A new method for estimating flow duration curves

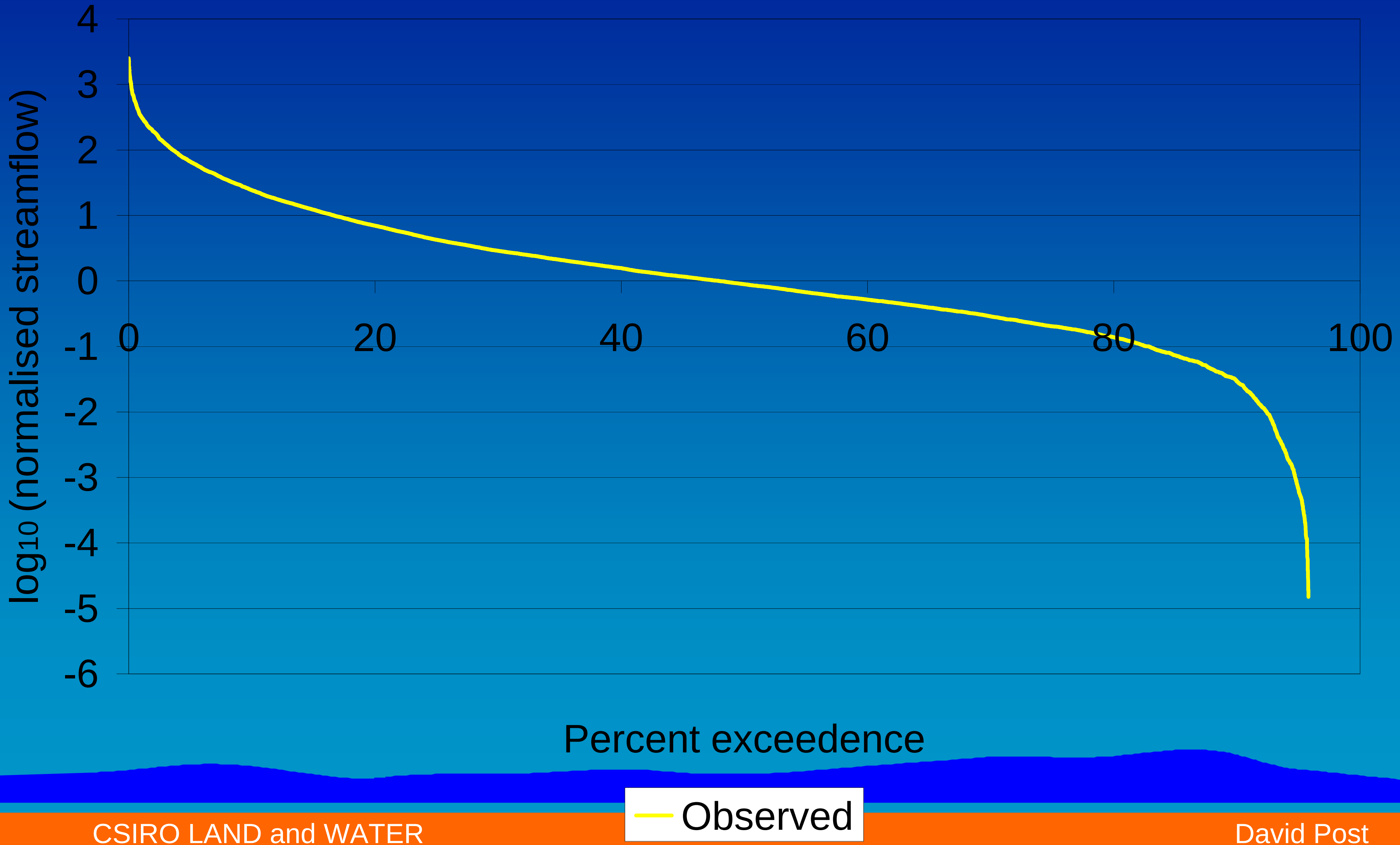
An application to the Burdekin River catchment, Qld, Australia

iEMSs, June 2004

Introduction

- The flow duration curve (FDC) provides information about the percentage of time that a streamflow was exceeded over some historical period.
- A new method of defining the FDC, using a simple two-parameter model will be presented.
- Possibilities for the regionalisation of the FDC from landscape attributes in the Burdekin Catchment, Qld, Australia will be discussed.

Shape of the FDC



Predicted FDC

- The shape of the FDC suggests that a logarithmic function would be a suitable approximation;
- The function chosen is of the form :
  - $y = \ln((a/x) - 1)/b$

