

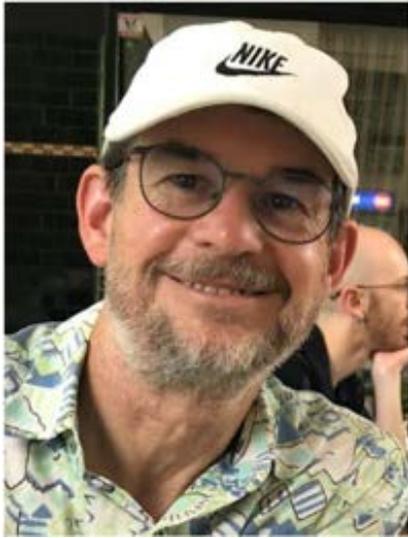
RORB Essentials for Water Modelling

Pre-course webinar

15 March 2023

Tony Ladson

About me



Tony Ladson

- Engineering undergrad back in the 1980s
- PhD in Environmental Engineering (River Health)
- Lecturer at Monash 2002-2007
- Wrote a book on Australian Hydrology
- Director of Moroka (Water Consultants)
- Blogger: tonyladson.wordpress.com
- ~~Twitter: @TonyLadson~~
- ~~Instagram: @tony.Ladson~~
- LinkedIn www.linkedin.com/in/tonyladson/
- Email: tony.ladson@moroka.com.au

Acknowledgements



David Stephens
Hydrology and Risk
Consulting



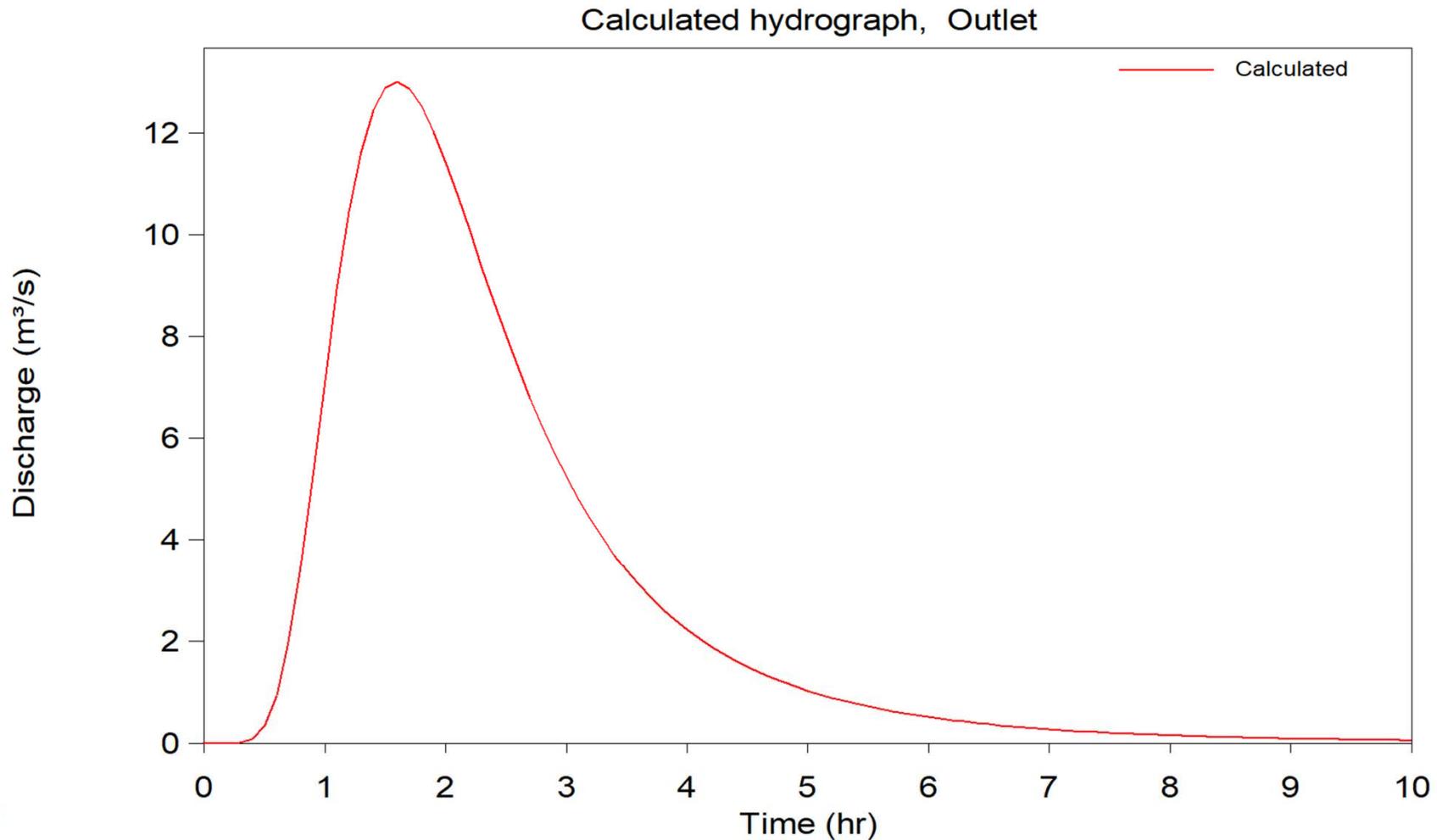
Rory Nathan
Uni of Melbourne

RORB Essentials for Water Modelling

- What RORB does (and doesn't)
- Why you may want to use it
- How RORB relates to Australian Rainfall and Runoff 2019
- Case study:
 - Inputs
 - Calculations
 - Outputs

What RORB does

RORB calculates flood hydrographs, usually from rainfall



Why RORB?

Easy to extract outputs to use for hydraulic model inputs

Been around, first release 1975

Kept up to date,
-Version ~6.5
- Runs under Windows 11

Supported by Melbourne Water

Can use data from the ARR data hub and BoM IFD

Useful for retarding basin design

Handles multiple rainfall temporal patterns
- Ensemble modelling

Monte Carlo sampling of inputs:
-rainfall depth
-temporal patterns
-losses

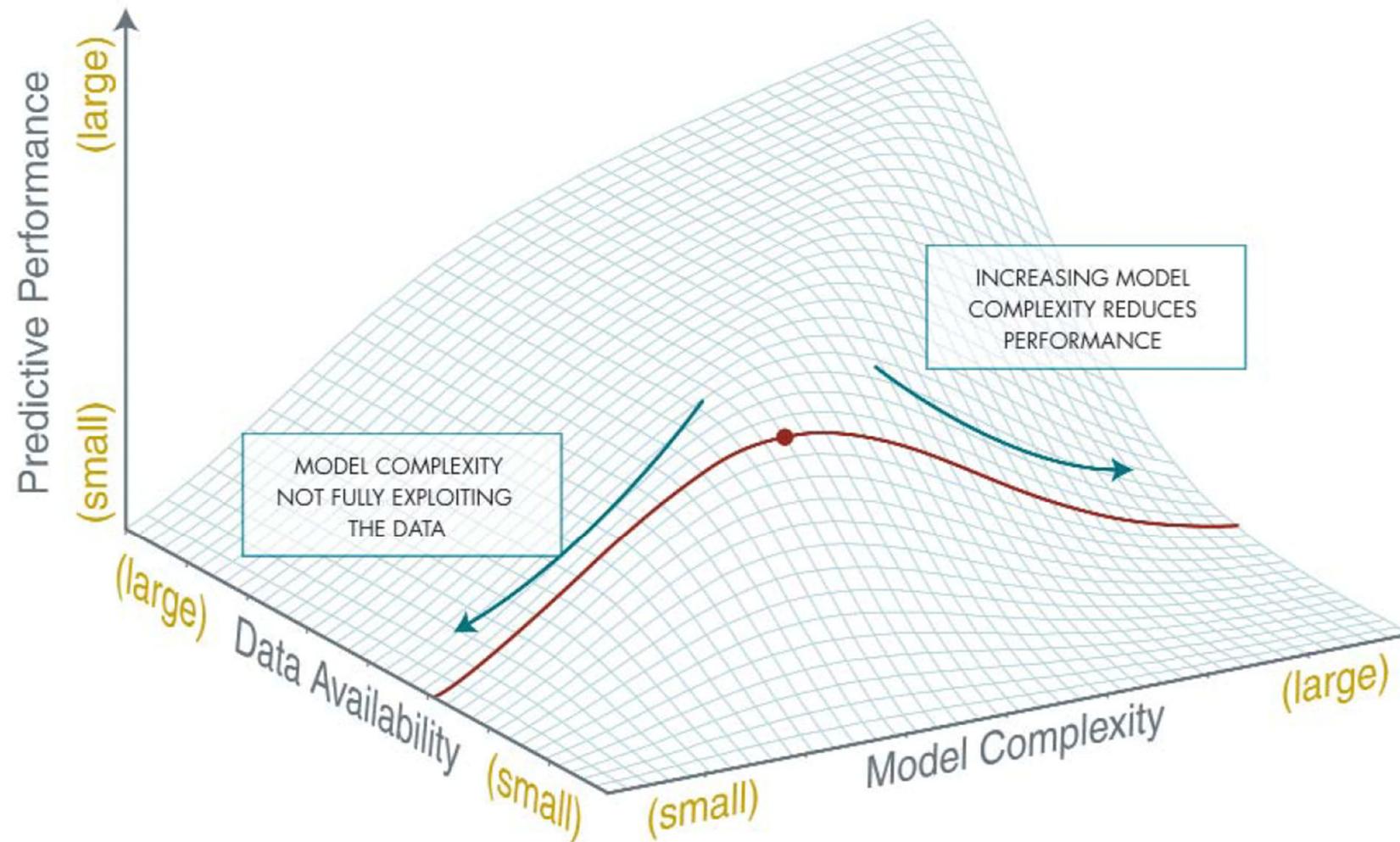
Before and after modelling of urban development

Models can be calibrated to stream gauge data

RORB is often used to:

- Estimate design flood hydrographs
- Design flood retarding/detention basins
- Generate hydrographs for input to hydraulic models
- Calculate rainfall excess for rain-on-grid modelling

Useful models balance complexity with data availability



Some things RORB doesn't do

- Doesn't model
 - Evaporation/transpiration
 - Soil moisture movement
 - Groundwater interactions

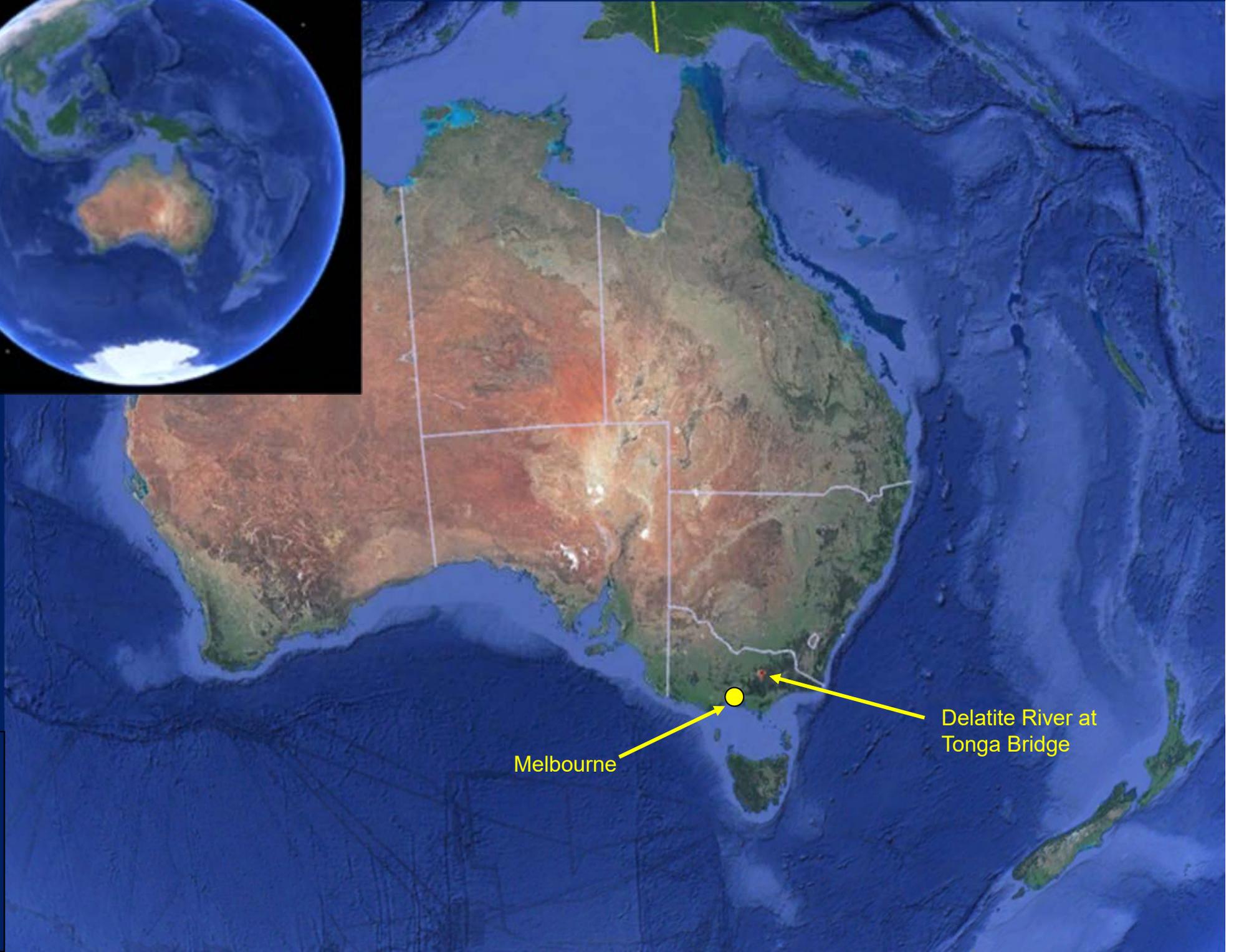
(Although you can add and subtract water from reaches)

Doesn't do hydraulics. Doesn't calculate velocities or depths

Case study:
Delatite River at Tonga Bridge

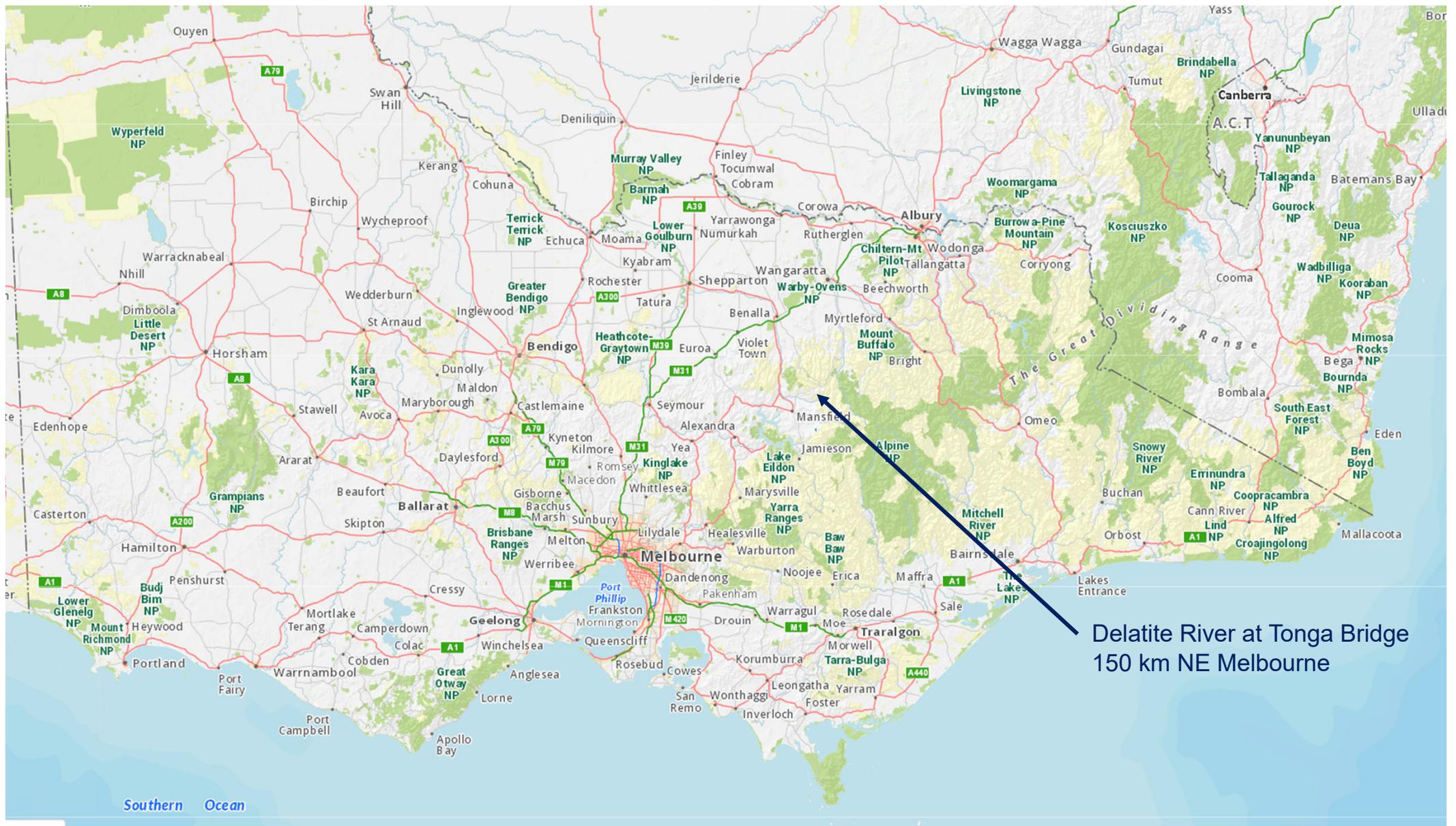
moroka

Three horizontal lines in blue, brown, and green colors are positioned at the bottom of the slide, with the word 'moroka' in blue text above them.

