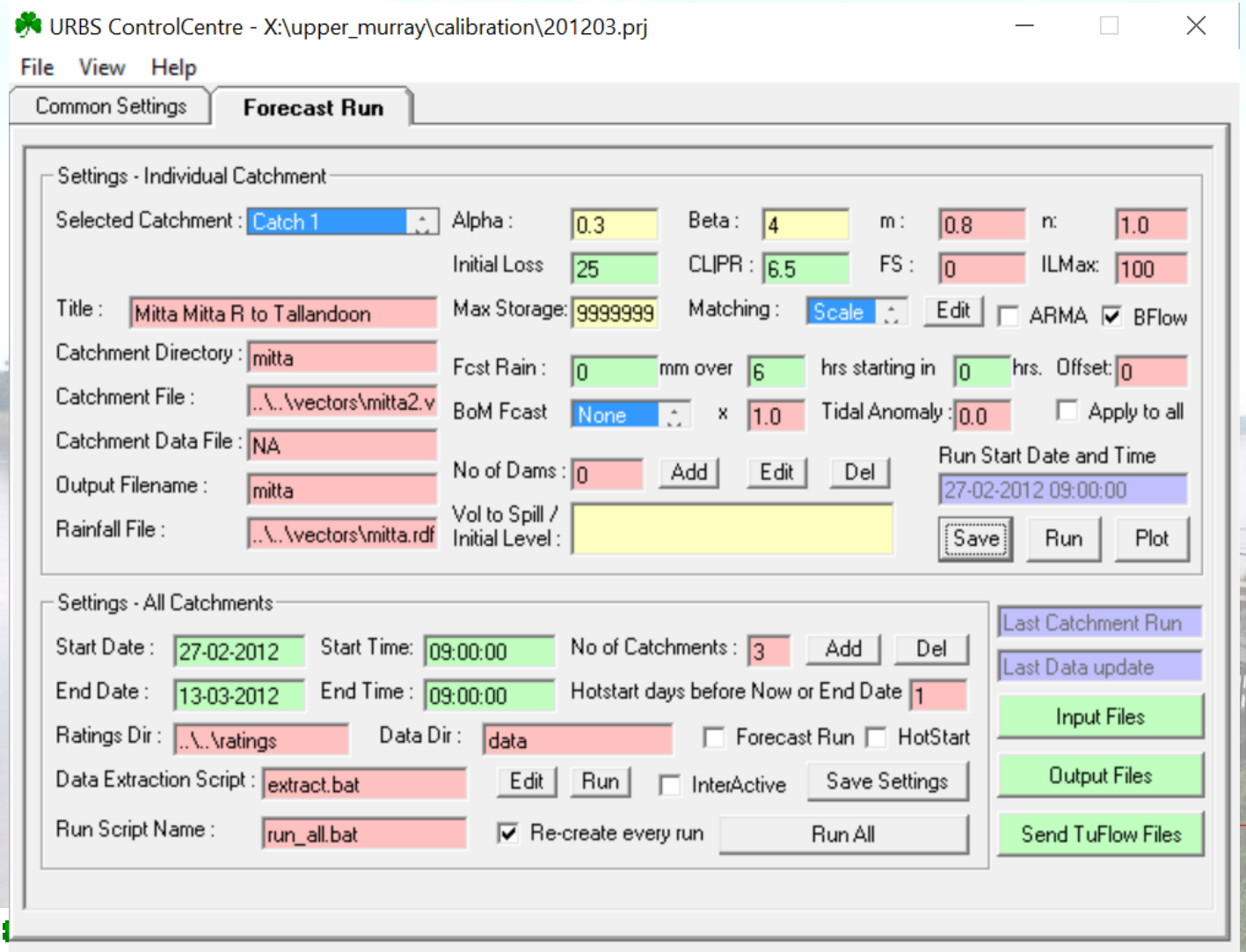
Change the Common Settings

Run the 201203 event

ControlCentre – Common Settings



ControlCentre – Forecast Page



Catch1 = Mitta
Catch2 = Upper
Catch3 =Below

Dates

Parameters

Run the Model

Plot the results

Exercise – Try to improve Calibration

Change alpha and beta and m

Change loss parameters

Change rainfall interpolation technique

McCallums included/excluded

Khancoban matching ?

Inclusion of IF make any difference

Discussion

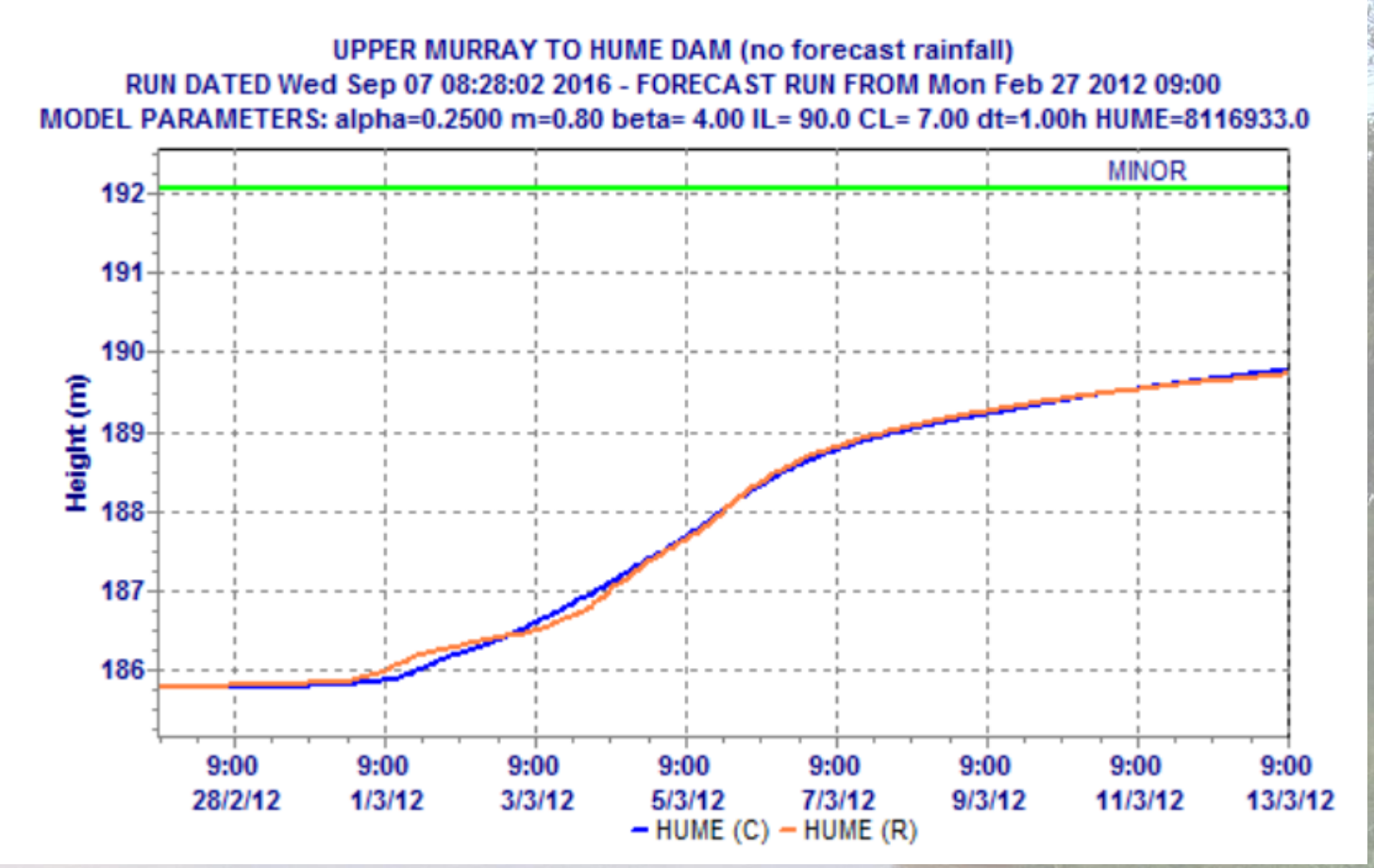
For Multi-Event calibration

- Routing Calibration parameters should not vary too much
- Each event needs to be weighted according to data availability & reliability
- Getting one event perfect does not guarantee a well calibrated model
- Always be suspicious of data (and even more of models ;-))