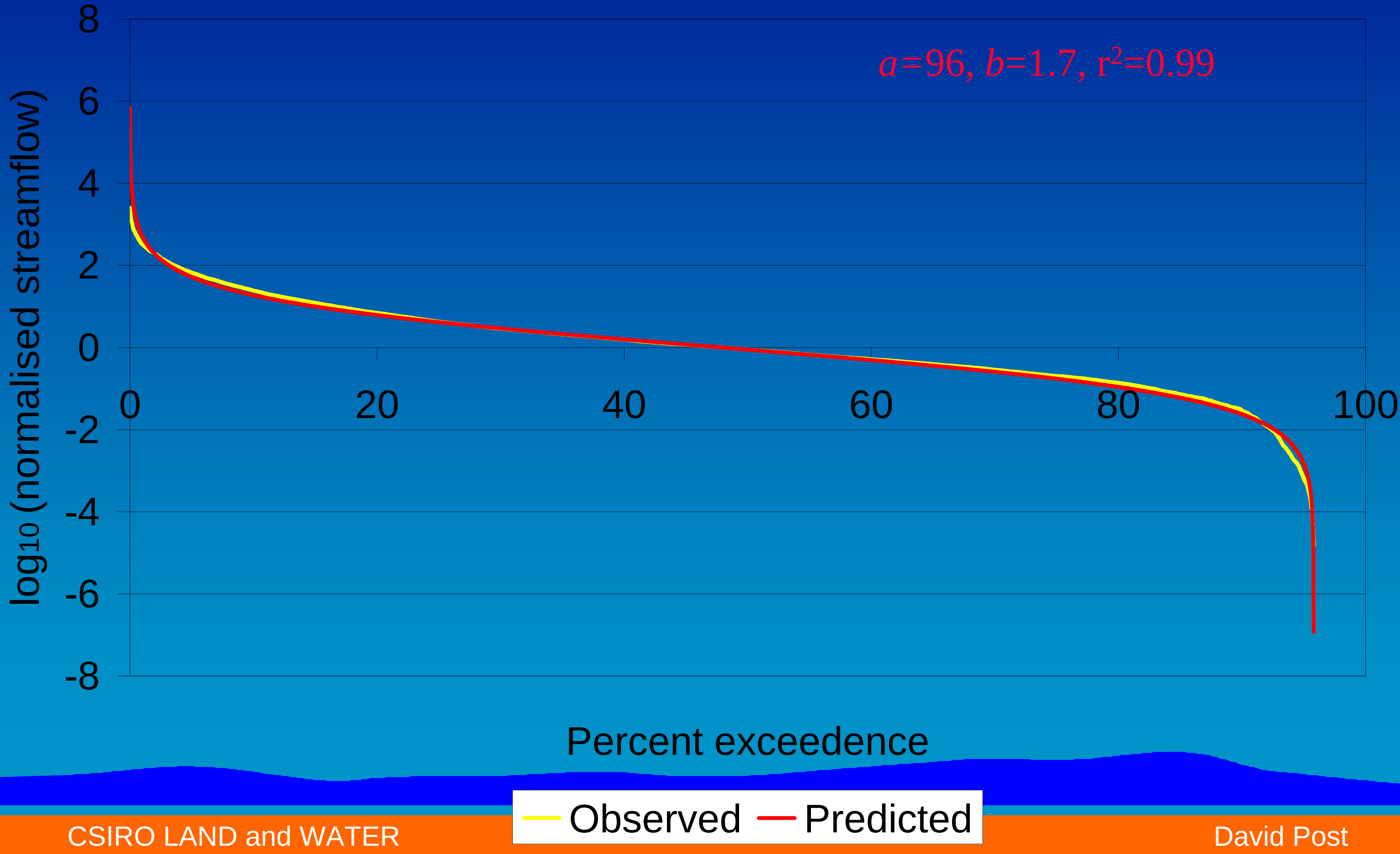
where $y = \log_{10}(\text{normalised streamflow})$

x = *percent exceedence*

a = *percent exceedence at the cease-to-flow*

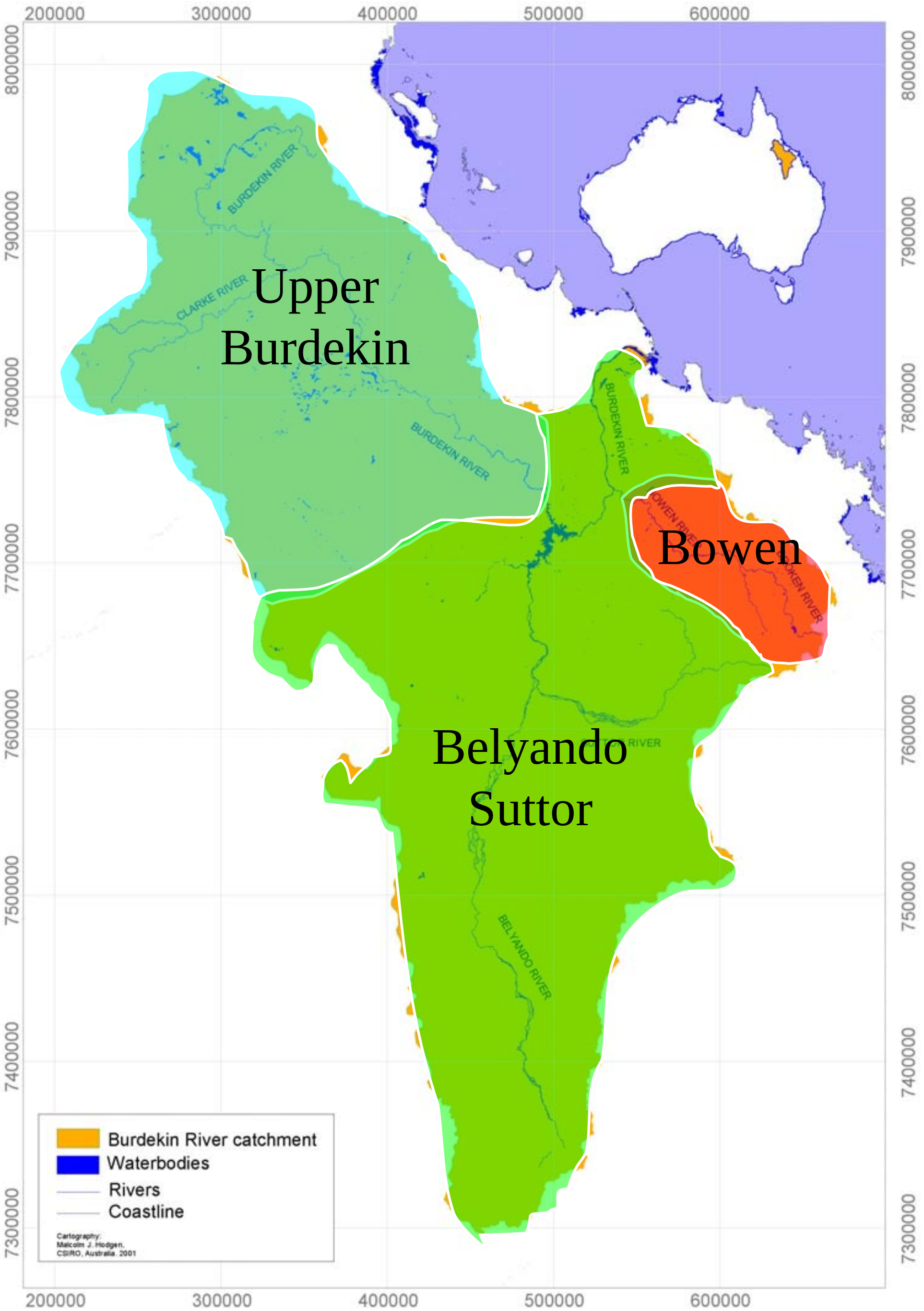
b = *constant controlling the slope of the FDC.*

