

IT ISN'T ROCKET SCIENCE. STREET TREES CAN MAKE A DIFFERENCE IN CLIMATE CHANGE!

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Abstract

For decades we have been listening to ordinary Australians saying that there is nothing that they can do about climate change. They argue that Australia with its small population is not really significant in the grand scale of global climate change and politics. But what we do affects not just a country but a whole continent and that is significant globally! During Covid-19 lockdowns, public green space showed its real value in terms of human physical and mental health, and overall well-being. The same is likely to be true of the worth of treed public open space during climate change.

So for those of us who are not interested in the ideology and point-scoring associated with climate change, there are lots of things that can be done to ease both frustration at inaction and disappointment at political reaction. Ordinary citizens can do things that will make a difference to the places and communities where they live, but urban forest professionals have much to offer. For those involved in managing trees, when I am asked, "What can we do about climate change?" my response is "If we don't or can't make a difference then who can?"

Introduction

For decades people have been reading about, listening to and watching ordinary Australians saying that there is nothing that they can do about climate change. They argue that Australia with its small population is not really significant in the grand scale of global climate change and politics. They argue that the national contribution to emissions when compared to other larger nations is insignificant and that anything done to reduce emissions is tokenism and conclude that nothing they can do will make a difference (Moore 2020a). But this is untrue at many levels.

The population, at over 25 million, is not as small as many Australians think and *per capita* Australians are among the highest contributors to green house gas emissions: residents of some States more so than others. Australians represent about 0.3% of the world's population and produce about 1.07% of the world's emissions (Department of Industry 2019). Furthermore, what Australians do affects not just a country but a whole continent and that is significant globally! What many people fail to grasp is that scientists have been giving warnings about climate change for 20-30 years and had hoped, or perhaps expected, that over time steps could be taken locally, as well as globally to reduce or minimise the adverse effects of climate change.

Applied scientists specialising in horticulture and arboriculture, have engaged with students about climate change since the 1980s, with a view to preparing them for the world in which they would work during their careers. Applied scientists are practical people working in the real world with the aim of solving problems and improving everyday lives. Most are not involved in party politics, but they are interested in doing things well, being efficient and saving society unnecessary expenditure. The notion that if you do nothing about climate change it costs you nothing is nonsense – doing nothing costs you now, but ensures costs will be higher in the future. It is the transfer of a significant financial and economic liability to the future.

It is curious that when Australians talk about climate change, it becomes apparent that most are aware of the predictions of warmer weather and possibly lower rainfall. There is indeed a strong likelihood that there will be 20% more drought months in many parts of Australia, but not necessarily in all (CSIRO 2015). However, most Australians seem to be unaware that for a huge continent like Australia, the effects will vary in different parts of the country and so generalising can be dangerously difficult. In parts of Australia, such as Sydney there could be an increase in hailstorm events and increased hailstone size, while in Melbourne there are likely to be fewer hail events. Depending on the type and age of a roof hailstones of 5cm can crack older tiles, while 7cm will crack newer tiles in good condition and 10cm hailstones can damage corrugated steel roofing (Snow and Prasad 2011).

Few Australians seem to be aware of predictions of heavier rainfall events in drier months which compound the effect of a lowered rainfall or the increased likelihood of flash flooding.

There is also the risk and likelihood of some coastal inundation as sea levels rise by up to 15cm by 2030-50, which could exacerbate higher local flooding levels in rivers near their mouths.

It is also curious that Australians seem to be unaware that trees are essential parts of urban infrastructure and have always been important to human health and well being (Table 1). There are many studies on the positive benefits that trees provide for physical and mental health, but the presence of trees correlates with quicker recovery after hospital treatment, better learning outcomes for school students, fewer prescription medicines for residents and even higher average baby birth weights. Contrary to what many people think higher tree density also correlates with lower crime rates – it is often dense shrubbery that is linked to increases in crime. In a major USA study, it was found that women living in and near greenspace had a 12% lower all-cause non accidental mortality and that the biggest decreases were in respiratory and cancer related deaths (James et al. 2016). They concluded that the association with greenness may be mediated by physical activity, removal of particulate matter (PM) and social engagement and that planting may mitigate climate change and improve health (James et al. 2016). Such benefits are not to be taken lightly as they can save society tens of millions of dollars each year. However, they are under-appreciated benefits and as trees are lost from urban landscapes the costs of living in these areas must inevitably increase.

