Comparing the annualised dynamic shade characteristics of twenty-one tree canopies across twenty-six municipalities in a high ambient UV climate, Queensland - Australia

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Abstract

Standardised assessments comparing the surveyed shade quality characteristics of twenty-one trees currently established and growing in public parks and playgrounds in Queensland, Australia are presented for informing local government, shade designers and municipal planners. Assessments focus on the ultraviolet protection of individual tree canopies which are reported in terms of the Shade Protection Index (SPI) and Ultraviolet Protection Factor (UPF) assessed at fine temporal resolution and averaged over a full calendar year. The UPF and SPI are used to determine tree species best suited for optimal shade with respect to twenty-six regional cities spanning 17° in latitude. This assessment included all local coastal districts from Bamaga ($-10.89°$ S, 142.39° E) to Southport ($-27.97°$ S, 153.42° E) showing a general (species dependent) decline in ultraviolet protection with increasing southerly latitude. Survey tree species are ranked and listed in order of best ultraviolet protection for respective localities enabling the quality of protection provided by living tree canopies to be compared across a range of environments.

Keywords: UPF, SPI, Ultraviolet, Tree, Standards, Shade

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1. Introduction

Solar ambient ultraviolet (UV) radiation contributes to lifetime personal exposures that are well correlated with elevated incidence of skin cancer (Rigel, 2008; Lucas and Ponsonby, 2002) and eye disease (Lucas et al., 2003; Gallagher and Lee, 2006). In Australia, this also includes increased incidence rates of cataract (Hollows and Moran, 1981) and pterygium (Moran and Hollows, 1984) with decreasing latitude in indigenous populations. As a consequence, Queensland, the most northerly and the third most populous state in Australia experiences the highest keratinocyte cancer incidence nationally (Perera et al., 2015; Australian Institute of Health and Welfare (AIHW), 2016). Queensland also experiences an annual melanoma incidence rate in excess of 67 cases per 100 000, almost twice the world's highest national incidence of 36 cases per 100 000 reported in New Zealand (Australian Institute of Health and Welfare (AIHW), 2016).

The greatest reduction in the risk of UV-related skin and eye disease can be achieved by avoiding exposure during peak UV periods, and wearing sun-protective hats, clothing and sunglasses which meet the required standards, as well as properly applying high SPF sunscreen and seeking effective shade (Lucas and Ponsonby, 2002). Sun exposure avoidance, practiced by staying out of direct sunlight can be achieved by making use of physical barriers, including purpose built shade structures (Parisi and Turnbull, 2014; Parisi et al., 2019) and quality tree shade (Parisi et al., 2001; Heisler et al., 2003; Gies et al., 2007). For Queensland, and other high ambient UV climates, optimal shade design of public spaces has the potential to promote better health outcomes for populations at risk of disease due to environmental exposure (Villanueva et al., 2015).

Queensland, Australia occupies a significant land area extending from Cape

York Peninsula at 11°S latitude to the densely populated South-Eastern corner of the state at 28°S latitude. Measures of shade quality which affect the skin and eye health of different population groups extending across such a significant latitude range result in clear measurable differences in annual shade patterns and solar ultraviolet intensity based solely upon location. This research is the first to provide sound and practical advice to each of twenty-six local municipalities along the eastern coast of the state, based upon a simple, scientific and reproducible method for assessing the solar ultraviolet protection provided by individual tree canopies. The outcomes are reported in the context of an ongoing state-wide tree shade canopy survey. Results for the first twenty-one trees of this survey are presented

2. Methods

2.1. Solar UV radiation model

A model was used to replicate the expected solar UV irradiance available at the Earth's surface under cloud free conditions for 26 different sites to facilitate calculation of a comparable tree shade assessment metric based exclusively upon the influence of 21 different tree canopies with geographic latitude (Figure 1). The surface solar UV irradiance was modelled at the top of each tree canopy (pre-absorption) and underneath each canopy on their northern facing side (post-absorption). Model calculations of the UV surface irradiance for survey trees were made in five minute intervals for the full 2018 calendar year and repeated at each regional city site from Bamaga (Cape York Peninsula) to Southport (Southern Queensland border) (Table 1). The ambient solar UV irradiance was derived for each five minute interval of the year according to the direct and diffuse component models of Green et al. (1974, 1980); Schippnick and Green (1982) and Rundel (1986).

The available solar UV under each respective tree canopy was expressed relative to the available ambient. The relative UV irradiance under a tree canopy expressed with respect to the available ambient was defined as a Protection Factor (PF), where:

$$PF = \frac{UV_{ambient}}{UV_{surface}}\,. \qquad (1)$$

$UV_{ambient}$ and $UV_{surface}$ represent the modelled ambient UV irradiance before and after passing through a tree canopy respectively. $UV_{surface}$ was derived here according to the approximation of Grant et al. (2002):

$$UV_{surface} = (I_{dir} \times P_o) + (I_{diff} \times F_s)\,, \qquad (2)$$

where I_{dir} and I_{diff} are the respective direct and diffuse solar UV irradiance components incident upon the top of a tree canopy that are each affected by the probability that direct solar radiation will pass through the canopy, P_o; and the remaining sky fraction under the canopy visible from the tree observation point, F_s. F_s was calculated as the proportion of the available sky pixels in respective video frames made of each tree canopy and recorded over a 140° field of view (FOV), assuming the remaining FOV toward the horizon is unobstructed. P_o, however is dependent on the solar position with respect to the moving tree canopy and diurnal path of the sun, being 1 if the sun in unobstructed and 0 if blocked by an overhead leaf or branch. The position of the solar disc with respect to each tree canopy was plotted onto video frames of the respective surveyed trees and cycled for every five-minute long irradiance interval in the 2018 calendar year. Solar azimuth and altitude, which affects the modelled UV irradiance, was derived for each of these five-minute intervals according to site latitude and time of day for the 26 Queensland municipalities included in this study (Michalsky, 1988).

Standard canopy assessment procedures were adopted to derive annual tree Protection factors (PF) which are expressed here as the Shade Protection Index (SPI) and Ultraviolet Protection Factor (UPF) for each of the 21 surveyed tree canopies. The SPI represents the unweighted PF (Equation 1) and is the ratio of the available unweighted solar UV surface irradiance (280 to 400 nm) relative to the unweighted solar UV surface irradiance underneath a tree canopy. The UPF represents the same ratio of the solar UV surface irradiance but is weighted to the erythema action spectrum for human skin (Commission Internationale de l'Eclairage (CIE), 1998). SPI represents the relative protective influence of an individual tree for the general solar terrestrial UV spectrum, while UPF represents the relative protection that an individual tree provides against biologically effective UV, which causes sunburn in human skin.

