18 The history of the human landscapes of New Guinea

GEOFFREY S. HOPE AND SIMON G. HABERLE

Introduction

Humans have been in the upland valleys of New Guinea for at least 30,000 years and presumably occupied the savannah plains that then connected the island to Australia for as much as 50,000 years or more. Through this immense time they have adapted and changed their environments until very few places on the island can be considered unaltered. In place of primary rainforests and seasonal forests they have created human landscapes such as the grasslands, secondary forests, and coastal woodlands. Prograded estuaries, infill in valleys and eroded slopes may be partially caused by human actions, together with the deliberate creation of terraced slopes and ditched plains. Fauna has become extinct and rare, offset by introductions through time. Dramatic climate change has also changed landscape and affected the potential of human societies over the same period. Did these events leave an imprint on populations or language? The record must be read from archaeology and studies of palaeoenvironments. This chapter reviews the history of human–environment interactions in New Guinea in three periods. These periods, roughly equating to pre-agriculture (ca 55,000–20,000 years ago), the spread of agriculture (20,000–5000 years ago) and post-Austronesian changes (5000 years ago to present) are not yet precisely defined; we do not have enough information to know how general and synchronous these were everywhere across the island. These periods span the whole prehistory of New Guinea during which modern people arrived from southeast Asia and became adapted to a new environment of strange animals and plants. The continuity of 2000 generations is expressed through language, stories and culture. The very broad periods discussed here represent the widespread adoption of new ways of life (perhaps cultural revolutions) that may have erased the previous cultures. But understanding the past may help understand the present.

Humans litter the landscape with the tools they use and stand out from other mammals by their use of fire. Evidence for their more indirect effects comes from dating geomorphological features such as alluvial fans, buried surfaces, activated sandsheets, and peaty infills in basins. Attribution of these features to human-caused erosion usually depends on correlations with archaeological deposits and specific human-caused features.

such as ditches, earthworks and quarries. The other main line of evidence comes from palaeoecology, in which the vegetation and faunas are reconstructed from dated fossil sequences. In New Guinea the main effort has been to use pollen, although some specialised swamp ditch systems have also been investigated, for example by Haberle et al. (1991), Golson (1991) and Sullivan et al. (1987). Past fire is inferred from swamp and lake sediments by counting microscopic charcoal fragments, and by dating larger fragments in a range of other deposits (Haberle et al. 2001).

At the time of European contact the population was concentrated along the coastal fringe with quite sparse and isolated groups in the rainforests and mountain slopes (Figure 1). Some areas, such as the Fojes Mountains, seemed to be totally without habitation. The large intermontane valleys with complex agriculture based on root cropping centered on the altitudes of 1400–1850 m were a major discovery of the twentieth century. Brookfield (1964) showed that this pattern reflects the chances for success with agriculture. The outer flanks of the mountains are perhumid, with precipitation more than double evaporation in almost all months. Under such misty conditions crops do not thrive (Hanson et al. 2001). In the intermontane valleys the mountains cut off the orographic rain and local circulations dominate in most seasons. Here air rises each day up the warmed slopes and descends over the valley, giving sunny conditions with adequate rainfall from afternoon thunderstorms. Away from the large highland basins, even small valleys may have this effect, and may thus support small hamlets. In these marginal settlements techniques of ditching and mounding are used to shed water from the fields. There is a north west-south east gradient from aseasonal precipitation to the appearance of a weakly defined dry season, and from relatively infertile limestones and mudstones in west Papua to richer soils fertilised by volcanic ash falls in Papua New Guinea east of the Strickland River.

The advent of humans, their spread into the range of environments, and their impact

