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History of land-use reconstructed for hydrologic modelling of the Tarcutta Creek catchment

Aleksandra Rančić, David Read, Brendan Christy, Terry McLean, Iain Hume, Gregory Summerell

NSW GOVERNMENT

Victoria The Place To Be

Aim

- To reconstruct the land-use history of the Tarcutta catchment,
  - based on imagery and other information sources
  - since 1950, on decadal basis
  - with fine resolution (1ha),
  - distinguishing between:
    - native and pine trees,
    - pastures,
    - cropping,
    - water bodies,
    - paved areas and other minor land-uses

so it can be used for calibration of the CATplus hydrologic model

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Introduction-background

- Landowners in Tarcutta catchment very active
- Kyemba and Oberne-Tarcutta Landcare groups
- Murrumbidgee CMA
- Concerns:
  - Rise in groundwater levels over time
  - Water logging, salinity, land degradation
  - Loss of water in the catchment due to pine plantations
  - Erosion and flood damage
- Survey showed widespread initiative in planting native trees in lower and central Tarcutta with aid from the landcare groups
- Interest and support for rainfall and groundwater monitoring
- History of land-use survey
- FFI – CATplus hydrologic study welcome

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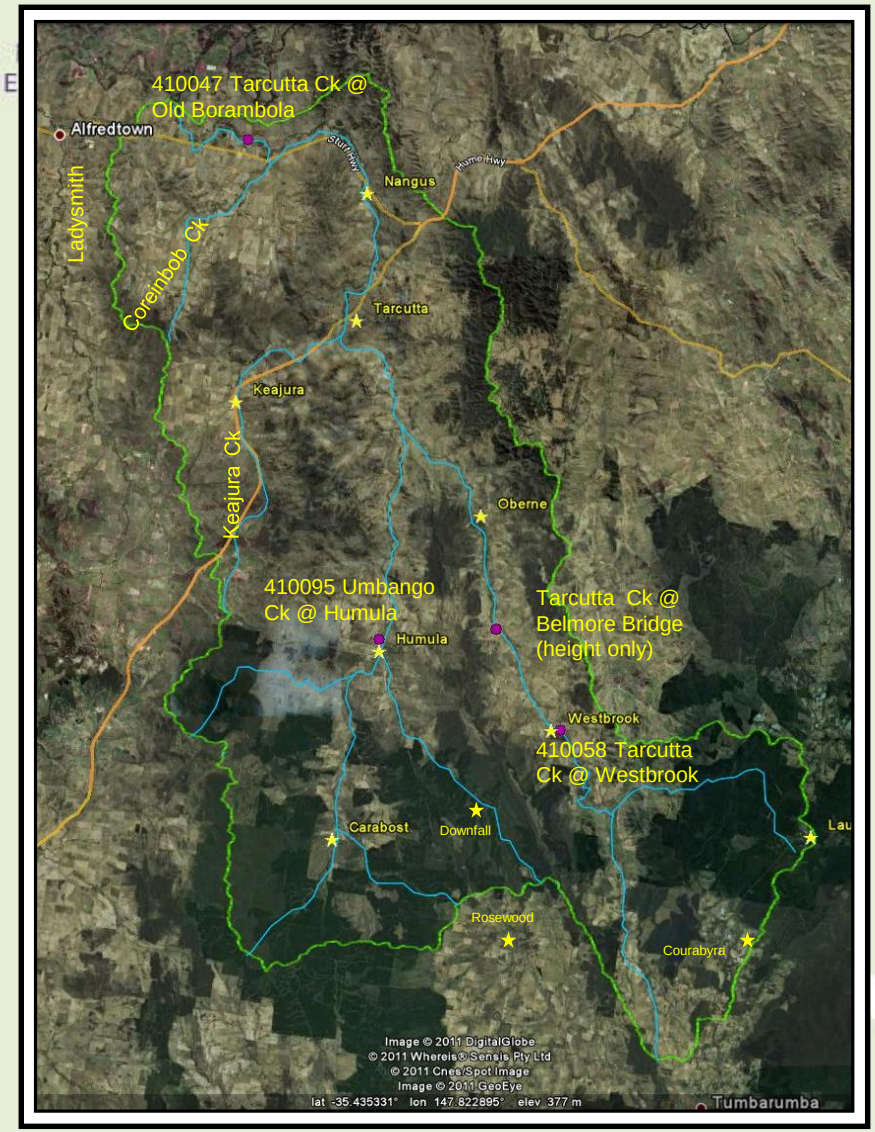
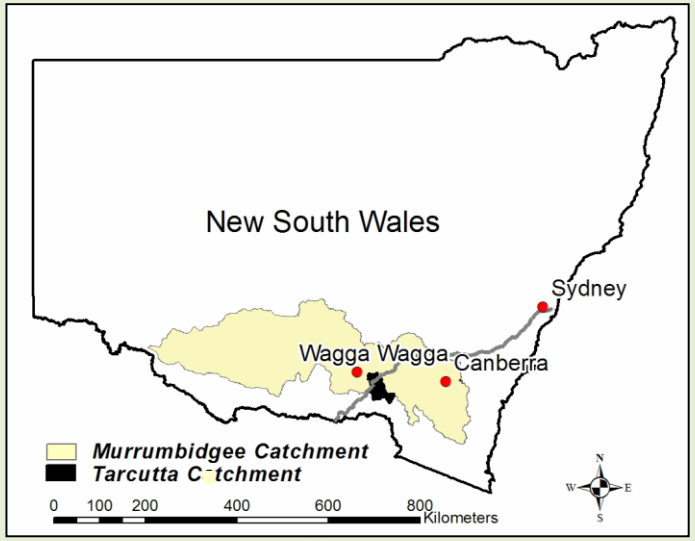
FFI CATplus hydrologic modelling

- A modelling study (Rančić *et al.*, 2014) was done using CATplus software (Christy *et al.*, 2011) to:
  - Test the influence of increasing perennial vegetation on water cycle and
  - Provide advice for management of environment and water resources-where more perennial veg. is needed
- Changes in land-use needed to be incorporated into the calibration process, on the spatial-temporal scale adequate for hydrologic modelling.
- Previous publications:
  - Christy, B.P., McLean, T., Rančić, A., Weeks, A., 2011. Changing land-use based on location in landscape affects catchment water yield. *In Chan, F., Marinova, D. and Anderssen, R.S. (eds) MODSIM2011, 19th International Congress o Modelling and Simulation.* Modelling and Simulation Society of Australia and New Zealand, pp 2310-2316. ISBN: 978-0-9872143-1-7. URL: www.mssanz.org.au/modsim2011/E12/Christy.pdf
  - Rančić, A., Christy, B.P., Read, D., McLean, T., Hume, I., Summerell, G., 2014. *CATPlus modelling in the Tarcutta River Catchment final report*. Research report, Office of Environment and Heritage, NSW Government, PO Box A290, Sydney NSW 2000, Australia. Report OEH 2014/0421.

