The Australian Institute of Landscape Architects

Climate Positive Design

Volume 1
Action Plan for Australian Landscape Architects

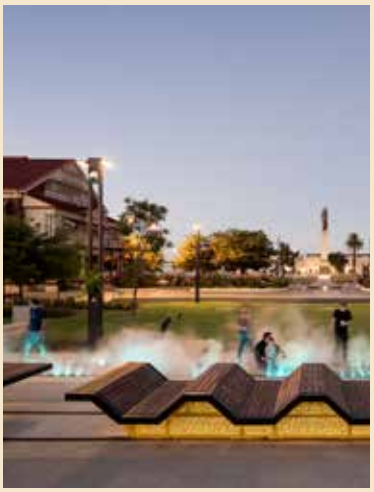
The Australian Institute of Landscape Architects acknowledges and respects Aboriginal and Torres Strait Islander Peoples of Australia, as the Traditional Custodians of our lands, waters, seas and skies.

We recognise their ability to care for Country and their deep spiritual connection with Country.

We honour Elders past and present whose knowledge and wisdom ensure the continuation of Aboriginal and Torres Strait Islander cultures.

AILA's climate positive design series

To help guide your climate positive journey, we have three separate documents, targeting three specific areas of our work and practice.



Your projects

Volume one

Climate positive design action plan for Australian landscape architects

Volume 1 provides clear, simple advice on what Australian landscape architects can do to understand and deliver climate positive design through good planning, design, documentation, construction and renewal.

Your office / business

Volume two

Organisation guide to climate positive

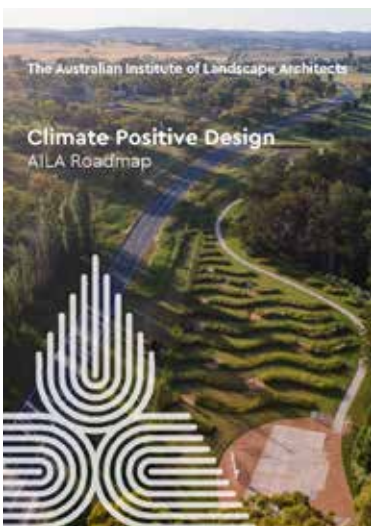
Volume 2 outlines the steps your practice, business or organisation can take to achieve carbon neutral certification and beyond to become climate positive.

Our institute

Volume three

AILA roadmap to delivering climate positive design

Volume 3 sets the framework, guidance and time frames for the AILA Executive and State groups to roll out climate positive design to members, and provide engagement and policy direction.



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O'Dea M, Moggridge B, James Kate, Bond S, Kearney Abi, McEwen Madeleine, Pfeiffer, Amy, Hawken S, Burke B. (2022) Australian Institute of Landscape Architects: Climate positive design action plan for Australian landscape architects.

Tjoritja / West MacDonnell National Park • Larapinta Trail- Ormiston Pound
Photo: Denise Beecroft

Foreword

"The land is a living, breathing entity. If you love the land, it will love you back. It's just the way it's always been..."

The late Archie Roach

Landscape architects are uniquely placed to lead and deliver climate positive design solutions for our planet. We have the ability to sequester more greenhouse gases than our projects emit.

Building upon our climate positive design position statement, this action plan is aimed at providing simple clear guidance and a toolkit for Australian landscape architects towards climate positive outcomes.

The challenge we face is great. As a profession we need to step up to a bigger scale and bring our big picture planning skills to help drive climate action at scales that matter.

We are needed to deliver cool green cities, climate resilient landscapes and beautiful places that foster health and mental wellbeing.

Beyond landscape as amenity, we need to help drive landuse change at an Australia wide level.

This document is focused on what we can do in the built and natural environment to make a substantial difference and be leaders on climate positive design for the public realm.

Version two of this document will include a foreword by AILA's Cultural Ambassadors with additional commentary. A further section on the scales of intervention of Climate Positive Design will also be included in the subsequent revision.

Ben Stockwin

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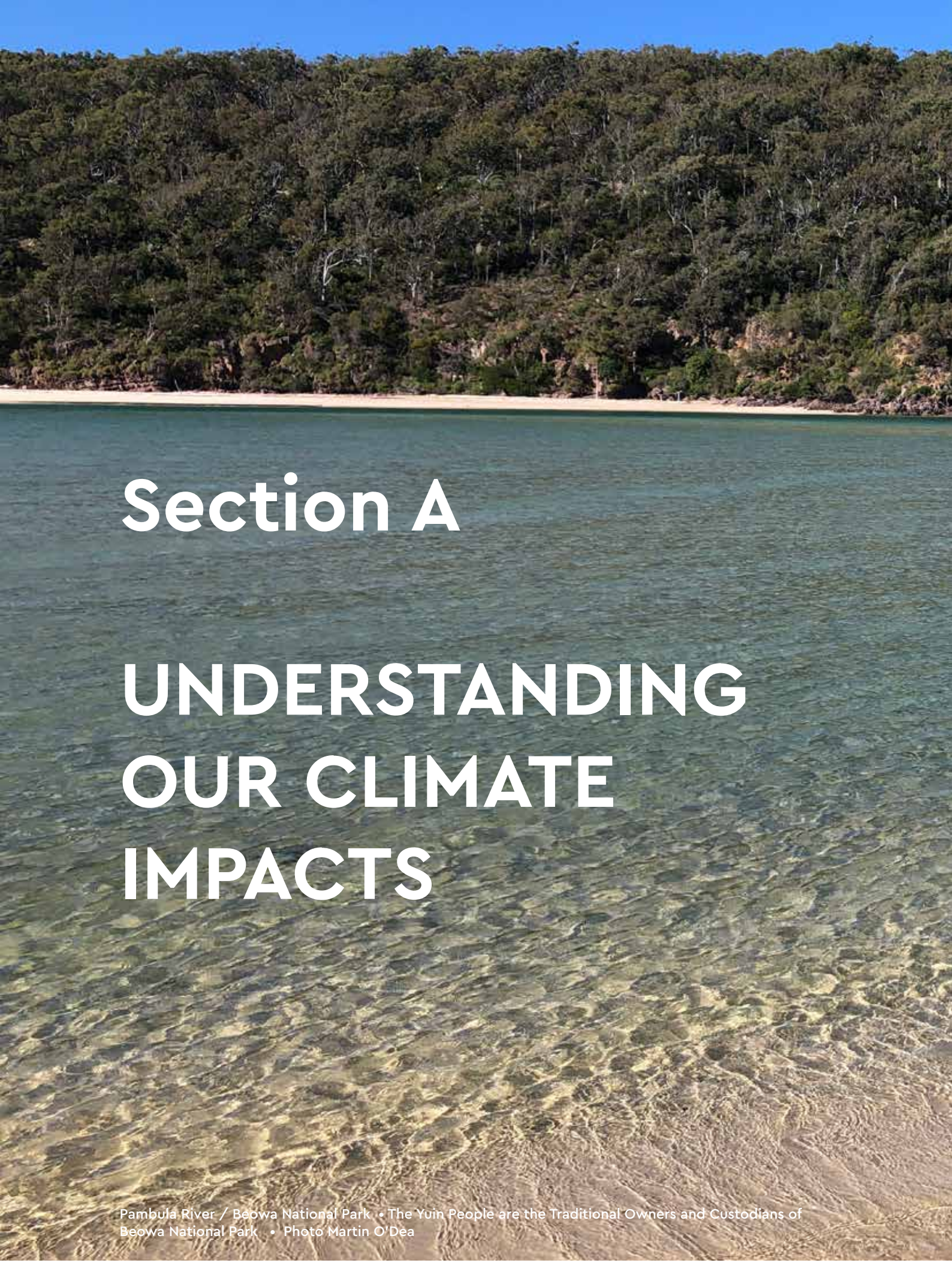
Climate Positive Design Committee Chair

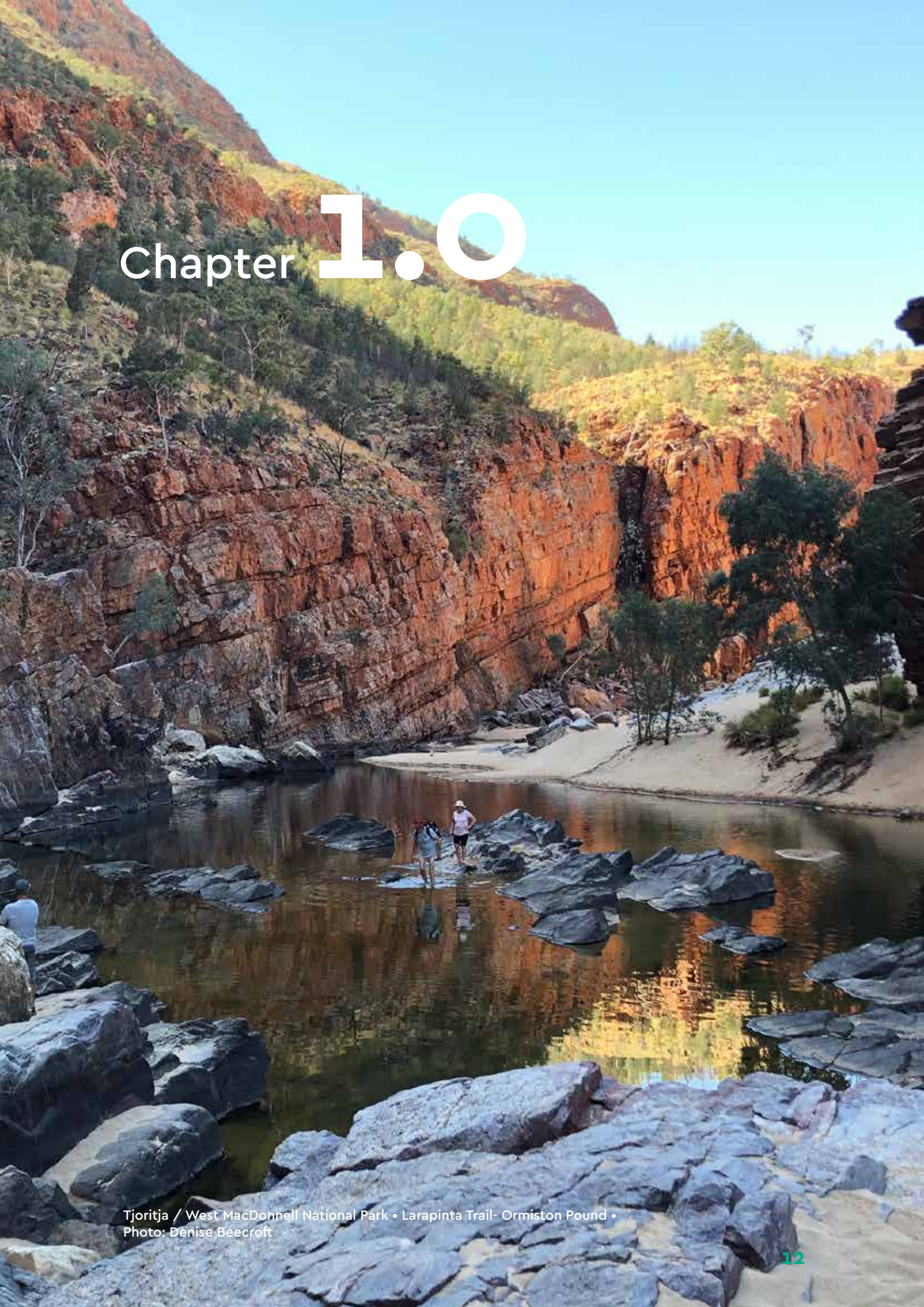


Section A

UNDERSTANDING OUR CLIMATE IMPACTS

Pambula River / Beowa National Park • The Yuin People are the Traditional Owners and Custodians of Beowa National Park • Photo Martin O'Dea

Chapter 1.0



Tjoritja / West MacDonnell National Park • Larapinta Trail- Ormiston Pound • Photo: Denise Beecroft

1.0 Aboriginal and Torres Strait Islander perspective on climate

"Indigenous people with their knowledge are ready to assist in the recovery of Country from the impacts of climate change."

Bradley Moggridge • Kamilaroi Water Scientist

Indigenous people living on the Australian continent have maintained diverse knowledge and connections to their respective traditional Countries for thousands of generations for over 65,000 years.

This knowledge, acquired over those generations, incorporates thousands of years of observations, testing country by ways of knowing and being Indigenous.

This has allowed them to understand, adapt to change, and manage landscapes sustainably to ensure the generations that follow have access to healthy country.

Understanding climate systems and actions based on knowledge to mitigate and then adapt to climate change falls within the lifetime of stories of Indigenous people around Australia.

For example, Nunn and Reid (2016)[1] identified stories linking to 21 Australian locations which tell of a time when the former coastline of mainland Australia was inundated by rising sea level.

This is a validation that the stories being told and re-told range between 7,250–13,070 years before the present, tracing their story to around the end of the last Ice Age. The authors add that longer-term cultural memories may be encouraged by:

a. cultural isolation,

b. terrain with obvious physical reference points,

c. an environment whose harshness advantages people(s) with a good memory for what is where.

One of the stories validated is the experiences of the Indigenous people of Port Philip Bay in Victoria (southern Australia) In this story, people moved to higher country due to the seas encroaching over a period of time, thus moving from the current ocean bed to where modern day Victoria is today.

The majority of Indigenous Peoples in Australia live in urban areas in southern and eastern Australia. But in remote areas, they are the predominant. This leaves them more vulnerable to the impacts of climate change, including impacts on health, land, waters, and sea.

Indigenous people are like a litmus test for climate change. They experience the changes firsthand. Some of those changes are already evident such as species disappearing or becoming extinct, the changing of seasonal and cultural indicators, such as flowering of plants, and the arrival or departure of certain birds, insects, or reptiles.

The other side of climate change is the impact of pest species on native and cultural species. Many of these pests thrive in the already drier, hotter southern climates or in the hotter, wetter northern climates, such as the cane toad (Bufo marinus).

In the case of the cane toads, as this pest species moves to more temperate regions due to climate change, the likelihood of increased fatalities of native snakes, goannas and even quolls are high. Southern species with no memory or experience of cane toads. They see the toads as a tasty snack, with deadly consequences.

Kamilaroi man Kye Moggridge walking on his dry country (Gwydir Wetlands) which only 2 months prior this, Gingham waterhole was full of water and healthy. (Photo B. Moggridge 2020)

A further implication of these native species dying from ingesting toads is the loss of cultural species, whether that is as a food source, or as a totemic or spiritual connection. The cultural implications of this loss of species are rarely considered in environmental and ecological studies or impact assessments. This is further replicated in threatened species assessments.

Over the past 100 years, there's been an exponential increase in greenhouse gases and carbon dioxide pollution, as well as a considerable land clearing of native habitats. This has resulted in fewer trees to absorb carbon from the atmosphere and seen global temperatures rise on average by 1.2°C.

Indigenous people want to see more efforts made to keep the temperature stable and below 2°C. They understand that achieving net zero by 2050 will require more urgent action on the part of governments and key policy makers. If these efforts fail, it will impact how Indigenous people can manage and plan for adaption outcomes while building resilience within their respective traditional land.

The difference between historical climate change, such as the ending of an ice age compared to modern day human induced climate change, is that it is occurring relatively fast. We're seeing these changes within a generation.

Indigenous communities, whose knowledge and subsistence systems remains tightly woven with ancestral lands, often suffer disproportionately from accelerating climate related biological disruptions and land-loss as well as from political, social and ideological marginalisation and persecution (United Nations 2009[2], Ford et al 2016[3]).

Indigenous people tend to be low emitters of carbon, contributing minimally to human induced climate change. Unfortunately, though they contribute the least, they are affected the most. This was evident in the recent Intergovernmental Panel on Climate Change (IPCC) Working Group II document Chapter 11 (11.4), which describes the impacts in the Torres Strait "For example, loss of bio-cultural diversity, nutritional changes through availability of traditional foods and forced diet change, water security, and loss of land and cultural resources through erosion and sea-level rise (TSRA, 2018)[4].

Climate change changes the exposure and risk for remote, coastal and island located Indigenous Peoples. It can lead to increased infection from waterborne and insect-borne diseases, and affect their access to clean drinking water and appropriate hygiene and sanitation. The impacts on health can be especially high if medical services are limited, not accessible or damaged by extreme weather events.

Recognition of the important role Aboriginal and Torres Strait Islander Peoples have in identifying solutions to the impacts of climate change is slowly emerging (UN, 2018) having been largely excluded from meaningful representation from the conception of climate change dialogue, through to debate and decision-making (Nursey-Bray et al., 2019)[5].

Here are some of the key findings from the recent National State of the Environment Report (SOE) (2021)[6]. All have a significant impact on how Indigenous people can mitigate and adapt:

- "Indigenous people read Country to understand climate and predict weather. Natural indicators in the environment tell Indigenous people when the rain is coming or when it's delayed – for example, because a certain flower has not bloomed. When Country changes with climate change, traditional knowledge changes and Indigenous methodologies are forced to adapt. Traditional knowledge can complement non-Indigenous ('western') science to provide a deep understanding of climate changes and impacts".
- "It is crucial that Indigenous people are involved in national and international climate forums and decision-making processes. Indigenous people are among the first to experience the direct impacts of climate change, even though they contribute little to greenhouse gas emissions. Indigenous ways and knowledge add to the global understanding of climate patterns and changes. More can be done to listen to, and include Indigenous voices in all climate forums, governments, organisations" and built environment professionals.

"Country"

Shannon Foster and Jo Kinniburg

Writing in "There's No Place Like (Without) Country"

The Australian Institute of Landscape Architects (AILA) recognises the Aboriginal and Torres Strait Islander Peoples as the oldest continuous living culture on Earth, and the Traditional Custodians of our lands, waterways, seas and skies.

AILA respects their wisdom, insights and connections to the land – the same land - 'Country' - which is the central focus of our profession.[7]

When we look at our planet, everything is interconnected.

While as landscape architects we have a shared desire to care for our land, rivers, oceans, environment and biodiversity. The idea of "Country" is more than just land or the environment.

We provide here a range of viewpoints to help show the depth and complexity of the notion of 'Country."

"Country is often misunderstood as being synonymous with land, but it goes far beyond that.

It comprises ecologies of plants, animals, water, sky, air and every aspect of the 'natural' environment.

Country is a spiritual entity: she is mother.

She is not separate to you: all things are connected, everything is interrelated." [8]

Image Credit: Moon rising over Uluru. Martin O'Dea

Dr Daniele Hromek

Writing in the NSW Government Architects designing with Country draft guidelines

"Country soars high into the atmosphere, deep into the planet crust and far into the oceans.

Country incorporates both the tangible and the intangible, for instance, all the knowledges and cultural practices associated with land. Aboriginal people are part of Country, and our identity is derived in a large way in relation to Country.

