

# Conclusions

## What have we learnt from past mistakes?

Many land-related changes that result from human activities take a long time to show themselves. The response time depends on a complex interaction of climate, geology and patterns of land development.

It is now well recognised that the management of Australia's lands has resulted in many land degradation problems. This recognition is not new. Tension between a desire to conserve and sustain Australia's unique flora and fauna and the pressure to develop and exploit have been persistent themes (Bonyhady 2000).

In the past decade there have been serious attempts by governments and primary industries to understand the Australian ecosystems more fully, and work within sustainable limits. Much of this has been driven by a realisation of the need to remedy past degradation. This response is particularly evident in southern Australia, where the extent of past degradation is greatest and most conspicuous. However, the continuation of poor practices and inappropriate land uses and landscape change continues in many instances.

Australia is in the process of transition from a predominantly primary industry-based economy to an advanced post-industrial economy. This change is being accompanied by a change in the value placed on land and has altered the relative revenues obtained from different land uses. In many regions of established agricultural land use strenuous attempts are being made to improve environmental, economic and social sustainability. Despite major adjustments to many agricultural industry sectors in the past decade, serious doubts exist as to whether these industries can finance the adoption of remedial and truly conservatory farming systems (NFF-ACF 2000).

In the light of these serious attempts to rectify the very significant environmental damage already done to the land, and its impacts on biodiversity conservation and water quality, it is worth assessing the extent to which current Australian policies on land are consistent with stated objectives on sustainable development. What is clear is that we are still making mistakes (see Box: 'Will we ever learn'). This report shows that in some parts of the continent the constraints of climate and soil are now appreciated. However, inappropriate land uses continue, driven by individual economic imperatives and, in some cases, an unwillingness to face, or accept, the reality of climate variability and the likelihood of environmental deterioration.

## Key issues

The following is a short summary of the issues that this report concludes are significant to Australia.

### Accelerated erosion and loss of surface soil

- Soil erosion remains a perennial, but unglamorous problem, given the slow rates of soil formation.
- Measuring and managing grazing pressure, particularly in pastoral country—a critical area is the impact upon estuaries, reefs and river systems where pollutants within sediments (e.g. DOM, pesticides, nitrates, phosphates) lead to pollution of another system.
- Lack of ways of documenting and differentiating what has happened in the past from current areas and extents of accelerated erosion, especially the loss of topsoil impairs our ability to assess how well management practices are performing.

### Physical changes to natural habitats

- Land clearing is a serious issue, in particular the problem of actually getting a definitive measure of the extent of clearing—with implications for greenhouse, potential salinity impacts and potential erosion impacts.
- Increasing pressure on AQIS and NRM incursion threats with a constantly increasing number of travel movements both international and internal.

## Will we ever learn?

### Land use fitted to climate?

In the 1860s the Surveyor-General of South Australia, George Goyder, correctly identified the limits to safe cropping in South Australia from natural vegetation associations. Responding to a question as to whether his famous line (closely following the edge of the 10 inch or 250 mm rainfall region) represented the boundary between cropping and pastoralism he replied:

'It does to a certain extent, but there is some of the country where, although the soil is eminently suited to tillage, and will grow anything, the peculiar position of it and its openness to hot winds render it such as can be only safely continued as pastoral land. That land is both inside the line and outside it, and is only fit for pastoral purposes.'

Nevertheless settlers pushed north of 'Goyder's line', only to have disastrous crop failures 10 years later; and some are still cropping north of the line in some areas. Today the successful farmers now have a suite of risk management practices that provide operational and financial buffers, using conservation tillage, growing high value grade wheats, and forward selling.

### Secondary salinity

In 1917 Professor J.W. Patterson of the University of Western Australia presented soil samples and a report to the Royal Commission on the Mallee and Esperance Lands, claiming a third of the area was too saline for profitable farming. The Commission's response (quoted in JAWA 1997) was:

'The Commission having given the question close consideration strongly urges that scientific prejudice against our mallee lands be not permitted to stand in the way of their being opened up for agricultural purposes.'

Advice from other scientists, such as the pedologists Burvill and Teakle in the 1920s and 1940s, similarly went unheeded. It was not until 1981 that the first clearing restrictions were imposed in south-western catchments of WA, and this state now takes the challenge of secondary salinity very seriously. In sectors of the farming community in Queensland secondary salinity is still not appreciated as a consequence of clearing (NLWRA 2001a).