Model fit



a=96, b=1.7, r^2=0.99
8
6
4
2
0
-2
-4
-6
-8
0
20
40
60
80
100
log10 (normalised streamflow)
Percent exceedence
Observed
Predicted

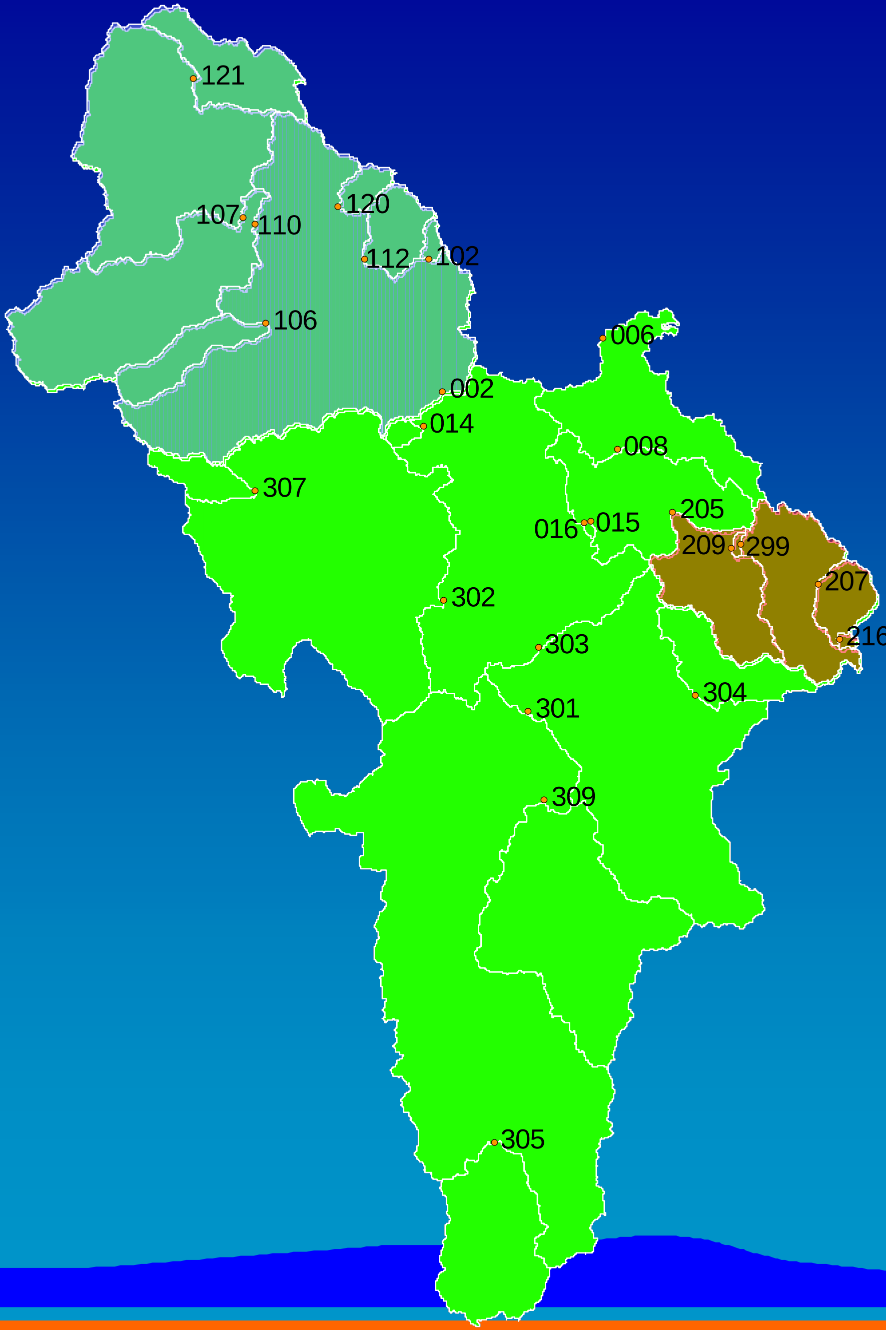
Location of the Burdekin catchment



Burdekin catchment study

- DNRM has 23 currently gauged catchments within the Burdekin, ranging in area from 68 km^2 to 130,146 km^2;
- Flow duration curves will be fit to each of these 23 catchments and the parameters defining these curves related to the catchment attributes;
- The parameters of this model will be related to *mean annual precipitation*, *catchment area*, *drainage density*, and *total stream length*.
- Some comments will be made regarding the potential uses of flow duration curves as catchment hydrologic signatures.