2.2. Canopy measurement

Tree canopies were measured at different stages of maturity and growing in a range of environments spanning 17° in latitude and east of the Great Dividing Range (GDR), Queensland. The selected trees represent the first 21 to be included in the Queensland Tree Canopy Survey (QTCS), which aims to catalogue the shade characteristics of solitary trees growing within every local government district of Queensland. The sample of 21 tree canopies presented in this research is a convenience sample representing all trees that have been surveyed to date as part of the QTCS that met our inclusion criteria. This included trees located on public land, footpaths or parks situated at least 15 m from any other tree, building or substantial structure that could potentially impede sky view. Trees were selected only if it were possible for people to sit or stand beneath its canopy and were included only if measurements were able to be carried out without endangering researchers or their equipment. Trees sampled from the eastern coastal districts, and included in this study, experience climates better suited to the growth of large trees and vegetation compared with the semi-arid environments of western Queensland. These coastal districts are the focus of this survey - phase one of the QTCS. Selected trees are used as models to demonstrate the value in making standard canopy assessments and to examine variation in protective quality with site latitude. The selected trees are assumed to be suitable to the full range of similar climatic conditions experienced along eastern Queensland regional districts and are included here for comparison. Tree canopy measurements were conducted on cloud free days between June and September 2018.

Survey trees included both native and introduced evergreen species growing on public land, footpaths and parks. To be included, trees needed to be at least 15 m from any other tree, building or substantial structure that could have the potential to impede the skyview from a standardised canopy observation point. A standard canopy observation point was chosen to account for possible variation in the measured sky fraction. Measurements of the skyview underneath each selected survey tree were made due north of each tree trunk (Southern hemisphere) and midway between the trunk and approximate canopy circumference. The approximate canopy circumference for each survey tree was calculated as the average of the longest and shortest canopy diameter (major and minor elliptical axis) by reference to publicly available aerial images (Google Maps, 2018).

The sky fraction of each survey tree measured at standard northerly observation points were assessed by video image analysis. Video image analysis of each tree canopy was chosen for the QTCS to take into account the likely dynamic action of each canopy. This is advantageous over single static image analysis

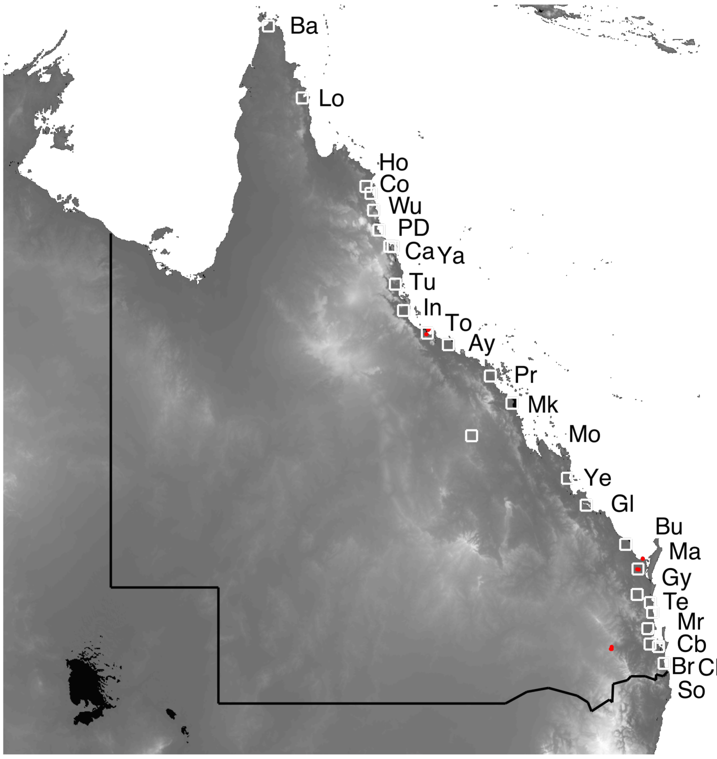
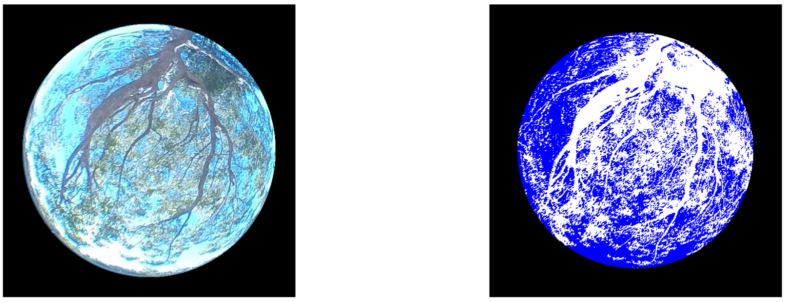


Figure 1: Survey tree sites (red dots) and city locations (white squares) for each of 26 coastal shire council regions from northern to southern Queensland beginning with Bamaga (Northern Peninsula Area Regional Council) and ending with Southport (Gold Coast City Council). Selected cities are located east of the Great Dividing Range with the exception of Moranbah (Isaac Regional Council) - mid figure.

as video analysis accounts for the possible range in leaf and branch movement. Video capture for each tree canopy was completed using a 4k hi-resolution video camera (GoPro Hero5, USA). The recording camera was levelled at a height of 1 m above the surface at each northerly observation point and fitted with a fish eye lens and 25% transmission neutral density filter (Celestron ND 96, USA) to capture 180 second long time lapse videos covering a FOV of 140°. The skyview for each recorded video frame was determined by image processing. Here, the relative fraction of Red and Blue pixel saturation values were used to process video frames into discreet *sky* and *tree canopy* pixels. To complete the analysis, all canopy videos were recored on cloud free days, eliminating any potential misclassification of cloud as tree canopy pixels. Figure 2 compares a single video frame recored under Tree 7 of the QTCS - *Cinnamomum camphora* before and after image processing to determine the sky fraction from underneath the canopy.



(a) (b)

Figure 2: (a) *Cinnamomum camphora* video frame recorded at the standard northerly observation point midway between the trunk and canopy edge. (b) Processed video frame showing sky (blue) and tree canopy (white) pixels used to determine sky fraction at the observation point.