Our belonging, nurturing and reciprocal relationships come through our connection to Country. In this way Country is key to our health and wellbeing."[9]

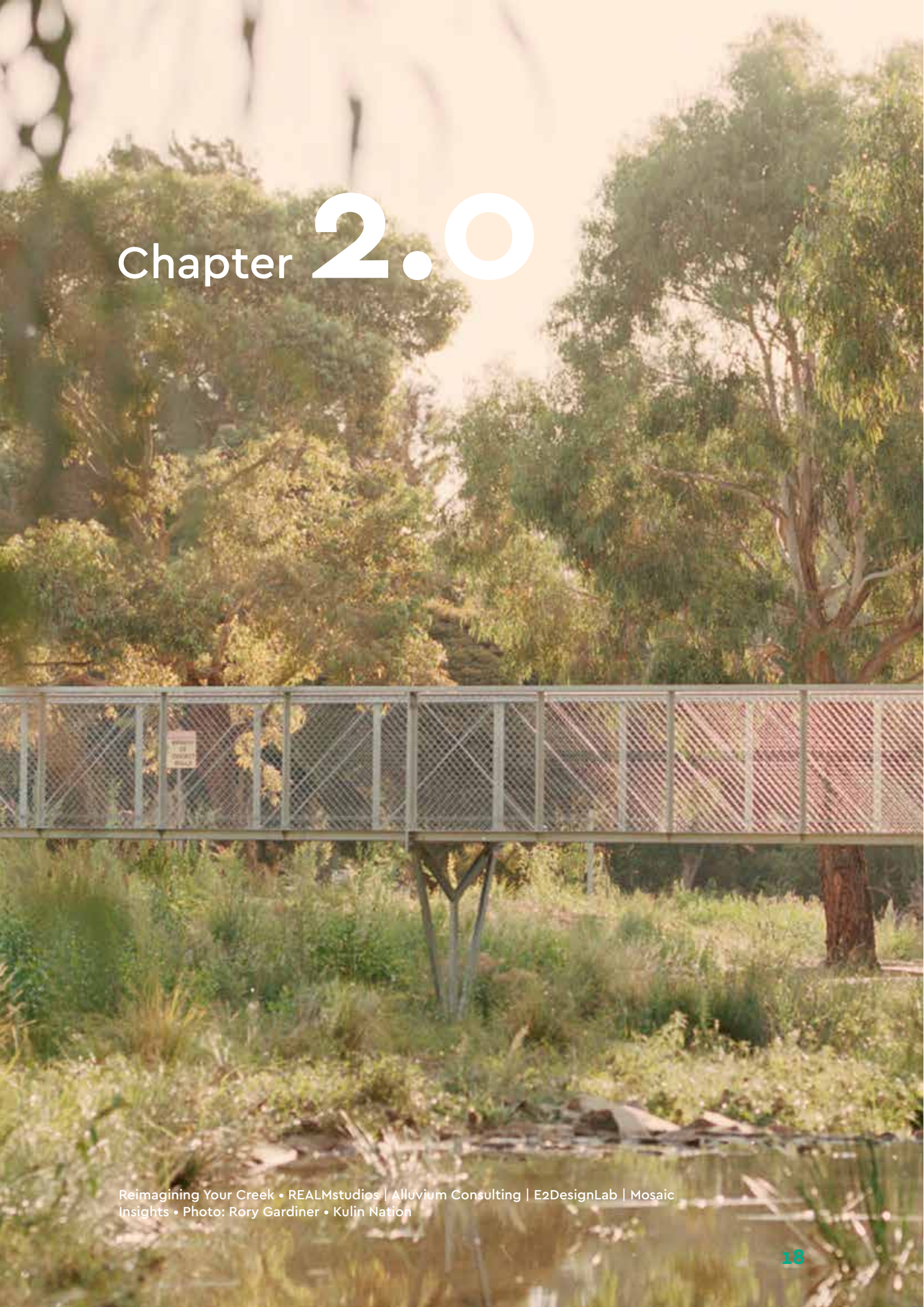
Professor Mick Dodson

Quoted on the Reconciliation Australia website that highlights that Country is more than just connection to land.

"When we talk about traditional 'Country'...we mean something beyond the dictionary definition of the word. ...we might mean homeland, or tribal or clan area and we might mean more than just a place on the map. For us, Country is a word for all the values, places, resources, stories and cultural obligations associated with that area and its features.

It describes the entirety of our ancestral domains. While they may all no longer necessarily be the title-holders to land, Aboriginal and Torres Strait Islander Australians are still connected to the Country of their ancestors and most consider themselves the custodians or caretakers of their land."[10]

Chapter 2.0



Reimagining Your Creek • REALMstudios | Alluvium Consulting | E2DesignLab | Mosaic Insights • Photo: Rory Gardiner • Kulin Nation

2.0 Climate positive design

"This century is the golden age of landscape architecture. The world really needs you. It needs what you know and what you believe in. Now is the time."

Martha Schwartz. New Climate Declaration Conference 10th June 2016

For over 65,000 years Aboriginal and Torres Strait Islander peoples managed and sustained Australia. They tell us that if you "care for Country, Country cares for you".

Our planet is facing an existential threat from global overheating. The international Federation of Landscape Architects is calling upon landscape architects to work towards climate action at scales that matter.

We need to position ourselves as leaders in climate solutions for the natural and built environment and drive meaningful change.

As stewards of the environment, Landscape Architects are well placed to embrace climate positive design, where we have the opportunity to sequester more green house gases than our projects emit. We now need to step up a level and embrace a new paradigm for how we design.

Sir David Attenborough has called climate change "the defining issue of our time". The science is very clear. This is the last decade to act decisively to protect our planet for future generations.

We need to deliver cool green cities, climate resilient landscapes and beautiful places that foster health and mental wellbeing.

Our time is now.

What is Climate Positive Design?

Landscape architecture aligned to climate positive design principles creates a better future for our environment and communities.

Climate positive design means that over the life of a project, it sequesters more greenhouse gases than it emits. Climate positive design projects can also provide multiple social, cultural, environmental and economic co-benefits.

Focus on emissions reductions first

Climate positive design is not just "net zero". It's taking steps to directly reduce greenhouse gas (GHG) emissions and draw down CO_2 from the atmosphere.

Emissions reduction is the starting point and the most important contribution we can make as landscape architects through our practice. Although offsets do make a difference, we cannot offset our way out of the situation we are in.

When looking at how your projects can be climate positive, you will see there are many co-benefits to taking climate action.

These include:

- Social
- Cultural
- Environmental
- Economic

Image credit: Will Salter

Social co-benefits

Climate action fosters equity and justice for all members of our community. As the planet gets hotter, acting on climate change provides social co-benefits including protection from extreme heat, resilience to extreme weather events and resilience and self-reliance for regional communities.

Some of the most vulnerable people in our community are the most at risk from climate change. Climate action provides the right to clean air and water, local food, aiding mental health, resilience and wellbeing.

Cultural co-benefits

There are many examples of climate positive projects underpinned by traditional knowledge in Australia, like the Indigenous Ranger Programs across Australia. Indigenous Ranger projects support Indigenous peoples to combine traditional knowledge with conservation training to protect and manage their land, sea, and culture.

Activities include bushfire mitigation, protection of threatened species, and biosecurity compliance. Indigenous ranger groups also develop partnerships with research, education, philanthropic and commercial organisations. This enables skills sharing and knowledge development, engagement with schools, and the generation of additional income and jobs in the environmental, biosecurity, heritage, and other sectors.

This action plan aims to establish a base line of recommendations and should act as a starting point for individual research into the various initiatives that represent the breadth and diversity of Aboriginal and Torres Strait Islander peoples across Australia and their leadership within land management. Landscape Architects and Traditional Owners have a natural affinity towards gaining an understanding of each other, centered around landscape design, and caring for Country.[11]

Environmental co-benefits

Climate positive projects improve local and global environments.

Through climate positive projects, displaced fauna species can return to restored habitats and those habitats can become self-sustaining. Improved biodiversity, soil retention and water quality are the building blocks for healthy and resilient ecosystems.

Healthy ecosystems are vital to humans as well, providing us with clean air, water and food.

Economic co-benefits

Climate action provides economic benefits through investment in new and sustainable industries, increasing employment, providing relevant up-skilling opportunities, and providing economic stability and growth for regional communities.

Climate positive investment in locally owned and run projects strengthens local economies.

Emissions reduction targets

The Climate Council in their 2021 publication "Aim High, Go Fast - why emissions need to plummet this decade" says Australia needs to reduce its green house gas emissions by 75% by 2030[12].

AILA have adopted this recommendation for an ambitious interim 2030 target of 75%.

2030 Target

All projects to be climate positive by 2030 using:

a 75% reduction in embodied and operational emissions.

and a 25% sequestration drawdown offsets to reach 100%.

2040 target

Aim for a 100% reduction in embodied and operational emissions without offsets by 2040.

Image credit: John Gollings

Emission benchmarks

Over the past two years the climate positive pathfinder application has logged over 560 projects with full details out of a total of 3,600 projects to December 2021.

As a general guide this data base has identified the following benchmark average emissions for the following generic project types as of September 2022 are as follows [13]:

- Parks: 26.1kg/m2
- Streetscapes and Plazas:37.2 Kg/m2

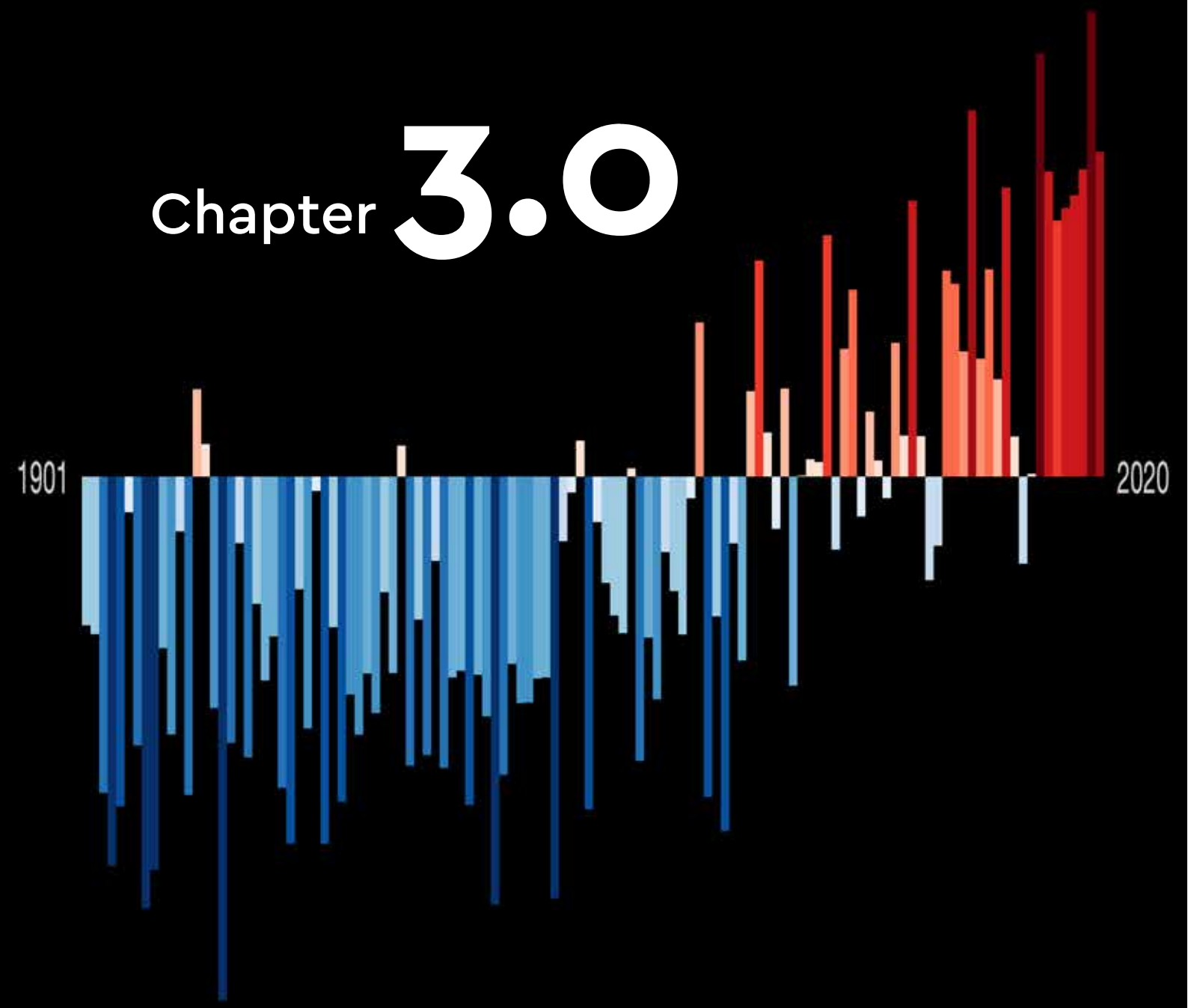
The Climate positive pathfinder challenge has recommended climate positive targets of:

- 5 years to positive for parks, residential, on-structure, mixed-use or campus developments
- 20 years to positive for streetscapes or plazas

To December 2021 the actual outcomes based on project data were:

- 17.5 years average to positive for all projects.
- 16 years average to positive for parks.
- 37 years average to positive for plazas and streetscapes.

Chapter 3.0



Climate stripes - Australia 1901-2020

3.0 Understanding climate trends and risks

"Climate change is the defining issue of our time – and we are at a defining moment. The time for ambitious climate action is now."

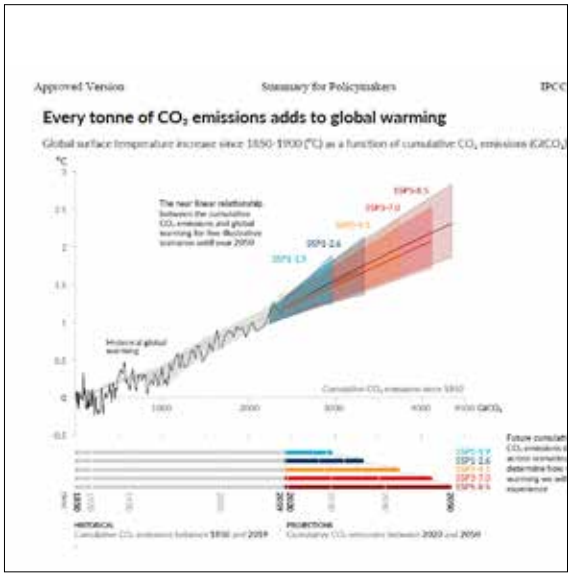
António Guterres. Secretary General of the United Nations. September 11. 2018[14]

The IPCC's 6th assessment report has made it explicitly clear that every extra tonne of CO_2 is heating the planet. This means that we have a large amount of agency to reverse that trend. In our practices and our projects, even small acts shift our knowledge as a profession and demonstrate a change in culture and practice to help us chart a new path.

You can't be what you can't see. When we see practices taking action, retraining staff, communicating their intent with peers, consultants and clients, climate positive design becomes normalised. This is where we need to be. We need to urgently make climate positive design the new normal.

This guide will help you get there. Start small and start today.

Climate change and global overheating



Anthropogenic greenhouse gases are heating up the planet

The primary driver of climate change is anthropogenic green house gases.

Greenhouse gases (GHG) regulate the Earth's temperature by trapping heat in the lower atmosphere. More greenhouse gases make the planet hotter.[15]

The primary green house gases are: Carbon Dioxide (CO2), Water vapour (H2O), Nitrous oxide (N2O), Methane (CH4), as well as Ozone (O3), Chlorofluorocarbons (CFCs) and Hydrofluorocarbons (includes HCFCs and HFCs) in man made refrigerants.

On a per molecule basis, each of these gasses has a different global warming potential (GWP):

- Carbon Dioxide (CO2) provides the baseline Global Warming Potential (GWP) of 1.0
- Methane (CH4) equates to 160x the potency of CO2 on day 1, to 86x the potency by 20 years and 28x the potency of CO2 over a 100-year period.
- Nitrous oxide (N20) equates to 310x over a 100-year period.
- Refrigerant gases like CClF3 = 13,900x over a 100-year period.

Every tonne of CO2 adds to global heating

Carbon dioxide accounts for about 76% of global human-caused emissions.

The IPCC's 6th assessment report has made it explicitly clear that every extra tonne of CO2 is heating the planet.[16]

Every extra tonne of CO2 emissions from our landscape projects is adding to the problem.

That means we need to be reducing emissions from landscape projects as a priority.

Our oceans are absorbing between 25-31% of CO2 that is emitted into the atmosphere.[17] This is creating significant problems for the ocean by causing acidification.

CO2 is a long lived gas and in times of glaciation it takes the planet about 1000 years to drop 1 Part per million (ppm).

The primary source of CO2 is burning of fossil fuels like coal, oil and fossil gas. This is completely overwhelming the balance of CO2 in the Earth's atmosphere.

Deforestation and land clearing accounts for 10% of all global emissions and cement production accounts for further 8% of emissions. By way of perspective, all air travel accounts for approximately 2%.

Eraring Power station. Photo credit Hartz. istock photos

Image credit: IPCC 6th Assessment report Working Group 1

The Earth's CO2 budget has doubled in the last 60 years

Only 100 parts per million of atmospheric CO2 separates our recent Holocene temperature from peak ice age with 2 km thick ice.

Over the last 800,000 years the Earth's CO2 levels have never dropped below 180ppm and never risen above 280ppm.[18]

This 100ppm from 180ppm-280ppm has been the effective operating budget of CO2 for the last 800,000 years. It represents a worldwide average temperature change of only 4 degrees Celsius.

Pre-industrial levels were about 280ppm. The safe threshold is thought to be around 350ppm and we are at 419ppm and increasing year on year.

The last 10,000 years of relatively stable temperature has allowed humanity to thrive.

In the last 60 years alone we have added another 100ppm of CO2 to the atmosphere.

Image credit: NASA

Keeping below 1.5 degrees

The Paris agreement adopted by 196 parties is a legally binding international treaty on climate change.

It set a carbon budget aimed at having a 67% chance of staying below 1.5 degrees Celsius.

1.5 degrees might not sound like much, but this relates to the average temperature increase over the entire planet.

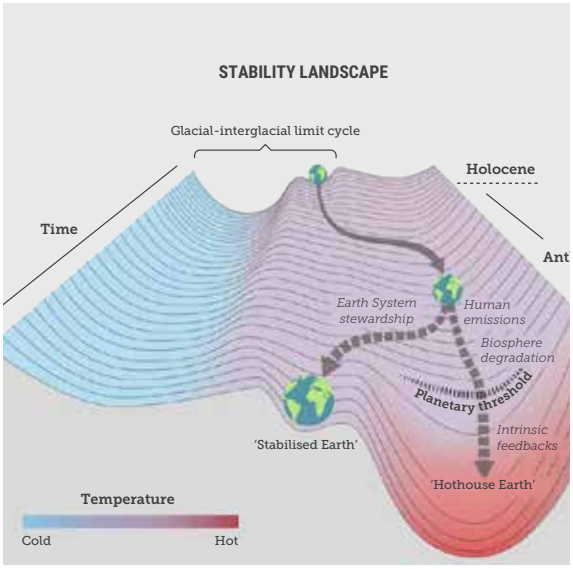
It takes a stupendous amount of energy to raise an entire planet's temperature by just one degree.

The current amount of heat increase of the planet from greenhouse gases is estimated to be equal to four Hiroshima bombs detonated per second.[19] Or 2.1 million bombs per year.

We urgently need to reduce GHG emissions. At the same time we need to remove billions of tonnes of CO2 out of the atmosphere, so the Earth can start to radiate excess heat into space and cool down.

While the 1.5 degree limit is a planetary average, it should be recognised that Australia has already warmed on average by 1.44 ± 0.24°C since national records began in 1910.[20]

Image credit: Martin O'Dea



Australia needs a 75% emissions reduction by 2030

Australia's remaining 4.7Gt carbon budget will be exhausted by 2028 at the current emissions rate of 500Mt/Pa.

The Climate Council in their 2021 report Aim high, go fast: Why emissions need to plummet this decade, calculated Australia's share of the world's 1.5 degree carbon budget to be 4.7Gt.

Due to a decade of inaction, this budget will be expended by 2028 with no change to our GHG emissions.

With a straight-line reduction it will be completely spent by 2038.

To extend our emissions budget to 2050, the Climate Council's assessment is that Australia's emissions have to plummet by 74% by 2030 to keep to our 1.5 degree Paris commitment.

Based on this, AILA has adopted 75% figure as our aspirational target.

Catastrophic tipping points

The Earth has feedback loops that amplify the effects of climate change. This is what keeps climate scientists up at night.

Imagine you are on a train that is accelerating. Ahead is a steep cliff, but we don't know exactly where it is. We need to slam on the brakes to avoid the cliff, because once we go over the cliff (tipping point) the brakes won't be able to stop the runaway train.

While the focus is on anthropogenic emissions, the Earth's own natural systems create powerful feedback loops that may greatly amplify anthropogenic sources.

Climate feedback loops can either accelerate or decelerate the global warming trend.[21]

All of these feedback loops can run in both directions. The ice/albedo feedback loop for example drives glaciation and its opposite - deglaciation.

This video series on feedback loops is very instructive here.

Image credit: Martin O'Dea

Image credit: The Climate Council

Australia's land sector GHG emissions

Cities drive large scale emissions

Cities are a main cause of climate change but can also be part of the solution in reducing GHG emissions.

Cities amount to 40% of global emissions; poor planning and layout are largely accountable. Low density suburban sprawl with inadequate public and active transport between homes and work or amenities result in dependence on polluting vehicular transport and road infrastructure construction.

With 70% of global populations living in cities by 2050, built environment professionals play a critical role in reducing emissions. Well designed, compact, walkable cities with good public transport greatly reduce GHG emissions.

The built environment generates nearly 50% of annual global CO2 emissions. Just three materials – concrete, steel and aluminium – are responsible for 23% of total global emissions.

Carbon smart alternative materials should be selected by default. Built environment designers have a critical role to play in all new construction projects; that is to reduce, reuse and sequester.

Image credit: Martin O'Dea

Large scale emissions

Large scale land clearing and fugitive emissions from fossil fuel extraction make a significant climate impact.

Australia is one of the world's leading land clearing nations, being the only developed nation on the worldwide list of deforestation hot spots[22]. This has a significant impact on GHG emissions and ability to drawdown carbon.

