Culture and climate: reconsidering the effect of palaeoclimatic variability among Southern California hunter-gatherer societies

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Abstract

The significance of palaeoclimatic change in the emergence of sociopolitical complexity among maritime hunter-gatherers in southern California has been an active subject of debate over the past fifteen years. Interpretations on the timing and nature of palaeoenvironmental change and its relationship to cultural change have shifted as new high-resolution climate records have been reported. I provide evidence for buffering mechanisms that evolved over centuries and propose that past Chumash societies were more equipped to respond to droughts, El Niño events, and other environmental transformations than were agricultural societies. I conclude that a ranked society developed in the Chumash region prior to the Middle/Late Transitional period (AD 1150 and 1300) and that chronological evidence currently lacks sufficient resolution to argue for punctuated change.

Keywords

Maritime hunter-gatherers; drought; palaeoclimate; ENSO; ranked society; punctuated; Chumash; California.

Introduction

'Climate change is a sexy explanation for changes in human society' (Fagan 2003: 334). On the eve of present-day global warming, understanding the effects of palaeoclimatic change on past societies becomes all the more compelling. Evidence is emerging that long-term palaeoenvironmental changes, sometimes abrupt, occurred during the Holocene and may have had significant effects on past populations (e.g. Alley et al. 2003; Dunbar 2000; Haug et al. 2003; Hodell 2001). More accurate reconstructions of the nature and timing of these

Routledge Taylor & Francis Group

World Archaeology Vol. 37(1): 92–108 *Archaeology of North America*
 ISSN 0043-8243 print/1470-1375 online
DOI: 10.1080/0043824042000329586

changes could enable archaeologists to explain social change within the context of shifting environments. Ongoing debate about the significant effects of climate on culture is a common concern (see deMenocal 2001) for worldwide examples). For example, Williams recently (2002) questioned the significance of drought for the collapse of ancient Andean states. Instead of environmental factors, Williams suggested social causes for disruptions in irrigation systems and water use and cautioned archaeologists whose explanations are focused on disaster agents 'rather than the process of coping with disaster and the inherent vulnerabilities in social systems' (Williams 2002: 372). Other debates on the timing and the significance of palaeoenvironmental change occur in many regions of the world (Blockley et al. 2000; Houseley et al. 2000; Overpeck 1996; Richerson et al. 2001). Nevertheless, we are still hampered by problems of chronological resolution, insufficient data, over-simplification, and a reliance on palaeoclimatic data at the expense of anthropologically based explanation.

The relationship of palaeoclimatic change to the emergence of sociopolitical complexity has been the subject of important debate among scholars who study Chumash societies in the Santa Barbara Channel region of southern California (Arnold 1992; Glassow 1996; Johnson 2000; Kennett 1998; Kennett and Kennett 2000; Lambert 1997; Raab et al. 1995; Raab and Larson 1997). The coastal Chumash were hunter-gatherers that subsisted primarily on marine products including fish, shellfish, and sea mammals, and wild plant foods such as acorns, bulbs, and hard seeds, and, to a lesser extent, terrestrial mammals and birds. Despite divergent opinions on the significance and timing of climatic shifts, most proponents of palaeoenvironmental models suggest that stressful environmental conditions served as a trigger for punctuated change during the Late Holocene (Arnold 1992; Glassow 1996; Johnson 2000; Kennett 1998; Kennett and Kennett 2000; Lambert 1997; Raab et al. 1995; Raab and Larson 1997; Raab 2000). This paper focuses on the period between AD 400 and 1500 and addresses evolutionary models that identify marine and climatic conditions as a major impetus to change. Most adherents of these models also suggest that change was punctuated, not gradual. In contrast, King (1990) has inferred that change was more gradual and that evidence of a ranked society with a hereditary elite appeared in the Santa Barbara Channel region at the end of the Early period (about 2,600 years ago). I propose that hunter-gatherer societies are less affected by deleterious palaeoclimatic change than agriculturalists and that we have been too uncritical in accepting the seductive concept that palaeoenvironmental change was a significant trigger for the emergence of complexity. I examine the data for 'punctuated' change and then close with evidence that the Chumash developed numerous adaptive strategies to cope with an often-unpredictable environment.