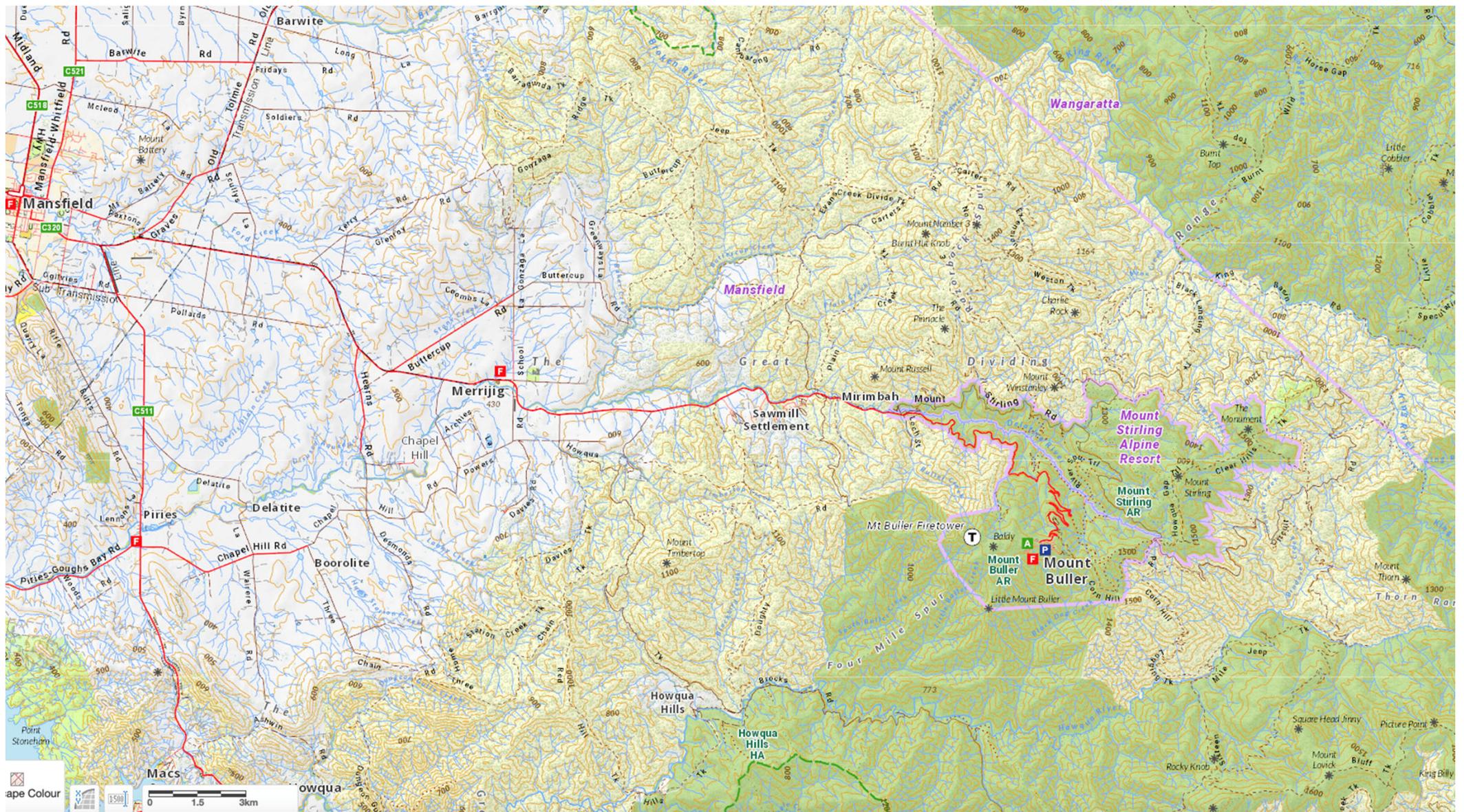


Melbourne

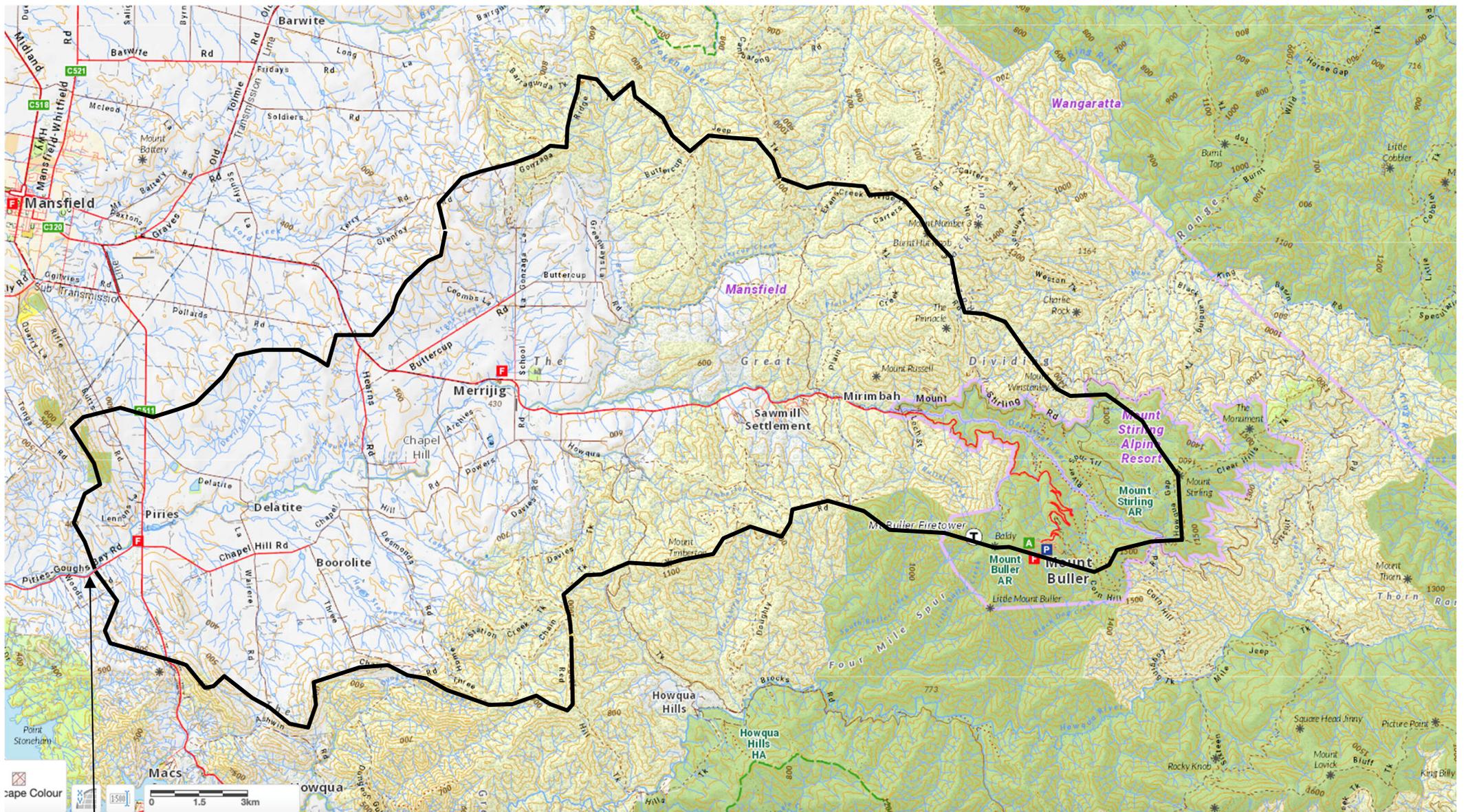
Delatite River at
Tonga Bridge



Delatite River at Tonga Bridge
150 km NE Melbourne

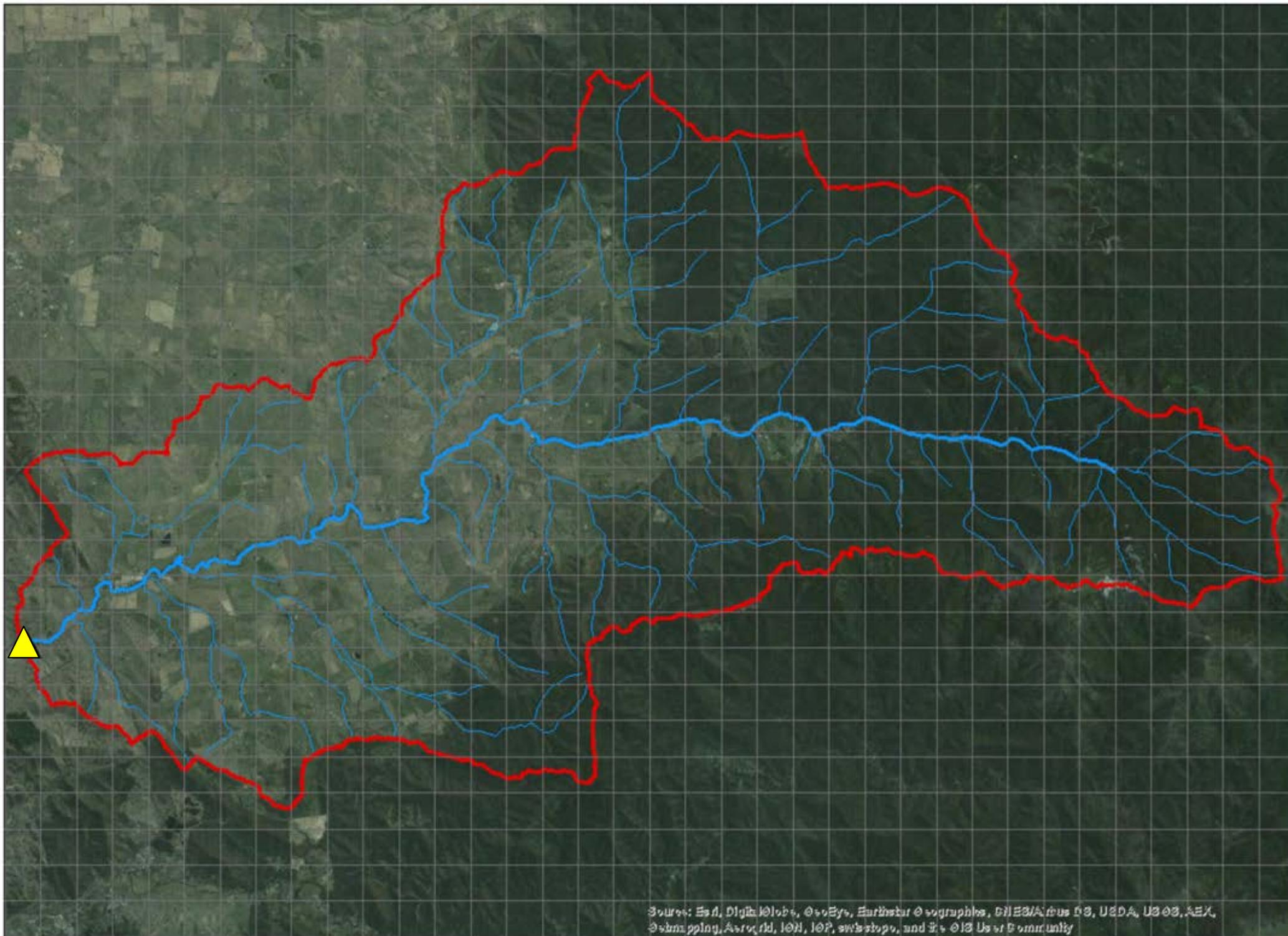


moroka



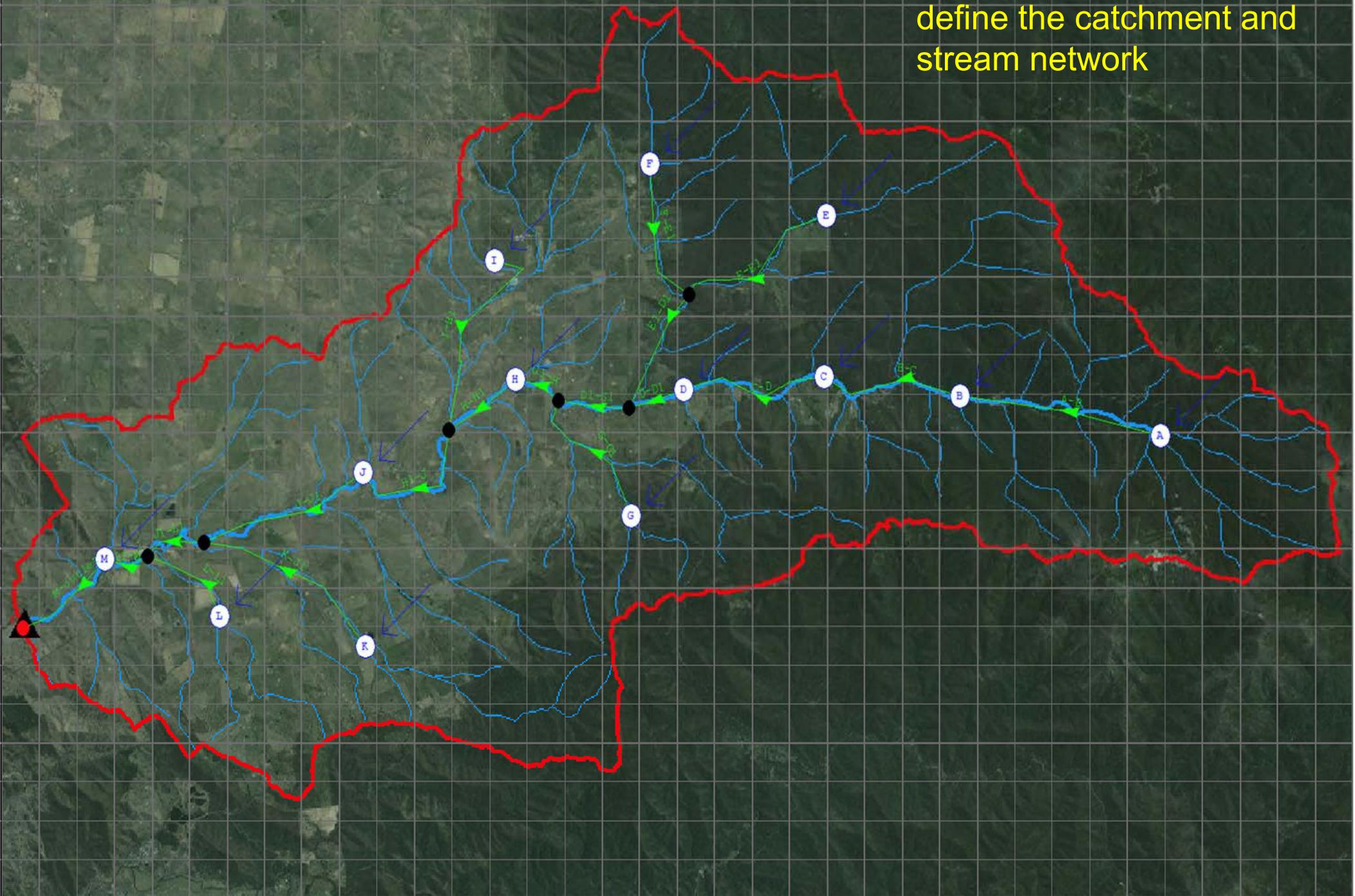
Delatite River at
Tonga Bridge

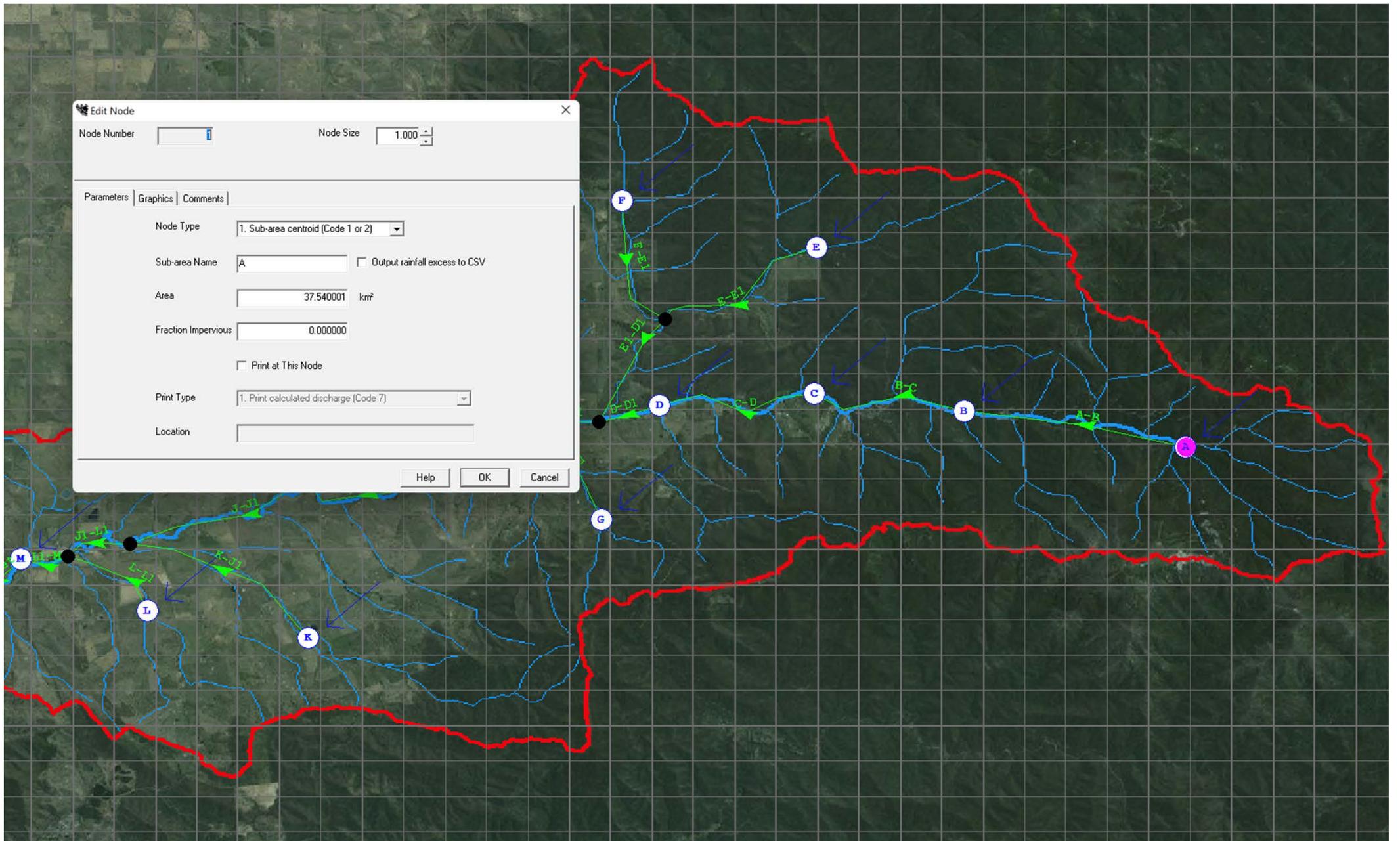
Catchment area = 368 km²

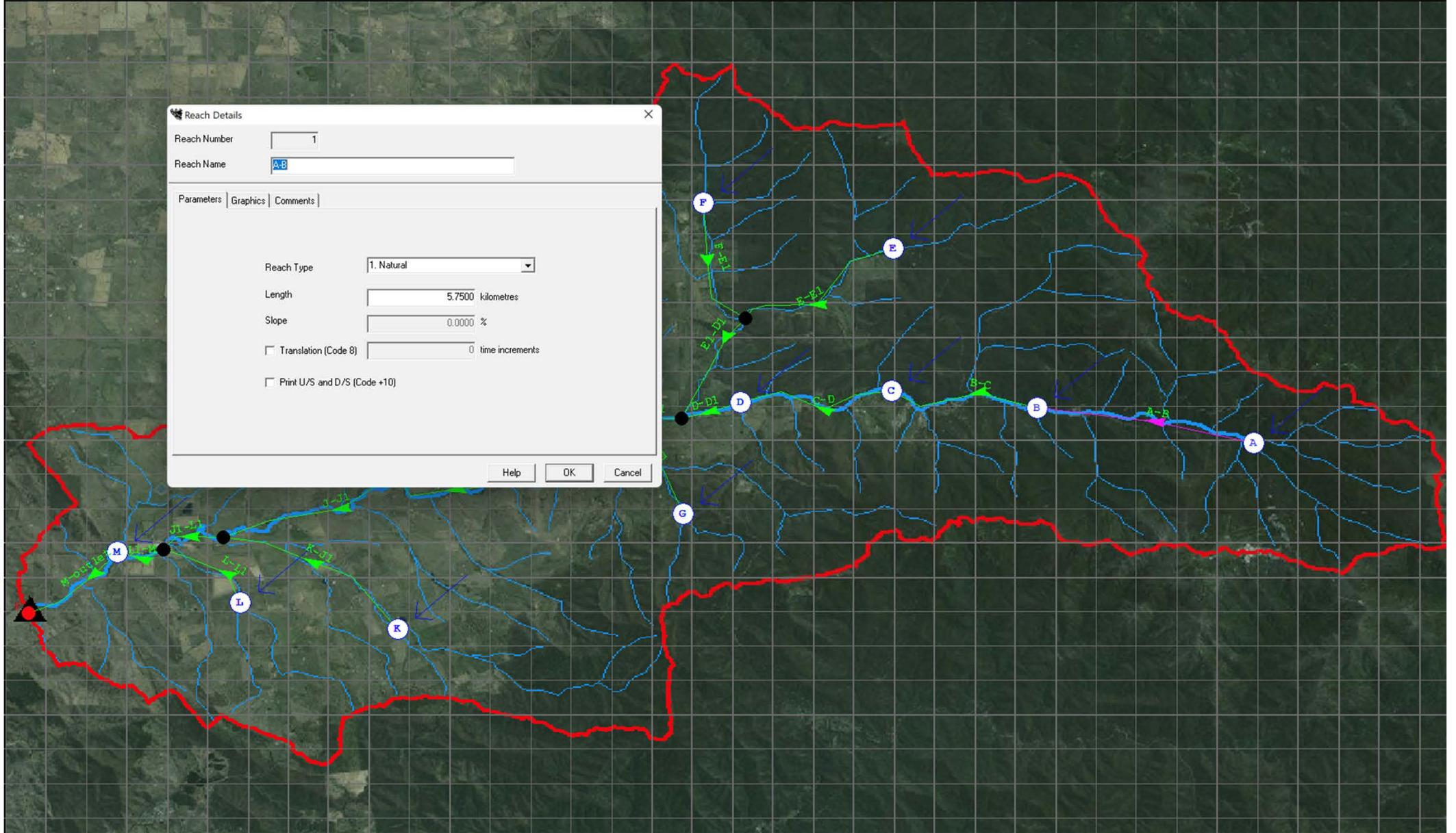


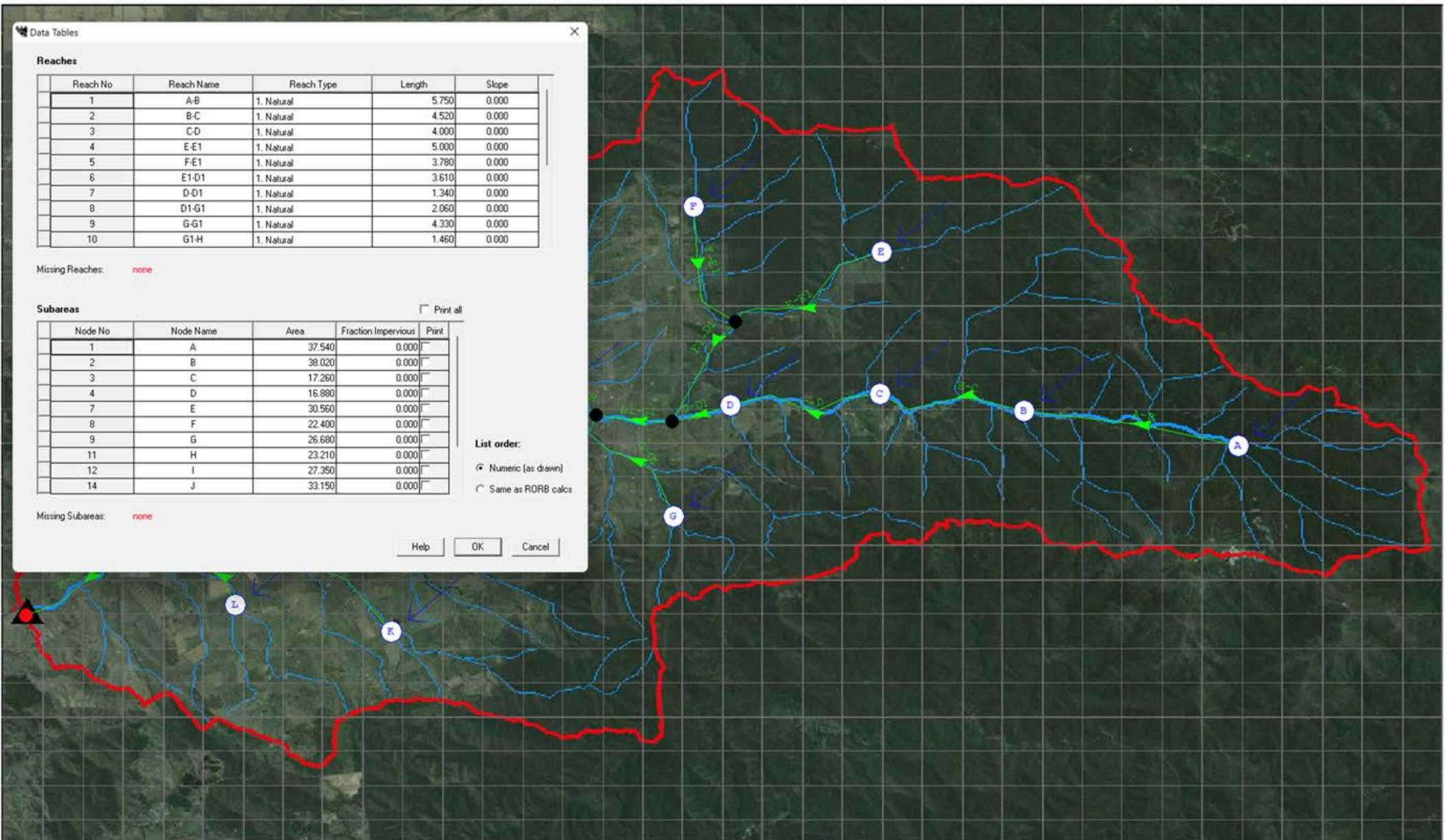
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero, Swisstopo, and the GIS User Community

Specify nodes and links to define the catchment and stream network









Input files

- Separate catchment and existing storm file
 - Single input file (original RORB format)
 - Separate catchment and generated design storm(s)
- IFD data type:

Catchment file

Storm file

Parameter configuration

- Single set of routing parameters for whole model (default)
- Vary routing parameters by interstation area
- Initial loss / continuing loss model
- Runoff coefficient model

Run options

- As specified in storm file
- FIT (initial loss only fitted by user)
- DESIGN (loss parameters specified by user)

Output options

Information detail:

Text and CSV outputs

Filename root:

Directory same as:

Cancel

Help

OK

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)

Choose an ARR 2016 file...

Browse...

 Use regional losses Use ARFs from file

Temporal Patterns (*.increments.csv)

Choose an ARR 2016 temporal patterns file...

Browse...

Standard area for areal temporal patterns (km²): None selected

IFD data

Choose BoM IFD file...

Browse...

View/edit IFD data

Simulation details

Simulation type: Single storm

 Extract MC HydrographsGroup batch results by: AEP or by

Select AEP:

to

 Duration

Select duration:

to

No. time incs to be modelled: 200

Temporal pattern details

Select patterns for deterministic runs

 Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

 Non-uniform pat.?

Edit Pattern

Pre-Burst

 Apply Pre-burst

Edit pre-burst

Areal Reduction Factor details

Edit Coeff.

 Replace total catchment area with value of 0.00 km²

Output directory

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1

Browse ...

Loss Factor details

 Constant losses Variable losses

AEP factors

Duration factors

Cancel

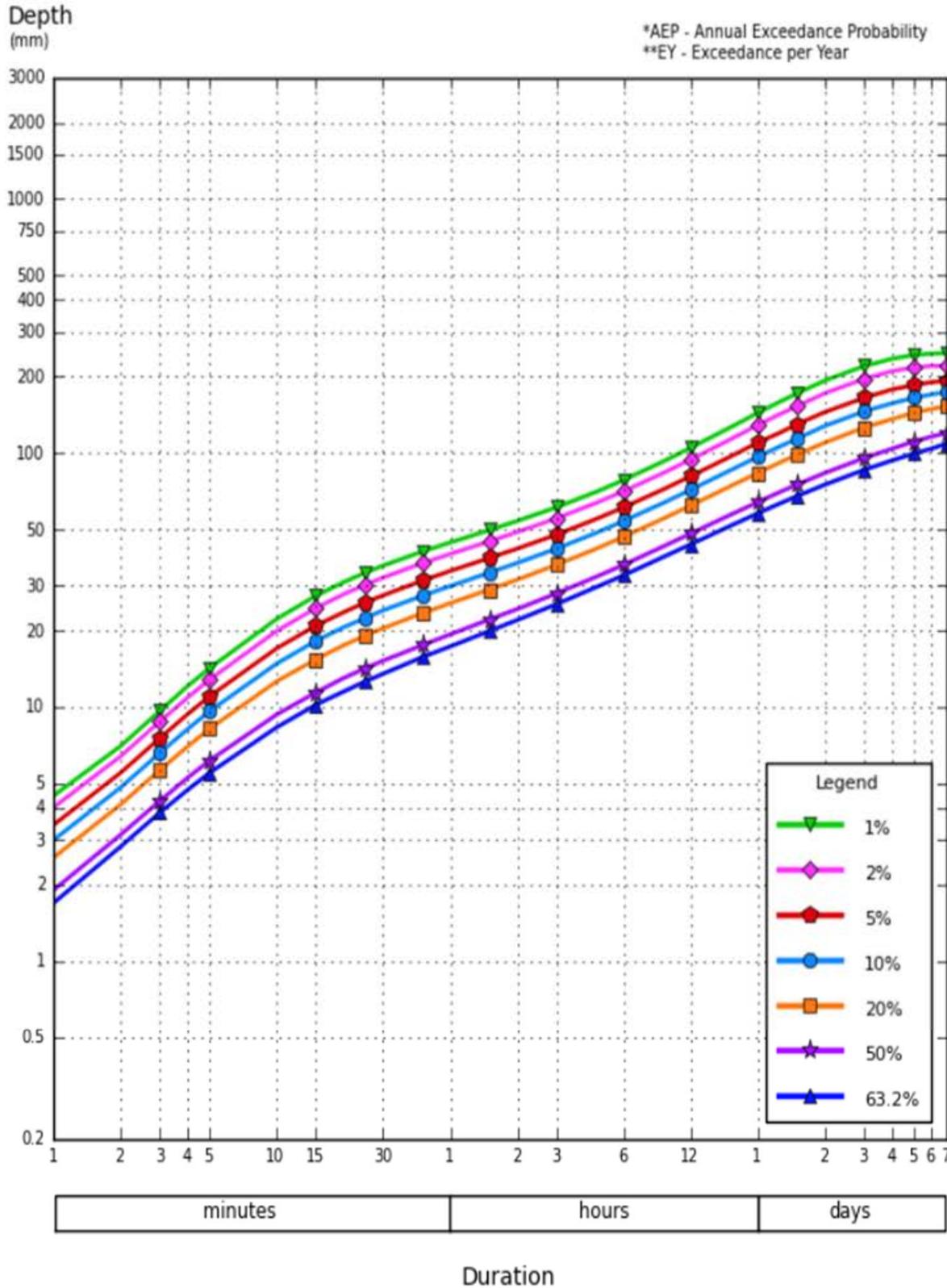
Help

OK



- Rainfall

- From a historical storm – when calibrating a model