### Desertification and risk management

In the 1890s and 1900s, the 1920s and 1930s, and again in the 1980s and 1990s, there were a number of government inquiries into the financial distress and desertification of the pastoral regions. Concern over the effects of herbivore grazing in semi-arid and arid rangelands has been expressed repeatedly in Australia, (e.g. Royal Commission 1901), particularly during the devastating effects of rabbit plagues in the pre-myxomatosis drought era of the 1940s as the following passage illustrates:

'The plain truth is that the pastoralists' existence will always be a gamble in the Australian inland, where the profits of the good seasons must be balanced against the losses of the droughts. The only sound and satisfactory pattern of settlement in this region . . . must be built up of units each capable of meeting the recurrent droughts on its own resources. If the nation prefers to enforce a different system, based on the assumption that the occurrence of drought can be ignored, it should be understood that it will be called on to pay for its preference in good hard cash. Settlement on such a basis must in the end be subsidized, and subsidized more and more heavily as time goes on.' (Ratcliffe 1938).

One of the most recent of such reports (Kerin and Hyder Consulting 2000) proposes a radical change to the tenure act that governs the use of the Western Division. However, we seem no nearer to achieving to this type of change than we were sixty years ago.

## Introduction of novel biota into native habitats and communities

### Weeds

- Actually getting on top of some of the weeds of national significance; herbicide resistance is a significant agricultural problem (but not so much an environmental one).
- Community perceived risk of GMO escapes is much greater than the best scientific assessment, which new legislation (December 2000) is designed to manage.

### Pests and diseases

- Problem of getting adequate resources to tackle non-agricultural pests and diseases because little infrastructure or resources are devoted to this issue.

### Weeds, pests and diseases

- The big issue is insufficient resources available to tackle even those species of identified national significance, let alone the threat from new incursions, and spreads of 'sleepers' or existing known problems (e.g. diamondback moth, *phytophthora* spp, western flower

thrips—which all attack hundreds of endemic species). Risk assessment protocols, strategies for containment etc. are all very weak for exotic threats of non-agricultural species.

### Secondary salinity and acidity

- The extent and likely spread of dryland salinity is now better understood, but can we develop agricultural systems that prevent recharge?
- The problem of massive increase in demand for water coming from an increasing number of users.
- Irrigated agriculture is rapidly expanding, especially outside traditional areas of reticulated systems, because of greater returns, reducing climate variability risk, etc.
- Some catchments and systems are now over-allocated (e.g. Namoi, five times over-allocated; Snowy, demands from traditional users versus urban populations and environmental flows etc.).
- Acid soils and acidification goes unrecognised as a contributory factor to low water use efficiency, yet the technology to improve plant water use is well developed.

### Nutrient and carbon cycling

- Carbon cycling in relation to land management issues:
  - e.g. carbon credits—no well developed systems of commercial operation or accounting are yet established,
  - incorporation of perennial vegetation into farming systems. The theory is well understood, but economic incentives and technical constraints under present land uses are still to be tackled.
- Nutrient balances of farming systems—an environmental issue—especially for intensive industries such as feedlots, in regard to off-site losses and eutrophication. It brings into question the level of industry self-regulation versus systems of government regulation and compliance. This is a critical issue. It is too costly for governments to police all types of effluent outputs, especially from diffuse sources, but is a difficult area for which to devise appropriate minimisation strategies.

### Soil and land pollution

- Lack of data on pesticide use and consequent inability to accurately measure potential risk or environmental impacts restricts sensible policy development and comprehensive use of ‘clean green’ labels. Also there is difficulty getting all stakeholders to a common view. There is no appropriate lead agency that is able (or willing) to take the role of monitoring, data acquisition and management of feedback.
- Lack of data on contaminated sites (industrial, urban, rural processing, orphan sites, rather than mining).
- Locations of past contaminated sites and their management is a ‘grey’ area: the regulation of small and medium enterprises that fall outside NPI are not well documented.
- Lack of scientific knowledge of impacts on biota and pathways to groundwater and other water bodies still hampers monitoring and regulation.
- The probable cost of clean-ups is often prohibitory except where high visibility or political pressure exists.

## Major findings from the Land Report

In comparison with the situation reported in the 1996 State of the Environment Report, the past five years have seen an increase in institutions and laws to protect the environment. However, Australian society is still struggling to come to terms with the scale of change that is required to halt or restore past and current land degradation.

### Emerging issues

- The dynamic nature of land use and land tenure. Big changes in tenure in inland Australia have occurred in the past 15 years particularly in relation to Aboriginal lands (see Human Settlements Theme Report for more detail). In addition substantial changes in land use have occurred, mainly on freehold land, throughout the eastern coast of Australia where lower value agricultural lands have been purchased for more

profitable sub-division for residential housing, shops, tourist and service centres. This is leading to changes in the 'value prism' (how we see and value land for different purposes).

