2.0 Chapter summary

Within palaeoecological research, cultural landscapes are generally understood as those transformed by human action, a conceptualization particularly influenced by the work of Carl Sauer. Global overviews present evidence of accelerating and destructive human impacts over time. While in one sense this is an important and unarguable message, it should not be read in a deterministic way. Further, recent work at a range of scales shows considerable spatial and temporal variability. Three themes – colonization, hunter-gatherer/agricultural impacts and post-industrial changes – are reviewed. In each of these, rethinking of substantive and epistemological issues is under way, and constant methodological refinement is occurring. Vigorous debate over the timing and effects of human impacts in the South Pacific and elsewhere contributes to a rethinking of the concept of colonization. Similarly, clear demarcations between hunter-gatherer and agricultural impacts are difficult to maintain, and there is considerable variability within each of the categories. High resolution of the record of the past few hundred years in some parts of the world is facilitating a shift from inductive to deductive approaches within this field of research. Important issues within the three fields include the re-emergence of environmental agency, the importance of multiple palaeoecological proxies, and the influence on interpretation of spatial bias in concentrations of research.

2.1 Changing the face of the Earth

Interest in long-term human impacts on the landscape – or the Earth as transformed by human action – comes from several research directions. Palaeoecological researchers have for a number of decades recognized the possibility of anthropogenic signals in the records under study, although there has been considerable debate over their interpretation. Workers more interested in contemporary timescales and problems have also sought to place these in historical perspective. There are thus a number of overviews to which readers can be directed for more comprehensive coverage. A brief review of their themes and approaches helps to set the approaches of this book in context. It will also help us start to ask a central question: how does/should understanding of long-term impacts help us deal with contemporary environmental management issues?

The term ‘cultural landscape’ is used in this literature in a variety of ways, but in an overall sense that a cultural landscape is one physically transformed by human action. Temporal overviews thus present a story of increasing human impact over time, accelerating with recent population growth and technological change. Thus, for example, Simmons’s (1989) *Changing the face of the Earth* uses a five-stage model of human history (Primitive man, Advanced hunters, Agriculture, Industrialists, the Nuclear Age) to chart human impacts. To help structure the mass of information, Simmons
also uses the study of energy flow through ecosystems as the currency by which those impacts are measured. Goudie (1993) recognizes similar stages of cultural development, although he subsumes them within chapters structured by different elements of the biosphere.

In overviews which cover the whole of the Quaternary period (Mannion, 1991; Williams et al., 1998), or focus on the Holocene – the past ten thousand years (Roberts, 1989) – the temporal structure provides a framework to understand increasing human impact towards the present, with varying amounts of detail depending on the intended audience. Most such overviews acknowledge that the impacts go in two directions: of environmental change on people, and of people on environment (e.g. Bell and Walker, 1992; Chambers, 1994).

Second, there are overviews of our present dilemmas, which usually include some temporal context in their introductory chapters. For example, Meyer (1996) refers to the formula by which human impact can be thought of as population multiplied by affluence (demand on Earth’s resources per person) multiplied by technology. He then provides an historical review of increases in each of the three elements.

Not all these authors use the term ‘cultural landscape’, and where they do, the meaning is often implied rather than explained. It is useful, then, to focus on the traditions in which these authors see themselves as working – to whose influence do they defer? The intellectual influences most frequently acknowledged are those of George Perkins Marsh, Clarence Glacken, W.L. Thomas and Carl Sauer. In a review that ends well before contemporary interest, Glacken (1967) showed that the questions were not new. For him, the question of human transformations of the Earth 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. Thomas’s 1936 edited volume Man’s role in changing the face of the earth is often seen to signal a turning point in contemporary awareness, at least by the academic community, and its lineage is traced to Marsh’s 1864 work Man and nature; or, Physical geography as modified by human action (Marsh, 1865 [1864]). Later works acknowledge these influences in their titles and forewords, e.g. Simmons (1989); Turner et al., 1990).

In the specific context of human impacts writing, the term ‘cultural landscape’ is most often associated with the work of Carl Sauer. (Although Sauer is generally considered responsible for the transfer of the concept into English, Jones and Daugstad (1997) attribute its first use to the German geographer Friedrich Ratzel (1895–6).) For Sauer,

The works of man express themselves in the cultural landscape. There may be a succession of these landscapes with a succession of cultures. They are derived in each case from the natural landscape, man expressing his place in nature as a distinct agent of modification. Of especial significance is that climax of culture which we call civilization. The cultural landscape then is subject to change either by the development of a culture or by a replacement of cultures. The datum line from which change is measured is the natural condition of the landscape. The division of forms into natural and cultural is the necessary basis for determining the real importance and character of man’s activity, ...

The natural landscape is being subjected to transformation at the hands of man, the last and for us the most important morphologic factor. By his cultures he makes use of the natural forms, in many cases alters them, in some destroys them. ...

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. (Sauer, 1965 [1925]: 333, 341, 343)) (Figure 2.1)
The main features of Sauer’s 1925 conceptualization are reflected in much of the literature referred to in this chapter: an unproblematic separation of the natural and the cultural; the idea of a pre-human baseline; humans as an agent of transformation; and the influence of varied causes operating over time. The so-called Sauerian view of culture has been subject to critique in the past few years, a debate that is reviewed in more detail in Chapter 4. However, it is important to remember that in the middle decades of the twentieth century Sauer and his colleagues were still having to address and combat ideas of environmental determinism, whereby particular environments were argued to give rise to particular cultures. They have done that so successfully that some writers today argue that we have lost sight of the agency of the environment, and of natural-scale changes (Nunn, 1999).

The tools to reconstruct cultural landscapes over remote times and places have changed dramatically in recent decades. Using a great variety of palaeoecological indicators, set in a temporal context with radiometric dating techniques, we can review human impacts over longer timespans and with better spatial resolution (Box 2.1). Just as Sauer’s ability to get at these questions was limited by the tools available – radiocarbon dating, for example, was not available until right at the end of his life – it is important to identify the ways in which our current thinking is a function of our tools. The literature is heavily weighted towards human impacts on vegetation, particularly in terms of the earliest evidence. But as examples discussed below show, the pollen record as often studied (or studied for other purposes) can bias thinking about human impacts in particular ways. These include the scale of change, the expectation of deforestation, and overemphasis on introductions of palynologically visible taxa.