3. Results

3.1. Comparison of trees by location

To make an objective comparison of the UV protection of a given tree canopy, the long term annual average SPI and UPF was calculated for each of the 21 survey trees. Annual average SPI and UPF calculations were repeated for 26 locations, each representing the position of a regional Queensland city. Selected cities represent the regional centres of each of Queensland's local government districts that share a border with the Pacific coastline. Survey characteristics of Trees 1 through 21 are included in Table 2 and 3. The current survey included trees at all stages of maturity and condition. Trees 5 and 6 were of the same species, *Albizia saman*. Tree 6 was exposed to a greater sky view due to the removal of some limbs on the northern side of the canopy. All remaining trees did not show signs of canopy pruning. Trees 9 and 10 were also of the same species, *Cupressus torulosa*. In this case, Tree 10 was slightly larger than Tree 9.

The annual average SPI and UPF for each survey tree are included for all 26 Queensland regional cities in Tables 4 and 5. In the tables, cites are presented in order of increasing latitude starting with city 1 - Bamaga, $-10.890°$ S (Northern Peninsula Area Regional Council) and concluding with city 26 - Southport, $-27.973°$ S (Gold Coast City Council). Tables 4 and 5 also include the modelled maximum and minimum SPI and UPF for each survey tree. The range in the calculated maximum SPI of all 21 survey trees varied from 2.34 (Tree 1 - *Archontophoenix alexandrae*) to 5.82 (Tree 14 - *Ficus benghalensis*). The order of canopy protection (lowest to highest) was also repeated with respect to the calculated maximum UPF, varying from 2.00 for Tree 1 - *Archontophoenix alexandrae* to 4.98 for Tree 14 - *Ficus benghalensis*. The level of broad spectrum protection provided by a tree canopy in each study location assessed according to the SPI was greater than the biologically effective canopy UPF. This result is due to preferential weighting of the erythema action spectrum of human skin to short UV wavelengths.

In all Queensland cities located in eastern coastal districts, the SPI and UPF decreased with increasing latitude. For cities located at the southern end of the state, the modelled solar position will always be further from the zenith compared to cites at lower latitude. Increasing latitude increases the proportion of time the sun is not blocked by a tree canopy as the sun is closer to the horizon for a greater proportion of the year. The annual arithmetic mean of five minute calculations resulted in lower average SPI and UPF with increasing latitude.

A given tree species will therefore generally have a higher SPI (and UPF) the further north it is located (depending on the canopy structure).

3.2. Best local tree canopies

Comparison of the order of maximum annual SPI (assessed as the highest SPI calculated across all 26 statewide locations) to the localised SPI shows that the order of the best protective canopy depends on location. The top five trees which provided the highest statewide maximum SPI were Tree 14 - *Ficus benghalensis*, Tree 16 - *Figus microcarpa*, Tree 5 - *Albizia saman*, Tree 10 - *Cupressus torulosa* and Tree 9 - *Cupressus torulosa*. The order of the highest maximum UPF was the same (Table 5). However, the order of the average SPI when assessed across all 26 localities individually showed that the highest average annual SPI occurred in Tree 14 - *Ficus benghalensis*, Tree 16 - *Ficus microcarpa*, Tree 5 - *Albizia saman*, Tree 10 - *Cupressus torulosa* and Tree 19 - *Mangifera indica*. Again this order was repeated for localised annual average UPF ratings (Table 5). These results indicate that while Tree 9 - *Cupressus torulosa* provides a high annual maximum SPI 4.20 (and UPF 3.60), when studied as an annual average, Tree 19 - *Mangifera indica* is likely to be a better option as its annual average SPI, ranging from 2.28 to 2.47 across all local regions, tends to be higher than Tree 9 - *Cupressus torulosa* which ranges from 2.22 to 2.40. This local trend was also repeated in the annual average UPF canopy modelling.

Common to all high SPI and UPF rated trees are low visible sky fractions, F_s from the observation point which affects the available diffuse UV that can reach the surface. Canopies with a low F_s that block more of the available sky view also increase the probability that the direct solar radiation will be obscured. In the current survey, trees with low F_s tended to have high density wide leafed canopies or were made up of canopies that covered a large physical area. These included many *Ficus* species but also the *Albizia* species with tree canopies exceeding diameters of 30 m. The top five trees with the lowest visible F_s (Tables 3 and 4) were Tree 14 - *Ficus benghalensis* ($F_s = 0.43$), Tree 16 - *Ficus microcarpa* ($F_s = 0.48$), Tree 5 - *Albizia saman* ($F_s = 0.50$), Tree 10 - *Cupressus torulosa* ($F_s = 0.54$) and Tree 19 - *Mangifera indica* ($F_s = 0.57$). Each of these trees obscured greater than 40% of the available sky view and are listed in the same order as the top five tree with the highest local average SPI and UPF.

The top 10 trees ordered with respect to annual average SPI for each of the 26 Queensland cities considered in this research are listed in Table 6. As noted above, by comparison of Tables 4 and 5, the order of protection measured as those trees giving the highest annual average SPI (and UPF) is the same for the first 5 trees at all locations (Tree 14, Tree 16,Tree 5,Tree 10, Tree 19). However, this order varied for trees placed 8th and lower. Variation in the place order of trees with lower SPI (and UPF) are likely to occur due to reduced canopy density. For example, *Ecalyptus* tree species including Trees 11, 12 and 13 have much more open canopies than for example many *Ficus* species. Open canopies, that provide sparse foliage densities are sensitive to latitude variation as the likelihood that the direct solar irradiance will be obscured depends on the individual density pattern of the canopy and the seasonal path of the sun. Open canopies that provide greater access to the sky are also more sensitive to wind and will move more noticeably than canopies with dense foliage. Some species provided very little effective protection, including Palm trees and *Ecalyptus* species. The bottom performing survey trees included Tree 1 - *Archontophoenix alexandrae* ($F_s = 0.95$), Tree 13 - *Ecalyptus tricarpa* ($F_s = 0.91$) and Tree 12 - *Ecalyptus tessellaris* ($F_s = 0.83$).

4. Discussion

A total of 21 individual tree canopies, representing the first phase of a statewide tree shade assessment survey have been analysed from standing tree specimens growing in coastal Queensland. The current sample includes evergreen tree species growing in different conditions and at different stages of maturity from which larger native, urban and regional canopy subgroups will be assembled in the future. A number of principal findings were determined from the current study sample.

4.1. Observations and regional shade design

Utilising the UPF to asses the protective quality of a tree increased the influence of solar UVB radiation which, due to Rayleigh's criterion, was more abundant in the modelled diffuse erythema weighted UV than longer wavelength UVA. During periods when the sun was obscured, all canopies, and especially those that did not block a wide skyview from the observation point allowed a greater proportion of diffuse erythema UV to reach the surface (reducing the UPF), compared with the longer UV wavelengths (which influence the SPI). This resulted in higher SPI than UPF at all study sites. In the tropics, and far northern regions of the state, the solar disc is located at lower zenith for a higher proportion of the year. At low latitudes the sun is therefore more likely to be obscured by tree canopies compared with districts further south resulting in higher annual average SPI (and UPF). Similarly, in the southern state districts, tree shade was found to be more effective during the summer months.