- Many current government programs on natural resource management are targeted at a stewardship ethic for *existing* land use, taking the view that the land will continue to be in the *current* land use, rather than changing use (such as farm forestry, recreation on former farms, marinas, hobby farms).
- The lack of sufficient finance to rehabilitate and restore vast areas of degraded rural land has been heavily emphasised in recent policy documents from non-government sources. Government response is to consider further ways of cost sharing through partnerships, but these have not proved successful in adequately addressing the overall financial demands so far.
- Laws and tenure conditions have traditionally enshrined rights to primary industries over rights of community, (water and health, biodiversity etc.) and these are now being increasingly challenged. There has been a rapid development of new property rights, with water being uncoupled from land, and new markets for salt and carbon trading developing.
- The value of ecosystem services is being seriously investigated, and environmental benefits of such functions as waste recycling by micro-organisms and fertilisation of food crops by insects is being estimated. Private sector investment is occurring as well as public research (e.g. the Myer Foundation project).

### 'Sleepers' that may become future threats

At present there is a strong focus on salinity and greenhouse as the two major land issues, but several others may be more important. These could include:

- Inadvertent introduction of a devastating pest or disease. This is always a potential risk, and the threat from the myrtaceous rust that is now devastating eucalypts in South America, for example, would be a case in point.
- Acidification. Acidification has been largely overlooked, as has the problem of managing dispersive sodic soils, both of which cover vast areas of Australia and contribute as much or more to poor water quality, secondary salinity and loss of ecosystem function than does clearing. These problems are 'sleepers' because they have not been able to be elevated to the position of political concern enjoyed a decade ago by algal blooms, or currently by salinity.
- Pesticide residue levels and pesticide resistance. At present these are considered of local and topical concern only, but the lack of knowledge about usage, extent and level of residues and resistance are very worrying, both in terms of managing pests, weeds and diseases, and in validating claims for 'clean and green', which is a strong trade imperative for primary produce in Australia.

### Persistent problems

The scale of community and government response and action on the ground is still inadequate relative to the scale of the problem in the case of salinity and erosion. Evidence for this includes the following:

#### Revegetation

- Estimates for land clearing (and tree loss) vary from 424 444 ha in 1999 (AGO 2001) and 564 800 for 2000 (ACF 2001) and an annual loss of 428 280 ha in the period 1990–95.
- Net loss (all gains versus all losses) was about 232 210 ha in the 1990–95 period, and AGO estimates for net losses from clearing in agriculture are twice the sinks occurring through forestry plantations, tree planting and other sequestration.
- Net loss is occurring despite the very substantial efforts of the NHT in revegetation and remnant vegetation preservation. The Bushcare program aims to protect and revegetate a total 300 000 hectares in 5 years, and while Landcare projects have added several million trees to the environment in the past decade, this is probably less than has been lost through natural decline and clearing native vegetation.
- Recent estimates from the ACF and NFF (NFF–ACF 2000) indicated that the current level of capitalisation for natural resource restoration, of \$640 million per year, is only 10% of the \$6.4 billion that their paper suggests is needed.

### **Climatic variability and calculated requirements in revegetation**

- Recent climate change studies show that there is annual to biennial fluctuations in the amount of carbon dioxide entering the atmosphere; globally, twofold variations are not uncommon.
- Variation in rainfall on the Australian continent likewise has a 20–50% variability between wet and dry years (ENSO variation), translating into differences in net biomass of 20–50%.
- These oscillations are so large that only the very largest anthropogenic changes are likely to have any measurable impact.
- Modelled estimates of the revegetation needed in those river basins that have less than 25% perennial vegetation is for 30–50% of cleared land to be restored to full perennial cover. Only a handful of subcatchments (principally in south-western Western Australia) are achieving this.

### **Performance of grazing industries**

- The chronic problems of under-performance in grazing industries are not being solved by current levels of industry restructuring.
- Most meat and wool production is not sufficiently profitable, except on large corporate farms, or where the livestock are part of mixed farming enterprises, for the industries to have sufficient resources to invest in natural resource management, let alone restoration. Alternatives could include:
  - destocking in most financially and environmentally stressed areas with farmers paid as land stewards,
  - deliberate rescheduling of those areas that are valuable for other purposes, such as water catchments, biodiversity value and tourism potential, for alternative land uses, rather than waiting for market forces to achieve this (which may not occur if land becomes too degraded).