In such a huge and diverse field of interest, overviews such as those referred to above provide essential perspective for students and researchers in various fields. In one sense a story of increasing and accelerating human impact is an unarguable and important message (Table 2.1). So too is the understanding that these impacts have occurred over a period of great climatic change with asso-

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**Box 2.1** Anthropogenic indicators in sedimentary records: some examples

**Pollen**

- Particular indicators need to be ecologically appropriate:
  
  (a) *Old World* – pollen of cultivated plants in a variety of combinations, and associated disturbance indicators (Behre, 1981).
  
  (b) *New Zealand* – decline in forest pollen, increase in *Pteridium* (McClone, 1983).
  
  (c) *Southeast Asia* – increase in abundance of secondary forest tree taxa, e.g. *Trema, Macaranga, Dodonaea*, and increase in herbs (Flenley, 1988); problems and potentials in identification of cultivar pollen and using weeds as indicators (Maloney, 1994).

- *Africa* – some forest increases can be anthropogenic (Taylor et al., 1999).

- *New Guinea* – high proportions of degraded *Nothofagus* pollen, grass increases if accompanied by forest decline and swamp grasses excluded, *Casuarina* increases as part of agro-forestry, *Pandanus*. Pollen of many known crops, e.g. *Ipomoea batatas* and *Colocasia esculenta*, are not visible in the fossil record (Haberle, 1994).

**Diatoms**

- Indicate eutrophic conditions at Lake Coba, Mexico, at a time when there is no support from other indicators for a climatic explanation. Diking for a reservoir is argued to be a viable hypothesis (Leyden et al., 1998: 119).
Microscopic charcoal
- A record of fire–rainfall events (Clark, 1983).
- Needs particular attention to scale (Clark, 1983).

Influx of inorganic sediments
- As measured by loss-on-ignition (Flenley, 1994).
- Magnetic mineral analysis (Haberle, 1994).

Charcoal and wood
- Human impacts have been identified in highland New Guinea as early as 28,000 BP, on the basis of charcoal in slopewash deposits in the Baliem Valley, Irian Jaya (Haberle et al., 1991). Although the connection to humans is circumstantial, natural fire is extremely rare in these cool, wet montane forests (see also McGlone, 1983).

Soil instability
- Soil instability can obviously have other causes, but when associated with charcoal is extra evidence (McGlone, 1983).

Phytoliths (plant opal silica bodies)
- Identification of major New World domesticates, e.g. maize, squash, gourd, and many utilized wild plants, e.g. palms and bamboo. But not New World root crops such as manioc, potato and sweet potato (Pearsall, 1994). Future potential considerable since many palynologically invisible taxa produce phytoliths.

Plant macrofossils
- Native ruderals (disturbed ground plants) and introduced weeds (Baker et al., 1993b).

Molluscs
- Particular species, species associations and diversity as indicators of vegetation interference and clearance on the chalklands (Evans, 1994).
- Land snails as transported through Pacific islands by people (Kirch, 1984: 136–7).

Insects
- Beetles associated with dung, polluted waters and cultivated plants as evidence of European settlement in North America (Baker et al., 1993).
- Prehistoric change is most strongly associated with agriculture, in the mid-Holocene.

For example, in one of the most detailed overviews, Roberts (1989) shows explicit links between the shift from hunter-fisher-gatherer to agriculture to urban-industrial systems (Figure 2.2). Cultural landscapes, associated with modification of the environment, appear with agro-ecosystems, and are the period of the Holocene when human influences (H) are seen to override environmental ones (E).

There is a risk that historical trajectories will be read in a deterministic way that forecloses other possibilities (in both interpretation of the past and implications for the future), although this is certainly not the intention of the authors.
TABLE 2.1 Selected forms of human-induced transformation of environmental components: chronologies of change

<table>
<thead>
<tr>
<th>Form of transformation</th>
<th>Dates of quartiles</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>Deforested area</td>
<td>1700</td>
</tr>
<tr>
<td>Terrestrial vertebrate diversity</td>
<td>1790</td>
</tr>
<tr>
<td>Water withdrawals</td>
<td>1925</td>
</tr>
<tr>
<td>Population size</td>
<td>1850</td>
</tr>
<tr>
<td>Carbon released</td>
<td>1815</td>
</tr>
<tr>
<td>Sulphur released</td>
<td>1940</td>
</tr>
<tr>
<td>Phosphorus released</td>
<td>1955</td>
</tr>
<tr>
<td>Lead released</td>
<td>1920</td>
</tr>
<tr>
<td>Carbon tetrachloride production</td>
<td>1950</td>
</tr>
</tbody>
</table>

B. Percentage of change by the times of Marsh and of the Princeton symposium

<table>
<thead>
<tr>
<th>Form of transformation</th>
<th>Percentage Change 1860</th>
<th>Percentage Change 1950</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>50</td>
<td>90</td>
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<tr>
<td></td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>65</td>
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<td>30</td>
<td>40</td>
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<td>&lt;1</td>
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<td></td>
<td>&lt;1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

Source: Turner et al. (1990: Table 1.3)

* Calculations assume a baseline or pristine biosphere about 10,000 BP and 100 per cent change as of the mid-1980s. Percentages refer to the total of the later or 100 per cent figure.
* Number of vertebrate species that have become extinct through human action since 1860. Does not include possible waves of Pleistocene and earlier Holocene human-induced extinctions because of continuing controversy over their nature and magnitude.
* Total amount of water now withdrawn annually for human use.
* Total mass mobilized by human activity.
* Present human contributions to the sulphur budget.
* Amount of phosphorus mined as phosphate rock.

The dangers of a teleological approach are recognized by Simmons (1993a: 110). Nevertheless, practising and training environmental scientists are less likely to go from the overviews to the source literature where more detailed discussions of scale, complexity and interacting causal processes are to be found. Further, most overviews are dominated by northern-hemisphere, particularly north-west European, perspectives. The attempt here to increase the visibility of southern-hemisphere work not only starts to fill the gaps from an empirical point of view, but also shows that the nature and limitations of the evidence itself continue to influence our understanding and
the terms in which debates are conducted. In a global overview of the earliest palynological evidence of human impact on vegetation, Walker and Singh (1994) show that only in the Australasian/South-East Asian region are impacts suggested to pre-date the Holocene. The exception to this is Hoxne, South-East England, where last-interglacial vegetation disturbance has been attributed to human activity (West and McBurney, 1954; West, 1956). In North America even agricultural impacts have low pollen visibility, showing up in less than 20 of over 300 published pollen diagrams spanning the past 12,000 years (McAndrews, 1988), although site selection and sampling have not always been appropriate for seeing human impacts (Delcourt, 1987). The studies also emphasize the importance of understanding local ecological conditions, particularly in terms of interpreting fire and charcoal records.

