Riparian Forest and Ground Cover Levels

in South East Queensland Catchments

Queensland Government

Prepared by: Remote Sensing Centre, Science and Technology Division, Department of Environment and Science

Citation

Healy, A. 2022. Riparian Forest and Ground Cover Levels in South East Queensland Catchments. Brisbane: Department of Environment and Science, Queensland Government.

May 2022

Contents

Introduction

Why monitor riparian vegetation

Riparian forest and ground cover is the vegetation beside waterways which can help reduce pollutant flow to the waterways and stabilise the stream bank. Areas which are non-forested and have very low ground cover levels may be areas of concern for soil and nutrient loss to the stream (Hubble et al, 2010, Lyons et al. 2000, McMahon et al, 2017, Simon and Collison 2002). Maintaining and enhancing riparian forests and ground cover in riparian areas is therefore important to minimise impacts on water quality in South East Queensland catchments (Croke et al, 2017).

Reporting riparian vegetation extent

For reporting, we define and map the riparian area as any area within 50 metres of a (mapped) stream, or riverine/lacustrine wetland. In this report, we separate riparian vegetation into two components, riparian woody vegetation and riparian ground cover. We used data derived from Sentinel 2 satellite imagery to estimate riparian woody vegetation and ground cover levels, as well as data from the Statewide Landcover and Trees Study (SLATS) (https://www.qld.gov.au/environment/land/management/mapping/statewide-monitoring/slats), and the Queensland Ground Cover Monitoring Program, (https://www.qld.gov.au/environment/land/management/mapping/statewide-monitoring/groundcover).

For those areas defined and mapped as the riparian area, we report on:

- the present extent of riparian woody vegetation
- the amount of woody vegetation loss in recent history and up to 2019
- the level of ground cover in non-woody riparian areas

Project Area

The South East Queensland region consists of 14 subcatchments from the Noosa River catchment in the north to the Nerang / Gold Coast catchment in the south (Figure 1). It includes the western catchments of the Upper Brisbane River, Lockyer Creek and Bremer River.

Methods

Monitoring and reporting of riparian vegetation extent (and cover) is made up of three key components:

1. Defining and mapping riparian areas.
2. Mapping riparian woody vegetation extent and measuring changes to this extent over time.
3. Estimating riparian ground cover.

Defining and mapping riparian areas

Riparian areas range from small headwater creeks to major rivers. Many studies have shown the benefits of using GIS and remote sensing to analyse vegetation within a range of specified distances to a stream (Goetz, 2006; Yang, 2007, Apan et al., 2002). For the purposes of this report, we defined riparian areas using a 50m buffer zone applied to a combination of topographic drainage line data for streams of order 1 or higher, and riverine or lacustrine wetlands as mapped by the Queensland Wetlands Program (Environmental Protection Agency, 2005). Palustrine wetlands were not included due to the focus on streams, however some parts of these wetlands will fall into the buffer zone for streams and lacustrine wetlands. Estuarine areas were excluded from the analysis. This is the same riparian dataset used in the 2017 era mapping (reported in 2019), converted to a 10m resolution raster dataset aligned to the underlying Sentinel-2 datasets. The raster conversion will lead to slight differences in area measurements, but has greatly increased processing speed, as well as more appropriately reflecting the scale of the source datasets.

Figure 1 - Location of South East Queensland catchments

Mapping riparian woody vegetation extent

In previous reporting, riparian woody vegetation was mapped using Landsat (prior to 2017) and Sentinel-2 (2017 reporting) satellite imagery. An index of woody vegetation density or cover, known as Foliage Projective Cover (FPC) was applied to the satellite imagery to predict areas of woody vegetation cover within the riparian area. Riparian woody vegetation or forest were defined as those areas in the riparian area with an FPC greater than or equal to 16%, chosen as a threshold suitable for SEQ. These FPC datasets generally provided a good indication of woody vegetation but required selection of an appropriate threshold and were also affected by missed cloud or other data issues. Predictions were also sensitive to annual variability in greenness. This can affect reliable change estimates and monitoring when FPC is compared between years, regardless of the thresholds used.