### **Land use**

- Changes in society's attitudes to land and what it is used for is increasing in southern and coastal Australia. These include:
  - recent natural resource management policies of the Commonwealth government emphasise greater collaboration and partnerships among stakeholders, a range of economic and regulatory interventions, alternative wealth generation, education and research to improve environmental condition,
  - competition for land in high value zones (peri-urban, coastal, along transport routes), is shifting land use from predominantly agricultural to multiple use, or intensive high value products.

## Glossary

- agrichemicals** manufactured chemicals produced to perform specific plant and animal protection actions in agricultural activities. They include insecticides, herbicides (to kill weeds), fungicides (to kill fungal pathogens), anthelmintics (to kill internal animal parasites), and hormone preparations for both plants and animals. The term is not normally used to cover fertilisers.
- agricultural land** any land on which crops or pastures are cultivated or domestic stock are grazed
- algal blooms** a sudden proliferation of microscopic algae in water bodies, stimulated by the input of nutrients such as phosphates
- anthropogenic** of human origin or human induced; can be used in the context of emissions that are produced as a result of human activities
- arable land** land that is, or has the potential to be, cultivated for crop production
- arid zone** often arbitrarily defined in Australia as those areas receiving less than 250 mm of annual rainfall in the south and 350 mm (or sometimes higher) in the north
- baseline information** information relating to a specific time or defined area of land or water, from which trends or changes can be assessed
- benchmark** the value for an indicator that has some defined environmental significance (or threshold) in the functioning of the natural system. An example is the concentration of pollutants that can be tolerated without damaging health. Whereas targets have a basis in policy and reflect human values, benchmarks are scientifically determined (*see* targets)
- best practice** an agreed standard of practice that conforms with an internationally agreed set of standards. Professional bodies, the International Organization for Standardization (ISO) and other agreed standards institutions have sets of standards covering a wide range of practices. ISO 9000 series cover practices in manufacturing industries, and ISO 14000 series cover environmental management of processed goods.
- biodiversity** the variety of all life-forms: the different plants, animals and micro-organisms, the genes they contain and the ecosystems they form. Often considered at three levels: genetic diversity, species diversity and ecosystem diversity.
- biogeographic region** an extensive region distinguished from adjacent regions by its broad physical and biological characteristics
- biological control** controlling a pest by the use of its natural enemies
- biomass** the quantity of organic materials within an ecosystem (usually expressed as dry weight for unit area or volume)
- BIOS model** BIOSequil, a steady state biosphere model developed by CSIRO Land and Water for quantifying the coupled balances (stores and fluxes) of carbon, nitrogen, phosphorus and water in Australian landscapes. Estimates of biomass production and nutrient stores have been determined. BIOSequil has been applied at a spatial resolution of 5 km across the Australian continent.
- broadacre farms** commercial farms producing relatively low value crops such as wool, sheep meat, beef, cereals, on large areas
- bushfire** almost any form of fire burning out of control (*see* prescribed fire)
- calcareous** composed of, or containing lime or limestone
- carrying capacity** the maximum population size that can be supported indefinitely by a given environment, and can apply to any trophic level of organism (carnivore, herbivore, microbial, autotrophic, etc)
- catchment** the area determined by topographic features within which rainfall will contribute to runoff at a particular point under consideration
- CFCs (chlorofluorocarbons)** synthetic products, which do not occur naturally and contain chlorine and fluorine; commonly used in various industrial processes and as refrigerants and, prior to 1990, as a propellant gas for sprays; deplete ozone in the stratosphere and are powerful greenhouse gases
- chenopod shrubland** areas dominated by shrubs of the Chenopodiaceae family (commonly known as saltbushes and bluebushes)
- chlorophyll** the green pigment in plants that functions in photosynthesis by absorbing light from the sun
- clearfelling** the removal of all trees on a specified cutting area (*see* coupe); in many cases some trees are retained for environmental protection or conservation reasons