Catastrophic bushfires can easily surpass Australia's annual gas emissions. The 2019-2020 bushfires equated to 170% of annual emissions. Under current IPCC rules however, these emissions are not counted.

Australia is a major contributor to global emissions, ranking third largest fossil fuel exporter after Saudi Arabia and Russia. To stay within 1.5 degrees warming, the International Energy Agency and the IPCC advise against any new fossil fuel extraction. Mining and exporting of fossil fuel is a gargantuan footprint that cannot be offset by tree planting.

Image credit: The Wilderness Society

Australia's climate risks

The catastrophic summer bushfires of 2019-2020 and 2022 floods in NSW and QLD show that we are already in the middle of the climate crisis. The Bureau of Meteorology estimates that Australia's average temperature has risen to 1.44 degrees Celsius relative to pre-industrial levels.

Anthropogenic climate change impacts that we need to consider in design and planning for future landscapes include:

Preparing for the 50 degree Celsius city. Penrith was above 48 degrees in both January 2018 and 2019. Dr Sebastian Fautch recorded an unofficial temperature record of 50.5 degrees in Airds in January 2020. Mitigating urban heat island is one of our primary challenges for cities and towns.

Deadly heat days. Because we sweat to cool down, wet bulb temperatures above 35 degrees can be fatal within hours[23]. Darwin is experiencing increasing numbers of dry bulb days above 35 degrees. This is also of critical concern to our tropical Asian neighbours.

Shifts in bioclimatic zones. What is a suitable tree now may not be suitable by 2100. We need to be selecting trees and shrubs tolerant to expected bioclimatic shifts.

Biodiversity collapse and the 6th Mass Extinction. This is just as pressing as climate action. Biodiversity is critical to humanity's survival. Ensuring we design for net biodiversity gain is essential. We can be guilty of "blandscaping" with a select few tough species. We must consider biodiversity, habitat connectivity, and pollinator-friendly species mixes.

Changing rainfall regimes. Parts of Australia are becoming drier, while other parts are becoming wetter.

Intense rainfall and flooding events. Greater heat energy in the ocean and hotter air is able to carry more moisture. This leads to more frequent and more intense rain fall events.

Drought, heat stress and water scarcity. Increased temperatures are bringing hotter and drier conditions, much like what was seen in the lead up to the 2017-2020 drought. This will place heat stress on our tree stock. The threat to their health and longevity may be exacerbated by drought-driven water restrictions. We need to protect our urban trees as they are long term assets.

Intense bushfires. Increasing temperatures and drier ground is changing the landscape. 2020 saw wet rainforests burn.

Image credit: Yvonne Doherty.

Sea level rise and salinity incursion. Rising temperatures and expanding oceans are contributing to sea level rise. The current prediction is for 900mm by 2100, with 3-5 metres by 2300. This will have a substantial impact on the design of coastal areas. Not just from sea level rise and storm surge, but rising salt water tables that will kill trees and vegetation.

Food and water security. Australia produces enough food for 60 million people. Our ability to continue to produce food is impacted by rainfall and bioclimatic zone changes. What might have been a suitable grain growing region may not be in the near future.

Rural lands and agriculture emissions. Agriculture accounts for 13% of Australia's emissions, of which 42% is methane[24]. Land clearing has substantial climate impacts. Privately owned rural lands covers 51% of Australia. How land, soil and ecosystems are managed will have a considerable impact on our ability to get to net zero.

Spread of diseases. COVID-19 demonstrated the impact of zootonic diseases on the planet as we encroach more upon the natural environment. Temperature changes are extending the geographic range for insect-carrying diseases such as malaria and Ross River fever southwards.

Extended ranges of insect pests. Longer warmer periods are having significant impacts on places like Kosciusko National Park where warmer winters are allowing insects to proliferate and this sustained attack is creating substantial dieback.

The elevator to extinction. Australia is so old it is very flat. Our highest peak is just over 2 Kilometres up. We have specialised mountain species adapted to these alpine habitats, along with wet tropics mountains. As temperatures rise, so do the habitat zones, tree lines and snow lines. At current rates of global heating, these habitat zones are rising so fast that the unique species that live there will have no land to live on within decades.

Social impact of mass migration. Deadly urban heat and sea level rise are likely to drive substantial migration away from the equator over the next 50 years with unknown impacts for Australia.[25]

Big picture trends

The time frame for planetary carbon neutrality is 2050. In that time frame there are a number of mega trends and shifts that are likely to impact what we need to do as landscape architects.

Population increase from 7 billion to 9 billion people. It's estimated that 70% of the global population will be living in urban environments by 2050. Cities are the largest piece of infrastructure we need to reimagine, redesign and regenerate. Populations in Australian cities are expected to double in some cases by as early as 2036.

Adopting net zero 2050 pathways. Climate targets set by industry, State and Local governments are helping to drive change. Federal legislation of 43% will help make these transitions mandatory rather than voluntary.

Low carbon materials. Our largest emissions are embodied in materials. We foresee a substantial shift in the next decade towards green steel, green aluminium, and low carbon concrete. AILA is a founding partner of the Materials Embodied Carbon Leadership Alliance (MECLA) that is driving such change.

Phasing out fossil gas. This will impact residential developments with the phase-out of gas and no new gas reticulation in our footpaths.

Image credit: Martin O'Dea.

Connection to Country and Traditional Knowledge systems. There is increasing recognition of Traditional Knowledge systems for land, seas, water and sky management. With over 65,000 years of connection to Country, these will be crucial to managing Australian landscapes in the 21st century.

Renewable energy visual impacts. The demand for renewable energy while important, will have significant visual impacts and ecological considerations. In Tasmania for example, the number of wind farms is set to double. The prime areas for these are on highly visible hill tops, often in very scenic areas. Massive utility-scale solar can have habitat and other impacts.

Some utility-scale solar are enormous in scale. Sun Cable's proposed Northern Territory solar farm is 12,000 hectares[26]. In addition are the construction impacts for the 1100 workers and the associated transmission lines and battery storage facilities

Electric vehicles, virtual powerplants and distributed power. The shift to electric vehicles will have impacts on urban planning. Integration of charging stations into the streetscape will be just one challenge. By 2050, 90% of vehicles are predicted to be electric. With say 20 million electric vehicles each with a 50KW/hr battery each, we will have a movable virtual power plant of 1 billion Kw/hr. This will change how the electrical distribution networks design.

Autonomous vehicles. Autonomous vehicles should enable a reduction in run-out clear zones for roads. The implication will be the ability to plant trees closer to the carriage way. This will expand green street grid planting in cities, on rural roads and highways.

Decentralised power and water systems. We are moving away from large, mega scale power and water systems that cost billions. The future is in smaller scale decentralised systems that are more flexible and adaptable and can be incrementally developed at precinct scale.

Circular economies and zero waste. We currently have a very wasteful linear economy. Items are produced, used once and thrown away. Circular economy thinking like recycling water, zero ocean outfall, and other ideas will need to be part of our climate solutions tool kit.

Net biodiversity gain. This is a critical part of the climate and biodiversity crisis. Biodiverse landscapes have greater habitat value and sequester more carbon than monocultures.

Regenerative agriculture. Regenerative farming works with nature rather than against it. It focuses on soil health, rather than the crop or stock. This is a diametric shift from industrial agriculture that treats soils as a receptacle to hold imported fertiliser and pesticides. Grazing animals can have a major role to play in grassland management.

The social cost of carbon. A number of studies have attempted to place a cost to society to adapt and repair the damage from carbon pollution. In 2018, Katharine Rickie placed the median cost at US$417 or a bit over AUD $600/tonne depending upon exchange rates[27]. If this true cost of externalities was factored into the extraction of fossil fuels, not a single coal or gas fracking project in Australia would be financially viable.

International carbon price. It is likely that the world will settle somehow on an international carbon price. This change is perhaps a decade away, but it will have a profound effect on the landscape. It will place a monetary value on emissions, the landscape, our environment and ecosystem services.

Carbon border adjustment mechanisms. These are levies on products from countries like Australia that have weak climate laws and no carbon mechanism or price. The implication is that it may well force the government to reintroduce a carbon pricing mechanism.

Biodiversity loss and climate change

Healthy ecosystems are more resilient to climate change and so more able to maintain the supply of ecosystem services on which our prosperity and wellbeing depend.[37]

Climate is driving rapid change faster than natural systems can adapt. Bioclimatic regions generally moving poleward and to higher altitudes.

Climate change is a major driver of biodiversity loss. Conversely, biodiversity loss reduces the ability of the Earth to adapt to climate change. This close relationship, makes it critical to tackle both crises in a coordinated way[28] .

Biodiversity is the variety and variability of life on Earth. It is complex and our understanding changes with the continued discovery of new species. The specific relationship between different organisms have evolved over millions of years.[29] [30]

These interconnected relationships support important ecosystem functions. They provide fertile soils and clean rivers and streams. Healthy ecosystems support seasonal pollination and resilience to pests and diseases. The supply of healthy ecosystem services support our own prosperity and wellbeing. The services provided by healthy ecosystems are estimated to be worth trillions of dollars, double the world's GDP.

Natural cycles driven by temperature and timing like plant flowering times and insect growth cycles are now moving out of sync with other natural cycles like bird hatching[31].

Image credit: Martin O'Dea.

Climate change and associated biodiversity impacts are concerning Aboriginal and Torres Strait Islander peoples. Changes to indicator species and calendar markers are leading to disruptions to optimal time to hunt, fish and gather resources throughout the year.

Aboriginal and Torres Strait Islander peoples are also concerned that visible changes to seasonal timings of specific events such as flowering times, might also point to changes to things that cannot be directly observed, such as to microorganisms[32].

Environmental functions assist in regulating climate, defending or tempering climatic extremes, and adapting to new climatic conditions. Biodiversity loss reduces the ability of the Earth's organisms and human society to adapt to new climate realities.

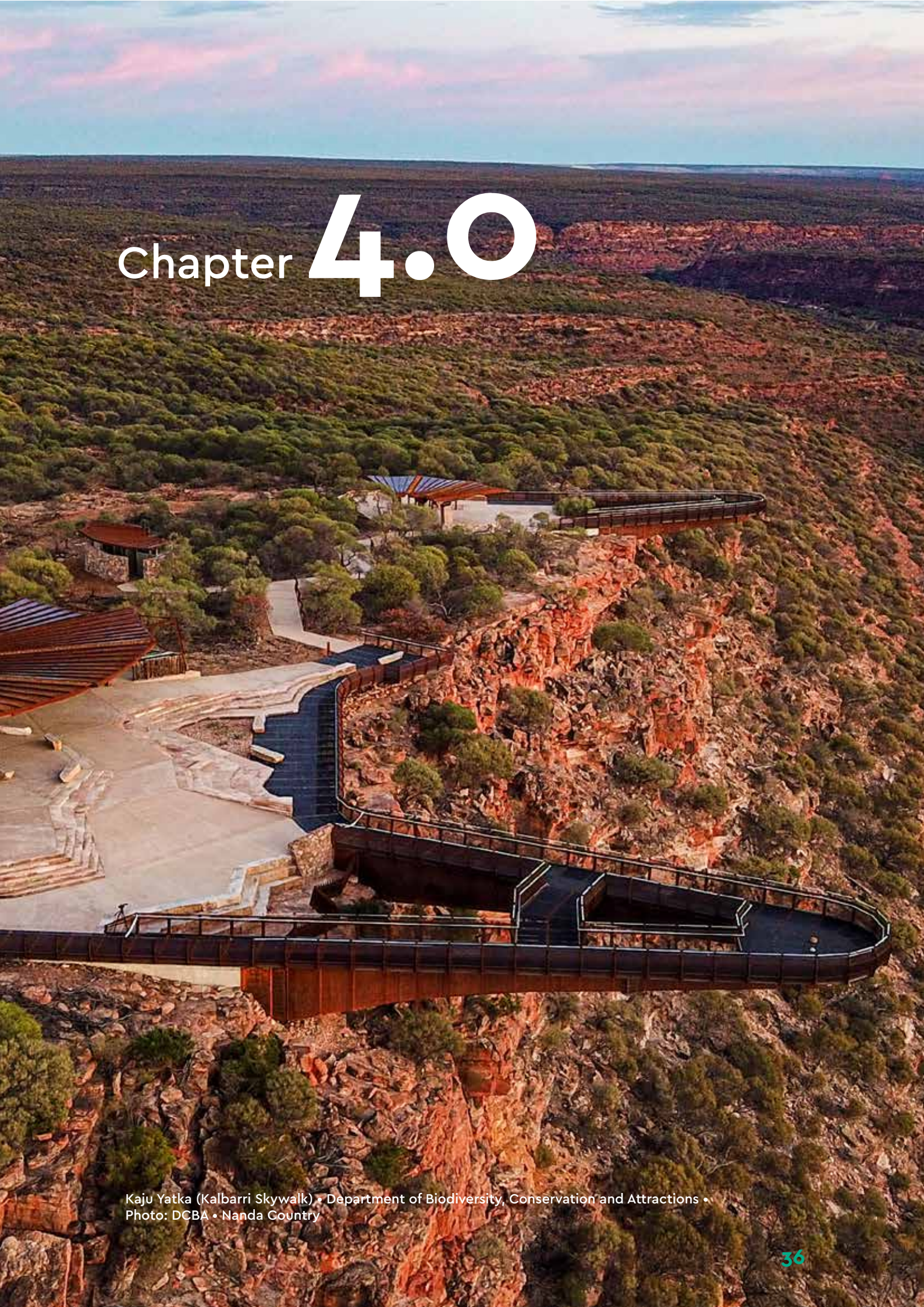
It is estimated that 44% of the world's land surface needs increased protection to maintain these vital environmental functions. Measures include improved land management practices, stronger planning and development controls and formal areas of protection. Approximately 1 million wildlife species are at risk of extinction, raising serious concerns of a sixth mass extinction.[33] [34] [35]

Developing practical ways of mitigating biodiversity loss and promoting biodiversity positive outcomes in urban and regional development is critical to manage the effects of climate change[36]. Landscape architects can play a leading role in improved conservation and management of existing ecosystems that value indigenous plants and materials. They can also create more informed constructed landscape that targets a positive net-contribution towards local biodiversity and establishment of new ecosystems.

Australia's Biodiversity Conservation Strategy 2010–2030 is focused on removing threats and building resilience in Australia's ecosystems to facilitate adaption to climate change.

The risks of climate change and biodiversity loss continue to increase without effective measure to reduce CO2 emissions and to halt damaging activities such as land clearing and insensitive landuse change. Cities and towns across Australia are continuing to degrade biodiversity, and in doing so, they increase their vulnerability to climate change and limit the ability of urban areas to adapt and remain liveable.

Chapter 4.0



Kaju Yatka (Kalbarri Skywalk) • Department of Biodiversity, Conservation and Attractions • Photo: DCBA • Nanda Country

4.0 Emissions and sequestration

"Landscape architects are likely emitting more greenhouse gas emissions than they are sequestering. It's time for radical change in the field of landscape architecture."[38]

Pamela Conrad. April 2022.

Most landscape architects would be shocked if they knew the actual climate impact of their projects. Yes our projects have trees that sequester CO2, but in many instances it might be 40 to 60 years before we reach a positive outcome.

On many projects the majority of the carbon emissions are locked-in by concept stage.

Based on life cycle assessment data from the Pathfinder application, we know that on average 75% of emissions are embedded up front, the day project is opened.

Landscape architectural project emissions are found in unexpected places. Knowledge of these helps drive better design outcomes.

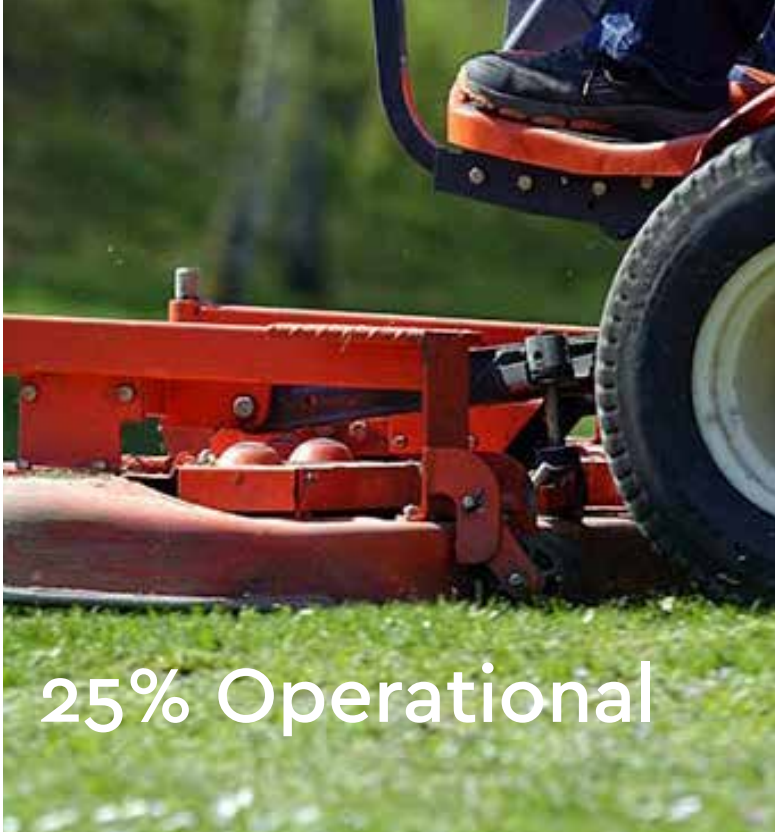
75% Upfront/ embodied emissions

Understanding our project emissions

Upfront embodied greenhouse gases account for approximately 75% of Landscape project emissions, from the day your project is opened

Ongoing operations and maintenance account for the remaining 25%

Image credit: Top: Brett Boardman, Below Dianna Snape



Upfront embodied construction emissions

Upfront construction emissions account for the majority of our projects' greenhouse gas budget. These are also called "embodied" emissions. They include materials like concrete, dimension stone, kiln dried timber, aluminium and steel.

Our challenge as landscape architects is to find ways to reduce these up-front emissions. We can achieve part of this through good design and materials choices as we outline in "Designing low carbon landscapes and places" on page 62

The issue for us is that there are few low readily available carbon construction materials to choose from. We need to drive industry to provide these low carbon alternatives. Keep asking for environmental product disclosures (EPDs) and specifying low carbon products.

To meet our emissions reduction targets we need to engage with companies that supply our concrete, bricks, steel, aluminium and timber. Their support is crucial to meet our 75% GHG reduction target by 2030.

Operational emissions

Operational emissions include fossil fuel powered maintenance equipment, electricity, fertiliser emissions and lifecycle replacements.

Lifecycle emissions

Consider the entire life cycle emissions of a project

When assessing our climate budget we need to consider the entire cumulative greenhouse gas impacts of a project.

This should assess the "cradle to grave" life cycle of a project. This encompasses:

- Pre-design, policy setting and strategic planning
- Design and documentation
- Tender and construction stage
- Operational stage
- Demolition and re-use

Refer to Building Transperancy.org embodied carbon action plan for good information on lifecycle considerations.

The emissions of your practice in designing a project should be managed separately.

Refer to our volume 2 "Organisation guide to climate Positive" for an understanding of business emissions.

Image credit: Dianna Snape

Vegetation removal

There can be significant carbon and biodiversity impacts at the beginning of projects with land clearing and site preparation.

Long term sequestered CO_2 in trees is lost within a few years when they are chipped and eventually decompose.

We also lose the forgone future sequestration, ecosystem services, canopy and habitat benefits from these trees.

Soil carbon is lost when it is turned over and disturbed.

There are biodiversity and habitat losses, particularly with older trees that might provide nesting hollows.

Image credit: Martin O'Dea

Cement and concrete and products

Cement and concrete make up 8% of the world's CO2 emissions. To put this into perspective, all of the world's air travel contributes only about 2%.

Emissions from cement and concrete come from liberated fossil CO2 from the cement manufacture process and embodied CO2 in transportation and delivery.

In concrete, 95% of the emissions come from 5% of the content - the Portland cement. This is made from burning lime - which is fossilised CO2 originally locked-up in seashells.

There are a number of lower carbon concrete options available in Australia. The main options use fly ash to replace part of the Portland cement.

There are a few zero carbon concrete products in the Australian market that use purchased offsets through the government's Climate Active programme to achieve "net zero".