Table 1. Some high value social and medical benefits correlated with higher tree canopy cover that are typically under-appreciated

Lower heatwave related rates of mortality	Higher average baby birth weights
Lower overall crime rates	Better learning outcomes for students
Quicker recovery after hospital treatment	Fewer prescription medicines for residents
Reduced social disadvantage	May reduce self-harm and suicide rates
Increased human resilience under stress	May reduce domestic violence
Longer life spans for residents	Higher levels of resident general health
Improved mental and physical health in aged care facilities	Longer life spans in aged care facilities

This paper is not about the divisive, ideological and wedging politics related to climate change, but rather some of the simple and logical things that people could do to: make a difference, save some money and ultimately save lives. In particular, it begins by considering what typical Australians might do to cope with a changed climate and then addresses the role that trees have in mitigating some of the effects of climate change and in allowing people to cope with the inevitable changes to climate that are coming. There must be leadership from urban forest managers and engagement with the wider community if the potential benefits that trees and green space provide are to be

The times and Climates they are a changing

The models of climate change affecting many Australian cities suggest warmer and drier weather conditions. They also suggest that when it does rain in some cities, the downpours will be heavier and in the warmer months of the year so the effective precipitation will be even lower than the lowered rainfall averages. The higher temperatures don't just mean warmer days. The higher temperatures indicate that there is more energy in weather systems and so there will be stronger winds and more violent storms. It also means that cyclones are more likely to occur further south in Australia (further north in the Northern hemisphere) than was previously the case in the history of such events.

So what are some of the things that people might have to confront in relation to their homes and increased wind speeds (Snow and Prasad 2011)(Table 2)? How well are the tiles fixed to the roof? Is it one in four, one in six or perhaps one in eight tiles that are fixed to the battens? Are the iron sheets and cladding attached with appropriate screws? Should every tile be fixed and the batten timbers be of a stronger grade to cope with stronger and more frequent storms? Similarly, are the roadside signs, billboards, utility poles and rooftop structures strong enough to withstand such storms? Should the foundations be larger, supporting structures made of stronger steel and the attachment fixtures, such as nuts and bolts be stronger (Snow and Prasad 2011)?

Fortunately, these are the responsibility of other professions, but some of the concerns are shared. Such changes are efficiently and relatively cheaply made as part of routine maintenance and scheduled replacement programs, but if changes have to be made all at once after a fatality or major failure, it will cost millions of dollars.

This is really starting to get to the nuts and bolts of climate change. Given advanced warning changes can be made over a long period of time, spreading the cost and maximising efficiency. This is certainly true of maintaining, defending and expanding the urban forest. Increasing the canopy cover of urban vegetation inevitably takes time – sometimes decades. By failing to make the most of the time provided by early warnings, every Australian citizen will bear a greater cost. By failing to make the most of the past twenty or more years, the economic costs of climate change have been hand-balled unfairly to future generations.

As global temperatures rise, people often say that there is nothing they can do because it is a global problem. This is untrue. One of the simplest things that can be done is to make sure that there is adequate tree canopy cover. The urban heat island (UHI) effect causes increased urban temperatures, but open green space, and particularly tree canopy cover and the shade it provides, can reduce temperatures. So more greenspace and tree cover in a city is a simple and effective way of reducing city temperature. Temperatures will also rise in rural towns and regional centres and canopy cover will be as important there, if not more so, than in larger cities. The appropriateness and wisdom of high density housing development in rural Australia for liveability and sustainability must be questioned under climate change scenarios.