- clearing** removing vegetation, particularly trees and shrubs, from a landscape, often with the intention of replacing it with plants regarded to be more directly useful to humans
- climate** the synthesis of the day-to-day weather conditions in a given area; the actual climate is characterised by long-term statistics of the state of the atmosphere in an area
- climate variability** the natural year-to-year and season-to-season variation of the climate system
- codes of practice** sets of guidelines adopted by management agencies concerned with minimising impacts of operations on the environment and with worker safety
- conservation farming (tillage)** farming systems designed to reduce runoff so that water storage in the soil is maximised and soil erosion is reduced
- coupe** an area of forest harvested in a single operation; usually 10 to 300 hectares harvested over a single season
- desertification** the degradation of land in arid, semi-arid, and other areas with a dry season; caused primarily by over-exploitation and inappropriate land use interacting with climatic variations
- diffuse-source pollution** pollution from sources such as an eroding paddock, urban or suburban lands and forests; spread out, and often not easily identified or managed
- domestic animals** selection of animals with desired traits for use by humans: for food (meat, milk and milk products), other animal products (hair, hides for leather, horn, wool), transport (bullocks, camels, horses), or recreation and pets (cats, dogs, racing horses, dogs, falcons, pigeons) (*see also* feral)
- drainage** the interception and/or removal of surface and/or groundwater from a given area by natural or artificial means
- dry sclerophyll** a type of eucalypt forest found in moderate rainfall (less than 1000 mm per year) areas sometimes called 'open forests' (*see* wet sclerophyll)
- dryland cropping** cropping without irrigation, usually in areas of relatively low rainfall
- dryland salinity** land salinity that occurs as a result of clearing deep-rooted perennial vegetation, or other activities that interfere with the water and salinity balance and lead to shallow water tables; hydrological response to the replacement of deep-rooted perennial native vegetation with shallow rooted annuals which use less water; as a consequence of which more rainfall enters the groundwater, causing water tables to rise close to the soil surface
- Ecologically Sustainable Development (ESD)** development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (for the ESD core objectives and guiding principles, see Council of Australian Governments 1992b)
- ecology** the scientific study of living organisms and their relationships to one another and their environment
- economic efficiency** the extent to which managers are able to make optimum use of resources in production by accounting for the relative prices of resources and products; prices are used to select from a number of technically efficient combinations of resources; where market prices do not coincide with community values the result is the selection of products and practices that are socially inefficient
- ecosystem** a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
- ecosystem services** the role played by organisms and environmental processes in creating a healthy environment for human beings, from production of oxygen to soil formation and maintenance of water quality
- effluent** (a) a discharge or emission of liquid, gas or other waste product; (b) description of a stream network which draws water out of or away from a river or water body
- El Niño** a warm water current which periodically flows southwards along the coast of Ecuador and Peru in South America, replacing the usually cold northwards flowing current; occurs once every five to seven years usually during the Christmas season (the name refers to the Christ child). Occasionally (e.g. 1925, 1972–73, 1982–83 and 1990–94) the occurrence is major and prolonged; the opposite phase of an El Niño event is called a La Niña (*see* ENSO)
- endemic** native to a particular area and found nowhere else; having originated in the region where it is now found
- ENSO (El Niño –Southern Oscillation)** a suite of events that occur at the time of an El Niño; at one extreme of the cycle, when the central Pacific Ocean is warm and the

atmospheric pressure over Australia is relatively high, the ENSO causes drought conditions over eastern Australia (*see* El Niño, SOI)

**environmental indicators** measures of physical, chemical, biological, social, cultural or economic factors which best represent the key elements of complex ecosystems or environmental issues

**environmental stress** the damaging influence of human activities on the environment (for example, through pollution or consumption of natural resources) or that generated by natural events such as storms or droughts

**erodible** susceptible to erosion: erosivity is the capacity (e.g. of rainfall) to erode, erodibility is the susceptibility (e.g. of soil or rock) to erode

**eutrophication** process by which waters become enriched with nutrients, primarily nitrogen and phosphorus, which stimulate the growth of aquatic flora and/or fauna

**evapotranspiration** water withdrawn from soil by evaporation and/or plant transpiration

**exotic species** a species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities (including exotic organisms, GMOs and translocated species *see also* native species, novel biota)

**Extensive Landuse Zone** the non-improved land tenures of Australia that are used for grazing. These occupy over 60% of the continental area.

**fallow** a phase when land is not being actively cropped

**fauna** the entire animal life of a region (*see also* flora)

**feral** animals that have reverted to a wild state from domestication (for example, feral cats, pigs, dogs, camels, horses, donkeys etc), sometimes accompanied by reversion of those traits selected for in domestication (morphology, size, behaviour).

**fertiliser** natural and synthetically produced inorganic and organic plant nutrient compounds. Nitrogen, phosphorus and potassium salts are the most heavily and extensively used, but micro-nutrients and trace elements are manufactured to correct deficiencies in essential nutrients for plants for the elements calcium, magnesium, sulphur, zinc, iron, copper, manganese, molybdenum, and also for cobalt in animals. Organic fertilisers are derived from plant and animal residues but plants acquire them as simple salts after decomposition and breakdown in the soil.

