LANDSCAPE REGENERATION FOR OUR FUTURE

THE NEED FOR CHANGE

Landscape degradation is an issue of national and global concern. Landscape management practices including, but not limited to agriculture, forestry and fire have caused significant damage and in the process have altered the earth's natural biosystem. Consequently the precious resources of soil and water necessary to sustain life are being lost at unsustainable rates.

Unprecedented global challenges are arising in the face of this massive degradation of the landscape. These challenges are interrelated and, if left to evolve, will risk manifesting themselves in social instability crises.

Soil erosion due to traditional agriculture is occurring at a rate between 10 and 100 times faster than the soil's natural formation process (*pedogenesis*)[1,2]. Although the lack of good data makes predictions highly uncertain, at the current rate of topsoil loss, indications are that the earth may only have 48 years of topsoil left[3]. Estimates also suggest a reduction in global food production of 30% in the next 25-50 years due to soil degradation alone[4]. Healthy soils are necessary to provide sufficient amounts of food with quality nutrition to meet global food requirements.

Three billion people globally already have inadequate water and sanitation. It is assessed that 80% more water will need to be accessed by 2050 to feed the potential global population of more than nine billion[5]. This requirement is in the face of declining water availability, primarily through severe aquifer reduction in China, India, Africa and the Middle East. Unless all limited fresh water resources are understood and wisely managed, its decreasing accessibility and our absolute dependence on it, will risk escalating social disruption and regional instability.

Even with its significant land area, Australia is not immune to the consequences of landscape degradation and increasing future needs. The repercussions of our past environmental and heritage management are highlighted in *Australia: State of the Environment 2011.* This document describes a number of environmental issues that continue to cause concern and exert pressures on our environment, reducing our ability to deal with current and future challenges[6].

Despite good practices of a number of land managers and farmers allied to some good science, the realities of an increasingly arid and degraded landscape are being experienced across the country. These include:

- increasing acidification, particularly in the south-east;
- declining soil health, caused by the loss of soil organic carbon (SOC);
- erosion;
- severe salinity;
- diminishing river flows;
- high evaporation and runoff rates;
- decreasing availability of groundwater; and
- reduced resilience to impacts of extreme and variable weather events such as drought, flood and fire.

The current state of the Australian natural landscape is further challenged by stresses from our changing climate, unsustainable management practices, increased mining activity and urban expansion. These will impact significantly not only on the productivity and viability of agricultural enterprises but also on the health of our environment and the wellbeing of every Australian.

The national and global challenges being faced, as detailed in this chapter, are interrelated and can be best met through a comprehensive coordinated approach focused on improved regenerative environmental management practices. Also outlined, are the current status and pivotal roles of the three key process drivers for landscape regeneration – soil, water and vegetation. Restoring the biosystem, through effective landscape management focusing on these three interrelated components, and becoming more efficient in the use of natural resources is fundamental to the provision of sufficient food, fibre and water for a growing population.

Chapter Two discusses how action already being taken by innovative farmers is successfully and profitably regenerating the landscape.

Chapter Three provides their stories.

By supporting innovative farmers undertaking regenerative landscape management practices, we can restore the Australian landscape

FEEDING A GROWING POPULATION

By 2050, the global population is projected to be in excess of nine billion. With the current dependency on and demand for increasingly scarce fossil fuels and other resources, the pressure being placed on the earth's natural resources will compound exponentially.

The future world demand for food risks placing huge pressure on global food production systems[7]. The world will require around a 70% increase in global agricultural production to cope with population growth to 2050[8] with decreasing availability of agricultural land and water and reduced fertility of soil. Further, agriculture is heavily dependent on fossil-fuel-based inputs and, in the process, vulnerable to increasing resource prices. Water is often used inefficiently, to the extent that agriculture now accounts for 70% of global freshwater use. Groundwater extraction for irrigation is estimated to have contributed nearly half of the observed rise in sea level between 1961 and 2003[9]. As production outputs must continue to grow, inputs must be reduced and efficiency improved as global capacities and thresholds are being reached. Continuation of current usage patterns is not viable.

