CLIMATE CHANGE / CLIMATE CRISIS **Prepared by: Dr Kerry Callaghan – 2 April 2019**

Quote: "*The science is crystal clear, we are already committed to dangerous levels of climate change and Australia is the most vulnerable nation in the developed world. Even if greenhouse gas emissions were stopped immediately the earth is locked into further warming as the climate system establishes a new equilibrium over centuries to Millennia …. Any further increases in greenhouse gases in the atmosphere will compound dangerous climate change already baked into the system from past emissions, and they will keep rising until emissions are actively removed.*

The current challenge is to stop releasing new greenhouse gases and begin to rapidly pull historical emissions out of our atmosphere."

Joëlle Gergis: Sunburnt Country: The History and Future of Climate Change in Australia 2018.

GLOBAL WARMING:

Reputable scientific studies now tell us that the overall temperature of our planet is rising significantly since the industrial revolution, and dramatically since the 1950s. This is attributable in large part to human activity.

WELCOME TO THE ANTHROPOCENE

These activities include:

1. Burning fossil fuels (carbon stored underground for millennia).
2. Deforestation: The lungs of the planet sustaining complex biodiversity and converting CO2 into sugars, water and oxygen.
3. Desertification of land and sea. **Note**: The importance of shrubs, forbs[1], grasses (especially perennial deep rooted grasses), kelp beds, mangroves and wetlands, coral reefs.
4. The destruction and loss of bacteria mycorrhizae and fungi in soils.
5. Loss of insect life, bird life (species), fish, the mass extinction of many species of bird and animal life, ie the loss of self-sustaining self-regenerating ecosystems.
6. The mechanistic mindset which encourages lineal cause → effect thinking as opposed to ecological thinking.
7. The failure to understand the limits to perpetual growth. The economics of more is better.
8. The inefficient and wasteful disposal of human waste products.
9. Contamination of land, rivers, lakes and sea with plastics, chemicals, DDT, glyphosate, hormones, antibiotics, etc.
10. Overpopulation.

The consequences of global warming

The heating of land and sea temperatures leads to:

- Melting of polar icecaps and glaciers;
- Changes in sea currents;
- Rises in sea levels and more severe storm surges;

[1] A broad leafed herbaceous flowering plant associated with grasslands, eg, wild bergamot, sunflower, sage, rosemary.

- Die off of grasslands and forest cover on land, kelp and coral die-offs in the oceans, fish deaths etc in rivers, ie desertification of land, shores and oceans;
- Changes in wind, rain and storm movements – disruption of regular and predictable seasons;
- More intense severe weather events, severe bush and forest fires even in subtropical and alpine regions:
    - Icy storms and freezing temperatures in northern hemisphere winters as the winter vortex over polar icecaps moves towards the equator;
    - Severe cyclones, tornados, monsoon-like events in subtropical areas (eg Townsville), flooding etc as a result of water evaporating off ever warming oceans, ie unpredictable extreme weather events.

This equates to climate change and climate crisis.

"The Elephant in the room" that no-one wants to talk about! Is that because we are in the elephant?

Mitigation of global warming

1. Shift to renewable and sustainable energy sources: away from fossil fuels such as coal, oil and gas to wind, water, solar, hydrogen with battery storage etc, ie, reduce carbon emissions, stop putting ever increasing amounts of carbon into the atmosphere. *This shift is already underway*.

2. Drawing carbon down out of the atmosphere and putting it back into the soil where it belongs (even if we could drastically reduce carbon emission overnight there would still be many tons of it already in the atmosphere for thousands of years).

   Photosynthesis in plants is the oldest and most efficient mechanism to do this:

   $CO_2 \rightarrow C + H_2O + O_2$

   Carbon dioxide → carbon to plant roots (as sugars) + water + oxygen

   Trees (especially while growing), shrubs, forbs and grasses (especially perennials with deep root systems).

"*To store carbon as a solid at room temperature it requires sunlight and green leaves*!" Tony Lovell.