For this report, the extent of riparian woody vegetation was mapped using the new Statewide Landcover And Trees Study (SLATS) Sentinel-2 - 2019 woody vegetation extent layer (DES, 2021). This new woody vegetation extent layer is based on a U-net convolutional neural network classification, fitted on very high spatial resolution (i.e. ~1m) Earth-i satellite imagery to produce an initial binary woody presence/absence classification, as described in Flood et al (2019). The classification was subsequently down-sampled to 10m to approximate the spatial resolution of Sentinel-2, given it will be used for ongoing monitoring. The initial predictions were then manually edited, and quality checked by a team of remote sensing scientists through an extensive editing and quality assurance process to produce a 2018 baseline woody extent layer. To produce the 2019 dataset, a 2018 baseline extent was updated using SLATS clearing data for the 2018-2019 reporting to produce a 2019 woody extent.

Features were categorised as either woody or non-woody, where woody vegetation defined in DES (2021) as stands of woody vegetation greater than 0.5ha with a crown cover greater than 10% are represented. A minimum width of 20m was applied to linear features. No distinction is made between native and non-native vegetation; woody vegetation such as woody weeds and horticultural crops are included as woody in the final classification. Both woody and nonwoody features smaller than these sizes have been filtered out of the data set. Ancillary data on dams and waterbodies were also used to further refine the woody classification for the riparian analysis. These waterbodies were classified as 'no data'.

It is important to note that this change in data source from FPC to woody extent means direct comparisons with previous reporting are not appropriate.

Measuring changes to riparian extent over time

Historical and recent losses of riparian vegetation are analysed using woody vegetation clearing data from SLATS. Due to the historical time-series required for this component of the reporting, these analyses rely on the use of SLATS Landsat-based data, which has an archive extending to the late-1980s (for Landsat 5, 7 and 8). Some scale/resolution differences may reduce the precision and accuracy of some of the reporting statistics derived from this component, particularly when comparing losses mapped by SLATS using Landsat imagery with current woody vegetation extent mapped using Sentinel-2 imagery. The recent losses relate only to anthropogenic clearing, and do not include vegetation loss from natural events such as storms and drought stress. This distinction is determined through the SLATS classification process (for further details see Queensland Department of Environment and Science, 2021).There was a major methodological change in the 2018-2019 SLATS reporting period, with a shift to using Sentinel-2 at 10m resolution, rather than Landsat (30m). Clearing numbers are not directly comparable due to this methodological change. A new category of 'partial clearing' was also created, however this report only uses the 'full clearing' category.

Riparian woody vegetation loss in extent is reported for two time periods for the South-East Queensland catchments:

- From 1988 to 2016-2017, for historical woody vegetation clearing summaries.
- 2017-2018 to 2018-2019 for recent clearing since the last report

Estimating riparian ground cover

For riparian areas classed as non-woody, we estimated ground cover for the dry (winter) season (July - August 2019). Ground cover monitoring is included to recognise the importance of having some level of vegetation cover in riparian areas to help minimise erosion, particularly where woody vegetation is not present to stabilise the soil through deeper root structures. Ground cover reporting in riparian areas is based on Sentinel-2 seasonal fractional cover data derived using the method described by Flood (2017). The Sentinel-2 fractional cover product is not specifically a ground cover product, and does contain woody vegetation. However, as its use is restricted to non-woody areas it is suitable for the purposes of assessing ground cover. Three classes of ground cover were used for reporting: 0-30%; 30-70%; and, greater than 70% ground cover. Very low ground cover can indicate degraded areas, such as gullies. It may also be present naturally in areas containing sandbars, sand dunes and rocky streams.

The different cover types were then combined into a raster layer for the riparian area within each catchment, coded as follows:

1 - High ground cover , ie Non woody, 70% and greater cover

2 - Medium ground cover, ie Non woody, between 30% and 70% cover

3 - Low ground cover, ie Non woody, less than 30% cover

4 - Woody Vegetation

5 - No/missing data

Regional Ecosystems within the riparian area

We analysed the status of Regional Ecosystems (Biodiversity status of 2019 remnant regional ecosystems - Queensland, Department of Environment and Science, version 12.2) within the riparian area. We report on the proportion and amount for each category (endangered, of concern, least concern and non-remnant) in each catchment's riparian area.

The Regional Ecosystem mapping includes some polygons with a mix of Regional Ecosystems. Where these polygons intersected the riparian area, we calculated areas based on the proportion of the polygon assigned to each Regional Ecosystem. This is an approximation, as riparian areas are not a random sample of the ecosystems within a mapping polygon. The total riparian area will also be slightly different, as this was calculated as a vector intersection rather than raster calculation.