Evidence of palaeoclimatic change in Southern California

Arnold (1987, 1992) proposed that environmental conditions had a profound effect on the emergence of sociopolitical complexity among the Chumash. An unfavorable warm water period in the Santa Barbara Channel region (Fig. 1) between AD 1150 and 1250 adversely affected the Chumash on the northern Channel Islands according to Arnold. Following this environmental degradation, emerging elites took advantage of the situation through

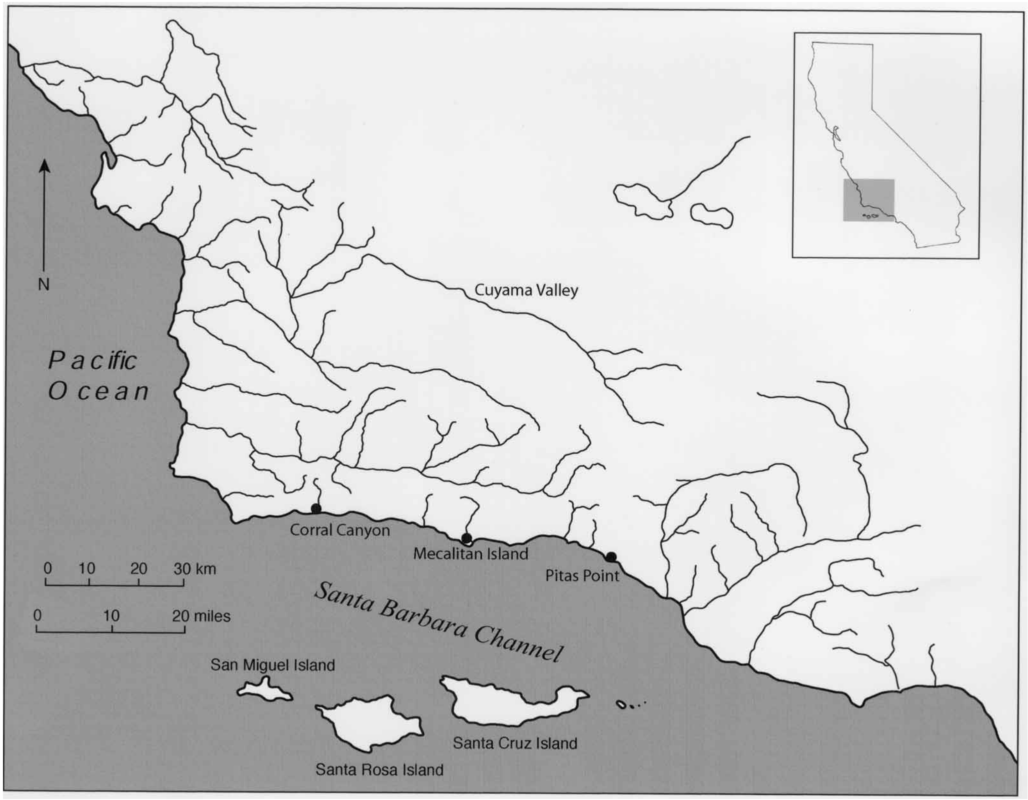

Figure 1 Map of the Santa Barbara Channel region.

political opportunism and manipulation of labor, with a ranked society eventually appearing in the area between AD 1200 and 1300. Arnold found this event of such significance that she proposed a new chronological period, the Middle/Late Transitional (AD 1150–1300). This period marked 'punctuated' or rapid change in the region. To arrive at this conclusion, Arnold (1992) and others working in the region (Colten 1995; Glassow et al. 1988; Lambert 1994; Larson et al. 1994; Walker and Lambert 1989) relied on Pisias's (1978, 1979) palaeoclimatic model based on analyzed data from a varved sediment core in the Santa Barbara Basin. (Some of these same researchers also included discussions of possible terrestrial droughts.) This model indicated there were unusually warm sea surface temperatures (a high of 21 degrees C) between about AD 1150 and AD 1300. These findings were challenged by Kennett and Kennett (2000) who provided a high-resolution Holocene marine record based on twenty AMS C14 dates and oxygen isotope analysis of two planktonic foraminiferal species from a sediment core in the Santa Barbara Basin. They inferred from this record that sea surface temperatures (SSTs) were cool during the period that Pisias suggested warm waters prevailed. These cool waters were associated with high marine productivity and sustained terrestrial drought between AD 450 and 1300 in the Santa Barbara Channel region. In response to these climatic events, they propose that significant competitive and co-operative cultural changes occurred, including increased sedentism, trade, regional violence, and intensified fishing practices. Despite Kennett and

Kennett's revised record of palaeoclimatic change, Arnold (see Arnold et al. 2004; Arnold 2001a) still adheres to the model of a warm water event between AD 1150 and 1250, in part based on shellfish found in dated strata from sites on Santa Cruz Island (Arnold and Tissot 1993).