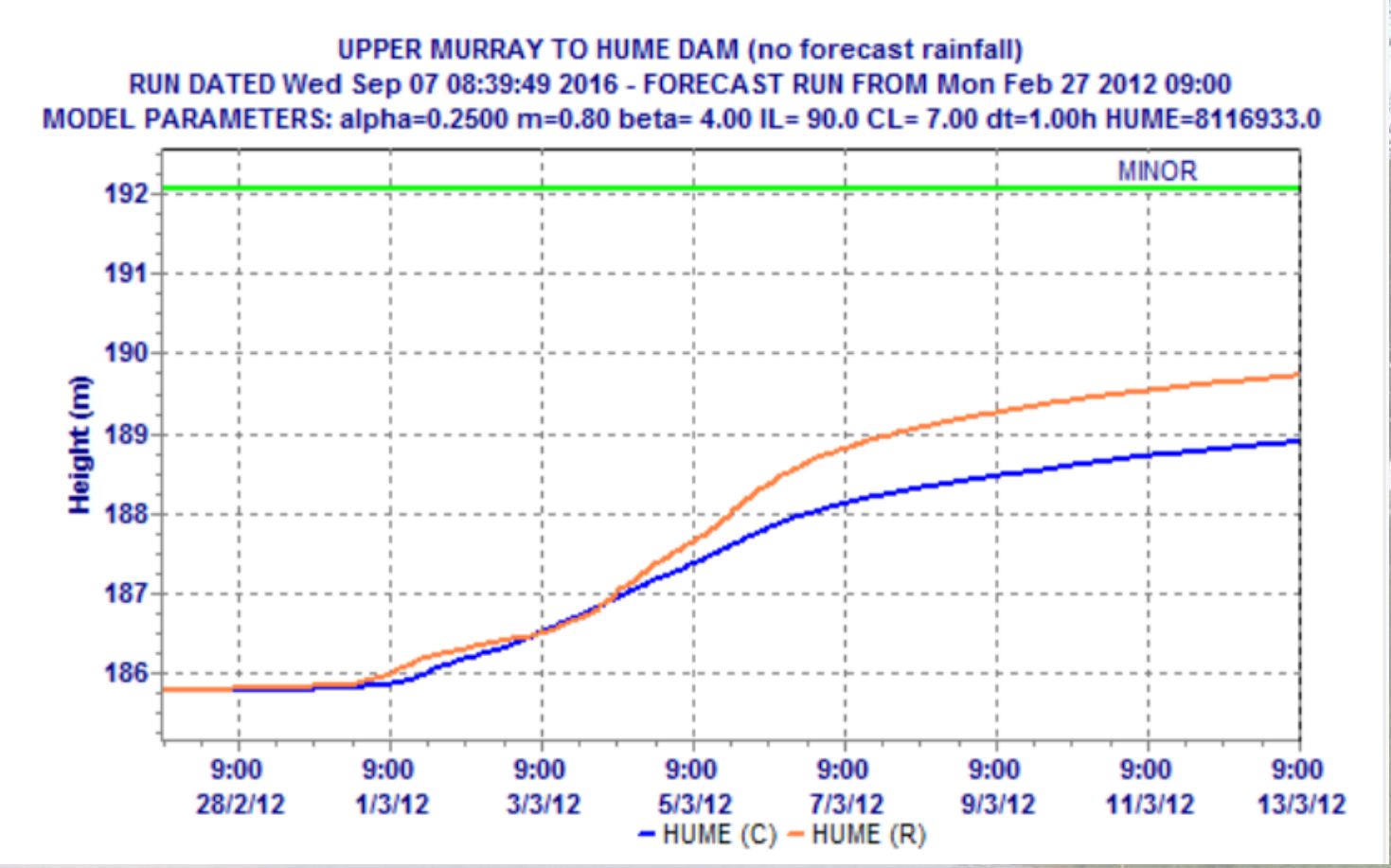
Day 2:

- Further from Day 1
- Model Results
  - Dartmouth Dam
  - Jingellic
  - Hume Dam
- Recommended Parameters
- Operational Considerations
- FEWS & URBS – adding new events

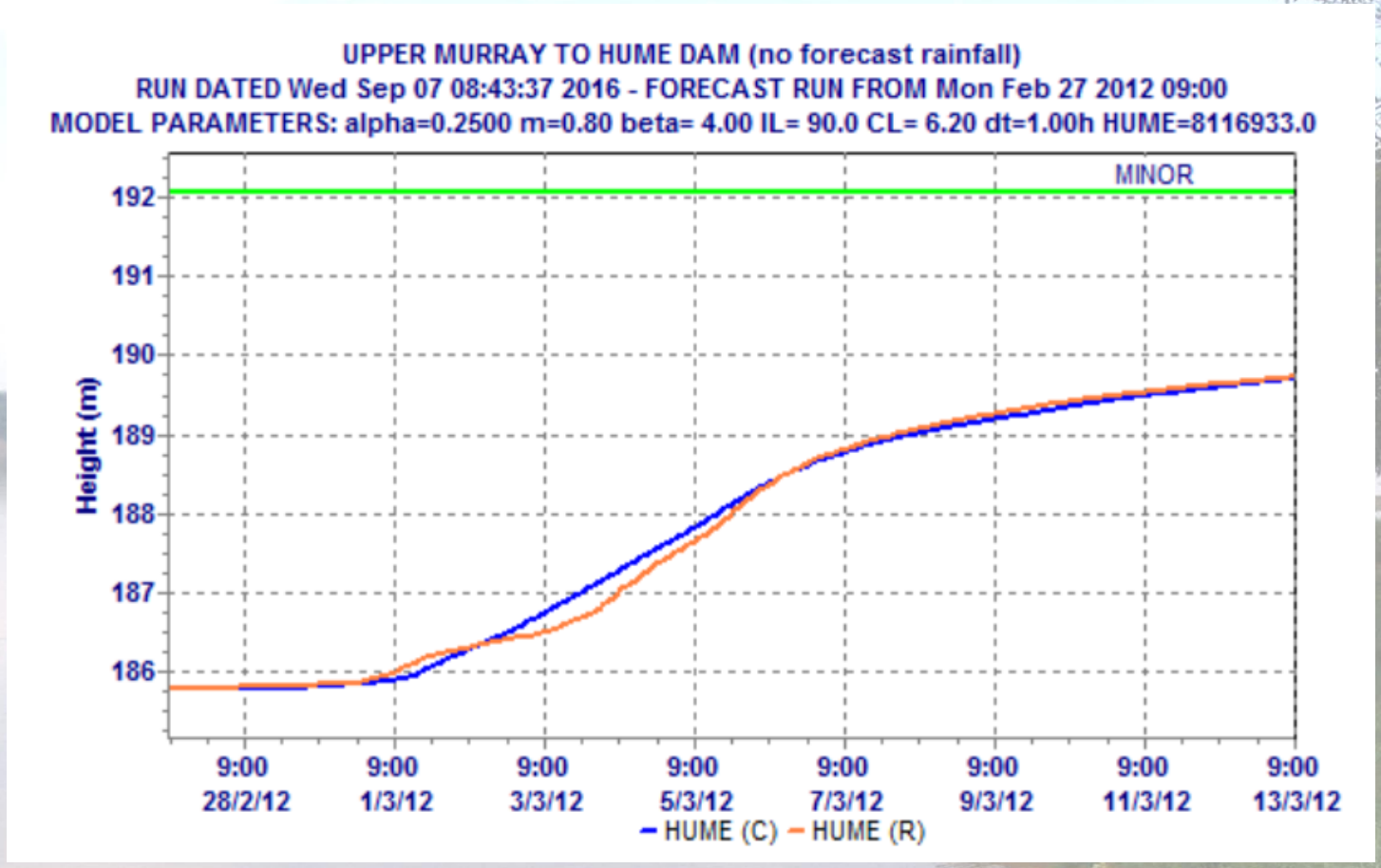
IF + Triangulation + McCallums + SMS flows



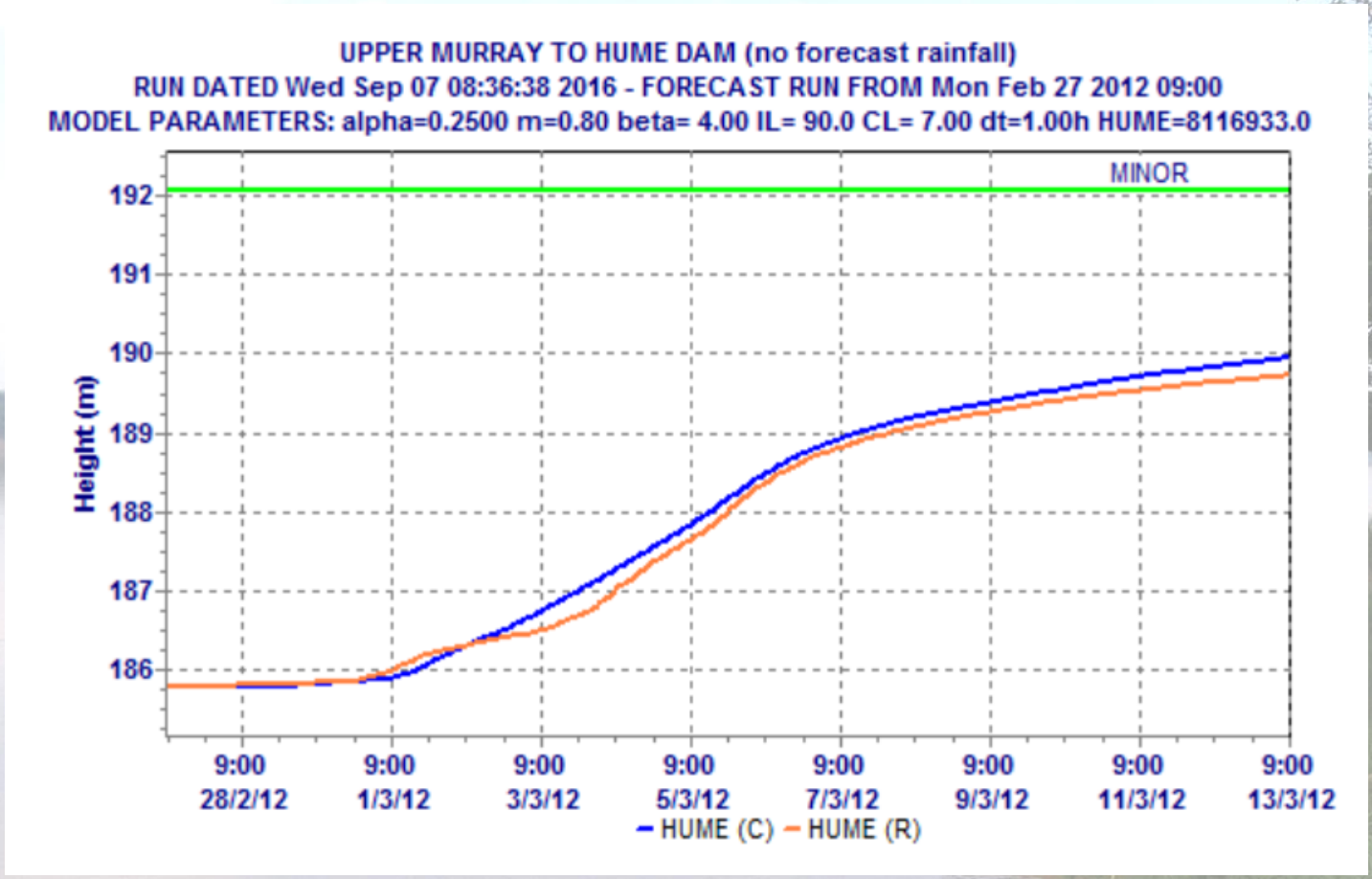
-IF + Triangulation + McCallums + SMS flows



