Chapter 3

Island contexts

Introduction

Perhaps the thing that most distinguishes islands, at least oceanic islands… is their extreme vulnerability or susceptibility to disturbance (Fosberg 1963: 559).

This chapter examines the wider context of island research as introduced in the framework in Figure 1.5 with regards to the notion that islands represent a model system, from which globally occurring processes can be understood. The chapter aims to provide a brief overview of islands and what characterises them, both as islands, and as locations from which to explore human-environment interactions. Recent examples of human-environment research in some Pacific islands, where wide ranging archaeological and comparative-led research has been carried out, are also reviewed. From this research, hypotheses regarding human impacts on environments can be developed with regards to the Faroe Islands.

Island contexts as models for human impact and global change

The smaller, more manageable spatial scale and insularity of island environments and societies, has made islands (particularly remote islands) popular field locations for research in a variety of disciplines, including biology, ecology, biogeography, ethnography and more recently, environmental archaeology. Islands have been referred to as outdoor laboratories (Kirch 1997a, Fitzhugh and Hunt 1997), where human-environment research can be approached from a comparative perspective, where examples from one island can be transferred to other islands as well as other locations, and where theories of general importance can be developed and tested (Whittaker 1998). Although islands are not closed systems, they are perhaps our best representation of model systems in which globally occurring processes such as human colonisation, population change, landscape and ecological modification, and impacts of climate change can be effectively isolated and measured, allowing cause and effect relationships to be more easily clarified (Kirch 1996).

The existence of several islands in groupings or archipelagos that span a variety of climatic and ecological settings promotes a wide and varied range of research. Islands share some characteristics, but differ slightly in others, allowing comparative studies to be made. Within Remote Oceania (Green 1991) in the eastern Pacific, there are some 7,500 islands which share similar aspects such as climate and cultural origins, but which differ with respect to elevation, ecology, geology, resource availability and degree of insularity (Figure 3.1).

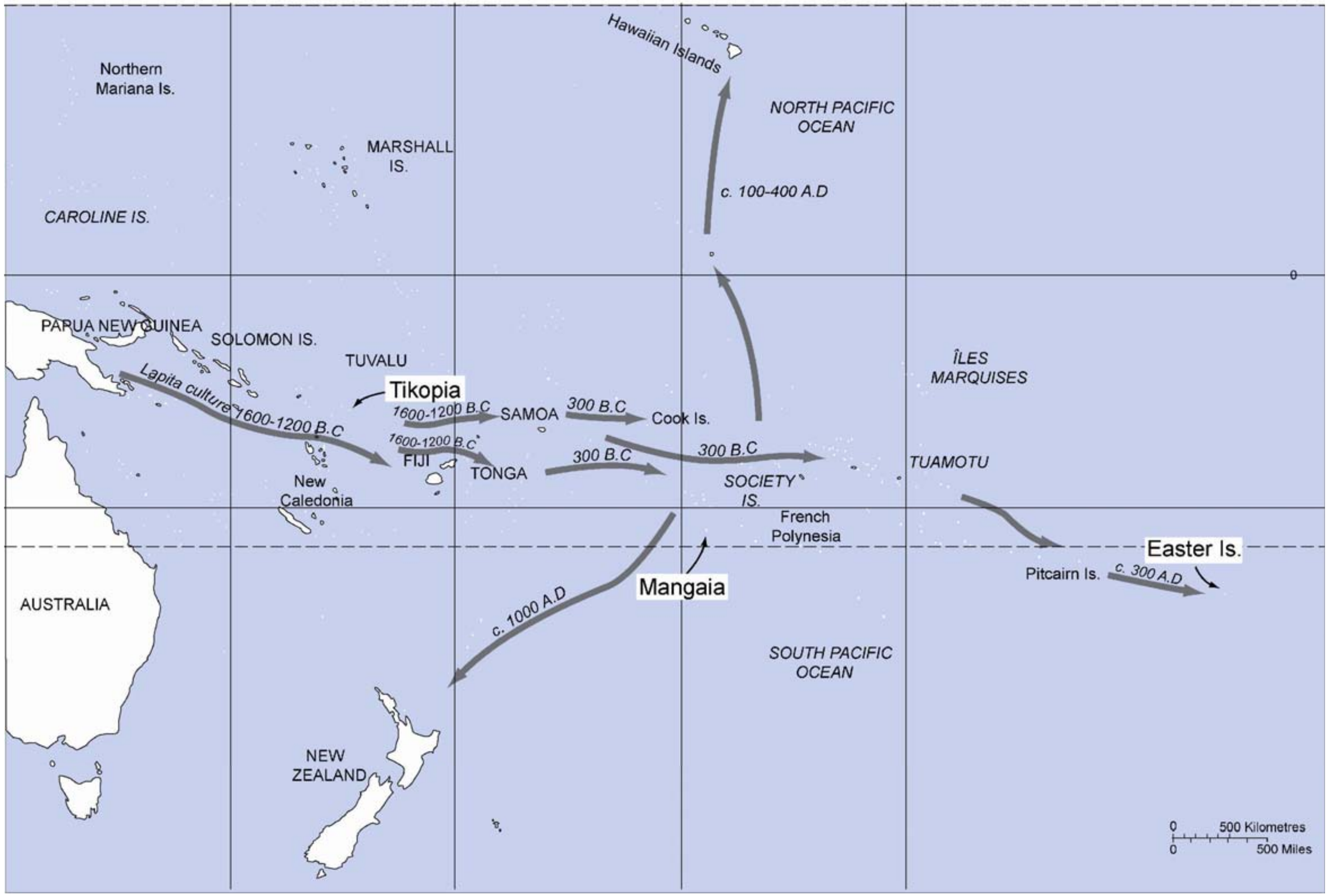

Figure 3.1: Pacific islands including proposed routes and timings of colonisation (dating of colonisation after Kirch 2000).

