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The (Aboriginal) face of the (Australian) earth

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THE (ABORIGINAL) FACE OF THE (AUSTRALIAN) EARTH

THE IDEA that humans are a dominant part of the global ecosystem seems very straightforward to us today. We know that people have cleared a large proportion of the earth's vegetation, extracted and utilised non-renewable resources, and contributed to climate change. In the second half of the twentieth century, geographers and archaeologists contributed greatly to this understanding, via a body of research that looked at the details of how human activity has transformed the earth. The human role in changing the face of the earth became a key theme, marked by the publication of Thomas (1956) and stimulating a number of related volumes since then (e.g. Simmons 1989; Goudie 1993).

Early manifestations of the human role in changing the face of the earth are perhaps best encapsulated in the work of Berkeley geographer Carl Sauer, famous for his 1925 conceptualisation of the cultural landscape. Sauer argued that ‘[t]he division of forms into natural and cultural is the necessary basis for determining the real importance and character of man's activity…’ (Sauer 1965[1925]: 343). He considered that the cultural landscape is ‘fashioned from a natural landscape by a culture group. Culture is the agent, the natural area is the medium, the cultural landscape the result.’

If that particular encapsulation of a cultural landscape looks rather old-fashioned to us now, for a number of reasons (Head 2000a), it is worth pondering for a moment just how radical a notion it was that humans (‘man’, of course) could shape the face of the earth. This was
not because no one had ever thought of it before — indeed geographer Clarence Glacken reminds us that the question of human transformations is one of the three most persistent questions that 'men' have asked about their relationship to the habitable earth since the beginning of western thought (Glacken 1967). (And when they did first ask it, those transformations were seen as improvements rather than destruction, as we are more likely to consider them today.) Rather it was radical because the intellectual context in which Sauer and colleagues were writing had been dominated in the early decades of the twentieth century by environmental determinism, which emphasised the role of environment in shaping culture. One of the most famous of this school was the Australian geographer Griffith Taylor, who argued that the climate changes leading to the aridification of Australia had made agriculture impossible and forced the Australian to remain 'a primitive hunter living from hand to mouth' (Taylor 1946: 99).

The ubiquity of Aboriginal fire and its role as an agent of environmental transformation have been commented on since Europeans first arrived in Australia (Merrilees 1968; Hallam 1975). This evidence came to be utilised in international debates. Carl Sauer was in fact one of the earliest researchers to recognise that hunter-gatherer use of fire may have profoundly altered vegetation (1952: 11-12).

Even the abobine Tasmanians helped their food gathering by burning over the ground. A little-explored subject is the use of fire to change the character of the vegetation deliberately... In not a few cases, fire became a deliberate instrument of land management by deliberate deformation of the plant association.

Sauer's conclusions were constrained by the methods of the time: the tools to pursue the issue further, in the form of pollen and charcoal analysis datable by radiocarbon, were not well-developed until the very end of his life.

It is now a well-known story that the decades following 1952 saw an explosion of research into precisely that theme, using many of those tools. What I want to do here is
- briefly review the achievements and perspectives of those decades;
- consider the current challenges to the way we understand human transformations of the landscape; and
- sketch out an alternative perspective that does justice to both the achievements and the challenges. I am going to apply it to debates over Aboriginal people, fire and vegetation, although I think there are implications here for a much broader set of debates within Australian prehistory, including megafaunal extinctions and the changes within the last few thousand years, often referred to as the intensification debate.

My argument is in many ways quite straightforward. We have a history of debating these issues in a very polarised fashion — I do not mean personally, although that happens also. Somehow we have set up false choices for ourselves: it was either humans or climate, either society or climate is dominant. Such false choices are clearly incompatible with current evidence, as I shall illustrate. We need to put much more systematic research into examining the mechanisms of interaction.

**Review**

We are now aware from a diverse range of evidence that the environments that had been thought of as without culture turned out to be full of culture. That is true for environments separated from us in both time and space: cultural landscapes as conceptualised by Sauer were both earlier in human history and more pervasive across the face of the contemporary earth than had been recognised.