In contrast to Arnold, Raab and his colleagues (Raab et al. 1995; Raab and Larson 1997) suggest that marine conditions had less of an effect on the subsistence base of the Chumash than did droughts because certain marine species replaced those that were adversely affected by SST, and warmer SSTs could result in a more favorable subsistence base. Instead of emphasizing shifts in marine temperatures, they propose that droughts, some quite severe, occurred intermittently between AD 800 and 1400 and had a profound effect on southern California Indian societies (Raab and Larson 1997). They primarily rely on tree-ring and pollen records, most of which are for areas outside the Santa Barbara area. In addition, Lambert (1994, 1997) has suggested that drought was a significant factor that contributed to resource stress and conflict. Johnson (2000) also used recent palaeoenvironmental data to examine climatic change and human response, proposing that the Chumash economic system emerged in the Middle-Late Transition to 'to buffer drought-caused food shortages' (Johnson 2000: 317).

For evidence of resource stress and violence, many scholars rely at least in part on a significant and impressive body of osteoarchaeological data from the Santa Barbara Channel region (Lambert 1993, 1994, 2002; Lambert and Walker 1991; Walker and Lambert 1989). The most thorough discussion of these data is by Lambert (1994), who examined burial records and skeletal remains of 1744 individuals from thirty archaeological sites in the Santa Barbara Channel region for evidence of resource stress and violent conflict. After assigning the data to general time periods, she compared samples from the mainland Chumash area with samples from Santa Cruz and Santa Rosa Islands. Lambert (1994, 2002: 217–19) found that healed cranial vault fractures are present during all the time periods but are more common between approximately 1500 BC and AD 1380. In contrast, lethal projectile wounds do not increase in frequency until approximately AD 580, at about the same time that the bow and arrow is introduced to the region. Some of the victims had wounds from larger points that Lambert associated with spears, not arrows (1994: 149 and Table 6.27). Between AD 580 and 1350, approximately 10 per cent of the sample examined by Lambert exhibited evidence of projectile wounds, and many of these individuals were from the mainland, not the Channel Islands (Lambert 2002). After AD 1350, Lambert noted a decline in warfare that she attributed to improving climatic conditions. Lambert (1994) also linked evidence of resource stress in the skeletal remains to a period of aridity between AD 580 and 1350. In another study, Walker (1996) found that the northern Santa Barbara Channel Island inhabitants showed greater evidence of nutritional stress than Chumash living on the mainland.

Palaeoclimatic data for the Chumash: how bad was it?

A detailed examination of the palaeoclimatic reconstructions during the Late Holocene in southern California leaves us with a fragmented scenario of environmental change.

Kennett and Kennett's (2000) data provide convincing evidence of cooler waters in the Santa Barbara Channel between AD 450 and 1300. Their data are based on a long laminated/unlaminated sediment core and have the highest resolution yet for marine core analysis (based on twenty-five- and fifty-year averages). The analysis assumes laminated sediment preservation is related to warm or cold SST and the effects of ocean circulation creating anaerobic (laminated from lack of bioturbation) or aerobic (unlaminated due to bioturbation) bottom conditions. Unfortunately, they did not present any definitive confirmation for terrestrial drought in the region during this period. They noted that historical records indicate a link between marine and terrestrial climatic conditions, although their relationship is complex. One example of this complexity can be seen in evidence that has linked drought cycles to cosmological events such as solar variation (Biondi et al. 1997; Hodell 2001; deMenocal 2001), thereby complicating the relationship between SST and terrestrial climate all the more. Another example can be seen in a recent study in the Magdalena Basin off Baja California, Mexico, where Ortiz and colleagues (Ortiz et al. 2004) examined a marine core that was comparable to the one that Kennett and Kennett analyzed from the Santa Barbara Basin. The Magdalena Basin marine core had a similar laminated/unlaminated sediment sequence. Ortiz et al. propose that marine organic matter production may have a significant control over whether sediments are laminated or not. Furthermore, they point out that organic production varies greatly at different localities due to rapid and dynamic fluctuations in species and conditions. Their findings suggest that the data used by Kennett and Kennett may indicate very different climatic conditions than the ones they proposed.