Islands in the North Atlantic, although considerably less numerous than those of the Pacific, share similarities in terms of their common parental population, cultural capital and oceanic setting, but differ in factors including climate and ecology. This allows environmental factors and the impacts of people in the Faroes, Iceland and Greenland to be effectively compared and contrasted.

Islands are often geographically isolated by their nature, and although the perception of isolation changes through time and space (e.g. whereby past societies viewed the sea as a highway rather than a barrier), their discreteness results in the definition of clear environmental and social boundaries. Feedbacks, responses to change and thresholds of change can be investigated at a manageable level in island societies, whereas in continental or landlocked societies, defining geographical, ecological, historic and social boundaries is problematic. Biological and socio-political diversity is diminished in island ecosystems and social systems and this allows interconnections between human and environmental factors to be assessed more specifically, increasing the visibility of impacts observed in environmental records, which is critical in the adoption of a multi-scaled approach.

The relatively short temporal scale of island habitation compared to that of continents also supports the study of human-environment interactions. The length of occupation of most Remote Oceanic and North Atlantic islands has been on a multi-generational scale, which is long enough to look at human-environment interactions, but has not been on a multicultural scale where cultural mixing makes human-environment research more difficult. Remote Oceanic islands such as Hawai'i, Pitcairn, Mangareva and Easter Island were only settled within around the last 1500 years, while the North Atlantic islands of Faroes, Iceland and Greenland were colonised by the Norse after *c*.1200 years ago. Although these dates may differ by a few centuries, the colonisation periods of the islands of Remote Oceania and the North Atlantic are effectively similar in broad cultural terms. In contrast, Near Oceanic islands such as Samoa and larger islands such as Madagascar and Australia have much longer occupation histories spanning thousands of years and are more culturally complex, while remote islands in the South Atlantic such as Tristan de Cunha, Gough, St Helena and Ascension were not discovered and settled by Europeans until the 16th century, which is perhaps too short an occupation period from which to view and understand historical human-environment interactions and adaptations.

In addition to initial colonisation impacts, the islands of Remote Oceania and the North Atlantic are ideal subjects on which to examine the longer-term social and environmental diversifications. Within both island groupings, people with a similar cultural background and language settled the islands and initially adopted a similar mixed farming subsistence economy. Within a few generations, however, individual island populations may have been following different routes, in order to adapt to or manage to the contrastive environments and differing internal social dynamics. Understanding the similarities and differences between islands is therefore essential for understanding under what circumstances people put unsustainable demands on their environment, because similar sequences of events on islands have produced some very different outcomes. While some islands have undergone a cultural or biotic collapse, the people and ecosystems of other islands have adapted and survived.

Island ecosystems and biogeography

Island ecosystems vary significantly from those of continents. While the biota of Oceanic islands have been comparatively stable, for example climatically, over long periods of geological time, they are highly unstable to rapid ecological change, including that caused by human perturbation (Cronk 1996). Comparisons between the biota of continental regions and Oceanic islands are demonstrated in Table 3.1, while comparisons between Oceanic island and high latitude island biota are illustrated in Table 3.2.

Island ecosystems are determined by their insularity, which is influenced by their isolation and limited size. The insularity of island ecosystems results in the limitation or absence of resources, limited biodiversity, a low species immigration rate and the evolution of endemic species over millions of years. Island ecosystems are well adapted to their pre-human circumstances, having evolved over long periods in isolation from human influence and indigenous mammals. Paradoxically, however, they are extremely vulnerable to invasion by human impact, especially in the eastern Pacific and more remote areas. In comparison to continents or regions such as Africa or Asia where the ecology has evolved alongside people, on islands, biotic systems have evolved in isolation and have developed a stable equilibrium that is particularly susceptible to disruption. Endemic species are susceptible to impact by perturbations of the environment caused by humans and other introduced animals, such as grazing mammals, which were previously absent. Also, Pacific plants, which have evolved with little experience of fire, are not able to recover as easily from burning as continental species that had evolved alongside humans or where natural fires were more common (McNeill 2001). However, the vulnerability of islands to disturbance results in easier identification and measurement of the palaeoenvironmental record and threshold crossing events can be compared across islands and archipelagos.

The biogeography of islands is dependent on the dispersal of groups of plants and animals, to a large degree affected by the distance from both mainland source regions and between other islands that act as stepping stones. Also critical to island biogeography are the possibilties for new species to evolve and as a result, speciation has led to high degrees of

	Oceanic	Continental
Ultimate stability (geological time)	HIGH	LOW
Proximate stability (ecological time)	LOW	HIGH
Ultimate diversity (uniqueness)	HIGH	LOW
Proximate diversity (species number)	LOW	HIGH

Table 3.1: Comparisons between oceanic island and continental biota. After Cronk (1996).

	Low/mid latitude	High latitude
Ultimate stability (geological time)	HIGH	LOW
Proximate stability (ecological time)	LOW	HIGH
Ultimate diversity (uniqueness)	HIGH	LOW
Proximate diversity (species number)	LOW	LOW

Table 3.2: Comparisons between low/mid latitude island and high latitude island biota. Adapted from Cronk (1996) by A. Dugmore (*pers. comm*.).

endemism in certain islands or archipelagos, e.g. Hawai'i (Kirch 2000). Island faunas are also very different from those of continental regions as islands have limited, or no populations of mammals and reptiles, but a richer diversity and abundance (prior to colonisation) of sea and land birds, invertebrates and access to sea mammals. These aspects had important consequences for colonising human populations (Kirch 2000). As people moved from the large Near Oceanic islands into Remote Oceania, they increasingly found the newly discovered islands lacking in many familiar plants and animals. In the more remote islands, there were few indigenous plants with edible tubers or fruits and few edible fauna except land and nesting sea birds. The high ultimate diversity or uniqueness, and low proximate diversity or species number (Cronk 1996) of oceanic islands therefore make islands and their ecology vulnerable to human impact. This inherent instability may be significant in understanding the circumstances whereby people put unsustainable demands on island environments.