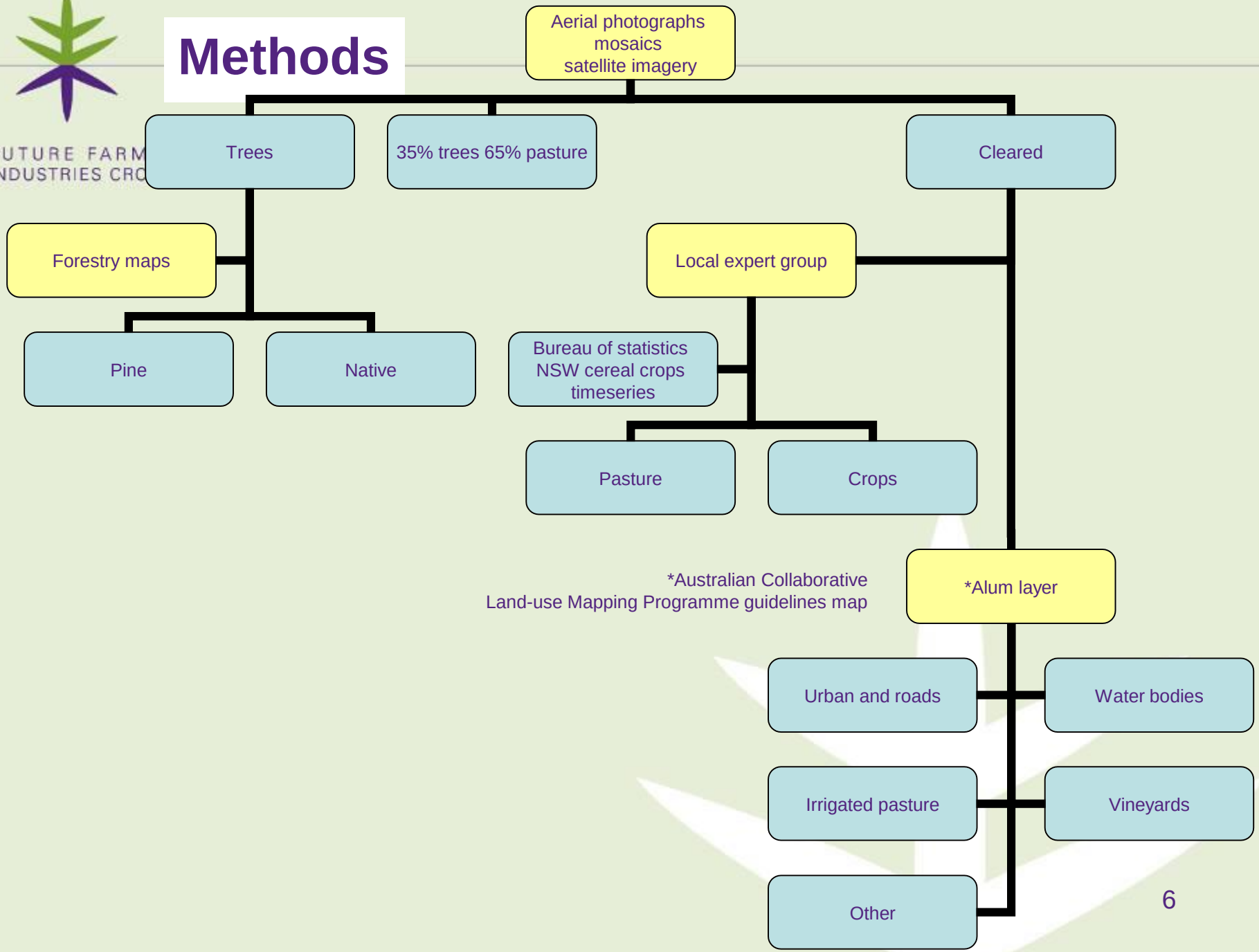
Tarcutta catchment (1700 km²)





- Stream gauge
- Locality

Methods


Aerial photographs
mosaics
satellite imagery
Trees
35% trees 65% pasture
Cleared
Forestry maps
Local expert group
Pine
Native
Bureau of statistics
NSW cereal crops
timeseries
Pasture
Crops
*Australian Collaborative
Land-use Mapping Programme guidelines map
*Alum layer
Urban and roads
Water bodies
Irrigated pasture
Vineyards
Other

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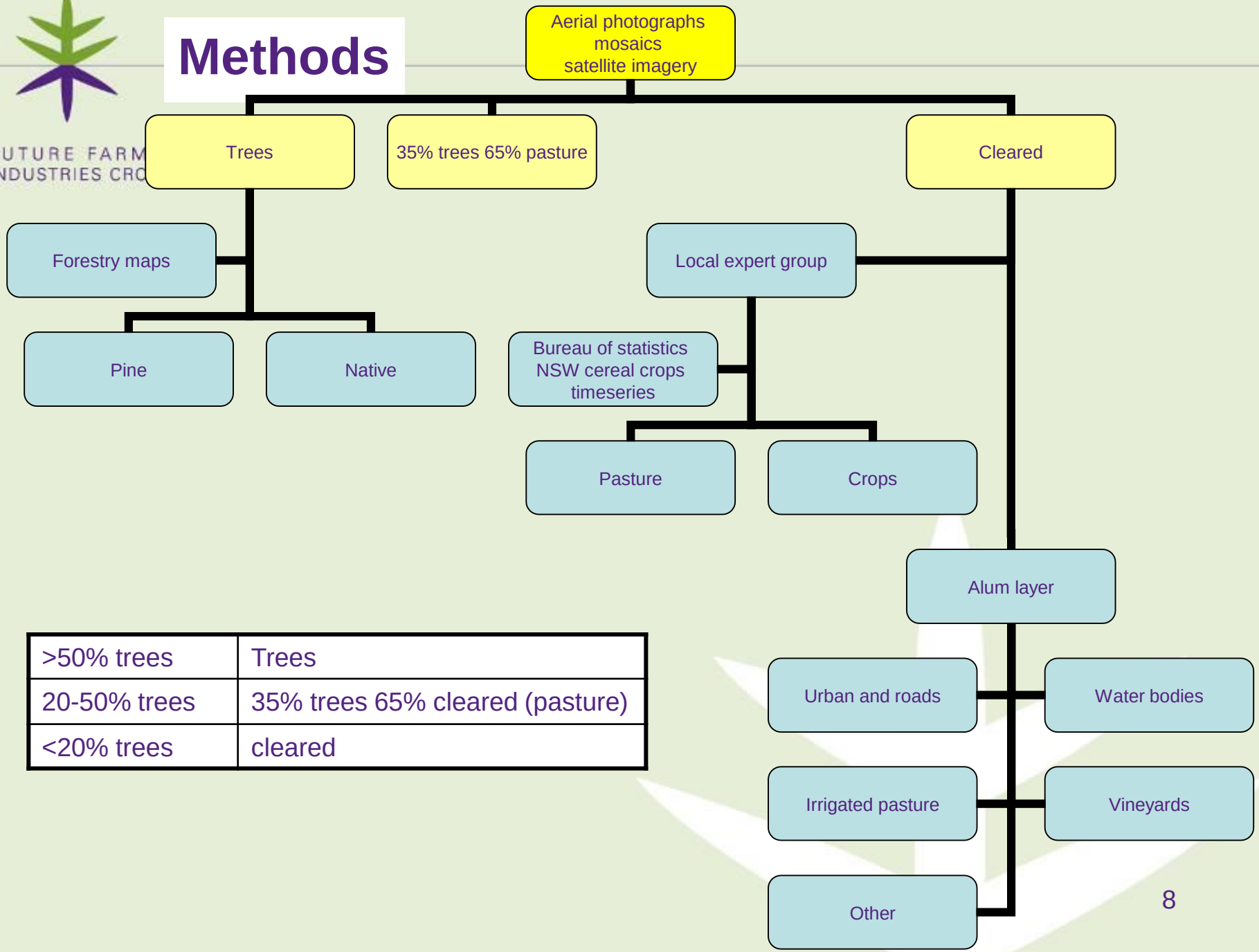
Aerial photography and satellite imagery used in the study

Decade	Photograph		Photo mosaic		Satellite	
	Tarcutta	Rosewood	Tarcutta	Rosewood	Low resolution	High* resolution
1950	X	X				
1960	X			X		
1970		X	X			
1980					X	
1990					X	
2000	X				X	
2010						X

