Australian Centre for Sustainable Catchments

Riparian woodlands in crisis? Disturbance ecology on the Condamine floodplain

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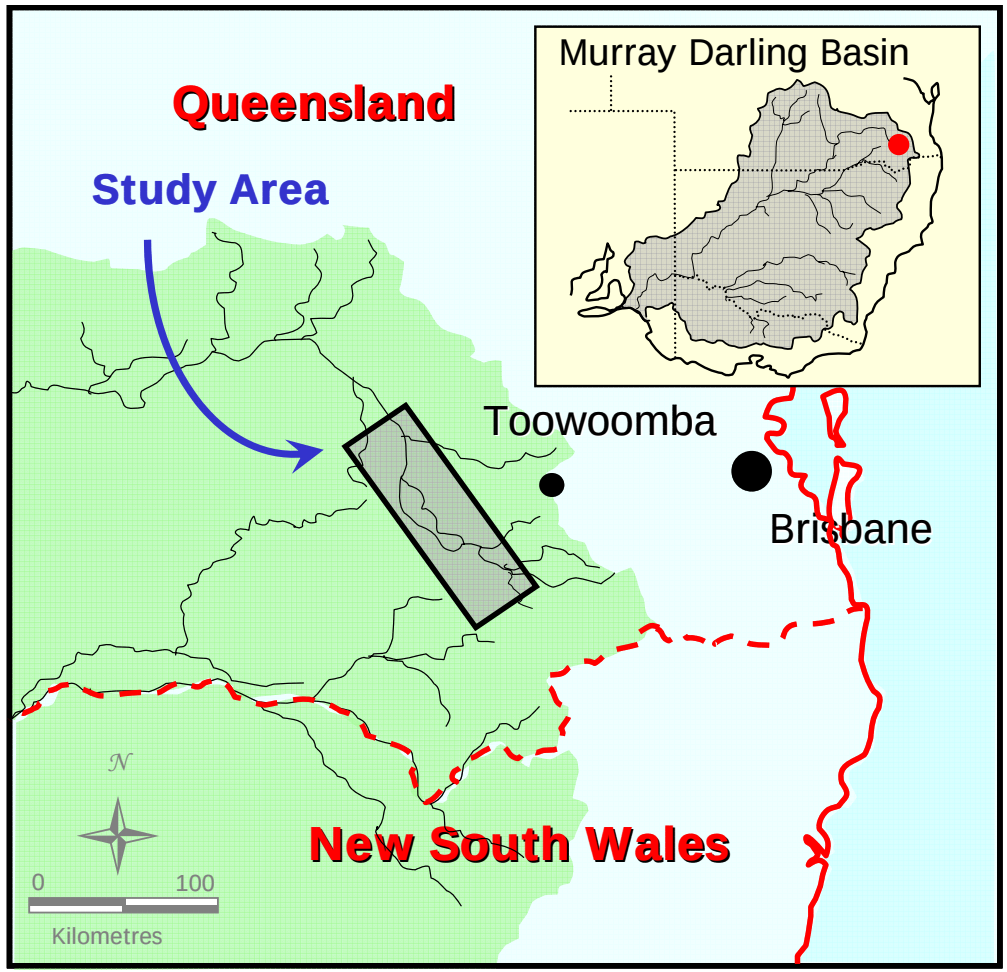
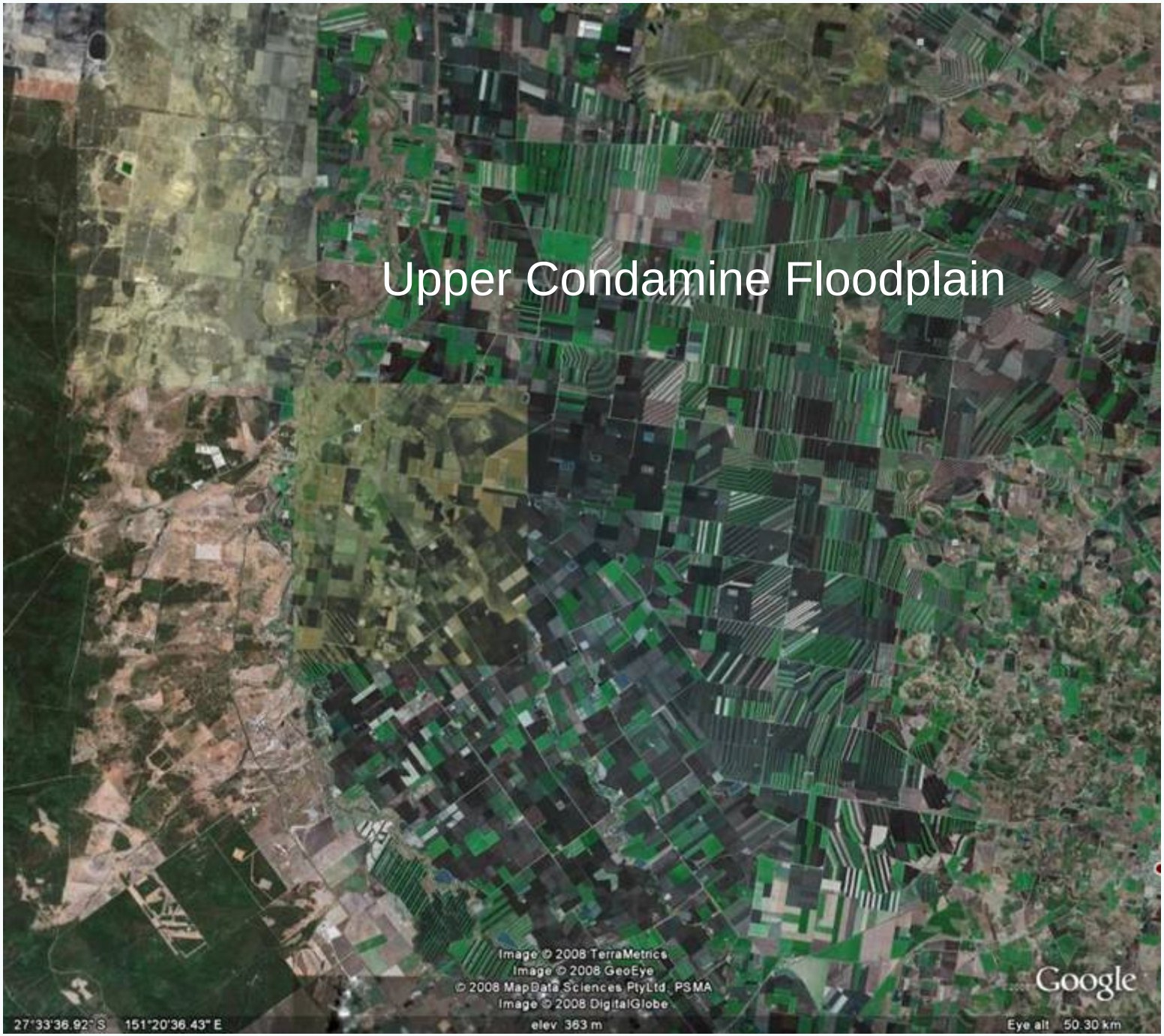
Study area:


Murray Darling Basin
Queensland
Study Area
Toowoomba
Brisbane
New South Wales
N
0
100
Kilometres


Upper Condamine Floodplain
Image © 2008 TerraMetrics
Image © 2008 GeoEye
© 2008 MapData Sciences Pty Ltd, PSMA
Image © 2008 DigitalGlobe
Google
27°33'36.92" S 151°20'36.43" E
elev 363 m
Eye alt 50.30 km

Floodplain ecosystems:

- dynamic non-equilibrial disturbance-driven systems
- hydrological connectivity (longitudinal, lateral, vertical, temporal)
- species & ecological communities adapted to historical disturbance 'regimes' (scale, intensity & frequency)

Modified floodplains:

- altered extent and integrity of natural habitats with development
- altered streamflow regimes (regulation, allocation & harvesting of in-stream & overland flow and/or groundwater) & hydrological connectivity
- changes in resource availability & changes in the frequency & extent of species dispersal/immigration events
- changes in abiotic & biotic interactions/feedbacks & resilience

Woodland condition:

Key questions:

* what is the status of health & function of riparian woodlands on this highly modified floodplain landscape?

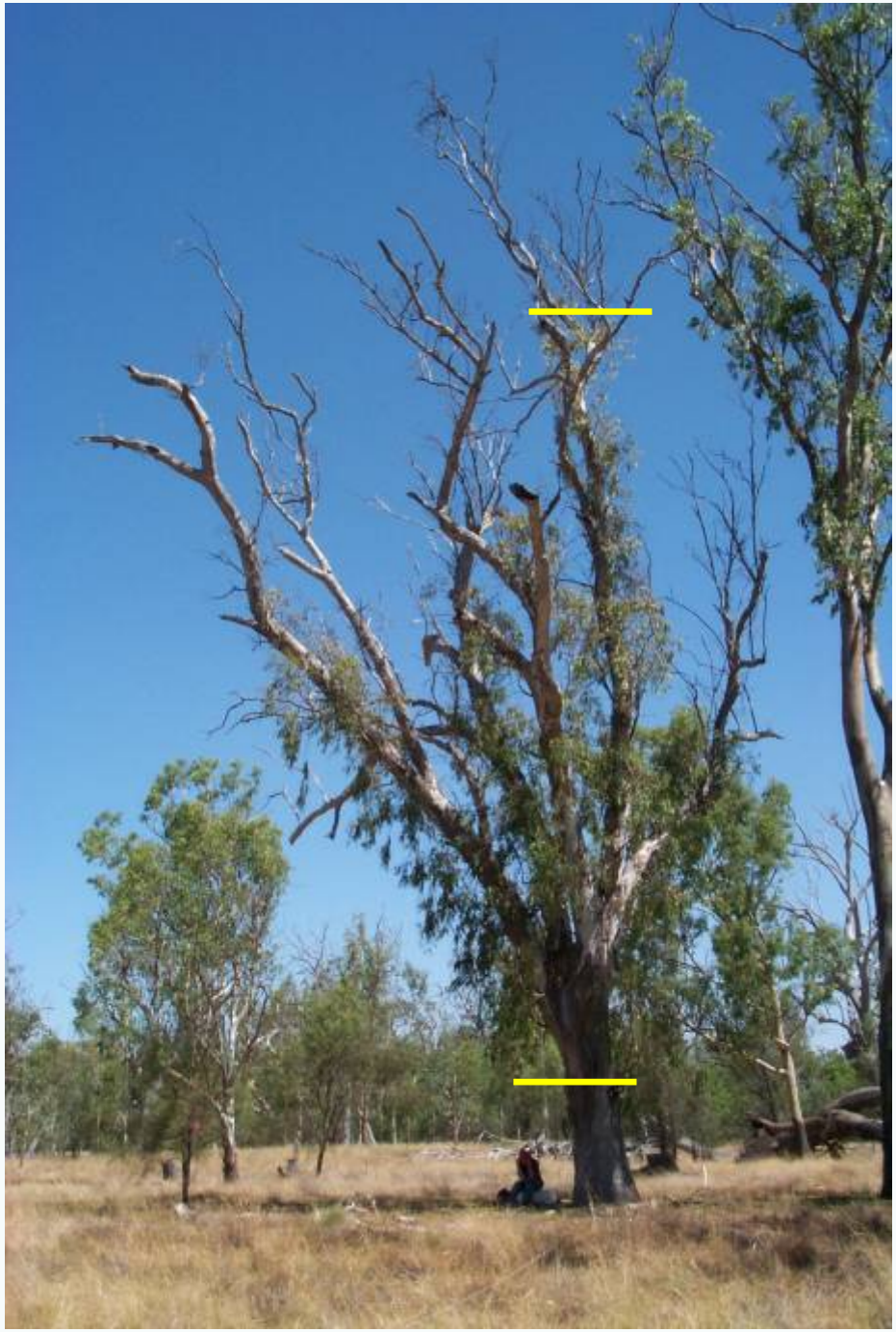
* what is the native vegetation response to landscape context, hydrological status and weeds?

* what is the potential for retaining function & resilience through time with increasingly variable climate?