For guidance on how to specify low carbon concrete see: "Specifying low carbon materials and alternatives" on page 66

Image credit: James Newman

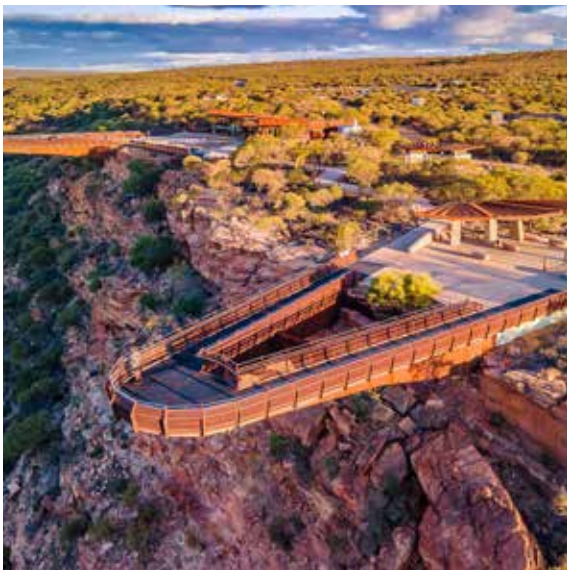
Dimension stone

While a natural product, dimension stone has a high embodied emissions from its manufacturing processes.

The Melbourne EPiC Database shows that dimension stone has an oversized GHG footprint. Dimension granite pictured here has 3,498 kgCO2e /m3 or say 175 kgCO2e/m2 if 50mm thick.

When laid on a reinforced concrete slab, the GHG emissions factor can be substantial.

Image credit: Martin O'Dea



Steel, aluminium and galvanised products

Steel, aluminium and galvanising are very energy intensive products.

Where that energy is derived from fossil fuels there is very high embodied CO2.

Aluminium is one of the most energy intensive processes.

Steel manufacture uses coking coal that releases large amounts of CO2 in both the coking process and steel making process.

There is very high energy involved in galvanising as the bath of molten zinc is kept at 450 Degrees Celsius.

Much heavy industry and metal workshops in Australia still uses energy derived from coal fired power.

Image credit: Wondrous World Images

Furniture and kiln dried timber

Street and custom furniture including lights, seats, bins and bollards are a substantial contributer to our emissions.

Many commercial seats are made from aluminium along with kiln dried timber slats. Emissions can be as high as 500-1000kg per seat.

They quickly add up on projects. A concerning trend is custom designed seats on a concrete slab. Emissions per seat might be 500kg/each depending on length.

A good quality external timber should last between 15-20years. The stored CO2 is then lost when the timber is chipped or allowed to decay.

There is substantial embodied CO2 and fossil fuel energy in using a kiln to dry timber.

The short overall lifespan for timber, might requires two or more replacements in a 50 year project.

Image credit: Martin O'Dea

Operational emissions

Operational emissions include fossil fuel powered maintenance equipment, electricity, fertiliser emissions and lifecycle replacements.

Small petrol and two stroke engines are incredibly polluting. Fossil fuels are burnt using ride-on mowers, leaf blowers, hedge trimmers and whipper snippers. There are also health impacts to workers, such as asthma and hearing damage.

According to a study by the California EPA, one hour of leaf blowing produces the same pollution as driving a Toyota Camry 1700km, from Sydney to Mackay. [39]

The **power consumed** to run our projects including night safety lighting and decorative lighting, pumps and filter equipment for pools, water play and fountains and irrigation systems.

Many **synthetic fertilisers** use fossil fuels as their base ingredients. Once applied these fertilisers can break down and emit nitrous oxide (N_2O). Even a small amount can make a very large difference, as N_2O is 300x more potent than CO2 as a greenhouse gas.

Replacements. Over their 50 year design life some items such as timber decking, and asphalt might need to be replaced several times, doubling or tripling the original emissions.

Image credit: Martin O'Dea

Fashion, trends and laziness

Fashion driven lack of longevity and a "cut and paste" approach to documentation is making landscape unsustainable.

The Piazzo San Marco in Venice was first paved in the 12th Century and then re-paved in 1723.

A recent review of past AILA award winners revealed that 16% no longer existed.

There have been some projects ripped up after as little as 10-15 years and replaced to suit fashion.

Laziness is another issue. Business as usual and commercial imperatives lead to the re-use of details and specifications, instead of considering low carbon alternatives.

Concerted effort is required to update office detailing and specifications to match low carbon requirements.

Image credits: Martin O'Dea

Landscape drawdown and sequestration opportunities

Tree carbon

On most landscape projects the largest amount of sequestration will come from new tree planting.

Carbon dioxide pulled from the atmosphere is sequestered into the woody biomass of the tree as carbon. The bigger the tree and the denser the timber, the greater the carbon.

As a guide, approximately half the dry weight of a tree is carbon. When you add back in the weight of the liberated oxygen atoms, the CO_2 equivalent will weigh almost double that of the tree.

CO_2 from the atmosphere is pulled into the tree via stomta in leaves. So to maximise sequestration the tree needs to achieve maximum leaf canopy coverage.

Sequestration in trees is not a straight line graph. It takes time for trees to get to their full drawdown potential.

As embodied CO_2 is related to tree volume, there is an exponential relationship of trunk diameter to embodied CO_2. As a guide

150mm diameter eucalypt - 236kg CO_2e

300mm diameter eucalypt - 1,800kg CO_2e

600mm diameter eucalypt - 12,616kg CO_2e

Image credit: Martin O'Dea

Soil carbon

Due to the sheer size of the Australian continent, an increase in even just 1% of soil carbon is substantial.

Carbon can be sequestered into the soil through the process of photosynthesis, the transfer of sugars into the soil, decaying plants, and production of microbes and soil fungi.

To build soil carbon, we need maximum photosynthetic coverage (green cover) on the soil, to pull in CO_2 by living plants. Soil microbes and fungi provide critical functions, and if vegetation cover is removed by tilling or grazed bare, then we can lose these other functions.

Synthetic fertiliser kills soil biota. Using organic based probiotic fertiliser builds soil microbiota.

Image credit: Martin O'Dea

Blue carbon

Blue carbon is the carbon stores in our oceans, mangroves, estuaries, wetlands and coastal ecosystems.

Estuarine ecosystems with mangroves and saltmarshes, and associated muds and silts can store significant amounts of carbon. However, recent studies have shown that the amount can be highly variable.

Mangroves are effectively drought tolerant as they grow in salt water.

As coastal ecosystems are highly altitude dependent, living within a very narrow habitat niche relative to sea level, they are highly susceptible to sea-level rise.

They are highly valuable for biodiversity and should be protected and rehabilitated.

Image credit: Martin O'Dea

Cultural burning

While burning releases CO_2 Cultural Burning reduces the risk of catastrophic burns that can destroy the entire ecosystem.

The Victorian Traditional Owners describe Cultural Burning as the "Right Fire, Right Time, Right Way and for the right (cultural) reasons according to Lore". It requires a great deal of skill and knowledge[40].

A cultural burn, sometimes called a "cool burn", will be self extinguishing. It will trickle along, at a pace that allows insects to escape. It won't touch the canopy and should be cool enough to walk on in bare feet[41].

Cultural burning, increases biodiversity and brings back the herbaceous shrub layer rather than hot fire species. It will decrease the risk and intensity of future fires.

See these excellent short videos by the ABC that convey the intricacies of cultural burning

- Australian Story featuring Vicktor Steffensen
- Indigenous fire methods protect land before and after the Tathra bushfire

Image credit: Australian Broadcasting Corporation

Chapter 5.0

Sunset Heritage Precinct • HASSELL • Wajuk Country

5.0 Measuring your project's climate impacts

"I believe there is an incredible opportunity for landscape architects to re-imagine landscapes so they are not only wonderful places for people, but also help solve the climate crisis."

Pamela Conrad - Climate Positive Pathfinder app designer - The Dirt 12/01/2020 [42]

You can't change what you don't measure or know.

AILA recommends using the Climate Positive Pathfinder app to measure your project's greenhouse gas budget on a 50 year life-cycle assessment period.

This is a free web-based, on-line calculator with no software to download. It is a design and planning tool rather than an in-depth carbon accounting tool.

It allows you to test out design alternatives for your projects and learn about low carbon options.

Californian Landscape Architect Pamela Conrad designed the application for landscape architects.

For an understanding of the application and the assumptions that underpin it, refer to the AILA website. You can watch our three minute introduction video or our one hour detailed AILA training video session. Further video resources can be found at the AILA Climate Positive Design website.

We recommend setting up two company accounts that staff can access. The main account is for tracking your projects.

We recommend a second account to build up a library of components. Make sure for each project here you check the box identifying it as "an academic study or project not expected to be built". This ensures the data generated by your library doesn't impact the overall annual reporting from the Climate pathfinder to partner agencies like AILA.

Ongoing app development, improvements and bug fixes are managed by Pamela and a small IT team in Melbourne.

She relies on donations and crowd funding. AILA recommends that users contribute a fee per project to help manage the application and improvements. So please consider making a payment based on fair use of the application here.

It is hoped that ongoing additions and improvements can add more specific Australian data.

Measuring your project GHG life cycle

Measuring and benchmarking your projects

Evaluate and track your projects emissions using a common benchmark of emissions per m2.

- ☐ Use a common emissions intensity per m2 from the pathfinder score card to benchmark and compare all projects and set annual emissions reductions targets.
- ☐ The 2021 average m2 emissions from the pathfinder for parks was 26.1kg/m2 and Streetscapes and plazas at 37.2 Kg/m2
- ☐ Establish your landscape architectural emissions measurement boundary, as different from the building or civil road components. For example, if a roof slab needs to be thickened to account for the planting, you should include the additional structural thickening in your emissions.
- ☐ The Pathfinder app assumes regular shrub replacements over the 50 year full life cycle. Factor in realistic expected 50 year survival rates on your shrub material areas:
  - Botanic garden / high end park– 90%
  - Managed residential estate – 70%
  - Low management / natural systems - 50%
  - Domestic garden owner change – 20%
  - Low or zero maintenance – 10%

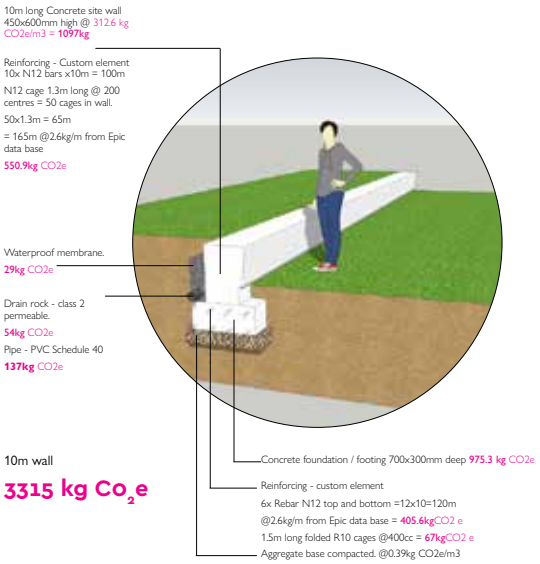
Image credit: Hassell

Landscape GHG lifecycle assessment tools

Specialised landscape carbon and life cycle assessment tools can measure your projects' GHG footprint.

- ☐ As noted AILA recommends the Climate positive pathfinder application which is specifically designed for use in assessing landscape projects.
- ☐ The Carbon Conscience App by Sasaki has been designed to look at likely carbon footprints while your project is at a concept stage.
- ☐ The Environmental Performance in Construction (EPiC) database developed by the Melbourne School of Design is an embodied carbon data base for over 850 common building elements and materials.
- ☐ The Melbourne Green Factor Tool assesses green infrastructure credentials of building developments in the City of Melbourne.
- ☐ Developed by the US forest service the i-Tree tool help people understand the benefits of tree planting and has a number of different modules including Landscape / Canopy / Design and eco. See AILA's training video
- ☐ The Full Carbon Accounting Model (FullCAM) by the Australian Government calculates large scale GHG emissions and sequestration from the land sector.

Image credit:Pamela Conrad - Pathfinder app



Other GHG lifecycle assessment tools

There are a number of carbon calculator tool on the market. Some are free, others require purchase or subscription.

- Athena Impact Estimator evaluates the life cycle assessment (LCA) of whole buildings.
- Embodied Carbon in Construction Calculator (EC3) provides information about the embodied carbon impact of building materials during the material selection process using American Environmental Product Declarations data.
- Tally is a Revit plugin that allows designers to quantify the environmental impact of building materials for whole building analysis as well as to compare design options.
- Beacon is a Revit plug-in allowing engineers to manage embodied carbon in structural projects.
- One Click LCA helps calculate and reduce the environmental impact of building and infrastructure projects.
- eToolLCD is a whole building LCA and design software.
- Zero Tool calculates energy reduction baselines and targets for buildings.
- Fitzpatrick+Partners facade planning tool.

Image credit: Fuzz Digital

Building a complex custom element

Where there are no pull down menus for complex elements you can construct your own.

- Custom elements can simplify data input into Pathfinder. A linear seat wall with 10 separate inputs can be made into a one metre long item that can then be used as a custom element. It can then simply be multiplied by the length of the wall.
- Custom elements allow you to use manufacturers' EPD data for furniture like seats, bin and lights etc.
- Custom elements can be used to estimate the emissions in small structures like pergolas and pedestrian bridges.
- You can make custom elements with a simple spreadsheet or the Pathfinder custom element, or combination of the two.
- Use the EPiC database and manufacturers' product data to generate a carbon dioxide equivalent for each elements. Combine to get a composite Co2e value.
- Learn more with our four minute custom element training video on the AILA climate positive design website.

Image credit: AILA / Martin O'Dea

Section B

MANAGING AND MITIGATING CLIMATE IMPACTS

Image credit: Martin O'Dea. Lake Tabourie. Meeroo National Park

Chapter 6.0

Image credit: Martin O'Dea • Uluru-Kata Tjuta National Park

6.0 Climate mitigation and Indigenous Traditional Knowledge

"Cultural fire means everything. It means healing Country and when you heal Country, you heal people".

Wurundjeri Elder Dave Wandin [43]

Indigenous peoples are well placed through the Indigenous estate to influence a change from the post-industrial greenhouse gas emissions to move to more renewable energy sources.

However, there is added pressure on Indigenous people to provide solutions on climate adaptation and mitigation, through sharing their knowledge mostly for free of charge. This is not appropriate.

This has been identified in the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES):

Indigenous peoples and local communities possess detailed knowledge on biodiversity and ecosystem trends. This knowledge is formed through their direct dependence on their local ecosystems, and observations and interpretations of change generated and passed down over many generations, and yet adapted and enriched over time. Indigenous peoples and local communities from around the world often live in remote areas, interacting with nature and managing resources that contribute to society at large. They are often better placed than scientists to provide detailed information on local biodiversity and environmental change and are important contributors to the governance of biodiversity from local to global levels (IPBES, 2019)[44].

Mitigation as defined by the IPCC as:

A human intervention to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2014, pg1769)[45]

Adaptation as defined by the IPCC as:

The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects (IPCC, 2014, pg1758)[46].

Some of the key findings from the recent State of the Environment Report (2021)[47], all of which have a significant impact on how Indigenous people can mitigate and adapt:

- "Warming of the Australian climate and associated changes in the climate system, largely driven by increasing concentrations of greenhouse gases in the atmosphere, continue unabated".
- "Since the early 20th century, average Australian land temperatures have increased by 1.4 °C. This is similar to the global average rate for land areas. Regional sea surface temperatures have increased by 1.1 °C. Most of the increase has occurred since the 1950s. In a warming climate, it is expected that the frequency of warm extremes (including heatwaves) will increase, and that of cold extremes will decrease".
- In general, rainfall is declining in the south of Australia and increasing in the north. Snowfalls are decreasing. Droughts and periods of extreme fire conditions are expected to become more common, as are more intense rainfall events.

Indigenous engagement on establishing adaptation frameworks for climate change is limited at best. The lack of acknowledgment of Indigenous people's direct knowledge of Country has created a significant gap in developing a framework in Australia that genuinely engages their voice and knowledge, National State of the Environment (SOE,2021)[48].

"Climate adaptation for Indigenous peoples embodies all the old ways of seeing and doing that have been the basis of their survival for millennia and which now form the foundation of their own, contemporary responses to the challenge of current climate change"[49]

Engaging Indigenous people and their knowledge as equals is a priority for developing future adaptation structures. These include emission targets, the use of cultural burning, investment in renewable energy and carbon reduction projects.

Along with implementing solar rebates, and installing culturally appropriate electric vehicle charging stations. Importantly we need to be re-creating carbon sinks in urban landscapes (including wetlands), and seeing the landscape through Indigenous eyes.

Removing concrete barriers and structures will help to slow down water and increase carbon sequestration through vegetation.

Indigenous people with long, deep, and connected knowledge of Country are experts in sustainable management of their land and waters. This encompasses the management of some of the important conservation areas that are also home to threatened species and carbon sinks.

The Intergovernmental Panel on Climate Change has recognised the critical role that Indigenous peoples play in stewarding and safeguarding the world's lands, waters and biodiversity, as well as the unique vulnerabilities of Indigenous peoples to a changing climate[50].

We Indigenous People are here and ready. Come join us at our sacred fires to listen. We can answer the call for action on climate change, just as our thousands of past generations have done[51].

Chapter 7.0

Monash University Forum Landscape • Taylor Cullity Lethlean | Peter Elliot Architecture • Wurundjeri Country

7.0 Climate mitigation and adaptation Toolkit

"We've got to be tougher and better at doing this. It's not enough to be a good designer, but an active designer, to take leadership in the era of climate change and stay relevant in an ever changing world"

Martha Schwartz. New Climate Declaration Conference 10th June 2016

Responses to climate are often placed into two key areas. Firstly, **mitigation** measures that directly reduce greenhouse gases that are heating up the planet.

And secondly **adaptation,** which is about responding to changes anticipated with rising temperatures, sea levels and other climate change impacts.

In reality the work of landscape architects integrates both, along with other **co-benefits** such as biodiversity, health and well being.

When we plant a street tree it is providing both mitigation and adaptation outcomes. It mitigates by pulling Co2 out of the atmosphere, helping to cool the planet. It provides adaptation from its shade which stops pavements heating up and contributing to the urban heat island effect. It captures urban stormwater and filters pollutants out of the atmosphere. The tree also has multiple co-benefits. It is attractive to look at, in a park it provides health and well-being benefits, along with nesting and food for insects and birds. Economic benefits include savings from intercepted stormwater and increased property values.

Climate mitigation

Climate mitigation measures reduce greenhouse gases that are heating up the planet. By preventing them entering the atmosphere in the first place. Secondly, by drawing down excess emissions out of the atmosphere.

The number one priority needs to be emissions reductions. Landscape mitigation solutions can draw upon the following opportunities.

Traditional Knowledge systems from 65,000 years of continuous culture provide clear direction on climate mitigation through indigenous led work on Country.

The next step is **designing low carbon landscapes and places.** This starts with strategic decision-making down to how we specify materials.

We can **design walkable, cyclable and public transport friendly cities.** These reduce reliance on private fossil fuel transport.

We can **save energy elsewhere** by cooling buildings through planting and local food production that reduces food miles.

Renewable energy systems provide a direct decarbonisation pathway away from fossil fuels. As landscape architects, we may be directly involved in smaller scale projects. For larger utility scale systems we might play a supporting role in siting, strategic planning and integrating systems into the landscape.

Image credit: John Gollings

Our next biggest lever is **drawing down CO2.**

Out of all of the greenhouse gases, the only gas we can pull out of the atmosphere is carbon dioxide. The simplest method is using **trees and nature-based solutions**. This draws down CO2 into trees, shrubs, grasses, soils, peatlands and coastal ecosystems. These are part of the landscape architect's primary toolkit.

This needs to start with retaining and protecting the vegetation we still have left. Australia's plants – from deserts to forests to ocean – play a vital role"[52].

At a planetary scale we only have the ability to draw down about 10% of our total emissions. So our drawdown options need to be reserved for pulling existing CO2 out of the atmosphere, not offsetting new fossil emissions.

For a bigger picture of drawdown opportunities see Project Drawdown and their 2020 drawdown review.

Beyond the scope of this document are technological ways of removing CO2 from the atmosphere - currently at great cost and very low scale. These include Direct Air Capture, or DAC. And of course the perennial fossil fuel favourite - Carbon Capture and Storage or CCS, which has very few successful projects[53]. Both of these rely on specific geological conditions to actually work, and are thus limited in application.

Climate adaptation

Climate change adaptation is what we need to do to adapt society to locked-in climate change.

This includes:

- Higher temperatures, more intense heatwaves and longer-lasting heatwaves.
- More severe weather events including more intense rain events and longer periods without rain.
- Increased drying and increased bushfire risk.
- Locked-in sea level rise, coastal inundation, and rising salt water tables.