For direct information on drought, Kennett and Kennett (2000: 385) rely most heavily on Larson and Michaelson's unpublished 1989 manuscript on tree-rings from the Southern California Bight, and Stine's (1994) data based on lake level fluctuations in the southern Sierra Nevada. Larson and Michaelson (in Kennett and Kennett 2000) defined three periods of drought (AD 500–800, AD 980–1250, and AD 1650–1750) and Stine (1994) defined two periods (AD 892–1112 and AD 1210–1350). Unfortunately, the Michaelson and Larson information that Kennett and Kennett (2000) and others (Raab et al. 1995; Raab and Larson 1997) depend on for their arguments has not been published, although graphs based on their data do appear in these works. Stine's data are significant but are based on lake level fluctuations in the southern Sierra Nevada. Historical records indicate that rainfall patterns in the Sierra Nevada have not always corresponded with the rainfall patterns in the Southern California Bight region. As more detailed palaeoclimatic data are generated, some of these problems should be resolved. Until then, we should certainly consider the possibilities of extended droughts and the effects on the Santa Barbara Channel Islands and the southern California mainland and continue to search for archaeological correlates.

The strongest archaeological evidence that is used to support palaeoclimatic change is based on data from the Channel Islands, not the mainland (e.g. Arnold 1992, 2001a, 2001b; Munns and Arnold 2002; Kennett 1998; Kennett and Kennett 2000; Kennett and Conlee 2002; Raab et al. 1995). Several scholars have noted that there are relatively few sites with radiocarbon dates between AD 1150 and 1300 on the northern Channel Islands (Arnold 2001b; Munns and Arnold 2002; Erlandson et al. 1997; Kennett 1998). Kennett (1998) and Kennett and Conlee (2002) suggest that a possible disruption of settlement locations on Santa Rosa and San Miguel Islands may have been caused by drought conditions. Kennett (1998) observed that the sites on the northern Channel Islands that have dates from this period tend to be associated with large watersheds that provided perennial water supplies even during long-term droughts. He proposed that people living on the islands intensified fishing (which was highly productive because of cool SSTs) to compensate for the reduced terrestrial resources.

Archaeological evidence for environmental change on the Santa Barbara mainland is not as definitive as that for the northern Channel Islands. The stratified site of Corral Canyon (CA-SBA-1731) on the mainland coast has a series of radiocarbon dates between AD 500 and 1600 and spans Arnold's Middle/Late Transition period (Erlandson and Rick 2002). 'Faunal assemblages show little evidence of unusually warm water temperatures or any serious degradation of the marine environment' at the site (Erlandson and Rick 2002: 175–6). Drought conditions are not part of their discussion. Preliminary evidence from the Pitas Point site, another mainland coastal site that spans the Middle/Late Transition period, indicates diversity in fish remains with numerous pelagic species as well as species from other habitats throughout the period that the site was inhabited (approximately AD 1000 to 1500). No hiatus in occupation of this site has been noted (Gamble 1983). Mortuary data from the mainland coastal site of Malibu in the southern Chumash region provide strong evidence for the existence of a ranked society with a hereditary elite prior ($\sim$ AD 950–1150) to the Middle/Late Transition period and the ostensible drought (Gamble et al. 2001). There is additional evidence for a ranked society among the Chumash during the late Middle period, including data from Mescalitan Island (Gamble 2004).