**Period 1: 55,000–20,000 years**

The timing of the arrival of people in New Guinea is part of the wider controversy of when people arrived in the Australian region, since the two landmasses had continuous connections across the then dry Torresian Plain until only 8000 years ago. Dates of 55–60,000 BP have been suggested from southeastern and northern Australia (for example Thorne et al. 1999) while a faunal extinction event that takes place 48–43,000 has also been proposed (Roberts et al. 2001) as marking early occupation. Others (O’Connell & Allen 2000) have pointed out that this evidence is tenuous and have disputed any ages greater than ca 38,000 BP. Coastal occupation in the oceanic islands east and west of New Guinea is proven from at least 33,000 BP (Spriggs 1997; Irwin et al. 1999). The oldest claimed site in New Guinea is still the Huon Peninsular where finds of stone adzes were made on a raised marine terrace (Groube et al. 1986). The terrace formed about 55,000 years ago when sea level was 65 m lower than present, and was occupied after initial uplift, at an estimated 48,000 BP. However only a few scattered archaeological sites are currently known for this period, including 30,000 BP sites in the Birds Head (Pasveer 2003) and Lachitu near Vanimo (Gorecki et al. 1991). A similar age site is also known from Lemdubu Cave on the Aru islands, southwest of New Guinea but then connected to it and Australia by the Torresian landbridge (O’Connor et al. 2002).
Perhaps because of the higher populations and a greater concentration of research, evidence for early settlement in the highlands is slightly more abundant. People are present by 32,000 or earlier at Kosipe (White et al. 1970), near Chuave (Mountain 1993), Mount Hagen and the Baliem Valley (Hope 1998; Haberle et al. 2001). Although our knowledge of earliest settlement is extremely sketchy, there is a better understanding of the Pleistocene climates, thanks in part to long environmental records from marine cores (for example Wang et al. 1999), which allow extrapolation of less continuous terrestrial records. From these it is known that the ice age climates of New Guinea were drier than present, grasslands and savannah probably extending right across the Torresian Plain. The climate at high altitudes was also colder, with ice caps on many mountains along the central ranges. Alpine vegetation covered over 50,000 km² above 2700 m altitude at the height of the glaciation about 20–15,000 years ago (Hope 1996) compared to ca 800 km² today above 3900 m. Despite changes in composition through time, the mountain flanks and northern coasts may not have changed very much. pollen evidence from peat sections near Mount Trikora (Hope et al. 1993), Tari (Haberle 1998) and Lake Sentani (Hope & Tulip 1994) provide records back 50,000 years or more. These suggest that closed tropical and montane forests have continuously occupied many areas from before the likely arrival times for people. The wet conditions that supported the rainforests seem to have been maintained all along, indicating that the warm tropical waters north of New Guinea named the Western Pacific Warm Pool have persisted through the late Pleistocene (Thunnell et al. 1994). However it is likely that rainshadow effects north of the main range were strengthened. The Popondetta, Markham, upper Ramu, Sepik and Sentani areas may have been drier than present, dominated by Nauclea woodlands and possibly experiencing...
natural fires. *Eucalyptus* savannah, like that around Port Moresby today, was probably more extensive all along the southern coast.

**Faunal change**

New Guinea has a curious fauna which included several large mammal species at the time that people first arrived (Flannery et al. 2002). The island lacks some families of marsupials found in Australia but has a rich rodent fauna. Mammalian predators are almost lacking, their niche being filled by pythons and large birds of prey. Several cave and swamp sites are known (Flannery 1995; Menzies & Ballard 1994) from the central highlands of the island which contain bones of extinct taxa, principally species of large kangaroos (*Protemnodon* spp.) and diprotodontids (for example *Hulitherium*, *Zygomaturus* and *Maokopia*). These are poorly dated but occur around 35,000 years or older, suggesting that they may have been contemporary with humans. For example a calf-sized diprotodontid, *Maokopia ronaldii* has been recovered from Kwiyawagi in central Irian Jaya where it seems to have been adapted to extensive subalpine grasslands. It lived until perhaps 30,000 years ago, but no association of its remains with human artefacts has been found. However fire is apparent from around 33,000 years ago in the Baliem Valley, the same catchment as the fossils (Hope 1998). The subalpine fauna seems to have disappeared well before the climate warmed after 14,000 years BP at which time forest limits rose and the mountain grasslands diminished. Hence some other cause (which may include human hunting or disturbance) must be involved.

A more direct case for human interaction is known from Nombe Cave in the Simbu of Papua New Guinea (Flannery et al. 1983). Here extinct fauna occurs in the horizons just preceding human artefacts. The altitude of Nombe makes it likely that it was forested, hence hunting may have been a more gradual process than in open country. Humans have also been responsible for introducing biota to islands in the Pleistocene and subsequently. An example is the Northern Common Cuscus (*Phalanger orientalis*) which arrived in New Ireland about 20,000 years ago (Heinsohn 2001).