- Design rainfall based on Intensity, Frequency, Duration data



Design Rainfall

Duration	Annual Exceedance Probability (AEP)						
	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	1.69	1.90	2.55	2.99	3.43	4.02	4.47
2 min	2.82	3.14	4.13	4.82	5.51	6.40	7.02
3 min	3.84	4.27	5.65	6.60	7.54	8.77	9.65
4 min	4.72	5.27	7.00	8.19	9.38	10.9	12.1
5 min	5.50	6.15	8.20	9.61	11.0	12.8	14.2
10 min	8.31	9.33	12.6	14.8	17.0	19.9	22.2
15 min	10.2	11.4	15.4	18.2	20.9	24.5	27.4
20 min	11.5	13.0	17.5	20.6	23.6	27.8	31.0
25 min	12.6	14.2	19.1	22.4	25.8	30.3	33.8
30 min	13.5	15.2	20.4	24.0	27.5	32.3	36.0
45 min	15.7	17.5	23.4	27.4	31.4	36.8	40.9
1 hour	17.3	19.3	25.6	29.9	34.3	40.0	44.4
1.5 hour	19.9	22.1	29.0	33.8	38.6	44.9	49.7
2 hour	22.0	24.3	31.7	36.9	42.0	48.8	54.0
3 hour	25.4	28.0	36.3	42.0	47.7	55.3	61.1
4.5 hour	29.6	32.5	41.9	48.4	54.9	63.5	70.2
6 hour	33.0	36.3	46.8	54.0	61.1	70.7	78.3
9 hour	38.9	42.8	55.1	63.5	71.8	83.3	92.5
12 hour	43.7	48.2	62.1	71.7	81.1	94.3	105
18 hour	51.6	57.0	73.9	85.4	96.7	113	126
24 hour	57.9	64.1	83.5	96.7	110	129	144
30 hour	63.2	70.1	91.6	106	120	142	159
36 hour	67.7	75.2	98.5	114	130	153	172
48 hour	75.1	83.5	110	128	145	172	193
72 hour	85.9	95.6	126	146	165	196	220
96 hour	93.5	104	136	157	178	210	235
120 hour	99.5	111	144	165	185	217	243
144 hour	104	116	149	170	190	220	246
168 hour	109	120	153	174	192	220	247



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Choose an ARR 2016 temporal patterns file...

Browse...

Standard area for areal temporal patterns (km²): None selected

IFD data

Choose BoM IFD file...

Browse...

View/edit IFD data

Simulation details

Simulation type: Single storm

 Extract MC HydrographsGroup batch results by: AEP or by

Select AEP:

to

 Duration

Select duration:

to

No. time incs to be modelled:

200

Temporal pattern details

Select patterns for deterministic runs

 Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

 Non-uniform pat.?

Edit Pattern

Pre-Burst

 Apply Pre-burst

Edit pre-burst

Loss Factor details

 Constant losses Variable losses

AEP factors

Duration factors

Areal Reduction Factor details

Edit Coeff.

 Replace total catchment area with value of 0.00 km²

Output directory

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1

Browse ...

Cancel

Help

OK

Data Hub files

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\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1

Browse ...