In terms of biotic evolution, the islands of the North Atlantic have evolved differently from those of the Pacific (refer to Table 3.2). While the ultimate or geological stability of low latitude Pacific islands has been high, allowing the evolution of unique species, in the North Atlantic, ultimate or geological stability has been low because of repeated glaciations, resulting in very limited time for the development of endemism. As a result, the ecology of the North Atlantic islands would be expected to be less affected by external perturbations, such as human settlement, than the biota of low latitude islands.

Colonisation of remote islands

The factors involved in the colonisation of islands is exemplified by islands in the east Pacific, or Remote Oceania, that are far from the mainland, and often small in size, making navigation difficult. Although expansion into the near Pacific began around 40,000 years ago (Kirch 2000), further development of voyaging and the expansion into Remote Oceania did not begin until after 1500 BC. The reasons for the onset of remote island colonisation is unclear; while improvement and introduction of new technology would have been required before people and their resources could be moved across such massive distances, this alone would not have led to the expansion of colonisers into remote islands. In addition to technology, an ideology was also required that viewed the sea as a highway rather than a barrier. Major advances in maritime technology in Oceania can also be correlated with the advent of a food-producing, horticultural economy, and as human populations grew, the search for new lands to plant and control became a driving force of cultural change. This encouraged the build up of another new ideology bound to a social structure whereby the discovery of new landscapes could be "claimed, named, divided, planted and inherited" (Kirch 2000: 304). Reasons for the colonisation of the less geographically remote islands of the North Atlantic (the Faroe Islands, Iceland and Greenland) are also varied and may not be dissimilar to those cited in relation to Pacific islands. Explanations have included land hunger, the development of Scandinavian shipbuilding, the increase in trade of luxury goods, changes in mainland Scandinavian society or as part of general independent seaborne expansion across the North Atlantic.

After colonisation of Remote Oceania, long ocean journeys may have become regularised through repeated economic transactions for trading and social transactions, for example, by visiting neighbouring islands for marriage or to trade natural resources (Kirch 2000). Through these repeated journeys, the colonisers developed a complex network of interactions that were vital to the sustainability of cultural and environmental island systems. As with Oceanic islands, the colonisers of the North Atlantic maintained a network of interactions between other islands and the mainland, although climatic changes or socio-political issues inhibited contact during some periods.

On settling a new island, the colonisers would have sought to transform their new environment into a familiar and manageable landscape by creating “transported landscapes”, also referred to as a “portmanteau biota” (Crosby 1986) or “cultural capital” (Diamond 2005) that echoed the environment of their homelands and promoted ecological homogenisation. A transported landscape consisted of a combination of specific plants, animals and subsistence methods as well as knowledge, beliefs, and social organisation that were introduced and implemented from the homeland to each newly colonised island. Colonisers of Remote Oceania brought with them a cultural capital of pigs, dogs, chickens and rats and edible plants such as the taro, yam, sweet potato, banana, coconut and breadfruit. The Norse introduced a cultural capital to the islands of the North Atlantic of cows, pigs, sheep, goats, horses, ducks, geese, dogs and barley. The use of fire to assist vegetation clearance and the heavy reliance on wild marine resources such as molluscs, fish and turtles, were also introduced features and part of the transported landscape that became familiar across Oceania, while a reliance on birds and marine resources was crucial in the Atlantic islands. The introduction of a suite of farming and subsistence practices to an island where these were previously unknown causes a change in the natural landscape and ecology. The outcome of initial unexpected impacts caused by the introduction of unfamiliar biota may have been a circumstance that induced the colonisers to make unsustainable demands on their environment. In Iceland, for example, although the plant/bird ecology of the island would have appeared outwardly similar to that of mainland Scandinavia and accustomed to by the Norse, tephra or volcanic ash from previous eruptions lay only a few centimetres below the stable looking surface vegetation. Unbeknown to the settlers, penetration of the sod layer above a thick tephra deposit could lead to a sudden catastrophic destabilisation of the whole farm (Dugmore and Buckland 1991, Dugmore *et al* 2000).

Timing of colonisation

The timing of colonisation is a key issue with regards to the extent of human impact in island environments because to determine human impact as having been rapid on the one hand, or prolonged on the other, is dependent on for how long the island has been colonised. However, there remains a problem of dating the colonisation of islands when reliable historical data is not available. Direct, unequivocal evidence of human colonisation is one line of evidence, most often based on archaeological remains or evidence of introduced species. Indirect evidence of inferred human impact, such as a significant increase in erosion, is another line of evidence. Direct evidence is often spatially limited and difficult to date, while indirect evidence is more extensive. However, in both cases there are problems concerning the accuracy and precision of the dating. These issues have arisen in determinations of the timing of arrival and earliest environmental impacts of the first New Zealanders, where debate has centred on the accuracy of radiocarbon dates of materials accepted as anthropogenic, and in the interpretation of environmental change as having an anthropogenic cause (Newnham *et al* 1998). As a result, divergent models concerning the length of New Zealand's prehistory have arisen in part because of varying interpretations of the same palynological data. The significance of the issues encountered in dating the timing of colonisation in New Zealand extends to migrations to central East Polynesia, as Anderson (1995: 128) states:

> …the archaeological hypothesis of late colonisation might turn out to be wrong, but it has the great virtue of being eminently falsifiable. One manifestly early site or one clear indication of anthropogenic change in the environmental record in central East Polynesia, or better still in the marginal archipelagos, would do it (Anderson 1995).