Finally, when considering climate change and its effects on indigenous mainland populations, a re-examination of Lambert's sample is useful. To determine changes through time, Lambert reconfigured King's (1990) chronological divisions into a five-phase sequence, dividing King's Early and Middle periods into two phases each and his Late period into one phase (L: AD 1150–1804, or AD 1380–1804 if calibrated dates presented in Lambert (1994: Table 4.1) are used). Most of the samples that Lambert examined have a narrower date range (than the five-phase sequence), which is provided in her dissertation (1994: Figure 5.1). Dating is further complicated because King's chronology was not based on calibrated C14 dates. In order to address this problem, Lambert offered revised calibrated dates suggested by Erlandson and Colten (Lambert 1994: Table 4.1). Lambert cautions that these revisions are less clear for the Late period because King based his chronology partly on cross-dated artifacts from the American Southwest, but may work best for the periods predating the Late Period. Despite the complications associated with dating that Lambert clearly addressed, she was able to examine only one skeleton and one burial record from the mainland for King's (1990) Late period, Phase 1 (AD 1150–1500), the era that includes Arnold's Middle/Late Transition (AD 1150–1300). (If we use the calibrated dates for Late period, Phase 1 (L1), they are AD 1380–1670.) This small sample for the mainland Chumash during L1 makes it very difficult to identify cultural transformations in this region during a period of time when archaeologists propose that rapid environmental and cultural changes occurred on the Channel Islands. However problematic the sample was, unfortunate overstatements about Lambert's work exist. A recent example can be seen in the following statement: 'Whatever might have been transpiring climatically and ecologically, major cultural change was accelerating, and poor health and lethal violence peaked during the Santa Barbara region's Transitional period (Lambert 2002: 217–19)' (Arnold et al. 2004: 18). Lambert synthesized data from her earlier work in this 2002 article and never made such an unequivocal statement. Thus, to avoid misinterpretation, the current evidence is in need of more complete data to support claims of social change, especially for the mainland Chumash.

Despite problems with sample sizes, chronological control, and the tenuous nature of interpreting the palaeoclimatic impact in the Santa Barbara Channel region, the Chumash probably experienced significant environmental change that may have been abrupt. These events include changes in sea surface temperatures, droughts, floods, and other major climatic perturbations, some of which were related to El Niño/Southern Oscillations (ENSO) which have been occurring for thousands of years (Allan 2000; Diaz and Markgraf 2000). ENSO events usually recur every two to seven years and last for eighteen to twenty-four months, although the timing of these episodes can be irregular. Claims have been made for much more severe and persistent climatic disturbances, including droughts that persisted for decades or even centuries in California (Overpeck 1996: 1820). I now turn to adaptive strategies that the Chumash developed to cope with climatic events in the past, some probably long and severe.

Chumash response to palaeoclimatic change

Hunter-gatherer societies, including sedentary and densely populated societies, were more equipped to adapt to changing climatic conditions than agriculturalists because of their flexibility and their generalized plant-exploitation strategies (Richerson et al. 2001). For example, many agricultural societies relied on irrigation canals that are subject to disruption as a result of floods. Although agriculturalists will buffer food shortages by harvesting wild resources (O'Shea 1989), their knowledge of these resources and the often-intensive processing requirements of some foods will decrease with greater dependence on cultivated crops. Hunter-gatherers who rely on wild foods are more readily prepared to revert to less preferred foods when necessary.

Diversification is just one risk minimization strategy. Additional strategies practiced by the Chumash and other southern California Indian societies include storage, exchange, and mobility (see Halstead and O'Shea (1989) for a discussion of these coping mechanisms). Evidence of diversification in maritime fishing practices has been identified at several sites in southern California. Raab and his colleagues (Raab et al. 1995; Raab and Larson 1997) demonstrated that certain species of marine mammals and fish, such as dolphin, yellowtail, and tuna, are attracted by warm waters during ENSO events, and that the inhabitants (the Tongva/Gabrielino, neighbors of the Chumash) of Little Harbor on Santa Catalina Island shifted their subsistence base to take advantage of these species. This shift is a clear example of diversification, or 'broadening the base of the subsistence system' (Halstead and O'Shea 1989: 4). Data from the mainland site of Pitas Point in Ventura County, which was occupied between AD 1000 and 1550, confirm that yellowtail and tuna were relatively common during the Transitional period on the mainland as well (Gamble 1997). Pletka (2001: 238) recently analyzed fish remains from numerous sites on

Santa Cruz Island and found that fishermen during the Transitional period exploited a wider variety of habitats than at other times. Certainly today, sports fishers rejoice during El Niño events because species such as yellowtail and tuna seek waters farther north than usual and also venture closer to the shore.