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The situation is no different in Australia. Current government policy emphasises the importance of lifting agricultural productivity through agricultural research and development[10]. Whilst this is important, the more urgent requirement is to change how we manage the paddock, including clearly understanding the essential interconnectivity of soil, water and vegetation. Without so doing and despite some good farming and scientific practices, the realities of an increasingly degraded landscape, less reliable access to water, and increasing input costs for fuel and non-organic fertilisers, will further impact on the productivity and viability of agricultural enterprises.

Food quality, as well as food quantity, is of vital importance to meet the needs of the population. Nutritious food is fundamental to good health and disease prevention. The integrity of food is suffering due to the breakdown in the nutrient cycle. Farmland soils have been stripped of nutrients in a one-way flow of minerals and nutrients from the soil, to food, to consumption, to waste. The health and nutrient dynamic of soils must be regenerated to increase mineral and nutritional densities of our food to ensure proper nourishment requirements.

Over-reliance on chemical inputs and non-regenerative practices have contributed to degradation of Australian agricultural land

RELIANCE ON HIGH ENERGY INPUTS

Current land management practices place a heavy reliance on increasingly scarce and expensive inputs: fossil fuel, extracted minerals, chemicals and water. As oil prices increase through scarcity and demand, the viability of maintaining many oil based agricultural inputs will decline. The United Nations Food and Agriculture Organization (FAO) has highlighted concern of the global food industry's dependence on fossil fuels, saying that excessive reliance on that form of energy is likely to undermine efforts to produce enough food for the world's growing population[11]. By 2050, it is estimated that 2% of global energy consumption will be devoted to production of nitrogen fertiliser[12].

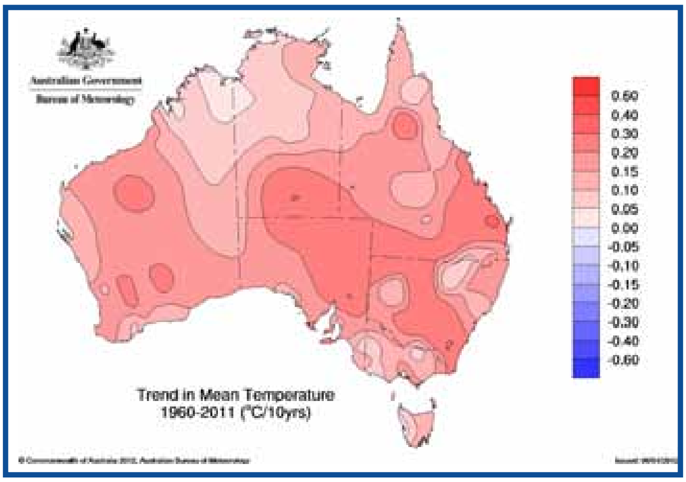
Through the practice of specialised monocultures, soil has lost its natural inputs in not only carbon, but also nitrogen and phosphate, relying instead on costly artificial fertilisers. Increasing input of these fertilisers, together with herbicides and pesticides, has contributed to the depletion of the health of soils and its capacity to produce food sustainably.

Alternatives to such input dependencies need to be found, due to the increasing prices and doubts over future availability of fossil fuels, extracted minerals and water.

Efficiency gains can often come from modifying existing farming and processing practices at little or no cost. These can include the use of more energy efficient engines, the use of compost and precision fertilisers, irrigation monitoring and targeted water delivery, adoption of no-till farming practices, the use of less-input-dependent crop varieties and adaptive animal breeds.

VULNERABILITY TO A CHANGING CLIMATE

The impacts of climate change are global in scope and unprecedented in scale. Whilst the predicted effects of a changing climate continue to be debated, it is clear that a more resilient landscape will be imperative if we are to adapt and respond to the challenges of the future. Robust ecosystems underpin resilience in landscape function. To achieve these, healthy soils, better use and conservation of available rainfall, pragmatic use of vegetation and groundcover, and increasing biodiversity are key.