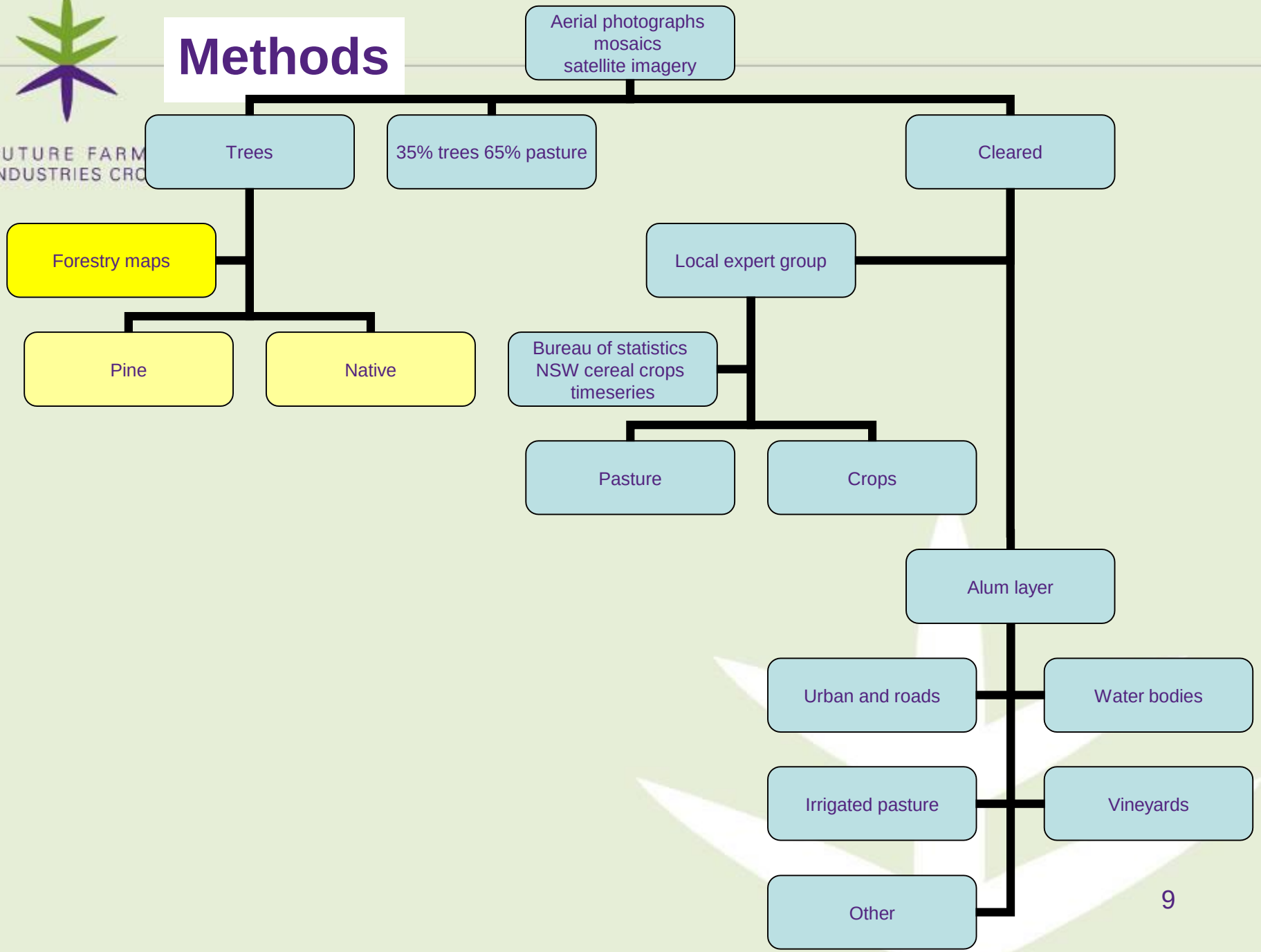
*ADS40 satellite photography (50cm accuracy):

Methods



>50% trees	Trees
20-50% trees	35% trees 65% cleared (pasture)
<20% trees	cleared

Methods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Methods

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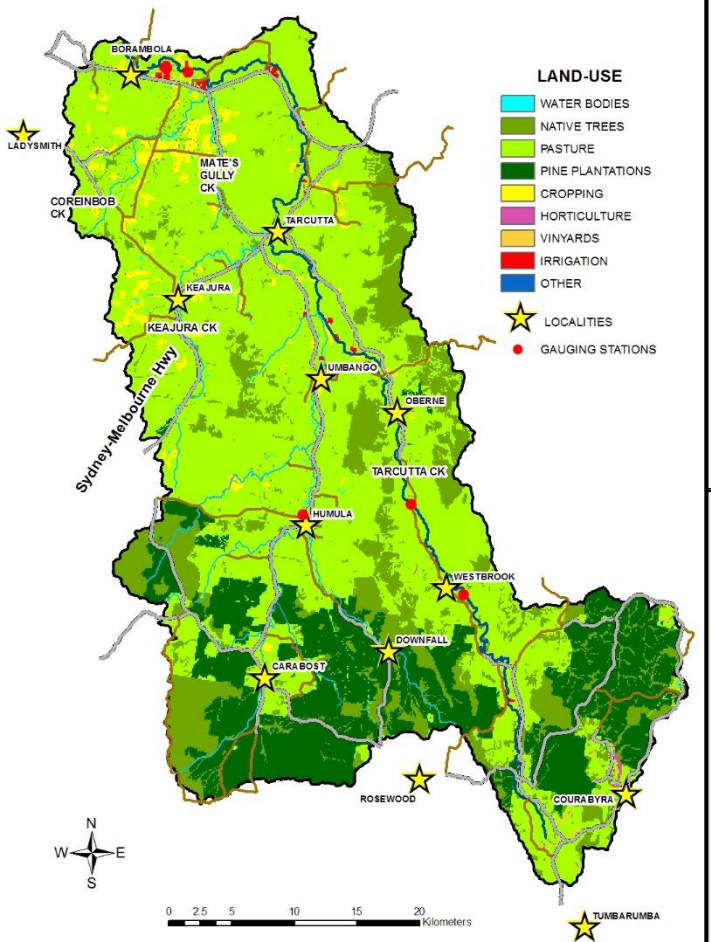
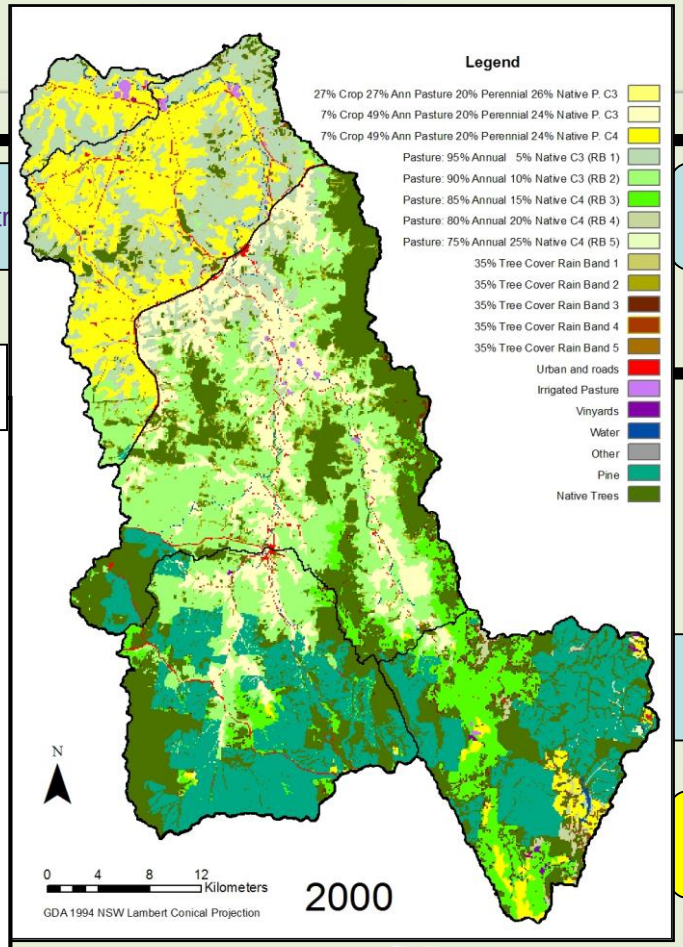
Trees