As a complement to the overviews cited above, three slightly different areas of research are reviewed in this chapter. I hope to convey the excitement, innovation and relevance of recent research. I focus on regional syntheses which bring together data from a number of sites. Additional themes which this work brings include:

- Increased emphasis on potentially early hunter-gatherer impacts. There is much controversy in this field, and few areas of consensus. Disagreements have, however, led to more explicit attempts to delineate criteria of human presence and activity.
- These methodological debates have fed back into less controversial areas, such as agricultural impacts. At different scales, very clear demarcations between hunter-gatherer and agricultural impacts disappear, and each category of land use shows considerable internal variability.
- There has been a recent reappearance in the literature of the agency of the environment, and attempts to discuss this in a non-deterministic way.
- Each of these points connects with debates over the mutual constitution of society and environment that will be discussed in Chapter 4.

### 2.2 Landscapes of colonization

In debates over human transformations of the Earth, writers have traditionally distinguished between old lands such as Africa, where humans coevolved with other parts of the biosphere, and newly colonized parts of the world. Human colonization of new lands theoretically provides the laboratory experiment about human transformations of those environments – they provide the ‘datum line’, in Sauer’s terminology. If a recent argument that African hunters were influencing biospheric processes, including climate, as early as 3.5 million years ago (Burchard, 1998) is correct, even this theoretical baseline may disappear, but we will maintain it for the purposes of the present discussion.

What sorts of transformations occur when people enter an ecosystem which has not experienced them before? To restate the obvious, people always come from somewhere, bringing with them plants, animals and cultural concepts. Drawing on Anderson (1952), Kirch (1984: 135–9) referred to these as ‘transported landscapes’. In different contexts the outcomes include extinctions and introductions of biota, and both deliberate and adventitious impacts on pre-existing vegetation and landforms. Two examples with very different timescales of colonization, Australia
and New Zealand, show that this debate is never straightforward. It is important to emphasize that the issues considered in this section are particularly controversial; it is not my intention to try to solve them. Rather, I focus on how the evidence is used, and the links between transformation and colonization. There are thus important parallels between these debates and those in other parts of the world, particularly the Americas.

For more than twenty years, archaeological debates about the timing of first human occupation of Greater Australia (present-day Australia and New Guinea) have been intertwined with palaeoecological ones about the mooted impacts of those first settlers on both flora and fauna (Singh et al., 1981; Horton, 1982). When did people arrive, did they change the vegetation through burning it, and did they cause the extinction of the megafauna? An important dimension of the controversy is that the timing of Aboriginal burning as interpreted from the pollen and charcoal record has always been much earlier than the archaeological evidence, even though both have changed over the decades. For example, Aboriginal burning was suggested at Lake George in south-eastern Australia at around 125 ka (Singh et al., 1981) at a time when the archaeological dates were still around 35–40 ka.

Current archaeological estimates for the time of human arrival vary from around 40 ka (O’Connell and Allen, 1998; Mulvaney and Kamminga, 1999) to around 60 ka (Roberts et al., 1990, 1994) or beyond (Fullagar et al., 1996; Roberts et al., 1998; Thorne et al., 1999). Archaeological debates centre on the relative efficacies of dating techniques (radiocarbon, thermoluminescence and optically stimulated luminescence), and on taphonomic issues such as post-depositional movement of artefacts within sediments. The latter is relevant because the sediments rather than the contained artefacts are being dated.

Even on the shortest scenario, then, the time frame covers a period of significant environmental change. It has thus been recognized for some time that palaeoecological separation of anthropogenic and climatic influences requires records which cover at least the last glacial–interglacial cycle and preferably longer (Kershaw, 1986). A recent overview of nine such records (Kershaw et al., in press) spans south-eastern Australia to the Indonesian offshore region, and examines charcoal within ‘time slices selected to represent major identified past climatic phases’ (Figure 2.3). Charcoal peaks are present in drier phases (oxygen isotope stages 2, 4 and 6) and during times of major climate change. In addition there is at least one charcoal peak in all records during the period 30–40 ka, one of the most climatically stable periods of the late Pleistocene. The burning had variable impacts on vegetation. At Lynchs Crater in north Queensland, drier araucarian rainforest began to be replaced by eucalypt woodland, and in the Banda Sea impacts on both Indonesia (reduction of Dipterocarpaceae rainforest) and northern Australia (expanded grasslands relative to eucalypts) are indicated. In the southern areas the vegetation impacts were less pronounced. The authors attribute these peaks to Aboriginal burning – which they infer ‘impacted the whole of the Australian landscape, as well as some parts of Indonesia, within a short period of time’ (p. 12) – but argue that the effect was to accelerate existing trends within vegetation rather than to transform whole landscapes.

Kershaw et al. (in press) now consider that this data set provides some support for the model of late colonization, about 40 ka, since there are no charcoal peaks in the 50–60 ka age range. Charcoal peaks with associated vegetation changes around 135 ka at several sites are no longer attributed to human agency (see Kershaw et al., 1993), and vegetation changes at around 175 ka at two of the northern sites do not have associated charcoal peaks. In these earlier events, ‘vegetation change appears to have preceded charcoal peaks’ (p. 11), and it is suggested that fire is a result of climatically driven drift towards more open vegetation. Thus while fire activity is interpreted to have increased throughout the period of these records, ‘late Quaternary vegetation changes have been less dramatic than originally suggested’ (p. 11). This evidence is in accord with geomorphological evidence for increasing aridity over the past few glacial–interglacial cycles.
The question of landscape transformation extends beyond the vegetation to the fauna, and particularly to a suite of larger fauna which became extinct in Greater Australia at a variety of unknown times within the past 100,000 years. The relative influences of climate and people have been debated for more than a century; the most recent advocacy of a climatic explanation comes from Horton (2000), and of overkill by people from Flannery (1990, 1994).