**Fire**

Human hearths up to 30,000 years old are known from the Balem, the Wahgi peatlands and Kosipe Mission (Hope 1998). Some sedimentary sequences, for example peat beds at Tari and Lake Hordorli in the Cyclops Mountains, record no fires at all over tens of millennia in the Pleistocene. In such places the appearance of charcoal is probably an indicator of human activity (Haberle et al. 2001). The pollen record from the Tari Basin is the only record that shows a continuous sequence from before 28,000 BP through to the present (Haberle 1998). The study shows that, prior to 21,000 BP, forests dominated by *Nothofagus*, *Castanopsis*, and *Myrtaceae* covered the basin floor. Just before the onset of the last glacial maximum at around 21,000 BP we find the first evidence for burning that created a mosaic of grassland and forest. Although there is no direct archaeological evidence for humans in the basin at this time, the rapid increase in burning and opening up of the vegetation is unprecedented in earlier glacial records from the basin and is therefore considered to be a consequence of the arrival of humans in the region. This is at least 10,000 years later than the charcoal records from the Balem and Kosipe and archaeological sites at Chuave. It may represent a later occupation of the wetter sites.
Kosipe is a large swamp 100 km north of Port Moresby which provides a record of more than 40,000 years from 2,000 m altitude. Although subalpine plants were more common during the glacial times the area was always forested. Records of human occupation are preserved in the cool climate organic soils of the slope above the swamp, from ca 28,000 years BP (White et al. 1970). Fire is evident from about 30,000 BP in the swamp sediments while hearths have been identified in the slope mantle. It seems likely that people occupied or visited this high altitude site to collect the large heads of *Pandanus* nuts. They left behind massive stone blades, possibly adzes. The usage to which these were put is still not known.

**The manipulation of plants and landscapes leading to agriculture**

*Period II 20,000–5000 years ago*

Evidence for the extension of human landscapes is apparent on sensitive ecological boundaries such as the savannah-rainforest in the lowlands and the alpine treeline during the period of climate transition about 12–10,000 years ago. In these locations the encroachment on areas by forest has been resisted by fire and perhaps active clearance. The highlands have always supported forest and here the timing of clearance is quite variable, although the large basins so far looked at seem to have substantial clearances by 7000 years ago (Hope & Golson 1995). Similarly the long history of occupation along trade routes far from modern settlements demonstrates that the linkages have an extensive past. The highlanders are separated today by wet lower montane forests from the coastal resources. Although this ecological zone has not been well investigated, available data suggest that clearance is relatively recent (Gorecki & Gillieson 1989). It may be that this zone has contributed to the isolation of the highland peoples, despite the obvious passage of people and trade goods through it.

**The highland valleys**

In the montane zone there are relatively few pollen records that are continuous through this time period (Figure 2). Reasons for this may be the cooler and possibly drier climate that prevailed during the late glacial transition which altered conditions for deposition and preservation of organic material in sedimentary basins. Alternatively, increased burning and manipulation of forested environments by people may have caused erosion or deflation of sediments resulting in breaks in sedimentary records. However, it remains true that the separation of human activity from climate change as driving forces behind the sediment records we study is problematic in the absence of independent archaeological or palaeoclimatological data. This problem is exacerbated in the last glacial period when human activity in the landscape may have been strongly influenced by climate change rather than outpacing or overriding the climate signal (Haberle & Chepstone-Lusty 2000).

During the last glacial maximum at around 18,000 BP the highland valleys between 1500 and 1700 m asl were subject to a much cooler climate, perhaps as much as 7°C cooler than present mean annual temperatures, and frequent frosts and droughts (Haberle 1998). At Haeapugua in the Tari Basin (1630 m asl), where *Nothofagus* forests and open grasslands formed a mosaic vegetation pattern, the appearance of cold-adapted herbs such as *Astelia* (only found above 2700 m asl today) reflect the influence of cold mean annual temperatures on the basin floor. At Kuk Swamp in the Wahgi Valley (1580 m asl; Powell
1982, 1984) and at Telefomin (1500 m asl; Gillieson & Hope 1989) forest cover dominated the valley floors with some minor fire disturbance being recorded.