From the assessed sample of 21 trees, broad-leaved and large canopy area species that covered the largest proportion of the available skyview were found to provide optimal annual protection in each local state district. The highest measured SPI was recorded for Tree 14 - *Ficus benghalensis* at SPI 5.83 (4.98 UPF). Statewide, this was followed by another *Ficus* species, Tree 16 - *Ficus* *microcarpa* (SPI 4.66 and UPF 3.99) and the large canopy species, Tree 5 - *Albizia saman* (SPI 4.48 and UPF 3.83). The study maximum UPF of 5 determined for Tree 14 - *Ficus benghalensis*, a tree which also obscured a skyview of 67% would however on its own not significantly contribute to the reduction of erythematic solar radiation. Assuming complete obstruction of the available skyview by a hypothetically opaque tree canopy from 0 to 65° in SZA, the highest annual protection factors for Brisbane, the state capital city of Queensland, would rate at SPI 8.02 and UPF 6.86 (and higher in the tropics). These findings are compatible with previously published UPF measurements of other common Australian tree species ranging between UPF 5 and 10 (Gies et al., 2007).

The SPI and UPF were listed in Tables 4 and 5 to 2 decimal places to highlight differences between individual canopies assessed over annual time scales. While this level of precision is far too fine to make a practical difference that could be noticed by persons utilising tree shade under similar canopies, the ratings included in the tables can be utilised to make long term, site specific comparisons of UV protection for each respective region.

4.2. Limitations and future directions

Designs that integrate best practice to encourage public use of outdoor space consider the whole environment and all the factors which influence the use of shade. These considerations are not limited to the rated SPI or UPF of a single tree canopy but may include consideration of perceived thermal comfort when under shade in humid tropical regions, leaf and fruit litter, habitation by local bird, bat and insect species, public safety, convenience, accessibility and maintenance of publicly shaded spaces. In this initial phase of the Queensland tree canopy survey, we considered the quality of tree shade by introducing standards that allow the local assessment of tree canopies through the derivation of annual canopy SPI (and UPF). The UV shade quality of listed trees measured from the current phase one survey data can be assessed by reading down each respective column of Tables 4 and 5 to provide a rank order of best canopy protection by region. Good shade design as shown in this research is regional but also dependent upon local bylaws, regulations and public safety.

Optimal shade design was considered for individual trees. No trees were studied if other trees were located nearby and all assessments were made on the north side of a tree (Southern hemisphere). To standardise assessments, all surface objects below SZA 65° were removed and considered free of obstruction. In reality, it is likely this region of the sky, particularly in urban settings will be obstructed by buildings or other plants such that the actual SPI and UPF of a planted tree will be higher than the minimum ratings presented in Tables 4 and 5. How a tree is intended to be used was also not considered in our comparative tree shade assessment. For example, trees with canopies extending to the ground were not included, but are likely to provide optimal cover if the observation point is accessible. Some trees may be intended for screening of private spaces and will also likely have canopies that extend to the ground. Such trees may provide excellent UV protection, especially if planted as part of a tree or shade grove. In the current study, direct and diffuse solar UV irradiance was calculated every five minutes of the year and compared to a moving tree canopy, provided the solar disc was located above the horizon. Depending on the application, if a given tree is only intended for use between certain times of day (or during certain seasonal periods), an optimised SPI (and UPF) canopy assessment tailored to times of interest may be more appropriate.

This study is limited to an assessment of individual trees that belong to 19 species growing in Queensland. Poor shade performers such as Tree 1 - *Archontophoenix alexandrae* are likely to provide better quality protection when planted in groups or as part of larger garden plantings. The developed methods do not consider the UV shade quality of a survey species if planted in proximity to other trees of the same or different species. Future assessments have the potential to provide interesting results which could inform regional authorities of optimal tree group planting options by utilising the video and modelling techniques developed in this research. Analysis of individual trees grouped by the same or similar species at common stages of maturity also has the potential to guide informed shade design and will be considered in later research applying the techniques developed here.

In the current study we compared two trees of the species *Albizia saman* (Trees 5 and 6) and two trees of the species *Cupressus torulosa* (Trees 9 and 10). Comparison of Trees 5 and 6 showed clearly the influence of canopy pruning on the measured results with Tree 5 - *Albizia saman* (maximum SPI 4.48 and UPF 3.83) rating considerably better than Tree 6 - *Albizia saman* (maximum 3.45 SPI and UPF 2.95) at all 26 regional cities. Trees selectively pruned to accommodate overhead electrical infrastructure, or those pruned regularly to meet public safety and to facilitate accessibility could be measured and compared in later research to inform optimal pruning options that preserve shade or to study the seasonal effect of pruning. Comparison of Tree 9 (maximum SPI 4.20) and Tree 10 (maximum SPI 4.31) showed that both individuals of the same species provided similar levels of protection, with the larger tree providing slightly better SPI (and UPF) at all study locations. Future studies that assess the specific protective canopy characteristics of a selected species will yield greater information on the expected range and consistency in measured protection factors. As the QTCS expands this information will become available.

5. Declarations of interest: none

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6. Tables

Table 1: Coastal Queensland regional council districts, study cities and abbreviations.