Results

Changes in extent of riparian vegetation

Recent riparian woody vegetation loss in South-East Queensland has generally fluctuated around a mean of 822 hectares (0.15%) per year, between 1988 and 2019, with a recent higher mean of 1017 hectares (0.19%) per year for the 2017-2019 period (Figures 3 and 4). However, this recent period includes a notable increase in 2018-2019, which may be partly attributable to the methodological changes to SLATS for this reporting period. For the 1988-2019 period, the Pumicestone catchment had the highest proportion of riparian vegetation loss, largely due to forestry activity (Figure 2).

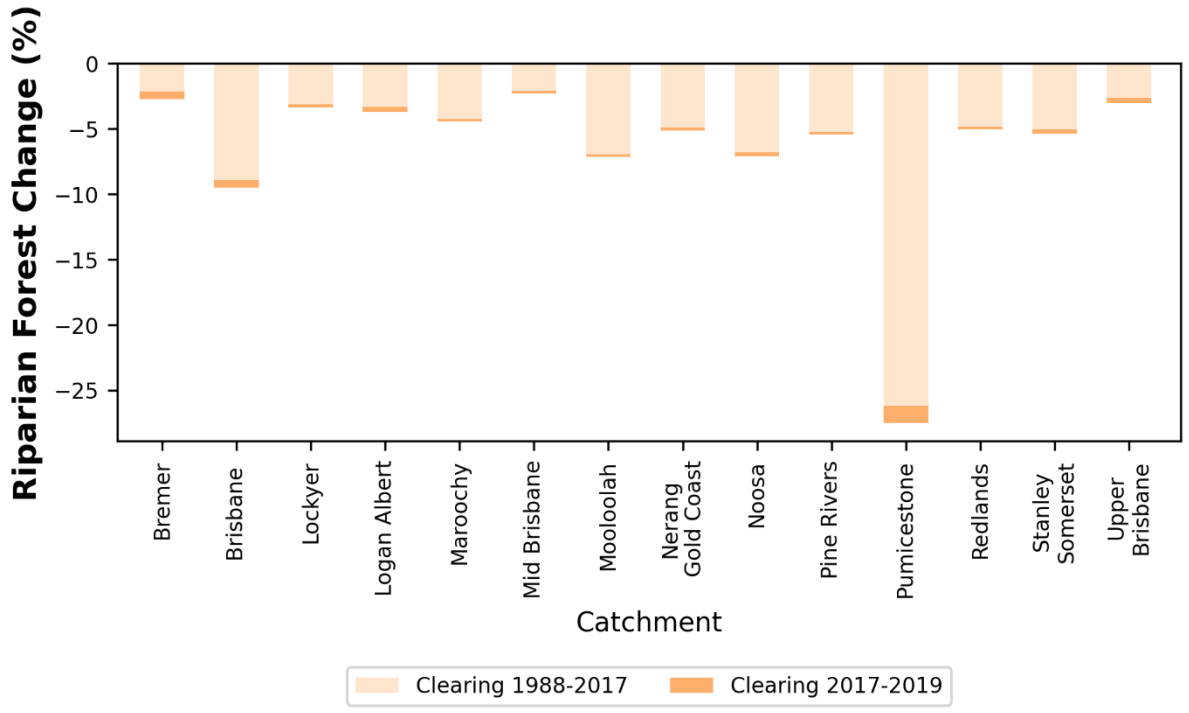
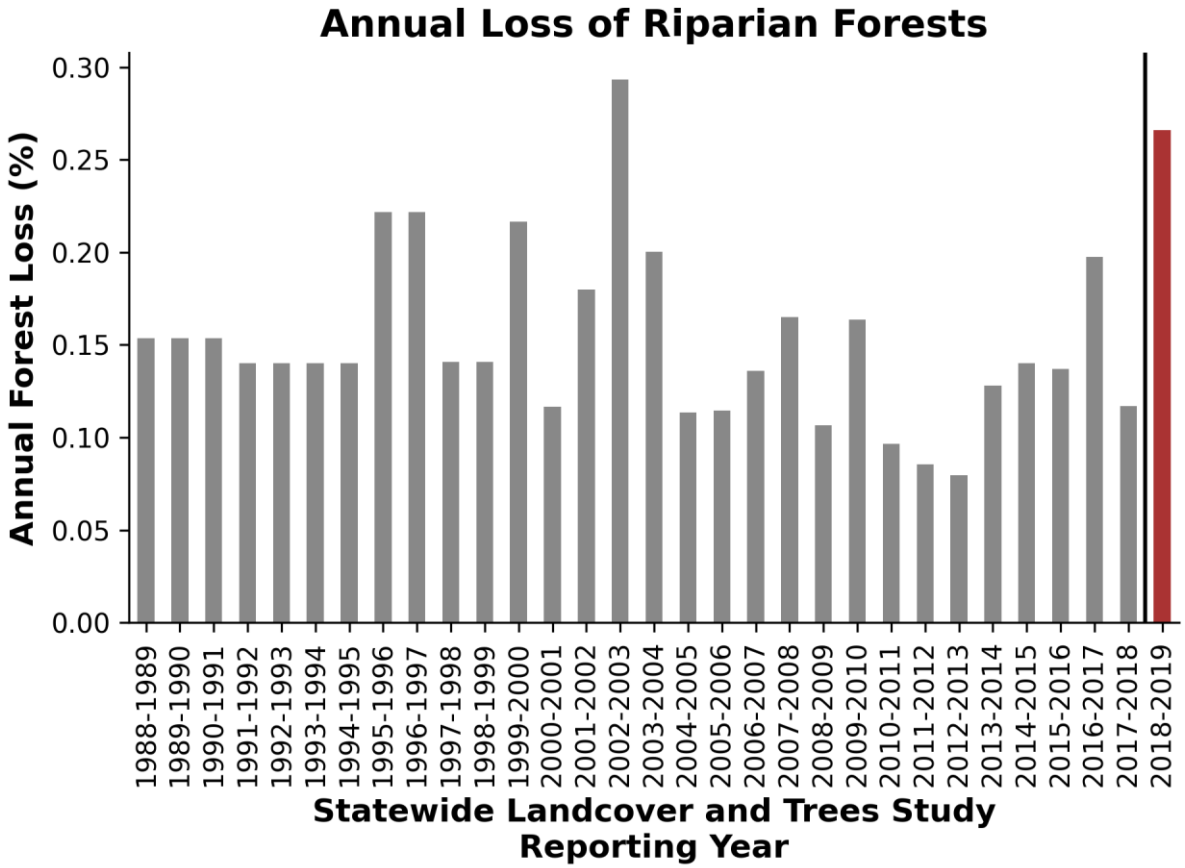