Australian researchers made significant contributions to this shift in thinking through their analyses of long-term Aboriginal interactions...
with the environment. Indeed, Australian contributions to this understanding are among the most important of our intellectual exports. They are perhaps the best example we have of practitioners in the sciences and humanities working together in Australia to solve problems of mutual interest. They are also precisely the sort of public-good research that always struggles for funding.

The Australian contributions were particularly valuable not just because of the individuals involved, although they were important. Rather they were hewn out of a particular convergence of methods, as well as the ecology and sociality of the place that we are talking about (Head 2000b). Four key streams converged in this conversation:

1. the long-term history of human presence in and interaction with the environment, as evidenced in archaeology and palaeoecology (Tindale 1959; Jones 1969; Mulvaney and Golson 1971; Singh et al. 1981);

2. the rich ethnographies and ethnographies of the nineteenth and twentieth centuries that provided another perspective on similar themes, giving us an understanding that Aboriginal environments should be seen not as landscapes but as ‘humanised realm[s] saturated with significations’ (Stanner 1979: 131);

3. the evolutionary history of the continent which gave us an understanding of its long-term aridification and a realisation that fire had been part of this evolution on a timescale of many millions of years, i.e. that fire was not a disturbance somehow external to the system, but an integral part of what is normal in Australia, and that it had been part of that system since long before people arrived (Gill et al. 1981); and

4. the increasing participation of Aboriginal voices in public debate, with their own expression and ‘take’ on landscape interactions. These voices have been unashamedly political, fighting the political dimensions of dispossession. They have also gone a long way to rectifying the resulting cultural erasure — putting people back into discussions about the Australian earth.

These were the great contributions of what I shall refer to as the Golsonian generation. I do not want to imply that there is a single generation here, but I am talking about the people like Golson who set up the first teaching and research departments in Australian universities and the first wave of doctoral students they trained. In doing so I also want to acknowledge the inspirational impact that the 1971 Mulvaney and Golson volume, Aboriginal Man and Environment in Australia, had on me when I encountered it as an undergraduate in the late 1970s.

The story of this ‘generation’ has been told in a number of recent festschriften as various of its members retired (Spriggs et al. 1993; Bonyhady and Griffiths 1996; Anderson et al. 2001). In brief, they:

— overturned the idea of an unchanging people in an unchanging land;

— put the ghost of environmental determinism to bed, without denying the importance of environment; and

— radically changed perceptions and understandings of hunter-gatherers from the eternal primitive to active and engaged environmental managers. Even the polarised debates over Aborigines as influencing vegetation through their use of fire and playing a role in megafaunal extinctions have had the shared characteristic that they are seen as an ecological force.

The understandings that were generated have seeped into public consciousness in a variety of ways. They have contributed to nation building in Papua New Guinea and debates over national identity in Australia. They have influenced public policy in relation to land and heritage management and native title (Head 2000a, b). A much broader definition of ‘cultural landscape’, which includes human associations rather than simply physical transformations, is now embedded in World Heritage listings.

So prehistory is very much entwined with the present — a lot of it is about us. And so it is with fire. We have woven the fire story into a
number of morality tales. Either Aboriginal people were ecological angels and we should learn from them, or Aborigines buggered up the place when they first arrived, but they adapted to the Australian environment and created a sustainable society, therefore we should too.

It is undeniable that the public now has a more dynamic view of Australia’s prehistoric past than it had thirty years ago. Yet our understanding of that past still has much in common with nineteenth century views of Aboriginal history. The chronological revolution is built on linear notions of time and teleological conceptions of historical progress that have proven easier to extend than to overturn. We have made a place for hunter-gatherers in that history, but we have not changed the underlying story. The fact that much of our evidence is built up in sedimentary layers does not help: it is hard to think archaeologically or palaeoecologically without those layers.

Yet the evidence from a number of different disciplines is challenging us to reframe our thinking in more fundamental ways and I want to spend some time considering those challenges and their implications.