Therefore: Solutions

- Maintain and retain wilderness and forest areas allowing the biodiversity of plant, animal, bird, insect and their subsoil support system of bacteria and micro byzae fungi to flourish and act as reservoirs to feed adjacent landscapes.
- Preserving, maintaining and recreating wetlands and mangroves and their biodiversity.
- Managing rivers, lakes and streams so they maintain their function of hydrating the land around them as well as providing habitat for fish and their complex ecosystems, including human food productions. (Note: Australia's river systems are different to the northern hemisphere river systems [see Peter Andrews – Natural sequence farming – The Mulloon Institute etc]).
- Protecting underground water supplies:
    - Recharging aquafers and capping bores;
    - Banning fracking for gas.
- Reclaiming deserts:

- Use underground water to enlarge and extend the biodiversity around oases and desert margins, planting trees, shrubs, grasses, etc, destocking and using planned rotational grazing where appropriate.

Oceans and ocean shorelines

- Kelp forests pull large amounts of carbon dioxide out of the atmosphere, so kelp farming as well as protecting existing kelp beds could contribute to drawdown.
- Maintaining and replanting natural vegetation of sand dunes, estuaries, etc.
- Marine Reserves along coastlines giving fish a chance to breed and restock surrounding waters (eg as in New Zealand which was hoping to establish 10% of the coastline - Nelson in the North Island).
- Ecologically sustainable fish farming – a long way to go!
- Agriculture:

  Changing from an industrial approach to a regenerative one which aims to build healthy soils by the use of cover crops, minimal tillage, crop rotations and managed grazing of livestock, using minimal or no pesticides and low need for artificial fertilizers.

  More of this topic in a later discussion paper.

A further quote from Joëlle Gergis:

"*Australia's future depends on every person in this country voting for governments that will take strong visionary policy action on climate change. We all need to make our voices heard by voting for Local, State and Federal Politicians who are genuinely committed to implementing climate change policy that meaningfully addresses the largest intergenerational ethical challenge in human history.*"

REFERENCES:

Books:

1. *Sunburnt Country*: The history and future of climate change in Australia by Joëlle Gergis (published by Melbourne University Press 2018).
2. *Drawdown*: The most comprehensive plan ever proposed to reverse global warming. Edited by Paul Hawken (published by Penguin 2017).
3. *Atmosphere of Hope*: Searching for solutions to the climate crisis by Tim Flannery (published by Text Publishing Melbourne 2015).
4. *Beyond the Brink*: Peter Andrews' radical vision for a sustainable Australian landscape. By Peter Andrews (published by ABC Books/Harper Collins 2008).
   (See especially Chapter 14 the Murray-Darling: 4 Simple Problems Really).
5. *Call of the Reed Warbler*: A new agriculture, a new earth, by Charles Massy (published by University of Queensland Press 2017).

YouTube Talks/Lectures

Joëlle Gergis:

Our Sunburnt Country: State Library Victoria; 42.05 mins; Lighter Footprints; 6.13 mins.

Joëlle Gergis (continued) ABC News Breakfast; 5.20 mins.

Tim Flannery:
For Thought: Hope for the Planet 25.13 mins; Talks and ideas.
Professor Tim Flannery Talks Climate Change / Studio 10; 10.16 mins.
Professor Tim Flannery / Sunlight and Seaweed: A way to transform our future?; 18:06 mins.
Sir David Attenborough and Tim Flannery on Climate Change: The RS; 6.55 mins.
Peter Andrews:
How Peter Andrews rejuvenated drought struck land / Australian Story; ABC News (Aust) 28.46 mins.

Charles Massy:
How regenerative farming can help heal the planet and human health. TEDx Talks; 17.25 mins.

Dr Demetra Kandalepas
Fungi Matter. TEDxLSU; TEDx Talks; 17.33 mins.

Tony Lovell:
Soil Carbon – Putting carbon back where it belongs – in the earth. TEDx Talks; 20.46 mins.