Figure 2: Proportion of riparian forest loss in South-East Queensland catchments since 1988



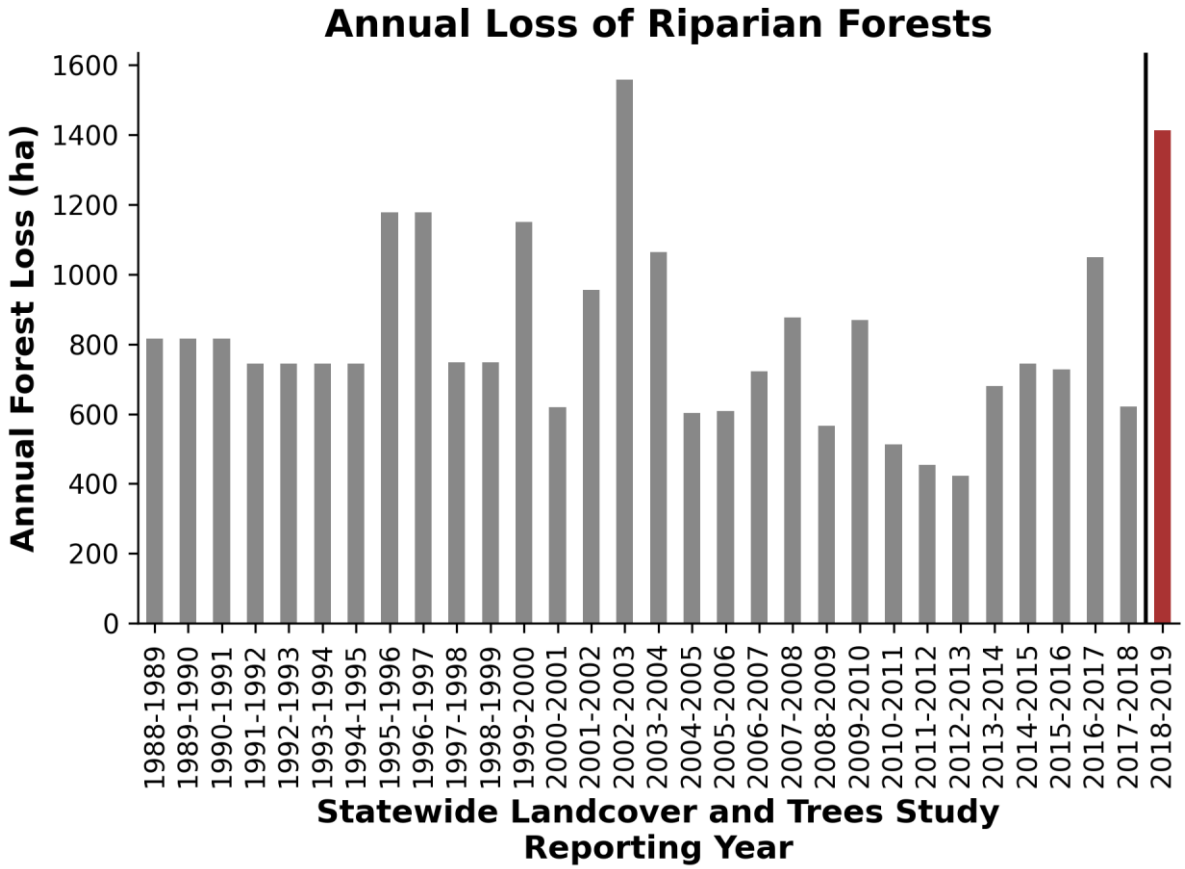


Figure 3 and 4: Annual loss of riparian woody vegetation in South East Queensland catchments. Note a different method is used from 2018-2019 onwards.

Proportions of riparian forest and ground cover

In 2019, approximately 63.9% (339 524 hectares) of the riparian area of South East Queensland catchments were woody. The remainder is assumed to be non- woody.

Non-woody areas where the ground cover was less than 70% but more than 30% accounted for 0.6% (3176 hectares) of the total riparian area. Non-woody areas which have less than 30% ground cover were 0.005% (30 hectares) of the total riparian area (**Error! Reference source not found.**).

Importantly, those catchments which have historically had greater development and therefore have a low proportion of woody areas (e.g. Bremer, Lockyer, Logan Albert, Upper Brisbane and Stanley Somerset) all have relatively large proportions of their non-woody areas with greater than 70% ground cover, indicating that there is at least some vegetation cover in these areas which could help reduce runoff and erosion. The 'Missing Data' category includes dams and other waterbodies, as well as areas obscured by cloud in the data products derived from satellite imagery.