These all have associated risks to infrastructure, human health and natural ecosystems.

As landscape architects, much of what we do is in some way responding to climate adaptation. Many of the toolkit actions for adaptation would be described as "sustainable" initiatives. Or even just good landscape architecture.

The adaptation toolkit is focused on key landscape actions that relate to climate.

Adaptation measures include:

- Managing urban heat for human comfort through **cool green cities**.
- **Water resilient cities** that can respond to more intense rainfall events as well as extended periods of low rainfall.
- Using **nature-based solutions** to leverage ecology and natural systems to manage climate impacts at large scales.
- **Designing for locked-in sea level rise** on our coastal fringes.
- **Protecting vulnerable communities** from the worst impacts of climate change.
- **Building biodiversity** to buffer against biodiversity loss and bioclimatic shifts.
- Moving towards a **circular economy** to make the most of limited resources.

Climate mitigation and traditional knowledge

Land

Land or Country is at the centre of Indigenous peoples being. Where they belong. Their spirit is born from and returns to country. It is identity, language and lore. So, protecting it, is a cultural obligation and a birth right.

There is a saying in Indigenous world, **"If you look after Country, it will look after you and if Country is sick, we are sick"**. The current state of country, including the climate, is not ideal. Cultural indicators of season are telling us that Country is sick and we need to work together to bring it back to health.

Opportunities for adapting to a sick climate:

- This could involve divesting high emitting carbon enterprises and leading a change to greener, lower emitting targeted enterprises across sectors.
- The aim is for decarbonisation whilst protecting country and includes the implementation of a cultural burning regime. While acknowledging that burning country still emits carbon, it allows for the right fire for the right country and leads to less likelihood of catastrophic wildfires.
- Indigenous groups across Australia are also working to re-introduce fire burning as a cultural adaptation strategy. Fire burning was traditionally used to help establish and maintain hunting grounds, to crack rocks, to create tools and weapons, to maintain trade routes, keep travel corridors open, clear water ways and to ensure seed germination[54].
- Establish solar farms and battery storage facilities that are dual purpose. Work with local traditional owners to identify cultural plant species that could be planted as understory to solar panels that can be harvested.
- Plant endemic drought-tolerant local and native species rather than deciduous non-native species, to reduce nutrient loads in water ways. Deciduous trees tend to go dormant in colder months compared to natives, limiting carbon dioxide take up.
- Develop renewable energy strategies to reduce carbon footprints with Indigenous people. Allowing them to be at the start of projects and throughout.
- Developing solar, battery, wind, hydro rebates at local levels to ensure there is a return or reciprocity for knowledge input and exchange.
- Installing culturally appropriate and visually electric vehicle charging stations. Further actions could include reducing subsidies and taxes on electric vehicles purchasing and registration.
- Local agencies developing culturally designed skins or stickers by local Indigenous people for electric and low emission fleet vehicles.

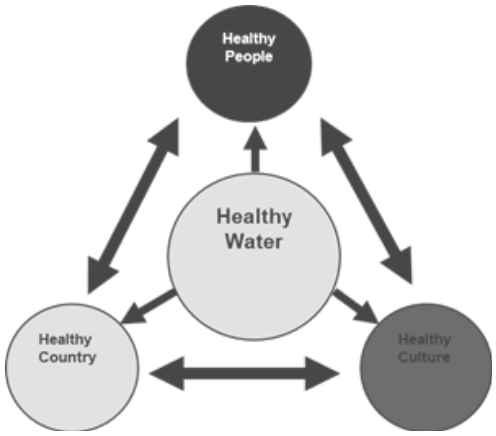
Image credit: Bradley Moggridge. Heathy wetlands are great carbon sinks, internationally significant, prime habitat for many species and an indicator of healthy country. Gwydir Wetlands

Water

Water has always been a crucial component of Aboriginal people's subsistence and survival in the sometimes harsh and ever drying landscape of Australia. This has been the case for up to 65,000 years or in Aboriginal people's stories, time immemorial (or day 1). Water is sacred and at the core of wellbeing and healthy people, culture, and country. The diagram opposite is a basic understanding of that relationship.

Opportunities for adapting to a sick climate:

- Re-creating carbon sinks in urban landscapes (including wetlands). Seeing the landscape through Indigenous eyes by increasing waterway vegetation.
- Removing concrete barriers and structures to slow down water and increase carbon sequestration through vegetation while stripping nutrients out of urban run-off.
- Many urban spaces have reclaimed wetland systems or have installed systems fed by natural springs. Re-establishing these wetlands and creating water features that are aesthetically pleasing and places to enjoy.
- Planting out riparian zones of waterways and protecting those buffer zones. Establishing watering points for cattle away from waterways.
- Protecting recharge zones for groundwater systems (maintain natural buffers and reduce drawdown of groundwater levels), to ensure natural springs continue to flow, so their water-dependant species are sustained, and cultural values are protected.
- Manage the recharge of groundwater systems by injecting collected rainfall and treated urban stormwater to replenish depleted groundwater systems.



The relationship and importance of healthy water to a healthy country, healthy people and a healthy culture (Moggridge and Mihinui 2010[55] , in Moggridge and Thompson 2019.[56]

Designing low carbon landscapes and places

Influence policy and make good strategic decisions

Our biggest levers are policy settings and making the right strategic decisions.

- ☐ Enable substantial change through government policy, legislation and standards at local, state and federal levels.
- ☐ Convince clients to aim high with climate positive design. Sell long-term benefits and point of difference.
- ☐ Make good strategic decisions to provide substantial long-term emissions savings. For example compact cities.
- ☐ Make upfront decisions that reduce fossil fuels. For example, a policy to exclude new fossil gas for a residential development locks out long term emissions.
- ☐ Actively work towards landscape architects being represented, influencing and driving national land sector, built environment and climate policy.
- ☐ Up to 80% of emissions are locked in by concept stage so early decision making is critical.

Image credit: Wondrous World Images

Embed climate positive design thinking upfront

If we start with a climate positive design philosophy, it permeates all decisions.

- ☐ Include measurable low carbon and climate positive outcomes in consultant design and planning briefs.
- ☐ Embed climate positive design as part of your office, studio, or practice culture.
- ☐ Set embodied carbon benchmarks targets and at the beginning of each project. Require carbon accounting for each project to track and measure.
- ☐ Set climate positive design as a target goal and success factor at the beginning of every project.
- ☐ Find the climate champions in your office to help drive climate positive design and give them the resources they need.
- ☐ Ensure your boss, managing director, or department head is on board to help drive acceptance and reassure those unsure of the change to business as usual.
- ☐ Measure your projects emissions and set annual per m2 emissions targets for your projects practice wide. Aim to reduce these yearly to hit a 75% reduction by 2030.

Image credit: Rush Wright Associates

Retain as many trees on site as possible

Mature trees sequester far more CO_2 than smaller trees as they have maximum leaf coverage and therefore photosynthetic capacity.

- ☐ Minimise tree removal.
- ☐ Retain and protect as many large trees as possible for their stored carbon. Larger diameter trees store exponentially more carbon than smaller trees.
- ☐ Protect retained trees from service trenching and other construction impacts.
- ☐ Design around retained trees considering changes to water tables and sunlight.
- ☐ Find opportunities to recycle felled timber to protect the stored carbon.
- ☐ Protect intact ecosystems.
- ☐ Protect old growth forests and their associated ecosystems.

Reduce demolition, recycle and re-use materials

There are embodied emissions in previous construction that if retained, reduces new emissions.

- ☐ Examine what can be retained and re-used at an early concept stage.
- ☐ Re-purpose existing buildings and elements through renovation and adaptive re-use.
- ☐ Incorporate salvaged demolition materials on site. The image above of Small's Creek shows the former concrete lined culvert broken up and re-used.
- ☐ Conserve and protect valuable resources like topsoil by fencing off areas so they are not compacted and disturbed to maintain valuable soil carbon.
- ☐ Minimise soil disturbance where feasible.
- ☐ Carefully strip and salvage site topsoil for re-use. Ensure different soil horizons are managed separately.

Image credit: James Newman

Image credit: Alan Hoban

Reduce the extent of high carbon elements

Focus on reducing high emission intensity elements like concrete, steel and aluminium, dimension stone and urban furniture.

- ☐ Reduce the extent of emissions intensive hard-paved surface and replace with soft surfaces, or surfaces such as gravel.
- ☐ Reduce the extent of concrete paving, concrete walls and concrete blocks as seat bases.
- ☐ Limit the use of dimension stone unless it has a planned 50 year design life.
- ☐ Design out steel and galvanising where practical. Replace with Fibre Reinforced Plastic (FRP).
- ☐ Design out aluminium where practical.
- ☐ Reduce the use of kiln dried timbers where feasible.
- ☐ Reduce intensively managed lawns reliant on chemical fertilizer and petrol powered maintenance machinery.

Image credit: Coptercam

Maximise soft surfaces and soil root plate volumes

Trees and soil carbon are key drawdown measures that have multiple co-benefits.

- ☐ Maximise shallower (one metre deep) horizontal soil volume root plate areas over so called "deep soil" planting.
- ☐ Prioritise high-quality ground preparation over tree stock size.
- ☐ Maximise soil interconnectedness for soil microbes, biodiversity and tree health.
- ☐ Specify probiotic innoculants to promote soil fungi and other beneficial microbiota.
- ☐ Promote regenerative approaches that build soil carbon, for better climate and drought resilience.
- ☐ Plant as many large trees as possible to maximise long term carbon sequestration in woody material.
- ☐ Aim in general for a proportion of 70% soft to 30% hard surfaces.
- ☐ Use passive irrigation and wicking beds to maximise soil moisture growing capacity of trees.
- ☐ Use green roofs to reduce building heat loads and intercept and slow down stormwater runoff.

Image credit: Dan Schultz

Increase biodiversity

Biodiverse landscapes store more carbon and are more resilient to climate change.

- ☐ Provide a biodiverse species mix for pollinators and to build high ecological values.
- ☐ Increase biodiversity for greater carbon sequestration outcomes.
- ☐ See section on "Protecting and increasing biodiversity" on page 84

Image credit: Martin O'Dea

Design for longevity

The Spanish Steps in Rome were opened in 1725 and remain largely unchanged. The main attraction is the people.

- ☐ Consider simpler, more timeless detailing, less patterning and use of robust materials.
- ☐ Award projects that show "Thinking. Leadership and Results" and not just the latest and greatest big budget project.
- ☐ Recognise that Life Cycle Assessment calculators such as the Pathfinder App are based on the assumption of a 50 year lifespan.
- ☐ If you have a commission that impacts a project under 50 years old, speak to the original designers, look at re-purposing, and recycling first before re-building.
- ☐ Include the remaining embodied emissions to a 50 year lifespan of the project in your GHG assessment.

Photo credit: Ilnur Kalimullin on Unsplash

Specifying low carbon materials

Change your specifications and details to low carbon

We are in a high carbon world, but many low carbon alternatives including concrete are available.

- ☐ Use assessment tools and information from the Green Building Council of Australia on the selection of responsible products to help guide material selection decisions.
- ☐ Use resources from the Materials Embodied Carbon Leadership Alliance (MECLA) for up to date information on low carbon construction materials.
- ☐ Specify only special concrete not normal concrete, E.g. S25 not N25. All low carbon concrete requires an S designation. Use polymer concrete / low carbon concrete using fly ash substitutes which are readily available in most states except South Australia. Examples include Boral Envisia and Holcium Ecopact. Some manufacturers provide net zero concrete that is offset.
- ☐ Work with your engineer to change the 28 day concrete curing period to up to 90 days where structural supporting is not required (e.g. paving).
- ☐ As there is little low carbon steel available in Australia (as of October 2022), specify steel from manufacturers who are certified to a credible stewardship scheme for example ResponsibleSteel[57].

Image credit: Phillip Hayson

Set realistic and verifiable emissions targets

Targets need to be achievable and manufacturers and suppliers need to prove the specified outcomes.

- ☐ Research what are the lowest embodied carbon products on the market. Use this information so you can specify a measurable CO2e /unit outcome for the product.
- ☐ At time of publication concrete substituting Portland cement for fly ash, depending on product specified have a range of emissions per m3 as a guide of:
- ☐ 20MPA - 176-191 kg/m3
- ☐ 25MPA - 184-209 Kg/m3
- ☐ 32MPA - 194-238 kg /m3
- ☐ 40MPA - 249-282 Kg/m3
- ☐ Require environmental product disclosures (EPDs) to prove the emissions in low carbon materials meet what was specified.
- ☐ Push manufacturers to develop EPDs to provide greater choice and transparency.

Image credit: Simon Wood

Talk to tenderers, suppliers and manufacturers early

Incorporating low carbon alternatives can take longer than business as usual.

- ☐ Consider pre-qualified tenderers that you know will be working with you on low carbon alternatives.
- ☐ Offer to partner with manufacturers on tests and trials.
- ☐ Look into early contractor involvement during design and development.
- ☐ Provide a longer than normal tender period.
- ☐ Provide sufficient tender time and flexibility for the tenderer and their respective supply chain to source low carbon products.
- ☐ Provide a weighting system or other means, to encourage contractors to select the specified low carbon alternative over cheaper standard products.

Specify probiotic organic fertiliser not synthetic

Probiotic fertiliser produces no Nitrous Oxide emissions or damaging phosphate runoff.

- ☐ Use organic based fertiliser not one manufactured from fossil fuels. Typical ingredients might include chicken manure, blood meal, bone meal, fish meal, humic fulvic acid and live microbial inoculants.
- ☐ Ensure the organic fertiliser has appropriate levels of: Calcium, Magnesium, Sulphur and trace elements–iron, copper, manganese, boron, molybdenum, chlorine, zinc, and nickel.
- ☐ Biodynamic / probiotic fertilisers build soil biota and don't release nitrous oxide, or lead to excessive phosphorous in waterways.
- ☐ Compost lawn clippings and green matter to recycle sequestered carbon rather than remove them off site.
- ☐ Test existing soils to see what is deficient and build fertiliser specification NKP ratios to match soil and species requirements.

Image credit: Spiire

Lessons from regenerative farming

Image credit: Martin O'Dea

Require electrical maintenance equipment

Switching over to electric maintenance equipment reduces emissions, providing a safer, quieter, pollution-free work environment.

- ☐ Specify all electric maintenance equipment in your projects. Talk to your client so they know and can enforce it through site check ups and log books.
- ☐ Switching to all electric maintenance equipment is quieter with health benefits for staff.
- ☐ Provide guidance and training for staff to transition to new electric equipment that operates in a different way to petrol equipment, and how to manage it efficiently.
- ☐ Ask councils, clients and your preferred landscape contractors to switch to electric. This interview with Dan Mabe, founder of the American Green Zone Alliance provides excellent advice on the benefits of all electric landscape maintenance.

Image credit:: Martin O'Dea

High carbon soils through regenerative agriculture

Regenerative farming focuses upon the health of the soil and increased biodiversity[58] and not the stock or the crop. Key principles include:

- ☐ **No bare ground and maximising photosynthetic cover**. This maximises carbon drawdown, limits erosion, improves water holding capacity, and keeps soil microbiota alive.
- ☐ **Managing the water cycle, slowing water down.** Slow moving water hydrates the soil profile. High carbon soils can hold far more water so they are drought resilient.
- ☐ **Building soil biota and the soil mineral cycle**. Healthy living soil has million of organisms from earthworms and nematodes down to fungus.
- ☐ **No pesticides**. Synthetic pesticides do incredible damage to our environment and impact insect pollinators.
- ☐ **No industrial chemical fertilisers**. Regenerative farming mimics natural systems and does away with high cost, damaging phosphorous runoff and nitrous oxide emissions.
- ☐ **Maximise species biodiversity and ecosystem services.** Regenerative farming builds biodiversity to increase pollinators and natural predators including insects and birds.

Saving energy elsewhere

Green roofs, walls and facades, shade trees

Green roofs provide stormwater detention, biodiversity enhancements, and evaporative cooling benefits.

- ☐ Set green roof targets and statutory requirements to provide evaporative cooling and biodiversity benefits.
- ☐ Utilise air conditioner condensate to provide passive irrigation to green roofs.
- ☐ Combine with rooftop photo voltaic for higher efficiency. Recent studies have shown green roofs lower the ambient temperature allowing solar panels to be up to 3.6% more efficient[59].
- ☐ Green walls provide cooling benefits but require intensive water use. They should be considered where irrigation is provided by recycled or reclaimed water. See Sydney's One Central (Pictured above)
- ☐ In cooler climates, use deciduous trees to provide winter sun and summer shade to building. Use higher trunked, clear stemmed trees for the same in higher latitudes.
- ☐ Use high albedo surfaces to limit heat absorption.

Image credit: Martin O'Dea

Local food production to reduce food miles

Integrate local food production in the landscape to promote more localised self-sufficiency.

- ☐ Provide local community gardens and encourage local farmers markets to reduce food miles.
- ☐ Build in food production into rooftop agriculture. Most building roofs have very high solar incidence making them ideal places for crop production.
- ☐ Protect our remaining peri-urban agricultural areas from being lost to development and keep food production and transport in the city.

Image credit: Martin O'Dea

Nature-based and inspired climate solutions

Image credit: : Martin O'Dea

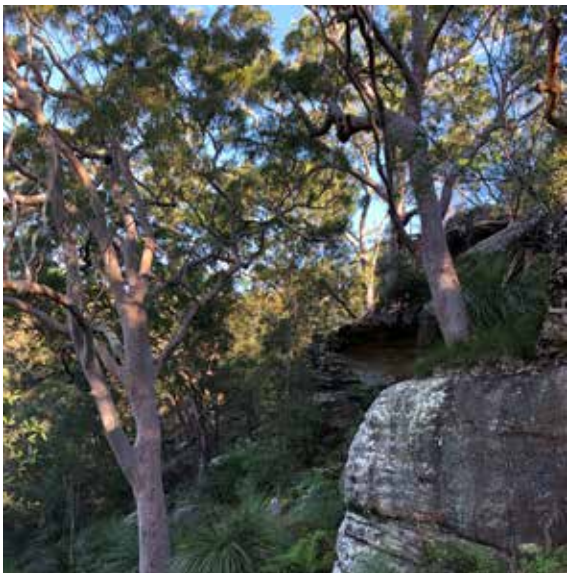


Image credit: : Martin O'Dea

Nature-based solutions that harness the power of functioning ecosystems are part of the landscape architects toolkit.

The International Union for the Conservation of Nature (IUCN) describes nature-based solutions as "actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature" [60]

Nature-based solutions use the power of natural ecosystems.

Nature-inspired solutions include innovative design and production of materials, structures and systems that are modelled on biological processes and are nature-inspired. For example, biomimickry uses strategies found in nature to solve challenges. They are not necessarily based on functioning ecosystems.

Nature-derived solutions include wind, wave and solar energy, all of which are derived from nature and help fulfill low carbon energy needs through production methods deriving from natural sources. Although these energy sources come from the natural world, they are not directly based on functioning ecosystems.[61]

Protecting and restoring terrestrial ecosystems

Australian native forest communities are vast store houses of carbon, plus they provide ecosystem services such as clean air and water.

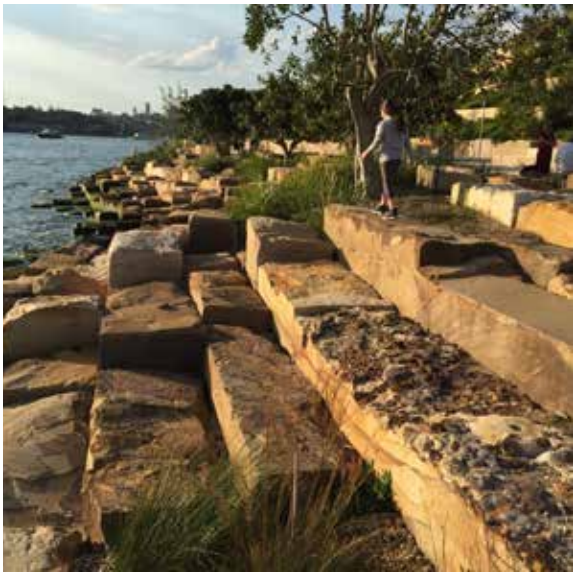
- Protect old growth forests and their diverse ecosystems. We are out of time to lose these ecosystems.
- Stop clearfelling for forestry and large scale land clearing for agriculture. These are incompatible with a future-safe planet.
- Manage, protect and extend existing ecosystems on your projects.
- Restore degraded landscapes through natural regeneration and habitat restoration.
- Develop urban forests and set canopy targets for urban afforestation opportunities.