30% tr

Cleared

*Australian Collaborative Land-use Mapping Programme guidelines map





Alum* layer

Urban and roads

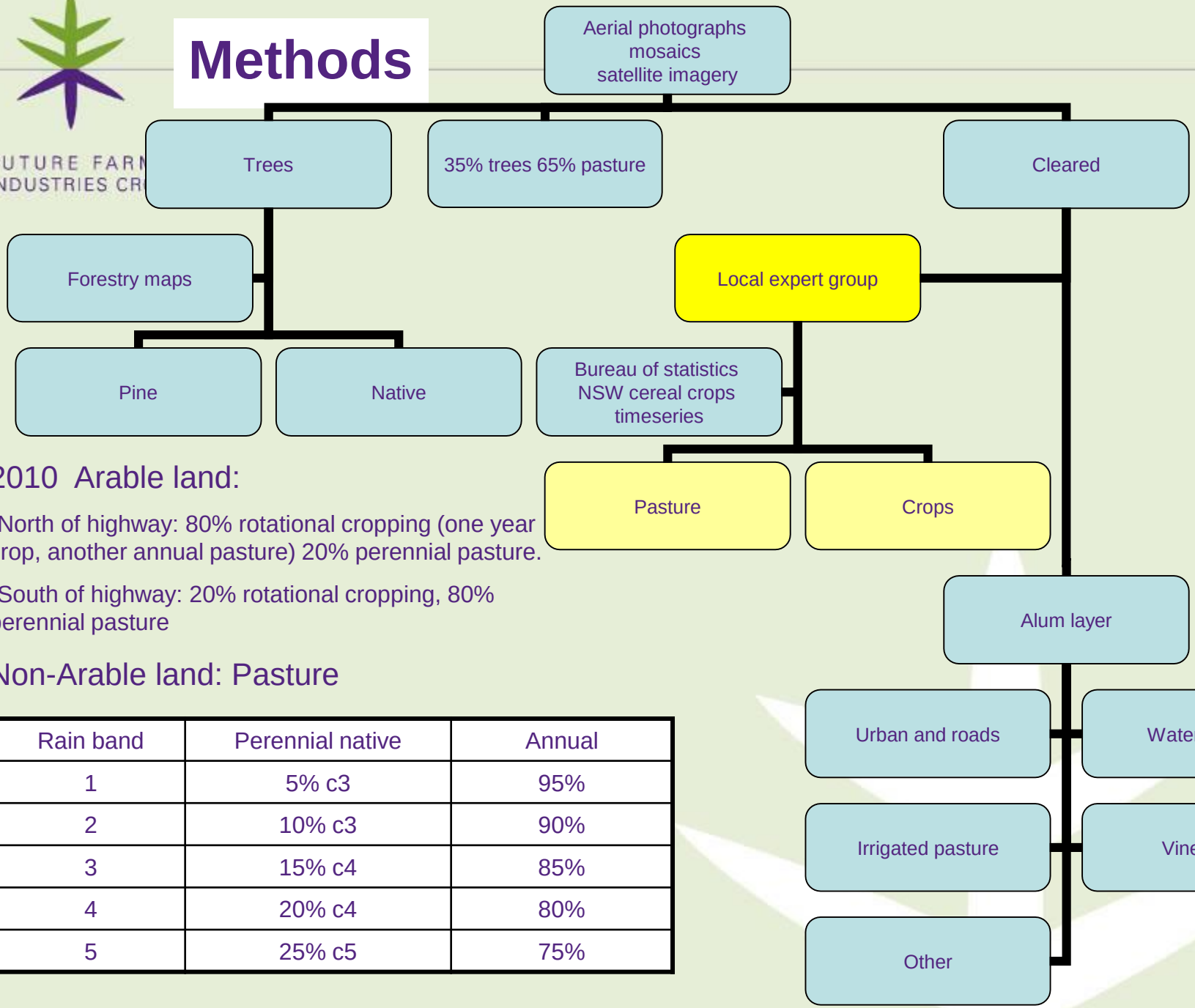
Water bodies

Irrigated pasture

Vineyards

Other

Methods



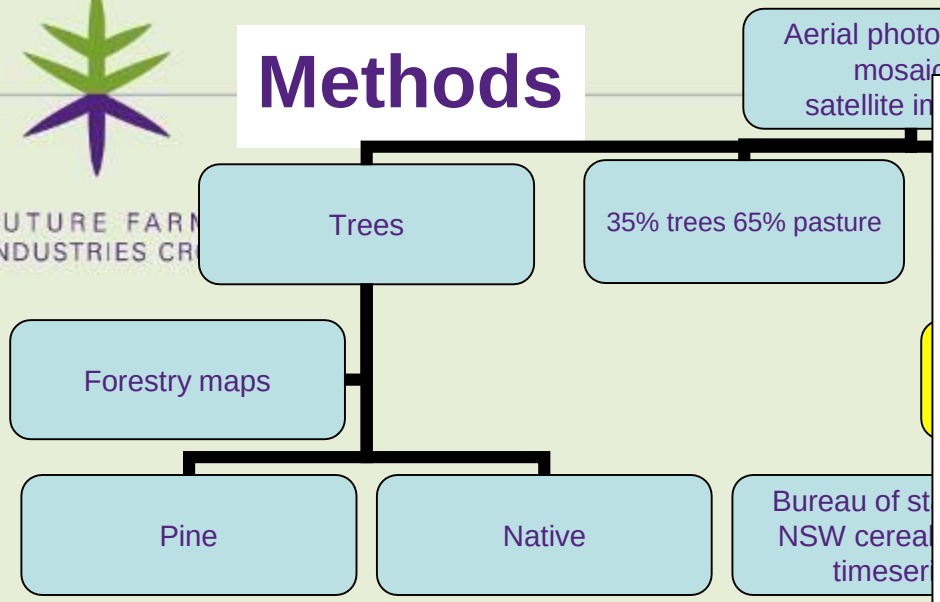
2010 Arable land:

- North of highway: 80% rotational cropping (one year crop, another annual pasture) 20% perennial pasture.
- South of highway: 20% rotational cropping, 80% perennial pasture

Non-Arable land: Pasture

Rain band	Perennial native	Annual
1	5% c3	95%
2	10% c3	90%
3	15% c4	85%
4	20% c4	80%
5	25% c5	75%

