Climate shifts and the re-forestation of northern Australia to restore former rainfalls

Global warming is increasingly threatening the viability of Australia's agro-ecosystems, its water and food security and our dependent economic and social wellbeing and future.

However far from being an issue that can be addressed progressively over the coming fifty years by reducing greenhouse emissions, the reality is that dangerous climate change is happening now and has already seriously reduced rainfalls in southern Australia.

Australia south of 30 degrees latitude is not in drought, but in a systemic climate shift that has displaced cold moist westerly fronts from Antarctica to our south, decreasing winter rainfall by some 30 per cent throughout southern Australia. Similar serious rainfall impacts are already occurring globally including rainfall increases in some regions, such as in north-west Australia.

> *But the temptation to frame these debates in terms of certainty is fraught with danger. Certainty is an unforgiving taskmaster. It may seem prudent to say when the scientists are certain then we'll know what to do, but it is a mere step from there to say we should do nothing until we are certain.*
>
> *David Malone,* New Scientist
> *4 August 2007*

Australians and international environmental refugees will inevitably look to Australia's wetter and relatively under-populated north as regions for possible expanded agricultural and urban settlement.

Can northern Australia deliver on such expectations?

Australia has some 698 million hectares (m Ha) of land with over 200 m Ha under tropical savannah woodlands. These savannahs contain over a thousand rainforest patches that have survived from the wetter, more mesic[1] climates and floras that existed up to 4,000 years ago prior to increased fire impacts.

The rainforest patches often occur on similar soils and sites and have dynamic boundaries with the savannah woodlands. The rainforest boundaries often retreat following severe fires or extend under milder fires as soil microbial conditions conducive to increased litter and nutrient recycling, reduce fire risk and enhance rainforest expansion and growth. The micro-biology of these processes and how they can be managed are reasonably well understood.

As such, these processes can be used to naturally extend and restore some of Australia's northern savannah to their former rainforest climax, reversing some of the ecological impact of the recent more intense fires and rainforest decline. Through extending and seeding new patches it may be possible to restore parts of the savannah into their more bio-productive and bio-diverse rainforests and sustainable agri-systems, naturally, quickly, safely and affordably.

The restoration of such rainforests in northern Australia may also help restore the hydrology and rainfall of much of inland Australia which pollen paleo-data confirms was higher and more reliable prior to the extensive recent intense burning, de-forestation and desertification.

Even today vast quantities of water vapour continue to evaporate from the ocean to the north-west of Australia and flow to the south-east over Australia as the former Australian monsoon. While clouds and some precipitation occurs over the Kimberley, most re-evaporates and passes over inland Australia without precipitating. Some of this humid air again condenses and precipitates when it reaches still-forested regions in eastern Australia but most is lost over the Pacific.

These monsoon air flows and precipitation processes sustained the moist eco-systems over northern and inland Australia in previous inter-glacials and from 19,000 to 4,000 years ago. While the humid air flows persist, vegetation changes due to intense fires and de-forestation over the past 10,000 years may have significantly altered rainfall processes and patterns.

Can we restore the natural processes that paleo-evidence confirms previously extended the formation of clouds and rainfalls over much of northern and inland Australia and thereby help restore the former more mesic and productive bio-systems?

The formation of first clouds and then rain depends on the sequential availability of two different types of nuclei. Very small (<0.1 microns) cloud condensation nuclei are needed for water vapour to

1. a mesic habitat is a type of habitat with a moderate or well-balanced supply of moisture

condense into micro-droplets to form hazes and clouds. However much larger (>1 microns) water-attracting nuclei are then needed to coalesce the thousands of cloud micro-droplets required to form a raindrop heavy and stable enough to precipitate as rain.

Dust and particulate pollution as well as marine and forest aerosols are important as nuclei for the formation of cloud condensation micro-droplets. Ice crystals, salts but particularly certain bacteria, are essential to coalesce the cloud micro-droplets into raindrops and rainfall. Rainfall, particularly in inland warmer regions, is therefore often highly dependent on the availability of such large biological nuclei. Over one billion tonnes annually of these organic nuclei are produced globally, particularly over forests – enough to nucleate 50 per cent of global rainfall.

It follows that deforestation and land management changes can directly alter regional rainfalls by affecting these critical cloud and rain nucleation processes.

Both the higher former rainfalls over much of inland Australia and its systemic shift to dryer desert and savannah over the past 10,000-4,000 years is fully consistent with the paleo evidence that the more intense frequent fires and deforestation resulted in a decline in the production of essential biological rain nuclei and rainfalls. Field studies support this.

For example winter rainfall has increased by some 70 per cent in formerly cleared regions in south-west Queensland that have been allowed to regenerate. The increased rain can only have resulted from the increased nucleation of humid air that has flowed over the desert from the Indian Ocean. Similar associations between forests and enhanced rainfalls relative to adjacent cleared areas occur in south-west Western Australia on either side of the rabbit proof fence. These differences can also be explained if forests increase the level of such biological rain nuclei.

Fires and land clearing, apart from decreasing the production of rain nuclei, may also increase the level of dust and hence the persistent suspended humid hazes of cloud micro-droplets too small to coalesce into raindrops if there are not also the essential biological rain nuclei. Such 'humid haze droughts' have increased across Australia, significantly lowering rainfalls. Similar 'Brown Hazes' over Asia have also reduced their monsoonal rainfall by some 30 per cent.