Cancel

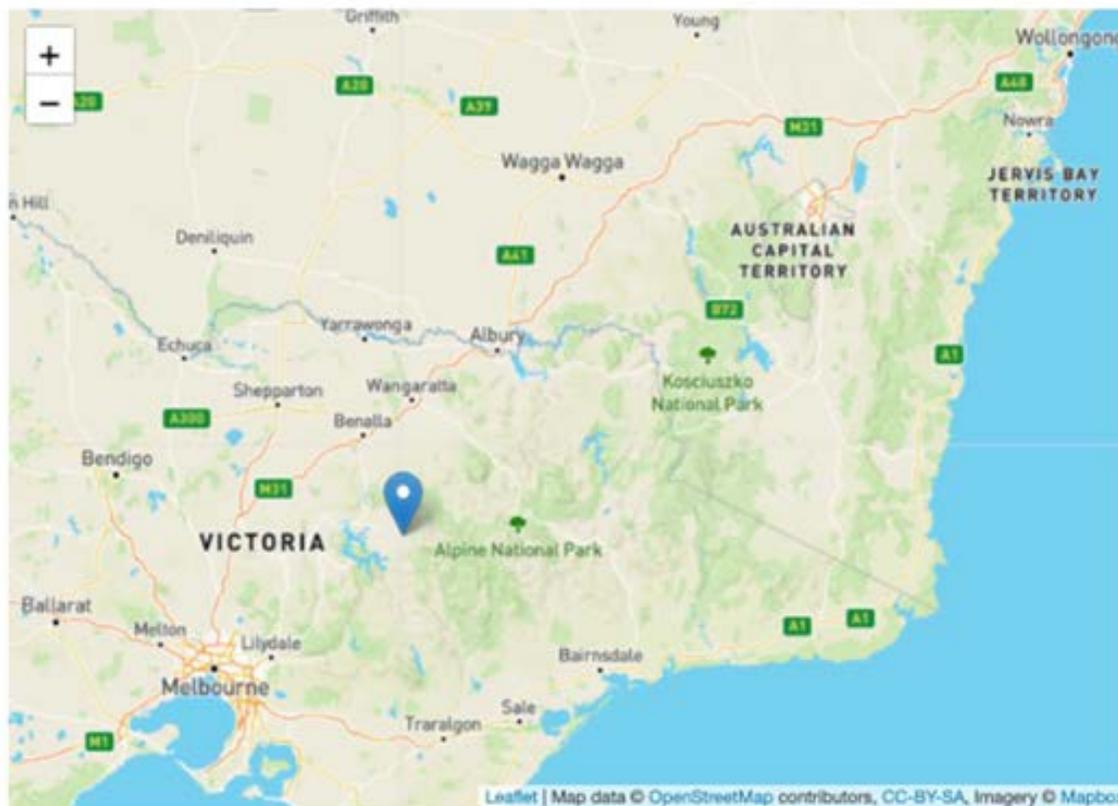
Help

OK

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	146.26
Latitude	-37.1
Selected Regions (clear)	
Temporal Patterns	show



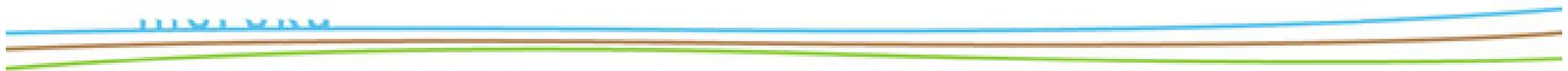
Data

Temporal Patterns [Download \(.zip\)](#)

code	MB
Label	Murray Basin

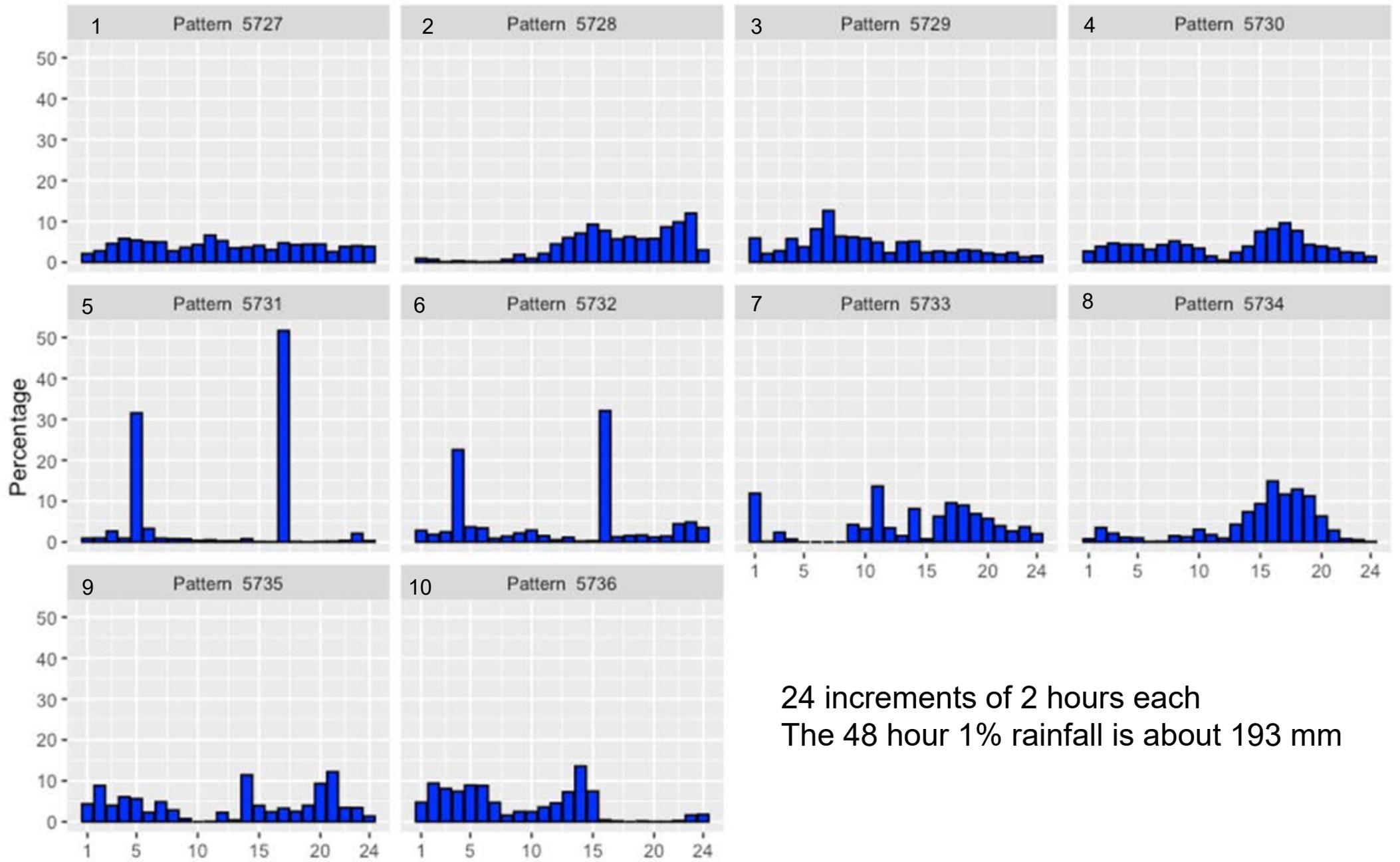
Layer Info

Time Accessed	14 March 2023 04:33PM
Version	2016_v2



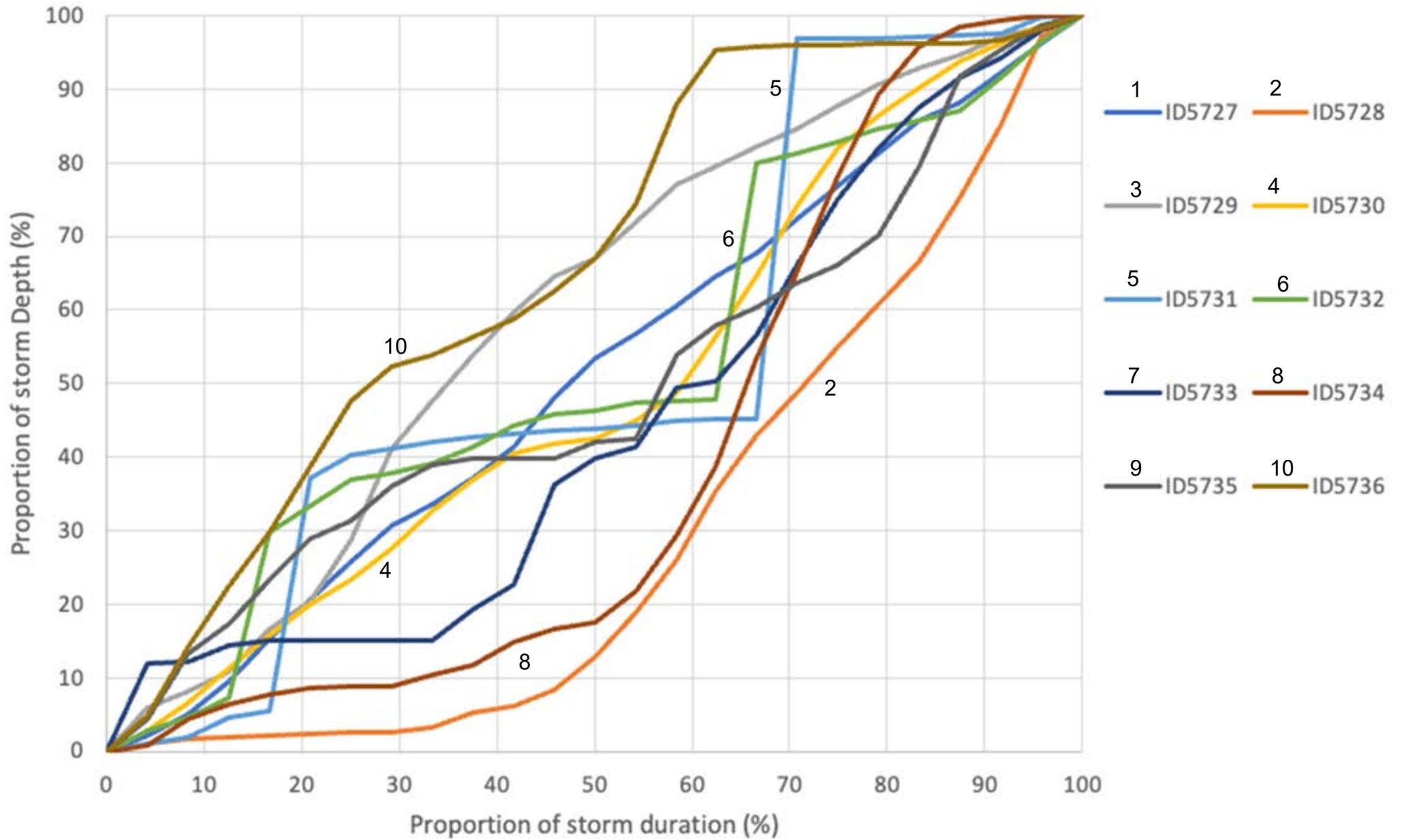
Rainfall temporal patterns

Region = Murray Basin, Duration = 48 hours, Area = 500 km-squared



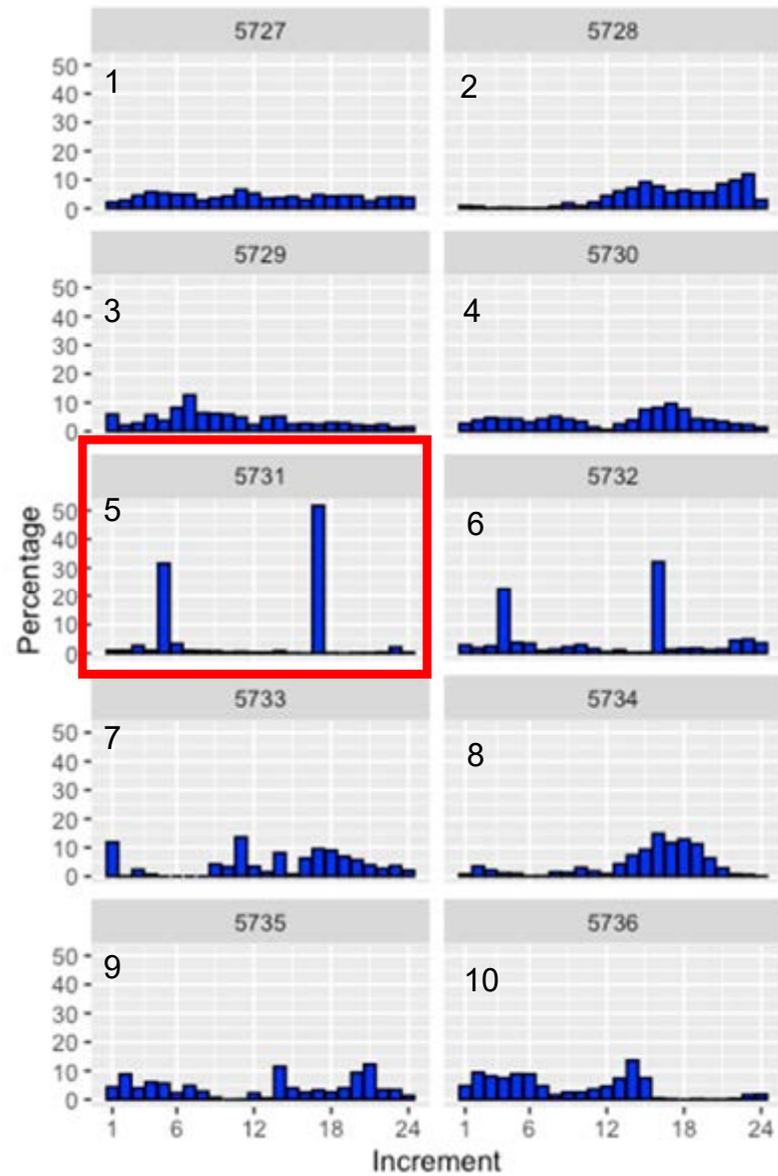
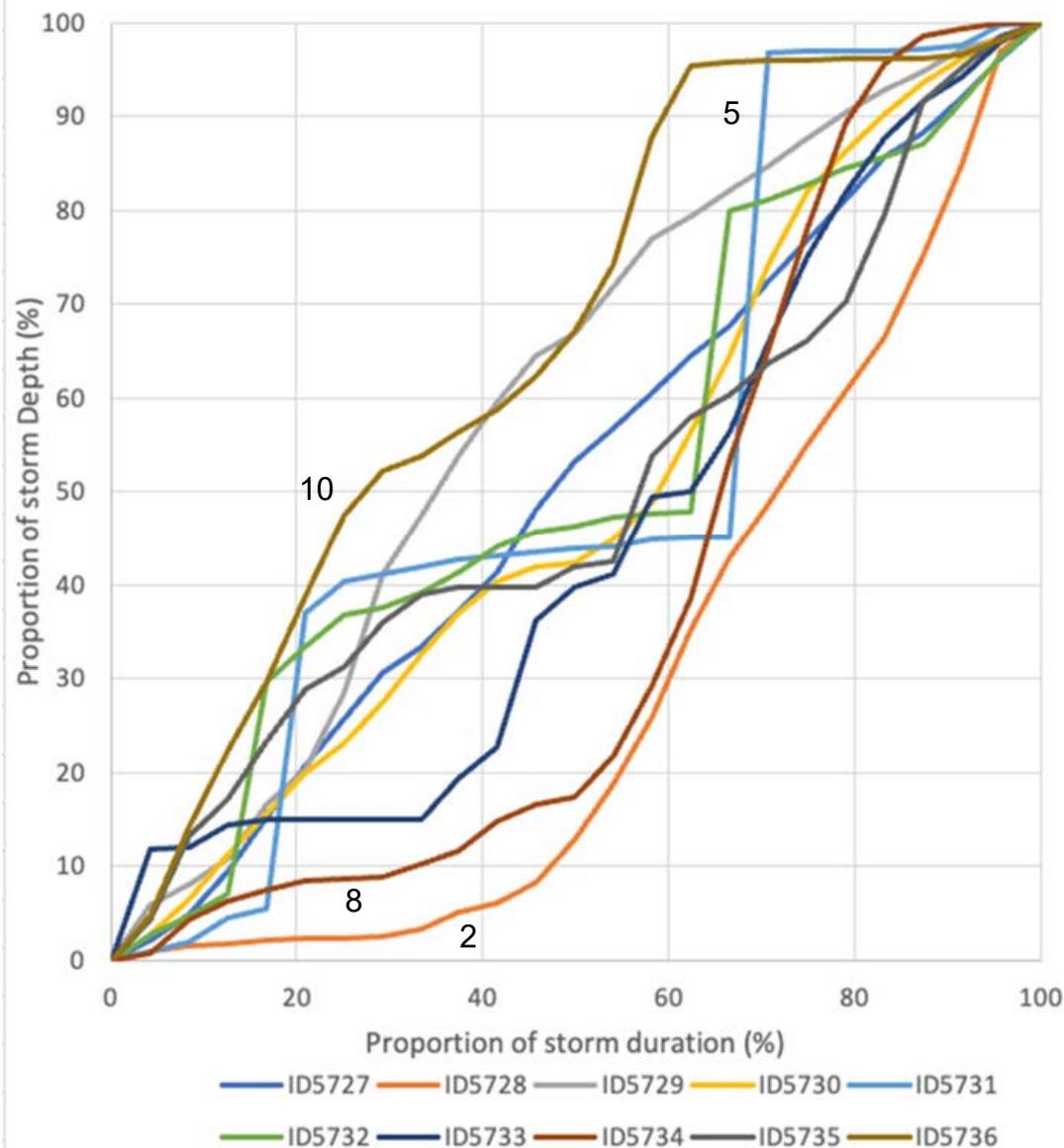
24 increments of 2 hours each
The 48 hour 1% rainfall is about 193 mm

Cumulative Temporal Patterns for 500 km² 48 hr storms



moroka

Cumulative Temporal Patterns for 500 km² 48 hr storms



moroka

Data Hub files

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Choose an ARR 2016 file...

Browse...

 Use regional losses Use ARFs from file

Temporal Patterns (*.increments.csv)

Choose an ARR 2016 temporal patterns file...

Browse...

Standard area for areal temporal patterns (km²): None selected

IFD data

Choose BoM IFD file...

Browse...

View/edit IFD data

Simulation details

Simulation type: Single storm

 Extract MC HydrographsGroup batch results by: AEP or by

Select AEP:

to

 Duration

Select duration:

to

No. time incs to be modelled: 200

Temporal pattern details

Select patterns for deterministic runs

 Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

 Non-uniform pat.? Edit Pattern

Pre-Burst

 Apply Pre-burst Edit pre-burst

Loss Factor details

 Constant losses Variable losses

AEP factors

Duration factors

Areal Reduction Factor details

Edit Coeff.

 Replace total catchment area with value of 0.00 km²

Output directory

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1

Browse ...

Cancel

Help

OK

Data Hub files

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Choose an ARR 2016 file...

Browse...

 Use regional losses Use ARFs from file

Temporal Patterns (*.increments.csv)

Choose an ARR 2016 temporal patterns file...

Browse...

Standard area for areal temporal patterns (km²):

None selected



IFD data

Choose BoM IFD file...

Browse...

View/edit IFD data

Simulation details

Simulation type: Single storm

 Extract MC HydrographsGroup batch results by: AEP or by Duration

Select AEP:

to

Select duration:

to

No. time incs to be modelled:

200

Temporal pattern details

 Select patterns for deterministic runs Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

 Non-uniform pat.?

Edit Pattern

Pre-Burst

 Apply Pre-burst

Edit pre-burst

Areal Reduction Factor details

Edit Coeff.

 Replace total catchment area with value of

0.00

km²

Output directory

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1

Browse ...