Methods



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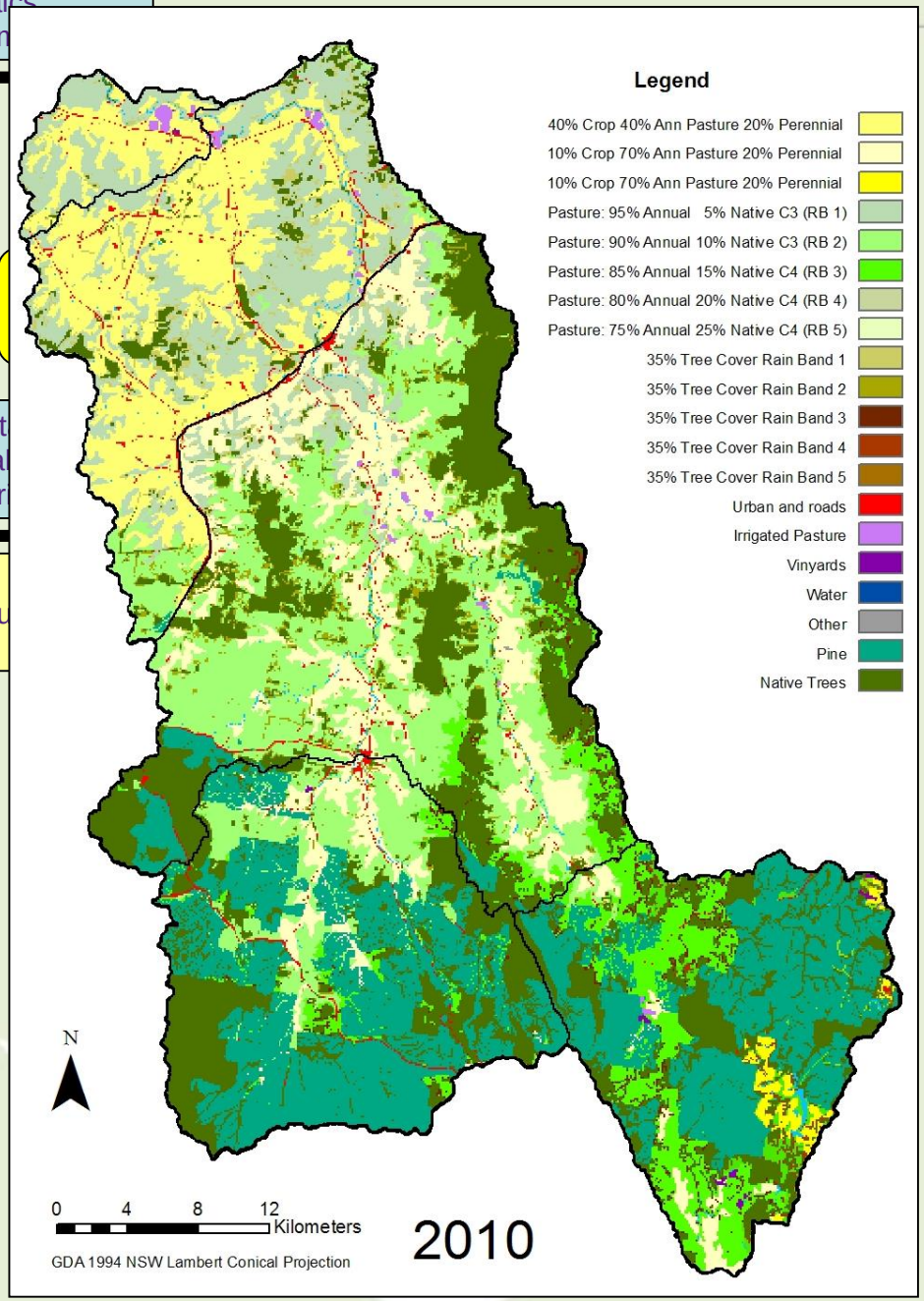
Non-Arable land: Pasture

Rain band	Perennial native	Annual
1	5% C3	95%
2	10% C3	90%
3	15% C4	85%
4	20% C4	80%
5	25% C5	75%



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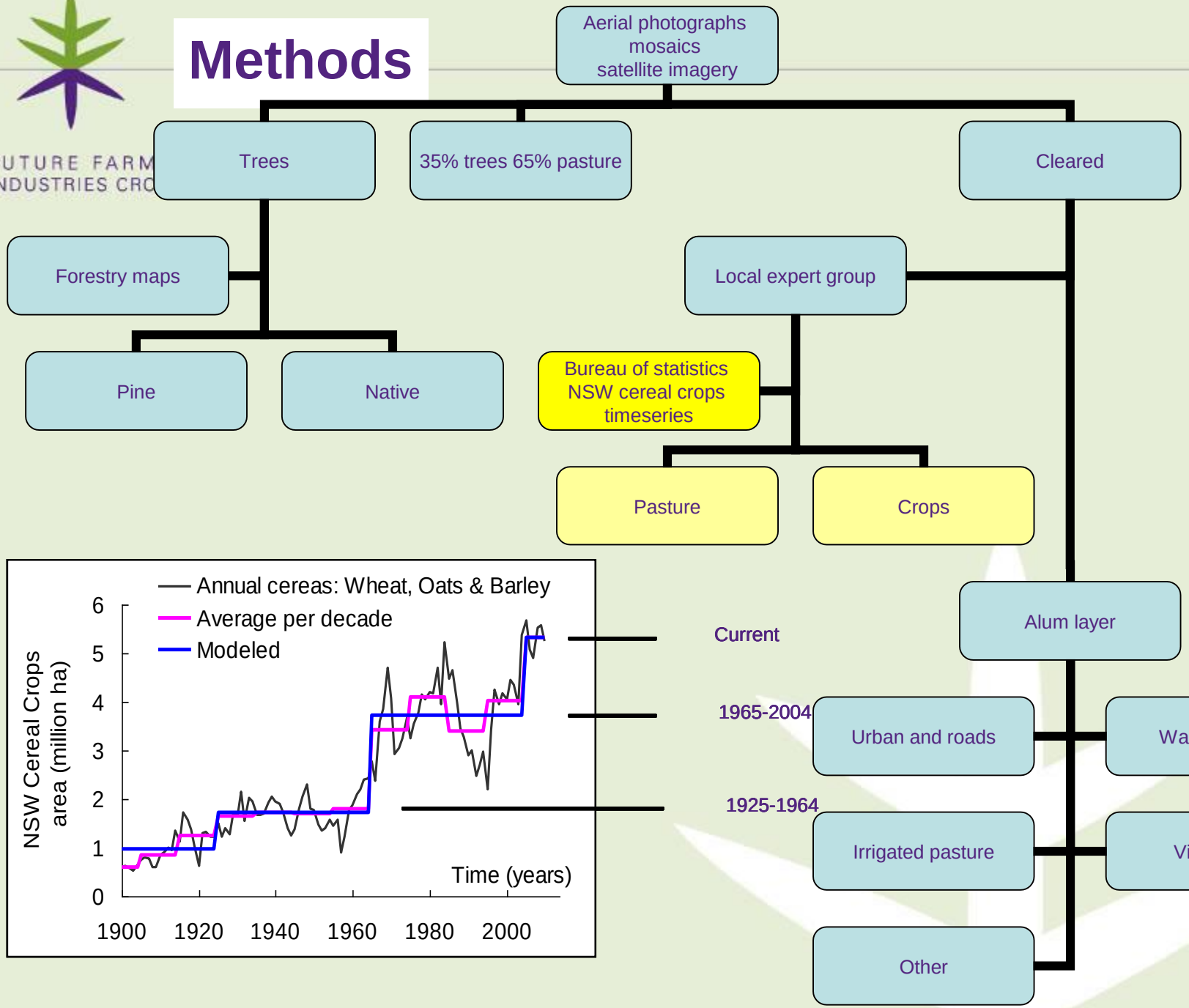
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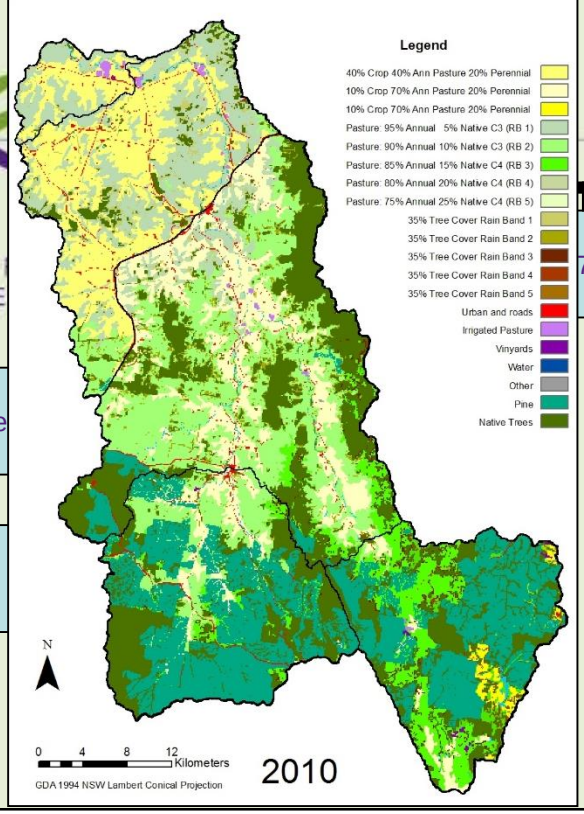
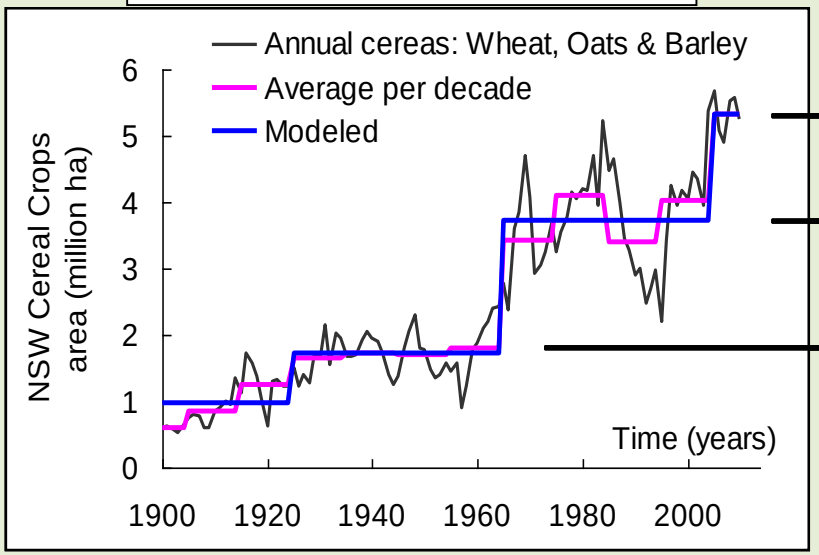
NSW cereal crops
timeseries
Pasture
Crops
Alum layer
Current
1965-2004
Urban and roads
Water bodies
1925-1964
Irrigated pasture
Vineyards
Other