The challenges

1. The cultural turn: unpacking culture

The ‘cultural turn’ (Chaney 1994) across the humanities and social sciences has broken down the monolithic view of culture exemplified by Sauer. It is now better understood as ‘a dynamic mix of symbols, beliefs, languages and practices that people create, not a fixed thing or entity governing humans’ (Anderson and Gale 1992). A very important dimension of culture is the range of environmental attitudes and behaviours seen across different social groups, i.e. not only is culture very dynamic but it also contains a lot of nature.

Archaeologists have made important contributions here in the way they have unpacked the neolithic (Thomas 1991). The package used to be seen as a bundle containing things such as plant and animal domestication, sedentism, pottery and land clearance, which would all appear at once. That is clearly not the case at a global scale, nor even within particular regions, and the New Guinea evidence has been influential in this regard, including that presented by a later generation of Golson’s students (Denham and Ballard 2003).

We thus cannot take for granted the nature of hunter-gatherer (or agricultural for that matter) interactions with the environment. These need to be demonstrated in particular circumstances on the basis of the evidence. And in saying ‘interactions’ here, I am referring to both material and conceptual interactions.

2. The new ecology: unpacking nature

Very different lines of evidence, from historical ecology and palaeoecology, indicate variability, complexity and non-directional change in ecosystems (Pickett and White 1985; Stott 1998; Zimmerer 1994, 2000). A number of examples show that what we have thought of as very distinct vegetation communities are often quite opportunistic and temporary associations of individual species. In the forests of North America, the altitude-determined vegetation belts of the Amazon and highland forests of central Africa, plant associations have been shown to form and reform as opportunistic collections of species in response to climatic change during and since the last glacial (Meadows 1999). This is less clear in Australia as the pollen records are usually not resolvable to species level, but we certainly have examples here in the recent past of vegetation communities for which there is no modern analogue. Human influences are often an important component of this variability, but they are not the only source. It is significant that these themes emerge from the convergence of quite different lines of evidence: from the sciences and humanities and from both very theoretical and very empirical perspectives (Head 2000a).
Thus:

— Neither culture nor nature should be thought of as a freestanding category. They are interbedded and entwined, both conceptually and materially. So when I talk about ‘interactions’, this is not just bringing together two unchanged things to meet in the middle.
— We need to think of variability and complexity as part of the normal state of affairs, not just as exceptions to wider trends.
— We have to somehow develop nonlinear, nondeterministic understandings of temporal change.
— We need to progress from prime-mover, single-cause explanations to thinking of a network of causal processes operating together.

It is inappropriate to have law-like generalisations that presuppose the very things we should be analysing and grand narratives that sweep the interesting variability into general explanations. We have, I think, been particularly prone to this in the Australian context, where we have had a couple of extra confluences. To even talk about the Aboriginal Face of the Australian Earth we have conflated Australia as a single land, despite the significant ecological variability and important questions of scale across the vast continent. In parallel, we have also conflated Australian Aboriginals as one people in many of our discussions. Both these confluences came mainly from the continental boundary being more or less coterminous with that of the nation. Again, this does not mean that we cannot seek pattern or holism, but we have to build it from the ground up, rather than assume it.

Alternative perspectives

I draw inspiration here from British palaeoecologist Tony Brown’s call for a more fragmentary narrative in which human impacts, natural events and ecological instability all have a role (Brown 1997). This is also associated with questions of methodology — what is the appropriate scale of analysis for the questions of interest? Or maybe, as I shall be focusing on fire, mosaic narratives is another way to express it.

So what would our fragmentary narratives look like, in relation to the debates about Aboriginal impact on vegetation through the use of fire? I shall address this using five examples. They include both very fine-grained analyses and some broad-brush ones.

1. Cultural and ecological variability

It is important to remember that Aboriginal use of fire has always been part of a wider set of landscape engagements, rather than an activity in and of itself. It has always combined social and ecological dimensions and has been embedded in the broader domains of Aboriginal life (Jones 1969; Hallam 1975). We know from a range of ethnographical and ethnographic research that fire was used, and in some places continues to be used, in various ways to manage animal and plant food resources. It was used for protection of fire-sensitive vegetation patches and for the clearing up of dirty overgrown patches. It was used for signalling and ceremonial purposes.