As global temperatures warmed and glaciers retreated, the late glacial transition in the highlands was achieved in a two-phase warming sequence with an initial period of climatic instability between 14,500 and 12,000 BP, followed by a more persistent warming between 12,000 and 8500 BP. At high altitude this led to an elevation in forest growth limits and a replacement of treeferns and grasslands with a closed upper montane forest (Hope 1989). In the highland valleys the combination of increasing mean annual temperatures, high atmospheric CO$_2$, and strengthening monsoon influence (Haberle et al. 2001) would be expected to result in expansion of forests into grassland habitat. This process is retarded in the Haepugua and Kuk Swamp (reported in Powell 1984 and Denham et al. 2004) sites where burning is persistent and frequent from around 21,000 to 8500 BP, resulting in the maintenance of grasslands at a time when forests are expanding in other areas. In response to increasing temperatures a shift in composition of existing forests occurs from a Nothofagus dominated community to a more mixed Nothofagus forest incorporating forest taxa from lower altitudes such as Castanopsis/Lithocarpus and Myrtaceae. Climate stability during this time may have been disrupted by a strengthening and possibly unstable monsoon system coupled with enhanced El Niño-related climate variability, resulting in an increased incidence of frost and drought (Haberle et al. 2001). This may have increased the probability of fire in the highlands, however, the increase in archaeological evidence for human occupation sites during this period points to an alternative interpretation. This is
one of *in situ* development of food-plant promotion and management in the highlands under a cold, highly variable environment subject to severe drought stress particularly during the late glacial transition period (14,500–8500 BP, Haberle 1998).

Despite the high fire activity at the end of the last glacial period the driving force behind forest expansion into grassland overrides the persistence of fire activity such that, in all sites that cover the early Holocene, we find swamp forest dominated by *Syzygium*, *Pandanus* and some gymnosperm taxa developed around wetlands in the valley floors. The relatively high biodiversity and resource value associated with swamp forests, including the high density of utilisable *Pandanus* species (*P. antaresensis, P. brosimos/julianettii* complex; Haberle 1995) may have led to these environments being a focus of human activity throughout the Holocene.

The appearance and spread of ‘agriculture’ in the highland valleys is covered elsewhere in this volume. However the earliest indications of ditching within a mosaic of forest and grassland around 9000 BP (Denham et al. 2003; Haberle 2003), accord remarkably well with the transition to ‘modern’ Holocene climates, points to the possibility that expansion of clearing and plant manipulation was partly environmentally controlled. By 7–6000 years ago the lower parts of the major highland valleys were cleared and would have looked similar to their appearance in 1933 (minus sweet potato cultivation). It is possible that the early Holocene was a time of more reliable climates, the El Niño-related drought and frost being much rarer (Grove & Chappell 2000). This would have rewarded experimental taro and banana planting and water manipulation (Denham et al. 2003, Denham et al. 2004).

*Above and below the intermontane*

In the areas around the great highland valleys the records are very varied. Subalpine areas near Mount Albert Edward, and north of Mount Trikora record fire almost as soon as the ice retreats, and pollen diagrams show continuing disturbance to the present day. At Mount Jaya firing starts about 11,000 years ago and the Mapala rockshelter records hunting from 5500 years ago that resulted in the extinction of a small wallaby (*Thylogale christensenii*). Hope et al. (1993) speculate that pressure of hunting allowed the copper ringtail possum (*Pseudocheirops cupreus*) to expand into the subalpine niche. This hunting post-dates the development of large human populations at lower altitudes. Other mountains, such as Mount Wilhelm, experience clearance only within the last millennium, apparently associated with rising limits to agriculture (Corlett 1984).

Isolated valleys and lower montane sites generally are cleared in the middle or late Holocene. For example Siruniki, on the Wabag divide at 2500 m altitude is cleared about 4500 BP (Walker & Flenley 1979). Telefomin on the other hand has at least three clearance events, reverting to dense forest between each one (Gillieson & Hope 1989). The Jimi Valley, at around 800 m, was cleared about 3000 years ago but clearance in isolated valleys near it is less than 300 years old (Gillieson et al. 1989).