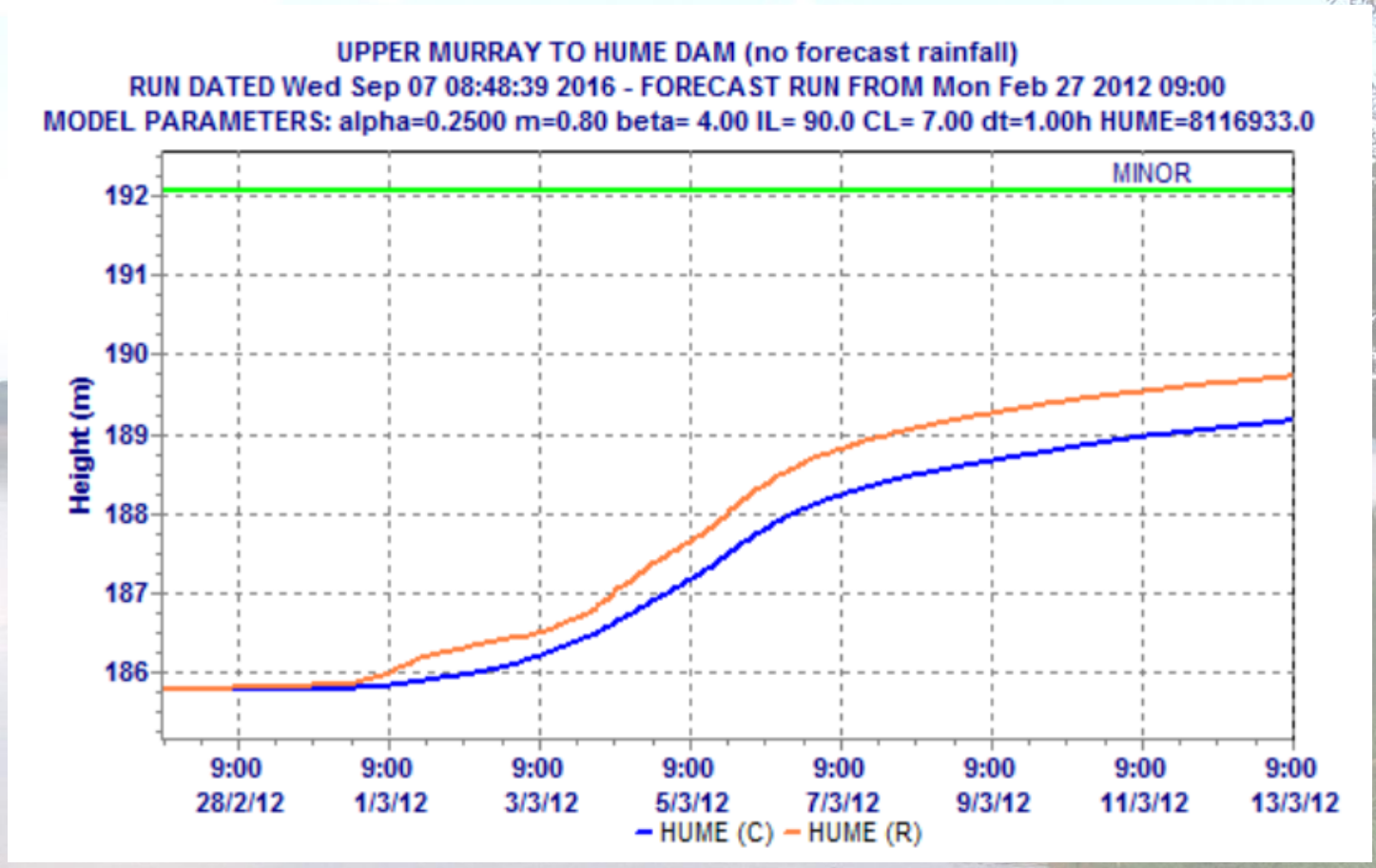
-IF+CL + Triangulation + McCallums + Khancoban Matched



