CLIMATE CHANGE

Drowned trees record dry spells

F. Alayne Street-Perrott

VIKING farmsteads in Greenland fjords, sunny vineyards in central England and flourishing fields of wheat and barley in south Iceland: these are some of the images conjured up by the Mediaeval Warm Epoch, as described by H. H. Lamb in *Climate, History and the Modern World*[1]. This period, from the tenth to the early fourteenth centuries, saw a great expansion of European civilization, in the context of persistently fine summers, matched only by the warm years of the late twentieth century. Not surprisingly, it has frequently attracted attention from climate historians as a possible analogue for the impact of future greenhouse warming[2]. Doubts remain, however, about the magnitude and geographical extent of mediaeval warming, especially in view of the skimpiness, ambiguity and anecdotal character of the existing documentary record, much of it in the form of Norse sagas or early monastic records[1,3].

S. Stine

'Graveyard' of pine stumps along the West Walker River, testament to ancient droughts.

The case for global significance is strengthened by new scientific evidence presented by Scott Stine on page 546 of this issue[4]. Like the one in the photograph shown here, many lakes, swamps and rivers in California are bordered by drowned tree stumps, indicating that lower water levels in the past had been succeeded by flooding. What Stine does is to make a radiocarbon assay of the outer (youngest) tree rings in order to date the time of inundation, and convert these ages to calendar years using the latest correction curve for radiocarbon dates[5]. He then determines the duration of the preceding dry interval by counting the rings in the interior of each stump.

The samples fall into two clearly separated groups, recording sustained droughts in the approximate intervals AD 892 to 1112 and AD 1209 to 1350; Stine's approach does not resolve interannual or decadal fluctuations within these intervals. To judge from how far the water levels dropped, the droughts were of far greater severity and duration than even the 'Dust Bowl' period between 1928 and 1934, or the recent Californian drought of 1987 to 1992. The existence of two discrete drought episodes, separated by a very wet interval, is in line with the evidence for a significant cold snap in northern Fennoscandia during the early twelfth century[3].

The four Californian sites are all vulnerable to variations in winter precipitation from Pacific storms travelling in the midlatitude westerlies. Drought in this area is most readily attributable either to a poleward contraction of the northern circumpolar vortex, or to a shift in the upper ridge–trough pattern over North America. An overlapping group of dates from two lakes in the lee of the Patagonian Andes, where a poleward shift in the main axis of the westerlies would tend to cause drought by intensifying the rainshadow effect, leads Stine to argue that the 'mediaeval' droughts involved a simultaneous contraction and/or a change in the wave pattern of the polar vortices in both hemispheres. A noteworthy effect of a change in the number or amplitude of the upper waves would be to cause climatic anomalies of opposite sign in different regions.

Stine's work provides welcome and all too rare experimental evidence for hydrological changes, which receive much less attention than temperature changes. And it serves as a salutary reminder that decadal to centennial variations in climate involve variables other than temperature[6]. The tenth to fourteenth centuries saw dramatic changes in the civilizations of the Americas, which have been attributed by some archaeologists to fluctuations in rainfall — for example, the collapse of Tiwanaku, the highest urban centre in the New World, between AD 1000 and 1100 (ref. 7); the brief florescence of Tula, in semi-arid Mexico, between AD 950 and 1150 (ref. 8); and the dramatic decline of the Anasazi cliff-dwellers in the American southwest around AD 1300 (ref. 9).

Nor was the New World the only area outside Europe to be affected by fluctuations in rainfall during mediaeval times. For example, widespread desiccation of lakes in East China occurred between AD 950 and 1250 (ref. 10). Close scrutiny of the exceptionally detailed historical records from different parts of China, however, confirms that secular variations in precipitation were complex, time-transgressive and of opposite sign in different regions[10–12]. Detailed, year-by-year mapping is essential if the underlying changes in atmospheric circulation are to be elucidated.

Five main causes of decadal to century-scale climatic variability are commonly identified[13,14]: random atmospheric variability; inherent or forced variations in the production rate of North Atlantic Deep Water; solar variability; variations in volcanic aerosols; and natural changes in the concentration of atmospheric trace gases. Whereas the last three have received considerable attention as part of the effort to predict future climate, our present lack of understanding of the natural variability of the atmospheric and oceanic circulations is a matter for serious concern. A detailed survey of the magnitude and distribution of climatic anomalies during historical warm and cold periods would be an invaluable step in this direction. □

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