Protecting and restoring coastal ecosystems

Coastal ecosystems sometimes known as "blue carbon", such as estuarine ecosystems, store significant amounts of carbon.

- Retain and protect coastal ecosystems including mangroves, saltmarshes, seagrass meadows, reeds, wetlands and associated muds and silts, can store significant amounts of carbon.
- Restore blue carbon ecosystems where they exist on your projects.
- Consider sea level rise in long term planning strategies.
- The ecological niches of coastal ecosystems are very narrow and highly determined by sea level. In particular, estuarine systems like mangroves and salt marshes which rely on tidal movements and regular inundation. Saltmarshes occupy an altitude range of only several hundred millimetres.

Image credit:: Martin O'Dea



Evidenced-based design and bio-mimicry

Much of what we build is recreated or constructed. Using evidence-based research can maximise sustainable outcomes.

- Design manufactured topsoil to mimic as closely as possible the soil profiles of your site. Barangaroo headland park is an exemplar of using science for the production of nutrient poor, biomimicked Sydney sandstone soils, and matching species to aspect and soil type.

Image credit: Martin O'Dea

Walkable, cyclable and public transport friendly cities

Image credit: Drew Echburg

Image credit: Martin O'Dea

Walkable and public transport friendly cities reduce reliance on private transport and in turn, reduce the greenhouse gas emissions produced by private vehicles

They also reduce land take and urban sprawl through use of compact and efficient neighbourhoods. They reduce road and parking infrastructure, freeing up, or conserving, land for more sustainable and climate positive land uses.

Combine this with the health, wellbeing and social equity benefits that come with walkable and public transport friendly cities. It is clear they are a critical component of climate positive design, even as private transportation transitions to an electric and 'greener' future.

Walkable cities

Walkable neighbourhoods reduce car dependency, save transport emissions, are healthy and socially equitable.

- ☐ Design for compact neighbourhoods. Orientate these around short and safe walking and cycling routes to key destinations. These might include city, town or local centres, schools and community facilities, open space and public transport.
- ☐ Prioritise walking over all other forms of transport within the movement network.
- ☐ Provide direct and convenient routes for pedestrians that enable them to travel the shortest distances across areas and between destinations.
- ☐ Provide access to a range of facilities typically within 10 minutes (up to 800 metres) walking distance from homes.
- ☐ Provide access to open space and recreation opportunities within 5 minutes (up to 400 metres) walking distance from houses, and 200 metres from an apartment.
- ☐ Increase street permeability and explore ways to break down barriers to pedestrian movement such as natural features, topography or major roads.

Cycle friendly cities

Designing cycle-friendly neighbourhoods has multiple health and climate benefits.

- ☐ A cycle-friendly city is where children can ride their bikes without parental supervision.
- ☐ Coordinate new cycle routes with local and state government agencies as well as bicycle groups and the community.
- ☐ Ensure they align with existing local and regional routes, and with local and regional strategic bicycle plans.
- ☐ Create connected, accessible, safe and comfortable cyclist environments.
- ☐ Provide end-of-trip facilities to encourage commuter cycle use.

Image credit: Martin O'Dea

Public transport accessible cities

Making public transport accessible, convenient and safe is critical to the creation of low carbon cities and neighbourhoods.

- ☐ Provide direct, convenient and comfortable pedestrian and cycle routes to public transport stops.
- ☐ Provide appropriate facilities at public transport stops and nodes, such as shelters at bus stops, and bike parking at light rail or rail stations.
- ☐ Consider distances people are willing to travel to access different types of public transport, for example:

- Bus stops are generally at frequent intervals and serve a smaller area and population catchment per stop;
- Light rail stops can be at less frequent intervals and serve a larger area and population catchment per stop;
- Heavy rail stations can be at less frequent intervals again and will serve a much greater area and population catchment.

Image credit: Martin O'Dea

Cool green cities

Image credit: Martin O'Dea

Australian cities are facing the prospect of 50 degree Celsius days. This is driven by anthropogenic climate change amplified by the urban heat island effect. We need to be designing for cool green cities.

Multiple lines of research show that trees are one of the most effective ways to provide urban cooling. Canopy shade can reduce pavement temperatures from 60°C to 30°C.

Evapotranspiration provides cooling that can drop local air temperature by a few degrees.[62]

Cool green cities are intertwined with water resilient cities that can provide the sustaining water for our trees. See also "Water resilient cities" on page 77

Prioritise vulnerable communities including those from lower socio-economic backgrounds with limited access to green spaces and tree canopy cover.[63]

Image credit:: GVL Gossamer

Urban forest strategies and tree canopy targets

We need to be re-foresting on a city scale by setting tree canopy targets and implementing urban forest strategies.

- ☐ Develop urban forest strategies and set canopy cover targets.
- ☐ Aim for a minimum of 40% canopy cover to the public realm by 2030, including retrofitting existing suburbs and new development. An achievable goal would be 15% cover for city core, 25% for outer core and 40% for suburbs.
- ☐ Maximise horizontal root plate volume and interconnected soils to promote healthy tree growth. A tree pit 10m x10m by 1m deep is substantially better than 4.5m x 4.5m x 4.5m deep with the same soil volume. Refer to Soils for landscape development by Simon Leake and Elke Haege.
- ☐ Plan for long term resilience by selecting species likely to manage predicted bioclimatic shifts over the tree's lifetime through website like Which Plant Where?.
- ☐ Develop end-of-life strategies for felled urban trees with a second life use such a furniture etc.
- ☐ Prioritise low socioeconomic areas with limited existing tree cover for new canopy planting.

Maximise tree cover in streets and urban areas

With ever-shrinking backyards, the public realm has become more important than ever for tree canopy cover.

- ☐ Street trees provide the green grid of connected tree canopy. They provide shade, intercept rainwater, provide visual amenity and improve property values.
- ☐ Challenge utility provider rules around services that greatly restrict opportunities for street trees. Re-think street cross-sections. Prioritise tree planting and urban cooling over unseen underground services. See re-imagined streescape sections in Western Parkland City, urban typologies and stormwater management. (page 10)
- ☐ Enable street trees in the parking lanes by using proprietary plastic support systems. These transfer vehicle loads through to the sub-base without compacting soils.
- ☐ Provide passively irrigated shade trees in new urban car parks to reduce heat island effects. Use proprietary plastic support systems to extend topsoil zones under pavements. Retrofitting existing car parks will help to reduce the urban heat island. Western Sydney has 6km2 of unshaded asphalt car parks[64]. See the Despicable Urban Places: study for research and justifications for your clients.

Image credit: Martin O'Dea

Design parks as local air conditioners

Parks can provide a cooling benefit or "park island effect" for several hundred metres through evaporative cooling.

- ☐ Protect and retain large and mature trees for their ecological, visual and carbon values. Protect parkland trees from drought stress by prioritising irrigation to them in times of water restrictions.
- ☐ Find an empty corner or underutilised space in existing parklands to plant out as a "carbon corner" for tree sequestration.
- ☐ Use passive irrigation and wicking bed lawns to maximise soil moisture.
- ☐ Use technology and irrigation systems to maximise evaporative cooling benefits for parklands. See also "Smart systems" on page 80
- ☐ Design climate smart playgrounds. Avoid hot materials such as synthetic grass that can quickly reach 70-75 degrees Celsius and rubber softfall. [65]
- ☐ Utilise nature-based solutions for ecological restoration of natural systems in our creeks (blue grid) network.
- ☐ Provide innovative long-term maintenance funding strategies for new public parks. Update planning frameworks so developer contributions can go towards recurrent maintenance.

Image credit: Martin O'Dea

Protect existing trees in the private domain

Use strong tree protection laws for the private domain to protect tree canopy from being slowly eroded and not replaced.

- ☐ Develop policies and strategies to reduce the continued loss of trees from urban development, to avoid a canopy cover gap over the next 20-30 years.
- ☐ Ensure sound tree retention policy to protect the existing canopy resources, including mature trees in residential properties.
- ☐ Develop tree valuation policies that reflect the true social, environmental, cultural and economic value of existing trees. See Melbourne City Council's excellent tree valuation fact sheet.
- ☐ Enforce tree protection measures on development sites to Australian standard AS 4970-2009.
- ☐ Require more robust tree replacement numbers than 1:1 for offsite planting in local streets and parks. Replacement tree numbers should be based on removed tree trunk diameter to help replace lost carbon stocks. While carbon stored in trees has exponential ratio to trunk diameter, a suggested strategy is one tree per 100 mm of trunk diameter. So a 300 mm diameter tree will require three replacement trees.

Image credit: TCL

Promote urban green infrastructure

Promote urban green infrastructure to be made an asset class for inclusion in high-value projects.

- ☐ Promote urban green infrastructure to be recognised as a critical infrastructure asset component with agencies like Infrastructure Australia.
- ☐ Promote green infrastructure as a replacement for grey infrastructure - particularly stormwater networks.
- ☐ Daylight creeks rather than piping them.
- ☐ Manage our living systems so they are still providing value in decades to come. Shift government mindset so that parks are not seen as cost burdens, but places of value for health and well being, and that maintenance is an employment opportunity.
- ☐ Communicate the value of green infrastructure to government and promote the economic advantages of street trees and urban forests. The City of Melbourne estimates its 80,000 trees are valued at almost $800 million[66].
- ☐ Counteract arguments about maintenance costs, by showing the benefits of reduced stormwater infrastructure, reduced temperatures and increased property values.

Image credit: Scott Burrows

Water resilient cities

We need to design and plan our cities to adapt to climate change that is leading to more extreme weather events. Global overheating is pushing hotter and drier conditions, but also more intense rainfall events.

As our cities expand, bushland and grazing land are being replaced with impervious housing estates. Increased runoff is resulting in valuable public open space being used to solve stormwater problems. At the same time, we are allowing enormous quantities of valuable stormwater to flow out to sea.

Australian towns and cities must be planning for gigalitre-scale stormwater capture and re-use as well as similar sewer mining and recycling of wastewater.

There is considerable embodied energy and carbon in purifying and transporting water from large-scale centralised dams, using it where it falls and seeking a zero ocean outfall

Cities need to target a 75%-80% reduction in water demand. Potable water needs to be protected as a resource. It needs to be reserved for use in droughts for drinking and irrigating century-old street trees, and other valuable vegetation in our parks and streets.

Gigalitre scale stormwater harvesting

Enormous amounts of stormwater is piped away and lost. We need to be harvesting stormwater on a Gigalitre scale in our Australian cities.

- Set city-scale, catchment by catchment stormwater harvesting targets. Aim for a 75-80% reduction in potable water use by re-use and recycling.
- Require all developments to harvest stormwater proportionally to the city-scale catchment targets.
- Design compact houses efficient enough to allow for at least 40% of the lot to be dedicated to soft / green space, to allow greater infiltration of stormwater.
- Consider community-scale roof water harvesting where rainfall exceeds 700mm/Pa, such as the Warrnambool, "Roof to Tap" scheme. Roof water is extremely clean, but most people don't know how to look after rainwater tanks. Roof to Tap takes clean water from domestic roofs to a centralised storage lake. It then only needs minimal treatment to be returned to houses as drinking water.
- Alternatively require rainwater harvesting tanks to provide non-potable uses such as laundry, toilet flushing and garden irrigation.

Image credit: Coptercam

Image credit: Martin O'Dea

Flood resilience: sponge cities

The Sponge Cities mantra is "retain, adapt, slow down and reuse." [67]

- Landscape architect Kongjian Yu coined the term "sponge cities" which seeks to reverse the idea of piping water away as fast as possible. The four key tenets are listed below:
- **Retain** water where it falls. Capture it for re-use. Retain in tanks, in soil moisture, in wicking beds, and in aquifers.
- **Adapt** to drier conditions by conserving water, using smart irrigation and limiting evaporation.
- **Slow down** moving water on the surface with soft surfaces and permeable paving, and by mimicking natural creek systems/ pool riffle functions using leaky dams, logs and stones on natural watercourses.
- **Reuse** water for drinking, and irrigating lawns, gardens, trees and crops. Harvest through passive irrigation.

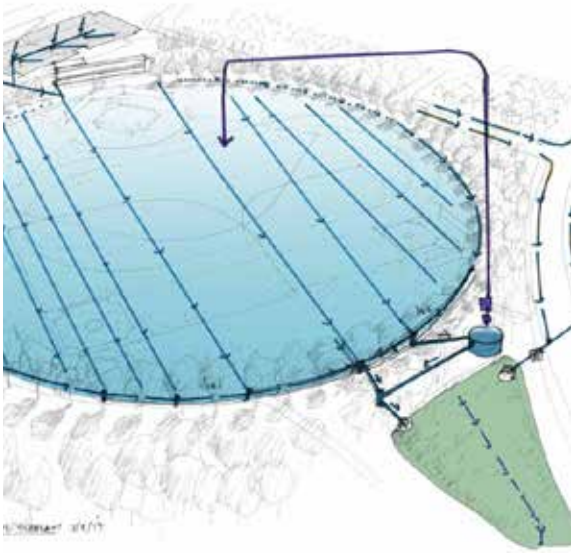
Image credit: Martin O'Dea

Use passive irrigation for cool green neigbourhoods

Capture excess runoff from urban areas to irrigate our public parks and street trees.

- Design for passive street tree irrigation.
- Utilise wicking bed technology to irrigate public lawns with urban stormwater.
- Include wet sump rain gardens that store water in the bottom 200mm layer of the raingarden media.
- For good resources on passive irrigation see Designing for a cool city – Guidelines for passively irrigated landscapes, by the Cooperative Research Centre for Water Sensitive Cities. See also work by DPIE in NSW.
- Ensure raingardens and flood detention basins are carefully integrated into the landscape to provide amenity to residents.

Image credit: Martin O'Dea



Stormwater harvesting for lawns and sportsfields

Sportsfields use substantial amounts of water. Summer usage can be 100,000 litres, several times a week.

- ☐ Design sportsfields to capture rainwater for re-use. Peel Reserve at The Ponds, captures all of the rainwater falling on the field and building roofs, along with any excess irrigation through subsoil drains. A kerb edge to the field edge walking path captures higher runoff events.
- ☐ Make the fields level and utilise wicking bed technology to irrigate sportsfield lawns.
- ☐ Where fields are co-located near creeks, consider a high-flow bypass strategy to capture of peak flows for irrigation. This reduces down stream flooding as a side benefit. The Blacktown City Council Angus Creek stormwater re-use scheme diverts high-flow events by using a simple overflow weir. This water is stored in ponds with floating wetlands. It is filtered and treated before irrigation use.
- ☐ In older catchments consider low-flow potable water leakage capture systems to harvest high-quality water for parklands. See the water for our community project in Canada Bay. This captures leaking potable water and treats it for re-use in parkland irrigation.

Image credit: CLOUSTON Associates

Zero ocean outfall: Gigalitre scale recycled water

There is considerable embodied energy and carbon in purifying and transporting water from large-scale centralized dams.

- ☐ Establish a zero ocean outfall strategy to drive the re-use of the sewerage water resource.
- ☐ Move to circular systems and away from our wasteful linear systems approach. We currently catch rain in distant catchments with low rainfall into large centralised dams, then we pipe it to a treatment plant, make it all drinkable, then drink only 10% of it and flush it all down the sewer system. We then treat the sewer to varying levels and dump it out to sea.

Image credit: Drew Echburg

Use smart systems for water resilience

Using smart systems, Internet of things, sensors and AI, to maximise the use of water.

- Smart systems can turn water storage areas into detention basins by partially draining lakes, rainwater tanks and storage ponds ahead of predicted storm rainfall events. This spreads the peak flow over more time, lessening downstream flooding. See systems and case studies by Opti in the USA.
- Manage irrigation demand through the use of smart systems, linked to real time sensors, predictive data forecasting from the Bureau of Meteorology, and back casting from machine learning of historic data. A trial is currently under way by Western Sydney University in Bicentennial Park Sydney, for SIMPACT (Smart Irrigation Management For Parks and Cool Cities). The software will be available in the next 2-3 years as a plugin to industry standard irrigation systems.
- Use albedo sensors and other devices to maximise efficiency of irrigation systems.

Image credit: Coptercam

Planning for low-lying flood-prone areas

With more intense rainfall events predicted, low-lying lands will become more vulnerable to flooding.

- Do not continue to build in flood-prone areas. Use flood-prone lands for agriculture not housing.
- Consider no development between the 1:100 and the probable maximum flood (PMF), or consider adapted solutions like 2 storey houses / stilt housing / ground floor from resilient materials.
- Restore flood plain functions and adopt a sponge cities approach.
- Build soil carbon to provide better water holding capacity, reduce runoff and slow water down.
- Plan for future impacts, resilience and evacuation plans and routes.
- Design creek and river infrastructure adaptable to high flows - jetties etc, bridges and boardwalks. For example, high piers to allow pontoons to float up, shear pins to allow bridge handrails to collapse with debris loading.

Image credit: Sydney Olympic Park Authority

Managed retreat from waterfronts and riverfronts

The town of Fairbourne in Gwynedd, North Wales [68]is the first place to announce a managed retreat to higher ground.

- The Lismore floods in NSW and coastal destruction at Clontalf Beach in Sydney have prompted similar questions. This is an extremely complicated issue where people become understandably attached to their place, their home.
- Consider climate justice issues for flood impacted properties, which are more likely to be inhabited by lower socioeconomic residents.

Image credit: Martin O'Dea

Image credit: Martin O'Dea

Designing for locked in sea level rise

The amount of heat-trapping greenhouse gases in the atmosphere has already locked-in considerable sea level rise (SLR). The CSIRO estimates a rise of 900mm by 2100 and the IPCC indicates a rise of between 3-5 metres by 2300.

Sea level rise is the slow burn of climate change. The current loss rates of land-based ice to the sea are accelerating.

Short term (next 50 years) will see an increasing need to temporarily protect lower lying areas. Longer term, will require more difficult relocation, retreat, and rebuilding.

Climate change and the resultant sea level rise has the potential to impact coastal groundwater tables via seawater intrusion (progressive encroachment through the subsurface) and inland migration of the fresh/saline interface.

Long-term impacts are dire and involve the relocation of hundreds of millions of people and the re-building of trillions of dollars of new infrastructure.

Design for water table rise and salt water incursion

Saltwater incursion of water tables is already present in low level islands in the Torres Strait Islands.

- Even only periodic salt incursions (for example, 2-4x a year)are killing crops that sustain livelihoods on Pacific Islands. Similarly, trees in harbourside parks are vulnerable.
- Lift the planting level for any significant waterfront trees that will be there for more than 50 years to limit groundwater salt incursion.

Image credit: Martin O'Dea

Image credit: Martin O'Dea

Consider sea level sensitive coastal ecosystems

Coastal ecosystems like mangroves and salt marshes are highly sea level dependent.

- ☐ Consider gentle slopes or terraces when re-building coastal ecosystems like saltmarsh to cater for rising sea levels.
- ☐ Natural ecosystems provide economically viable, large scale opportunities to draw down CO2 and embed it in biomass and build up soil carbon.
- ☐ Natural ecosystems can take centuries to develop, so protecting existing healthy ecosystems is critical with our rapidly closing time frame to 2050. Huge amounts of carbon are locked up in stable ecosystems.
- ☐ Restoring degraded coastal ecosystems and rebuilding destroyed ecosystems and biodiversity are the next most important steps.
- ☐ Consideration needs to be given to both above ground and below ground ecosystem biodiversity.

Image credit: Martin O'Dea

Implement short-term solutions

Manage short term sea level rise in a sensitive way to protect river and waterfront qualities.

- ☐ Provide openable levee gates like those illustrated above (Maclean on the Clarence River). These maintain a direct a physical relationship of land to water, a visual connection to the water, and allow stormwater in non-flooding events to drain to the river. Consideration may still be required for pump outs for combined high local rainfall and flooding events.
- ☐ Provide penstock valves on stormwater outlets to prevent backflow flooding via the stormwater pipe network.
- ☐ Restore and use natural ecosystems like mangroves and wetlands to provide storm protection. Recent work by Florida based firm Curtis + Rogers Design Studio, showed how a nature-based solution using islands would be superior to the US Army Corp's of Engineers concrete walls.
- ☐ New York landscape architect, Kate Orff has proposed a living breakwater made of oysters to help protect New York from a future Hurricane Sandy[69].

Image credit: Martin O'Dea

Protecting and increasing biodiversity

Biodiversity is essential to life on the planet. It is the foundation for resilient ecosystems that can respond to changing climate. The interactions of a diverse networks of species allows environments to adjust to change as well as maintaining essential ecosystem services.

Ecosystems take time to establish and reflect millions of years of co-evolution between species. Reduce climate and biodiversity footprint of your projects by working with existing ecological values.