Regional Council	City	Abbreviation	latitude	longitude
Northern Peninsula Area Regional Council	Bamaga	Ba	−10.890°S	142.389°E
Lockhart River Aboriginal Shire Council	Lockhart River	Lo	−12.875°S	143.343°E
Hope Vale Aboriginal Shire Council	Hope Vale	Ho	−15.294°S	145.108°E
Cook Shire	Cooktown	Co	−15.475°S	145.247°E
Wujal Wujal Aboriginal Shire	Wujal Wujal	Wu	−15.943°S	145.32°E
Douglas Shire	Port Douglas	PD	−16.483°S	14.465°E
Cairns Regional Council	Cairns	Ca	−16.918°S	144.778°E
Yarrabah Aboriginal Shire Council	Yarrabah	Ya	−16.928°S	145.872°E
Cassowary Coast Regional Council	Tully	Tu	−17.939°S	145.927°E
Hinchinbrook Shire Council	Ingham	In	−18.649°S	146.162°E
Townsville City Council	Townsville	To	−19.259°S	146.816°E
Burdekin Shire Council	Ayr	Ay	−19.568°S	147.406°E
Whitsunday Regional Council	Proserpine	Pr	−20.405°S	148.580°E
Mackay Regional Council	Mackay	Mk	−21.142°S	149.182°E
Isaac Regional Council	Moranbah	Mo	−22.002°S	148.057°E
Livingstone Shire Council	Yeppoon	Ye	−23.133°S	150.733°E
Gladstone Regional Council	Gladstone	Gl	−23.842°S	151.248°E
Bundaberg Regional Council	Bundaberg	Bu	−24.867°S	152.351°E
Fraser Coast Regional Council	Maryborough	Ma	−25.523°S	152.697°E
Gympie Regional Council	Gympie	Gy	−26.183°S	152.665°E
Noosa Shire Council	Tewantin	Te	−26.392°S	153.039°E
Sunshine Coast Regional Council	Maroochydore	Mr	−26.650°S	153.100°E
Moreton Bay Regional Council	Caboolture	Cb	−27.066°S	152.966°E
Brisbane City Council	Brisbane	Br	−27.469°S	153.025°E
Redland City Council	Cleveland	Cl	−27.533°S	153.266°E
Gold Coast City Council	Southport	So	−27.973°S	153.418°E

Table 2: Queensland tree canopy survey of Trees 1 through 12, including tree image, processed canopy, measurement location and tree dimensions.

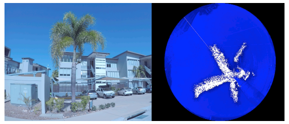
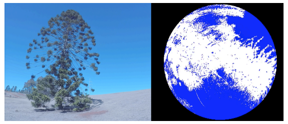
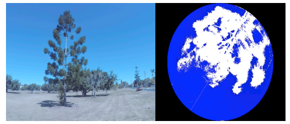
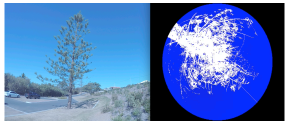
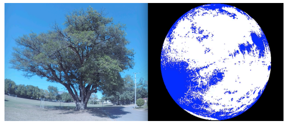
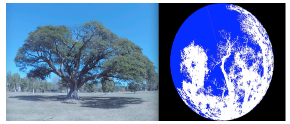
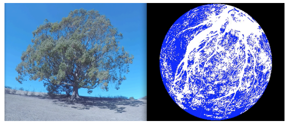
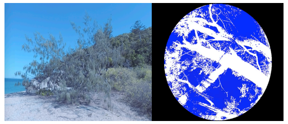
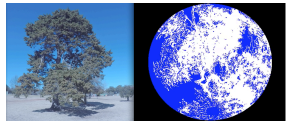
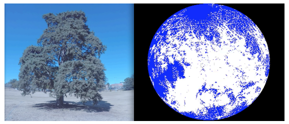
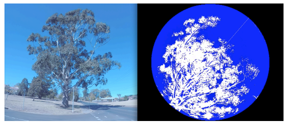
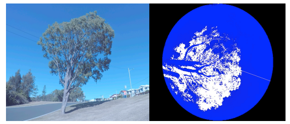
Description	Image and canopy	Description	Image and canopy	Description	Image and canopy
1. *Archontophoenix alexandrae* (Alexander's Palm) −19.160°S 146.857°E $F_s \approx 0.95$ canopy dia. ≈ 3.7 m height ≈ 8.1 m		2. *Araucaria bidwillii* (Bunya Pine) −27.601°S 151.941°E $F_s \approx 0.60$ canopy dia. ≈ 14.1 m height ≈ 19.0 m		3. *Araucaria cunninghamii* (Hoop Pine) −25.534°S 152.717°E $F_s \approx 0.70$ canopy dia. ≈ 4.6 m height ≈ 13.6 m	
4. *Araucaria heterophylla* (Norfolk Pine) −25.249°S 152.827°E $F_s \approx 0.79$ canopy dia. ≈ 5.3 m height ≈ 15.9 m		5. *Albizia saman* (Rain Tree) −19.292°S 146.793°E $F_s \approx 0.50$ canopy dia. ≈ 32.5 m height ≈ 30.3 m		6. *Albizia saman* (Rain Tree) −19.290°S 146.795°E $F_s \approx 0.66$ canopy dia. ≈ 31.8 m height ≈ 25.1 m	
7. *Cinnamomum camphora* (Camphor Tree) −27.537°S 151.962°E $F_s \approx 0.62$ canopy dia. ≈ 19.8 m height ≈ 13.6 m		8. *Casuarina equisetifolia* (Beach Sheoak) −19.155°S 146.860°E $F_s \approx 0.66$ canopy dia. ≈ 10.4 m height ≈ 16.2 m		9. *Cupressus torulosa* (Bhutan Cypress) −27.560°S 151.960°E $F_s \approx 0.57$ canopy dia. ≈ 10.0 m height ≈ 11.3 m	
10. *Cupressus torulosa* (Bhutan Cypress) −27.560°S 151.959°E $F_s \approx 0.54$ canopy dia. ≈ 12.5 m height ≈ 15.2 m		11. *Ecalyptus propinqua* (Grey Gum) −27.598°S 151.960°E $F_s \approx 0.84$ canopy dia. ≈ 24.3 m height ≈ 27.3 m		12. *Ecalyptus tessellaris* (Carbeen) −27.250°S 152.826°E $F_s \approx 0.83$ canopy dia. ≈ 7.9 m height ≈ 16.2 m	

Table 3: Queensland tree canopy survey of Trees 13 through 21, including tree image, processed canopy, measurement location and tree dimensions.