Research activities:

→ multi-faceted approach to investigate processes involved in the decline (and restoration) of these ecosystems:

- ground-based survey of current community composition and condition (27 sites), including germinable soil seedbank
- landscape (spatial) context
- hydrological (time-series) analyses
- tree-condition study – response to arboreal herbivory
- groundcover studies – tree condition, lippia and management
- riparian woodland system dynamics models (state and transition frameworks; Bayesian networks)

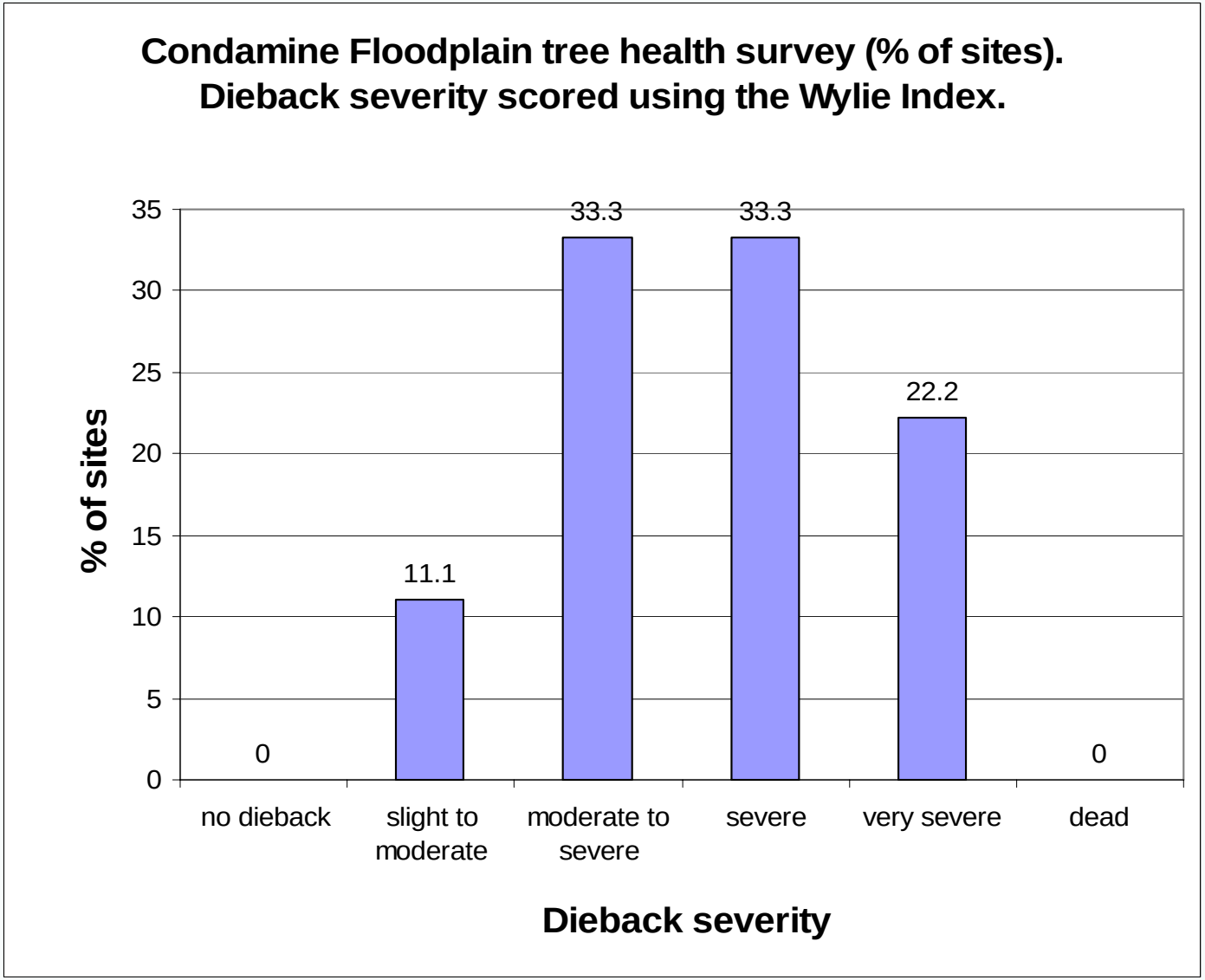


Scoring tree health:

Variable	Score	Comment
Foliage Index (FI) (%)	25	reduced crown
Percent tree remaining (PTR) (%)	75	Loss evident
Crown structure (CS)	3	Recent epicormic growth
Crown Dieback (CD)	3	Top of tree/tips of branches
Foliage colour	1	Healthy foliage colour
Dropped branches	2	evident
Mistletoe	0	No (live) mistletoe
Canopy proportion	0.66	11.6/17.5
Canopy density	30	

Tree Health Class	Definition
(i) very healthy	>= 95% FI – vigorous; full habit; few or no stags
(ii) healthy	75-94% FI – vigorous few stags; little epicormic growth
(iii) dieback: moderate to severe	30-74% FI – loss of vigour Stags; generally epicormic regrowth present moderate to poor health
(iv) dieback: very severe	<= 30% FI – loss of vigour recent epicormic shoots along trunk and branches from main canopy; Stags; very poor condition
(v) dead	No foliage; apparently dead crown