Table 2. Some general (Snow and Prasad 2011) and tree/plant climate related actions that home owners might undertake.

Tree/plant related actions	General actions
Plant two medium sized trees (8-10m) to the north or north west of homes for shade	Consider the orientation of the dwelling at construction and the use of verandahs
At least 40% of domestic block allocated to green, preferably treed, private open space	Properly sealed and insulated homes to reduce energy and electricity consumption
Use of evergreen and deciduous trees for summer shade and winter access to light	Stronger fixtures used to secure roof and other structures against stronger winds
Presence of trees to ameliorate against wind and reduce UHI effect	Double glazing at construction for insulation reduced energy consumption and wind protection
Provide treed private green space to absorb storm water and reduce local flooding	Have a fire plan that includes both dwelling and garden components
In fire prone districts plant fire resistant /retardant species in a fire smart garden	Collect/recycle water as a back up system that provides water for treed private greenspace
Plant and design the garden to redirect water from the house and so avoid local flood damage	In constructing decking have stronger foundations so it can be roofed to provide shade if needed
Plant trees along urban waterways to slow flood fronts and reduce erosion where a wider flood front will not cause damage	Capture natural ventilation such as roof ventilators and possible green roof applications
Where appropriate consider planting trees as a protection against large hailstorm events	Use solar and/or wind powered cooling/heating systems,

The vital role of tree in coping with climate change

Homes must be designed to cater for their orientation to the sun allowing access to winter sun and light, and protection from the hot summer sun. Are homes insulated and sealed to keep them cooler in summer and more energy efficient in winter? These are cheap and easy to do at construction, but cost thousands of dollars to retrofit (Snow and Prasad 2011). Of course, trees have a role to play around homes in providing summer shade and by using deciduous species allowing winter light to penetrate, but they need space and time to grow. Has the most been made of the time that the warnings of climate science have given?

Sadly, despite knowing the value of tree canopy cover in reducing UHI, in most Australian cities canopy cover is declining (Moore 2015). In Melbourne, the loss was at a rate of 1-1.5% per annum, due to the removal of trees on private land – front and back yards - for more intense housing development (Moore 2019). Studies from North American cities have also identified that private development could lead to an annual 1% decrease in urban tree canopy cover area above private land (Hurley et al. 2019). This can be a serious concern for cities and towns anticipating population increase and future densification.

In more detailed analyses of canopy changes, lower and more subtle rates of canopy loss were reported. Croeser et al. (2020) found a 1% decrease in Melbourne canopy over eight years due to the churning of trees on public land. Older, bigger trees were lost near development sites but were compensated for by new plantings. Furthermore, many of the trees lost were relatively young specimens, which threatens achieving future canopy cover targets (Table 3). Other studies have found that different regions or sectors within a city show rise and falls in canopy cover, but the overall trend is a reduction (Hurley et al. 2019; McManus 2019).

The subdivision of older dwellings involves the loss of mature trees on private open space, but there is an assumption that these losses will be compensated by street tree planting. However, this is pure fantasy – the large old house and block transforms into four townhouses with four driveways (crossovers) which leave little, if any, space in the nature strip for the planting of trees of sizeable canopy. There is a spiral into further canopy decline. There is insufficient public open space in many Australian municipalities to achieve a 30% tree canopy cover without having a contribution from trees growing on private open space. Ordinary citizens can make a difference by having trees in their front and back yards, which adds canopy cover in private realm and contributes to the services that trees provide.

Table 3. Urban tree canopy loss in different sectors and regions of cities.