This is also a key issue to consider regarding the timing of colonisation of the Faroe Islands, which is discussed in more detail in chapter 4.

Human impacts and environmental change in remote islands

Since Europeans began voyaging to Pacific islands in the 18th century, it was often maintained that small-scale, non-western island societies were so much a part of their natural surroundings that their presence did not alter the natural equilibrium (McNeill 2001, Spriggs 1997). In the late 19th and early 20th century, although the impacts of humans on island environments was becoming more evident, the observed changes were attributed to impacts caused by the arrival of Western peoples who had introduced new plants and animals. Disturbances caused by indigenous/pre-industrial populations were thought to have been minor or insignificant. Only more recently was this paradigm reviewed. In the 1970s research began to suggest that rather than living in an idealised state of nature, indigenous Pacific populations experienced various forms of exploitative relationships with the environment, which often resulted in degradation (Dodson 1992, McNeill 2001, Kirch and Hunt 1997, Kirch 1982; 1983; 1997a). Although the impacts of indigenous hunter gathering people may be *relatively* slight, the cumulative effects of high density agricultural peoples on their landscapes have been highly significant (Kirch 2000).

Evidence for historical degradation, erosion and depletion of global island environments and resources by early colonisers is today widespread. Human induced changes on islands began with the first permanent colonisers and their initial exploitation of resources, which probably caused massive ecological changes and disruption of habitats on many, if not the majority, of islands (e.g. Kirch 1982, Olsen and James 1984, Spriggs 1986, Flenley *et al* 1991, Steadman 1989 and Bayliss-Smith *et al* 1988). McNeill (2001) suggests that human modification of Polynesian island environments followed a two stage process, beginning with the exploitation and depletion of resources that were the easiest to utilise, with a second stage leading both to depletion of the most obvious resources and exploitation of new resources, achieved by developing new sources of food or emigrating elsewhere. Exploitation of local resources and the introduction of new species, both domesticates such as pigs, and stowaways, especially the rat, led directly to faunal and floral depletions and extinctions. Repeated forest clearance for gardens and orchards, and burning as part of shifting cultivation practices, caused the destruction of habitats, the depletion of wood resources and consequently increased soil erosion. Evidence of major vegetation changes, soil erosion, extinction of endemic species and decreasing biodiversity linked to human land-use actions is displayed in Pacific islands as varied as New Guinea, Vanuatu, New Caledonia, Fiji, Yap, the Cooks, the Society Islands, New Zealand, Easter Island and Hawai'i (Athens 1997, Athens and Ward 1993; 1995; 1997, Athens *et al* 1992, Bussell 1988, Dodson and Intoh 1999, Elliot *et al* 1995, Ellison 1994, Flenley and King 1994, Flenley *et al* 1991, Flenley and Bahn 2002, Diamond 2005, Hope and Hope 1976, Hope and Spriggs 1982, Hughes *et al* 1979, McGlone and Basher 1995, Parkes 1997, Stevenson 1998, Stevenson and Dodson 1995).

Although human impacts on the environments of remote Pacific islands have been most well documented, and floral and faunal depletions have been most severe, accounts of detrimental human impact are also recorded following colonisation of the North Atlantic islands, particularly with regards to the exploitation of forest resources, exploitation of wild food resources and soil erosion related to the introduction of grazing animals. Human impact on the North Atlantic islands is referred to in more detail in chapter 4.

Population and resources on remote islands: cultural stress and collapse

The impact of human colonisers on island environments has not only caused environmental degradation, but in some cases, the unsustainable demands put on island environments by colonisers instigated episodes of cultural stress. On some islands, such as Easter Island and Mangaia in the Cook Islands, this concluded with a sharp decline in population (Diamond 2005, Kirch 1997a; 1997b). Some of the events leading up to cultural collapses and their wider context are discussed below in order to explore the extent to which unsustainable demands made by the colonisers on island environments may have led to cultural stress.

Easter Island is characterised by its isolated location in the Pacific Ocean, more than 3200 kilometres away from the nearest continent of South America. It is a relatively small volcanic island, measuring 165 square kilometres, and has a relatively mild climate and predominantly gentle topography lacking deep valleys. A volcanic origin provides the island with fertile soils, but the island geology and low elevation limits supplies of fresh water. The origin of the islanders is controversial and will not be discussed here (Heyerdahl 1950; 1989 or see Flenley and Bahn 2002 and Kirch 2000 for an overview). The timing of settlement is also debated with current estimates placing colonisation at around 300-400 AD (Kirch 1984), although some estimates suggest a later date of 650-900 AD (Spriggs and Anderson 1993). The timing of colonisation of Easter Island colonisation therefore occurs at a similar period to that of the Norse settlement of the North Atlantic islands, at least in broad cultural terms.

Conspicuous forest clearance becomes visible in pollen diagrams from Easter Island after about 800 AD, most likely a direct result of human impact. Palynological investigations suggest that when the settlers arrived, Easter Island was covered by 21 species of trees, all of which are now extinct, along with woody bushes, scrubs, herbs, ferns and grasses, all of which had evolved over long time scales (Flenley and King 1984, Orliac 1998). The most common tree in the pollen record is a species of a now extinct large palm that was probably used for transporting and erecting the giant statues that epitomise the island, as well as providing a source of timber for fuel and for large rafts and canoes. However, the once widespread forest, including the large palm, had disappeared from the island by 1600 AD. Forest clearance initiated auxiliary environmental problems, such as soil erosion and a lack of wood with which to build boats to take advantage of good fishing in the area, thereby reducing access to resources at a time when they were most needed. A graph comparing data from the pollen record on Easter Island alongside estimated population and stratigraphic evidence of disturbance through soil erosion and charcoal is illustrated by Figure 3.2.