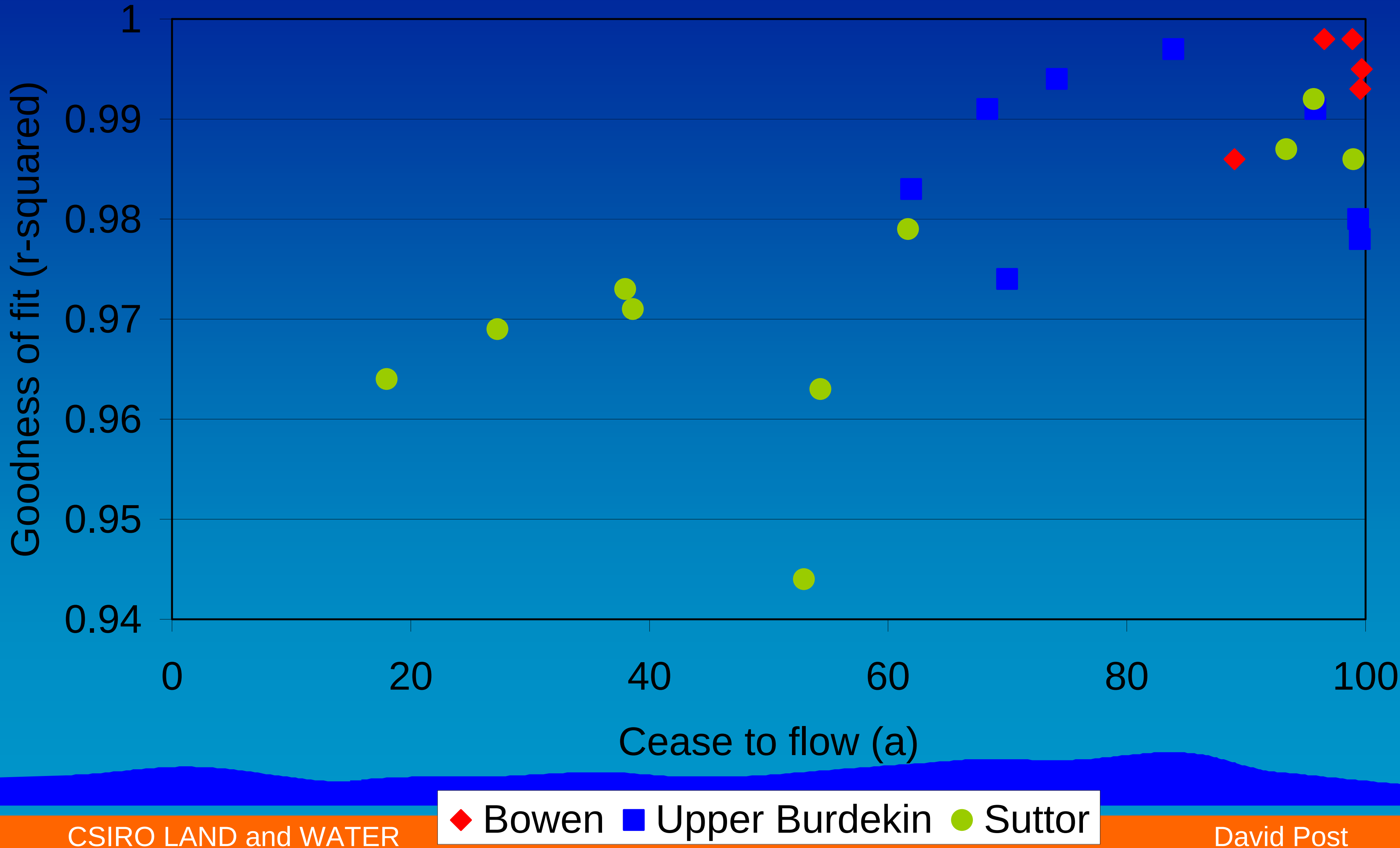
Location of stream gauging stations



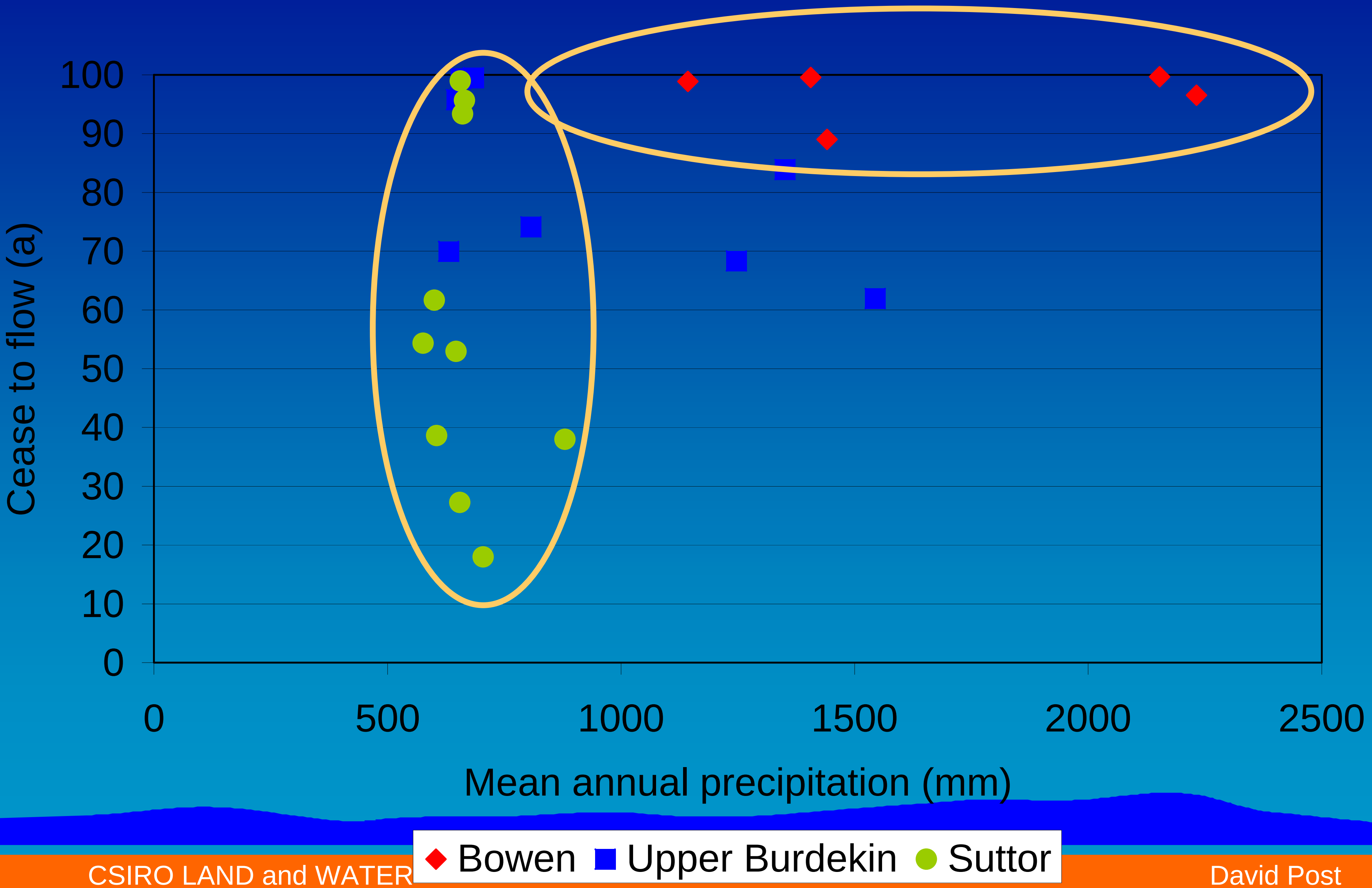
Goodness of fit

Catchment	*a*	*b*	r^2	Catchment	*a*	*b*	r^2
120002	96	1.7	.99	120205	99	2.1	.99
120006	96	1.7	.99	120207	100	2.6	.99
120008	93	1.7	.99	120209	100	2.1	.99
120014	18	1.6	.96	120216	97	2.6	.99
120015	99	2.0	.99	120299	89	2.2	.99
120102	62	1.6	.98	120301	62	1.4	.98
120106	70	1.7	.97	120302	53	1.1	.94
120107	100	2.1	.98	120303	54	1.4	.96
120110	99	1.9	.98	120304	38	1.3	.97
120112	68	1.6	.99	120307	27	1.6	.97
120120	84	2.0	.99	120309	39	1.4	.97
120121	74	1.7	.99				