The United Nations has declared 2021–2030 the Decade on Ecosystem Restoration. Only with healthy ecosystems can we enhance livelihoods, mitigate and adapt to climate change, and prevent further biodiversity collapse.

Five steps to protect existing ecosystems

Use this prioritised five step guide to protect existing ecosystems during planning and design.

- ☐ **Avoid** incremental habitat loss. Retain indigenous plants and habitat features such as established trees, shrubs and hollows, as well as seed collection.
- ☐ **Minimise** disruption during construction. Limit construction access, fence protected areas and include penalties. Design for succession rather than abrupt replacement.
- ☐ **Mitigate** long-term sensory impacts such as night lighting and noise and separate areas of high human activity from sensitive ecological features.
- ☐ **Rehabilitate** areas damaged by construction, and enhance degraded areas.
- ☐ **Offset** (off-site compensation) as a last resort. This can be very challenging to do given complex and location specific ecosystems.

Image credit: Martin O'Dea

Image credit: Martin O'Dea

Enable resilient and interconnected landscapes

Robust ecological systems build resilience, and humans are part of that system.

- ☐ Interconnected landscapes are essential for an adaptive and response to climate change.
- ☐ Connect with Indigenous history and culture in caring for Country. Incorporate design elements that support connections between people and biodiversity.
- ☐ Orient designs towards established ecological sites and habitat corridors.
- ☐ Consider connections at local, neighbourhood and broader landscape scales.
- ☐ Complement local ecological values to expand effective habitat extent.
- ☐ Construct diversified ecosystems, guided by 30% per family, 10% per genus and 20% per species.
- ☐ Design for succession rather than abrupt replacement.

Image credit: Martin O'Dea

Support planting with water, food, shelter and nesting

Consider the needs of the fauna inhabiting ecosystems.

- ☐ Plant selection is only one aspect of supporting a diverse ecosystem. The future of many current and threatened species will depend on actions to accommodate their needs within city boundaries.
- ☐ Create spaces which are safe, secure, provide water and food for species to stay and thrive.
- ☐ Provide food, shelter and nesting places to support existing habitats of native fauna.
- ☐ Design multi-functional landscape elements that support a diversity of species (bees, butterflies, birds, mammals, frogs and lizards).
- ☐ Ensure plant species of novel ecosystems are non-invasive and can provide the required shelter, nesting and food source equal to native species.
- ☐ Minimise light and noise pollution that can cause animals psychological stress. Avoid light near resting spots (like ponds, tall trees and hedges) and avoid white and blue wavelengths. Aim for warm yellow lights closer to 2000 Kelvin[70].

Image credit: Martin O'Dea

Use appropriate maintenance programmes

Maintaining biodiversity and habitat through more complex vegetation requires a shift from current practice.

- ☐ Consider how the landscape design can be maintained.
- ☐ Build design understanding and workforce skills and support training for managing biodiverse landscapes.
- ☐ Plan for maintenance requirements. For example, taller grass requires less frequent mowing and designs that allow access by larger machinery.
- ☐ Reduce invasive weeds with dense plant cover, inorganic mulches or low nutrient substrates.
- ☐ Specify maintenance requirements that support biodiversity and reduce reliance on chemical inputs.
- ☐ Work with maintenance teams to promote plant knowledge and organic maintenance methods.
- ☐ Schedule timing of maintenance to avoid breeding season or other sensitive periods.
- ☐ Stop using glyphosates and other pesticides including the neonicotinoid (neonic) chemical class of insecticides. [71]

Image credit: Martin O'Dea

Aim for biodiversity positive outcomes

Set out to convert cumulative habitat loss into cumulative habitat gain.

- ☐ Establish a vision and biodiversity goals and check outcomes against planning and design decisions (UK – mandatory 10% biodiversity net gain to be maintained for 30 years).
- ☐ Quantify biodiversity baseline to monitor and evaluate outcomes.
- ☐ Value all forms of blue and green infrastructure towards habitat gain.
- ☐ Seek understanding from Traditional Owners, ecologists, local indigenous nurseries and the community.
- ☐ Embed biodiversity positive design approaches into your practice. Advocate in conversations with clients and colleagues.

Image credit: Martin O'Dea

Use endemic or native species to enhance biodiversity

Increase flora and fauna biodiversity by using native, endemic and climate-resilient species.

- ☐ Use endemic species and native species where practical.
- ☐ Plan for seed collection well in advance as it can have long lead times and seasonal constraints.
- ☐ Consider long-term climatic shifts in species selection.
- ☐ Mimic soil types and profiles to selected species list.
- ☐ Avoid invasive species through low-nutrient landscapes.

Image credit: Martin O'Dea

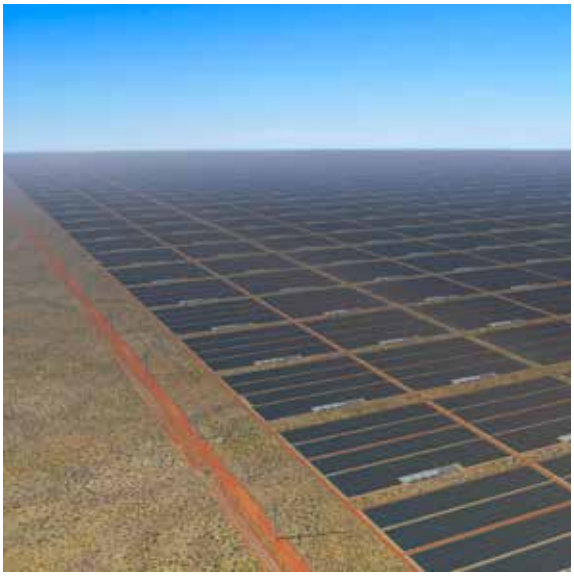
Provide habitat corridors

Rapid bioclimatic shifts require linear corridors to build biodiversity and assist with species movements.

- ☐ Use publicly owned land corridors free of agricultural management, like highways, roads, rail tracks, to re-build species diversity and interconnected ecosystem planting.
- ☐ Replace monoculture lawn verges and medians with biodiverse species mixes on verges with endemic soils to create self managing ecosystems[72].
- ☐ Provide green links to enable animals to reach habitat, food and mates. Avoid fragmentation and "ecological sinks" where animals are left without enough genetic diversity to sustain subsequent generations.
- ☐ Provide ecological bridges to connect flora and fauna across major barriers like highways and rail lines.

Image credit: Martin O'Dea

Renewable energy generation



Renewable energy systems provide a direct decarbonisation pathway away from fossil fuels. As landscape architects, we may be directly involved in smaller scale projects. For larger utility scale systems we might play a supporting role in siting, strategic planning and integrating these systems into the landscape.

There are two broad trends that we will need to work with as landscape architects. One is the development of mega-scale renewable energy projects that will have considerable visual, environmental and social impacts.

The second is the use of small scale distributed energy systems, such as rooftop and local solar and community batteries. This is going to evolve further when we include virtual power plants from electric vehicle batteries.

The benefit of small-scale distributed systems such as domestic rooftop solar, is that they don't require extensive and costly distribution networks. They can be incrementally installed along with the demand. So for example, a 500 lot residential development might include sufficient solar and a community battery to be largely self-sufficient.

Integrating utility-scale solar in the landscape

Australia has abundant solar and wind resources and stated desire to become a world renewable energy superpower.

- ☐ Manage the visual, environmental, social, and cultural impacts of mega-scale utility projects.
- ☐ Work with your ecological specialists to minimise environmental impacts from large scale solar.
- ☐ Work with Indigenous leaders to avoid and minimise cultural impacts.
- ☐ Minimise clearing of vegetation in the installation and construction phase.
- ☐ Use nature-based solutions and a natural systems approach to revegetate the understory areas of solar farms[73]. There are considerable biodiversity benefits, as well as improved efficiency for the panels, and reduced dust load that lowers panel efficiency.

Image credit: American Public Power Association on Unsplash

Image credit:: Sun Cable

Small-scale renewable energy and storage systems

Small-scale distributed solar combined with battery storage reduces fossil fuel dependence.

- ☐ Promote opportunities for remote regional communities to have energy independence through renewables and storage.
- ☐ Promote and develop policies to drive rooftop and small scale solar. Ensure these do not exclude other opportunities such as green roofs.
- ☐ Maximise solar potential In subdivision design through north south street alignments and best passive design lot orientation. Aim for a minimum of 70% of lots to be optimised for solar and passive architecture.
- ☐ Integrate small-scale solar with under planting for cooling efficiency co-benefits. For rooftop solar, combine with green roofs. In rural areas look for opportunities to co-locate within grazing farmland.

Image credit: ARENA

Community batteries

Community batteries provide opportunities to even out supply and demand. Increasingly they are being designed or retrofitted into our parks.

- ☐ Collaborate with your ESD and engineering team members in allocating space and siting for solar and community battery locations.
- ☐ Work with your ESD specialist in developing and promoting community rooftop solar with batteries. Community-level rooftop solar can maximise energy generation including east, west and even south-facing panels. These spread renewable energy generation into areas of higher demand. They can more effectively manage different individual residents' demand profiles. For example, a resident that works from home may need more daytime power than someone who commutes to work.
- ☐ There are many remote communities in inland Australia that rely on long supply chains with diesel fuel and diesel generators. There are huge opportunities with decentralised renewable energy power, combined with storage, to make these communities independent of fossil fuels.

Image credit: One step off the grid

Wind farm visual impacts

Wind turbines have been progressively getting larger with commensurate environmental impacts

- Five MW scale wind turbines have blades up to 120 metres in diameter and stand 150 metres high creating significant visual impacts, particularly when located in wooded hilltop areas.
- Minimise clearing and vegetation removal for construction access roads and cleared construction areas at the base of each tower. Rehabilitate cleared areas.
- Talk to your engineering team to specify a low carbon concrete for the tower footings.
- While more research is required, a five-year study in Norway identified reduced bird mortality where one blade was painted black.
- Evaluate pylon locations to minimise visual impact.

Image credit: Martin O'Dea

Electric vehicle charging infrastructure

Decarbonising transport requires all vehicles to be fully electric electric by 2050.

- Consideration is needed for the neat integration of charging infrastructure into our rural and urban landscapes.
- Future proof / design in two way charging for all new housing stock. Two-way vehicle-to-grid charging will be essential to enable cars to become virtual power plants.
- Future-proof new multi-story car parks for EV charging, associated substations and all the charging infrastructure is designed in to allow future installation or expansion.
- Design for and mitigate the visual impact of car charging points potentially on every parking bay.
- Consider opportunities and for siting fast charging stations within new residential communities, suburban centres and campuses.

Image Credit: myenergi on Unsplash

No new fossil gas reticulation

There is no place for fossil gas in a climate positive future aimed at 1.5 degrees.

- ☐ Set strategic policy guidelines for full electrification and to prohibit new gas.
- ☐ Ensure no new gas reticulation within suburban subdivisions, campus developments etc.
- ☐ Replace existing gas with full electrification.

Image credit: Martin O'Dea

Section C

COLLABORATE, COMMUNICATE, EDUCATE AND ADVOCATE

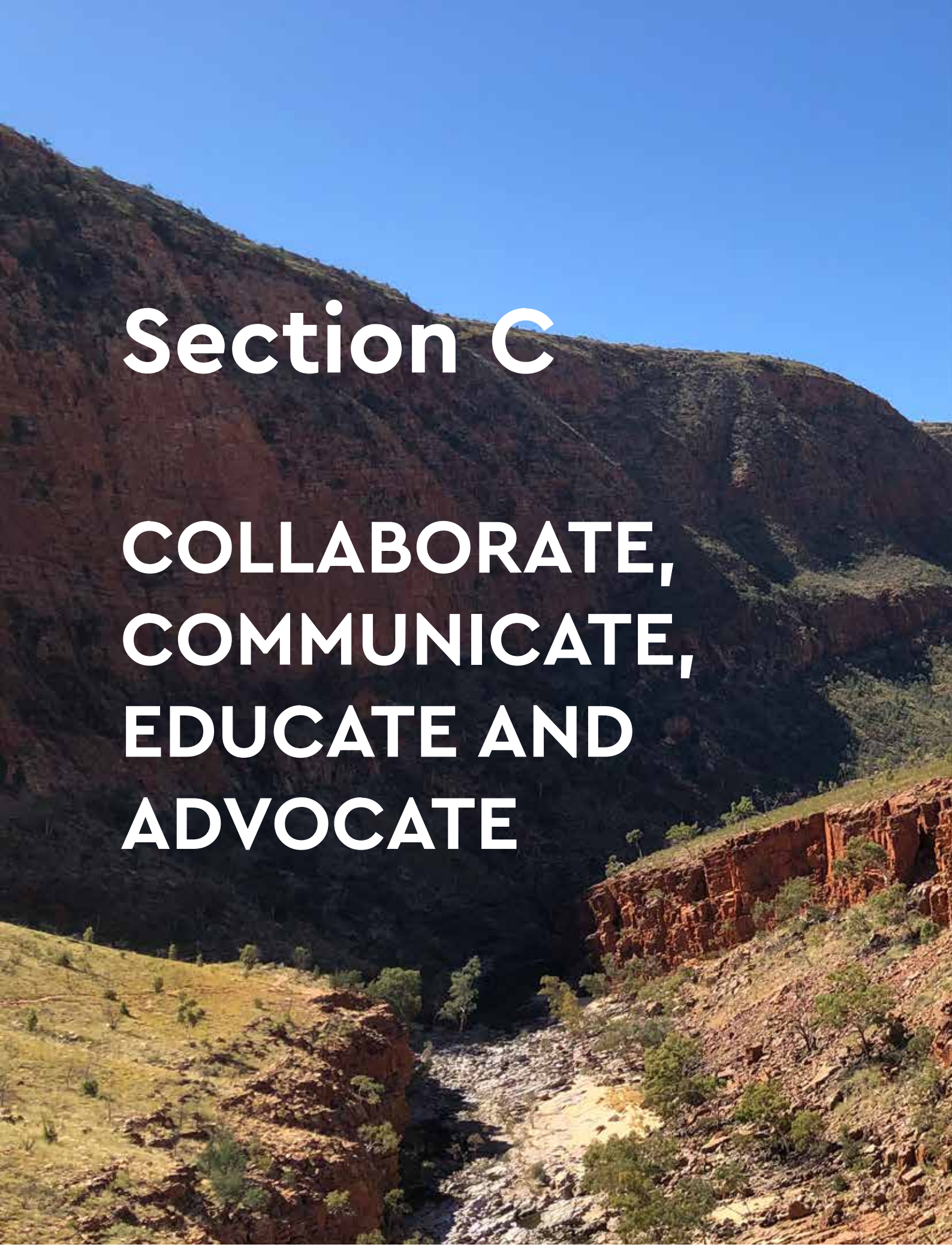


Image credit: Denise Beecroft Tjorita / West Macdonnell National Park

Chapter 8.0

Uluru • Uluru Kata Tjuta National Park • Photo: Martin O'Dea

8.0 Indigenous cultural perspective on collaboration

"Collaborating with Indigenous communities by the three 'T's – Time to build Trust over cups of Tea."

Bradley Moggridge • Kamilaroi Water Scientist

Indigenous people have and still are a part of all the regions (from urban, desert, coastal, alpine, tropics, temperate and river country) across Australia. With their deep knowledge of Country, they understand them. They dance and sing them. This has existed for thousands of years.

The connection does not stop at the borders of states and territories or at boundaries of private properties, nor does it stand apart from caring for country. The connection is deep and a birthright for Aboriginal people.

The diversity in Indigenous Australia should be acknowledged and respected. One should not view all Aboriginal people as a single group with common values, landscapes, language (over 300 different languages), governance, climates, lores, goals and capacity. The connection does not separate the aspects of the environment: the land, water and sky.

While considering these aspects of Indigenous culture, there are many resources available that provide protocols and principles for engaging and collaborating with Indigenous people. It just takes courage and effort to do so.

The CSIRO's Our Knowledge Our Way[74], in caring for Country Best Practice Guidelines, gives a voice to Indigenous land and sea managers who have found positive ways to strengthen their knowledge and build partnerships and collaborate for knowledge sharing in caring for Country. The Guidelines are Indigenous-led and were based on an open, transparent process established where:

- Indigenous people are using their Indigenous and traditional knowledge to care for their Country, including in the development of business opportunities and enterprises.
- Indigenous people have experienced positive engagement and good outcomes when their Indigenous knowledge has been brought into co-management or research projects.
- Indigenous people and their knowledge have been treated the right way when engaging with others (government, non-government organisations, researchers, industry, etc.).
- Indigenous land managers share lessons learned about knowledge sharing.
- Indigenous land managers identify the conditions under which good knowledge sharing can occur.

The content of these Guidelines is based on principles of respecting Indigenous ownership of Indigenous knowledge and ensuring free, prior, and informed consent (FPIC), and is discussed below.

A key component to achieving two-way collaboration is the building of trust between the parties, for without trust, a project is set to fail. Indigenous people will determine that a project cannot proceed if trust has not been established. If trust is established with integrity, the project will have better grounds of achieving the desired outcome.

The United Nations Convention on the Rights of Indigenous People has developed best practice principles for anyone seeking consent from Indigenous people, known as 'free, prior and informed consent' (FPIC) . FPIC requires that you have enough time, information, and resources to make a decision about whether or not you will consent (give permission) to an urban design project on public land.

FPIC means that consent is: free from force, intimidation, manipulation, coercion, or pressure; obtained prior to the project starting; and obtained after Indigenous people are fully informed about the costs, benefits, and risks of the project; and have the opportunity to seek independent advice.

When beginning the collaboration process, it must be noted that some communities may not be familiar with your area of expertise or project brief, planning and approval processes. They may be unfamiliar with your research processes, ethics, timelines and terminology. It's possible they may have had a complex and strained relationship with consultants in the past and, for a range of historical or cultural reasons, may not feel empowered to say what they would like to.

Indigenous cultural protocols are appropriate ways of interacting with Indigenous people and Indigenous communities. They encourage ethical conduct and promote interaction based on good faith and mutual respect.

By sticking to the values for creating trust outlined above, AILA can strives to engage and collaborate with Indigenous people and their cultural knowledge respectfully and in good faith.

The following engagement ideas are adapted from the Lowitja Institute - climate change and Aboriginal and Torres Strait Islander Health discussion paper and other sources including the Australian and International Indigenous design Charters.

Listen first

- ☐ Engage in conversation and listen to indigenous stories.
- ☐ Understand approach to Country and cultural frameworks.
- ☐ Listen first. Engage with indigenous community leaders early and often.

Place Based approach

- ☐ Recognise the diversity of Aboriginal and Torres Strait Islander cultures, as well as the diversity of climate impact.
- ☐ Aboriginal and Torres Strait Islander peoples know what is best for their Country.

Image credit: Australian Broadcasting Corporation

Building respectful partnerships

- ☐ Enable equitable voices for provide Aboriginal and Torres Strait Islander communities more certainty and control in protecting Country.

Co-design and collaboration

- ☐ Build respectful and trusting partnerships to share and weave together Aboriginal and Torres Strait Islander and Western knowledge systems.
- ☐ Co-design and Collaboration with Indigenous cultural lands management practices in your work.

Intellectual property protection

- ☐ Respect and protect Indigenous Intellectual Property.
- ☐ Leveraging valuable biocultural knowledge while protecting intellectual property.

Access to Country

- ☐ Promote access to country.
- ☐ Enabling direct action on country and co-benefits to indigenous communities
- ☐ Recognise importance of access to Country and the Rights of Indigenous People.

Build up usage and acceptance of Cultural fire

- ☐ Seek advice on potential for cultural burning to restore biodiversity and reduce fire risk on your projects.

Sustainable future engagement opportunities

- ☐ Provide ongoing future employment through life of the project. For example seed collection, propagation, maintenance.
- ☐ Providing sustainable resourcing and program flexibility to support innovation and long-term monitoring and evaluation.
- ☐ Ensure Indigenous people share in the benefits from the use of their cultural knowledge, especially where it is being commercially applied.

Chapter 9.0

Mollison Park • RPS • Photo: Scott Burrows • Turrbal and Yuggera people

9.0 Collaborate, communicate, educate and advocate

"What can we do to break this vicious cycle? The number one thing we can do is the exact thing that we're not doing: talk about it."

Katharine Hayehoe - "The most important thing you can do to fight climate change: talk about it" TEDWomen 2018

Advocating for climate positive design and practice is critical to AILA's core values.

Landscape architects are in a position to influence positive change. Collaboration with Traditional Knowledge holders, and our built environment colleagues can help drive good long-term outcomes. This can include the following actions:

Create change within your organisation through internal education and prioritisation of sustainable initiatives.
Provide interested and enthusiastic staff with the tools they need to make improvements. Encourage and allow time for internal training and knowledge sharing.