Satellite data indicate that the current aridity of inland Australia is due not to a lack of humid air but to the lack of suitable rain nuclei which formerly coalesced and precipitated the available haze micro-droplets into raindrops. Indeed, before extensive human and fire impact, much of northern Australia may have resembled the climate and flora of the Amazon basin where the biological nucleation of humid onshore air flows contributes to the repeated cycling of rain across the basin to support the high rainfall and bio-productivity of the forests. As is the risk in the Amazon now, excessive deforestation and fire in northern Australia is likely to have converted much of its rainforest into open, dryer savannah accentuating further fire degradation, except in the remnant patches.

I've just got back from living with the Penan people of Sarawak, Malaysia, who are losing their lives, livelihoods and their forests because of the outside world buying hardwoods. Forget demonising the loggers, we are the reason these things are happening. What we buy comes from so far away that we have no idea what consumerism is doing to the rest of the world.

Bruce Parry,
New Scientist, 8 September 2007

With global warming and the southward displacement of the cold wet fronts from Antarctica as well as more frequent and intense El-Nino events, Australia needs to urgently come to terms with these challenges to its climatic stability, water security and the sustainability of bio-systems. Restoring and enhancing the former natural monsoonal rainfall from the reliable humid air flows from the north-west may be critical in meeting these challenges and in naturally re-habilitating the fire degraded bio-systems and climates over much of arid inland Australia.

The natural extension and restoration of the rainforest patches and reforestation of parts of the fire-degraded savannahs of northern Australia may provide an opportunity to restore natural rain nucleation processes and so enhance and secure regional rainfalls safely, naturally, at minimal cost and with significant ecological, economic and social benefits.

The natural forests and agro-systems that could be expanded in inland Australia through this proposed strategy could potentially bio-sequester over a billion tonnes of additional carbon per annum. This could generate over $50 billion annually in potential carbon credits. The national returns from such forest and rainfall restoration, together with the associated dividends from improved water security, bio-diversity,

habitat and eco-systems services, should greatly exceed the modest projected costs of catalyzing such natural ecological restoration.

A re-forestation program also has the potential to generate major employment and multiplier benefits and provide the foundation for sustainable new biomass-based industries. These may be critical in remote regions in sustaining communities with the decline in cheap fuel oil.

The strategies and skills involved may also be of major relevance and interest internationally.

Such a natural re-forestation strategy may also be beneficial globally in creating a major new carbon sink and bio-habitat resource to offset the rampant destruction of natural rainforest within the wider region. It may also be beneficial in enhancing the resilience and viability of much of Australia's inland environment and economy in the face of the serious current and pending climate shifts and its impact on current farming systems.

Clearly humans, over millennia and through their impacts through burning, de-forestation, land degradation, desertification and more recently greenhouse gas emissions and pollution have fundamentally altered many natural eco-systems and processes. These impacts now risk the viability of many of these eco-systems and dependent populations, particularly their own.

Due to ocean lag effects and the long residence time of greenhouse gases, we can no longer avoid dangerous climate chaos by 2030 by just reducing future greenhouse gas emissions. We are at least 20 years too late for such reductions to be effective. However this does not waive our responsibility for mitigating the impact of our emissions. We simply must find more effective ways of avoiding their pending dangerous consequences in time.

As previously outlined (*Nature and Society* December 2006), the restoration of the natural cloud and rainfall dynamics over much of northern and inland Australia may be significant not just in restoring natural bio-systems, water and food security but in directly and rapidly mitigating global warming. Dense clouds, through their albedo effect, can reflect up to 90 per cent of incoming solar radiation back out to space significantly cooling vast regions. Indeed increasing mean cloud cover by just 3 per cent could reflect enough heat back out to space to cool the earth equivalent to restoring CO_2 levels and their greenhouse effect back to pre-industrial levels. Such cloud cooling effects can occur relatively quickly, not the 50-100 years needed to reduce CO_2 levels.

Our challenge is simply to restore the natural water and heat dynamics that drive such clouds. We can do this simply, cheaply, naturally and safely by restoring strategic forests and the transpiration and particularly the nucleation processes that govern cloud formation, cloud albedos and rainfalls. Restoring such forests simply involves the intelligent application of proven restoration ecology skills and our understanding of these eco-systems and regions.

Just as valuably, such strategies can also be implemented by communities regionally to both protect and enhance the resilience of agro-ecosystems in the face of pending climate impacts. Such action is not dependent upon political responsibility, initiative or international agreement.

All that is required is for communities to take responsibility, critically review the reality that they are facing and take appropriate effective regional action, hopefully in time.

Walter Jehne

Our secular, rational, industrial society, with its amazing scientific insight and technological skills, has established the first radically anthropocentric society and has thereby broken the primary law of the universe, the law that every component member of the universe should be integral with every other member of the universe and that the primary norm of reality and value is the universe community itself in its various forms of expression, especially as realized on the planet Earth.

Thomas Berry
The Dream of Earth, 2006, p.202

Certainty

As every climate scientist knows, there will always be facts that won't fit even the best model of global climate. That's the nature of models and the weather – and it illustrates just how badly we can be led astray by the fiction that science is about certainty. If we are honest and say the scientists' conclusions aren't certain, we may find this being used as justification for doing nothing, or even to allow wriggle room for the supernatural to creep back in again. If we pretend we're certain when we are not, we risk being unmasked as liars.

David Malone, *New Scientist* 4 August 2007