Cancel

Help

OK

Loss Factor details

 Constant losses Variable losses

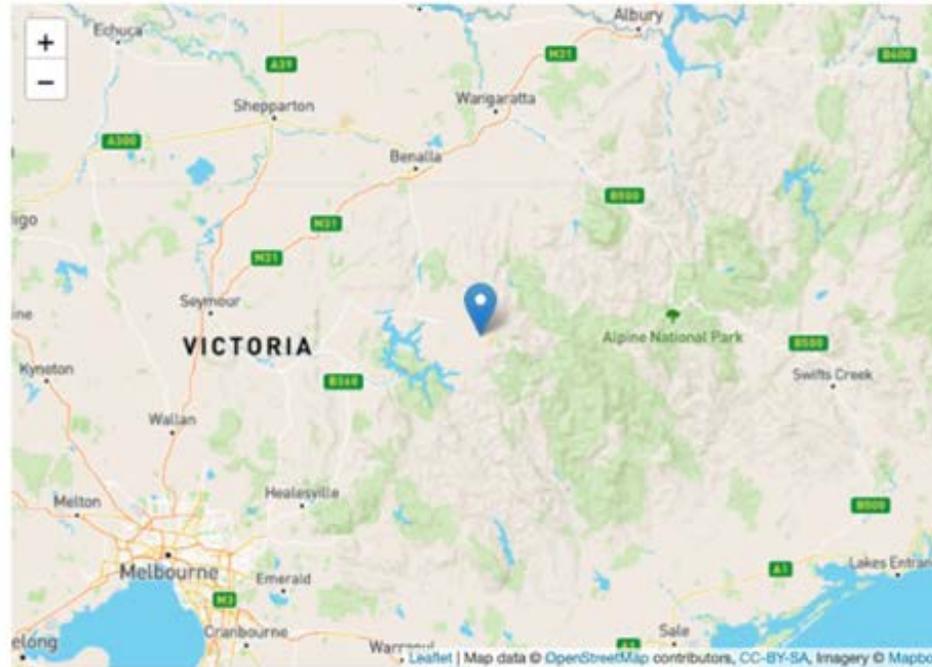
AEP factors

Duration factors

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	146.26
Latitude	-37.1
Selected Regions (clear)	
ARF Parameters	show



Areal Reduction Factor:
 Converts the rainfall intensity as measured at a rain gauge (0.01 m²), to the rainfall intensity suitable for a catchment (10⁶ m²)

Data

ARF Parameters

$$ARF = Min \left\{ 1, \left[1 - a (Area^b - \log_{10} Duration) Duration^{-d} + e Area^f Duration^g (0.3 + \log_{10} AEP) + h 10^{i Area \frac{Duration}{140}} (0.3 + \log_{10} AEP) \right] \right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Temperate	0.158	0.276	0.372	0.315	0.000141	0.41	0.15	0.01	-0.0027

Layer Info

Time Accessed	14 March 2023 04:53PM
Version	2016_v1

Short Duration ARF

$$ARF = Min \left[1, 1 - 0.287 (Area^{0.265} - 0.439 \log_{10}(Duration)) \cdot Duration^{-0.36} + 2.26 \times 10^{-3} \times Area^{0.226} \cdot Duration^{0.125} (0.3 + \log_{10}(AEP)) + 0.0141 \times Area^{0.213} \times 10^{-0.021 \frac{(Duration-140)^2}{140}} (0.3 + \log_{10}(AEP)) \right]$$

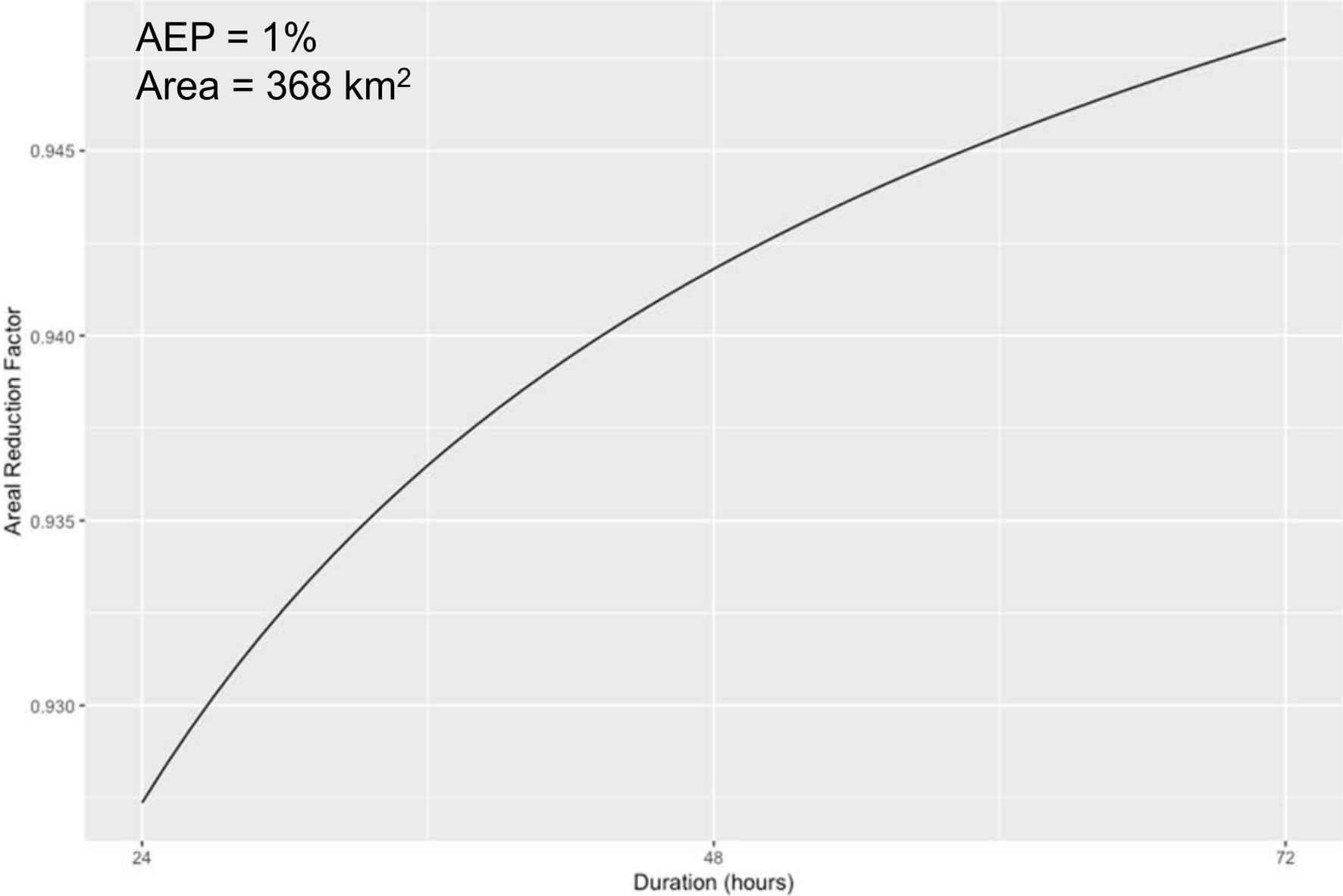
Function of duration, AEP and catchment area

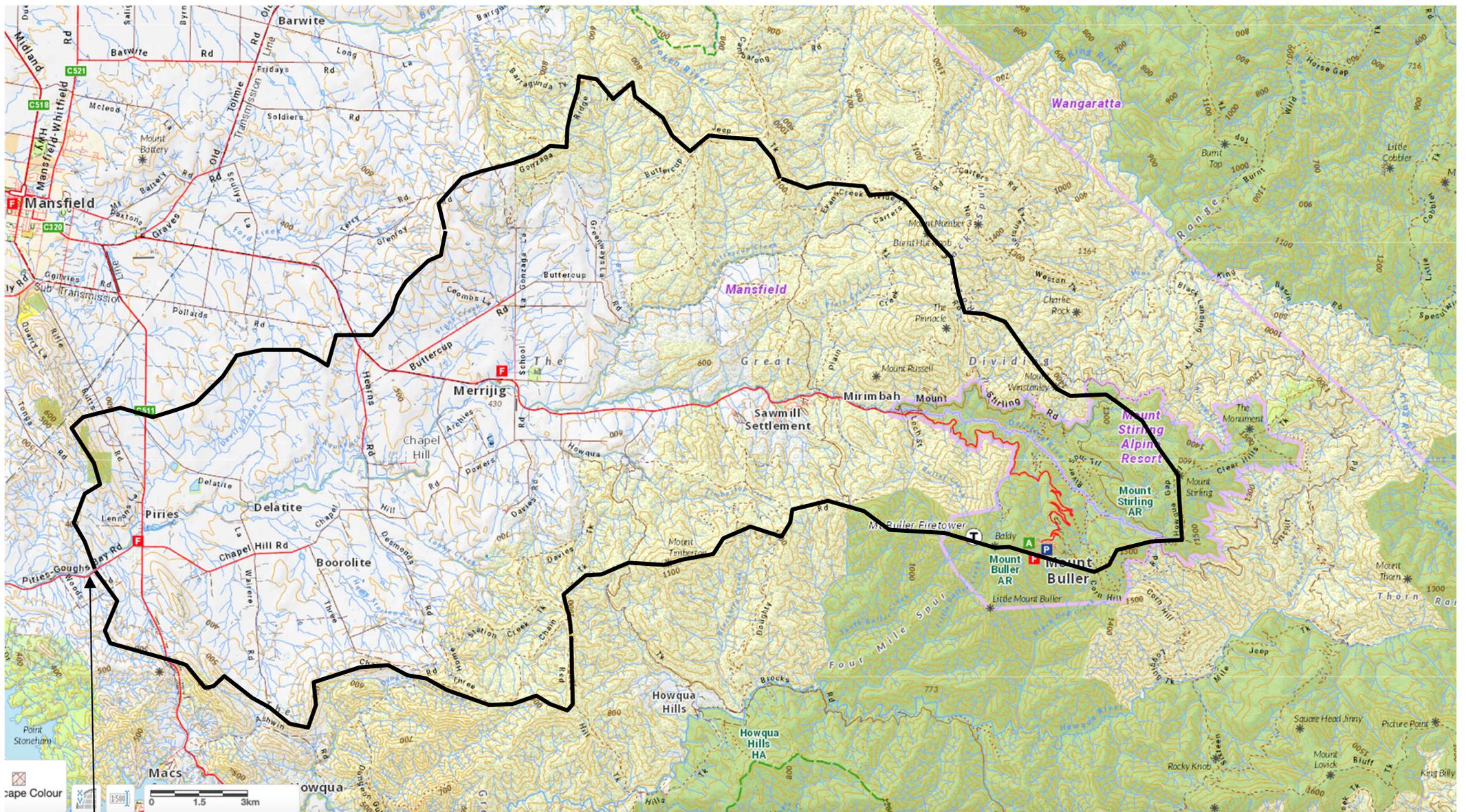
Download TXT

Download JSON

Generating PDF...

Areal Reduction Factor





Delatite River at
Tonga Bridge

Catchment area = 368 km²

Other things we need

Parameter Specification

Kc = ?? m =

	IL(mm)	CL(mm/h)
#01: Catchment outlet	15.0	2.5

Run Model

Routing parameters:

- Kc
- M

(Calibration or literature values.
RORB will suggest suitable values)

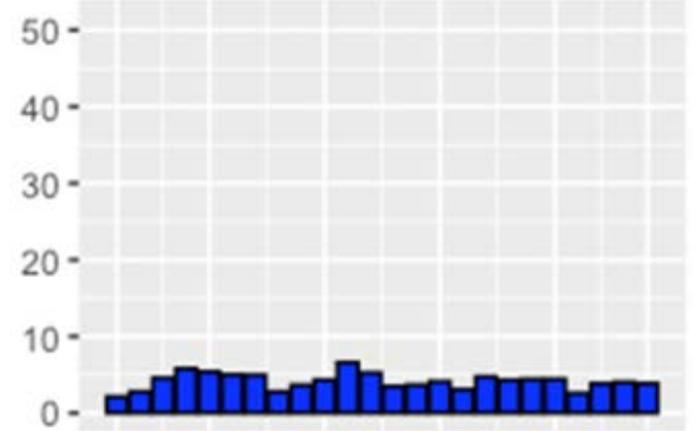
Losses

- Initial loss (IL) (mm)
- Continuing loss (CL) (mm/h)

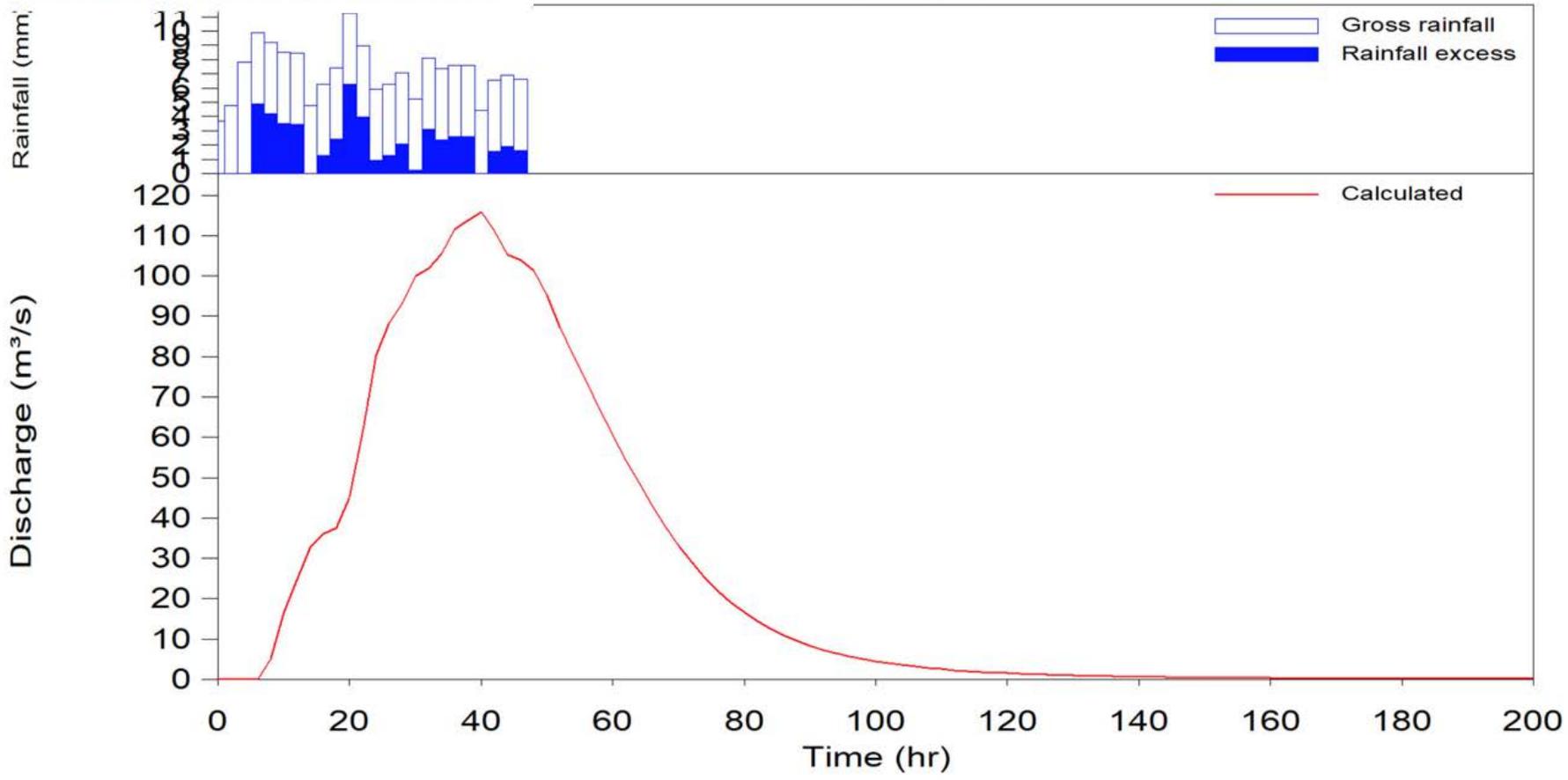
(Data hub or other studies)