**fire regime** the pattern of fires at a location; includes the frequency, intensity and seasonality of the fires

**flora** the entire plant life of a region (*see also* fauna)

**flux** the rate at which heat (energy, radiation, carbon dioxide, water vapour etc) flows across unit area (e.g. heat flux is the flow of heat in a heat exchange process)

**forest** The Australian definition (National Forest Inventory) is 'an area dominated by trees having usually a single stem and a mature stand height exceeding two metres with an existing or potential crown cover equal to or greater than 20%'. This definition is somewhat different to that of the United Nations Food and Agriculture Organization, which is 'land with tree crown cover of more than 10% and area of more than 0.5 ha. Trees should be able to reach a minimum height of 5 metres at maturity'.

**freehold tenure** land owned privately (*see also* leasehold land)

**fresh water** water containing no significant amounts of salts, potable water suitable for all normal uses; also known as potable water

**gene** the basic unit of heredity

**geographic information system (GIS)** a package of computer programs specifically designed to deal with data that are spatially related; a set of tools for collecting, storing, retrieving, manipulating, analysing and displaying mapped data from the real world

**GL (gigalitre)** one thousand million litres

**grassland** areas dominated by grasses and with few or no trees

**greenhouse effect** a popular term used to describe the role of atmospheric trace gases—water vapour, carbon dioxide, methane, nitrous oxide, ozone—in keeping the Earth's surface warmer than it would be otherwise; also known as enhanced greenhouse effect

**groundwater** water occurring below the ground surface

**gully erosion** a form of erosion involving the formation of deep, steep-sided channels or gullies which cannot be removed by cultivation (*see* rill erosion, sheet erosion)

**habitat** the place where an animal or a plant normally lives and reproduces

**hardwood** timber from sources other than pines and cypresses; includes timbers from eucalypts, wattles and most rainforest species (*see* softwood)

**headwaters** the upper parts of a river drainage system

**heath** a vegetation dominated by small shrubs with small hard leaves

- heavy metal** metallic element with relatively high atomic mass (over 5.0 specific gravity), such as lead, cadmium, arsenic and mercury; generally toxic in relatively low concentrations to plant and animal life
- hectare (ha)** 10 000 square metres. There are 100 hectares in 1 km<sup>2</sup>
- herbivore** an animal that consumes plants
- improved pasture** pasture that is sown with a mixture of introduced grasses and legumes inoculated with rhizobia to fix nitrogen, and fertilised on a regular basis. Such pastures, if well managed, are very much more productive than native pastures and rough grazing, which may consist of native shrubs, grasses, weeds, with or without a tree canopy. The most highly managed pastures may produce more than 20 times the dry matter and protein per hectare than rough grazing.
- infiltration** the passage of water through the soil surface and into the soil matrix
- Intensive Landuse Zone** agricultural area of Australia where the predominant landuses are cropping (both irrigated and rainfed) and improved grazing, with introduced grasses and legumes
- invertebrate** an animal without a backbone composed of vertebrae; examples include insects, worms, snails, mussels, prawns and cuttlefish (*see* vertebrate)
- KL (kilolitre)** one thousand litres, or one cubic metre
- L (litre)** a unit of volume equal to 1/1000 of one cubic metre
- land cover** the physical state of the land surface, including vegetation, soil, rock and human made structures, but specifically used in relation to vegetational changes, to describe the proportion of land covered by vegetation
- Landcare** a voluntary and cooperative movement that brings together rural people, government agencies and others with an interest in the long-term health of the land; the term was first used in Victoria in 1986 but spread nationally after 1988 when the Australian Conservation Foundation and the National Farmers' Federation persuaded the Commonwealth Government to provide significant financial support
- leakiness** horizontal and vertical leaching of cations from the soil profile into the water table and where it intercepts the ground surface
- leasehold land** land owned by governments on behalf of the people they represent but leased to specified people or organisations for a specific purpose; about 50% of Australia, mostly in the drier regions, comes under some form of leasehold; governments retain a variety of controls over how leasehold land is used
- medic** species of the genus *Medicago*, including lucerne, that have symbiotic rhizobia which fix nitrogen
- microgram (µg)** 1 x 10<sup>-6</sup> grams
- ML (megalitre)** one million litres, or 1000 cubic metres, (1 acre foot = 1234 cubic metres)
- multiple use** managing an area to achieve multiple goals or multiple outputs; (e.g. timber production, water and recreational opportunities)
- native species (indigenous species)** species that are native to (i.e. occur naturally) in a region (*see* exotic species)
- naturalised** an exotic species that, once introduced into an area, has the capacity to adapt to the new environment, survive in competition with the endemic floral and faunal populations, reproduce itself and establish itself as a persistent part of the plant community in one or more habitat (*see also* exotic species)
- Net primary productivity (NPP)** the ratio of all biomass accumulation and biomass losses in units of carbon, weight or energy, per land surface unit, over a set time interval (usually a year)
- nitrogen fixation** the conversion of gaseous nitrogen into more complex molecules that can be used by plants and other organisms; often carried out by micro-organisms in the soil or closely associated with some plant species (e.g. the legumes or pea relatives)
- novel biota** a species occurring in an area outside its historically known natural range as a result of intentional or accidental dispersal by human activities (including exotic organisms, GMOs and translocated species (*see also* exotic species))
- off-site impacts** consequences of an action or decision that occur beyond the area (e.g. the farm or catchment) under consideration; also known as externalities
- old-growth forests** forests dominated by mature trees and with little or no evidence of any disturbance such as logging, road building or clearing
- open woodlands** an area with scattered trees in which the tree crowns cover less than about 30% of land surface (*see* woodland)