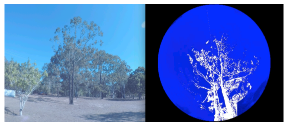
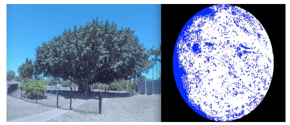
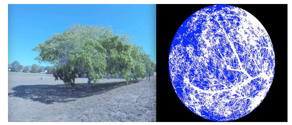
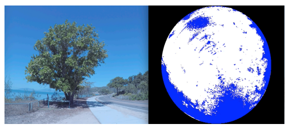
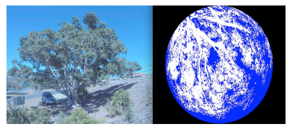
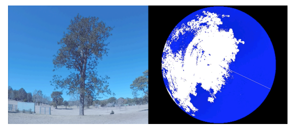
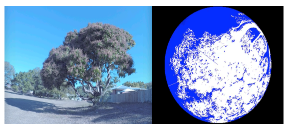
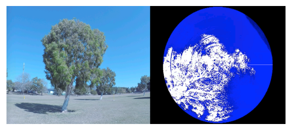
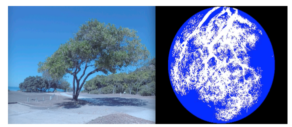
Description	Image and canopy	Description	Image and canopy	Description	Image and canopy
13. *Ecalyptus tricarpa* (Iron Bark) -25.523°S 152.674°E $F_s \approx 0.91$ canopy dia. $\approx$ 6.7 m height $\approx$ 16.7 m		14. *Ficus benghalensis* (Banyan Tree) -19.290°S 146.794°E $F_s \approx 0.43$ canopy dia. $\approx$ 35.6 m height $\approx$ 13.9 m		15. *Ficus benjamina* (Weeping Fig) -19.289°S 146.794°E $F_s \approx 0.60$ canopy dia. $\approx$ 12.8 m height $\approx$ 11.5 m	
16. *Ficus microcarpa* (Malayian Fig) -19.167°S 146.848°E $F_s \approx 0.48$ canopy dia. $\approx$ 11.9 m height $\approx$ 13.5 m		17. *Ficus rubiginosa* (Port Jackson Fig) -25.250°S 152.827°E $F_s \approx 0.61$ canopy dia. $\approx$ 14.4 m height $\approx$ 12.9 m		18. *Grevillea robusta* (Silky Oak) -27.560°S 151.96°E $F_s \approx 0.72$ canopy dia. $\approx$ 12.4 m height $\approx$ 24.6 m	
19. *Mangifera indica* (Mango) -19.291°S 146.794°E $F_s \approx 0.57$ canopy dia. $\approx$ 14.4 m height $\approx$ 14.2 m		20. *Melaleuca quinquenervia* (Paper Bark) -19.290°S 146.795°E $F_s \approx 0.78$ canopy dia. $\approx$ 6.1 m height $\approx$ 11.8 m		21. *Terminalia catappa* (Tropical Almond) -19.166°S 146.848°E $F_s \approx 0.66$ canopy dia. $\approx$ 13.3 m height $\approx$ 11.8 m	

Table 4: Annual SPI of all tree canopies calculated for each of 26 city locations (Figure 1) Bamaga (−10.890°S,142.389°E) through to Southport (−27.973°S, 153.418° E). Maximum and minimum annual SPI (range) evaluated across all cities is also included for each tree canopy.

Tree	**Ba**	Lo	**Ho**	Co	**Wu**	PD	**Ca**	Ya	**Tu**	In	**To**	Ay	**Pr**	Mk	**Mo**	Ye	**Gl**	Bu	**Ma**	Gy	**Te**	Mr	**Cb**	Br	**Cl**	So	max	min
1. *A. alexandrae*	**1.11**	1.10	**1.10**	1.10	**1.10**	1.10	**1.09**	1.09	**1.09**	1.08	**1.08**	1.08	**1.08**	1.08	**1.07**	1.07	**1.06**	1.06	**1.06**	1.05	**1.05**	1.05	**1.05**	1.05	**1.05**	1.05	2.34	1.02
2. *A. bidwillii*	**2.14**	2.13	**2.10**	2.09	**2.09**	2.09	**2.08**	2.08	**2.06**	2.05	**2.04**	2.04	**2.02**	2.02	**2.01**	2.00	**1.99**	1.97	**1.97**	1.96	**1.95**	1.95	**1.94**	1.94	**1.94**	1.93	3.73	1.22
3. *A. cunninghamii*	**1.76**	1.74	**1.71**	1.71	**1.71**	1.70	**1.69**	1.69	**1.68**	1.67	**1.66**	1.65	**1.64**	1.63	**1.62**	1.61	**1.60**	1.58	**1.57**	1.56	**1.56**	1.55	**1.55**	1.54	**1.54**	1.53	3.20	1.15
4. *A. heterophylla*	**1.46**	1.45	**1.43**	1.43	**1.42**	1.42	**1.42**	1.42	**1.41**	1.40	**1.40**	1.39	**1.39**	1.38	**1.37**	1.35	**1.35**	1.34	**1.33**	1.33	**1.33**	1.33	**1.32**	1.32	**1.32**	1.32	2.82	1.10
5. *A. saman*	**2.82**	2.78	**2.76**	2.76	**2.76**	2.75	**2.76**	2.76	**2.74**	2.74	**2.74**	2.73	**2.73**	2.71	**2.71**	2.71	**2.69**	2.69	**2.69**	2.67	**2.67**	2.66	**2.65**	2.65	**2.64**	2.64	4.48	1.29
6. *A. saman*	**1.82**	1.81	**1.79**	1.80	**1.79**	1.78	**1.77**	1.78	**1.78**	1.78	**1.77**	1.76	**1.77**	1.76	**1.75**	1.74	**1.72**	1.72	**1.72**	1.71	**1.71**	1.72	**1.71**	1.70	**1.71**	1.71	3.45	1.16