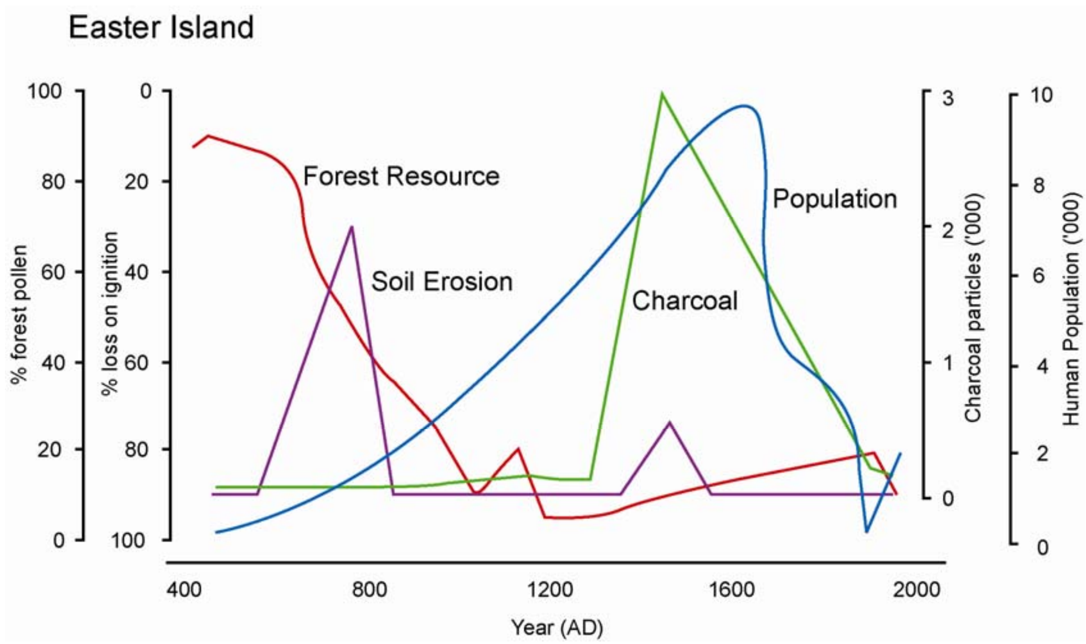

Figure 3.2: Graph indicating the changing temporal relationship between forest resources, population, soil erosion and charcoal in Easter Island. After Flenley and Bahn (2002).

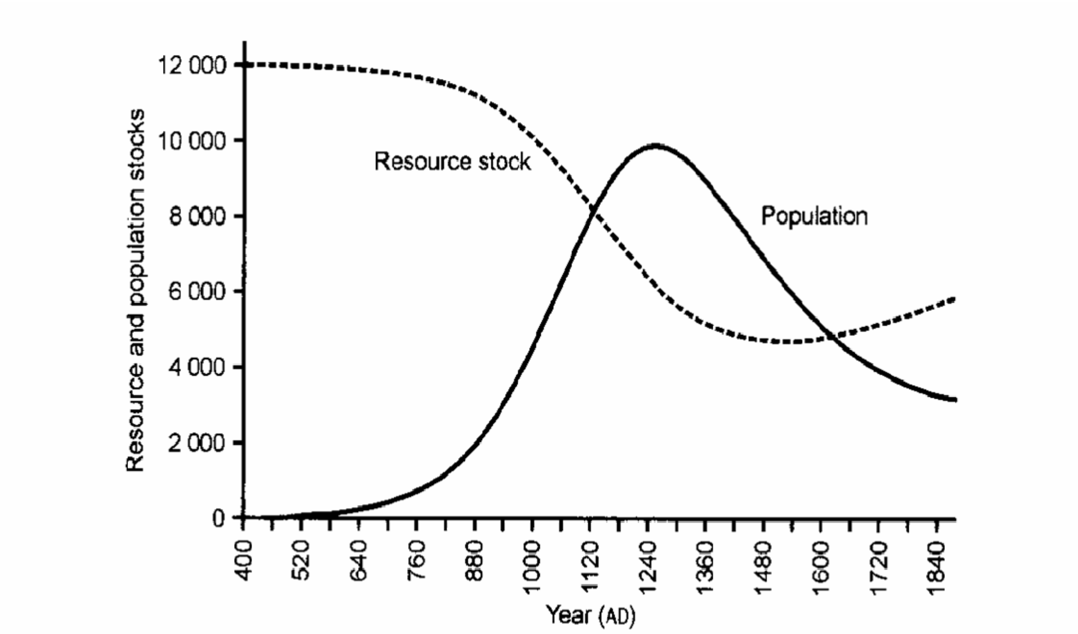

Figure 3.3: A Malthusian numerical model for Easter Island population and resources. After Brander and Taylor (1998).

As well as forest, there is evidence that the islanders over-exploited natural resources such as fish, porpoises, shellfish and seabirds. With at least 25 nesting species, Easter Island was once the richest seabird breeding site in Polynesia, but the colonies of more than half of the seabird species breeding on Easter Island or its offshore islets were wiped out and every species of native land bird became extinct after colonisation (Steadman 1989). The publication of recent research (Hunt and Lipo 2006) documents a later date for settlement than previously assumed. This implies that the construction of statues and degradation of the environment was initiated much sooner after colonisation than previously thought, beginning almost immediately after human colonisation. Palaeoenvironmental data from some parts of Iceland also documents the almost immediate clearance of forest, within less than fifty years of settlement (Hallsdóttir 1987, Mairs 2006). The consequence of this, at least in Easter Island, with a smaller area and less total forest cover, is that people begin to put unsustainable demands on island environments immediately after colonisation.