Sector	Cover (%)	Decrease/ increase (%)	Net decrease (%)	Period	Notes	Source
Parks	30	<-1.0 decrease	1.0	2008-16	Behind a minor change, there was a churning of young trees, with losses of cover being almost compensated by new cover	Croeser et al. 2020
Streets	15	0.4 increase				
Private	5	0.2 decrease				
CBD	16.5	2.3 decrease	5.7	2008-17	The loss of canopy is due to tree loss on private urban and suburban land	McManus 2019
Urban	32.4	5.6 decrease				
Suburban	39.8	6.8 decrease				
Public Land	50.5	0.5 decrease				
Private Land	31.6	7.5 decrease				
Roads	28.1	4.7 decrease				
Inner	11.8	0.8 increase	0.3	2014-18	Losses and gains with losses in the south and east compensated for by gains in the north and west	Hurley et al. 2019
Inner Sth East	18.3	0.8 decrease				
West	5	0.8 increase				
North	11	0.7 increase				
East	24.9	2.3 decrease				
South	11.7	0.2 decrease				

As urban canopy cover declines, it is staggering that trees are removed because of minor nuisance or infrastructure damage. Trees that have provided ecological and environmental services and substantial economic benefit for decades are removed when they cause damage to infrastructure that could be rectified for a few hundred dollars. Where are the cost-benefit analyses in these cases? Perhaps worse are thoughtless tree removals based on a whim, ignorance or prejudice precipitated when private property changes hands. Private land owners should understand that they too have a responsibility for managing trees for the greater community good.

The health and social benefits of active and passive recreation are well-known and the venues for such activities are normally public open spaces under local government control. It is easy to think that such activities and facilities are likely to bolster urban green space and provide opportunities for greater canopy cover. However, more club rooms, car parks and hard surfaces are seeing a gradual erosion of green space, even within older parks and recreation reserves. Furthermore, with the increase in the demand for sports ovals and pitches, especially with the massive increases in women's sport, there is enormous pressure on public open space to remove trees for more playing surfaces and to build facilities. This is not an argument against fostering greater participation in active and passive recreation, but rather a concern that there does not seem to be any strategy for increasing or even preserving open green space in light of these pressures and the demands of climate change. How is it possible given rising temperatures that state planning laws continue to ignore the value of trees and open space so that we are losing them from our cities at the very time we need them most?

It is not only the shade that the trees and green space provide that keeps the environment cooler. Trees take up water from the soil and release it to the atmosphere in the process of transpiration. Evapotranspiration not only cools trees, but also the air and environment around them, provided there is sufficient soil moisture for stomata to remain open. Trees do need water and at times of drought many people think that trees should not be irrigated. However, their shade and cooling means that soils do not dry as quickly and that air temperatures are lower and so in many ways trees efficiently use the water that is provided. Transpirational cooling can make a difference of 1-2°C during a heat wave which can be significant in reducing its effects on vulnerable members of a community.

Trees also mitigate the impact of winds, but which are the best species to plant and the best places to plant so that they afford the greatest protection of homes. In a Canadian Study, removing all the trees around homes resulted in a doubling of wind speed and increased wind pressure that is responsible for up to a third of a building's energy consumption. Removing all the trees around buildings can increase a building's energy consumption by up to 10% in winter and 15% in summer. Bare branches play a role so deciduous trees also reduce pressure loading on buildings year round – it's not only evergreens that are important (Giometto et al. 2017).

Bitumen is widely used in roads, footpaths and carparks and contributes to the urban heat island (UHI) effect. In the hot Australian sun the solvents that bind the asphalt eventually evaporate, leaving the surface crumbly and needing re-surfacing. Shade from trees of roads, footpaths and carparks can prolong the life of bitumen by up to 2-3 times (Moore 2016), which can save millions of dollars in re-surfacing costs for a tree-lined suburban street or a well-shaded shopping centre car park (Table 4). The shade also reduces the UHI, improves driver humour on a hot day and keeps cars cooler while people shop (Wolf 2003; Watson 2007). The presence of trees in shopping centres encourages more shoppers, particularly in the warmer months of the year and so retailers should be wary of demanding more car parks at the cost of street trees as their businesses can suffer (Wolf 2003). It is a simple and easy step to plant trees and provide shade and the benefits can keep coming for a century or more.