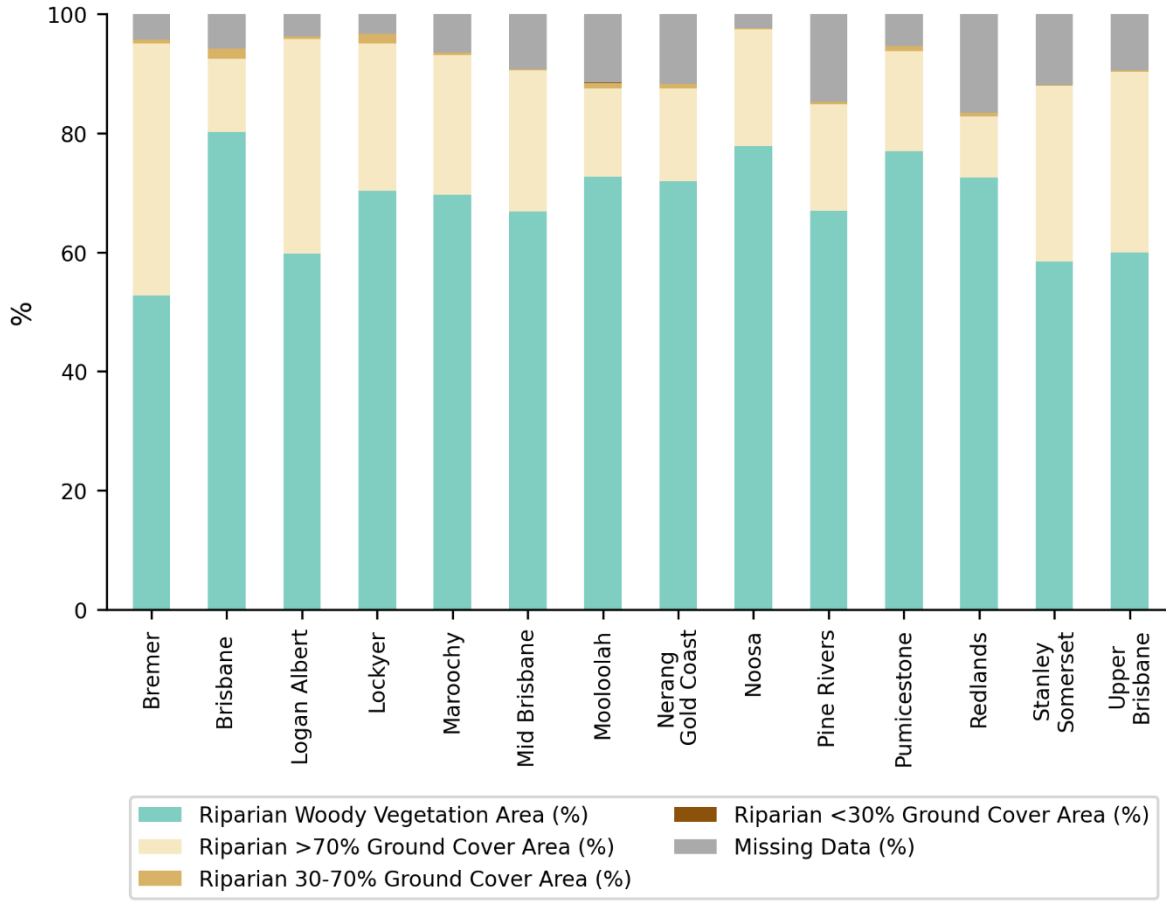


Figure 5: Proportions of riparian vegetation in South East Queensland catchments in 2019

Regional Ecosystems

In South East Queensland catchments, 2.2% (11 600 ha) of riparian areas were classified as endangered and 7.6% (40 500 ha) as of concern regional ecosystems (Figures 6 and 7). Most of the riparian areas were non remnant (66.2% 351 600 ha) The Noosa catchment has the highest proportion of endangered (6.4%) and of concern (18.1%) regional ecosystems. The Bremer catchment has the lowest proportion of endangered (1.3%) and regional ecosystems and also had the highest proportion of non-remnant (80.2%).