### 2.2.1 New Zealand

New Zealand is an example of the islands of the south and west Pacific that illustrates the transformation of isolated islands by entering peoples, although it is much larger than most and lies within temperate latitudes. As this case study shows, there are parallels with Australia in that debates about human impact are closely entwined with those about timing of color-
nization. The transformation of the islands was influenced by four main processes: introduction of new plants and animals; clearance of native vegetation for agriculture; hunting of native fauna for food; and accelerated erosion of hillsides and consequent lowland deposition (Enright and Gosden, 1992).

There are two competing narratives in this literature. The dominant one is that human impacts on islands were sudden and dramatic. This is clear from, for example, Fiji within the past 3000 years (Hope, 1999a), Yap (federated states of Micronesia) about 3300 BP (Dodson and Intoh, 1999), Mangaia (southern Cook Islands) at 1600 BP (Kirch and Ellison, 1994), and Easter Island around 630 BP (Flenley, 1994). It is important to point out that there is an alternative narrative (Nunn, 1994, 1999) which argues that human influences have been overstated relative to others.

In the New Zealand context the mooted human impacts include anthropogenic deforestation, extinction of the moas and other birds (Illustrations 2.1a and 2.1b), and decline in seal and fish populations (Anderson and McGlone, 1992). As in Australia, this is discussed in the context of a debate over whether New Zealand has a short (<600 yr), intermediate (c. 1000 yr) or long (>1500 yr) prehistory (Sutton, 1987; Holdaway, 1996; McGlone and Wilmshurst, 1999). And, as in Australia, the question focuses on whether palaeoecological evidence of vegetation and landscape disturbance provides evidence of human impacts independent of the archaeological record. Whereas in Australia the dating debates of relevance centre on radiocarbon compared with luminescence techniques, in New Zealand the questions are over the contamination and precision of radiocarbon dating (e.g. Newnham et al., 1998a; McGlone and Wilmshurst, 1999).

Recent resolution of the date of the stratigraphically critical Kahaoa Tephra at 665 ± 15 BP (c. 600 cal BP – calibrated radiocarbon years before present) (Lowe et al., 1998; Newnham et al., 1998b) clarifies these issues. In an analysis of 11 pollen records containing the tephra, Newnham et al. (1998) argue that inferred human impacts occur around the time of tephra deposition or later, lending support to the late colonization model. Others argue that early Polynesian impacts cannot be ruled out as explanations for early fire and disturbance, such as that around 1800 yr BP on Great Barrier Island (Horrocks et al., 2000). However, this possible early colonization period is also acknowledged to coincide with a period of increasing drought frequency which would have affected vulnerability to fire.

Most of the New Zealand flora is not fire adapted, and it is usually assumed that this factor and long successional recovery periods for forest made the vegetation particularly vulnerable to the fires of early colonists (Ogden et al., 1998). Reviewing dates from wood charcoal in South Island soils, and microscopic

**ILLUSTRATION 2.1a** Excavation in progress, moa-hunting site, Shag River mouth, New Zealand (by permission of Atholl Anderson)
charcoal from North Island sedimentary cores, Ogden et al. (1998) show that fire has existed throughout the Holocene, with apparent increases in frequency after about 3 ka in the South Island and 7 ka in the North, both well before human arrival. Once again, increased climatic variability, possibly associated with enhanced El Niño–Southern Oscillation (ENSO) activity, is implicated. There is also a problematic peak in soil charcoal about 1000 BP, within the contested period. Ogden et al. distinguish between ‘first anthropogenic fires’, which will not be distinguishable from the background level of natural burning, and ‘significant human impact’, which will (Ogden et al., 1998: 694; Illustration 2.2).

2.2.2 Palaeoecological criteria of human presence and impacts

Although none of these debates is resolved, the excitement generated by the research has stimulated the development and application of new techniques and strategies, some examples of which have been mentioned. Some of the technical advances are explored in more detail in other volumes in this series; I discuss here the broader question of how research design constrains and advances thinking. A diverse set of strategies have been proposed to examine the impacts of human activities (see Box 2.2 for a summary of examples). For the most part, these do not constitute testable hypotheses in
Box 2.2 Strategies and palaeoecological site selection for identification of human impacts: some examples

- Small pollen sites – more likely to reflect small-scale human activities (Brown, 1999).
- Separation of pollen studies from more explicit climatic proxies, e.g. collapse of Classic Maya civilization (Hodell et al., 1995).
- Separate natural and anthropogenic fire frequencies – calculate return interval (Ogden et al., 1998).
- Predict conditions of anthropogenic invisibility (even though present) (Barham, 1999; Head, 1996).
- Synchronicity of disturbance – varies with ecological conditions and occupation history. For example, rapidity of change in New Zealand is seen to support human factors (McGlone, 1983); non-synchronity is argued by Haberle (1993) for the humid aseasonal tropics.
- Compatibility between archaeological and palaeoecological evidence – most workers in Australia would argue for this (see Head (1994a) for review). Not seen as necessary in remote island context, even among people with internal disagreements (Kirch and Ellison, 1994; Spriggs and Anderson, 1993).
- Examine cessation of traditional burning after colonization.
- Compare adjacent mainland and island sites with different occupation histories (Hope, 1999b).
- Multi-method – post-European Iowa (Baker et al., 1993b).

Box 2.3 Scenarios and hypotheses about human presence and impacts in Central America and northern South America, 14–8 ka BP (from Cooke, 1998)

A human presence in Central America, Colombia and Venezuela (outside ‘Amazonia’) before the Late Glacial Stage (LGS) (~14–10 ka) requires substantiation. A survey of recent archaeological and palaeoecological evidence allows the specification of inferred high-probability scenarios, alternate scenarios whose resolution awaits better-quality data, and areas of investigation whose encouragement would improve knowledge.

High-probability scenarios

- A small and widely dispersed pre-Younger Dryas (El Abra Stadial, ~11–10 ka) human population.
- The pre-Younger Dryas (YD) consumption of extinct herbivores, including horse and gomphotheres, by cultural groups who made bifacial lanceolate points and carefully trimmed scrapers.
- More or less coincident with the YD and El Abra Stadial (10.5 ± 0.6 ka), a widely distributed, culturally affiliated and highly mobile (‘Palaeoindian’) population with a distinctive stone tool kit.
- The use of different forest and open vegetation types throughout the LGS from sea level up to c. 2500 m (except non-seasonal lowland rainforest).
- At or soon after the LGS/Holocene boundary, widespread forest-dwelling settlements, whose inhabitants habitually collected forest plant products, some of which appear to have been under domestication by 8 ka.