Trees around homes and buildings can act as insulators. Deciduous trees planted in the right places can allow winter access to sun and light and provide proper shade and cooling in summer. It is well-known that trees can cool homes by up to 6°C during warm weather, but they can also keep gardens around homes warmer during winter frosts. While trees have been found to keep temperatures cooler in winter in studies undertaken in the northern hemisphere, which is a negative impact of trees and adds to household costs (i-Tree Eco n.d), anecdotally it is observed that treed gardens around homes in rural Australia are often unaffected by frosts which damage surrounding paddocks. Trees can contribute to a general warming of up to 1°C during winter nights. There is a need for Australian research on this topic, as it affects the accuracy of the calculations of the value of ecosystems services provided by trees in programs such as i-Tree.

Table 4. Benefits of tree-shaded shopping centre car parks.

Benefits for shopping centres owners	Environmental benefits
Attract new shoppers who value their cars will be protected from sun damage/heat	Reduced stormwater runoff if roots systems have access to water
Maintaining shopper loyalty	Reduced levels of pollution
Keeping shoppers at the centre longer	Carbon sequestered
Increasing the street appeal of the centre	Lower urban heat island effects (UHI)
Decreasing tenant vacancies	Improved air quality
Willingness to spend more for products	Extended life of bitumen
More frequent shopping visits	Moderation/reduction of wind speeds
Extended life of bitumen	Reduced vehicle hydrocarbons emissions

Heatwaves are the biggest killers of people of all natural disasters. In the Victorian black Saturday fires of 2009, 173 people were tragically killed in the fires, but 374 people died of heat-related causes during the heatwave surrounding that Saturday. Hundreds of people have died in heatwaves since and the easiest, least costly and most sustainable way of cooling cities and towns is by increasing the green space and tree canopy, but it is not being done.

During the summer of 2019-20 as bushfires raged in many parts of Australia, several cities experienced high levels of particulate matter (PM) pollution from the resulting smoke. It came as a surprise to many Australians that cities, such as Sydney, Melbourne and Canberra had for several consecutive days the world's poorest air quality. Trees are important contributors to improved urban air quality by filtering chemical and PM pollution from the air (Moore 2017). Both deciduous and evergreen species make their contribution, which is often overlooked when people are considering benefits provided by urban trees. How often does the much-criticised London plane (*Platanus x acerfolia*) get recognition for its capacity to remove PM from air? The tree can cause irritation at certain times of the year, usually for short periods, but is this cost justified in terms of the benefits that the species provides?

As it gets hotter, there will be an increase in extremely hot days; a doubling in days above 40°C in some cities. Air conditioners will be increasingly used just to make homes liveable. This not only increases our electricity consumption, but in most places expands our carbon footprint. With electricity prices soaring, it also adds significantly to family fuel bills. Two medium-sized trees (8-10m tall) strategically placed to the north and/or north-west of you home can reduce the temperature inside your home by several degrees and save you in excess of AUD\$200 per year from your air conditioning/electricity bill. Incidentally, they will also sequester carbon and extend the life of the paint on your external walls.

COVID-19 LESSONS FOR CLIMATE CHANGE

It has been fascinating to watch the use of public open space during the various stages of Covid-19 lockdowns. The lockdowns precipitated significant public and high level political or bureaucratic concerns about peoples' physical health, their capacity for coping with the stressful situation in which many found themselves and the increased risks of self harm and domestic violence (James et al. 2016). There were also concerns about the learning environments for students at all levels of education and the potential development issues for pre-schoolers. The crisis also focused a critical light on aged care facilities, where the importance of plants and trees in improving the quality and lengthening the stay for residents is well known – so well known that it has been used as a piece of black humour in public talks for some audiences for over a quarter of a century (Table 5). If ever there was a time when the importance of treed public open space for human mental and physical health and general well-being came to the fore this was it.

Table 5. Trees, business models and choosing an aged care or retirement facility.