Annual cereas: Wheat, Oats & Barley
Average per decade
Modeled
NSW Cereal Crops
area (million ha)
0
1
2
3
4
5
6
Time (years)
1900
1920
1940
1960
1980
2000


Legend
40% Crop 40% Ann Pasture 20% Perennial
10% Crop 70% Ann Pasture 20% Perennial
10% Crop 70% Ann Pasture 20% Perennial
Pasture: 95% Annual 5% Native C3 (RB 1)
Pasture: 90% Annual 10% Native C3 (RB 2)
Pasture: 85% Annual 15% Native C4 (RB 3)
Pasture: 80% Annual 20% Native C4 (RB 4)
Pasture: 75% Annual 25% Native C4 (RB 5)
35% Tree Cover Rain Band 1
35% Tree Cover Rain Band 2
35% Tree Cover Rain Band 3
35% Tree Cover Rain Band 4
35% Tree Cover Rain Band 5
Urban and roads
Irrigated Pasture
Vinyards
Water
Other
Pine
Native Trees
N
0 4 8 12
Kilometers
GDA 1994 NSW Lambert Conical Projection
2010


Annual cereas: Wheat, Oats & Barley
Average per decade
Modeled
NSW Cereal Crops area (million ha)
0
1
2
3
4
5
6
Time (years)
1900
1920
1940
1960
1980
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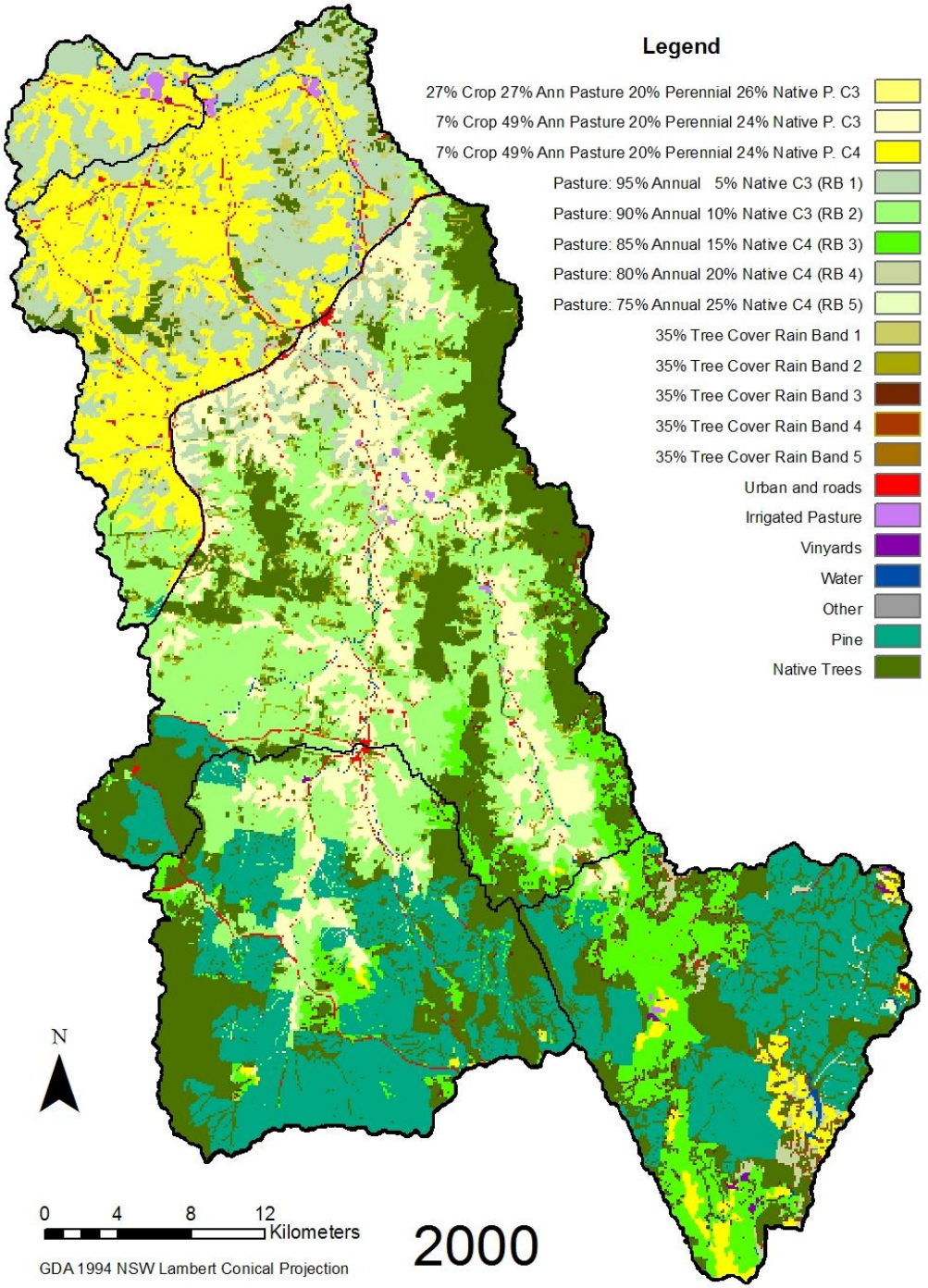
Legend
27% Crop 27% Ann Pasture 20% Perennial 26% Native P. C3
7% Crop 49% Ann Pasture 20% Perennial 24% Native P. C3
7% Crop 49% Ann Pasture 20% Perennial 24% Native P. C4
Pasture: 95% Annual 5% Native C3 (RB 1)
Pasture: 90% Annual 10% Native C3 (RB 2)
Pasture: 85% Annual 15% Native C4 (RB 3)
Pasture: 80% Annual 20% Native C4 (RB 4)
Pasture: 75% Annual 25% Native C4 (RB 5)
35% Tree Cover Rain Band 1
35% Tree Cover Rain Band 2
35% Tree Cover Rain Band 3
35% Tree Cover Rain Band 4
35% Tree Cover Rain Band 5
Urban and roads
Irrigated Pasture
Vinyards
Water
Other
Pine
Native Trees
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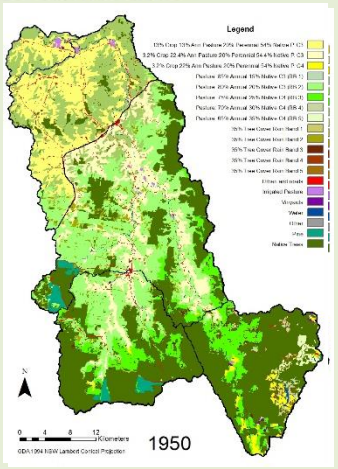
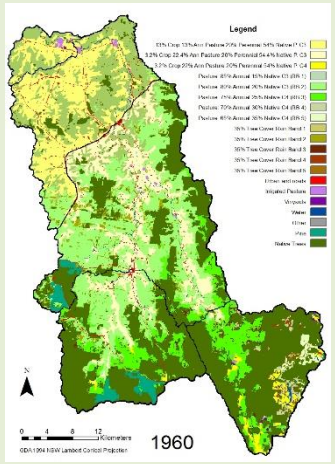
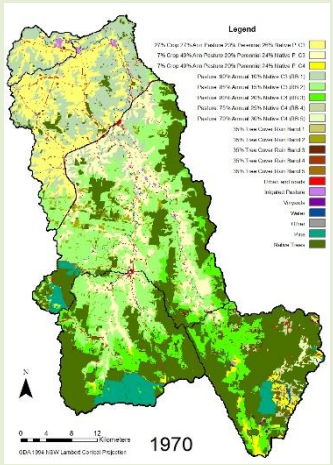
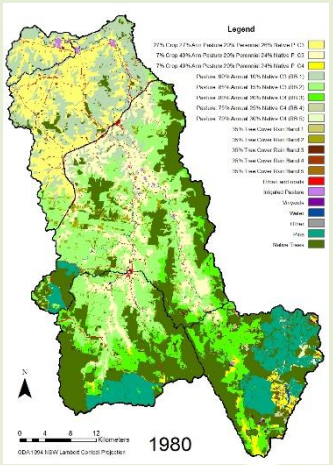
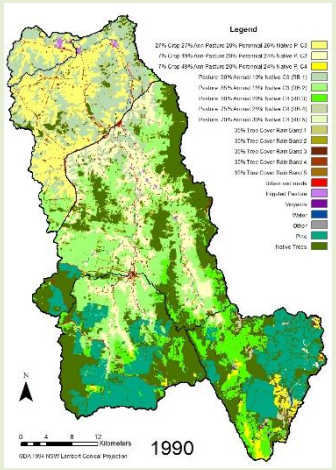
Results