As part of its role in the broader domains of life, fire would have been subject also to gender variability (Gleeson 1993). Bowman et al. (2001) and Vigilante (2003) have recently written about hunting drives undertaken by men in Arnhem Land and the West Kimberley respectively, while my own research has been mostly with women (Head 1994). Thompson’s (1949:18) account reminds us that the two purposes would not always have coincided.

While the burning of the grass yields an appreciable amount of animal food... it also has the effect of destroying the tops of food plants, which can then no longer be detected by the women...

Since ‘the woman is the provider of the vegetable food, which forms the chief food supply’ (Thompson 1949: caption to plate 9), we can imagine that words might have been exchanged, as the women...
contemplated the increased difficulty of gathering plant foods as the dry season advanced! This emphasises the importance of social controls and negotiated processes in all aspects of fire management.

In view of such variability, if we are thinking of looking in the prehistoric record for Aboriginal influences, there is no a priori vegetation change we should be looking for. Some fire activity would favour fire-tolerant vegetation, some would favour fire-sensitive vegetation. Some would have outcomes for vegetation that were quite unrelated to the original intent of the fire.

2. Differential influences on species, not ecosystems or communities

I want to illustrate this point by examining some fruit trees that were important plant foods, and their differential response to fire. My two main examples are *Buchanania obovata* (common name 'bush mango', Murinpatha name *kilen*) and *Persoonia falcata* (common name 'wild pear', Murinpatha name *kutham*). *Buchanania* and *Persoonia* are both members of a suite of several dozen fruit trees mostly found as the mid-storey in the tall-grass *Eucalyptus* savannas of monsoonal Australia. Crawford (1982) documents about forty such species. They mostly fruit early in the wet season, prompting two strategies recorded historically: gatherings to share the resource while it lasted, and collection and preservation for storage.

Again illustrating the interpenetration of the ecological and the social, Nganinyin lawmen of the West Kimberley have explained the fruit trees *gilo* (*Terminalia carpentariae*) and *golani* (*Vitex glabrata*) as central visual metaphors for education/continuing culture and the common law of Wunan respectively (Goring 2000: 322–3).

Wollongong PhD student Jenny Atchison’s work (Atchison 2000) shows that remains of a number of these fruits are found in archaeological sites in the East Kimberley and that the first evidence of sustained fruit processing is around 3500 years old. (It may have been happening before that, but the archaeological preservation is not good enough to tell us.) In fact, the only reason we have any archaeological signature, it appears, is because of the processing in order to make cakes of dried fruit suitable for storage and trading. The archaeological pattern of burning and fragmentation suggests that the seeds were cooked (or charred) and then smashed, most probably to extract the kernel. Pounding of *B. obovata* seeds has been recorded by Crawford (1982: 55–6) and in our study, but in neither case was burning part of the process.

After 3500 BP, the evidence from three sites shows variability in use of plants, until sometime within the last one hundred years or so, when processing of both species declined rapidly.

Atchison’s biogeographic study (2000: Chapter 4) showed that *B. obovata* persists in healthy populations at all three of her study sites, but *P. falcata* is in a more parlous state. It was not found within a 1km radius of one study site and its status is marginal at the other two. Atchison hypothesises (2000: Chapter 7, Atchison et al. 2005) that removal and reduction of Aboriginal fire regimes in the last hundred years, leading to a more intense fire regime, had contributed to this demise.

Meanwhile, in the West Kimberley, Charles Darwin University PhD student Tom Vigilante (2003) was pondering the conundrum that many fruit-tree species were in a suppressed state across much of the landscape under a current regime of frequent fires. Given the importance of such fruit resources for Aboriginal people, he wondered, how were they able to maximise this resource under such a regime?

In a series of natural experiments, Vigilante and Bowman (2004) examined the flowering (used as a proxy for fruit set) of five fruit species under different fire regimes. They found that ‘[f]lowering was significantly higher in unburnt trees for all species combined and for each individual species’ (Vigilante and Bowman 2004: 409–10), but
the different flowering levels of individuals affected their ability to respond.