Alternative scenarios which cannot be confirmed by current data

- Humans were/were not present during the upper Pleistoglacial and did/did not use extinct Pleistocene mammals such as mastodons.
All pre-El Abra Stadial populations were not acquainted with bifacial reduction processes.

- Pre-Holocene populations did not habitually collect wild plant foods.
- The extinction of Pleistocene mammals did not coincide chronologically with the disappearance of fluted points.
- Extant fauna, such as white-tailed deer, were not an important LGS hunting resource.
- LGS and early Holocene tool kits represent either short-lived, but areally distributed artefact types, or coeval assemblages belonging to different cultural groups with distinct subsistence orientations.
- Hunter-gatherers using bifacial projectile points and large blade/flake scrapers did not survive after 8 ka coevally with incipient cultivators.
- Universal forest expansion and/or increased sedentism after climatic amelioration did not lead to the development of several economic systems strongly correlated with specific geographic regions and/or vegetation types (i.e. an 'Andean hunting tradition', 'a Central American pre-montane horticultural system').

the sense discussed in Section 2.4 (p. 30). They depend heavily on issues of temporal and spatial correlation between, for example, palaeoecological and cultural indicators. However, increased methodological resolution is facilitating more explicit approaches (see Box 2.3 for an example).

The specific nature of landscape transformation feeds back into a rethinking of the concept of colonization. It is not just a question of whether people were there or not, but what they were doing and in what ecological contexts. It is interesting that much of this evidence is coming from islands, often considered the archetypal laboratories of instantaneous destructive impact. In the New Zealand context we can then, distinguish between:

- Colonization as discovery – early exploratory or accidental landings, possibly of a single canoe, from which rats escaped. This did not result in prolonged or widespread human occupation, but resulted in impacts on small ground-dwelling birds on which the rats preyed.
- Systematic colonization – later near-simultaneous archaeologically visible occupation associated with rapid, widespread deforestation and moa extinctions.

Detailed multi-method research on cave deposits in north-west Madagascar is clarifying the mechanisms of faunal extinction there within the past 2000 years (Burney et al., 1997). Humans have long been the main suspects in an event that was, in geological terms, extremely rapid. Many aspects of the extinction process are still unclear; there is, for example, no definite evidence for direct interaction between humans and extinct species other than tortoises. However, Burney et al.'s research shows that fire was an important environmental variable long before people arrived. Some extinct animals may have persisted for at least a thousand years after human arrival on Madagascar, probably owing to the remoteness from human activity of the north-west coast.

None of these examples denies the profound impacts of colonizing peoples. However, if the propensity for ecosystemic destruction is seen as part of an essential human nature, then the past is of little use because the outcomes are inevitable. Alternatively, if impacts are contingent on the conjunction of particular circumstances, the story of the past can be useful for contemporary management. In this case clarification of the rates and precise mechanisms of change becomes an important contribution.

2.3 Hunter-gatherer/agricultural landscapes

Hunter-gatherers have long been distinguished from agriculturalists partly on the
basis of attributes they lack, attributes that relate to interactions with landscape. Thus, it is argued, hunter-gatherers do not plant or tend gardens, they do not substantially modify their environment, nor do they purposefully manage it. In nineteenth-century parlance, they lack purchase on the land. Similarly, in some circles agriculturalists are defined by the changes they make to the genetic make-up of plants or animals. These arguments have come under assault from anthropological, archaeological and palaeoecological research in recent decades, to such an extent that clear delineation between ‘hunter-gatherers’ and ‘agriculturalists’ is rejected by some. It is beyond the scope of this book to review these debates, some of which are discussed in Chapter 4, but one important point emerges. Clear assessment of hunter-gatherer and agricultural impacts requires us to suspend judgement about the pre-existence of those categories. If they cannot be distinguished on landscape grounds, then this hitherto fundamental human taxonomy is further challenged.

This is not to deny the profound differences between some hunter-gatherer and some agricultural interactions with the environment. Rather it is to assess the evidence for landscape transformation with an open mind on whether we can ‘define a rubicon with social consequence and substance that can systematically differentiate [hunter-gatherer from small-scale agricultural or pastoral] societies’ (Felt, 1994: 438). Thus in this section I do not distinguish between hunter-gatherer and agricultural impacts, but instead review some case studies which illustrate methodological debates about the types of impacts/transformation which are visible in the palaeoecological record. Further, I want to show how those debates feed back into others relating to hunter-gatherer/agricultural transitions, and challenge us to rethink assumed categories.

2.3.1 North-west Europe

Mooted human transformations of the landscape of north-west Europe include assistance of rapid early-Holocene migration of Corylus (hazel) (Huntley, 1994). Mesolithic deforestation associated with fire (Behre, 1988; Simmons, 1994; Wiltshire and Edwards, 1994) and enhanced development of blanket mire (Caseldine and Hatton, 1994; Moore, 1994).

Brown (1997a) provides a critique of what he sees as this traditional account of ‘clearance’ or ‘deforestation’ in the Mesolithic/Neolithic of Europe, whereby an overall decline in tree pollen from around 3000 BC onwards in the British Isles is widely interpreted in terms of deliberate clearance and land management. He argues that the pollen evidence amounts to a record of decreases in canopy-forming taxa and the existence of open areas, generally followed by a delayed regeneration of woodland in the Mesolithic but an increasingly common lack of regeneration in the Neolithic and after. (p. 138)

Since there is a lack of archaeological evidence for ringbarking or stripping of trees, and no clear evidence of the use of mature trees on a large scale until the mid- to late Neolithic, Brown favours an opportunistic deforestation model, whereby a variety of natural factors (including drought or windthrow) are the initial causes of deforestation, with humans being the primary factor preventing regeneration.

A couple of points are of interest here. One is Brown’s call for ‘a more fragmentary narrative’ of human impacts, in which natural events and ecological instability have an increased role. Second, his interpretations, while they have theoretical ramifications, depend in the first instance on questions of methodology. Thus Brown (1999) calls strongly for more localized pollen analyses, and for recognition of the mismatch between palynological and archaeological sampling methodologies. Palynologists, he argues, have generally preferred sites which will provide regional vegetation histories. (Early palynology, keen to establish the field as a source of palaeoclimatic information, deliberately tried to exclude local variability.) Sites with larger pollen catchments may suggest vegetation homogeneity when the reality is much more patchy. There is also a bias in Britain towards upland and bog sites.