7. *C. camphora*	**2.10**	2.10	**2.07**	2.07	**2.07**	2.07	**2.07**	2.07	**2.05**	2.05	**2.04**	2.05	**2.04**	2.04	**2.02**	2.02	**2.00**	2.00	**2.00**	2.00	**2.00**	1.99	**1.99**	1.98	**1.99**	1.99	3.72	1.20
8. *C. equisetifolia*	**1.91**	1.90	**1.88**	1.88	**1.88**	1.88	**1.87**	1.87	**1.86**	1.86	**1.86**	1.85	**1.85**	1.85	**1.85**	1.85	**1.84**	1.83	**1.83**	1.82	**1.83**	1.83	**1.83**	1.83	**1.83**	1.82	3.46	1.12
9. *C. torulosa*	**2.40**	2.39	**2.37**	2.37	**2.37**	2.37	**2.37**	2.37	**2.35**	2.36	**2.36**	2.35	**2.35**	2.34	**2.32**	2.30	**2.29**	2.27	**2.25**	2.24	**2.24**	2.23	**2.22**	2.22	**2.22**	2.22	4.20	1.23
10. *C. torulosa*	**2.48**	2.45	**2.42**	2.42	**2.42**	2.42	**2.41**	2.42	**2.40**	2.40	**2.39**	2.40	**2.39**	2.38	**2.37**	2.35	**2.36**	2.34	**2.33**	2.31	**2.31**	2.31	**2.30**	2.29	**2.29**	2.30	4.31	1.20
11. *E. propinqua*	**1.66**	1.64	**1.62**	1.62	**1.61**	1.60	**1.60**	1.59	**1.59**	1.58	**1.57**	1.57	**1.55**	1.55	**1.55**	1.53	**1.53**	1.52	**1.51**	1.50	**1.50**	1.49	**1.49**	1.48	**1.48**	1.48	3.24	1.08
12. *E. tessellaris*	**1.41**	1.40	**1.39**	1.38	**1.38**	1.38	**1.38**	1.38	**1.37**	1.37	**1.37**	1.37	**1.36**	1.36	**1.36**	1.36	**1.36**	1.35	**1.35**	1.35	**1.35**	1.35	**1.35**	1.35	**1.35**	1.34	2.71	1.08
13. *E. tricarpa*	**1.14**	1.13	**1.12**	1.13	**1.13**	1.13	**1.12**	1.13	**1.12**	1.12	**1.12**	1.12	**1.12**	1.12	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	2.45	1.04
14. *F. benghalensis*	**3.72**	3.68	**3.66**	3.65	**3.63**	3.62	**3.61**	3.62	**3.59**	3.59	**3.57**	3.58	**3.56**	3.55	**3.54**	3.50	**3.49**	3.49	**3.49**	3.46	**3.48**	3.45	**3.45**	3.42	**3.40**	3.40	5.82	1.24
15. *F. benjamina*	**2.21**	2.20	**2.19**	2.18	**2.19**	2.18	**2.19**	2.18	**2.18**	2.18	**2.17**	2.16	**2.16**	2.14	**2.14**	2.12	**2.11**	2.10	**2.10**	2.09	**2.09**	2.09	**2.08**	2.08	**2.07**	2.06	4.09	1.15
16. *F. microcarpa*	**3.04**	3.00	**2.98**	2.97	**2.97**	2.96	**2.96**	2.96	**2.95**	2.95	**2.94**	2.93	**2.92**	2.92	**2.90**	2.88	**2.86**	2.83	**2.83**	2.81	**2.81**	2.79	**2.79**	2.79	**2.78**	2.77	4.66	1.30
17. *F. rubiginosa*	**2.10**	2.09	**2.08**	2.08	**2.08**	2.08	**2.08**	2.08	**2.07**	2.07	**2.06**	2.06	**2.05**	2.04	**2.03**	2.03	**2.03**	2.02	**2.03**	2.02	**2.02**	2.02	**2.01**	2.01	**2.01**	1.99	3.66	1.21
18. *G. robusta*	**1.65**	1.62	**1.59**	1.59	**1.59**	1.58	**1.58**	1.57	**1.56**	1.55	**1.55**	1.55	**1.54**	1.53	**1.52**	1.51	**1.50**	1.49	**1.48**	1.47	**1.47**	1.47	**1.46**	1.46	**1.46**	1.45	3.13	1.14
19. *M. indica*	**2.47**	2.44	**2.41**	2.41	**2.41**	2.40	**2.40**	2.40	**2.40**	2.38	**2.37**	2.37	**2.35**	2.35	**2.34**	2.32	**2.30**	2.30	**2.29**	2.29	**2.30**	2.29	**2.29**	2.28	**2.28**	2.28	4.17	1.24
20. *M. quinquenervia*	**1.49**	1.48	**1.46**	1.46	**1.46**	1.46	**1.45**	1.45	**1.45**	1.44	**1.44**	1.44	**1.44**	1.43	**1.43**	1.41	**1.41**	1.40	**1.39**	1.39	**1.39**	1.39	**1.38**	1.38	**1.38**	1.38	2.96	1.11
21. *T. catappa*	**2.04**	2.05	**2.05**	2.04	**2.04**	2.04	**2.03**	2.04	**2.03**	2.02	**2.01**	2.01	**1.99**	1.98	**1.97**	1.95	**1.94**	1.93	**1.93**	1.93	**1.92**	1.93	**1.93**	1.93	**1.92**	1.92	3.73	1.18