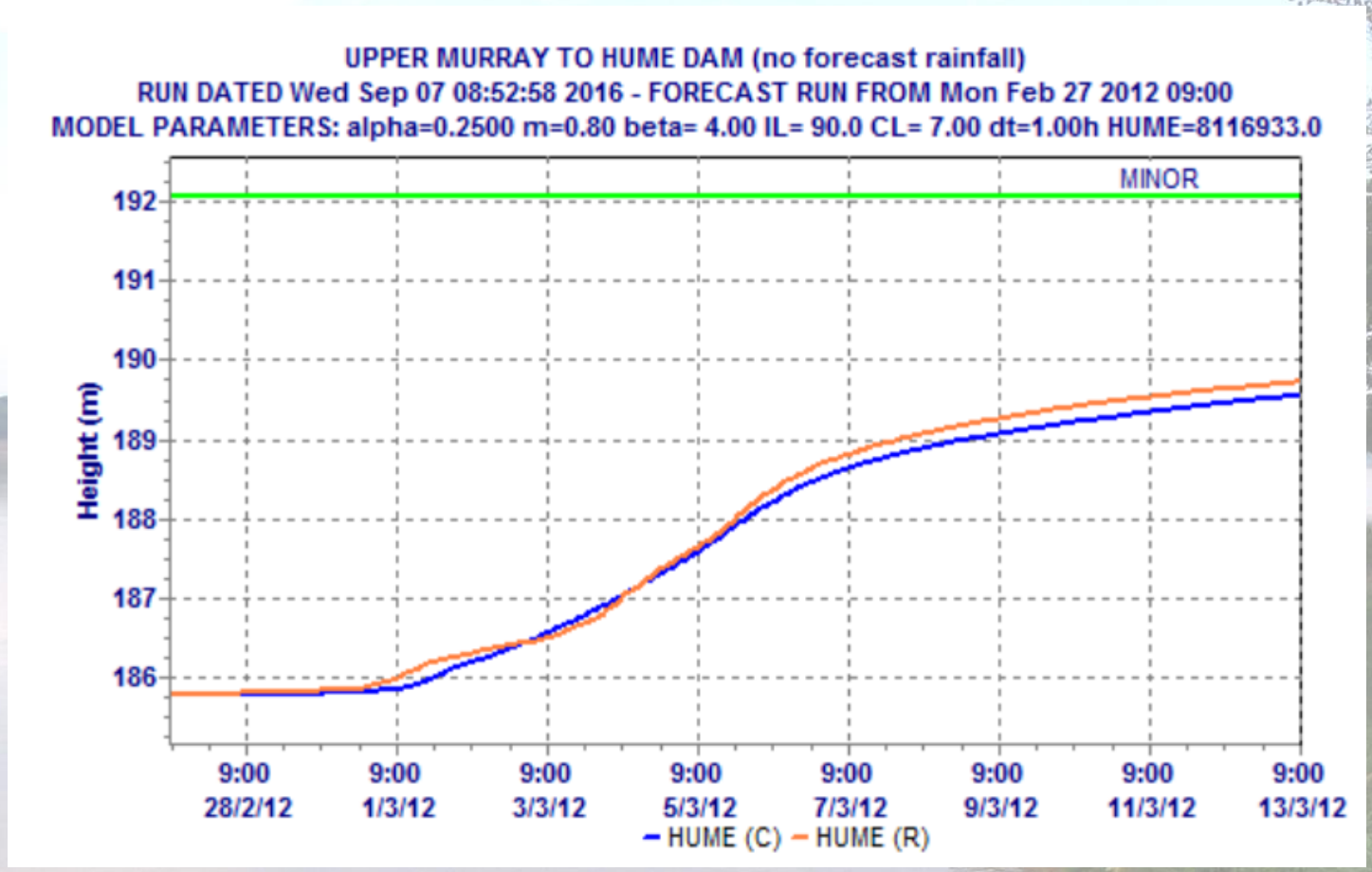
IF + IDW/rows + McCallums + SMS flows



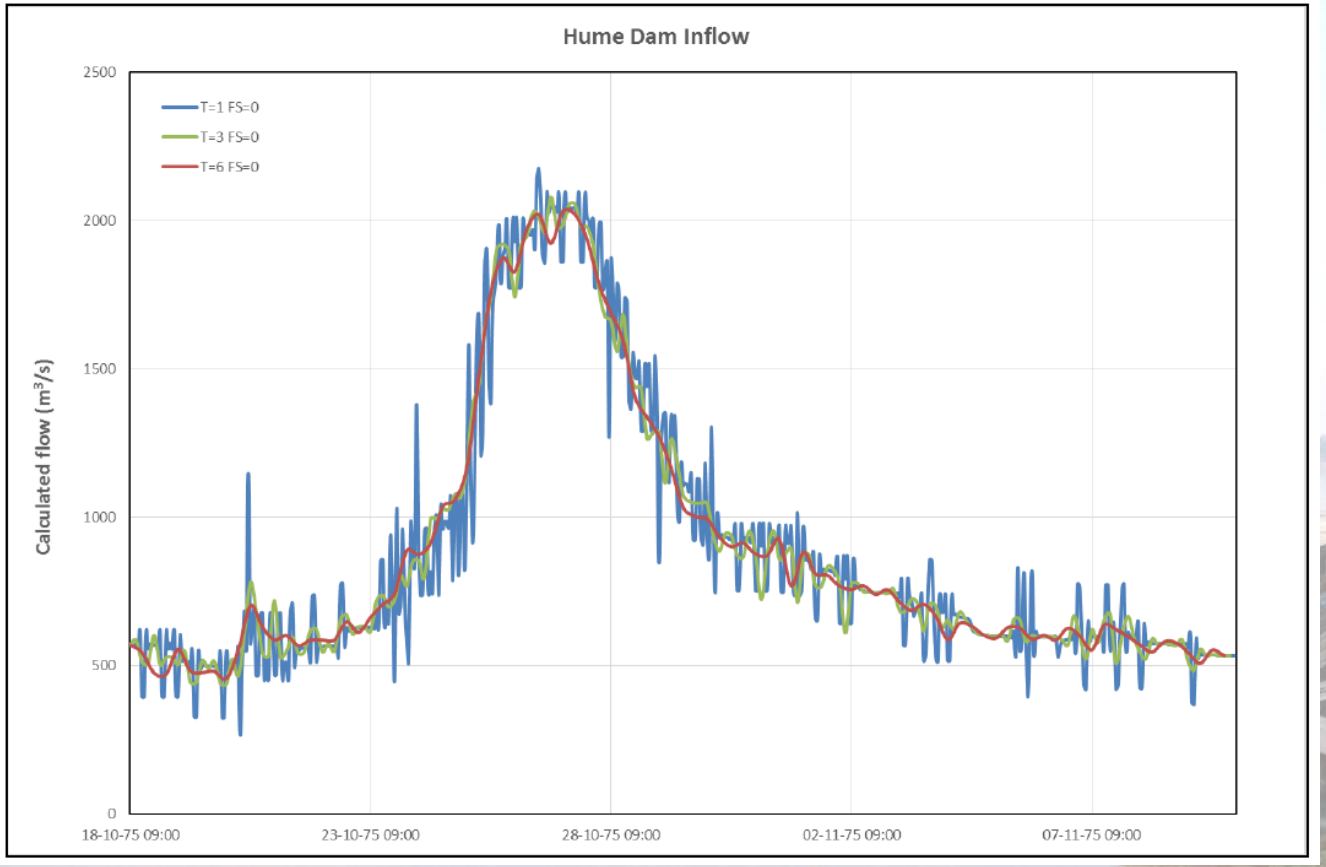
IF + Triangulation - McCallums + SMS flows



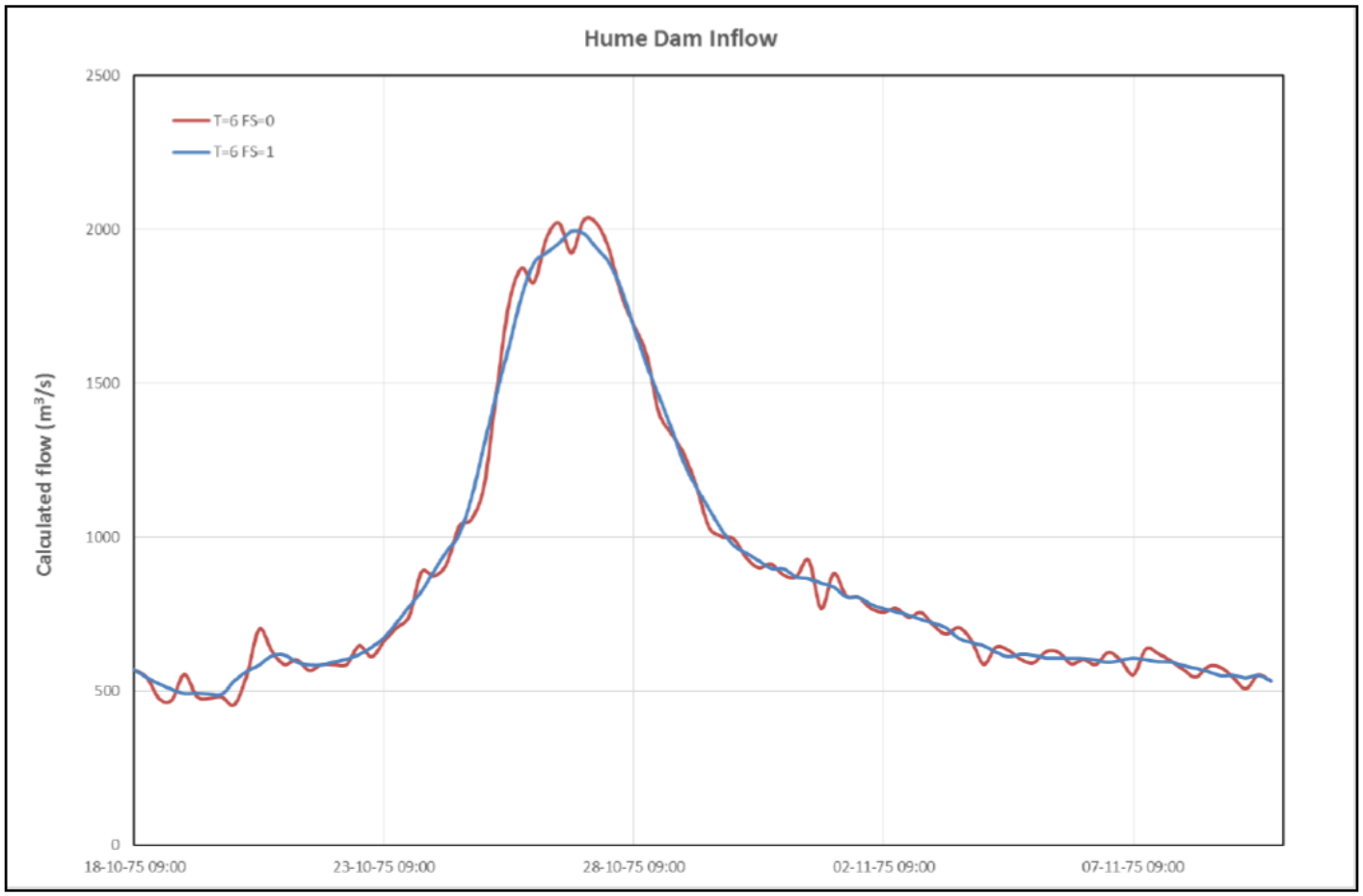
IF + Triangulation + McCallums - SMS flows