* definition of health classes as per Banks 2006

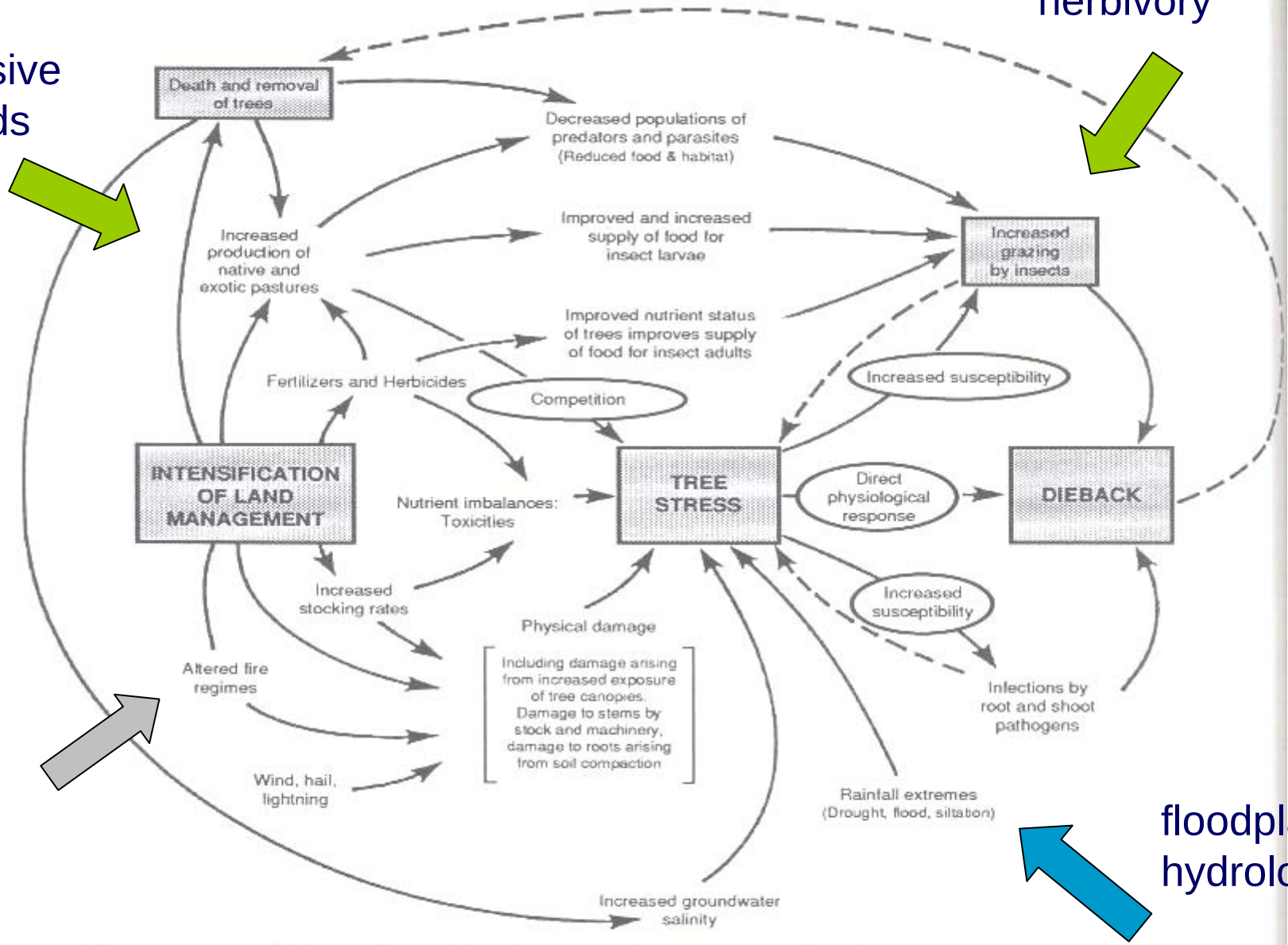


* Dieback severity index as per Wylie *et al.* 1992

Tree decline processes:

arboreal herbivory

invasive weeds



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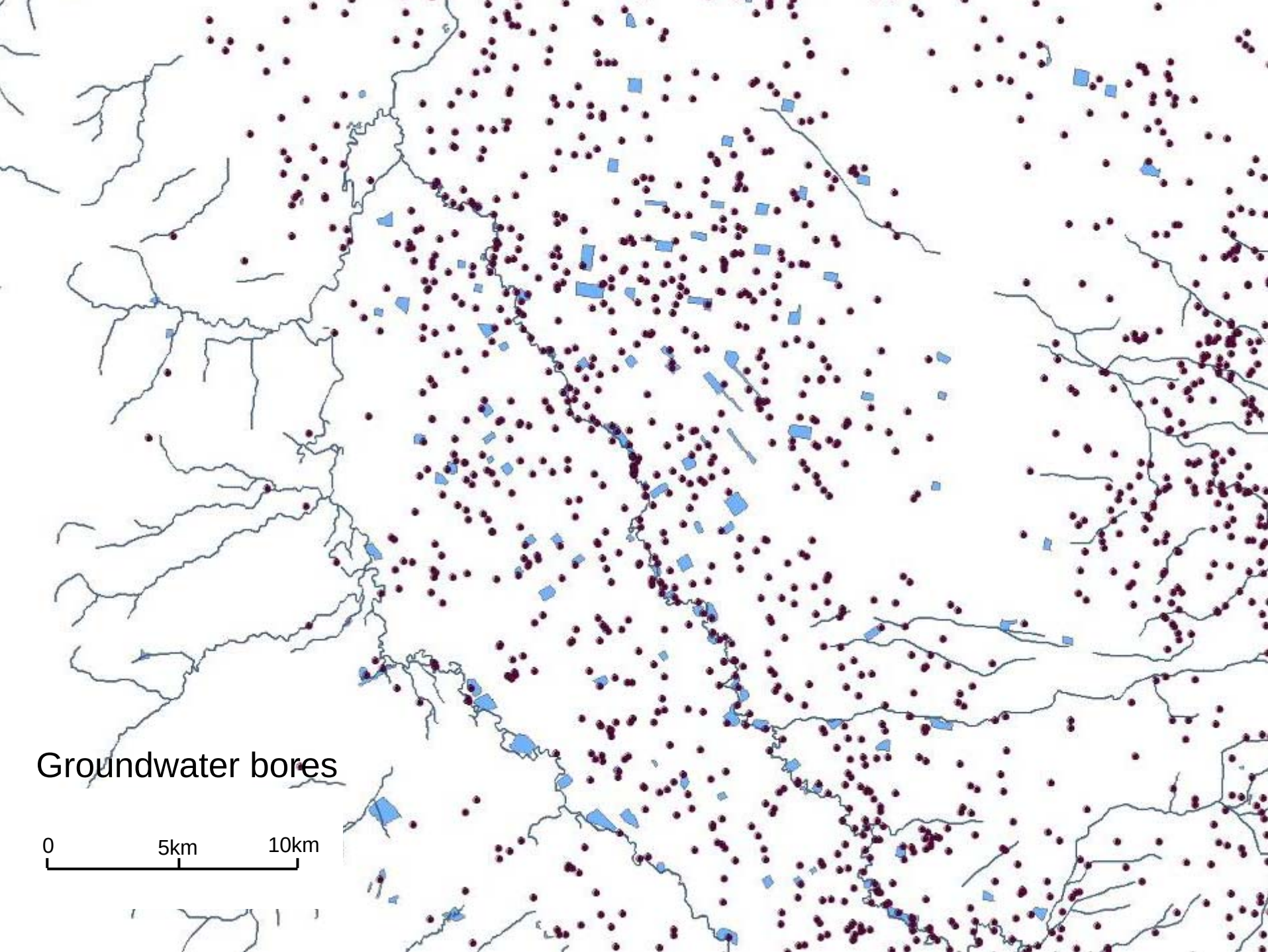
floodplain hydrology