<p>Setting the scene</p>	<p>In a meeting room or public hall. A talk is to be given on <i>The value of Trees, The trees in your garden</i> or perhaps <i>How to look after your Trees</i>. There is an audience of between 20 and 70: a majority are women and many are over 60 years of age. The audience is asked if they would like some tree related advice in choosing a retirement village or aged care facility. They are warned that there is a bit of black humour coming their way, but they always indicate that they are keen to continue</p>
<p>Telling the story</p>	<p>If you family takes you to inspect a prospective retirement village or aged care facility look for the trees as there are three scenarios to consider:</p> <ol style="list-style-type: none"> 1) The first facility is all brick, tiles and carpet, but not a tree in sight. This facility runs on a rapid through put business model as they know that folks don't last long in a place without trees. They make their profit by a rapid turnover of residents. Unless you have a death wish, get out of there as fast as you can. 2) The second facility is not quite so flash but the trees and gardens are great. This facility makes its profit through the long term occupancy of residents and they know that their trees and gardens improve the longevity and quality of life of their residents. You can add this one to your list for consideration. 3) The third facility is the same as the second, but when you get there, the chainsaws are running and they are removing trees and digging up the gardens for their building expansion program. Clearly, they have changed their business model so make a dash for it!
<p>The result</p>	<p>The audience chuckle, there is a little unease, but the point is made that trees are vital to human health and well-being</p>

With active recreation postponed, passive recreation by walking, jogging and cycling became the major physical activity with local parks and walking tracks packed. However, not every suburb or every region is well served by treed open space. It is well-known that the most impoverished sectors of societies are the most disadvantaged in their access to and use of treed open space, which in turn is associated with problems such as obesity, poor physical and mental health and social disadvantage (De Vries et al. 2003; Gies 2006; Maas et al. 2006; MacIntyre et al. 2008; Butler 2016; Braubach et al. 2017; Lamb et al. 2019). During Covid-19 lockdowns, it is highly likely that the most disadvantaged members of the community were further disadvantaged and subjected to higher levels of stress, because of a lack of accessible treed open space. There is evidence that greater health benefits may accrue to disadvantaged sectors of communities from the provision and use of treed open space and that its provision could be a mechanism for addressing social inequality (Gies 2006; Braubach et al. 2017; Moore 2020b).

It is also worth noting that the provision of treed open space meets some basic human physical, mental and psychological health needs that have their origins in the impact of locomotion on human evolutionary development (Lewis 2010; Wilkinson 2016). Navigating through a large and connected greenspace engages many senses –sight, hearing, smell, and perhaps taste and touch - at once, which activates various parts of the brain and hones a suite of spatial problem solving skills. Finding your way requires purpose, planning and patience as well as a knowledge of the space and perhaps memory if you have travelled there before. Such an activity is multi-tasking *par excellence*, but can only be achieved in a large and biologically complex space. All of these experiences facilitate full human development from infancy to adulthood (Lewis 2010). There are also the possibilities of activities that place such a demand on people that the brains' many dopamine secreting neurones are stimulated impacting on motivation, attention and persistence (Wilkinson 2016).

There are lessons to be learnt from the use of streets and public open space for passive recreation during the Covid-19 pandemic. The lockdowns commenced during early autumn, but what would have happened if they had occurred during summer (or continue into the summer of 2020-1)?

The importance of trees in providing shade would have been greater over summer months and while there may be sufficient in some parks and linear reserves can the same be said of suburban and urban streets? Anything which leads to a reduction in canopy cover may come at a price which involves greater risks of skin cancer and melanoma or a reduction in recreational activity with all of its associated health risks. What this reveals is the need to have a more thorough, or perhaps realistic, cost:benefit analysis in terms of retaining and increasing canopy cover and those factors driving its reduction.