By around 1600 AD, Easter Island society declined into chaos and cannibalism, to some degree related to the detrimental human impacts on the environment and over-exploitation of resources (Diamond 1995, Flenley and Bahn 2002). Some researchers suggest that the cultural collapse on Easter Island exemplifies Malthusian theory (e.g. Bahn and Flenley 1992, Brander and Taylor 1998, Brown and Flavin 1999, Diamond 1999; 2005, Flenley and Bahn 2002, Keegan 1993, Kirch 1997a; 2000 and Ponting 1991) and recent modelling experiments have also demonstrated such a relationship (Decker and Reuveny 2005, Brander and Taylor 1998) (Figure 3.3). Although technological progress and innovation play a role in alleviating resource constraints (Boserup 1981 and Simon 1996), even when incorporating technological innovations in their model, Decker and Reuveny (2005) found that endogenous innovation such as that envisioned by Julian Simon and Ester Boserup would have had limited ability to change Easter Island's fate. Technology-population-environment linkages may well be much more complex than is currently understood and Decker and Reuveny (2005) suggest that when per capita utility falls below some level, as it does on Easter Island, people may resort to violent conflict over resources, which in turn may limit the physical and mental capabilities of the population and reduce its ability to innovate. Easter Island, however, is an exceptional case, as there was very little or no communication with other islands, so it was effectively a closed system with finite resources. The majority of islands, whether in the Pacific or North Atlantic, experienced at least sporadic trade with neighbouring islands. Even so, evidence for parallel outcomes with that of Easter Island can be found on other islands such as Mangaia, the most southerly of the Cook Islands in central east Polynesia (Figure 3.4 illustrates the main proxy signals of change over the last 7000 years of Mangaia's history). The environment of Mangaia differs somewhat from that of Easter Island and is geologically the oldest island in the Pacific, extremely degraded and nutrient poor. The island is approximately 70 square kilometres and is

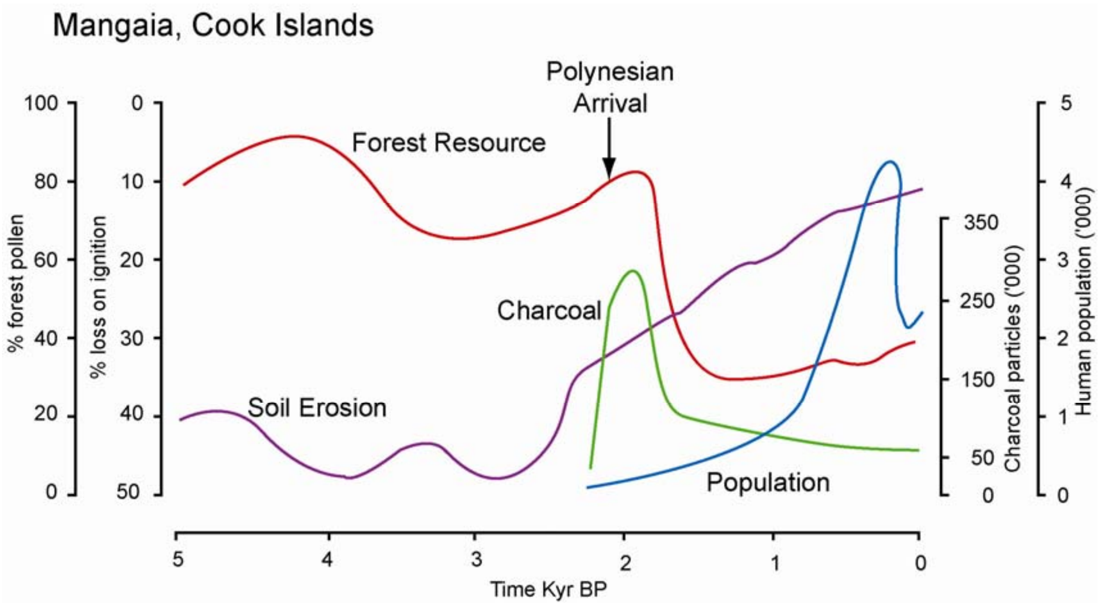

Figure 3.4: Graph indicating the changing temporal relationship between forest resources, population, soil erosion and charcoal in Mangaia in the Southern Cook Islands, reconstructed from palynological and archaeological data. After Kirch (1997a).

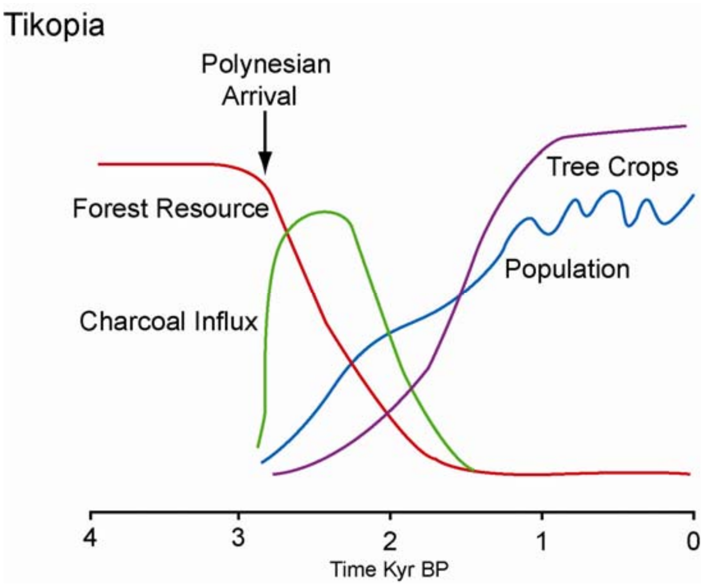

Figure 3.5: Graph indicating the changing temporal relationship between forest resources, population, soil erosion and charcoal on the island of Tikopia, an outlier of the Solomon Islands, reconstructed from palynological and archaeological data. After Kirch (1997a).