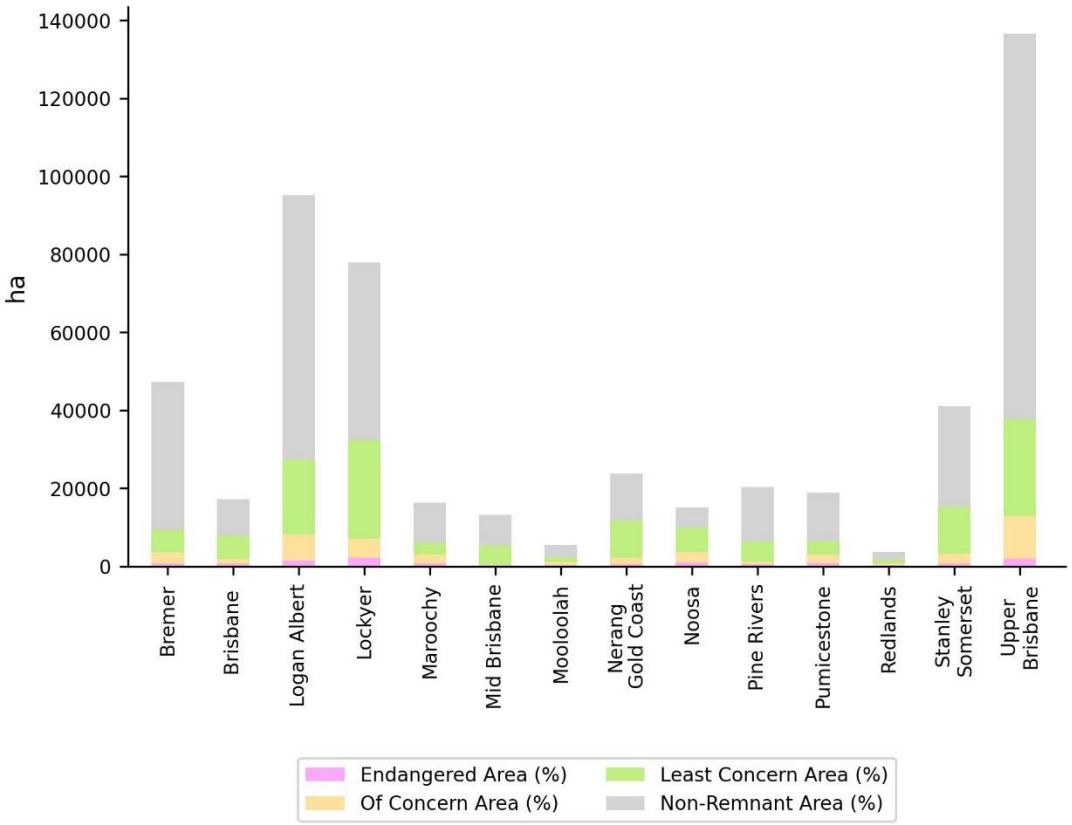


Figure 6: Area (ha) of riparian vegetation by Regional Ecosystem status, South East Queensland catchments 2019

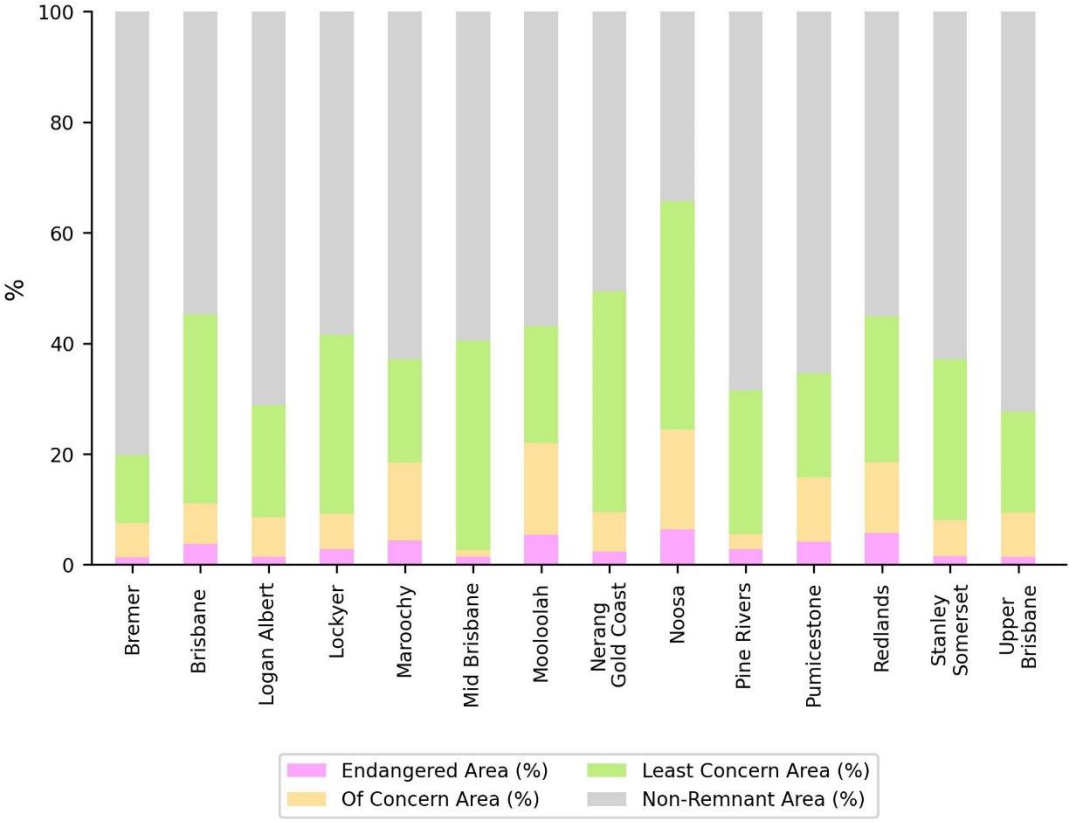


Figure 7: Proportion of riparian vegetation by Regional Ecosystem status, South East Queensland catchments 2019

References

Apan, A.A., Raine, S.R. and Paterson, M.S., 2002. Mapping and analysis of changes in the riparian landscape structure of the Lockyer Valley catchment, Queensland, Australia. Landscape and Urban Planning 59:43-57

Armston, J.D., Denham, R.J., Danaher, T.J., Scarth, P.F., and Moffiet, T., 2009, 'Prediction and validation of foliage projective cover from Landsat-5TM and Landsat-7TM ETM+ imagery for Queensland, Australia', Journal of Applied Remote Sensing, vol. 3, no.1, 033540-033567.