1 Pattern 5727

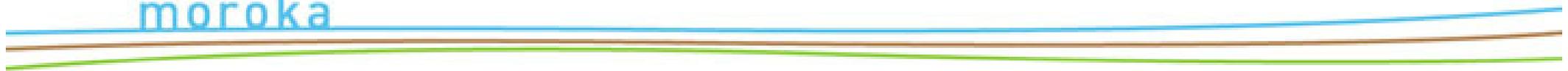
ΞP rainfall, single pattern



Calculated hydrograph, test

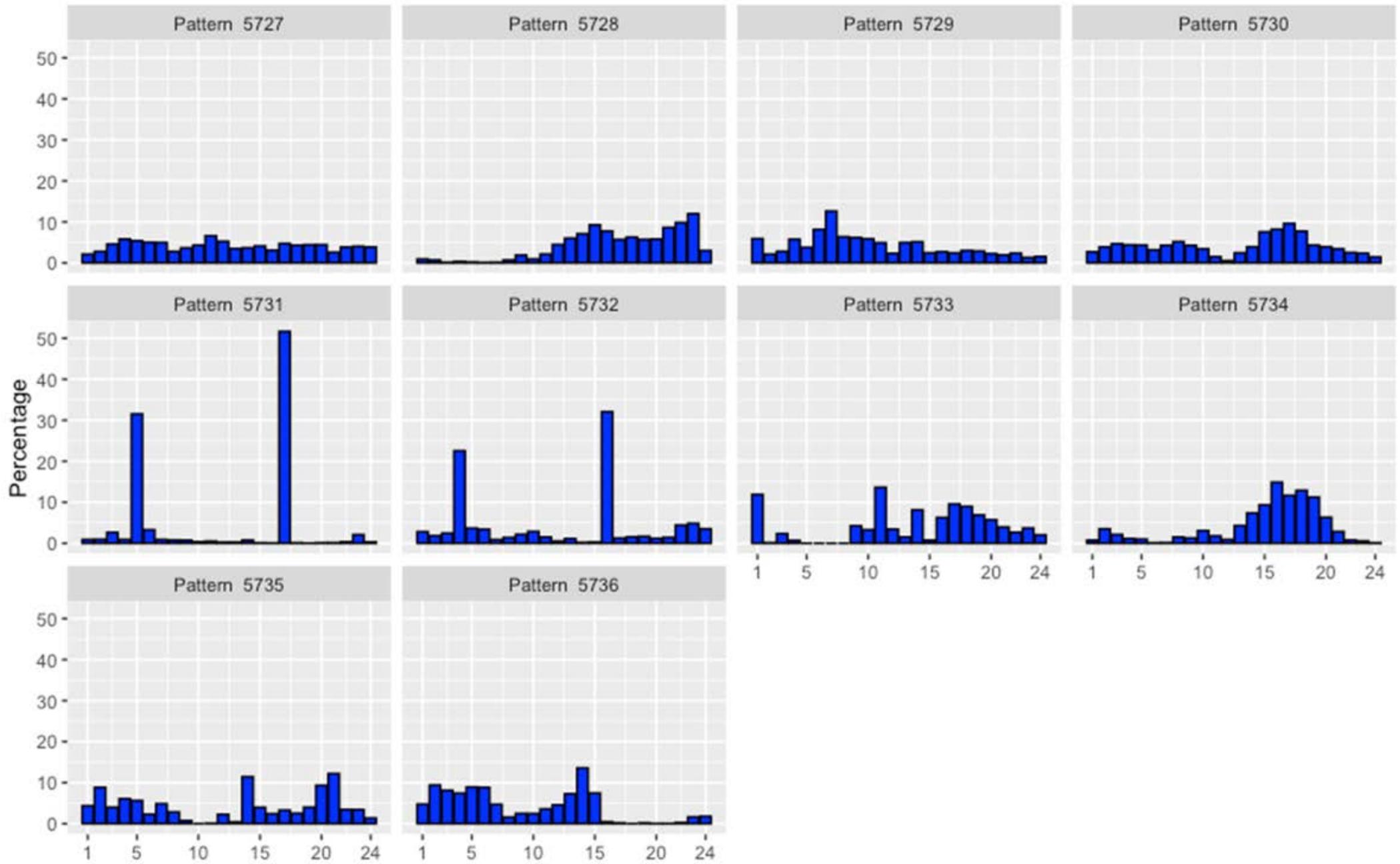


moroka

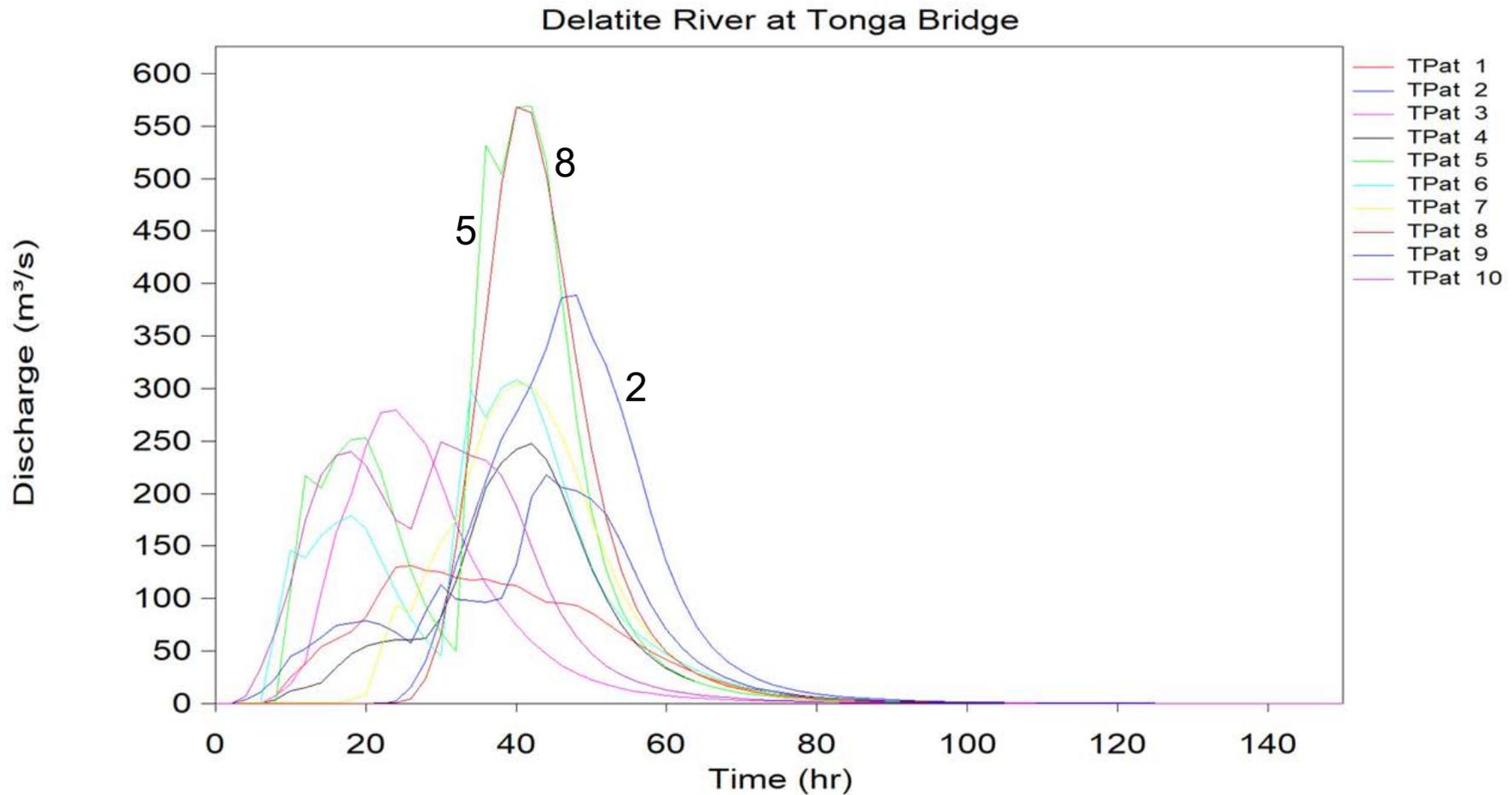


Rainfall temporal patterns

Region = Murray Basin, Duration = 48 hours, Area = 500 km-squared

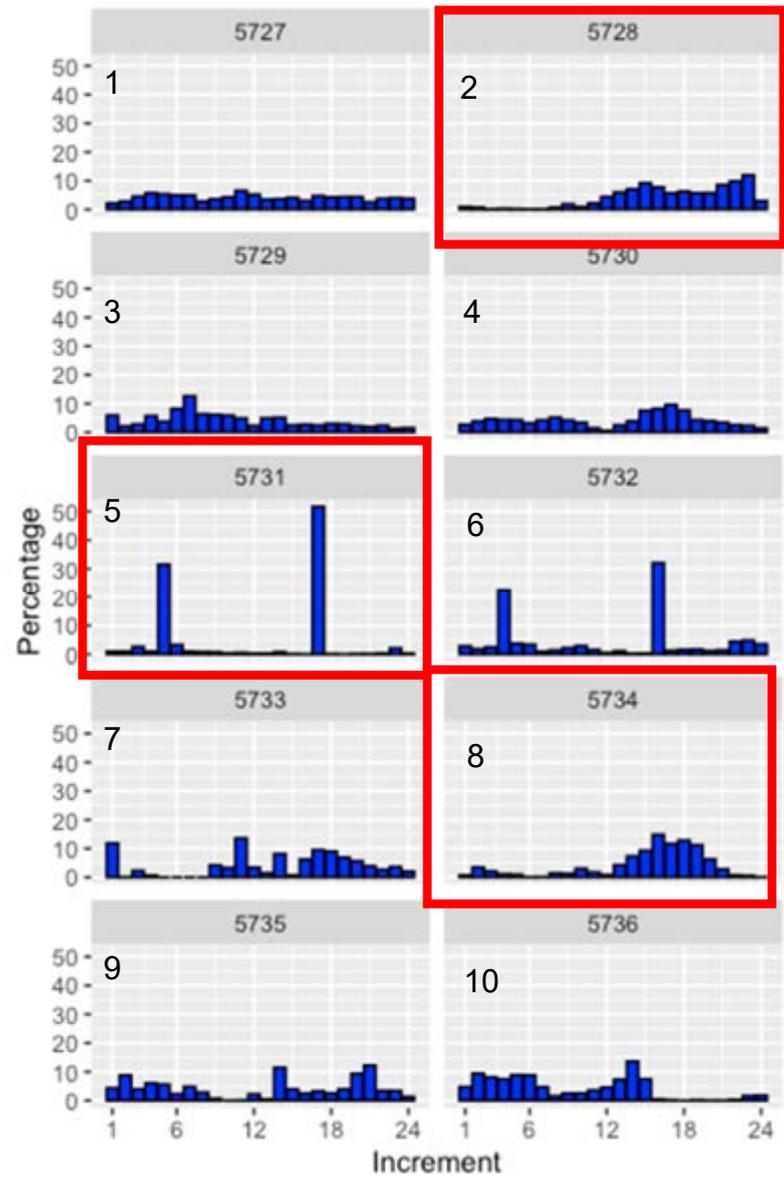
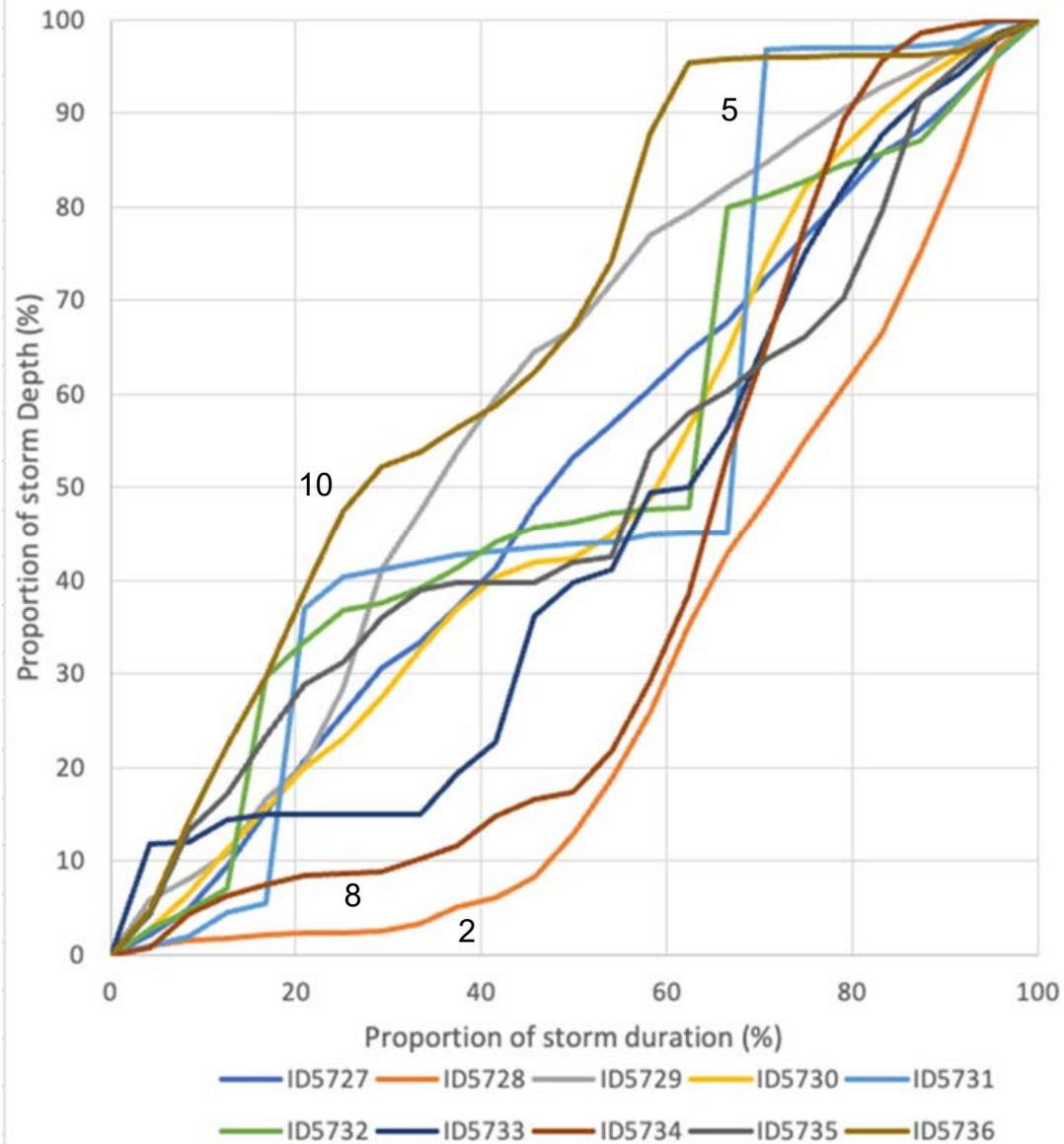


48 hour, 1% AEP rainfall, 10 rainfall temporal patterns

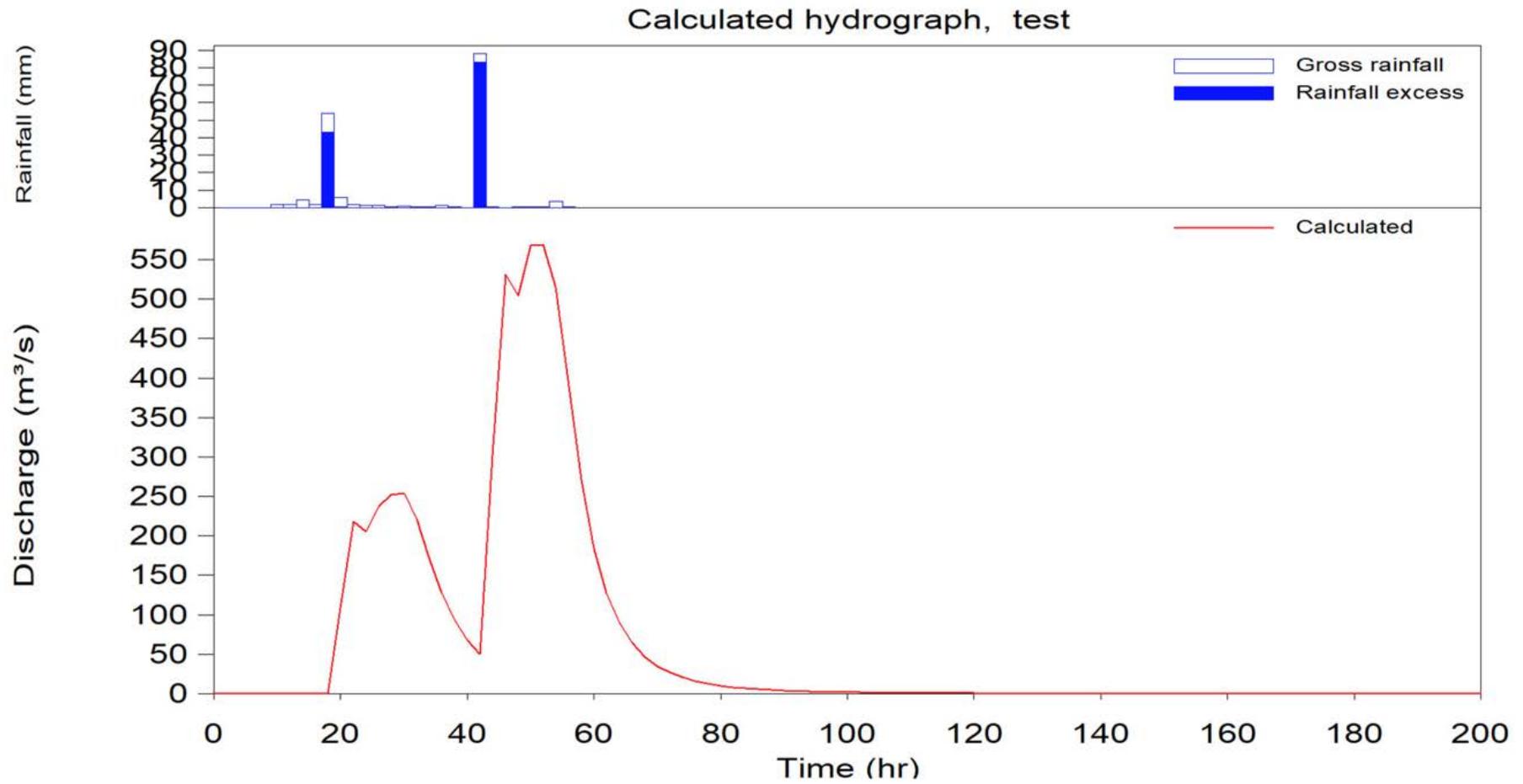


IL = 15, CL = 2.5

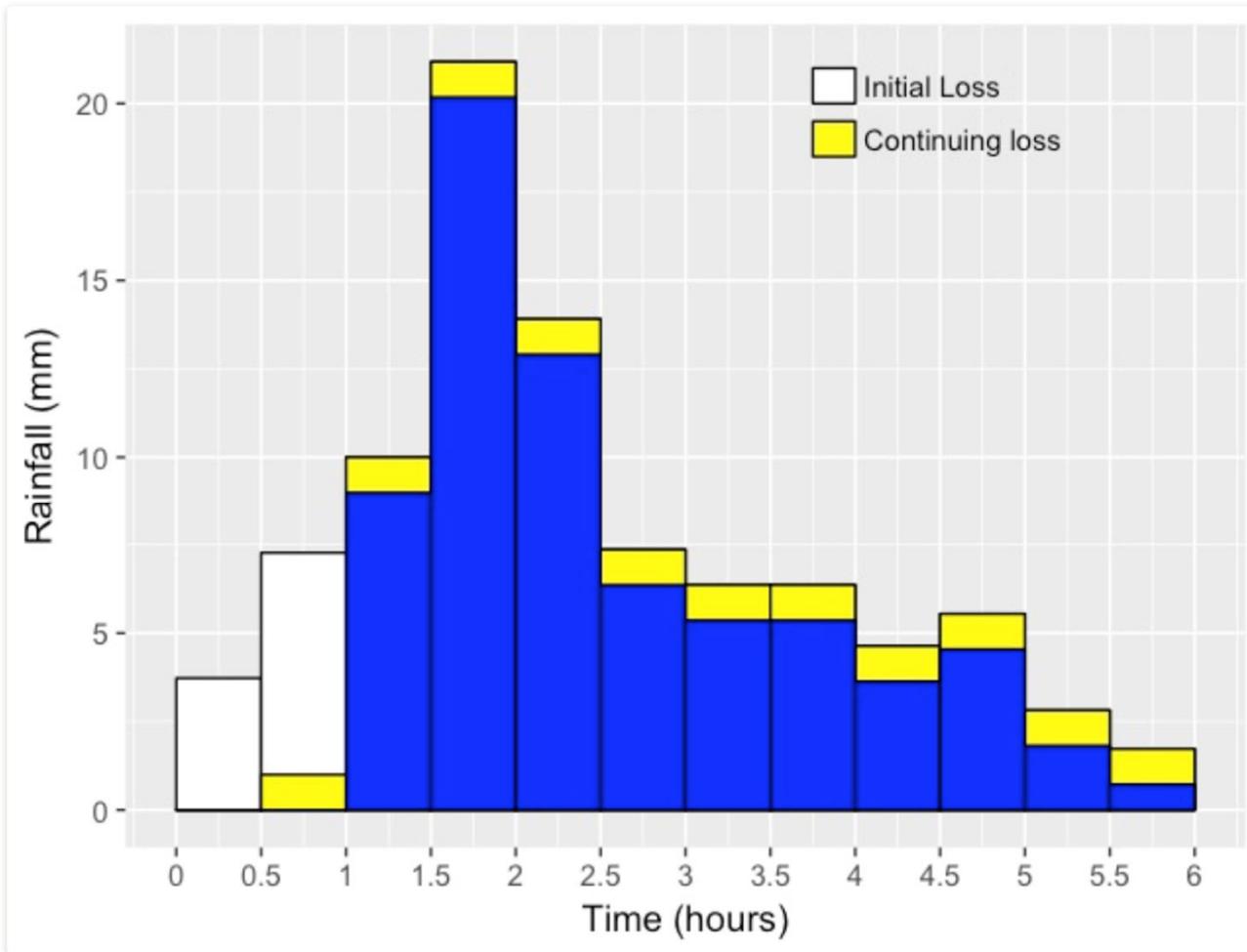
Cumulative Temporal Patterns for 500 km² 48 hr storms