Table 5: Annual UPF of all tree canopies calculated for each of 26 city locations (Figure 1) Bamaga (−10.890°S,142.389°E) through to Southport (−27.973°S, 153.418° E). Maximum and minimum annual UPF (range) evaluated across all cities is also included for each tree canopy.

Tree	**Ba**	Lo	**Ho**	Co	**Wu**	PD	**Ca**	Ya	**Tu**	In	**To**	Ay	**Pr**	Mk	**Mo**	Ye	**Gl**	Bu	**Ma**	Gy	**Te**	Mr	**Cb**	Br	**Cl**	So	max	min
1. *A. alexandrae*	**1.09**	1.09	**1.08**	1.08	**1.08**	1.08	**1.08**	1.08	**1.08**	1.07	**1.07**	1.07	**1.07**	1.07	**1.06**	1.06	**1.06**	1.06	**1.05**	1.05	**1.05**	1.05	**1.05**	1.05	**1.05**	1.05	2.00	1.03
2. *A. bidwillii*	**1.98**	1.98	**1.95**	1.95	**1.94**	1.94	**1.94**	1.94	**1.92**	1.92	**1.91**	1.91	**1.90**	1.90	**1.89**	1.88	**1.87**	1.86	**1.85**	1.85	**1.84**	1.84	**1.84**	1.83	**1.83**	1.83	3.19	1.27
3. *A. cunninghamii*	**1.65**	1.64	**1.62**	1.62	**1.61**	1.61	**1.60**	1.60	**1.59**	1.59	**1.58**	1.58	**1.57**	1.56	**1.55**	1.54	**1.54**	1.52	**1.52**	1.51	**1.51**	1.51	**1.50**	1.50	**1.49**	1.49	2.73	1.18
4. *A. heterophylla*	**1.40**	1.39	**1.38**	1.38	**1.37**	1.37	**1.37**	1.37	**1.36**	1.36	**1.35**	1.35	**1.34**	1.34	**1.33**	1.32	**1.32**	1.31	**1.31**	1.30	**1.30**	1.30	**1.30**	1.30	**1.30**	1.29	2.41	1.12
5. *A. saman*	**2.54**	2.52	**2.50**	2.50	**2.50**	2.50	**2.50**	2.50	**2.49**	2.48	**2.48**	2.48	**2.47**	2.47	**2.47**	2.46	**2.45**	2.45	**2.45**	2.44	**2.43**	2.43	**2.42**	2.42	**2.41**	2.41	3.83	1.35
6. *A. saman*	**1.69**	1.68	**1.67**	1.67	**1.67**	1.66	**1.66**	1.66	**1.66**	1.66	**1.66**	1.65	**1.65**	1.64	**1.64**	1.63	**1.62**	1.62	**1.62**	1.62	**1.62**	1.62	**1.61**	1.61	**1.61**	1.61	2.95	1.19
7. *C. camphora*	**1.93**	1.94	**1.91**	1.92	**1.92**	1.91	**1.92**	1.92	**1.90**	1.90	**1.90**	1.90	**1.89**	1.89	**1.88**	1.88	**1.87**	1.87	**1.86**	1.86	**1.86**	1.86	**1.85**	1.85	**1.86**	1.86	3.18	1.25
8. *C. equisetifolia*	**1.75**	1.74	**1.73**	1.73	**1.73**	1.73	**1.72**	1.72	**1.71**	1.71	**1.71**	1.71	**1.70**	1.70	**1.70**	1.70	**1.70**	1.69	**1.69**	1.68	**1.69**	1.69	**1.69**	1.69	**1.69**	1.68	2.96	1.14
9. *C. torulosa*	**2.19**	2.19	**2.17**	2.17	**2.17**	2.17	**2.17**	2.17	**2.16**	2.16	**2.16**	2.16	**2.15**	2.14	**2.13**	2.12	**2.11**	2.09	**2.08**	2.07	**2.07**	2.07	**2.06**	2.06	**2.06**	2.06	3.60	1.27
10. *C. torulosa*	**2.26**	2.24	**2.22**	2.22	**2.22**	2.22	**2.21**	2.21	**2.20**	2.20	**2.20**	2.20	**2.19**	2.19	**2.18**	2.16	**2.17**	2.15	**2.15**	2.14	**2.14**	2.13	**2.13**	2.12	**2.12**	2.12	3.69	1.24
11. *E. propinqua*	**1.56**	1.55	**1.53**	1.53	**1.53**	1.52	**1.52**	1.52	**1.51**	1.51	**1.50**	1.50	**1.49**	1.48	**1.48**	1.47	**1.47**	1.46	**1.46**	1.45	**1.45**	1.45	**1.44**	1.44	**1.44**	1.43	2.77	1.10
12. *E. tessellaris*	**1.34**	1.34	**1.33**	1.33	**1.33**	1.33	**1.33**	1.33	**1.32**	1.32	**1.32**	1.32	**1.31**	1.31	**1.31**	1.31	**1.31**	1.31	**1.30**	1.30	**1.30**	1.30	**1.30**	1.30	**1.30**	1.30	2.32	1.10
13. *E. tricarpa*	**1.12**	1.12	**1.11**	1.12	**1.12**	1.12	**1.11**	1.12	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.11**	1.11	**1.10**	1.11	**1.10**	1.10	**1.10**	1.10	**1.10**	1.10	2.10	1.05
14. *F. benghalensis*	**3.26**	3.22	**3.21**	3.20	**3.19**	3.18	**3.17**	3.18	**3.16**	3.16	**3.15**	3.15	**3.14**	3.13	**3.12**	3.10	**3.08**	3.08	**3.08**	3.06	**3.08**	3.05	**3.05**	3.03	**3.02**	3.02	4.98	1.30
15. *F. benjamina*	**2.00**	2.00	**1.99**	1.99	**1.99**	1.99	**1.99**	1.99	**1.99**	1.99	**1.98**	1.97	**1.97**	1.96	**1.95**	1.94	**1.93**	1.93	**1.93**	1.92	**1.92**	1.92	**1.91**	1.91	**1.91**	1.90	3.49	1.18
16. *F. microcarpa*	**2.73**	2.70	**2.68**	2.68	**2.67**	2.67	**2.67**	2.67	**2.66**	2.66	**2.65**	2.65	**2.64**	2.63	**2.62**	2.61	**2.59**	2.58	**2.57**	2.56	**2.55**	2.55	**2.54**	2.54	**2.54**	2.53	3.99	1.37
17. *F. rubiginosa*	**1.94**	1.93	**1.93**	1.92	**1.92**	1.92	**1.92**	1.92	**1.92**	1.92	**1.91**	1.91	**1.90**	1.90	**1.89**	1.89	**1.89**	1.88	**1.89**	1.88	**1.88**	1.88	**1.88**	1.88	**1.87**	1.86	3.13	1.25
18. *G. robusta*	**1.56**	1.54	**1.53**	1.52	**1.52**	1.52	**1.51**	1.51	**1.50**	1.50	**1.49**	1.49	**1.48**	1.48	**1.47**	1.46	**1.46**	1.45	**1.45**	1.44	**1.44**	1.44	**1.43**	1.43	**1.43**	1.42	2.68	1.17
19. *M. indica*	**2.25**	2.23	**2.20**	2.20	**2.20**	2.20	**2.20**	2.20	**2.19**	2.18	**2.18**	2.17	**2.16**	2.16	**2.15**	2.13	**2.12**	2.12	**2.12**	2.12	**2.12**	2.12	**2.11**	2.11	**2.11**	2.11	3.57	1.29
20. *M. quinquenervia*	**1.42**	1.42	**1.41**	1.41	**1.40**	1.40	**1.40**	1.40	**1.39**	1.39	**1.39**	1.39	**1.39**	1.38	**1.38**	1.37	**1.37**	1.36	**1.35**	1.35	**1.35**	1.35	**1.35**	1.35	**1.35**	1.34	2.53	1.13
21. *T. catappa*	**1.88**	1.89	**1.89**	1.89	**1.88**	1.88	**1.88**	1.88	**1.87**	1.87	**1.86**	1.86	**1.85**	1.84	**1.83**	1.82	**1.81**	1.80	**1.80**	1.80	**1.80**	1.80	**1.80**	1.80	**1.80**	1.80	3.19	1.21

Table 6: Top 10 survey trees for ultraviolet protection for Queensland cities listed in ascending order of annual average SPI.

City	1	2	3	4	5	6	7	8	9	10
Bamaga	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Lockhart River	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	7. C. camphora	17. F. rubiginosa
Hope Vale	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Cooktown	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Wujul Wujul	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Port Douglas	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Cairns	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Yarrabah	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	2. A. bidwillii	17. F. rubiginosa	7. C. camphora
Tully	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	2. A. bidwillii	7. C. camphora
Ingham	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Townsville	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Ayr	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Proserpine	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Mackay	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Moranbah	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Yeppoon	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Gladstone	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Bundaberg	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Maryborough	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Gympie	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Tewantin	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Maroochydore	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Caboolture	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Brisbane	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Cleveland	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii
Southport	14. F. benghalensis	16. F. microcarpa	5. A. saman	10. C. torulosa	19. M. indica	9. C. torulosa	15. F. benjamina	17. F. rubiginosa	7. C. camphora	2. A. bidwillii