Use local government and client relationships to provide important platforms for collaboration and communication.
Engage in conversations around sustainability project goals with clients early in the process. Landscape architects should advocate for sustainable outcomes, including climate positive projects.

Demonstrate through design practice.
Projects that showcase climate positive design provide benchmarks for future works. Climate Positive landscapes can demonstrate successful solutions for other practitioners.

Support sustainable business models.
Examination of supply chains and supply chain charters allow practices to let their money do the talking. Shift away from carbon-emitting and instead support carbon-neutral suppliers.

Advocate through purchasing and engagement power of your practice.
Encourage upstream and downstream suppliers to examine their own climate positive commitments. Discuss time frames for these changes with subconsultants and contractors. This can be a very impactful way for larger firms to advocate to their connected businesses.

Keep the message positive.
In design practice, focus on elements that work and productive discussions that informed the design process. Encourage others to speak up in their own practice to meet climate positive targets.

Share knowledge.
Landscape architectural practice continues to evolve, and is richer for the experience of everyone. Creating climate positive landscapes will become easier with each new project and lesson learned, and conversations between designers can encourage change.

"We don't need 10% of landscape architects going climate positive perfectly, we need 100% of landscape architects going climate positive imperfectly and learning from each other. Small changes add up, and often make big changes easier."

Collaborate and communicate

You and your business: In practice

Consider how to align your business or organisation with climate positive design outcomes.

- ☐ Aim for climate positive / biodiversity positive / water positive / energy positive outcomes in all projects.
- ☐ Develop a climate positive implementation plan and checklists, undertake climate design reviews, set targets and climate benchmarks and measure progress of your projects and organisation.
- ☐ Find your climate champion / climate lead.
- ☐ Invest in staff education about climate positive design and work to shift mindsets from business as usual.
- ☐ Use the Pathfinder app or other software to review your projects GHG footprint.
- ☐ Understand your business GHG footprint. Prepare a sustainability action plan and work toward carbon neutral certification. See our Climate positive design Volume 2.
- ☐ Identify R&D areas for your organisation on climate positive design.
- ☐ Build you own database - review past projects, e.g. emissions per m2, tree survivability, size and sequestration, etc.
- ☐ Update your base specification and typical details.

Image credit: GHD

Collaboration with allied professionals

Working collaboratively with our built environment colleagues for meaningful change.

- ☐ Build working relationships on climate with fellow built environment professionals to create climate positive projects including:

- Architects
- Urban designers
- Engineers
- Planners
- Ecologists
- Soil scientists
- Horticulturalists
- ESD consultants

- ☐ Raise awareness on climate positive design with your design collaborators.
- ☐ Provide space for discussions about how to maximise the environmental benefits from projects to ensure a multi-disciplinary approach.
- ☐ Prioritise engagement of consultants that are willing to provide creative solutions towards climate positive projects.

Image credit: CLOUSTON Associates

Work with manufacturers, suppliers and contractors

For every park, playground and streetscape to be climate positive, we need zero embodied carbon in construction materials.

- ☐ Research and talk to manufacturers about low carbon alternatives for materials used in your projects.
- ☐ Work with agencies, including the WWF Materials Embodied Carbon Leadership Alliance (MECLA), as well as ASBEC and the GBCA for low carbon materials.
- ☐ Always ask manufacturers to provide Environmental Product Disclosures (EPDs) for their products so you can make informed decisions and help drive industry change.
- ☐ Partner with manufacturers and suppliers to seek low carbon outcomes, and ensure they know that this is a priority for any specified product.
- ☐ Provide incentives in tender documentation for low carbon materials.
- ☐ Consider design and materials prototyping with manufacturers.

Image credit: Spiire

Working with and talking to Government

Policy change is critical. Landscape architects need to influence policy change.

- ☐ Work from the ground up with local councils, including: tree protection and urban forest strategies, green blue grid networks, passive irrigation, climate positive strategies, EV charging in streets, using low carbon concrete, probiotic fertiliser, banning dangerous insecticides and herbicides, and converting to electric maintenance equipment.
- ☐ Engage with State and Territory Governments to deliver their climate goals (all have 2050 net zero targets).
- ☐ Work towards and advocate for substantive Federal Government policy change on climate-related bills.
- ☐ Contribute to the Urban Green Infrastructure (UGI) Australian Standard to have UGI designated as an asset class.
- ☐ Showcase local and international exemplar projects as benchmarks of successful climate positive design and encourage successes to be used to inform policy.
- ☐ Advocate for stronger land clearing laws, biodiversity protection laws and limits to any new fossil fuel extraction.

Image credit: Wikipedia commons

Communicate

Climate justice and social well being

Climate impacts are not equally distributed. Those with lower socio economic means will be harder hit than others.

- ☐ Assess and address climate impacts on vulnerable communities, and speak out for people that may not have a voice where you do.
- ☐ Address climate justice. Climate is not fair. Poorer suburbs are already more disadvantaged and have fewer street trees, parks and reserves.
- ☐ Globally, changing climate will impact small island nations first and hardest. As rising oceans and climate instability threaten isolated communities they increasingly rely on larger nations to mitigate impacts.
- ☐ Use your skills to address imbalance: consider undertaking pro-bono design work to improve the lives of communities that suffer negative impacts from climate change.

Image credit: Hassell

Promote good climate positive design

Promote climate positive design in the public sphere by exemplar projects.

- ☐ Demonstrate good climate positive design through project work by demonstrating good climate outcomes.
- ☐ Communicate the reasons why a project is contributing towards climate positive outcomes. For example, has it changed a client to move from a business as usual solution. Has it shifted public opinion towards a better outcome?
- ☐ Outline the steps taken during the design process to move towards climate positive.
- ☐ In education, use studios to investigate climate positive design outcomes.
- ☐ In government, promote climate positive outcomes across agencies and departments. Use exemplar built projects to demonstrate it is possible.
- ☐ Liaise and collaborate with the Sustainability team in your organisation or consultant team.
- ☐ Enter your project into the AILA climate positive design awards.

Image credit: Robert Frith

Educate and advocate

Be active in your community

Write letters to the editor, get to know your local Member of Parliament. Take climate action.

- ☐ Participate in workshops, podcasts, presentations, committees and conferences within and outside of the landscape architecture profession with a focus on climate positive practice.
- ☐ Get to know your local Member of Parliament to communicate the importance of a climate positive agenda for Australia.
- ☐ Write letters to the editor, send in a op-ed piece, write in to correct errors or bias in articles about climate, contribute on social media.
- ☐ Take climate action on measures to rapidly reduce Australia's greenhouse gas emissions, to halt land clearing, fracking, and fossil fuel extraction.
- ☐ Talk to your superannuation provider and bank to understand where your money is being invested.

Be active within AILA

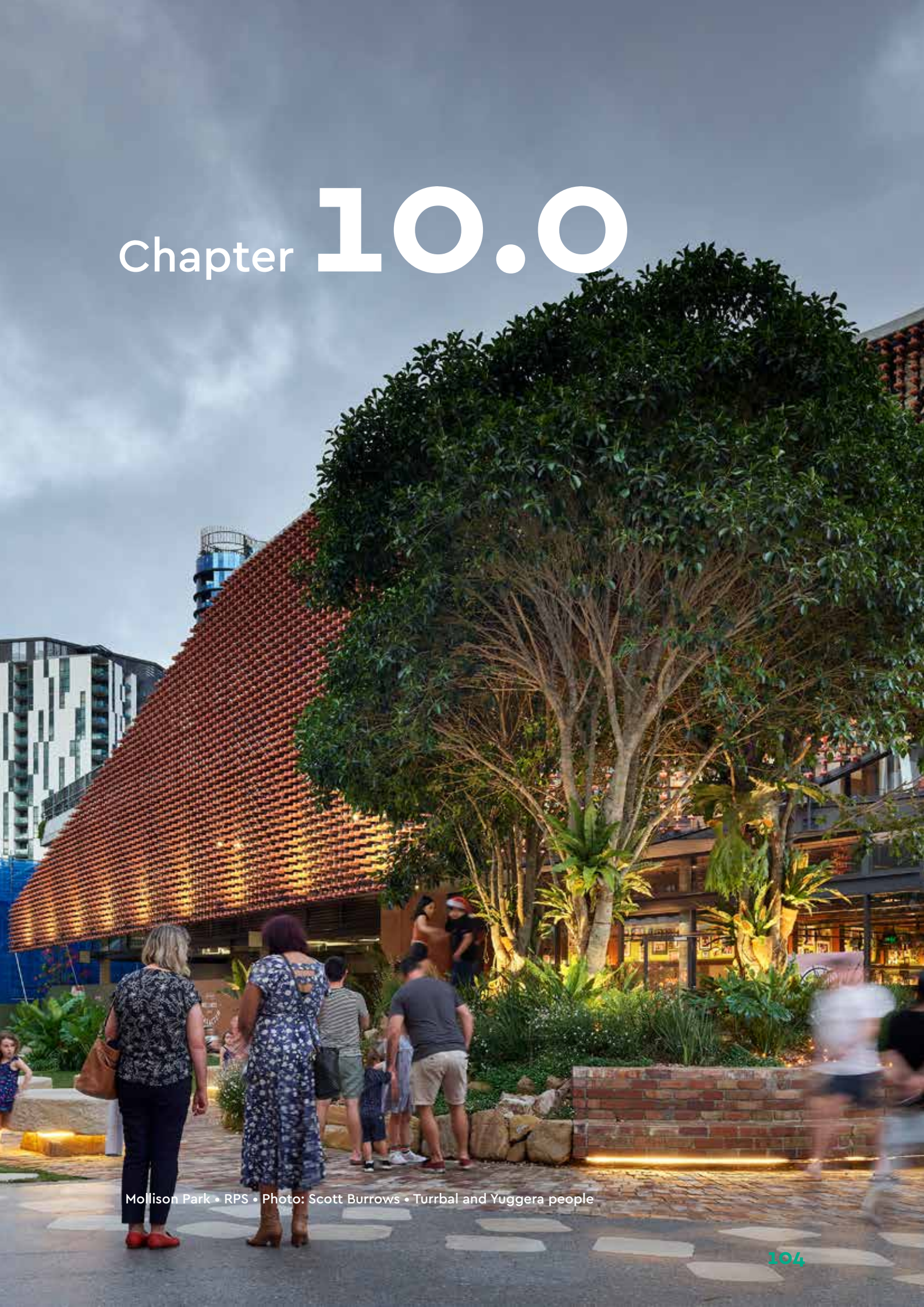
Help implement climate positive design as one of AILA's three strategic pillars.

- ☐ Become a member of the next climate positive design committee. Priorities for 2023-2024 include enabling sequestration research, continuing professional development material, communication and promotion of this document set, planning for AILA input into COP29. The full strategy is outlined in our volume three: AILA Climate Positive Design Roadmap.
- ☐ Help with researching data on sequestration by measuring trees on your older projects.
- ☐ Join or support the AILA advocacy committee for your state or Territory. Help write submissions to local, state and federal government on climate, biodiversity and landscape related issues. Submissions from AILA representing its nearly 3,000 members carries far more weight than individual letters or templated submissions.

Image credit: Martin O'Dea

Image credit AILA

Chapter 10.0



Mollison Park • RPS • Photo: Scott Burrows • Turrbal and Yuggera people

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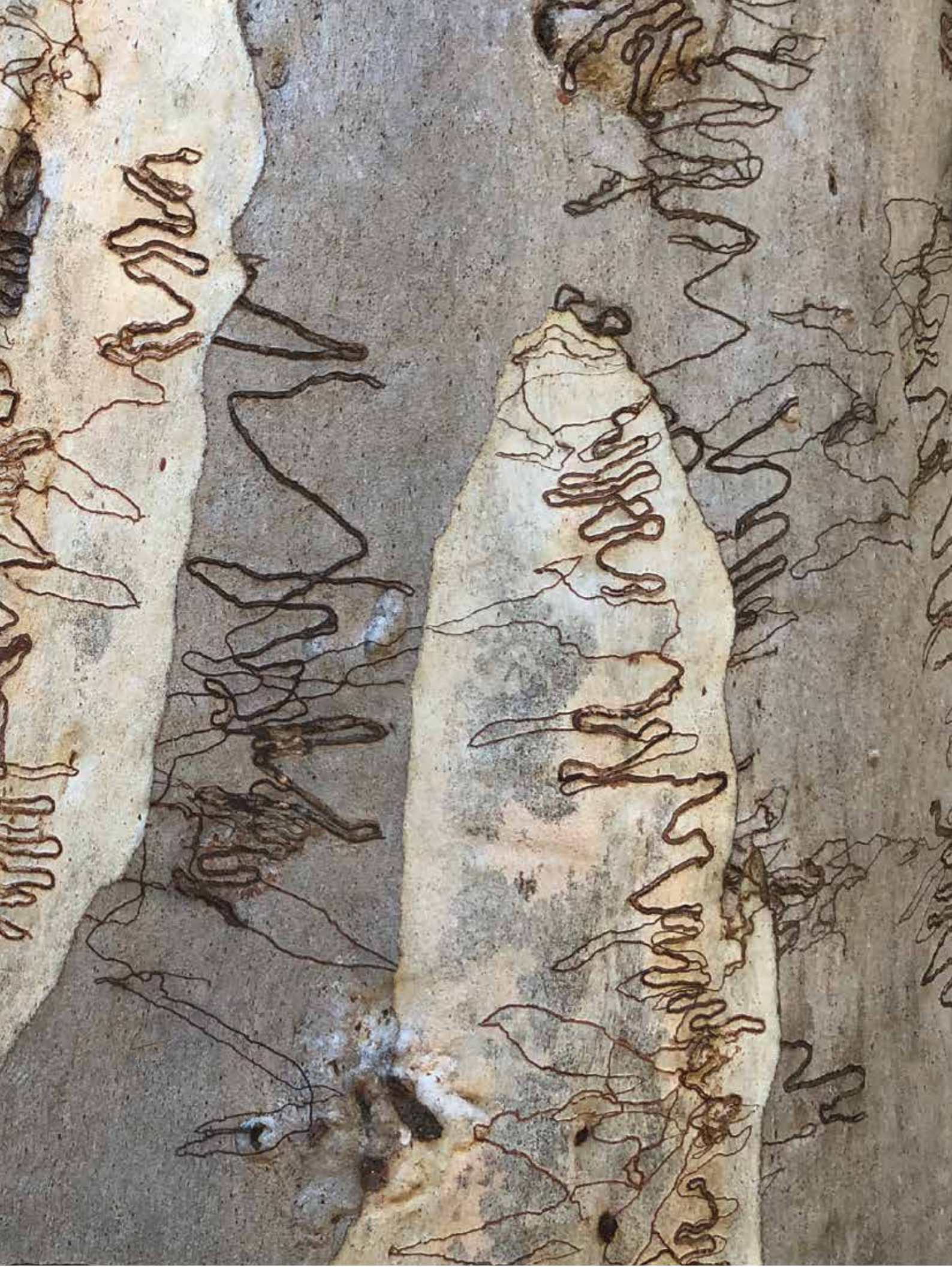
Wharf Street Basin - Next Generation Community Park • The City of Canning with Josh Byrne and Associates • Photo: Danica Zuks • Whadjuk Noongar Country

APPENDICES

Image credit: Martin O'Dea



Glossary

1.5 degrees The countries that signed the Paris Agreement in 2015 agreed to limit the increase in global temperatures to well below 2 degrees above pre-industrial levels, but preferably to 1.5 degrees. [75]

ACCUs - Australian Carbon Credit Units,.An ACCU is a unit issued by the Clean Energy Regulator (CER), representing one tonne of carbon dioxide equivalent (tCO2-e) stored or avoided by a project.

Carbon budget - This is the amount of CO2 that humans can add to the atmosphere between 2015 and 2050 before we reach 65% probability that we will exceed a global warming of 1.5 degrees. The median range is 180-520Gt.[76] Given annual planetary emissions are approximately 36Gt, we will hit 1.5 degrees in the late 2020s to mid 2030s without drastic action. Australia's Carbon budget from 2020 onwards is estimated by the Climate Council as 4.7Gt or approximately 8 years of current emissions.[2]

Carbon neutral - This term refers to net zero carbon dioxide (CO2) emissions are achieved when anthropogenic CO2 emissions are balanced globally by anthropogenic CO2 removals over a specified period. Net zero CO2 emissions are also referred to as carbon neutrality.

Climate positive design – Climate positive design projects provide net positive climate outcomes. They aim to provide social, cultural, environmental and economic co-benefits. Over a cradle to cradle assessment they sequester more greenhouse gases than they emit.

CO2e – Global warming potential is the heat absorbed by any greenhouse gas in the atmosphere, as a multiple of the heat that would be absorbed by the same mass of carbon dioxide. The main difference between CO2 and CO2e is that CO2 only accounts for carbon dioxide, while CO2e accounts for carbon dioxide and all the other gases as well: methane, nitrous oxide, and others.

Embodied emissions – Embodied emissions refers to the embodied greenhouse gas emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure.

Greenhouse gas (GHG) - Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of radiation emitted by the Earth's ocean and land surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH_4) and ozone (O_3) are the primary GHGs in the Earth's atmosphere. Human-made GHGs include sulphur hexafluoride (SF6), hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs) and perfluorocarbons (PFCs); several of these are also O3-depleting (and are regulated under the Montreal Protocol).

GT - (one **Gigatonne** = 1,000,000,000 tonnes)

Integrated Catchment Management (ICM) - may be defined as "the co-ordinated and sustainable management of land, water, soil vegetation, fauna and other natural resources on a water catchment basis". [77]

Intergovernmental Panel on Climate Change (IPCC) - the United Nations body for assessing the science related to climate change.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) - is an intergovernmental organisation established to improve the interface between science and policy on issues of biodiversity and ecosystem services. [78]

The International Federation of Landscape Architects (IFLA) - is an organisation which represents the landscape architectural profession globally. IFLA represents 77 national associations of landscape architecture globally.

Life Cycle Assessment (LCA) – is a technique for assessing the environmental aspects associated with a product over its life cycle. [18] The most important applications are analysis of the contribution of the life cycle stages to the overall environmental load, usually with the aim to prioritise improvements on products or processes.

Mt - (one **Mega tonne** = 1,000,000,000 kg)

Net-zero emissions are achieved when anthropogenic emissions of greenhouse gases (e.g. CO2) to the atmosphere are balanced by anthropogenic removals. Net-zero CO2 emissions are also referred to as carbon neutrality. Where multiple greenhouse gases are involved, the quantification of net-zero emissions depends on the climate metric chosen to compare emissions of different gases (such as global warming potential, global temperature change potential, and others, as well as the chosen time horizon). [7]

Natural capital - the world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of services, often called ecosystem services. Natural capital has financial value as the use of natural capital drives many businesses. [79]

Offsetting - carbon offsetting refers to the reduction in emissions of carbon dioxide or other greenhouse gases made in order to compensate for emissions made elsewhere. Offsets are measured in tonnes of carbon dioxide-equivalent (CO2e). [80]

Operational emissions - the amount of carbon emitted during the operational or in-use phase of a building or landscape. This includes the use, management, and maintenance of a product or structure. Operational carbon currently accounts for 28% of global greenhouse gas. [81]

Sea level rise - Sea level rise is caused by a combination of thermal expansion as the oceans absorb heat and meltwater from land-based ice. Sea levels are rising at approximately 3.6mm per year with predictions ranging from 600mm to 1100mm by 2100, and between 3000mm and 5000mm by 2300.[82]

Sequestration - the process of storing carbon in a carbon pool. Biological (or terrestrial) sequestration involves the net removal of CO2 from the atmosphere by plants and micro-organisms and its storage in vegetative biomass, woody stems and in soils. [83]

Scope 1 emissions: The release of greenhouse gases into the atmosphere as a direct result of activities occurring within a responsible entity's control (or geographic boundary).

Scope 2 emissions: The release of greenhouse gases into the atmosphere from the consumption of electricity, heating, cooling or steam that is generated outside of a responsible entity's control (or geographic boundary).

Scope 3 emissions: Greenhouse gases emitted as a consequence of a responsible entity's activities but emitted outside the responsible entity's control (or geographic boundary)

t - (One **Metric** tonnes = 1000kg)

T - (One imperial **Ton** = 2,240 pounds, about 1,016 kg)

WSUD / Water-Sensitive Urban Design - is a land planning and engineering design approach which integrates the urban water cycle, including stormwater, groundwater and wastewater management and water supply, into urban design to minimise environmental degradation and improves aesthetic and recreational appeal. [84]

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