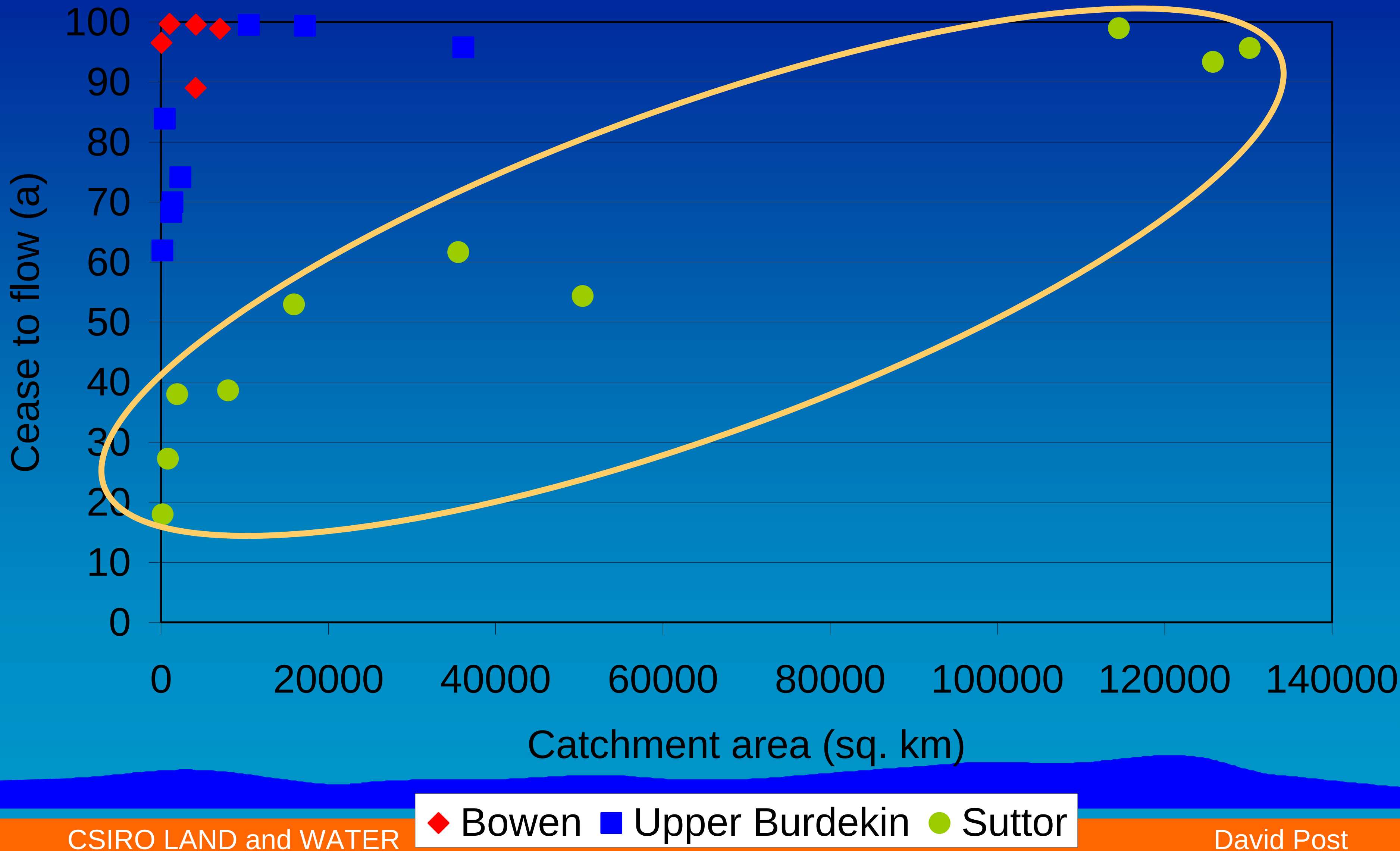
Perennial streams have higher r^2 values