Alluvial sites, Brown argues, provide the means to overcome both these problems. They are inherently local sites, but were also
important foci for prehistoric occupation, particularly in regard to the watering of cattle. He illustrates this with a study of the Soar and Nene valleys, in England’s east Midlands, in which palynological and archaeological evidence was examined at comparable (local) scales (Brown, 1999). Small-scale localized disturbances, in which natural events such as flooding and windthrow were important, occurred in the Neolithic, but these were temporary. Larger-scale deforestation with considerable spatial variability occurred in the Bronze Age, and by the mid- to late Iron Age the floodplains were almost totally deforested for stock management, with some cultivation on the terraces and fringes (see also Willis and Bennett, 1994, for a related discussion of scale in the Balkans).

In turn, these findings stimulated questions about human perceptions of the changes. Was the late Neolithic/early Bronze Age vegetation change associated with ritualization of the floodplain as recorded by barrow construction? And what was the cultural significance of the shift between the Bronze and Iron ages from a woodland landscape with openings to an open landscape with woodlands (Brown, 1999: 7)? These issues are discussed further in Chapter 4.

### 2.3.2 Central Africa

Even though both a long period of human occupation and the background variability of early Holocene landscapes are acknowledged, most workers in north-west Europe consider that early Holocene forests are, for all practical purposes, ‘pristine’ landscapes in terms of assessing human impacts. The issue is more problematic in parts of the world with longer human histories, for example the interlacustrine region of Central Africa — although, as Taylor et al. (1999) show, methodological issues such as scale of analysis, catchment size of pollen sites and articulation with the archaeological evidence are just as important. Further, establishment of independent climatic proxies, where possible, assists in teasing apart the human signals. For five locations in western Uganda over the past three thousand years, Taylor et al. use the following indirect proxies of human activity: reduced organic matter; increased sedimentation rate; charcoal; pollen from taxa associated with primary (Olea) and secondary (Celtis and Trena) forest; degraded soils (Dodonaea); and open vegetation (Vernonia and Poinciana) (Figure 2.4).

Two phases of forest disturbance are identified. The first, at Muchoya and Kabata Swamps and at Lake Victoria around 2200–2000 BP, could reflect the introduction of

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**Figure 2.4** Summary of variations in sediments and signals of human activity from five locations in western Uganda

*Source: Taylor et al. (1999).* By permission of David Taylor
iron working and agriculture to the region. The more widespread phase, associated with charcoal peaks with open and disturbance vegetation indicators at 1000–800 BP, correlates with Later Iron Age technological and settlement changes. However, the climatic context in which these changes were occurring was not static: conditions became more humid at this time, perhaps promoting major population movements into the area. Nor does climatic influence operate only in one direction: Kabata and Lake Victoria show a third phase of forest disturbance at 600–400 BP, a time of relatively dry climates. Mudwinai Swamp shows disturbance within the past 200 years, possibly associated with the colonial period.

In many places that would be considered a fairly comprehensive set of indicators. However, Taylor et al. argue that such a suite of proxies, although commonly used in the tropics, unnecessarily constrains our understanding of human impacts:

the choice of evidence has been partly guided by the ‘orthodoxy’ of deforestation, which views human activity in general as ecologically disruptive, intrusive and negative. Thus it is usually assumed that the onset of agriculture is, in the absence of direct indicators such as pollen from domesticated plants, marked by evidence of forest clearance and burning. (1999: 7)

Thus African evidence for variable agricultural strategies is ignored. For example, ‘shifting cultivators often make use of natural forest gaps and ... “forest” can be promoted by certain forms of agriculture, such as low intensity cultivation of oil palm (Elaeis guineensis)’ (1999: 7). Also problematic in the assumption is the role of fire and change in natural vegetation dynamics, with pollen samples dating back to the last glacial showing a long period of fire history.

Although they see the human signal in these five sedimentary records for the late Holocene as the loudest one, and thus human activity as the major cause of change, Taylor et al. thus emphasize that this interpretation is limited by the evidence. This does not demonstrate that these major and disruptive human impacts were the only form of human activity influencing ecosystems in the past three thousand years. Long-term coexistence of ‘regenerating’ and ‘stable’ patches of forest is indicated at Ahakgyeyzi Swamp (Taylor, 1993).

2.3.3 New Guinea and Indonesia

Human impacts have been identified in highland New Guinea as early as 28,000 BP, on the basis of charcoal in slopewash deposits in the Baliem Valley, Irian Jaya (Haberle et al., 1991) (Figure 2.5). Although the connection to humans is circumstantial, natural fire is extremely rare in these cool, wet montane forests. The relevance of understanding the long-term role of fire in tropical forests was further highlighted by the widespread forest burning across Malesia during the El Niño event of 1997–98. Haberle et al. (in press) analysed 10 sites from the eastern Indonesian archipelago and Papua New Guinea for which consistent charcoal measurements and good chronological control since 20,000 BP were available. These were compared with independent climate proxies such as ocean sediment records and glacial change, and with archaeological data on human occupation.

At this regional scale two main periods of high fire frequency were identified: during the last glacial transition (17–9 ka) and to the mid-to late Holocene (past 5 ka) (Figure 2.6). Although people were in the region throughout the period, Haberle et al. suggest that fire frequencies were related more to climatic factors than to changing subsistence patterns. Between 17 and 9 ka, increasing temperatures led to an expansion of forest vegetation. The dominant cause of fire is argued to be a weak and unstable southern-hemisphere summer monsoon and its contribution to increased frost and drought, at least in the highlands. Within the past 5 ka climate variability associated with El Niño (Sandweiss et al., 1996; Rodbell et al., 1999) is implicated. Haberle et al. emphasize that changes in fire patterns are influenced more by climatic instability than by simply dryness per se.