Public open spaces have served their purpose admirably during Covid-19 lockdowns and given the opportunity and with proper planning they will do so again in enabling cities to cope with climate change. However, if cities and suburbs keep losing open space, green space and canopy cover then their capacity will be restricted and society as a whole will be the loser. There is also genuine concern that in the tight economic circumstances that will follow Covid-19, one of the first areas to be subjected to expenditure reduction will be parks, gardens and greenspace. The reason for voicing such a fear is because there is a history of such cuts in the past by those who do not understand the value of green infrastructure. By raising an alert now, perhaps such a short-sighted outcome can be avoided.

Town or country, climate change is the same: Trees are essential

In rural and regional Australia, planning and planting on a regional level can be as effective as increasing tree canopy cover in a city in mitigating some of the worst effects of climate change. The impacts of stronger winds can be reduced and the value of shade enhanced by the preservation of remnant vegetation and by revegetating less productive land. Planting along creeks and rivers can lower water temperatures, facilitate the success of native fish, which are highly temperature sensitive and reduce silting of creeks and catchments by minimising the erosion of river banks. There are benefits too from a greater canopy cover for increased farm production and reduced windblown soil erosion during drought. Planting trees along waterways can slow flood water fronts and reduce erosion, provided there is sufficient room for a widened flood front so that there is not increase in flood damage.

In both urban and rural Australia, while in many places annual rainfall will diminish, when it does rain, the rainfall events will be heavier increasing the risk of localised flash flooding and erosion. Current stormwater systems and pipes in cities and larger regional centres will not be large enough to accommodate these volumes of stormwater run-off, and the cost of retro-fitting larger pipes is prohibitive. Trees are a great way of mitigating the likelihood of flash flooding as they can hold over 40% of the rain water in their canopies for a time (i-Tree Eco nd; Livesley et al. 2014). Depending on the weather conditions some of this water will never reach the ground but even if it does, it is dispersed over a longer period of time and drains may be able to cope.

Furthermore, if the rainfall can access soils where tree are growing, roots can take up the water and also be part of bio-filtration systems that remove pollutants (Denman 2015). For trees growing on both private and public land to be effective impermeable surfaces such as roads, footpaths and curbing may have to be redesigned to allow the water to get to the tree. This requires a reduction in impermeable surfaces, and reinforces the importance of permeable paving in urban landscapes (Johnson et al. 2019). Some local councils have already installed systems to intercept stormwater and direct it to tree pits and trialled porous pavements, but many have not and the costs of flood damage and erosion can be enormous.

If you are fond of stone fruit, what happens if the cold winters needed for full and efficient stone fruit production and ripening are lost as weather warms? Have growers considered this possibility and commenced growing some of the many alternatives available to them which would minimise personal and societal economic losses. This need not be calamitous change as the range of potential commercially viable alternatives is quite wide. If agricultural and horticultural practices have to change as the climate does, and they will certainly have to change in many parts of Australia, having long lead times will reduce the extent of industry disruption. The notion that doing nothing about climate change doesn't cost individuals or society is simply nonsense.

In relation to bushfires, there have long been predictions of earlier fire seasons, more intense fires, winds bringing fire from different directions and bushfires occurring in places where they hadn't in the past, such as peri-urban parts of major towns and cities. The political response to the 2019-20 fire season is both disappointing and concerning. The fires were described as unprecedented, but this is not the case. There have been many precedents – some this century, but also during the 1900s and 1800s. By describing them as unprecedented, the implication is that they are rare, unusual or worse than normal, but such fires will happen again.

In the aftermath of these fires tens of thousands of trees were felled. Some of the felling was simple opportunism – trees were removed to reduce future maintenance and inspection costs or to access the timber. Some trees were removed because of often unfounded fears that they might represent a future risk frequently without any arboricultural input to such decisions or proper tree risk assessments. In almost all cases the trees were not considered to have any economic value and there was no consideration of the loss of the ecological or environmental services that they were providing.

The political grasping for a simple solution to the bushfires has seen prescribed/control/cool burns linked to indigenous land management practices promulgated as a remedy. These practices have a role in future fire management but they are not a panacea and to think that they are presents some serious problems. Widespread use of cools burns puts ecosystem integrity and biodiversity at risk, but it may have a significant role at interfaces between natural ecosystems and human settlement. As early as the Ash Wednesday fires of 1983, it was learnt that forests that had been prescribed burnt carried crown fires just as unburnt forest did.