- organochlorine** a hydrocarbon compound containing chlorine. Includes many pesticides and industrial chemicals.
- particulate matter** in this report, the term particulate matter has been used interchangeably with particles
- pastoral areas** those areas used predominantly for grazing livestock with little or no cultivation or improved pastures
- pathogen** agent causing disease
- perennial plants** plants that live for more than one year
- peri-urban** low density housing and road development on the periphery of urban areas, still retaining small areas of rural land within networks of suburban building
- pest** an animal, or sometimes a plant, occurring where it is not wanted by humans (*see* weed)
- photosynthesis** the biochemical process in plants and certain other organisms by which energy from the sun, captured by chlorophyll, powers the production of organic matter from carbon dioxide and water, releasing oxygen (*see* chlorophyll)
- point-source pollution** pollution from an easily discernible, single source such as a factory (*see* diffuse-source pollution)
- pollution** the direct or indirect alteration of the physical, thermal, biological or radioactive properties of any part of the environment in such a way as to create a hazard or potential hazard to the health, safety or welfare of any living species
- population** a group of individuals of the same species, forming a breeding unit and sharing a habitat
- precipitation** any form or all forms of liquid or solid water particles that fall from the atmosphere and reach the Earth's surface; includes drizzle, rain, snow, snow pellets, ice crystals, ice pellets and hail
- prescribed fire** a fire deliberately lit and controlled by humans, usually as part of a land management program (e.g. to reduce the chance of uncontrollable bushfires, or to control weeds)
- primary productivity** the rate at which plants produce organic matter through photosynthesis, generally expressed as net (all increase minus all decay)
- primary salinity** salinity mobilised in the landscape from a change in the hydrologic cycle either from climate change or clearing
- productivity (biological)** the rate of accumulation of organic material in an ecosystem or the rate of change in the physical agricultural production of a unit of land, as described by yield (tonnes/ha) per year
- productivity (economic)** the sum of technological change and change in economic efficiency. 'Total factor productivity' is the ratio of the index of all product outputs of production to the index of all inputs used to produce the same level of output.
- rangelands** areas of native grasslands, shrublands and woodlands that cover a large proportion of the arid and semi-arid regions, including tropical savanna woodlands: regular cropping is not practised and the predominant agricultural use, if any, is grazing of sheep and cattle on native vegetation
- recharge** the action by which water is added to a rock layer either naturally or artificially
- reduced (or minimum) tillage** a soil management system in which tillage is avoided as much as possible
- residence time** the period during which a substance remains in its active form in the environment
- rill erosion** a form of erosion involving formation of shallow gutters which may be removed by cultivation (*see* gully erosion, sheet erosion)
- risk analysis** classical risk analysis, as used in engineering applications for example, is a matrix analysis of type of impact by frequency of occurrence. Risk is predictive, hazard is qualitatively estimated
- runoff** that portion of precipitation not immediately absorbed into or detained upon the soil and which thus becomes a surface flow
- salinisation** the process by which soluble salt levels in the soil increase to the point where plant growth is affected (*see* secondary salinity)
- saltbush** *see* chenopod shrubland
- savanna** a vegetation type with scattered trees over a grassland, usually found in subtropical areas