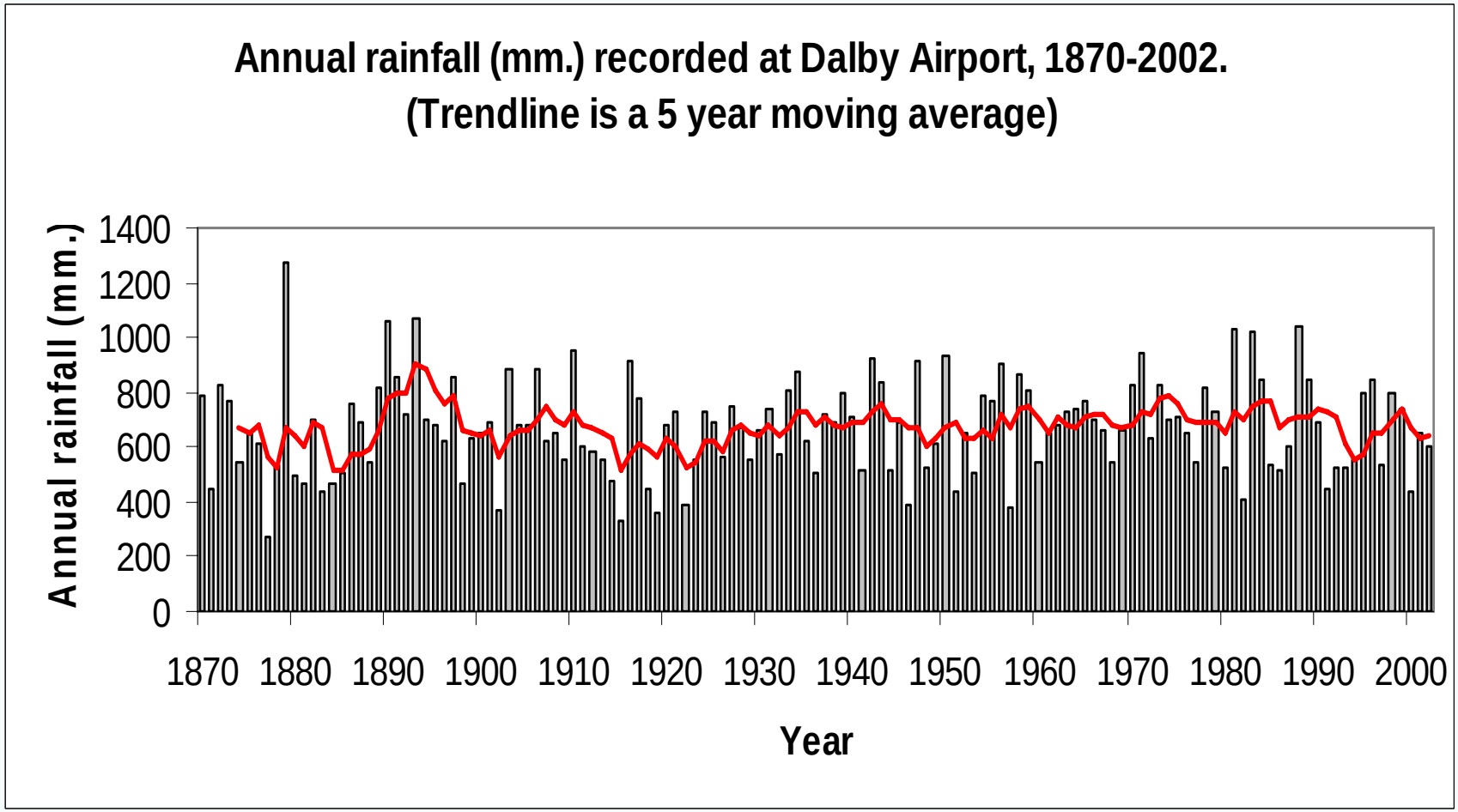
Figure 4. A model of initiation and development of dieback of rural trees in southern Queensland.