Wetter catchments tend to have more perennial streams



…as do larger catchments…

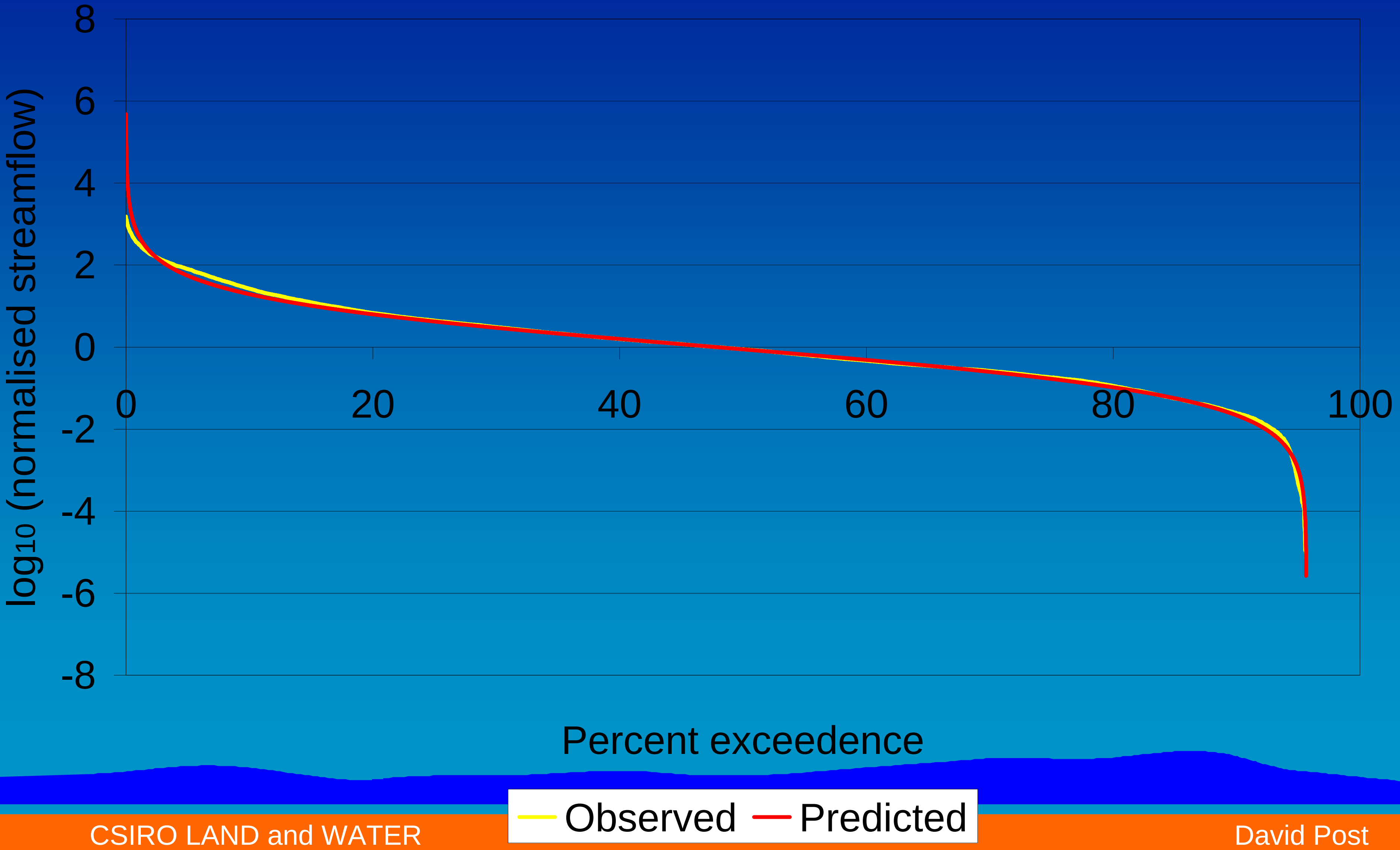


Derived relationships

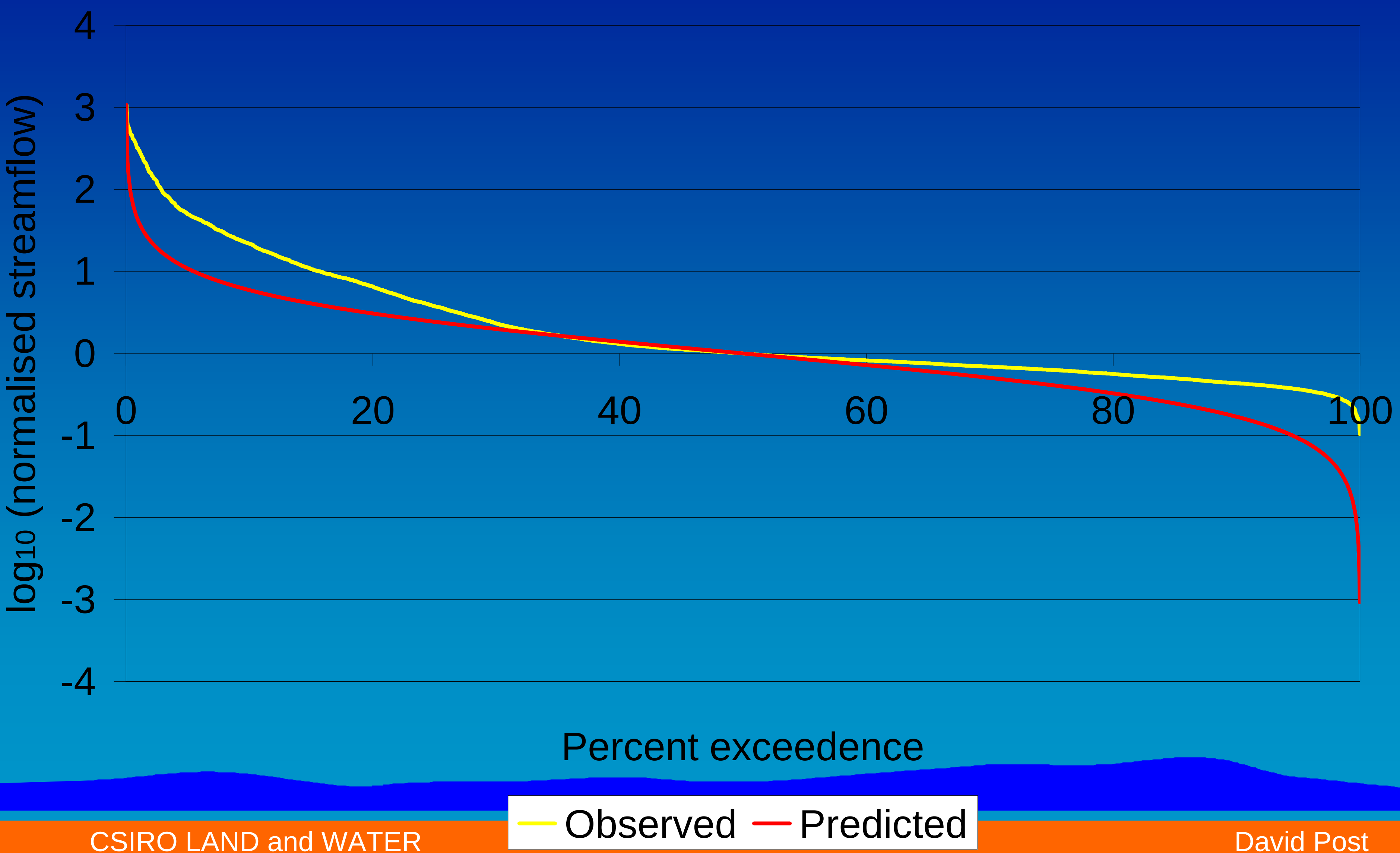
- a_s = fn (*area, drainage density*) Suttor r^2=.95
- a_u = fn (*area*) Upper Burd. r^2=.51
- a_b = 1 Bowen r^2=...