Managed burns should only be done on the basis of well-research ecosystem impacts and not by political or bureaucratic prescription. Research must inform whether acceptable fire management regimes of the past are still relevant today as climate changes and present new environmental circumstances. As the opportunities for undertaking managed burns diminish due to climate change, it must be understood that such burns are costly, resource intensive and that it may not be possible to carry out a prescriptive regime in some years due to weather or resource restrictions.

At an arboricultural level, there are some simple things that can be done. Make sure that property owners have a fire plan and that they take some of the simple steps to protect homes and other buildings. Clean gutters, have good gutter guards, consider the appropriateness of wooden decking and install fire resistant windows, doors and fly screens. Fire proof your property as much as possible so that if you evacuate, the buildings have a good chance of surviving the fire. All of these things can be done at the time of construction or over years as part of regular home maintenance, but can be costly if you do them all at once.

Trees and plants also have to be considered as part of you fire plan. In bushfire prone regions of Australia having a fire smart garden is essential. Such a garden reduces fire related risk as some plants will slow the spread of fire and act as excellent ember screens. Something as simple as raking your garden around your house to keep potential fuel away from walls and doors, especially if you have mulched beds, can make a difference to the risk of fire damage, but you have to think of doing it and put it in your fire plan.

Trees, utilities and climate change

Among the recommendations of the Royal Commission into the Victorian, Black Saturday bushfires was the suggestion that utility services should be underground. It was one of the very few recommendations that the government of the day rejected on the basis that it was too costly to implement. But was it really too expensive? If you look at the cost of installation and maintenance over many years, underground systems would be cheaper. The problem in some states is that distribution companies pay for installation and land owners and local councils pay for maintenance and there is no incentive for either party to come together to look for the cheapest long term option. So Australia is left with an ageing above-ground utility infrastructure that is unlikely to cope with climate change

With bushfires, stronger winds, and flooding all likely to increase, it is probable that the nation cannot afford not to go underground. The incentives for underground services in the wake of bushfires and more regular storm damage and outages would seem over-whelmingly strong, but it is not being done. Indeed the usual response to a natural disaster is to replace the utility infrastructure with the same or similar system that existed before the event learning little from the experience. Instead of making changes to utility infrastructure over a period of 40-50 years at relatively low cost as an aging infrastructure was renewed, it will be done in response to a calamity. After all 20-30 of the years over which climate change scientists gave us warnings to prepare for climate change have already gone.

If utility services were placed underground, home owners and local councils will save the cost of pruning trees to provide clearance of cables and other infrastructure.

These costs alone amount to hundreds of millions of dollars *per annum*, but removing the need to prune will also preserve the carbon fixed in the tree canopies and increase the shade and other environmental benefits and services that larger trees provide. In many states, electricity generation adds to the carbon footprint of every citizen and it is ironic that line clearing then compounds things by regularly pruning trees that might offset that carbon production.

Conclusion

For those not interested in the ideology and point-scoring associated with climate change, there are many things that can be done to ease both frustration at inaction and disappointment at political reaction. The stakes are high economically as well as environmentally for if the roles of public greenspace and the urban forest are not understood and appreciated politically, the consequences for human health and well-being will be profound and the cost to society will be massive.

For those involved in managing trees, who are dispirited by the loss of canopy cover and the slowness of recognition of the essential importance of the urban forest, persistence will bring its reward for there is no viable or sustainable alternative. Cities must have open space and trees if they are to be liveable and sustainable! The uncertainty is whether they have them now as part of proactive action in anticipation of climate change at moderate cost or later in response to the demanding consequences of climate change at far greater cost. When they are asked what can be done about climate change, surely the response must be: "If arborists and urban forester don't, won't or can't make a difference then who can?"

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