Ecological consequences of clearing and fragmentation of native vegetation

Denis A Saunders

Fellow CSIRO Sustainable Ecosystems, GPO Box 284, Canberra ACT 2601
denis.saunders@csiro.au

The removal of native vegetation on a broad scale is non-random process that leads to a collection of fragmented vegetation patches in a matrix of different vegetation and/or land uses. The result is a series of fragments or remnants located in different positions in the landscape, on different soil types, possessing different vegetation types and associated fauna, and varying in size, shape, isolation and type of ownership. What are the ecological consequences of this reduction and fragmentation of native vegetation?

Removal of native vegetation results in changes in radiation fluxes with increases in solar radiation leading to higher temperatures during the day. There are also increases in re-radiation at night resulting in lower night temperatures. Surface and soil temperatures increase in range and may be very much greater by day and lower at night than before clearing took place. There also may be an edge-effect in relation to solar radiation depending on the angle of the sun; the higher the latitude, the more it penetrates the edge of the remnant. The implications of these factors alone are significant. Changes in microclimate may result in changes in the species composition at the edges of remnants and may have major impacts on the soil biota with potential effects on ecological processes such as nutrient cycling. In addition, species present before clearing may not be able to be re-established because the changed microclimate may not provide a suitable environmental for them.

Clearing native vegetation also results in changes to the pattern of wind flow across the landscape, with less resistance and protection. Species that established themselves when the vegetative cover was continuous were relatively well-protected from the effects of wind. Increased exposure often results in increasing rates of wind throw and wind pruning of dominant plant species. This creates gaps in cover with increased chances for invasive species to establish. Increased exposure to wind can lead to increases in evapo-transpiration, reduced humidity and increasing dessication rates. Increased wind may also lead to increases in fall of litter with potential for changes in the litter fauna. In addition, there may be increasing movement of dust and seed into patches from the outside, further increasing the chances of invasion by species from outside the remnant.

Major changes in the hydrological cycle result from the removal or thinning of native vegetation. Deep-rooted perennial vegetation uses much more water than the annual plants that largely replace the former vegetation. More rain falls directly to the ground in cleared areas than under uncleared land, with the potential to damage the soil by impact. There may be less buffering and more extreme run-off events. More water flows across the landscape, moving topsoil around, in some cases into the remnants themselves, while in other cases soil and litter is removed from the remnants; this depends on the position of the remnant in the landscape.

Native vegetation is often resistant to invasion, but is less so when disturbed and enriched. Water moving soil from areas surrounding remnants into remnants can constitute a major disturbance. The soil is usually accompanied by seed and nutrients (eg, fertiliser, droppings from domestic livestock). This provides ideal enriched conditions for the establishment of weeds.

In extensively cleared areas, more water enters ground water resulting in a rise in the water table, in some cases very rapidly. Water-logging occurs when the water table reaches ground-level. Rising water tables are often accompanied by salt (sodium chloride) that has been stored deep in the soil profile leading to increasing soil salination, destroying otherwise productive agricultural land and remnant vegetation. The effect depends on the position in the landscape. Dryland salinity is now a major problem in many parts of Australia. In addition, saline waters flow into watercourses leading to destruction of freshwater ecosystems and loss of potable water. It is ironic that in the driest continent after Antarctica, some of our environmental problems stem from too much water in the landscape.

Loss of native vegetation and its fragmentation has a number of biotic consequences that can be moderated by a number of factors. For example, time since isolation or creation of the remnant is a major modifying factor. The Theory of Island Biogeography states that at the time of isolation the island (in this case remnant patch) is carrying more species than it is capable of carrying over time and so species will be lost. This is the process of species “relaxation.” The longer a remnant has been isolated the more species it will lose. Obviously for some species, such as those dependent on native vegetation with requirements for large areas, the process of relaxation will be rapid, probably a matter of years. However, for long-living, sedentary species, like the dominant tree species, it may take centuries. **The point to note is that remnants will lose species over time and this will pose major management problems**.