Both *B. obovata* and *P. falcata* have reduced flower production if burnt, so Vigilante and Bowman argue it would have been beneficial for Aboriginal people to protect areas of significant fruit-tree concentration, such as are found on some alluvial soils, by creating fire breaks around them. However, this long-term fire protection could increase the risk of accidental fires and would create the need for occasional intense burns to reduce such hazards. In the broader savanna landscape, where these species occur in lower densities, Vigilante and Bowman think they would probably not have been subject to particular fruit-based interventions such as these undertaken to safeguard fruiting, but to more generalised fire regimes. These might be comparable to fires over evolutionary time, to which species were resilient because they had places in the landscape to retreat to, but also a range of flowering and reproductive strategies to deal with such fires.

Thus, not only are there different effects on different species, but the same species can be subject to different fire regimes under different conditions.

Vigilante notes that reduced abundance and productivity of fruit-bearing trees have been implicated in the decline of small frugivorous mammal species in northern Australia since European colonisation (Woinarski et al. 2001). A key difference in the response of species to present-day regimes is the fragmentation of the landscape under different forms of land alienation, such that refuge areas, and thus the opportunity for flexible and variable species responses, are considerably reduced.

3. The problematic concept of ‘impacts’

The notion of human impacts on the earth has built into it assumptions that become problematic if we take seriously the sorts of variability, complexity and blurring of boundaries discussed above. These assumptions include:

— the concept of a clear separation of natural and cultural processes and forces;
— the implication that humans act independently of, rather than in and through, ecological processes; and
— the implication that if you could remove the humans and reverse their impact, all problems would be solved. This is particularly applicable to discussion of our contemporary environmental dilemmas.

There is one space-time where it is most theoretically possible to test for a human impact that might be separable from other long-term processes such as climate change, and that is of course the earliest arrivals of people in the continent. But even here, can we establish a controlled experiment in which all other variables can be held constant? As Haberle et al. (2001:260) argue:

> The antiquity of human induced disturbance is generally discerned in the palaeoecological records by the appearance of ecological processes operating at rates that are unprecedented under ‘natural’ conditions and that can be directly related to human activity through archaeological data (Walker and Singh 1994). However, even when these conditions are met, there is a possibility that ‘unusual natural’ events may have been responsible for recorded vegetation change.

This could be the case, for example, with the pollen and the charcoal records from Lynch’s Crater in North Queensland and Lake George in New South Wales, just down the road from Canberra. These have long been presented as examples of the sort of situation described at the beginning of the above quotation, specifically one where we have one or more glacial/interglacial cycles without people and one with people. The cases in question are more directly compromised as examples because they cannot be related to human
activity through archaeological data. Indeed, the arguments based on them become circular because we do not actually know when people got to Australia.

It was always problematic to extrapolate to the continent from just two sites. More recently regional comparisons have been better developed. Looking at available long records in a roughly north-south transect, Kershaw et al. (2002a) have shown that fire events have been around for hundreds of thousands of years, usually in association with a climatic boundary, i.e. a time period of rapidly changing climate. The main exception, they argue, was the period 30-40,000 years ago when the climate was relatively benign and stable.

Such broad comparisons have been further developed within the tropics to compare eastern Indonesia and northern Australia (Wang et al. 1999; van der Kaars et al. 2000; Kershaw et al. 2002b). Table 1 shows the times of sustained change in vegetation and/or burning recorded within the pollen diagrams at five sites across the region.

The vegetation changes indicated are all characterised as changes towards more open and/or sclerophyllous vegetation. They include:

— decline of lowland Dipterocarpaceae rainforest in eastern Indonesia post-37ka. Prior to this date members of the Dipterocarpaceae, many of which are long-lived ‘climax’ rainforest species, formed an important part of the tropical lowland vegetation of eastern Indonesia.

— post-37ka expansion of grassland and concomitant decline in Eucalyptus in northern Australia and the Sahul Shelf region, with increased burning; and

— decline of Araucarian dry rainforest around Lynch’s Crater.