These findings are not a surprise. For example, Moseley and Feldman (1988) noted that El Niño perturbations had a much greater impact on irrigated agriculture than on traditional fishing practices in Peru. Agriculturalists tend to be at much greater risk of starvation or milder forms of subsistence stress than hunter-gatherers, especially agriculturalists in dry climates who rely on irrigation. The massacre at the Crow Creek site in the Missouri trench area of the Great Plains is another example of the devastating effect that climatic events can have on agricultural societies. A mass grave with over 486 individuals was found at the site, most of whom had been mutilated and obviously massacred (Bamforth 1994). The site is in a region that is considered marginal for cultivating crops like corn that require a long growing season. Bamforth suggested that, after years of periodic, unpredictable, and severe food shortages, the fortified settlement at Crow Creek was attacked by desperate invaders who killed most of the inhabitants, mutilated the bodies, then burned the houses and fortifications. Events like these are markedly different from the violence recorded by Lambert and Walker for the Chumash.

Even during severe droughts or other stress-induced environmental events, the Chumash employed multiple strategies to reduce risk and the impact of climatic change. They relied on a wide spectrum of plant and animal foods and were fully capable of exploiting less preferred species to avoid hunger or starvation. Moreover, the coastal Chumash did not inhabit as harsh an environment as many groups in southern California, including the Cahuilla and Kumeyaay. Indeed, the mainland coastal Chumash settlements were optimally situated adjacent to major drainages, productive estuarine environments, and beaches where boats could easily land. As Yesner (1980) noted years ago, locations such as these served to reduce many risks.

One of the best strategies for minimizing risk due to relatively short-term (up to several years) climatic fluctuations was the storing of foods. The Chumash and other California Indians stored acorns, dried and smoked fish, seeds, and other foods in indoor and outdoor storage facilities (Gamble 1991, 1995; Lathrap and Hoover 1975). Storage allowed the Chumash to have a reliable source of food to support fairly dense levels of populations (some settlements had over 1000 people) throughout the year, even in years when harvests were unpredictable. Without the storage of important resources, the population densities of the Chumash would not have been as great as has been recorded.

When assessing the effects of palaeoclimatic changes on humans, it is important to consider the direct effect of climate perturbations on core resources. Acorns, which could be stored for up to several years, were a primary staple in the diet of the Chumash. Oak trees are generally considered to be a 'mast flowerer'; they cycle through years of irregular abundant acorn production interspersed with years of lesser production. One of the most comprehensive studies of acorn production was completed by Koenig and his colleagues (1994), who measured the variation of acorn yields for five different species of oaks over a fifteen-year period in central California. All five species in their study (*Quercus lobata, Quercus douglasii, Quercus chrysolepsis, Quercus agrifolia*, and *Quercus kelloggii*) currently grow in Santa Barbara County and Santa Cruz Island and produced acorns used by the

Chumash. Acorn production is dependent on numerous factors and varies from species to species (Koenig et al. 1994). A bad year for *Quercus agrifolia* is not necessarily a bad year for other species of oaks. Even during severe drought years, one species of oak may produce ample acorns while others may not. Variables other than amount of rainfall are also significant to acorn production, including the timing of rain and freezes (Bean and Saubel 1972; McCarthy 1993). A heavy rainfall or freeze in the spring when the oaks are laden with pollen can be devastating. Floods and freezes can also cause severe food shortages, variables seldom mentioned by proponents of climate change models. Usually several species of oaks can be found within a short distance of each other. Koenig and Haydock (1999) found that annual variability in overall acorn crop size and the probability of acorn crop failures decline as more species of oaks are present. The Chumash and other California Indians (Baumhoff 1978) used preferred species of acorns when available, but gathered less-preferred species when necessary.