KEY PROCESS DRIVERS FOR LANDSCAPE REGENERATION

Many of the challenges being experienced are not isolated events, but are related to landscape degradation, loss of biodiversity and resultant impact on what should be a naturally balanced system.

Soil, water and vegetation, supported by a constant flow of solar energy, are the fundamental and interrelated process drivers necessary to provide essential natural ecosystem services.

ESSENTIAL ECOSYSTEM SERVICES

SUPPORT: nutrient cycling, water release and retention, soil formation, habitat for biodiversity, exchange of gases with the atmosphere, degradation of complex materials;

REGULATION: carbon sequestration, greenhouse gas emissions, water purification, natural attenuation of pollutants;

PROVISION: food and fibre production, water availability, platforms for construction;

CULTURAL: protection of archaeological remains, outdoor recreational pursuits, landscapes, supporting habitats[13].

Increasing landscape degradation and inefficient resource use are clearly evident within our current management of soil, water and vegetation. These areas are strongly interdependent and damage to one causes detriment to another. Equally, however, regeneration in one area can also bring positive results to the others as part of natural biosystem cycles, as discussed further in Chapter Two.

SOIL

Pedogenesis processes over the past 420 million years helped transform arid bare rock into the healthy soils that still underpin our biosystems, hydrology, climate, water, food security and survival. Microbial ecologies governed these pedogenesis processes through the bio-sequestration of carbon to build soil structures, water holding capacities, nutrient availabilities, bio-productivity and resilience to stress.

Today, the dramatic loss of SOC from soils, and related implications, is one of the two issues featured by the *UNEP Year Book 2012*. This flagship publication highlights the imperative to sustain and enhance soil carbon stocks in order to manage serious consequences which are already being experienced in terms of climate change, food security and the health of ecosystems. The earth's ability to provide the interrelated ecosystem services, of which soil carbon quantity is a major determinant, has also declined.

For example, around 60% of the carbon in the world's soils and vegetation has been lost as a result of land uses since the 19th century[14]. As a result of soil carbon losses, one-quarter of the global land area has suffered a reduction in productivity during the past 25 years[15].

Australia: State of the Environment 2011 confirms that SOC stocks are low in many Australian agricultural systems. On average, Australia's current SOC content is around 1%. By comparison, when the explorer and geologist Sir Paul Edmund Strzelecki collected 41 soil samples around south eastern Australia between 1839 and 1843, average soil organic matter in the top ten most productive farm samples was 20%, with levels of organic matter up to 37.75% – equating to SOC content of 10% to nearly 20%[16].

Current landscape management practices are contributing to poor health of our soils through the loss of carbon and topsoil, acidification, erosion, mineral deficiencies and chemical dependencies. Nutrients are being chemically locked-up and made unavailable to plants, or being lost through waste in urban areas which is not returned to the soils for use by plants and animals.

Threats to the soil will increasingly affect Australia's agriculture unless carefully managed. In 2001 soil acidity was estimated to be costing around $1.585 billion per year in lost agricultural production[17].

Due to the current structure of Australian soils, extreme weather events, such as flooding or high winds, continue to degrade the landscape, washing or blowing away valuable topsoil and further reducing remaining carbon content.

WATER

Securing an adequate supply of safe, reliable water is likely to become a strategic determinant for communities, regions and nations within the coming years. It is estimated that the global community will require access to an *additional* 14,000 cubic kilometres of water – the equivalent of 11,000 Sydney Harbours – to meet our future water demands in feeding a global population of nine billion[18].

50% of Australia's typical rainfall is lost to evaporation.

Australia is the driest inhabited continent with variable rainfalls. Whilst many regions in Australia received very healthy rainfalls in 2010, the 2010 CSIRO/BOM *State of the Climate* report highlighted that reduced rainfall in eastern and southern Australia, together with more intense rain events are likely to be the norm in the future[19]. Drastic flood events have already been experienced in northern Australia for consecutive years with devastating results.