Reverse Routing – Increasing time interval



Reverse Routing – Smoothing



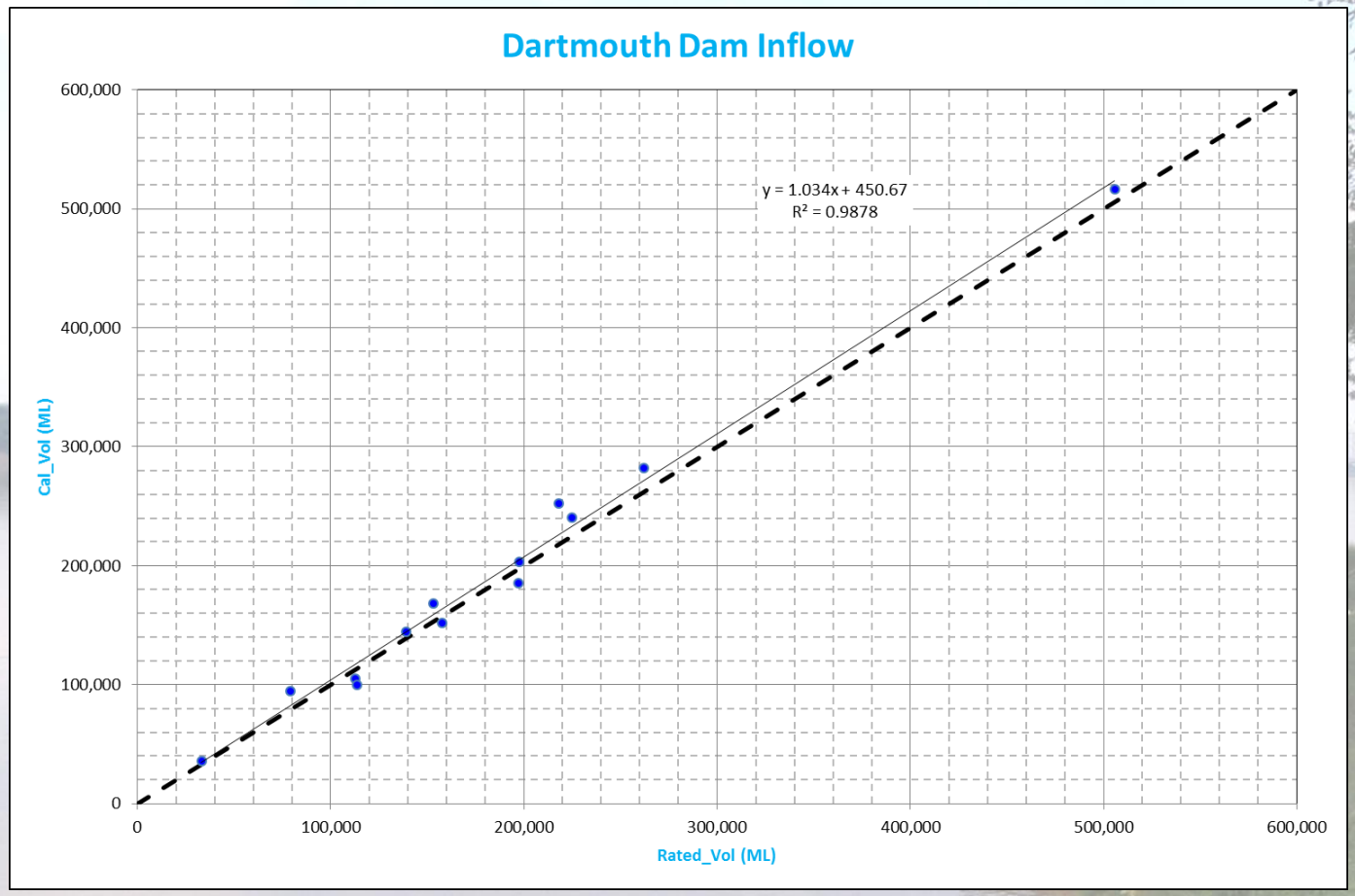
Criteria

Class	Score	Peak ratio	Volume ratio	Nash-Sutcliffe	Event magnitude	Quality of rainfall data
Excellent	5	<±10%	<±15%	≥0.95	90%	>2008
Good	4	<±15%	<±25%	≥0.90	75%	>2000
Fair	3			≥0.85	50%	>1990
Poor	2	<±50%	<±50%	≥0.50	25%	<1970
No data/exclude calibration	0	>±50%	>±50%	<0.5	0%	

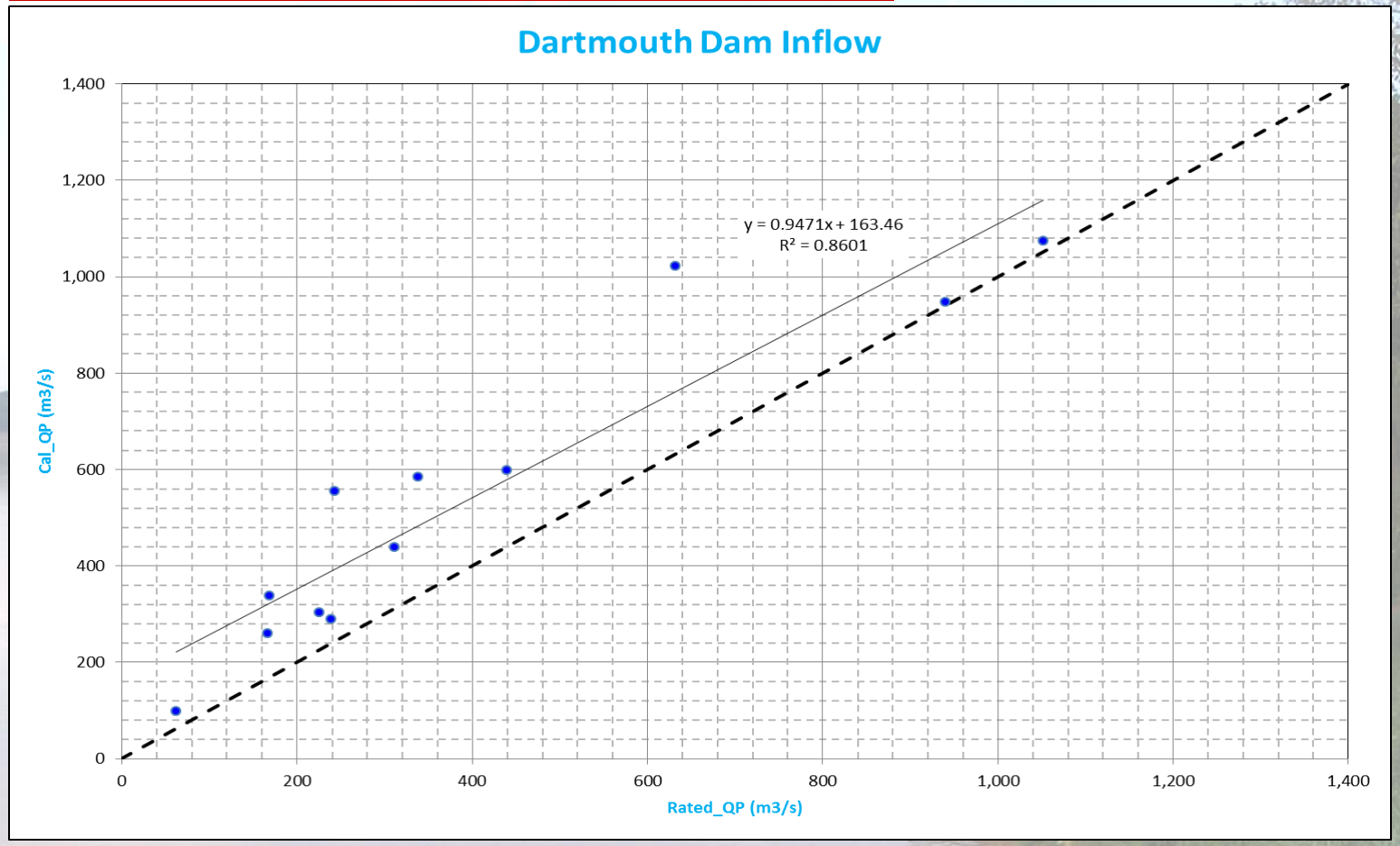
Weighting Events

Event	Calibration parameters					Calibration performance ranking			
	IL	CL	Alpha	Beta	m	PR	VR	NS	Weight
197401	35	4.3	0.30	3.0	0.8	5	4	0	5%
197410	10	1.8	0.30	3.0	0.8	2	5	2	7%
197510	15	1.1	0.30	5.0	0.8	4	5	4	8%
198107	10	1.8	0.35	4.0	0.8	2	5	3	6%
198308	5	2.3	0.30	3.0	0.8	2	5	0	5%
199210	5	3.8	0.25	3.0	0.8	2	5	3	7%
199310	0	2.8	0.30	5.0	0.8	4	5	3	7%
199607	10	1.3	0.35	5.0	0.8	2	5	2	6%
199610	10	3.5	0.40	5.0	0.8	4	2	0	4%
199809	35	4.0	0.30	4.0	0.8	2	2	0	4%
201009	20	2.6	0.35	5.0	0.8	2	5	3	7%
201010	15	5.3	0.25	3.0	0.8	0	5	3	7%
201012	30	7.0	0.30	4.0	0.8	2	5	3	7%
201102	60	8.1	0.30	4.0	0.8	2	5	2	7%
201109	15	5.4	0.25	3.0	0.8	2	5	0	5%
201203	80	6.0	0.25	4.0	0.8	5	5	2	8%