Water, another significant resource that is compromised during extended droughts, was also stored by the Chumash. An account from Father Ascención's diary of 1602 provides an example of water storage among the inhabitants of Santa Catalina Island. Upon landing on the island, members of the expedition were thirsty and requested water from the indigenous inhabitants: 'Our people asked them by signs for water. They at once brought a rush barrel full of water, which was good, and said that the spring from which they took it was somewhat distant' (Wagner 1929: 236). The most common form of water storage used by the Chumash was the twined basketry water bottle with asphaltum lining in the interior. Because asphaltum preserves relatively well in the archaeological record, the remains of water bottles and water bottle manufacturing can be observed. Heated pebbles, known as tarring pebbles, were used to coat the interior of water bottles with asphaltum to make them watertight (Craig 1967). Asphaltum impressions of water bottles are relatively common in many Chumash sites, as are tarring pebbles, but unfortunately these artifacts have not been consistently recognized, quantified, or reported. The largest archaeological collection of tarring pebbles in the Chumash region is from the Pitas Point site, where over 651 tarring pebbles were found, some associated with features (Gamble 1983). The most spectacular feature at the site (which has been interpreted as a basket-making area) was inside one of the houses next to a hearth where a pit, lined with large, flat rocks, many of which had asphaltum on them, was recovered in association with caches of tarring pebbles. The density of tarring pebbles at the Pitas Point site far exceeds the number found at most sites in southern California, possibly because its inhabitants were making water bottles for export to the islands. (Arnold (2001a, 2001b, 2001c) provides no mention of tarring pebbles on Santa Cruz Island.)

If long-term climatic fluctuations occurred, then other strategies for procurement of water may have been necessary. The Cahuilla, as well as other desert groups in southern California, dug wells, some of which were rather elaborate walk-in types with steps and sloping floors and were believed to have been used prehistorically (Lawton and Bean 1968). A relatively obscure and early reference for the Chumash use of wells appears in a diary by Father Zalvidea, who, on 23 July 1806, visited the countryside in the Cuyama Valley in the interior Chumash region which he noted was dry and without trees (Cook 1960: 245). At two Chumash settlements in the valley (*Cuia* [*Kuyam*] and *Siguecin* [*Tsiwikon*]), Zalvidea noted that wells were being used by the inhabitants, and on the same trip he observed wells at two Serrano villages (neighbors of the Chumash), one of which was in the San Gabriel Mountains. These wells were possibly introduced by the Spanish; however, their prehistoric use is more likely. The Chumash exchanged goods with the Cahuilla (King 1995) and other desert groups and had limited contact with the Spanish in the Cuyama Valley before 1806. Prehistoric wells have been excavated by archaeologists in Arizona and should be identifiable in the archaeological record in the coastal areas of southern California. If drought was indeed as severe as some have suggested, wells may have been used to minimize risk, even on the coast. It is possible that we have overlooked such features in the archaeological record in part because they are difficult to recognize (as are house floors and storage pits in the Chumash region – see Gamble (1995)), and in part because of our excavation strategies.

Exchange among the Chumash was probably one of the most significant means of coping with an unpredictable environment. When the Spanish arrived, the Chumash practiced a system of wealth finance involving the exchange of prestige goods that was partially supported by extensive marriage ties linking settlements in different ecological zones (Johnson 2000; King 1976). Exchange of food, manufactured goods, raw materials, and other items between adjacent regions with varying resources served to insure a more stable subsistence base and minimize risk. Chiefs and powerful individuals amassed considerable wealth in the form of prestige goods, large stores of food, feasting vessels, shell beads that were used as currency, and plank canoes. Powerful network systems that in part revolved around cyclical ceremonial feasts were maintained by chiefs and orchestrated with the help of the *paxa* or ceremonial leader (Blackburn 1976). Through the ownership of sea-worthy plank canoes (Gamble 2002), chiefs and wealthy individuals managed a critical resource in the island-mainland exchange system. Shell beads were used in the Santa Barbara region for thousands of years, but their function as currency probably began about AD 1150 (Arnold 2001b; King 1990). Prestige goods, such as shell beads, when used in exchange for food items, have been identified as a form of social storage and function as a means of insurance against food shortages (O'Shea 1981; Rowley-Conwy and Zvelebil 1989). The use of currency is more prevalent among complex societies with a market economy than in hunter-gatherer societies and clearly indicates the Chumash focus on exchange. The emergence of shell beads as a form of money has not yet been fully investigated. Nevertheless, the use of prestige goods as a form of social storage developed over thousands of years, possibly in response to cyclical droughts and other climatic events that periodically challenged the subsistence base of the Chumash.