Croke, J., Thompson, C., and Fryirs, K. 2017 'Prioritising the placement of riparian vegetation to reduce flood risk and end-of-catchment sediment yields: Important considerations in hydrologically-variable regions', Journal of Environmental Management, 190:9-19

Environmental Protection Agency (2005) Wetland Mapping and Classification Methodology – Overall Framework – A Method to Provide Baseline Mapping and Classification for Wetlands in Queensland, Version 1.2, Queensland Government, Brisbane. ISBN 0 9757 344 6 6

Flood N. 2017. Comparing Sentinel-2A and Landsat 7 and 8 Using Surface Reflectance over Australia. Remote Sensing. 9 7:659.

Flood, N. 2013. Seasonal composite Landsat TM/ETM+ images using the medoid (a multi-dimensional median). Remote Sensing, 5 12: 6481-6500.

Flood, N., Danaher, T., Gill, T. and G, S., 2013. An operational scheme for deriving standardised surface reflectance from landsat TM/ETM+ and SPOT HRG imagery for eastern Australia. Remote Sensing, 5 1: 83-109

Flood, N., Watson, F. and Collett, L. 2019. Using a U-net convolutional neural network to map woody vegetation extent from high resolution satellite imagery across Queensland, Australia.International Journal of Applied Earth Observation and Geoinformation, Volume 82. https://doi.org/10.1016/j.jag.2019.101897.

Goetz, S.J., 2006 Remote Sensing of riparian buffers: past progress and future prospects. Journal of the American Water Resources Association. 42:133-143

Guerschman J, Scarth P, McVicar T, Renzullo L, Malthus T, Stewart J, Rickards J & Trevithick R 2015, 'Assessing the effects of site heterogeneity and soil properties when unmixing photosynthetic vegetation, non-photosynthetic vegetation and bare soil fractions from Landsat and MODIS data', Remote Sensing of Environment, vol. 161, pp. 12–26.

Hubble, T., Docker, B. and Rutherfurd, I. 2010 The role of riparian trees in maintaining riverbank stability: A review of Australian experience and practice. Ecological Engineering 36:292-304

Kitchen, J., Armston, J., Clark, A., Danaher, T., and Scarth, P., 2010, 'Operational use of annual Landsat-5 TM and Landsat-7 ETM+ image time-series for mapping wooded extent and foliage projective cover in north-eastern Australia', in Proceedings of the 15th Australasian Remote Sensing and Photogrammetry Conference, Alice Springs, Australia, 13 -17 September 2010.

Lyons, J., Trimble, S. W., and Paine, L. K., 2000. Grasses vs trees: Managing riparian areas to benefit streams of central North America. Journal of the American Water Resources Association. 36:919-930.

McMahon, J., Olley, J., Brooks, A., Smart, J., Rose, C., Curwen, G., Spencer, J. and Stewart-Koster, B. 2017 An investigation of controlling variables of riverbank erosion in sub-tropical Australia. Environmental Modelling & Software, 97:1-15

Queensland Department of Environment and Science. 2021. Statewide Landcover and Trees Study – Methodology Overview v1.0. Queensland Government, Brisbane.

Queensland Department of Environment and Science. 2018. Statewide Landcover and Trees Study: Overview of Methods. DES, Brisbane.

Scarth P, Roder A & Schmidt M 2010, 'Tracking grazing pressure and climate interaction – the role of Landsat fractional cover in time series analysis' in Proceedings of the 15th Australasian Remote Sensing and Photogrammetry Conference, Alice Springs, Australia, pp. 13–17.

Simon, A., and Collison, A.J.C., 2002. Quantifying the mechanical and hydrological effects of riparian vegetation on stream bank stability. Earth Surface Processes and Landforms. 27:527-546.

Specht, R.L. (1970) Vegetation. Pages 44–67 in Leeper, G.W. (ed.), "Australian Environment", 4th edn. Melbourne University Press, Melbourne.

Yang, X. 2007. Integrated use of remote sensing and geographic information systems in riparian vegetation delineation and mapping. International Journal of Remote Sensing. 28:353-370