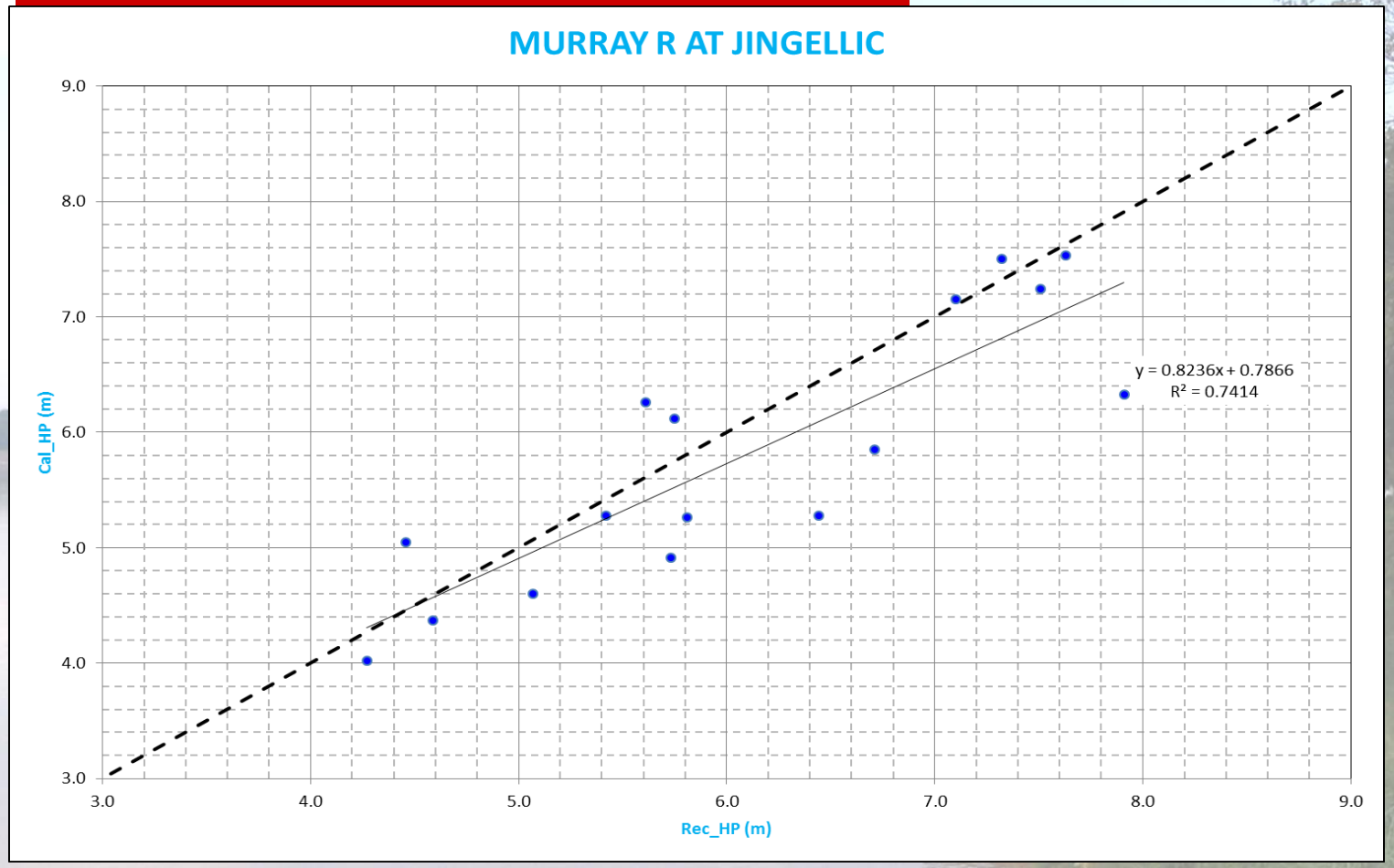
Dartmouth Dam – Volume Inflow



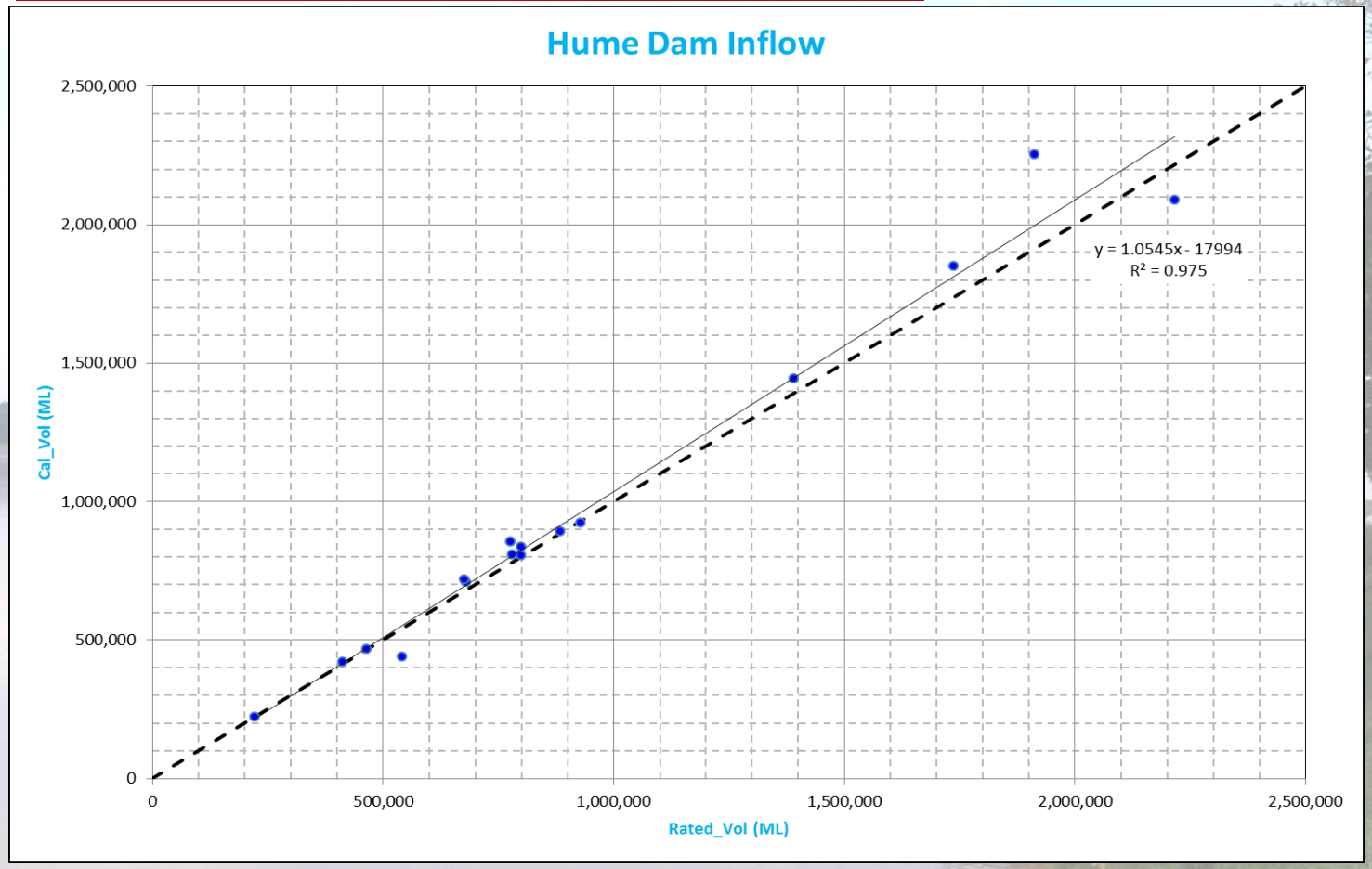
Dartmouth Dam – Peak inflows



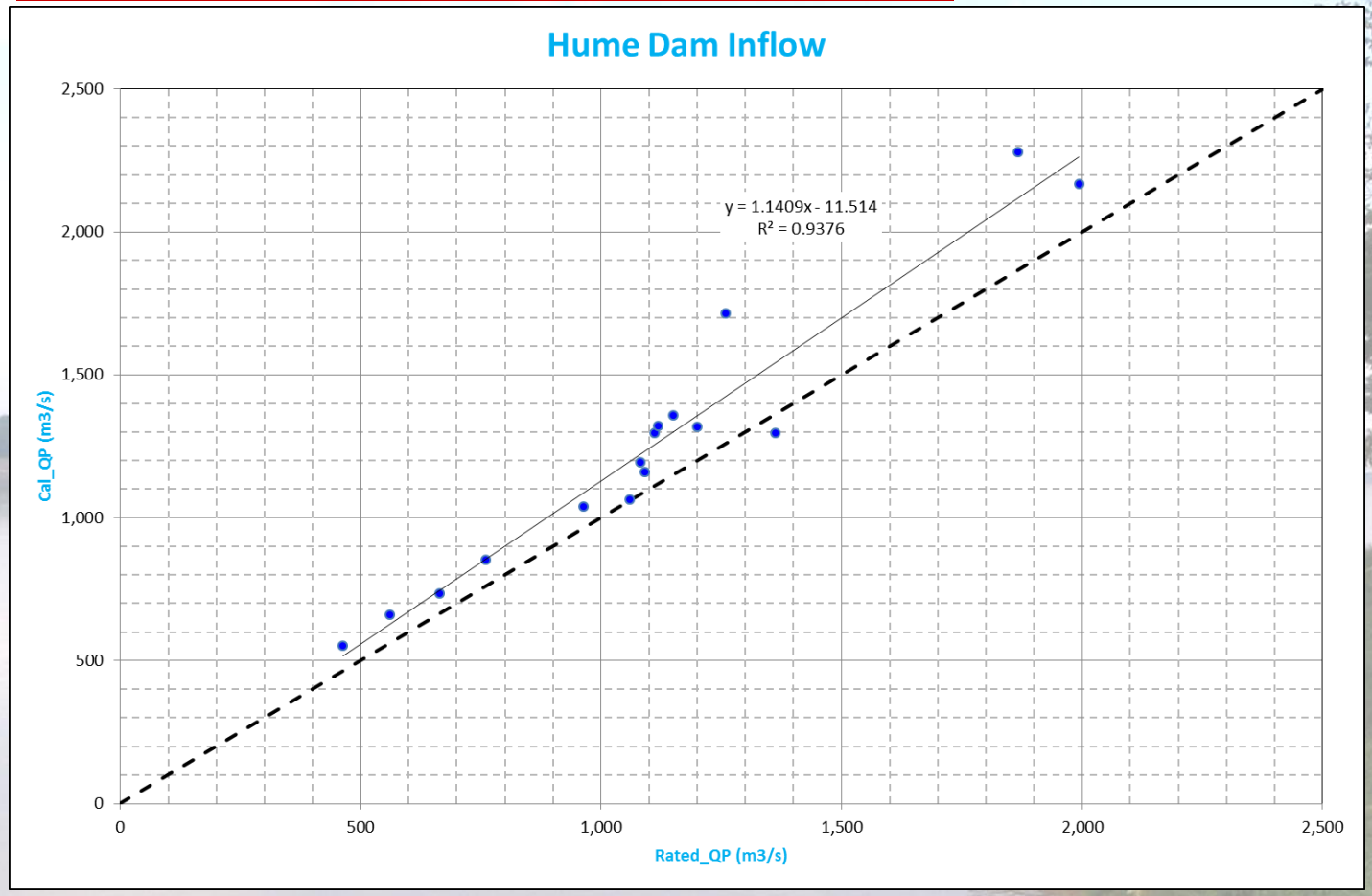
Jingellic - Flows



Hume Dam Volume Inflows



Hume Dam Peak Inflows



Recommended Parameters

Mitta Mitta

Percentile	IL (mm)	CL (mm/hr)	Alpha	Beta	m
5th	0	1.4	0.20	3.0	0.8
95th	68	7.6	0.43	5.3	0.8
Std Deviation		2.4	0.07	1.0	0.0
Recommended	To suit antecedent conditions	4.1	0.27	4.0	0.8