Conclusion

A review of relatively recent publications on palaeoclimatic climate change and the effects these changes had on the Chumash remind us of the powerful forces in nature and the resiliency of human populations. I suggest that hunter-gatherer societies, particularly maritime hunter-gatherers, are more capable of coping with severe climatic changes than agriculturalists. Certainly the implications of deleterious palaeoenvironmental events are more threatening for sedentary and densely populated hunter-gatherer groups than nomadic groups who use mobility as a strategy for buffering risks. The Chumash Indians of southern California, who lived in an unpredictable and sometimes hostile environment in a temperate region yet had relatively dense populations and complex sociopolitical organization at the time of European contact, were successful in their response to palaeoclimatic change and serve as an excellent example for scrutiny. Some scholars interested in the sociopolitical evolution of the Chumash and their response to often-harsh environmental conditions have suggested that punctuated versus gradual change characterized Chumash adaptive mechanisms. Others (Erlandson 2002; Erlandson and Rick 2002) have taken a more cautious approach and note the difficulty in distinguishing between a rapid and more measured rate of change given the incomplete archaeological record for the region. Instead, they suggest that a combination of gradual and punctuated changes were typical during the Late Holocene.

The archaeological evidence for the Chumash region, including the osteoarchaeological data, indicates that we lack the chronological resolution in the archaeological record necessary to link cultural change directly to past climatic events. Moreover, disagreement on the nature and timing of palaeoclimatic change further hampers our ability to assess its impact at definitive intervals as has been suggested by many scholars. Claims to support hypotheses, some of which remain static despite new data, add to the muddled record that has been created. I propose that adequate data have not been presented to support the argument for punctuated change. Violence and resource stress occurred prior to the Middle/Late Transition period, and a careful examination of Lambert's (1994) data shows gaps in the record and gradual increases in levels of resource stress during the Middle and Late periods, with a slight decline in the Late period. An increase in deaths due to violence occurred during the late Middle period. Significant sub-lethal violence occurred prior to this period. Furthermore, mortuary data provide evidence for a ranked society prior to the Middle/Late Transition period (Gamble et al. 2001; Gamble 2004).

If we look at the development of cultural complexity in other parts of the world, we find that archaeologists have explained emergent sociopolitical complexity without invoking environmental triggers, even when the evidence for palaeoclimatic disturbances is more clearly documented. Before we can substantiate claims that Chumash society responded to severe droughts, warm water SSTs, cold SSTs, or ENSO-related events during definitive time periods and that these events caused sudden change, I suggest that a series of critical research issues should be addressed.

1. There is a need to develop models that concentrate on coping strategies that have been overlooked, such as wells and the production and use of water bottles.
2. More in-depth analyses of resources and technological developments, including water sources, alternative foods, intensification, and diversification strategies need to be investigated.
3. The use of prestige goods as a form of social storage, their significance, and the emergence of currency require greater attention.
4. The emphasis on the archaeology of the offshore Santa Barbara Channel Islands is not matched with information on the mainland where the large centers and more powerful chiefs were situated. More detailed archaeological studies and syntheses of the mainland sites are essential to balance observations from island sites.

5. More data on subsistence remains are needed to determine if in fact there was a crisis, exactly when it occurred, and how widespread it was. The concept of a Middle/Late Transition period should be investigated further to determine if it is warranted.

If scholars focus on these critical research issues, then greater strides in understanding cultural change and its relationship to climatic events in the past should strengthen explanatory models for scholars studying complex maritime hunter-gatherers throughout the world.

Acknowledgements

I am grateful to Tom Blackburn, Michael Glassow, Paul Goldstein, John Hildebrand, John Johnson, Chester King, Pat Lambert, Michael Moseley, Phil Rundel, Glenn Russell, Phil Walker, and David Yesner for providing references and sharing their knowledge on this topic. I also want to thank Jon Erlandson, Patricia Knobloch, Pat Lambert, Glenn Russell, and an anonymous reviewer who made constructive comments on earlier drafts of this paper. Thanks are also due to Seetha Reddy who invited me to participate in a symposium entitled 'Stability, Change and Cultural Adaptations along the California Coast' at the 68th Annual Meeting of the Society for American Archaeology in 2003 where I presented an early version of this paper. I especially am indebted to Jeff Parsons and Walt Koenig who provided insight on the intricacies of climate change and references on the subject. I also want to acknowledge Naomi King who helped format the references and Lori Palmer who drafted the map in Figure 1. Finally, I thank Peter Rowley-Conwy and Michael Shott for inviting me to submit a paper to *World Archaeology* and for overseeing the publication process.

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