Source: Wylie *et al* 1992

Remnant Vegetation

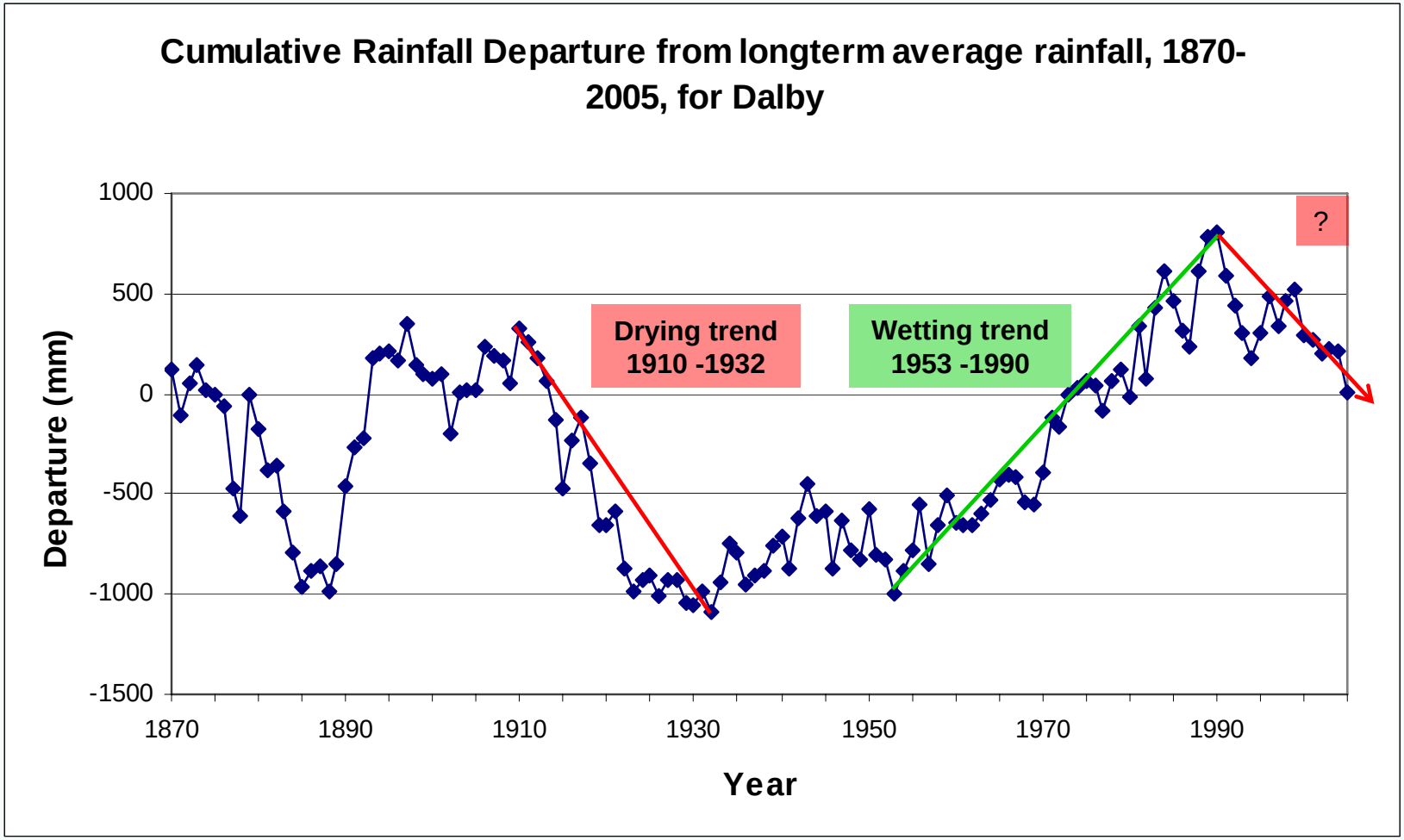

Groundwater bores
0
5km
10km

Rainfall:

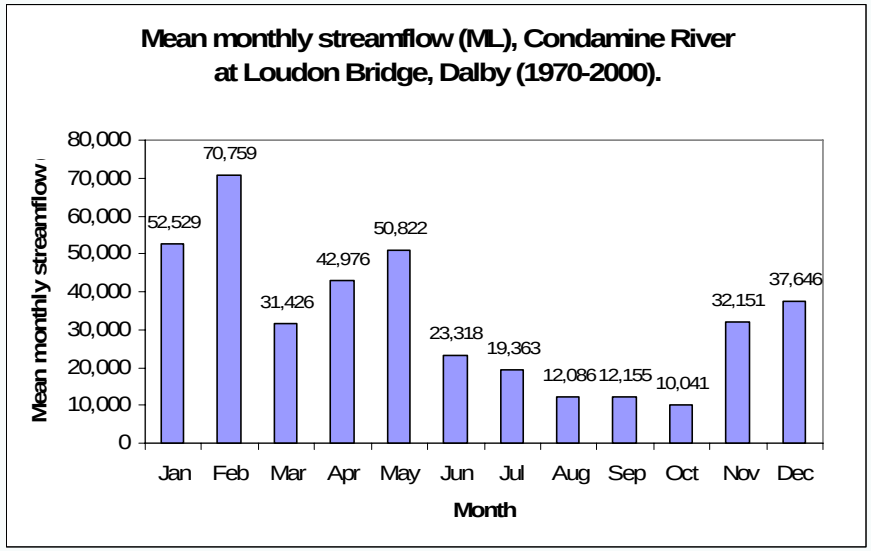


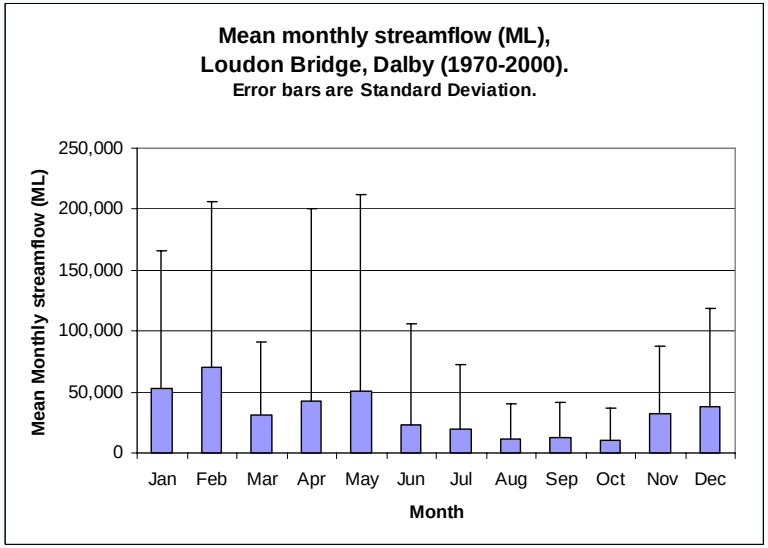
Data source: Bureau of Meterorology: composite data for stations 513041023 (Dalby Post Office; 1870-1992) & 513041522 (Dalby Airport; 1992-2005)

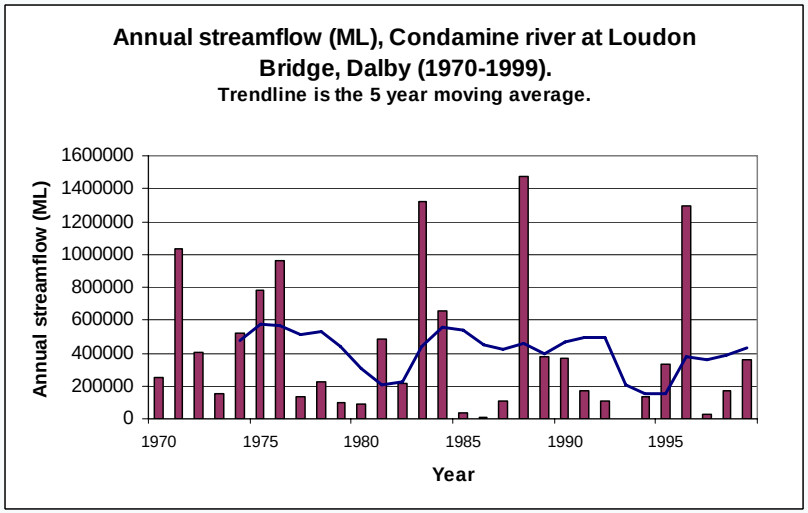
Rainfall:

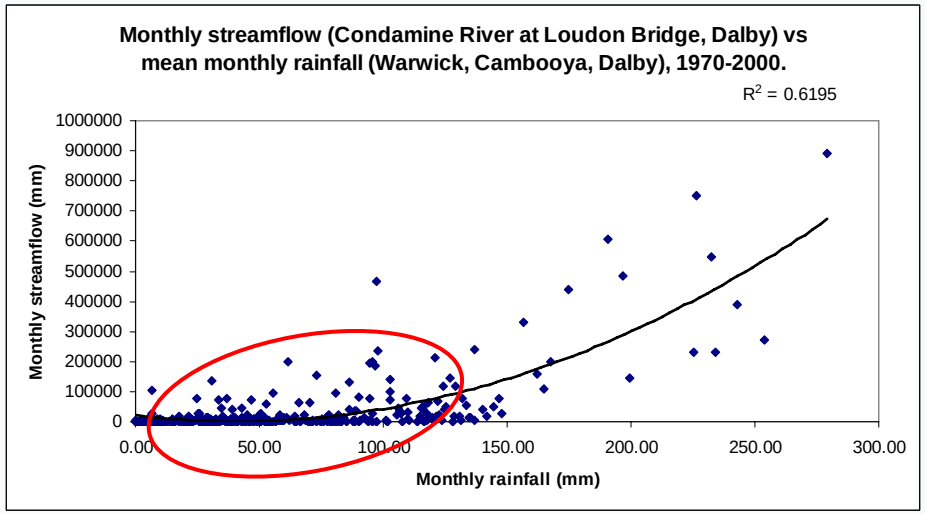

Cumulative Rainfall Departure from longterm average rainfall, 1870-2005, for Dalby
Departure (mm)
1000
500
0
-500
-1000
-1500
1870
1890
1910
1930
1950
1970
1990
Year
Drying trend 1910 -1932
Wetting trend 1953 -1990
?

Streamflow:

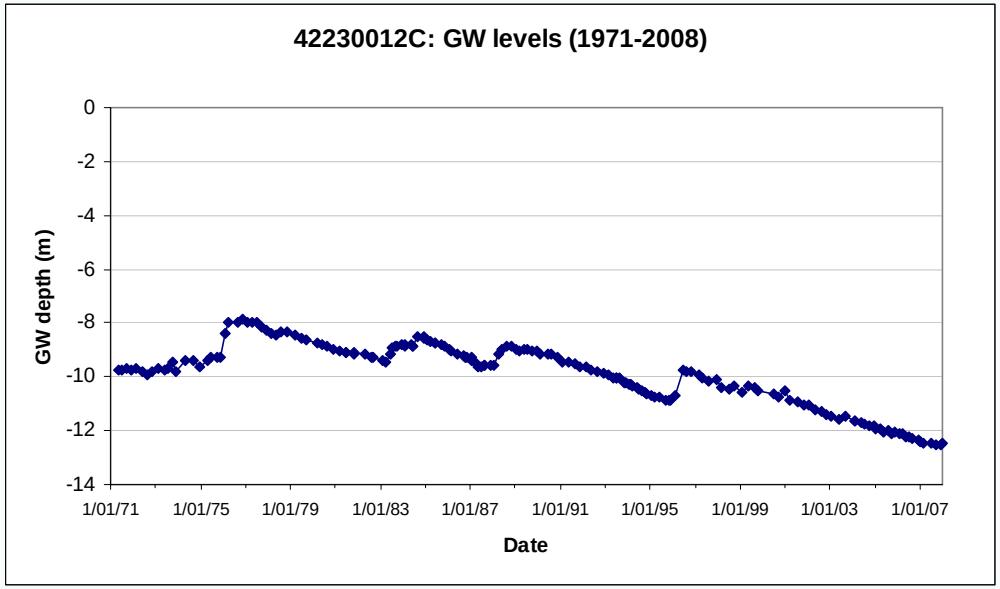

Mean monthly streamflow (ML), Condamine River at Loudon Bridge, Dalby (1970-2000).
Mean monthly streamflow (ML)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
52,529
70,759
31,426
42,976
50,822
23,318
19,363
12,086
12,155
10,041
32,151
37,646
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

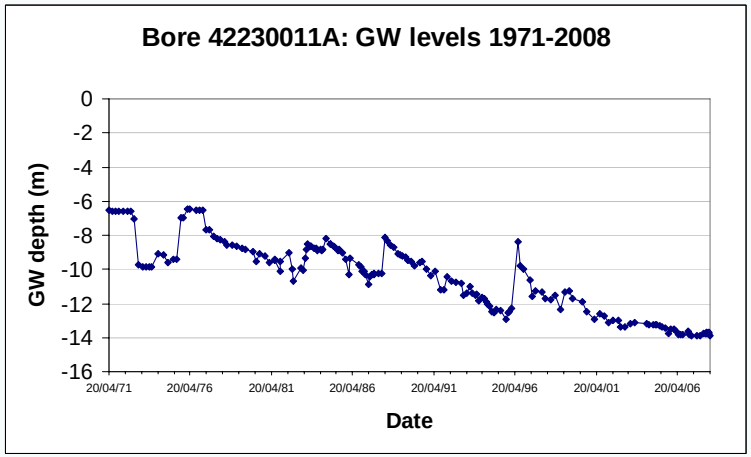

Mean monthly streamflow (ML), Loudon Bridge, Dalby (1970-2000).
Error bars are Standard Deviation.
Mean Monthly streamflow (ML)
250,000
200,000
150,000
100,000
50,000
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