Soil organic matter forms through the breakdown of organic materials on the soil surface and below the ground. It comprises approximately 50% carbon

Every gram of soil organic carbon can hold up to 8 grams of water.

Soil health must be built; depletion cannot be rectified by adding chemical elements to address identified symptoms. Carbon is a master variable within soil that controls many processes, such as development of soil structure, water storage and nutrient cycling. Every extra gram of carbon in soil can retain and make available up to eight extra grams of water. Without carbon in the soil, the resilience of the landscape is weakened, water losses to the effects of wind and extreme temperatures continue and the capacity to respond and adapt to a changing climate declines. It is vital that carbon is returned to Australian soils through increased biodiversity of vegetation to facilitate carbon sequestration and restore hydrology, bio-productivity and resilience.

Slowing the flow of water across the landscape helps to restore riparian areas

Australia's landscape used to be characterised by 'in-soil' reservoirs. Complex microbial ecologies maintained soft deep soils which allowed for infiltration and retention of rainfall into well-structured subsoils. These in-soil reservoirs then leached any salt to depth and slowly recharged and sustained what were typical reed covered billabongs, meandering waterways and fully functioning floodplains. As a result, most of Australia's inland rivers did not discharge rainfalls to the sea, but recharged aquifers or created highly productive inland deltas and extensive wetlands and intermittent lakes.

It is assessed now that over a quarter of Australia's river systems are close to unsustainable extraction and groundwater is being over extracted by almost 15%[20]. Furthermore, 94% of wetlands have been destroyed and over one million kilometres of Australia's rivers have been incised[21].

Australians are also some of the highest per capita consumers of water. We need to secure many times the actual water that is projected to be available under current practice. With rainfall patterns changing, how each drop received is conserved and used is critical. The structure of soil is imperative to maximise efficient infiltration and capture of water.

What happens to water when it falls on the landscape as rain has to be managed in such a way that every drop is utilised to the maximum advantage; whether in maximising its capacity to hydrate the soil; to replenish relevant aquifers or when saved through capture from rooftops, roads and storm water drains or recycled from waste; it all has to be properly managed. Water is only a renewable resource if the water cycle is functional[22].

The greatest potential for improvements in conserving water and using it intelligently can be found in reducing the high evaporation rates. Current approaches to water management, such as policies related to the Murray Darling Basin and Snowy River, are focused mainly on the average 12% of rainfall that ends up in streams, rivers and eventually into dam storage – the 'end of pipe'. However, the greater potential for efficiency lies in making better use and conservation of rain where it falls - the 'front of pipe'. Eighty-six per cent of rainfall initially falls on Australian soils, but around 50% - 25 times the quantity held in all dams - is currently being lost to evaporation.

ON AVERAGE,
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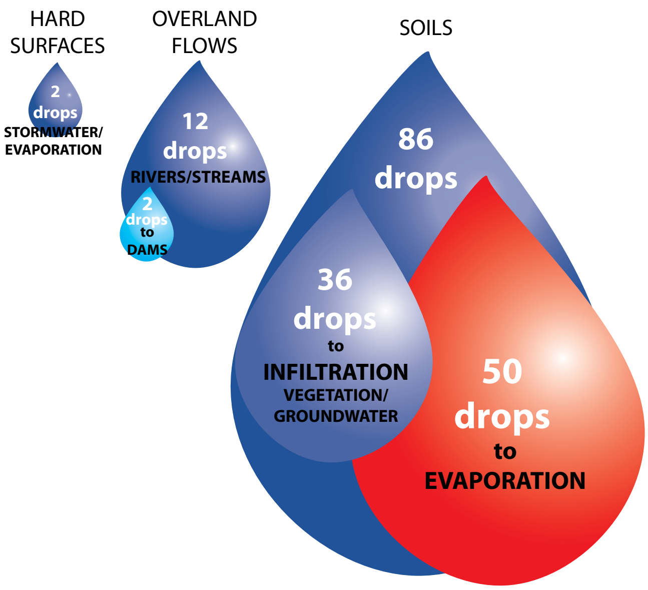

100 DROPS

Of a typical 100 drops of rainfall that currently fall on the Australian landscape, approximately 12 of these flow into streams and rivers, with only 2 ending up being stored in dams for agricultural, industrial, urban and domestic use. 86 drops fall onto soil, and, on average, 6 of these go into groundwater and 30 into vegetation. The remaining 50 drops are lost to evaporation[23].