If we focus on the more recent end of this timescale, a further example of forms of agriculture which actually promote some forest
Figure 2.5 New Guinea location map
Source: Haberle (1998: 1). Reprinted by permission of Australian Archaeology

Figure 2.6 Sedimentary charcoal, climate and occupation sites in highland New Guinea since 20000 BP
Source: Haberle et al. (in press) By permission of Elsevier Science
elements comes from highland New Guinea (Haberle, 1998a), although in this example it was chosen for detailed study precisely because of its good palaeoecological visibility. This area is better known for its very early dates for agriculture, with organic infill from a drainage ditch in the Wahgi valley dated to around 10,000 BP (Haberle, 1998a: 4), although, as Haberle argues, there is no evidence for forest clearance in Wahgi pollen diagrams until about 4000 years later. (There is, however, evidence from other parts of the highlands for human impacts in the late Pleistocene (Haberle et al., 1991, and see above).) The past 2000 years was an important period in which agricultural and pig husbandry activities and exchange networks took on their contemporary configurations. Haberle focuses on one element, *Casuarina* agroforestry, in order ‘to examine its origin in space and time and to develop hypotheses regarding possible causes’ (1998a: 1).

Many traces of agricultural staples, particularly sweet potato (*Ipomoea batatas*) and taro (*Colocasia esculenta*), have proved frustratingly invisible to researchers in the region. This is due to a combination of poor pollen production and preservation and vegetative means of reproduction. Haberle thus turned to proxy indicators of agricultural activity, among them the *Casuarina* pollen record. Although *C. oligodon*, which is planted for its nitrogen-fixing properties that enhance fallow regeneration and soil fertility, is not palynologically distinguishable from other *Casuarina* species, increases in *Casuarina* pollen above low background levels are ‘considered to indicate development of agroforestry practices associated with firewood, fencing and soil fertility enhancement’ (Haberle, 1998a: 2). In a compilation of data from 16 archaeological and 23 palaeoecological sites across the highlands, other indicators were increased forest disturbance (reduction in forest pollen types and expansion of secondary forest and non-forest taxa), increased soil erosion (increased input of inorganic sediments) and archaeological features and artefacts.

Haberle identifies at least two periods of widespread but not necessarily synchronous change within the agricultural system in the past 2000 years (Figure 2.7). *Casuarina* agroforestry first appeared around 1190–970 cal yr BP in the Wahgi and Biliem valleys, up to 400 years later in the Kainantu valley to the east,

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**Figure 2.7** Comparison of climatic trends and human impacts in New Guinea highlands over the past 2000 years

*Source:* Haberle (1998a: 9). By permission of *Australian Archaeology*
and not until modern times in other areas. In the Wahgi the *Casuarina* increase post-dates a period of forest clearance and slope erosion. There was a second period of intensified activity after 650–400 cal yr BP, first in the Wahgi Valley. Increases in *Casuarina* planting were part of this, but raised-bed cultivation, decreased forest cover and increased soil erosion are also involved. Haberle argues this is probably the period when sweet potato was introduced to the highlands.

Haberle’s comparison of climate proxies and volcanic events with the agricultural changes cautions against using temporal correlations to invoke or refute causation in a simplistic way. Nevertheless, he considers drought and volcanism to be implicated in the shift from wetland (Kuk phase 4) to dryland (*Casuarina* agroforestry) agriculture after 1200 cal yr BP (see also Haberle, 1998b). The relative roles of climate and other factors in the intensification phase after 400 cal yr BP are less clear-cut.

Although improved dating precision is useful, together with increased spatial resolution, the sorts of studies referred to here indicate that the most constructive use of increased precision will not be to demonstrate simple causal links between processes or events. Rather, it offers the scope to identify significant but short-lived changes, thresholds and variability that have until recently been invisible in the palaeoecological evidence. For example, Leyden *et al.* (1998) showed that, while Mayan agriculture on the Yucatan Peninsula was devastated by variable precipitation, native vegetation in the area was scarcely affected. Also important here is that such processes operate at timescales perceptible to humans; responses are likely to be the result not of selection pressure over time, but of deliberate cultural strategies.

Of particular importance in the late Holocene is climatic variability, which continues to be influential through El Niño-related droughts. Indeed, Haberle (1998a) shows cross-Pacific parallels between New Guinea and Peru in the use of dryland agroforestry, which ‘may have been adopted as a response to low crop productivity and the need to rehabilitate abandoned dryland crop lands after prolonged climatic stress’ (Haberle, 1998a: 6). Understanding such interactions will be important for policy development contributing to future sustainable food production in the highlands, since ‘rapidly expanding populations, increased deforestation and alienation of productive land for town and plantation use are the hallmark of present-day highlands development’ (Haberle, 1998b: 10).

### 2.3.4 Australia

Although the Australian pollen and charcoal data set is biased in its coverage to the better-watered edges of the continent, 58 records were considered by Kershaw *et al.* (in press) to have sufficient resolution and chronological control to enable comparisons across the Holocene (Figure 2.8). Studies from a variety of environments show fire to be a consistent part of the ecosystem since 11 ka. The greatest increases in charcoal are associated with the arrival of Europeans about 200 years ago. ‘This period was followed by a reduction in burning to present day levels which are, on average, lower than at any time during the Holocene’ (p. 14). Within the prehistoric period there is a slight increase in burning in the past 5 ka; this is of interest as it is a period of both significant ENSO influence, as discussed above, and suggested intensification of Aboriginal occupation (Lourandos, 1983, 1993; Head, 1989).

The spatial and temporal resolution of both the palaeoecological and archaeological records is much improved since these issues were first raised in Australian debates some 20 to 30 years ago. However, all the examples discussed in this section show that we are somewhat misguided in our continuing attempts to ‘decouple’ or ‘disentangle’ human and natural causes. Instead we can productively focus on understanding in a more detailed way the environmental contexts in which humans have operated over much longer timescales.

### 2.4 Post-industrial impacts

Human impacts in the past few hundred years increased in variety and intensity and are
Figure 2.8 Relative importance of burning in time slices from the Holocene deduced from individual site rankings of charcoal abundance for 58 site records, and separately for different ecosystems, in south-eastern Australia.

Source: Kershaw et al. (in press). By permission of Peter Kershaw.

clearly evident in a range of indicators. Pollen evidence which is equivocal over prehistoric impacts is much less so over European colonisation, for example in North America (McAndrews, 1988) and Australia. Temporal overviews of the more recent end of the timescale focus on the past three hundred years or so (Turner et al., 1990). Within palaeoecological research, better preservation of recent evidence, larger numbers of young deposits and fine-resolution studies have facilitated a shift from inductive to deductive approaches (Oldfield, 1994). For much of the Quaternary, and for the debates discussed above, there has been little alternative to inductive approaches which aim to fill gaps in knowledge. While these may eventually lead to bodies of data amenable to the testing of specific hypotheses, that is already possible in some large-scale palaeolimnological projects. The human transformations referred to here extend, then, to climate, for example research into acid rain. This work also has the role of what Oldfield calls 'projective' research, in which the long-term perspective is used to project future change, such as under enhanced greenhouse warming (e.g. Punning et al., 1997b).