Upper Murray

Percentile	IL (mm)	CL (mm/hr)	Alpha	Beta	M
5th	4	1.3	0.25	3.0	0.8
95th	65	7.3	0.36	5.0	0.8
Std Deviation		2.0	0.04	0.8	0.0
Recommended	To suit antecedent conditions	3.8	0.30	4.0	0.8

Below Hume Weir

Percentile	IL (mm)	CL (mm/hr)	Alpha	Beta	M
5th	0	1.4	0.30	3.0	0.8
95th	61	6.5	0.50	5.0	0.8
Std Deviation		1.9	0.08	0.9	0.0
Recommended	To suit antecedent Conditions	3.2	0.36	4.3	0.8

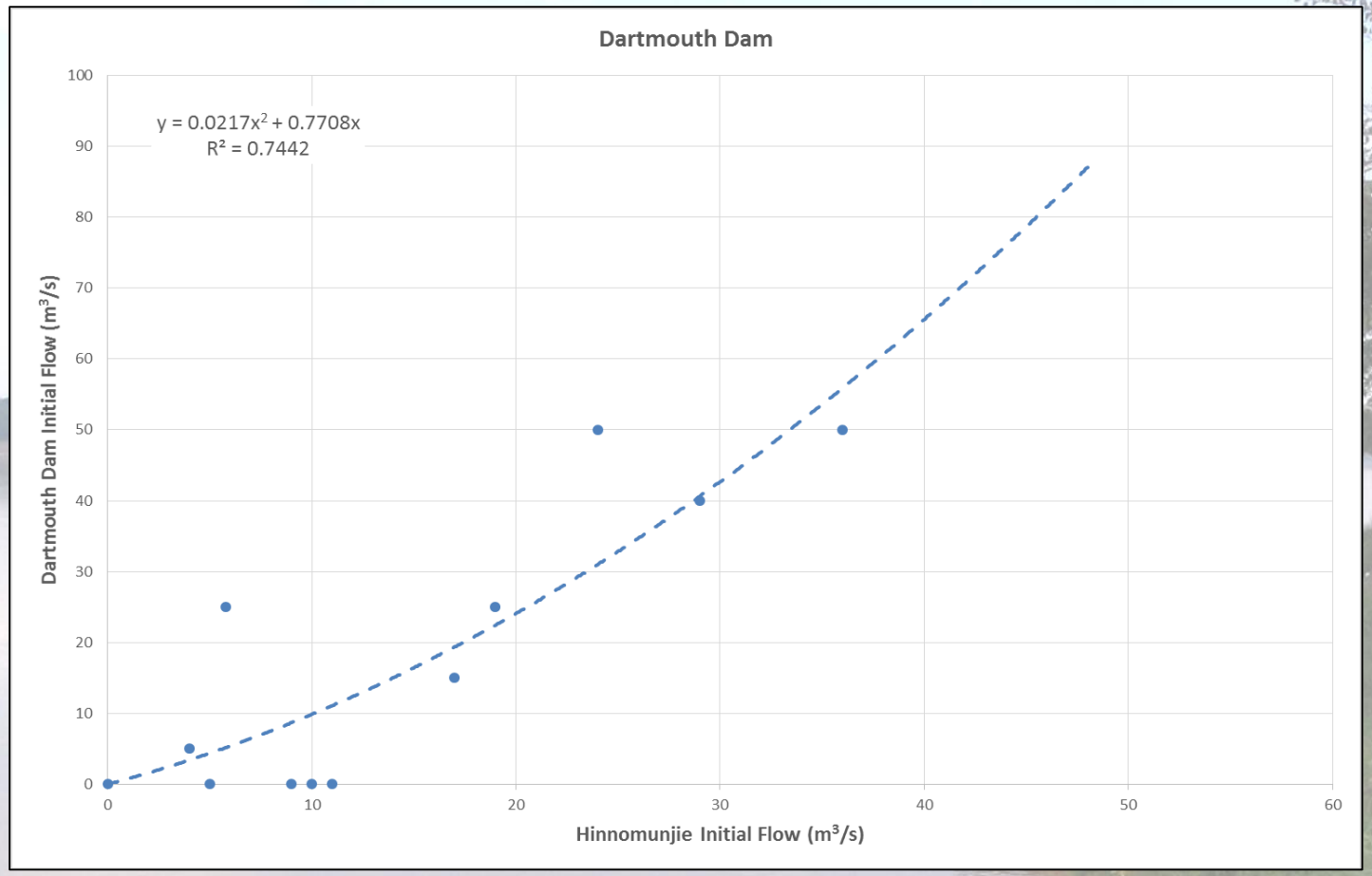
Operational Considerations

- Number of Rainfall stations???
- Dam Starting Levels and Initial Baseflow
- Antecedent Conditions
- FEWS-URBS

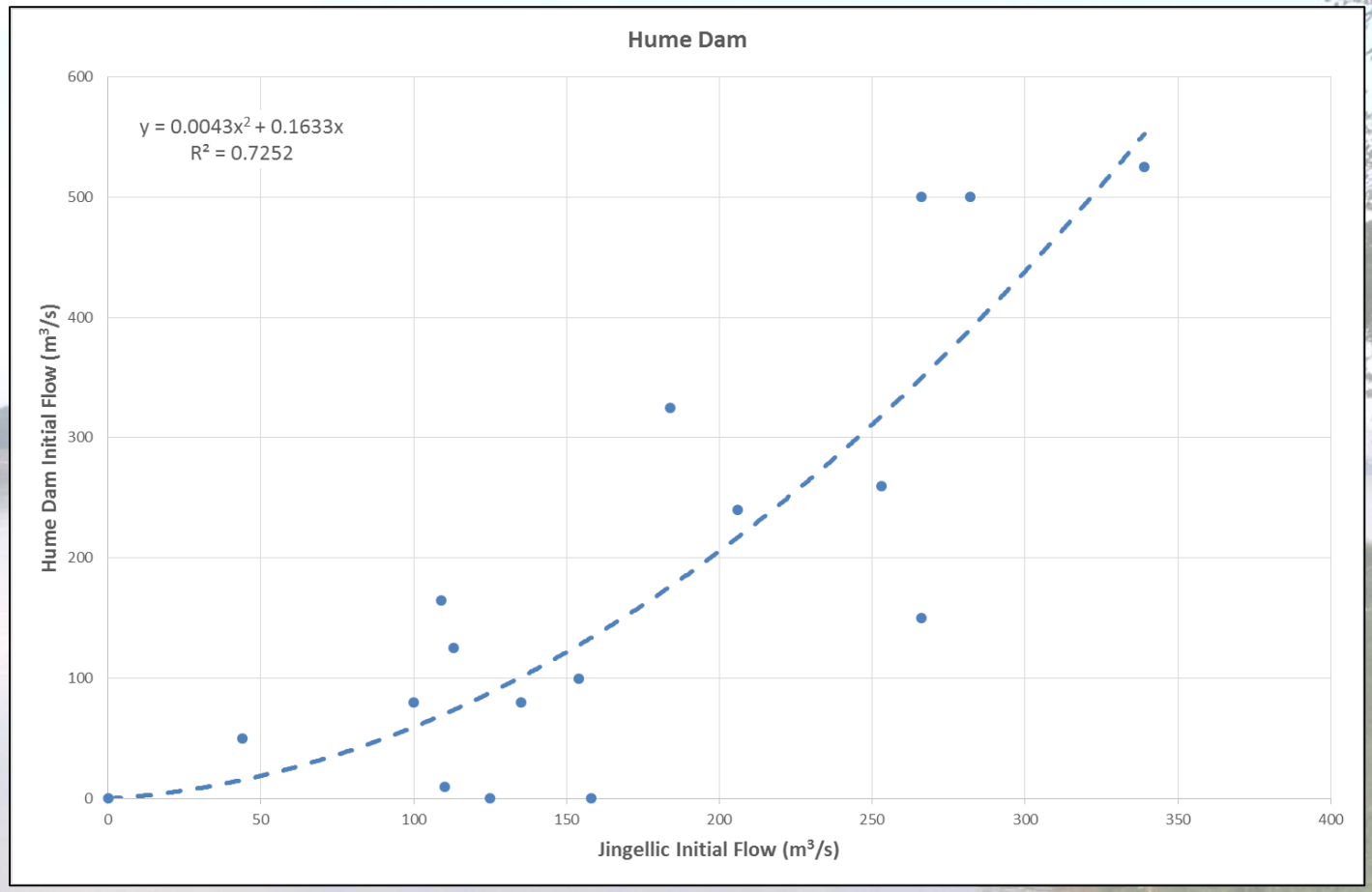
Rainfall Stations

- Upper Murray
  - Area approx. 15000 sq km
  - Realtime Pluvs ≈ 5 - 10
- Brisbane River: 14000 sq km
  - Realtime Pluvs ≈ 300
- Gold Coast Region: (excluding Logan)
  - Area approx = 1000 sq km
  - Real Time Pluvs ≈ 50