*The lowlands*

Considering the long period of occupation of the coast and lowlands (O’Connor & Chappell 2004), it is curious that the disturbance history resembles that of the highlands. Expansion of grasslands occurs in the Lake Sentani region at 11,200 BP (Hope 1996) and it is likely that this also applies to the seasonal woodlands of the Markham Valley as Lake Wanum records burning from the base of a core dated to ca 9000 BP (Garrett-Jones 1979).
There are no data on the history of the southern eucalypt savannah woodlands which remain cryptic, since occupation there is only known from the mid-Holocene. Early occupation and the transfer of fauna to the islands of New Britain and New Ireland and the Admiralties by 30–20,000 years ago (O’Connor & Chappell 2004) is not mirrored by evidence of substantial environmental change. Local clearance (in a parallel to Kosipe) has been found at 24,000 BP at Yombon, in inland New Britain (Pavlides & Gosden 1994).

The difference between the southern and northern coasts of New Guinea is that the former has an extensive shelf while the latter is steep. Thus sea level change saw much more dramatic changes to the southern coast (Chappell this volume). An exception to this is the large river systems of the Ramu and Sepik (and to a lesser extent the Mamberamo) which had cut down more than 100 m below their present mouths during the time of lower sea levels. Widespread mangrove remains and shell tools, hundreds of kilometres up river (Swadling & Hope 1992), indicate that a large estuary existed for a few thousand years before it silted up to the present backswamp complex. Although valleys were not incised, similar change has occurred along the south coast as the shores established about 6000 years ago. Rapid siltation and coastal progradation has been demonstrated along the southern coast of Papua (Ellison 2005).

The arrival and effects of Austronesian-speaking agriculturalists

Period III ca 4000–Present

The Austronesian arrival around 4000 years ago shows very little correlation with environmental change. Some indications (but almost no local evidence) are that the minor climatic fluctuations known as the little ice ages probably commenced after 3500 BP with small variations in ice extent on the highest mountains. These alternations of slight cooling and warming probably did not change the forest at lower altitudes. However the frequency and severity of El Niño events may have increased, ushering in the drought and frost events that have an effect on cropping and societies at all altitudes (Brookfield 1989; Brookfield & Allen 1989). These droughts may also have allowed fire to extend grasslands into humid forests. Grasslands of Imperata cylindrica (kunai) occur in many areas on poor soils such as the iron- and magnesium-rich ultramafics of Sentani, Telefomin and Popondetta. These clearings are probably of considerable antiquity as regeneration may take thousands of years. In New Ireland and the Jimi Valley, forest clearance within the last 3000 years leads to a short-term phase of gardens for perhaps a few centuries. The sites are abandoned and the mineral soil buried by the buildup of peat swamp due to increased runoff from open vegetation into the valley bottoms (for example Gorecki & Gillieson 1989).

The adjustments of the coast to the establishment of high sea level at 6000 BP continues throughout the late Holocene. For example, beach ridges in New Ireland contain sequences of pottery that are stranded up to 800 m inland by coastal progradation (White et al. 1991). At this time villages probably moved frequently. This earlier dynamic coastline of beach building was replaced by a static lagoonal strand as the growth of coral reefs caught up with the sea level rise and blocked wave action. The modern reef flat is largely dead as it has reached mean sea level, and its growth is concentrated on the seaward edge. This process has been widespread except where abundant river sediment or sand movement has hindered coral growth. Thus for many coastal villages the marine resources available have changed radically in the last 5000 years, with open coasts being replaced by active reefs and finally lower reef productivity.
The pollen of *Casuarina* becomes much more common across the highlands after ca 1800 years ago suggesting that this was a time of widespread silvicultural planting. This rapid spread supports an hypothesis that there was effective diffusion of ideas despite linguistic and social barriers. Similarly the spread of crop plants such as sweet potato also seems to have been almost universal in the highlands resulting in the new clearance of slopes and higher altitudes that becomes apparent in the last few centuries, and in the abandonment of some swampland field systems.