volcanic, with a central cone surrounded by a ring of upraised reef limestone known as *makatea*. Interdisciplinary research carried out on Mangaia (Kirch *et al* 1991, Kirch *et al* 1992, Ellison 1994, Steadman and Kirch 1990 and Kirch 1997a; 1997b) has highlighted the degree of human impact on the island's environment. For example, following the arrival of people, 8 of 13 of the land birds and 3 of 9 species of sea birds that were present at the time of human arrival were lost (Steadman and Kirch 1990), and there were devastating declines in populations of fruitbats and of marine resources. Forest clearance and increased erosion rates also dominate the palaeoenvironmental records (Kirch 1996; 1997a) and human impact on both forests and native birds appear to have been swift and absolute, similar to on Easter Island (Steadman and Kirch 1990). In addition, pigs which were a culturally prized food resource were eliminated because they became too competitive with the human population for the same food (Kirch 1997a). Parallels are therefore evident between Mangaia and Easter Island, not only in terms of the considerable reductions in forest cover and natural biotic diversity, heightened soil erosion and increased fire regimes, but also in terms of the unchecked population growth, again drawing parallels with Malthusian theory.

Population and resources on remote islands: population regulation and sustainability?

A key question to consider is to what extent the cultural consequences experienced on Easter Island and Mangaia were inevitable, or to what extent people themselves direct their responses to enhance self-inflicted environmental change. Evidence from Easter Island and Mangaia suggests that people overexploited their resource base leading, perhaps somewhat inevitably, to a devastating population crash and social stress. However, evidence from the island of Tikopia in the southwest Pacific illustrates that despite significant environmental impact and erosion, comparable with that of Easter Island and Mangaia, significant cultural collapse *can* be partially prevented by the direct actions of the islanders. Tikopia is a small (4.6 square kilometres), isolated island, yet at its peak its population has reached as many as 1700 people, and the island has supported continuous occupation for over 3000 years. Initial human impacts of forest clearance, burning, and increased erosion and the exploitation of wild foods such as sea and land birds, fruit bats, fish, shellfish and sea turtles, led to depletion of the island's biodiversity including extinction of the population of fruit bats and five of Tikopia's bird species (Kirch 1997a) (Figure 3.5). Less than a millennium after human settlement, the quantities of fish and bird bones being deposited in middens had declined by a factor of three and molluscan remains by a factor of ten (Kirch 1997a), indicating a significant reduction in available wild food resources. Pigs, which were introduced by the first settlers and were culturally important, were increased significantly as other natural protein sources were reduced and this caused further environmental pressure. However, rather than a situation of conflict and population collapse developing, the islanders initiated active measures which allowed a steady population to be sustained. For example, native trees were replaced by extensive orchards that provided edible fruits and nuts, and around 1600 AD all the island's pigs were killed in a decision made collectively by the islanders in order to reduce environmental pressures (Diamond 2005). Population control and regulation was also applied, through wide-ranging methods including infanticide, abortion, celibacy and ritualised suicide. Despite environmental stress, the population of Tikopia was sustained, but only as a result of adaptation and decision-making made collectively by the population.

Overpopulation and the associated over-exploitation of environmental resources is a considerable issue for many Oceanic islands and may also be significant in the North Atlantic islands. Population pressure (or conversely a lack of population with which to carry out subsistence activities) can be identified as a circumstance whereby people put unsustainable demands on island environments. Discussion of population-environment linkages in the North Atlantic islands are discussed in chapter 8.

Inherent sensitivity of island ecosystems

Although many environmental impacts on Oceanic islands can be related to human arrival, the scale and extent of human impact may not be entirely dependent on the impacts themselves but may be connected to the island's inherent disturbance potential, i.e. the intrinsic fragility, sensitivity or vulnerability of the island environments. For example, the biota of low latitude oceanic environments is more sensitive to human disturbance than those in the North Atlantic, as a result of their geological stability and biotic evolution over a long period of time and the evolution of endemic species (Cronk 1996). The inherent fragility of several of the Pacific islands has been considered in a paper by Rolett and Diamond (2004) who examined nine environmental variables; rainfall, elevation, area, volcanic ash fallout and Asian dust transport, the presence of *makatea* (upraised reef limestone) terrain, latitude, age and isolation, and used these to model the intrinsic fragility of the island ecosystems. On the basis of these variables, Easter Island with low tephra and dust fallout, an isolated position at relatively high latitude, the absence of *makatea* and terrain that is low and dry, was exemplified as an inherently fragile island and would therefore be expected to be more vulnerable than other islands to human impact. Accordingly, Rolett and Diamond (2004) suggested that the massive scale of environmental and cultural deterioration on Easter Island was not a result of imprudent decision-making on behalf of the population, but because the settlers faced one of the Pacific's most fragile or sensitive environments. Although inherent environmental sensitivity may well be a circumstance under which people put unsustainable demands on island environments, it has been demonstrated, for example, in the case of Tikopia that the actions of people are also important, and that effects of human impacts can not be assigned entirely to inherent environmental sensitivity.