Samantha Tellatin:
Cover Crops: An idea worth planting? TEDxMU; 16.35 mins.

Gabe Brown:
Regeneration of Our Lands: A producer's perspective. TEDx Talks; 16.25 mins.
Regenerating Our Resources (Regenerative farmer, North Dakota). Kathryn Dryden Communications; 44.16 mins. The History of His North Dakota Ranch. Transcend Productions; 12.50 mins.

David Marsh:
On His Transition to Regenerative Farming – Interview. Charlie Abbott; 6.49 mins.

Allan Savory:
Running out of Time / Documentary on Holistic Management. Savory Institute; 47.29 mins.

So what about Methane (CH_4)?

Methane is another greenhouse gas accumulating in the atmosphere and contributing to global warming, but its life in the atmosphere is measured in a few hundred years as opposed to carbon dioxide (CO_2) measured in thousands of years. Both carbon dioxide and methane are recycled naturally and both have been essential to maintaining a liveable earth temperature of around 15°C.

Global warming has been increasing markedly since the Industrial Revolution and dramatically over the last 50 years. This is a result of human activity whereby more greenhouse (planet warming, heat trapping) gases are being produced than the earth's ecosystems can recycle, ie, the system is out of balance.

Where does Methane come from?

1. Natural sources: Swamps, wetlands, melting tundras, natural gas leaks, volcanoes, forest fires, decaying organic matter.

2. Animals and birds, fish, whales and other sea creatures, ie all animals that excrete waste products from a digestive tract. If it poops it produces methane!

3. Certain herbivores produce more than others; the ruminant herbivores such as deer, antelope, elk, elephants, giraffe, bison, camels, goats, sheep, cattle, produce more methane because of the extra stomach (rumen) used to ferment premasticated and partially digested fodder.

4. Ruminants co-evolved with grasslands and are a vital part of nature's supply of nitrogen and other minerals deposited in the form of urine, faeces and decaying bodies. Naturally they tend to move in large herds congregated together by predators. They graze and move on leaving their nutrients behind to feed the soil and allowing the grasses and shrubs to regrow (pulling more CO2 out of the atmosphere!)

This is part of a self-sustaining ecosystem.

5. Anthropomorphic sources (ie due to human activity): Slightly over half of total emissions of methane are due to human activity. Since the Industrial Revolution human activity has had a major impact on concentrations of atmospheric methane, increasing atmospheric concentrations by 25%.

1. In all aspects of the coal, oil, and gas supply chain during production, processing, storage and transmission, and distribution of natural gas in particular, a significant amount of methane is lost to the atmosphere (approx 13Tg per year).

2. Agriculture, land, and forest clearing and industrial agriculture of monocrops reduces soil microbe and mycorrhizal activity, their ability to store carbon from CO_2 (carbon dioxide) and CH_4 (methane).

(Some soil bacteria are methanotrophic and act as sinks for methane; photosynthesis in plants stores carbon in the soil and in their woody stems, trunks and branches).

3. Rice Agriculture: Due to the swamp-like environment rice paddies act like wetlands; they yield 50-100 million metric tons of methane emissions each year, ie, rice agriculture is responsible for approximately 15-20% of anthropogenic methane emissions.

4. Beef, dairy, goat and sheep farming now on an industrial scale with feedlots requiring increased production of grain and other fodder and transportation etc. Over-grazing leads to soil degradation and desertification.

Managed rotational grazing of diverse pasture can improve soil fertility for other crops and studies indicate that ruminant animals managed in this way do produce less methane (see ***regenerative agriculture***).

5. Landfills: decaying organic matter and anaerobic conditions cause landfills to be a significant source of methane.

Removal Processes (for methane): Any process that removes methane can be considered a methane sink; the most prominent of these processes occur as a result of methane either being destroyed in the atmosphere OR broken down in the soil.

Forest soils act as good methane sinks.

In the upper atmosphere oxidation of methane is the main source of water vapour.

Humans have yet to act as any significant sink for atmospheric methane.