**Discussion**

This thumbnail sketch of 50,000 years of history conceals the major feature of New Guinea that operates through time as well as across the island—its habitat diversity and unusual position as one of the world’s wettest regions. The topographic range and position next to the Western Pacific Warm Pool has preserved this diversity through the climatic fluctuations of the late Pleistocene, but boundaries have shifted dramatically and few places have been unaffected. The general picture of change can not yet be predicted at the local level and this has hindered the reconstruction of human environments. We can be quite sure that the modern barrier that separates the highlands from the coast—the everwet lower mountain forest zone—has remained intact throughout the period of human occupancy. Yet this is principally a barrier to agriculture and might have had some attractions for hunting and foraging, although humans do not thrive there today due to malaria, skin diseases and other problems (Riley 1983). At higher altitudes the highland valleys also supported dense wet forests with few resources during glacial times yet some settlement did take place.

New Guinea possibly had its ‘big game hunters’ in the Pleistocene, but the evidence is so diffuse that we can only note another unexplained extinction event and wonder if there might be anything in the origin myths of strange animals and birds. However the loss of species of rodents in the islands (Spriggs 1997) around 30,000 years ago is clearly coincident with human settlement. Flannery (1992) has suggested that a second phase of effective hunting of arboreal mammals could only start when the dog arrived about 3500 years ago. With the establishment of large areas of secondary vegetation a reduction in the significance of hunting has continued to the present day. In the upper Chimbu Valley in Simbu the animal called *Inkomugl* in the vernacular was widely remembered in 1970, even though no-one had ever seen one (Sterly 1997). This was the monotreme *Zaglossus bruijnii*, now probably wiped out near large population centres but preserved in stories.

The diversity of culture and language must reflect the need for local adaptation to specific environments that change over distances of a few kilometres. Yet on a long time scale of many centuries similar patterns of settlement and technology appear at the same time across the island. Diffusion of cultivars, land management practices and other techniques such as pottery or silviculture was probably relatively rapid despite the isolation of groups. The most rapid time of climate change and coastal stress, from ca 15–8000 years ago, rewarded adaptive cultures. The burning of some of the high altitude grasslands by 13,000 BP, 4000 years before the substantial clearance in the montane basins, suggests that trading links were in place across the mountains before the agricultural populations had increased. Similarly the scattered evidence for clearance and burning by 30,000 BP suggests that some ecological manipulation and selection was already taking place. Hence the emergence of an agricultural landscape in the highlands of
New Guinea can be seen as a result of gradual indigenous development punctuated by external influences such as introduced domestic plants and climate change and variability. Any ‘foreign’ influences would be small and possibly isolated to single locations in the cordillera. Our records come from swamps and these may have been the birthplace of an agriculture that depended on aroids and banana.

There is much we still do not know about the environmental history of the island. One example is that we are unsure of the causes of a ‘gap’ in sedimentation that occurs in many sites. At Kuk no sediments are known from the period 16–9000 BP, and the peatland is not present until 5500 years ago, by which time the catchment is virtually as deforested as the present day. From the handful of sites that cover this gap, such as Hordorli or Tari, there are few clues. Perhaps a phase of dry weather and widespread fires occurred and catchment clearance may be implicated. This lack of detail is frustrating because of our inability to relate the modern diversity to its past history. This will remain a major aim as the framework of sites and records is strengthened.

Acknowledgments

This review rests heavily on the work of many archaeologists and palaeoecologists. We are grateful to Michael Bourke, Tim Denham, Tim Flannery, Pawel Gorecki, Phillip Hughes, Jack Golson, Juliette Pasveer, Ron Petocz, Jocelyn Powell, Pamela Swadling, Marjorie Sullivan and Donald Walker for their insights. Our own work as palaeoecologists would not have been possible without the support of various Indonesian and Papua New Guinean authorities and the farmers and hunters of New Guinea who shared their real knowledge with us and provided practical assistance. We thank the Australian Research Grants Scheme and The Australian National University for financial aid and the Quaternary Dating Centre at the ANU for its massive program of dating in the island over the past 40 years.

References


1989, Frost and drought through time and space, Part III: what were conditions like when the high valleys were first settled? *Mountain Research and Development* 9:306–321.


O’Connell, Jim F. and F. Jim Allen, 2000, When did humans arrive in Greater Australia and why is it important to know? *Evolutionary Anthropology* 9:132–146.
The history of the human landscapes of New Guinea


Pasveer, Juliette, 2003, The Djieff hunters: 26,000 years of lowland rainforest exploitation on the Bird’s Head of Papua, Indonesia. Stencilwek, Leeuwarden: STIP.