Inherent environmental sensitivity may also be a factor that has influenced landscape impact in North Atlantic islands, as specific variables, such as climate or geology, might make certain North Atlantic islands more sensitive to change than others. Therefore, it will be crucial to consider the pre-colonisation landscape of the Faroe Islands in order to determine the influence of environmental sensitivity on the degree of human impact, in addition to the actions or adaptations that people implemented in order to deal with such impacts. This issue is discussed in chapter 7.

Climatic change on islands

Climatic changes occur at time scales ranging from millions of years to annual variations, but in terms of human communities and populations climate changes on a century to decadal scale are most significant. At this scale, extremes of climate may affect individuals and small family groups, but does not necessarily impact island communities. Societies are likely to survive even when the loss of individuals is high, because most of the time strategic responses and cultural buffers intervene between communities and catastrophes (Dincauze 2000). However, islands are particularly vulnerable and susceptible to disturbance, not only to that caused by people but also to natural disturbance such as climatic change. Depending on the size and geographical location of an island, different factors may assume importance in terms of climate, such as temperature, rainfall, storminess or windiness. A further consideration is that the variability, intensity, spacing and frequency of adverse climatic events assume greater importance than absolute temperature or rainfall variability when examining the interactions between climate and people (Dugmore *et al* 2007a).

Most Pacific islands lie within the tropical to subtropical range of climate, so although temperature change is the most significant climatic factor for North Atlantic islands, adequate rainfall is the most significant climatic factor for agricultural populations of Oceania. Although most Pacific islands receive adequate precipitation for agriculture, ENSO (El Niño Southern Oscillation) events may cause short-term changes in the Pacific island climatic regime, resulting in droughts in the western and central Pacific, and heavy rains, floods and increased cyclone frequency in the eastern Pacific. Short-term climatic shifts may also devastate fish populations and the seabirds that depend on them (Kirch 2000), with ramifications for the human populations dependent on these resources as food. However, Flenley and Bahn (2002) have illustrated that although an island's resources may vary in relation to periodic droughts, and that crisis may be reached in a drought year, drought is probably not the underlying cause of such a crisis.

While most researchers accept that human impact has caused the most significant changes to the vegetation and landscape of the Pacific islands over the settlement period, others have emphasised the impacts of natural change, such as the climate shifts caused by ENSO events (Nunn 1990; 1991; 2003). Yet although climatic shifts are important on a short-term scale with regards to impact on human populations, it is questionable whether climate change alone could have caused the scale of impacts observed in the palaeoenvironmental records of Pacific islands, which indicate large scale changes in soil cover and vegetation. Other extreme natural events, such as volcanic eruptions or tsunamis, may also have short-term impacts within the period of human occupation (Kirch 2000), but again, it is not obvious how these short-term impacts would have affected Pacific island environments to the degree illustrated by palaeoenvironmental records. Natural changes such as subsidence, tectonic uplift and sea level change might be significant on longer-time scales for a small number of islands (McNeill 2001), but probably not within the time-scale of human colonisation.

The overwhelming evidence from human-environment research on Pacific islands suggests that people have caused large scale environmental change, in some cases leading to environmental and cultural collapse. Although climate impact may not have been a significant factor in the human-environmental history of the Pacific islands, it will need to be assessed as to how the impacts of climate could cause people to make unsustainable demands on North Atlantic island environments, because of their geographic situation spanning key climatic and ecological thresholds.

Summary: A global model of island colonisation and human impact?

Although the outcomes on Pacific islands exemplify the significance of human impact on island environments, palaeoenvironmental evidence of deforestation and slope erosion in Iceland suggests that human impact in the North Atlantic islands may have been as great as that in the islands of Remote Oceania. It is therefore assumed at the outset of this research (refer to aims and hypotheses in chapter 1) that a model based upon the degradation of island soils and vegetation caused by human colonisers could be applied to a wide geographical variety of island colonisations encompassing the North Atlantic as well as the Pacific. Although the patterns of prehistory and the environments of the world’s islands are diverse, and nearly every island is in one way or another a special case (Dewar 1997), when compared, many extreme examples of human-environment interactions of island colonisations encompass the universal themes and wider significance of colonisation, long-term settlement and subsistence. Through a study of the circumstances by which islands in the North Atlantic were colonised, specifically the Faroe Islands, this study will assess if an understanding of a unique island in the North Atlantic can be applied, and contribute to, the development of a North Atlantic, or even global model of island colonisation. Within this model the following factors will be considered;

- The nature and importance of the long-term exploitation of birds and marine resources
- The importance of introduced domesticates
- The limited availability of fuel and building resources
- The role of population control by disease
- The degree of isolation and history of communication and outside contact
- The impacts of climate change and the significance of climatic thresholds
- The levels of extinction and reduction of biological diversity
- The degree of material/cultural competitiveness
- The degree of cultural/population collapse

Some of these factors have been considered above in relation to Polynesian islands and will be discussed in relation to the North Atlantic islands in chapters 7 and 8.

Chapter summary

This chapter has introduced some important factors to be considered when viewing islands as representations of model systems for investigating human-environment relationships. Islands make ideal field locations to research interactions between people and their environment because of their manageable size, isolation, relatively short human histories and limited cultural and ecological complexity. This chapter also summarised results of recent research carried out on remote islands, including on Easter Island, Mangaia and Tikopia in Polynesia. The recurring conclusion of recent research is that most island environments are characterised by significant and detrimental human impact, beginning with initial colonisation and in some cases leading to cultural stress. These conclusions form an overarching hypothesis that human impact on island environments is significant and detrimental. This thesis is approached against the backdrop of this overarching hypothesis.

The following chapter considers the Faroe Islands and the wider North Atlantic region within the framework of the wider literature, outlining environmental and cultural factors in their spatial and temporal context.