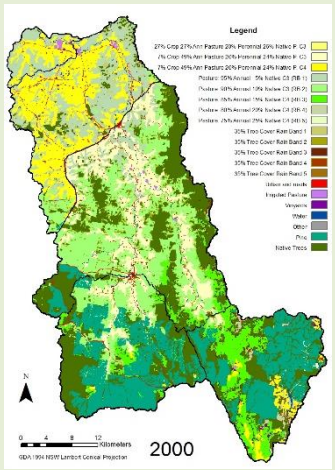


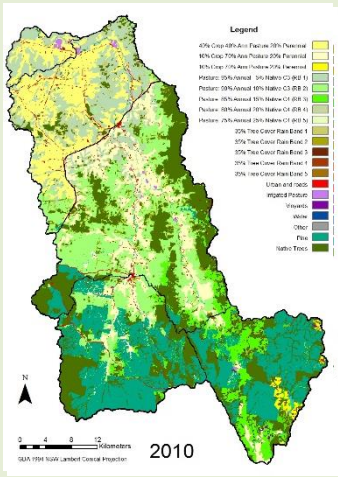


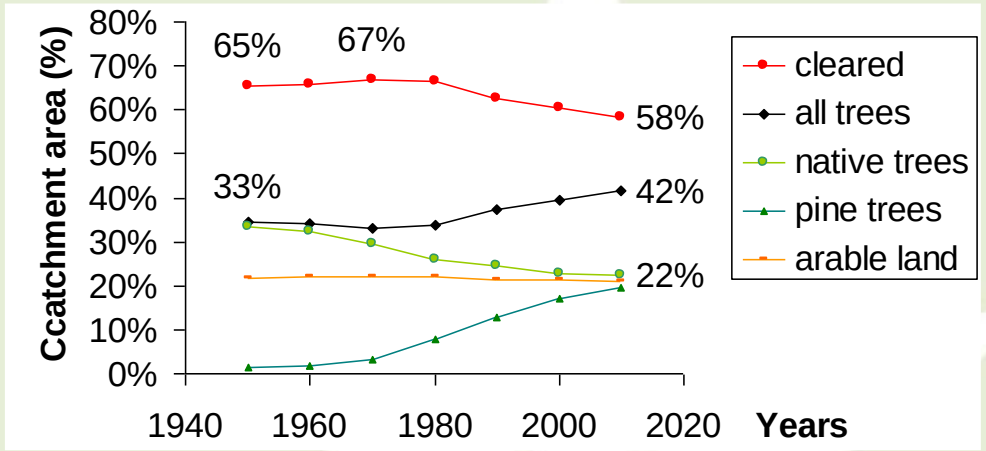




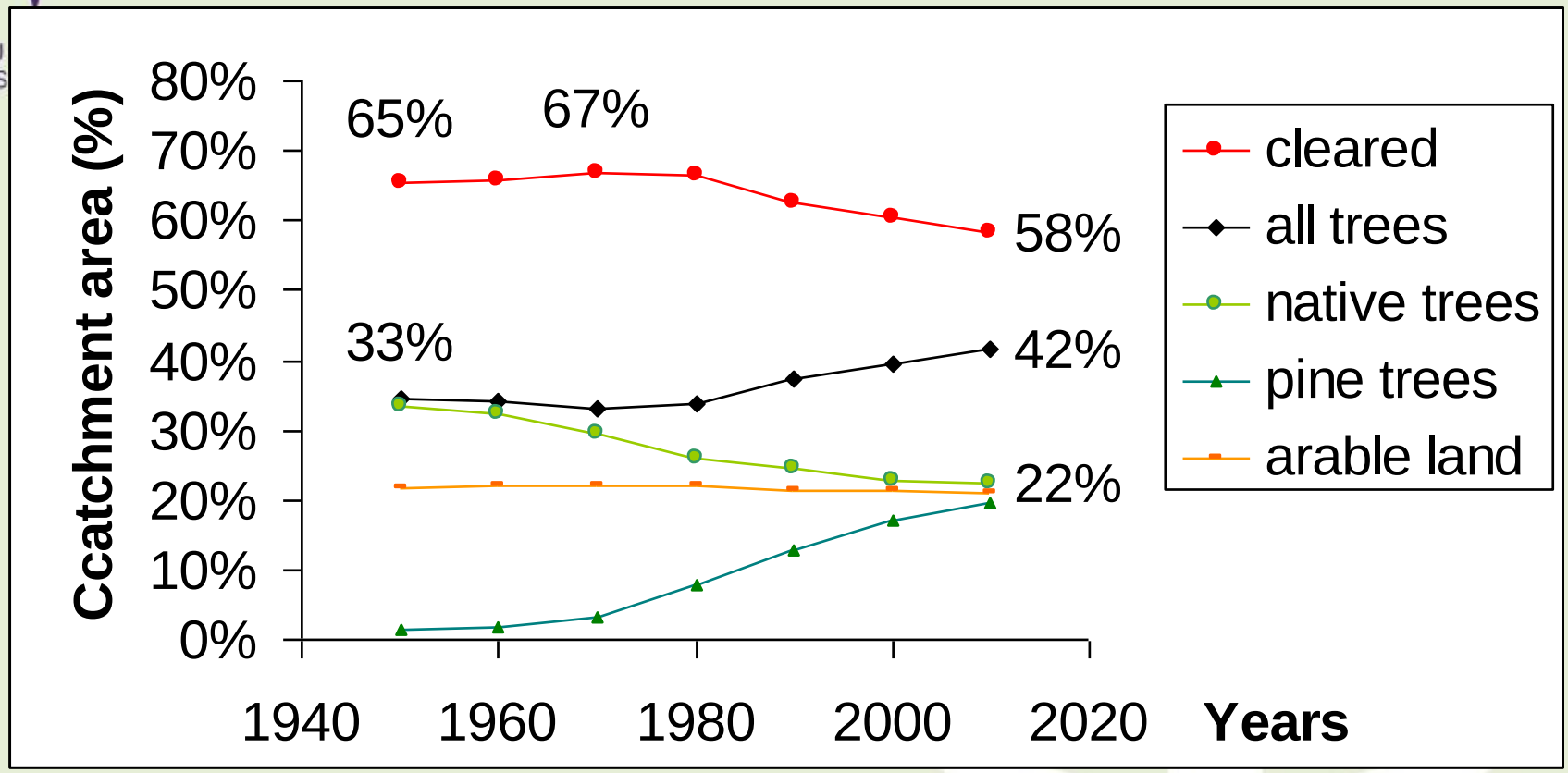








Results



- Cleared area peaked in 1970 (67%) and got reduced to 58%
- Rate of clearing <1% per decade for 1950-60 and 1960-70 decades
- **NO** massive clearing after the WWII (soldier settlements/mechanisation)

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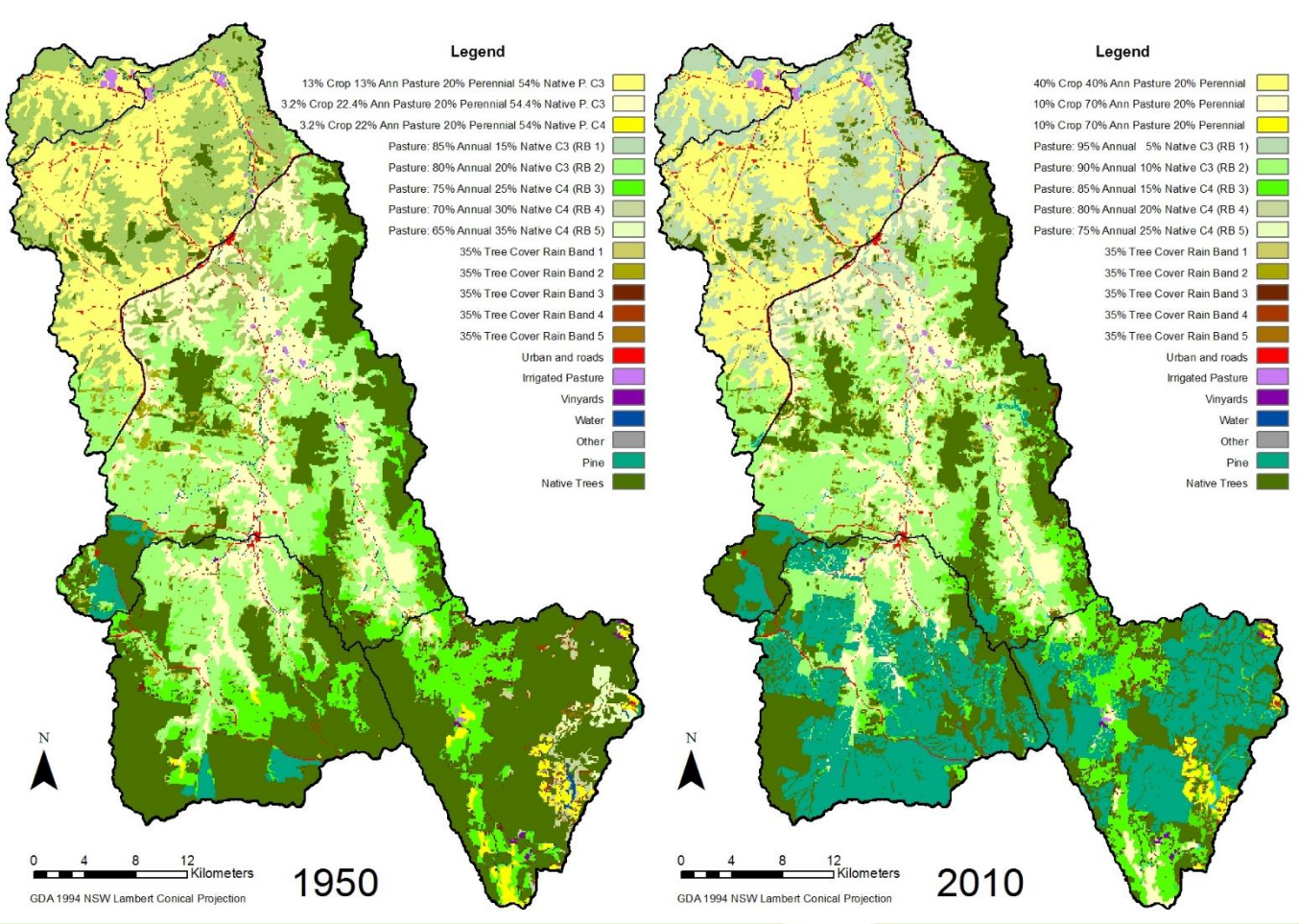
Discussion



- Loss of connectivity in native habitats in1950 in lower and central Tarcutta
- Some tree thickening and improvement along eastern highlands
- Pine expansion causes further loss of connectivity
- 9% of catchment converted back to trees =>
  slight shift towards the pre-European catchment hydrology
- Likely ~60% cleared by the early 1900s (**90%** of 67%)

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Conclusions

- By 1950 65% of catchment had been cleared
- No major clearing after the WWII
- Maximum clearing extent in 1970s (2/3)
- By 2010 9% of catchment converted from cleared to trees (58%)
- Likely < 10% of all clearing happened between 1903-1970.
- Pine plantations now account for half the tree-cover
- Loss of connectivity in native habitats
- Landholders active: plant trees to prevent waterlogging/salinisation
- The largest fine scale (1ha resolution) aerial reconstruction of land-use changes in Australia

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