Pattern 5



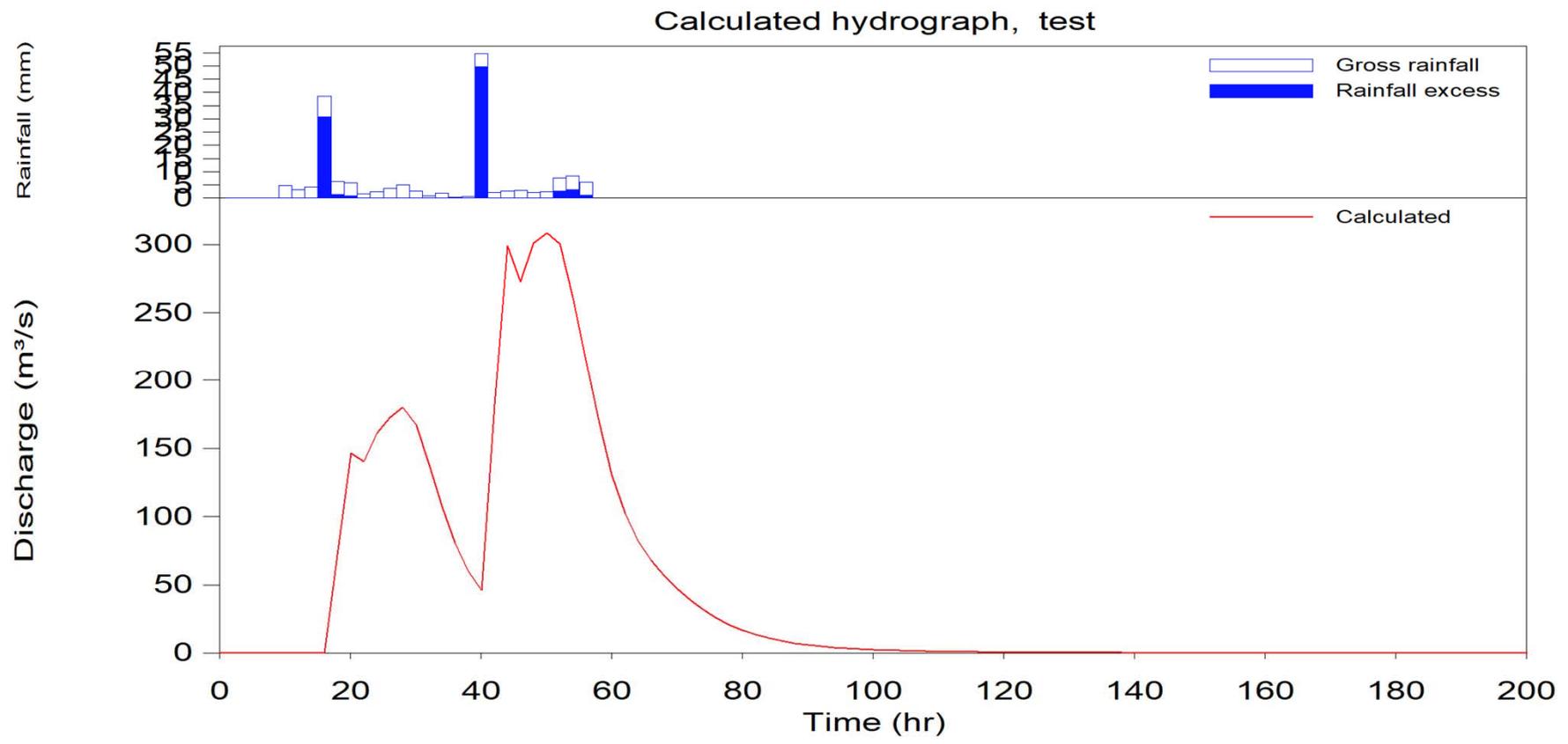
moroka



Remove the initial loss at the start of the storm

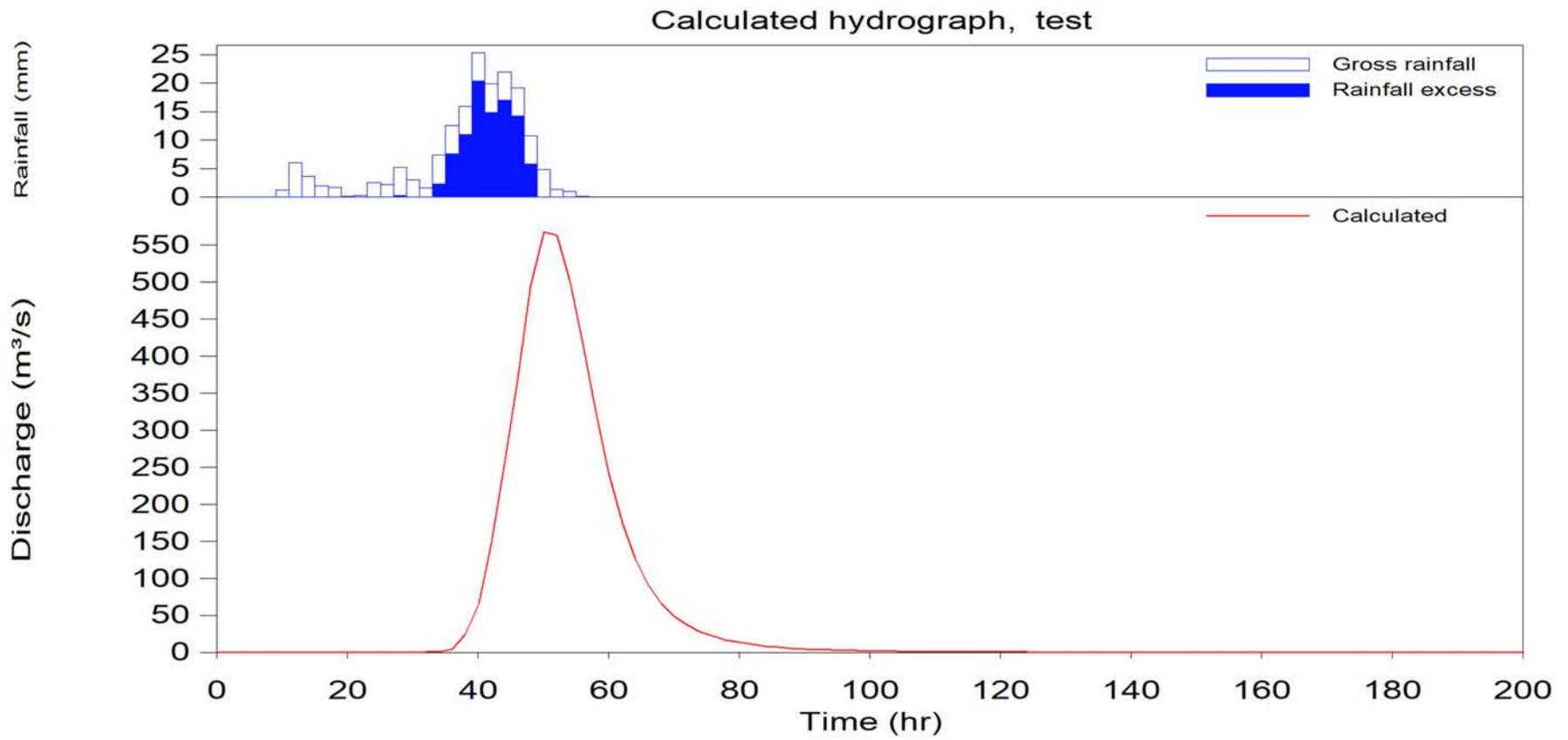
Remove the continuing loss for every time step once the initial loss is satisfied

Figure 2: Rainfall excess hyetograph



moroka





moroka

Input files

- Separate catchment and existing storm file Single input file (original RORB format)

- Separate catchment and generated design storm(s) IFD data type: ARR2016

Catchment file

D:\latite.catg Browse ...

Storm file

(Storm information automatically generated by program) Browse ...

Parameter configuration

- Single set of routing parameters for whole model (default) Initial loss / continuing loss model
- Vary routing parameters by interstation area Runoff coefficient model

Run options

- As specified in storm file
- FIT (initial loss only fitted by user)
- DESIGN (loss parameters specified by user)

Output options

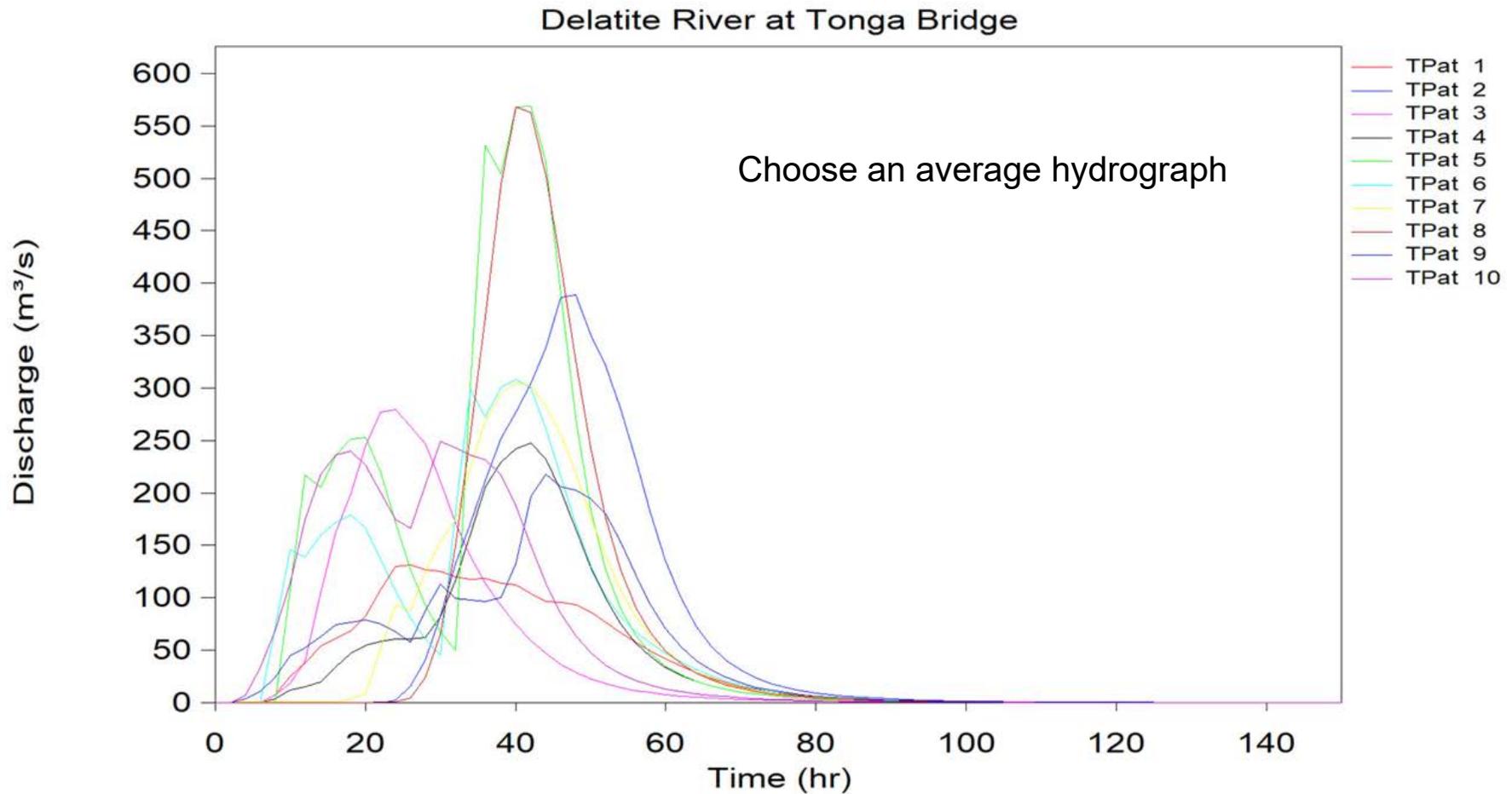
- Information detail: Flows & all input data
- Text and CSV outputs
- Filename root: Catchment+storm file
- Directory same as: Storm file

Cancel

Help

OK

48 hour, 1% AEP rainfall, 10 rainfall temporal patterns



IL = 15, CL = 2.5

Monte Carlo

- Sample:
 - Rainfall depth
 - Temporal Pattern
 - Initial Loss
 - Duration

Data Hub files

Main Data Hub file (*.txt, contains ARFs and losses)

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 2 Browse...

Temporal Patterns (*.increments.csv)

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1 Browse...

Standard area for areal temporal patterns (km²): From .CAT Use regional losses Use ARFs from file

IFD data

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1 Browse...

View/edit IFD data

Simulation details

Simulation type: Monte Carlo simulati

 Extract MC HydrographsGroup batch results by: AEP or by Duration

Select AEP:

Select duration: 12 hour

to

168 hour

No. time incs to be modelled: 200

Temporal pattern details

Select patterns for deterministic runs

 Filter Embedded Burst? Filtered Temporal Patterns Output File (MC)

Spatial pattern details

 Non-uniform pat.?

Edit Pattern

Pre-Burst

 Apply Pre-burst

Edit pre-burst

Loss Factor details

 Constant losses Variable losses

AEP factors

Duration factors

Areal Reduction Factor details

Edit Coeff.

 Replace total catchment area with value of 0.00 km²

Output directory

\\Mac\Dropbox\Projects\N639-Rail\RORB course Aug 21-2\Exercises\Day 1 Browse ...

Cancel

Help

OK

Monte-Carlo Simulation Details

Stratified Sample

Number of rainfall divisions: Number of samples per division:

Temporal Patterns

Point temporal patterns are sampled based on the AEP bin they are assigned to (frequent, intermediate, rare or very rare). See ARR Book 2, Chapter 5, Section 5.5.

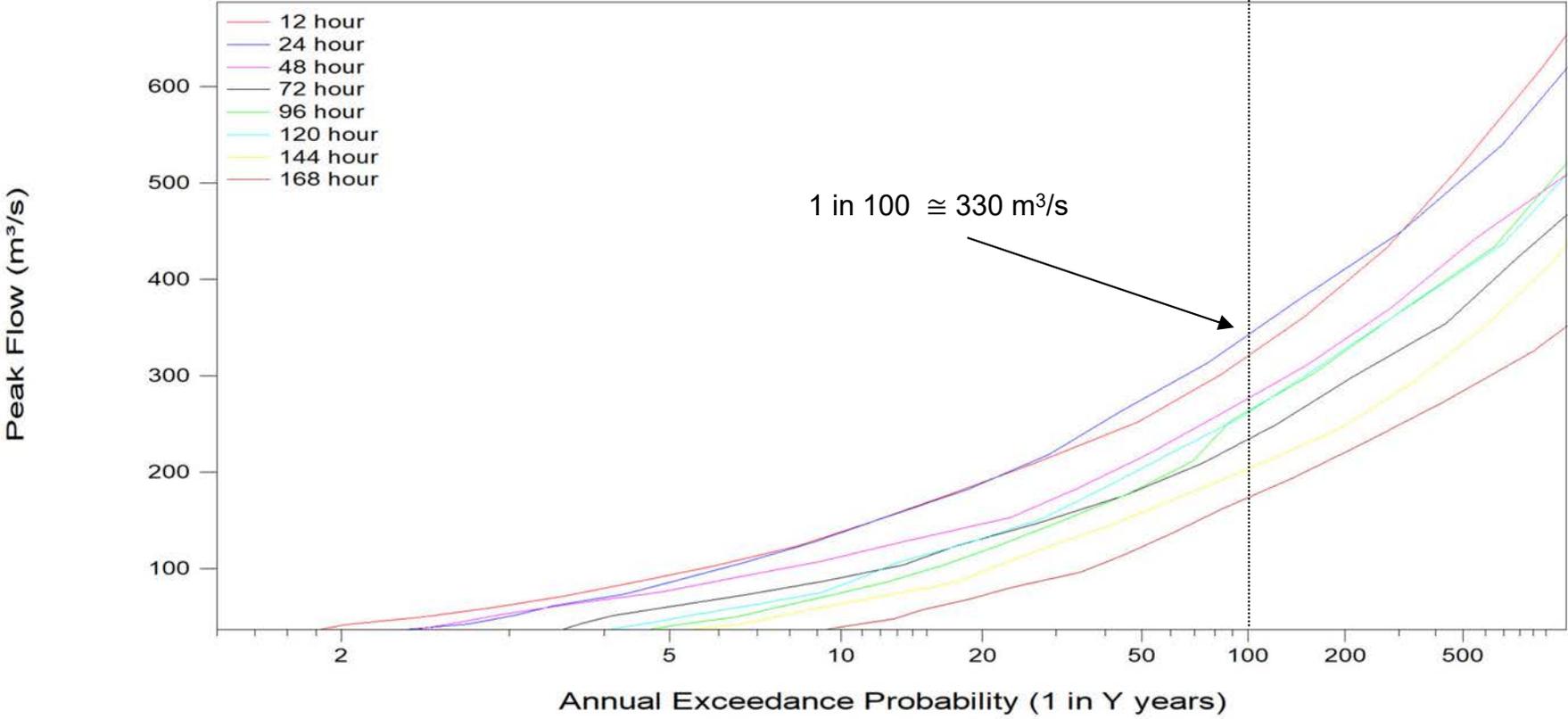
Initial loss selection

Fixed initial loss Monte-Carlo sample

Output details

Print individual run results Print analysis diagnostics

Delatite River at Tonga Bridge



DELATTE RIVER @ TONGA BRIDGE

Station number 405214
Latitude -37.16
Longitude 146.11
Data owner VIC - Department of Environment, Land, Water and Planning