<table>
<thead>
<tr>
<th>Date</th>
<th>Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. 40 kyr</td>
<td>Banda Sea, Lynch’s Crater, ODP 820, Lombok Ridge, Bandaung</td>
</tr>
<tr>
<td>c. 65 kyr</td>
<td>Bandaung, Lombok Ridge</td>
</tr>
<tr>
<td>c. 135 kyr</td>
<td>ODP 820</td>
</tr>
<tr>
<td>c. 195-175 kyr</td>
<td>Lombok Ridge, ODP 820</td>
</tr>
</tbody>
</table>

Given the history of the fire debate in Australia, this table could be seen to provide support for any one of four dates of colonisation of the Sahulian continent! The best explanation would seem to be that human activities around 37-40kyr did have a significant regional impact, and that they intensified or exacerbated a longer-term trend.

These issues are still under debate. The point here is to show how difficult it is, even in the colonisation scenario, to clearly separate human influences from climatic and other ones. Thus I have come to the conclusion that the term ‘impact’ should be reserved for meteorites and that the concept of ‘interaction’ is more useful.

4. Interactions

Certainly in the long period of human occupation of the old Sahul continent of Australia, Tasmania and New Guinea, together with the northwestern islands of the Melanesian chain, we can find varied examples of such interactions, with diverse outcomes, including extinction of some plant genera (e.g. Dacrydium and Xanthomyrtus at Lynch’s Crater [Bohle and Kershaw 1999]). Another example is provided by Haberle et al. (2001) in a focus on the Indonesian and New Guinea region. They argue (2001: 259) that ‘despite the
presence of humans in the region throughout the last 20,000 years, there is no suggestion that, on a regional spatial scale, fire frequencies were solely related to changing subsistence patterns of the human population. Rather, different patterns of fire variability are seen at different times, including high charcoal values during the period coming out of the last Glacial Maximum (17–12ka), high variability in charcoal values during the transition to the Holocene (12–9ka), low charcoal during the warmer and wetter early-mid Holocene (9–5ka) and highly variable charcoal values for the late Holocene, with peaks at a number of sites 4–2ka. The latter are associated, they think, with intensification of El Niño-related climate variability.

Both Haberle et al. (2001) and Kershaw et al. (2002b) emphasise the importance of periods of rapid climate change in altering fire frequencies. They argue that the fire pattern is influenced by relative stability, not just by relative dryness. This reminds us that, just as we must unpack different social processes, the different elements of climate must be teased apart, including those with very different temporal cycles. These cycles include Milankovitch cycles of about 100,000 years, 30,000 year cycles that may be related to changes in ENSO frequency and the ENSO cycles themselves, which operate at approximately decadal scales (Clement et al. 1999; Gagan et al. 2004; Kershaw et al. 2003).

The interactions around ENSO are very important. The onset of modern ENSO periodicities is argued to have occurred ~5ka, followed by an abrupt increase in ENSO magnitude ~3ka (Gagan et al. 2004). This corresponds to the period of highly variable charcoal values identified by Haberle et al. (2001). That trend is much less pronounced in southeastern Australia, where the highest fire frequencies postdate European arrival (Kershaw et al. 2002a). There may be a somewhat stronger ENSO influence in dry forest and heath formations.

The last 5000 years, of course, coincide with a period of significant archaeological change in Australia and I think there are many interesting local and regional analyses yet to come for this period. But the most interesting will not be the ones that just say, for example, 'social processes interacted with a more variable climate' to produce a particular type of archaeological or vegetation outcome. They will be those that can show, using multiple lines of evidence, exactly how particular aspects of social process and particular dimensions of climate or vegetation or something else interacted.

This may become somewhat clearer if I introduce my next point, which is that we need to go beyond correlation in our explanation.

5. Beyond correlation

There are two related aspects to this part of my argument, mechanisms and contextual explanation.

If we had the dating so well worked out that we knew the timing of the first human footprint, the first firestick and the very last Diprotodon, even if we had them all in the same site, we still would not have a causal explanation for the extinction unless we could demonstrate the mechanisms that connect them.