As Oldfield (1994: 17) points out, deductive approaches build on an immense body of pre-existing work. In the case of the palaeolimnological studies of lake acidification, that includes detailed taxonomy and understanding of pH, salinity and nutrient preferences of organisms such as diatoms, cladocera and chironomids. It also requires dating and sedimentation processes to be well understood. Hypothesis evaluation can then often be undertaken using careful site selection, analysis of multiple proxies and appropriate statistical techniques (Battarbee, 1991).

For example, Battarbee (1991: 160–5) showed how the following competing hypotheses for lake acidification in Europe and North America could be evaluated:

1. Lakes may be naturally acidic and have not changed over time.
2. There has been slow post-glacial acidification as a result of leaching.
3. There has been acidification since 1800 as a result of land-use changes including increase of conifer forest and decline of burning and grazing.
4. There has been acidification since 1800 as a result of increased acid deposition from fossil fuel combustion.

The first two hypotheses were relatively easily ruled out, since 'evidence for a marked reduction in lake-water pH is usually confined to the most recent sediments, postdating 1800 a.c.e. [after the Christian era, i.e. AD 1800] and usually following long periods of very stable conditions' (Battarbee, 1991: 161). A range of studies ruled out hypothesis 3. Adjacent non-
afforested and afforested sites show acidification over similar timescales, or that acidification preceded planting. Separating hypotheses 3 and 4 is more difficult when the timescales of land-use and acid deposition changes are the same.

However, it is possible to remove the influence of acid deposition either by examining a sensitive site with land-use change in a ‘clean’ area or by examining the lake response to an analogous change in soil or vegetation in the ‘clean’ (pre-1800 a.c.e.) past. Such a ‘past analog’ can be identified by pollen analysis ...

These data show that land-use changes in the absence of acid deposition have little effect on lake acidity; however, land-use changes in association with acid deposition can be important. (Battarbee, 1991: 161)

I have oversimplified this example to contrast the explanatory power of this type of study with the more inductive work on earlier periods, discussed earlier in the chapter. As the hypothesis becomes more precisely defined, it may allude to only part of a wider set of environmental issues. For example, while conifer afforestation in the UK is not implicated in lake acidification, it does have other detrimental effects, such as accelerated soil erosion through intensified catchment interference, and nutrient enrichment associated with fertilizer and pesticide use (Battarbee et al., 1985; Battarbee, 1990). Of course, high-resolution work in the more recent period also has the potential to show much more complex patterns of interaction and feedback. Industrial activities influence atmospheric, biological and geological processes in increasingly complex ways; simple relationships between cause and consequence should not be expected (e.g. Punning, 1994). A further feature of deductive approaches is the necessity of large research teams combining various skills and techniques.

Impacts assessed by a team from the Institute of Ecology in Estonia include those associated with the largest commercially exploited oil shale deposit in the world. Excavation of the oil shale leads to groundwater depletion and deforestation, and oil production results in atmospheric emission of fly ash (Punning, 1994). As well as indicators such as pollen, diatoms and charcoal, trace elements, spheroidal fly-ash particles and heavy metals have been examined (Varvas and Punning, 1993; Punning et al., 1997a). Historical data also becomes an important research tool in this context (Koff et al., 1998). The integration of multi-proxy palaeoecological indicators with historical evidence is a feature of studies of recent human transformations in diverse corners of the world (e.g. Baker et al., 1993b, in the midwestern USA).

2.5 Strengths, limitations and future directions

There are definite trends perceptible in the diverse examples included in this chapter. In all debates there is increasingly explicit attention to working at spatial and temporal scales appropriate to the questions being asked. In the case of questions about human impacts, local-scale studies are of particular importance. At the recent end of the time spectrum this work has led towards explicit testing of hypotheses. However, even in earlier periods in which not all variables can be controlled for, comparisons between different scales are producing important insights. In turn, more nuanced explanations can be developed, even if they are still within an inductive framework.

With the influence of a simplistic environmental determinism virtually completely removed, it has become possible to discuss the agency of the environment in more complex and interesting ways. Simple correlations with environmental variables, whether to invoke or to rule out causation, are spurious, and there is increasing interest in thresholds, perceptions and variability.

Some workers have argued that our thinking has been unduly constrained by the nature of the evidence to hand. For example, dominance of pollen and charcoal evidence in these debates has meant a focus on vegetation. While many would still argue that fire was part of the earliest human toolkits, it is important to think about the likely impacts of activities for which we have no evidence. The very clear trend to the use of multiple proxies will continue. Further, once we are no longer attempting to
deduce multiple processes from single or few indicators (for example, climate, ecological process and human impacts from pollen), each indicator can be used more effectively and appropriately.

Similarly, interpretations have been heavily biased by the regions where most research has been undertaken. With complex human histories and still limited palaeoecological work, South-East Asia and Africa stand out as regions that are likely to reorient our thinking in the next few decades.

As it is, the studies discussed do not just offer an increasingly detailed understanding of the ways in which humans have transformed the Earth over the long term. They also provide challenges to a number of debates within the social sciences. For example, very dichotomized views of hunter-gatherer and agricultural systems, and deterministic trajectories of evolutionary change from one to the other, are not supported by the evidence discussed here. The move away from very large scales of analysis that conflated a great deal of social and ecological complexity facilitates more systematic thinking about similarities and differences. Not just across the Australia–New Guinea divide, but more widely, we seem to be moving away from the assumption that hunter-gatherers automatically have certain sorts of (little) impacts and agriculturalists have others (big). There are connections between the palaeoecological perspective on these questions and the archaeological thinking (Chapter 4).

The apparently messy colonization stories, such as the New Zealand one, have the potential to subvert very linear notions of human history, of conquering the corners of the Earth. Even though it might be resolved in a non-messy way, it has great promise for a more complexly rendered understanding of the human history of the Pacific. What happened after deforestation? What are the permutations of land use? What were the relationships between social structures and land use? In helping us to think about colonization as a process rather than a single event, the record of human transformations also connects with conversations occurring in the social sciences, as will be discussed in Chapter 5.