- secondary salinity** human induced, largely believed to be related to irrigation, results from rise in naturally saline watertable to less than one metre from the root zone, causing salinisation (*see* salinisation)
- semi-arid zone** lands where rainfall is so low and unreliable that crops cannot be grown with any reliability (*see* arid zone)
- sheet erosion** the removal of a fairly uniform layer of soil from the land surface by raindrop splash and/or runoff (*see* rill erosion, gully erosion)
- shrubland** an area dominated by short, multi-stemmed plants; a typical example is the chenopod shrublands but sometimes the 'mallee' is classified as a shrubland (*see* chenopod shrubland)
- siltation** deposition of sediments from water in channels, harbours, etc
- sinks** processes or places that remove or store gases, solutes or solids in accumulating parts of the environment
- SLA (Statistical Local Area)** Population and related socio-economic statistics are gathered by collection districts, aggregated to SLAs and in turn these are aggregated to statistical divisions, and then to States and Territories. SLAs are roughly equivalent to administrative shires, and often follow the same boundaries. There has been substantial re-alignment of SLA boundaries in recent years, particularly in Victoria which has made analysis of spatially dispersed data (such as agricultural statistics) difficult to compare across years.
- sodic soils** soils with a high proportion of sodium relative to calcium, potassium and magnesium in the composition of the exchangeable cations on the clay fraction. This causes poor physical conditions through dispersion (spreading out of the clay in water); Sodicty affects about 30% of Australian soils.
- softwood** timbers from trees such as pines and cypresses; in Australia most softwood comes from pine plantations (*see* hardwood)
- SOI (Southern Oscillation Index)** an indicator based on the pressure gradient between the quasi-stationary low pressure region over Indonesia and the centre of the subtropical high pressure cell over the eastern Pacific Ocean. Traditionally, Darwin and Tahiti are used as the sites for determining the magnitude of the Southern Oscillation. A negative SOI is associated with higher than normal pressures over Darwin and drought conditions over much of eastern Australia (*see* ENSO)
- soil acidification** a gradual increase in the acidity of a soil as a consequence of a variety of natural processes and management actions
- soil conditioner** a chemical that improves the physical or chemical behaviour of soil by stabilising soil aggregates (or crumbs), changing the pH, or both. Common conditioners include lime (and dolomite) to correct acidity, and gypsum (calcium sulfate) to correct sodicity
- species** a group of plants, animals or micro-organisms that have a high degree of similarity and generally can interbreed only amongst themselves to produce fertile offspring, so that they maintain their 'separateness' from other such groups
- stocking rate** the number of animals carried per unit area of land on a year-long basis. If animals are 'set stocked' they occupy the same land all year, whereas animals that are rotationally or cell stocked occupy different areas as the pasture grows and decays in regions of variable seasonal growth.
- stocking density** the statistical number of animals on a farm or in a region, divided by the total area of grazing land available
- surfactant** a material that facilitates and accentuates the emulsifying, wetting and other surface-modifying properties of substances
- suspended solids** any solid substance present in water in an undissolved state, usually contributing directly to turbidity
- symbiotic** a close association between the individuals of pairs of species often leading to mutual gains
- targets** are specified levels or ranges of measurable parameters that decision-makers have agreed they will try to achieve. Targets are policy tools, but they may have a scientific base. Australia's commitment at Kyoto to restrict greenhouse gas emissions to 108% of 1990 levels by 2008–2012 is an example of a target.
- tillage** mechanical disturbance of the soil by using various implements to alter the soil structure; usually done to create a seedbed, kill weeds or increase water entry (*see* reduced (or minimum) tillage)

**total factor productivity** *see* productivity (economic)

**trend** a general direction or tendency; an indication of change (or its absence) in a property or condition

**turbidity** (a) a measure of the extent to which passage of light through water is reduced by suspended matter (b) the cloudy conditions caused by suspended solids in liquids

**urbanisation** the shift of population from rural to urban areas

**vector** a disease carrier

**vertebrate** an animal with a backbone composed of vertebrae, examples include mammals, fishes, frogs, amphibians, reptiles and birds (*see* invertebrate)

**water table** a surface defined by the level to which water rises in an open well or piezometer

**weed** a plant species growing where it is not wanted by humans, generally in relation to agricultural production or conservation of endemic biodiversity

**wet sclerophyll** a type of eucalypt forest found in high rainfall (more than 1000 mm per year) areas; sometimes called 'tall-open forests' (*see* dry sclerophyll)

**wetland** the land area alongside fresh and salt waters, that is flooded all or part of the time; marine and estuarine wetlands include tidal basins, saltmarshes and mangroves

**wilderness** 'a large tract of land remote at its core from mechanised access or settlement, substantially unmodified by modern technological society or capable of being restored to that state, and of a sufficient size to make practicable its long-term protection of its natural systems'. (The Macquarie Dictionary 1997)

**woodland** an area with scattered trees where the portion of the land surface covered by the crowns is more than 30% (open woodland) but less than 60% (forest)

**zero tillage** a production system in which there is no tillage at all. Many Australians use the term incorrectly to describe what should be referred to as reduced tillage (see reduced (or minimum) tillage).

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