I think Kershaw has greatly strengthened the case for the human role at Lynch’s Crater by proposing a mechanism that accounts for the facts that the changes took 12,000 years to happen and that the dry rainforest was greatly affected by burning but the wet rainforest was relatively unaffected. He has suggested that burning in sclerophyll communities near the dry rainforest margins would, over time, favour sclerophyll expansion by inhibiting regeneration of fire-sensitive dry rainforest species. Wetter rainforest communities, with more humid microclimates and mesic conditions, have more protection from such incidental burning. These ideas were implicit in his PhD thesis (Kershaw 1973), but have been much less explored in his various publications than the broader debates about dating and the correlation or otherwise with climatic change.
The task of elaborating mechanisms remains to be done for the other suggested vegetation changes that occurred about 37,000 years ago, for example the reduction of sclerophyll forest and expansion of grassland suggested for northwestern Australia and attributed to human influence (Kershaw et al. 2002b). It is not self-evident why or how people would do that. Most burning in savanna is done not to reduce tree cover but to manage the under- and mid-stories. As we have seen above, ethnographically observed examples of such burning have various influences on vegetation but little effect on the Eucalyptus canopy.

In this or any other example, some influential mechanisms may correlate in time or space, but others will not. I am drawing here on what Andrew Vayda (1994: 323) calls contextual explanation, explanation that contextualises actions or consequences by tracing the threads of influence upon them outward in space and backward in time. Examples of such 'context' can also be found in what the ecologists McDonnell and Pickett (1993) call 'subtle human effects', or what human geographers and sociologists of science now refer to as Actor Network Theory. Most of the effects have a strong temporal dimension and in fact the concept can apply to nonhuman effects as well as human ones. Recognition of them has come directly from the converging interests of environmental history, historical ecology and finer-resolution palaeoecology.

The importance of going beyond correlation can be illustrated particularly when we try to think of how we might use our understanding of long-term human/environment interactions to help solve environmental problems today. Consider the fact that many damaging environmental changes followed European arrival in Australia. At a certain level of explanation that view of correlation and causation is indisputable, but that does not actually help us much. It implies that if we just reversed the process — removed European Australia — the problems would be fixed. This is not going to happen, and even if it did, certain thresholds have been crossed that take us into completely new natures (Low 2002).

Thus, if we want to prevent continued plant and animal extinctions, we need to consider interactions of habitat reduction, changed fire regimes and ferals, to name a few. The combination will be different depending on the species under consideration. And each of the processes — habitat reduction, changed fire regimes, ferals — is itself an outcome of particular configurations of human and nonhuman activity.

Final threads

We can summarise some of the threads of current understanding. Fire has been part of Australian ecosystems since long before people arrived on the continent. It has interacted with increasing aridity over tens and hundreds of thousands of years to favour fire-tolerant vegetation types across much of Australia. The first identifiable human interactions seem to have occurred when the climate was relatively benign. However, our understanding of the climates of the last hundred thousand years is likely to be radically revised in the next decade or so as the multiple temporalities of climate change are further unravelled. These initial human interactions had more effect on vegetation in tropical than temperate Australia, possibly because of human changes to the seasonality of fire in the former. Long-term selection pressures have been in the direction of reducing fire-sensitive vegetation, but at various short-term scales both people (sometimes inadvertently) and climate would have countered this trend.

In the big-man world of Australian archaeology the polarised 'human impacts' debates of the last twenty years or so have, presumably inadvertently, reinforced the false choice between ecological and social processes. There has been something of a sense that the space in the middle is for wimps who are not prepared to take a stand.
I want it to be very clear here that the fragmentary narratives I am advocating are not the hits in the middle. They are trying to start from somewhere else. Rather I think of them as ragged but densely woven and contextualised pieces of explanation. They pay close attention to questions of spatial and temporal scale, to mechanisms of connection. They somehow weave together Milankovitch cycles of a hundred thousand years or more, ENSO cycles of a decade or so and the seasonal rounds of human, plant and animal life. They provide no support for lazy arguments that 'it's a mixture of everything', without any consideration of the mechanisms involved. Nor are they an excuse for a narrow particularism. They do require of us a disciplined refusal to extrapolate limited evidence just to fill the gaps (Holdaway et al. 2002 is a fine example of such refusal).

These are some of the challenges facing upcoming generations of researchers.

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