Dam Initial Base flows Dartmouth



Dam Initial Base flows Hume

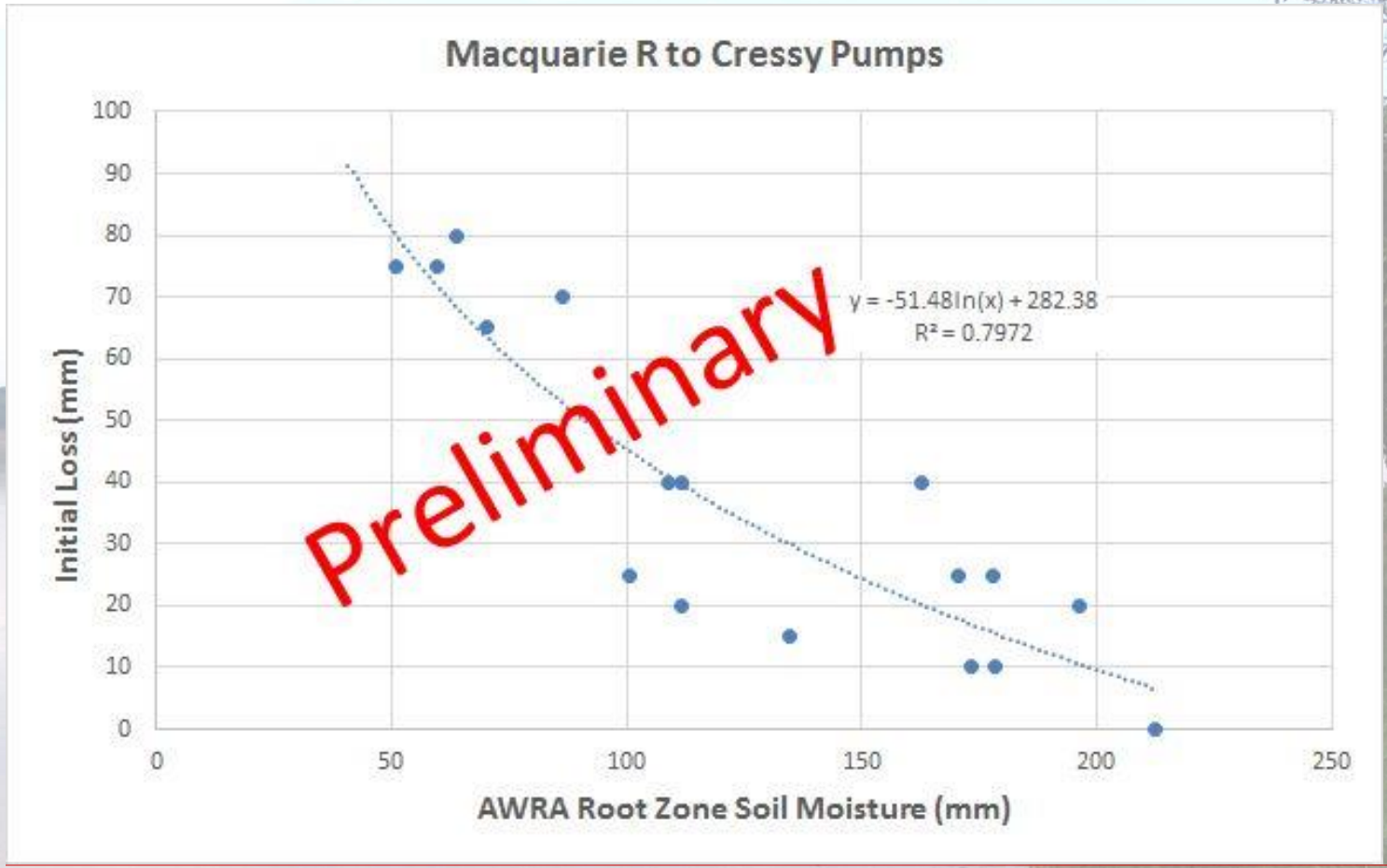


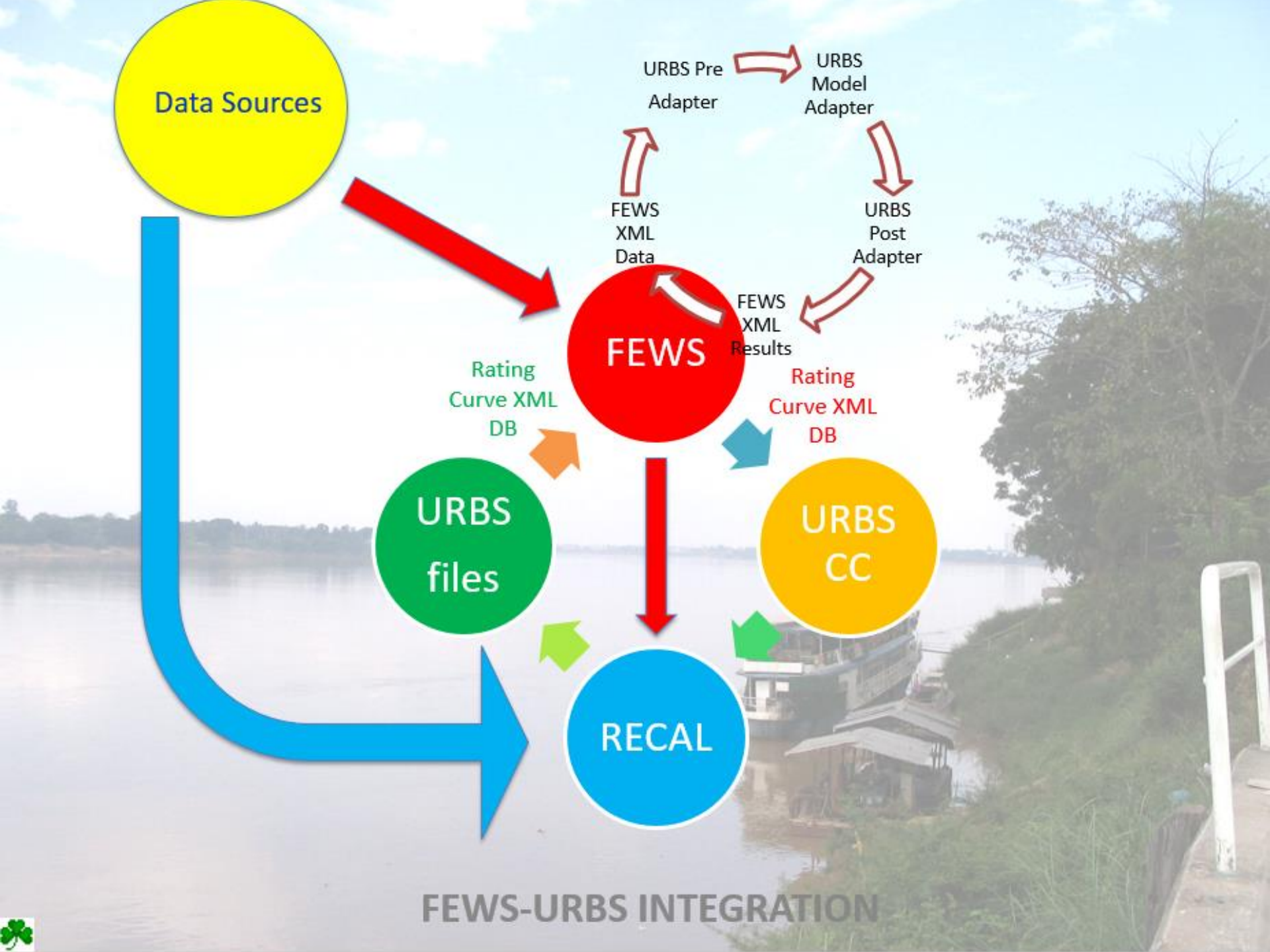
Rainfall Stations

Event	Initial Loss (mm)		Rainfall in Preceding Month
	Mitta Mitta	Upper Murray	
197401		35	Above Average to Very Much Above Average
197410		10	Above Average
197510		15	Above Average to Very Much Above Average
198107	15	10	Above Average to Highest on Record
198308	10	10	Average to Above Average
199210	0	5	Very Much Above Average to Highest on Record
199310	35	0	Above Average to Very Much Above Average
199607	0	10	Average
199610	0	10	Above Average to Very Much Above Average
199809	10	0	Average
201009	25	10	Above Average to Very Much Above Average
201010	40	20	Average to Above Average
201012	35	30	Above Average to Very Much Above Average
201102	90	60	Average to Above Average
201109	5	15	Below Average to Average
201203	10	25	Above Average to Very Much Above Average

No strong correlation in the above data between rainfall in the preceding month and initial loss!!

BoM AWRA Model





FEWS-URBS INTEGRATION

Recommendations

- Calibrated parameters be adopted
- Review the existing real time rainfall station network to improve spatial and temporal rainfall event definition
- Continuing update with every event including ratings
- An investigation as to whether the BoM AWRA-L real time root zone soil moisture modelling can be used to estimate initial losses

Thank You

And remember …

Pluralitas non est ponenda sine necessitate
William of Ockham (1285 – 1349)

Or

Keep it simple