- b_s = fn (*drainage density, stream length*) Suttor r^2=.73
- b_u = fn (*area, drainage density, precip.*) Upper Burd. r^2=.57
- b_b = fn (*precip.*) Bowen r^2=.95

Pre-dam


8
6
4
2
0
-2
-4
-6
-8
0
20
40
60
80
100
log10 (normalised streamflow)
Percent exceedence
Observed
Predicted

Post-dam



4
3
2
1
0
-1
-2
-3
-4
0
20
40
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Percent exceedence
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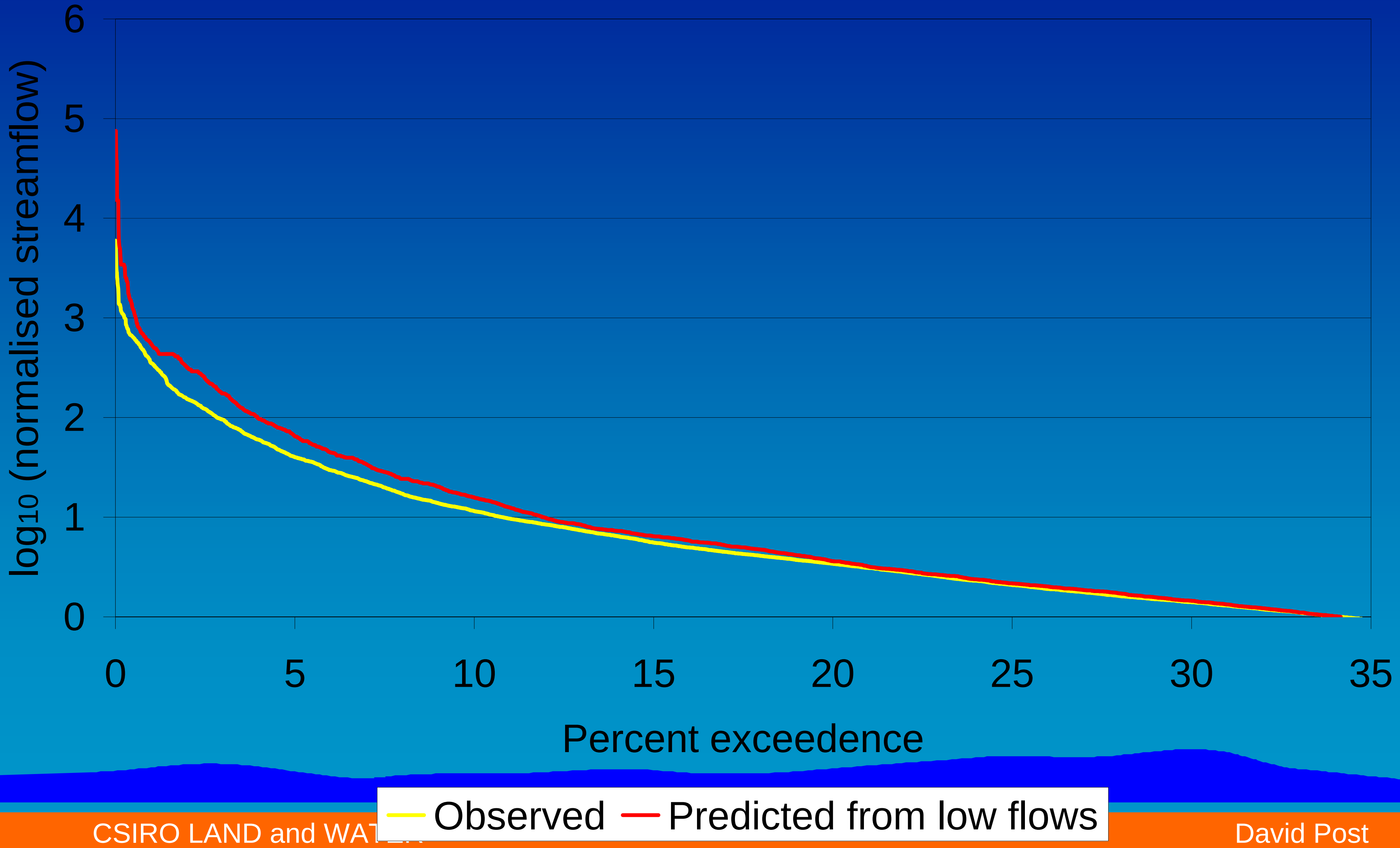
Predicting high flows from low flows



Conclusions

- A new method for estimating flow duration curves has been presented.
- The model used to estimate the flow duration curve (FDC) has two parameters – the percent exceedence at the cease to flow value, and the slope of the FDC.
- In the Burdekin Catchment (Qld, Australia), these model parameters are related to *mean annual precipitation*, *catchment area*, *drainage density*, and *total stream length*.
- As a result, these landscape attributes can be used to predict the FDC in ungauged sub-catchments of the Burdekin.
- The nature of the FDC means that there may be opportunity to predict high flows in gauged catchments from low flows.