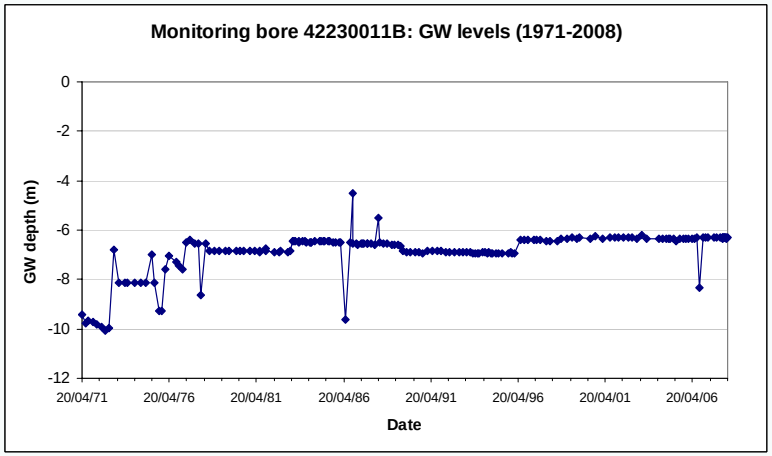

Annual streamflow (ML), Condamine river at Loudon Bridge, Dalby (1970-1999).
Trendline is the 5 year moving average.
Annual streamflow (ML)
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1970 1975 1980 1985 1990 1995
Year


Monthly streamflow (Condamine River at Loudon Bridge, Dalby) vs mean monthly rainfall (Warwick, Cambooya, Dalby), 1970-2000.
R2 = 0.6195
Monthly streamflow (mm)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
0.00 50.00 100.00 150.00 200.00 250.00 300.00
Monthly rainfall (mm)

Groundwater:





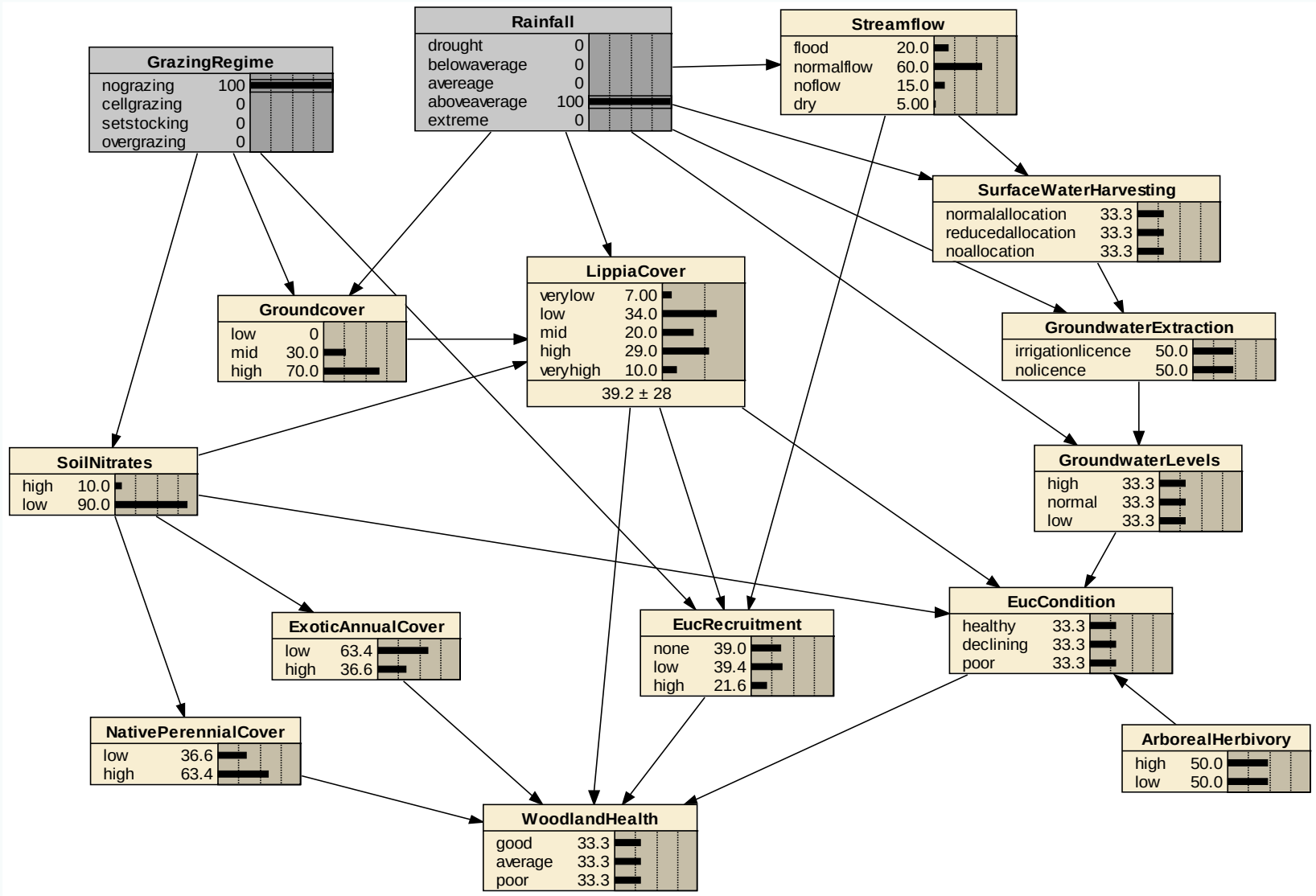


Upper Condamine floodplain system:

- Highly variable rainfall pattern
- Major drying and wetting trends evident
- Ephemeral river system
- Hydrological extremes (drought, flooding)
- Groundwater – important ecological buffer in extended dry periods?

- Major land and water use development during 1950-1990 “wetting phase”
- Reduced hydrological connectivity?
- Decline in extent and condition of dependent ecological systems
- Potential tipping point for agri-ecological system

Preliminary Bayesian Belief Network (BBN) model:



Bayesian Belief Networks:

- modelling tool (Netica™ software, Norsys Software Corporation 1998)
- organisation of current thinking into testable hypotheses
- updating with new knowledge and data

Advantages:

- synthesis of data from a variety of sources
- accommodates uncertainty (conditional probabilities)
- dynamic, quantitative models
- can be rerun with different assumptions (scenario analysis)
- supports adaptive management
- useful communication tool

Limitations:

- cannot incorporate system feedbacks

Significance:

- dynamic quantitative models enable updated prediction with greater knowledge and/or altered conditions (e.g. climate change)
- retain capacity for flexibility & improvement with updated knowledge (adaptive management)
- better management for remnant ecosystem health in complex production landscapes

Knowledge gaps:

- ecosystem responses to hydrological change (climate variability; environmental water allocations; surface-groundwater interactions)
- response times (time lags with long-lived species)