VEGETATION

World deforestation is estimated as 13.7 million hectares a year[24]. Current rates, extents and intensities of land use and land-cover change are greater than ever in history, causing significant loss of vegetation[25].

Healthy soils support vegetation regeneration and healthy nutrient cycles.

Australia has some 770 million hectares of land. Although former policies of active land clearing are no longer extant, around one million hectares of native vegetation was cleared annually in Australia in the decade to 2010. The most significant loss of vegetation has been in the over 470 million hectares of rural managed land that has been farmed at various intensities, with around half of this being variably degraded. The land use of greatest extent is livestock grazing, accounting for use of 55% of Australia's land area (428 million hectares)[26]. Land health is at further risk from changing land use, changed water and fire regimes and overgrazing[27].

As remnant vegetation continues to deteriorate, the land and soil degrades as topsoil is lost and erosion occurs[28]. Poorer soils are then unable to support regeneration of healthy vegetation and nutrient cycles break down.

Nutrients are necessary for healthy soil and vegetation functioning. These are also being lost to production systems through disruption to the natural waste cycle as a result of urbanisation and consumption habits. Cities are producing increasing volumes of waste, including significant organic matter, which is no longer being returned to the soils.

Nutrient deficient soils lead to nutrient deficient plants, ultimately the food source on which we survive. Massive mineral depletions in fruit and vegetables were identified over a research period 1940 to 1991. The food we eat today is less nutritious than it was before World War II[29].

Vegetation of all types contributes to carbon sequestration and restoration of hydrological cycles

A REGENERATIVE CYCLE

Together in a natural system, soil, water and vegetation provide a regenerative cycle. This regenerative cycle is possible because of the solar energy that bathes the earth each day. This light energy is converted by plants into food energy that flows through biota. It is this constant flow of energy through the biosphere that makes life possible.

Restoration of fundamental natural systems will regenerate the health and resilience of our landscape so it can bio-sequester and draw down current and past carbon emissions to safe levels into stable sinks; secure and restore the essential rainfall and natural water ecology on which our biosystem, economy, communities and life fundamentally depends; and regenerate the vegetation that also supports the biodiversity essential to maintaining the cycle.

Improving landscape management practices will maximise water use efficiency, improve soil health and nutrient cycling. In turn, this will also improve Australia's biodiversity, reduce weed invasion and improve production to help meet the needs of the global community, environmentally, economically and socially.

A properly structured soil will re-create effective in-soil reservoirs, through greater infiltration and retention of rainfall. Sequestering carbon is the safest, most practical and relatively quickest way of restoring the natural organic status of the soil to increase its water holding capacity. Carbon can be returned to the soil through establishing a biodiversity of vegetation cover.

In-soil reservoirs also allow water to slowly recharge waterways, particularly during times of limited rainfall. In times of increased rainfall, healthily structured soils can slow the flow of water across the landscape. Slowing down water rushing through the landscape by installing interventions that mimic nature also assists in the build up of sediment and the capture of water in the soil.

Returning to such natural hydrological processes can restore riparian areas, recharge flood plains and make water available for uptake by plants and animals over longer periods of time.

Installing interventions that mimic nature assist in the build up of sediment and the capture of water in the soil

Revegetation will improve ground cover, and subsequently the quality of the soil, enhancing water infiltration. In turn, improved soil health and efficiency in water use will contribute directly to the ability to further regenerate forests and vegetative cover in our landscape, expanding biodiversity of species and support agricultural food and fibre production. Vegetation also has the ability to draw down CO_2 and fix nitrogen in the soil, and plants with deep roots have the ability to recycle nutrients up to five metres in depth – improving both the soil and the nutrition of food grown.