The number of species lost will also be modified by the distribution of native vegetation and the dispersal mechanisms of the plants and animals of the remnant. The shorter the distance between remnants and the greater the number of species with the ability to cross that distance, the greater will be the chances of the species remaining. Some species, which require other species to help them move around the landscape, are doomed if their transport is lost from the area. This may be the case with some species of the genus *Santalum* when the emu is lost from an area.

Remnants now occur in a matrix of human-dominated landuses. Every one is likely to be affected by what is happening in the surrounding land. This means that what happens in that land can have a major impact on the remnants. Nutrients and seeds being deposited in the remnant have been mentioned earlier. Species that depend on the surrounding land can also have an effect. Domestic stock are obvious examples but there are other more subtle ones; like the galah that has expanded its range because of human activities and competes with remnant-dependent species for nest hollows, damages and kills trees, and introduces the seed of invasive species via its droppings.

There are a number of characteristics of remnants that help to modify some of the degrading processes. Remnant size is an obvious one. The larger the remnant the longer it will be able to resist some of the degrading processes. Unfortunately we have no general information on how large remnants should be; that will be determined on a case by case basis, depending on position on the landscape, etc. Larger remnants will contain more species than smaller remnants. However, the non-random nature of clearing of native vegetation will almost always ensure that the larger privately owned remnants are on the poorer soils and are not representative of the original vegetation associations.

The shape of the remnant will also help modify the effects of degrading processes, as will the position of the remnant in the landscape. Larger remnants have less edge compared with their area than smaller remnants and are therefore subject to fewer edge effects. Those remnants lower in the landscape can be exposed to more of the impacts from the surrounding matrix.

The ultimate remnant is the individual tree isolated from other elements of native flora by “parkland clearing.” This vegetation type needs urgent protection and management. We are faced with vast areas of these "living dead"; aging trees with no replacements. What will these landscapes look like in 50 or 100 years without extensive management? They will be vastly different and, on present trends very much species poorer than at present.

What follows from the ecological imperatives?

History tells us that clearing is no longer the major degrading force. The era of broadscale clearing has finished; if only because most of the land suitable for agricultural, horticultural, etc (but not for urban development) purposes has been cleared. There is still the danger of whittling away at the remainder; the supposed “death of a thousand cuts.” There is no doubt that both education and legislation are required to halt this process. Legislation needs to put all applications for clearing into a perspective that shows transparently that the planned clearing will not result in the loss of a remnant of high conservation value or of high ecological value. That means identifying and weighing its value as part of the ecological function of the area; in its water use, moderation of erosion, etc. Individual trees also require this type of protection.

We also need to value remnant vegetation better in an economic context. At present, remnant vegetation on agricultural land is valued on the basis of the economic value of the land on which it occurs, if put into agricultural production, or on the contribution it adds aesthetically to the resale price of the property. This valuation system is fundamentally flawed because it takes no account of the contribution the remnant vegetation makes by providing a range of ecosystem services from local to regional scales.

The critical need in relation to native vegetation is that of management. **Most remnants are degrading. Simply putting a fence around them to stop domestic livestock from grazing them will not be sufficient to halt the loss of species.** Management of internal dynamics of remnants is necessary in order to halt the process. This management will depend on the size of the remnant. With larger remnants it may be necessary to manipulate disturbance regimes like fire as well as the population dynamics of key organisms. In addition it will be necessary to examine external influences and see if they can be moderated. On smaller remnants it will be necessary to concentrate on the external influences. **Management of remnants is essential.** This means integrated landscape management on an ecological basis with knowledge of what each remnant contributes to the ecological whole.

Managers of native vegetation need to concentrate on the practical issues relating to the impact of fragmentation on natural ecosystems and managing fragments for their retention. This means understanding both the physical and biological consequences of the fragmentation of landscapes, and the options available to mitigate the processes leading to the degradation of the fragments.