Watercourse discharge

- Time series explorer
- Period of record summary
- Quality and gap summary
- Daily data summary
- Monthly data summary
- Yearly data summary
- Monthly mean statistical analysis
- Yearly statistical analysis
- Ratings and gaugings
- Duration curve
- Flood frequency analysis**
- Difference from mean analysis

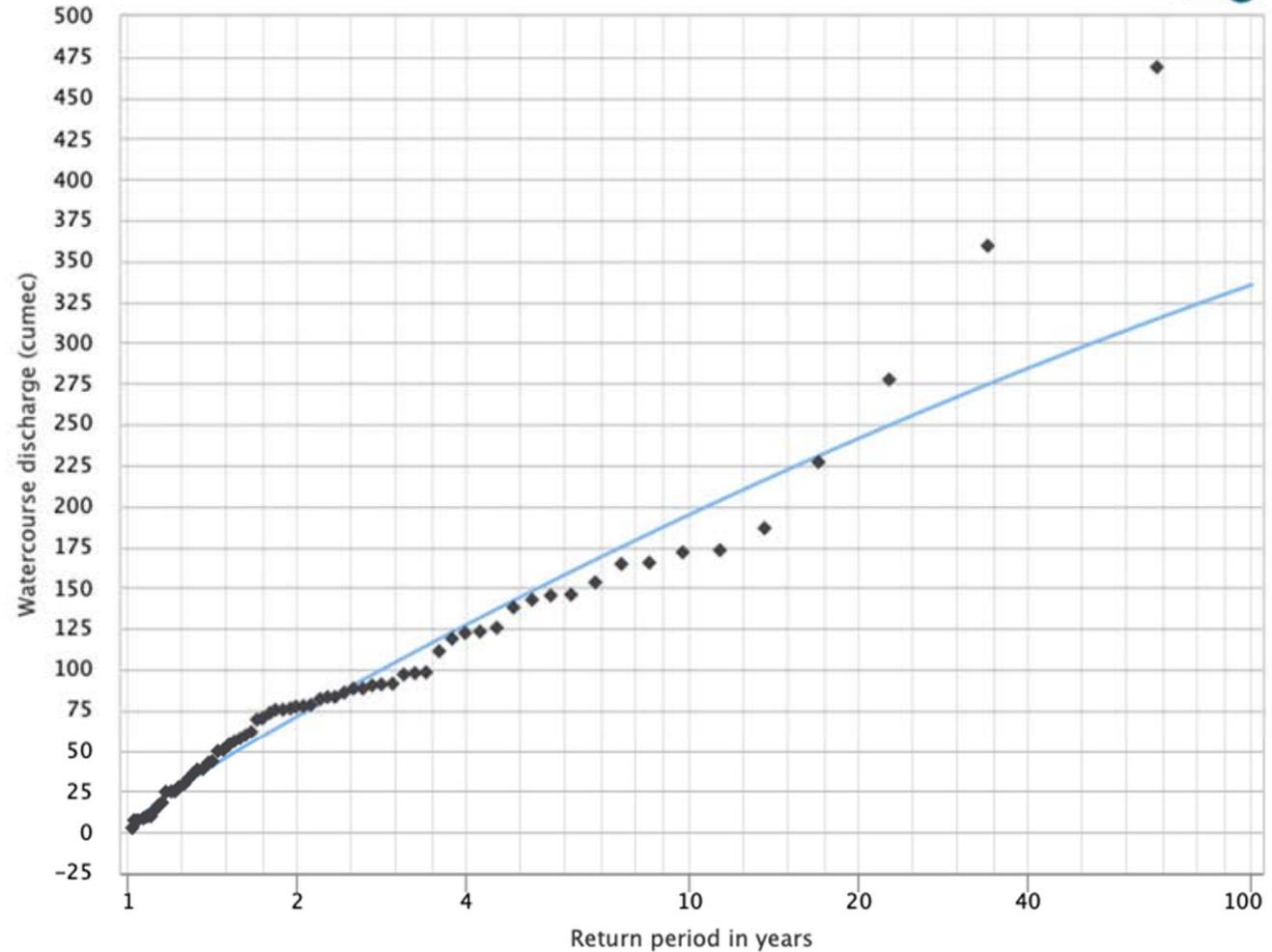
Watercourse level

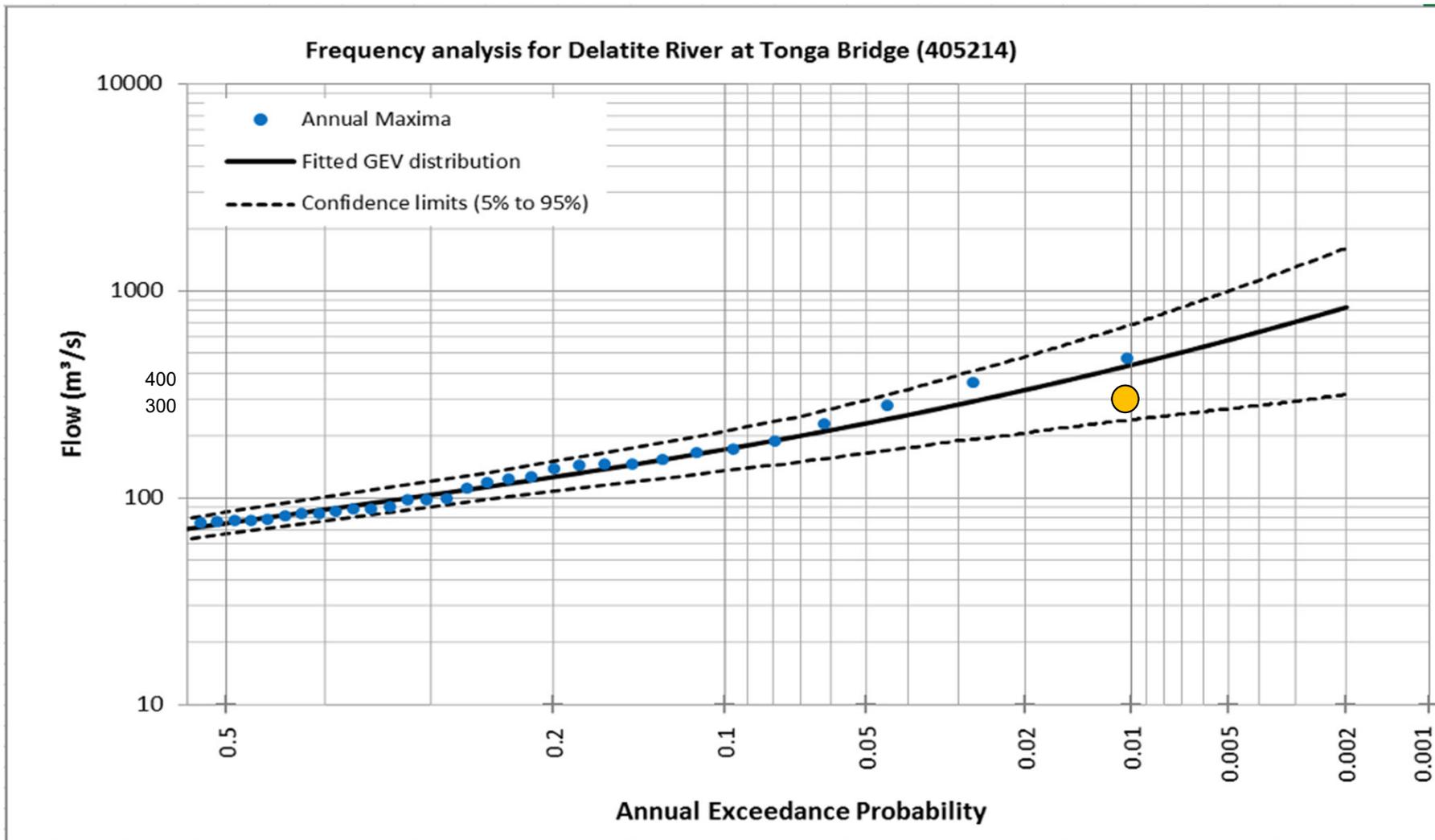
Rainfall

Data download

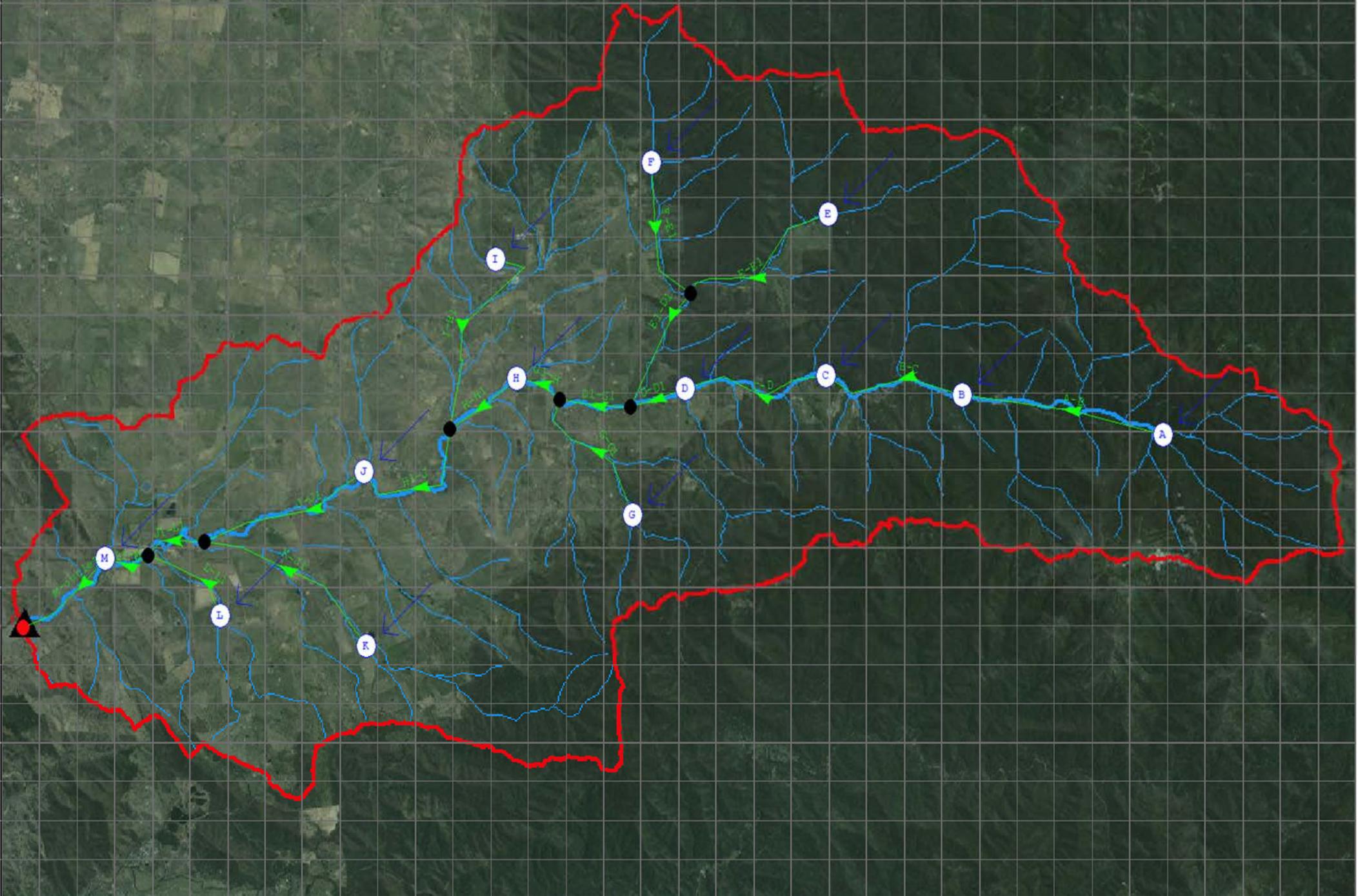
Flood frequency analysis ?

Function **Pearson Log.3**





Conclusion



What's next?

Courses:

- Live Course: [RORB essentials for water modelling](#)
- On-demand: [ARR Training Series](#)
- Especially: ARR Course #5: [Design Estimation](#) (included in the RORB course fee)

- On-demand: [Hydrology and Hydraulics Essentials Series](#)
- Especially: [Stochastic hydrology, #4 H&H Essentials](#);
- [Flow routing, #3 H&H Essentials](#); [Infiltration and losses, #2 H&H Essentials](#)
- On-demand: [HEC-HMS Essentials](#)

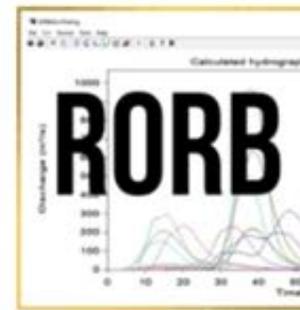
Free Webinars:

- What's new with Australian Rainfall and Runoff 2019: <https://youtu.be/YIcYIYtiDW8>
- Australian Rainfall Runoff ARR Essentials: <https://youtu.be/hsTjFBkdInE>- Probable Maximum Flood (PMF): <https://youtu.be/0etZZ7M3nAQ>

- Panel Event: Australian Rainfall and Runoff – to the extreme! <https://youtu.be/Nb03NF91Okw>
- Fitting the curve: <https://youtu.be/ekduoQrOU2o>
- Manning equation in hydraulic modelling: <https://youtu.be/JhIPDFwA5UU>

Live Course: RORB essentials for water modelling

Pre-course webinar 15th Mar - register today +



Using RORB to model general runoff and streamflow routing from rainfall and other channel inputs

(Course code: LC-23-2-073)

This course is focused on getting started with RORB and building attendees' understanding so that they can take on more advanced topics.

This two-session live online course also incorporates the material covered in AWS's On-demand ARR Course 5: Design Estimation. The principles of Design Estimation will be introduced in the first session of RORB essentials, and discussed further in the second live session.

Further course details below.

Date: Thursday, 20 April 2023 - Thursday, 18 May 2023

Time: 10:00am (Australia/Sydney; [find your local time](#))

Location: Online

Format: x2, 2 hour live interactive sessions + ARR On-demand Course 5 (3hrs); live recordings available post session

Cost: Early bird rate - AUD\$495.00 (INC GST) closes 20th March 2023

Enter coupon code at checkout: Early-Bird-Rate-LC-23-2-073

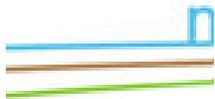
Standard fee \$595.00 (INC GST)

Contact: training@awschool.com.au

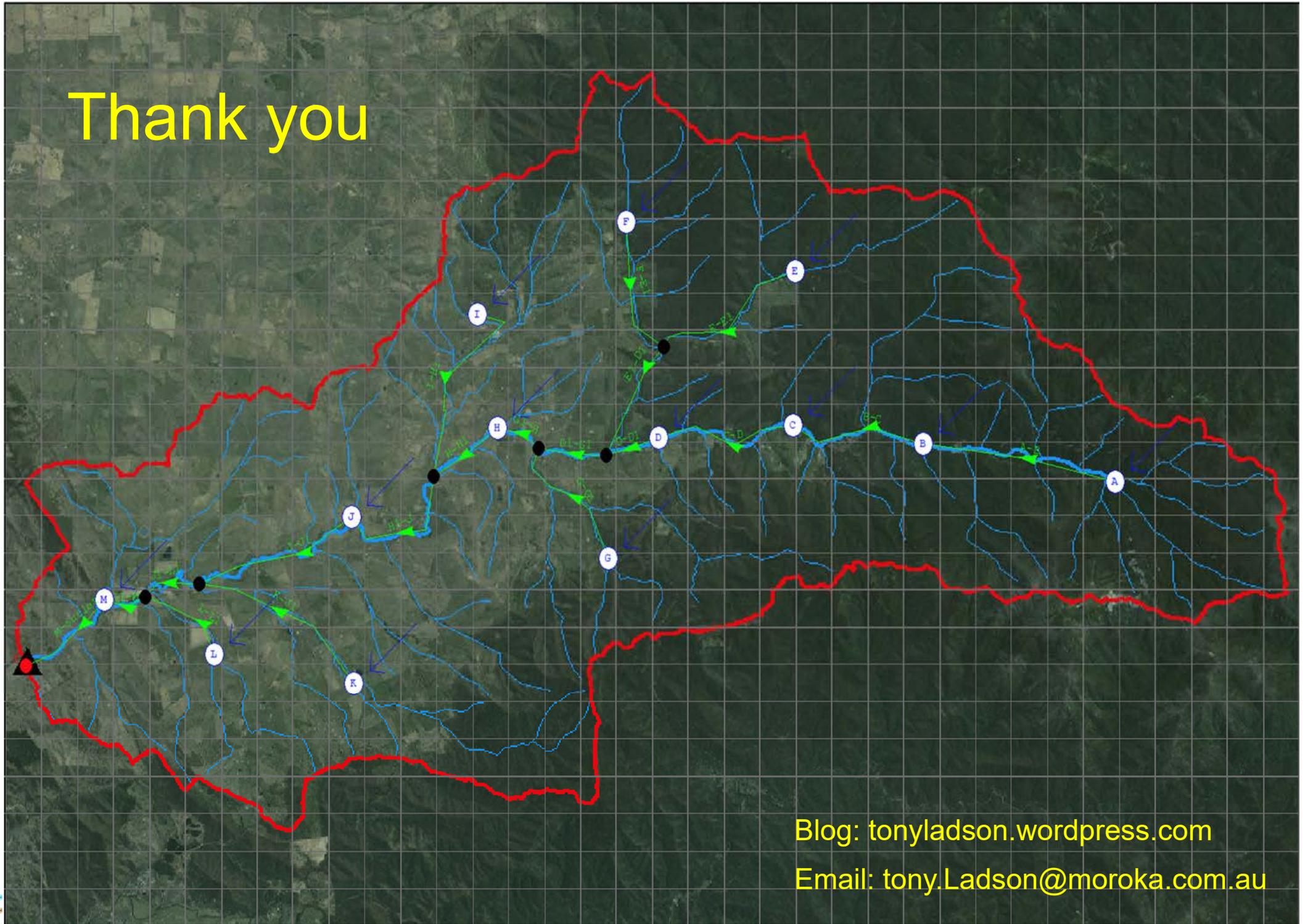
Register +

Print

Share



Thank you



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