Trees and other plants also have a profound influence on climate through their ability to moderate temperature. Vegetation protects the ground from overheating and drying out. It also optimises the amount of evaporation by transpiration through the many pores (*stomata*) on the leaves. Vegetation influences the transformation of solar radiation, in its ability to bind up solar energy in transpired water vapour which is then carried away and released upon condensation in cooler locations. This cooling effect from transpiring plants, especially trees, is the perfect air conditioning for the earth, as well as a key component of the small water cycle for moderating precipitation[30].

Returning carbon to the soil and restoring the biosystem will recreate the unique natural processes that govern productivity and resilience of our soils. This can heal the damage that has been done to the landscape and enable it to tolerate, adapt and even influence climate extremes. Increased soil carbon also enhances the essential biological activity of fungi and microbes, facilitating the availability of minerals and nutrients to plants. Healthy soils and plants lead to healthy food and animals and by extrapolation, healthier people[31].

LEADING CHANGE

The challenges facing a growing population in a gradually degrading landscape – exacerbated by a changing climate - together with continuation of our current behaviours will increasingly manifest themselves in water, food and social instability crises. The wellbeing of people, in terms of health, lifestyle and the future for the next generations, both here in Australia and around the world must be of strategic concern to leadership.

The recent United Nations report *Resilient People, Resilient Planet: A Future Worth Choosing* includes in its recommendations, "Governments and international organisations should work to create a new green revolution – an "ever-green revolution" – for the twenty-first century that aims to at least double productivity while drastically reducing resource use and avoiding further loss of biodiversity, topsoil loss and water depletion and contamination, including through the scaling-up of investment in agricultural research and development, to ensure that cutting-edge research is rapidly moved from laboratory to field..."[32]

Current Australian investment in management of the land environment, in research and development programs and knowledge and information systems that underpin good land management, has been assessed as inadequate. Per hectare of agricultural land, Australia invests less in natural resource management than in Europe and the United States, and this is generally regarded as insufficient to meet Australia's environmental management needs[33]. *Australia: State of the Environment 2011* emphasises the need to choose our approaches to environmental sustainability to continually and intelligently mitigate or adapt to the ongoing drivers of climate change and population growth[34].

In Australia we continue to treat the symptoms of the degraded system through controls on stored water, massive expenditure on weed control and reliance on chemical interventions, rather than address the cause. This needs to change. Effective practical policies and actions are needed now. Indeed, it is imperative that there is a better connection between innovative farm practice and peer-reviewed science to learn more about these approaches and to help support the generation of new reliable knowledge that can be translated to other properties. Business as usual is neither viable nor sustainable.

The earth's natural biosystem is balanced so that no element leaves the planet, and stores are contained in the right place in the right volumes. However this balance has been disrupted and storage thresholds have been reached. We need to be more effective at recycling the elements and restoring them to where they belong in the natural system.

The solution to the many and varied, yet interrelated problems, lies in the regeneration of the landscape, particularly our soil. This undervalued component of the earth's highly complex natural biosystem is only just beginning to receive attention outside the realm of soil scientists[35]. By adopting a practice of high performance regenerative landscape management, the natural balance will be restored, returning carbon to the soil, effectively capturing water, ensuring plant and animal biodiversity, providing resilience to the landscape and ultimately contributing to sustainable production outputs and better human health.

As discussed in Chapter Two and presented in Chapter Three, innovative farmers are using high performance regenerative landscape management methods and fighting the trend of continued degradation of the landscape with its heavy reliance on external inputs. They are demonstrating sustainable, regenerative practices on their land.

These innovative farmers are small in number now – probably less than 5000 – however with relevant policies and incentives these practices could be extended successfully and quickly to involve at least 30,000 of Australia's 135,000 farmers.

Whilst there are always opportunities to learn more, enough is already known to take action now.