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Dec 18th 2003 | SAN FRANCISCO
 From The Economist print edition



Bridgeman

Natural climate change may have started civilisation. And the spread of farming may have caused as much global warming as industry is causing now

PEOPLE, like most animals, are naturally lazy. So the ascent of mankind is something of a mystery. Humans who make their livings hunting and gathering in the traditional way do not have to put much effort into it. Farmers who rely on rain to water their crops work significantly harder, and lead shorter and healthier lives. But the real back-breaking, health-destroying labour is that carried out by farmers who use irrigation. Yet it was the invention of irrigation, at first sight so detrimental to its practitioners, that actually produced a sufficient surplus to feed the priests, politicians, scholars, artists and so on whose activities are collectively thought of as "civilisation".

Given all the extra effort involved, why people first bothered to plant crops, and more particularly why they then went on to plant them near rivers running through deserts—with all the attendant canal-digging that required—is a puzzling question. But some light was shed on it at a recent meeting of the American Geophysical Union, in San Francisco. It may all, it seems, be down to climate change.

Necessity and invention

In the past 10,000 years, the world's climate has become temporarily colder and drier on several occasions. The first of these, known as the Younger Dryas, after a tundra-loving plant that thrived during it, occurred at the same time as the beginning of agriculture in northern Mesopotamia, in land now controlled by Turkey, Iraq and Syria. It is widely believed by students of the field that this was not a coincidence. The drying and cooling of the Younger Dryas adversely affected the food supply of hunter-gatherers. That would have created an incentive for agriculture to spread

once some bright spark invented it.

Why farmers then moved on to irrigation is, however, far from clear. But Harvey Weiss, of Yale University, thinks he knows, and he outlined his ideas to the meeting.

Dr Weiss observes that the development of irrigation coincides with a second cool, dry period, some 8,200 years ago. His analysis of rainfall patterns in the area suggests that rainfall in agriculture's upper-Mesopotamian heartland would, at this time, have fallen below the level needed to sustain farming reliably. Farmers would thus have been forced out of the area in search of other opportunities.

Once again, an innovative spark was required. But it clearly occurred to some of these displaced farmers that the slow-moving waters of the lower Tigris and Euphrates, near sea level, could be diverted using canals and used to water crops. And the rest, as the cliché has it, is history.

Even irrigated civilisations are not, however, immune from climate change. One of Dr Weiss's former students, Sarah Parcak, of Cambridge University, presented data to the meeting on how a third period of cooling and drying, 4,200 years ago, destroyed the Old Kingdom of Egypt.

Ms Parcak re-analysed a number of satellite photographs to produce a comprehensive survey of "tells" in part of the Nile delta. A tell is a mound that marks the site of an ancient settlement (it is the result of debris from human activity in the settlement building up over the years). Her analysis located 44 previously unidentified tells, which she then dated from shards of pottery she picked up there. Adding her data to that from known and studied tells, she was able to tell, as it were, the story of the Old Kingdom's demise, and its connection with climate change.

Though Egyptian agriculture was (and still is) based on irrigation, the flow of the Nile is controlled ultimately by rainfall patterns at its headwaters. Ms Parcak found a precise correlation between settlement patterns in her study area and climate change. The population shrank drastically as the global climate cooled. Some 27 sites were occupied before this happened. That dropped to four after the change.

Of course, rain-fed agriculture is even more vulnerable to climate change than the irrigated variety, as Ms Parcak's Cambridge colleague Lauren Ristvet showed the conference with her study of northern Syria during the same period as the fall of Egypt's Old Kingdom. Like Ms Parcak, she identified sites from satellite photographs and then dated them by visiting them. She then correlated the data from these visits with estimates of local rainfall made by examining the composition of rocks from nearby caves. These suggested that rainfall had fallen by 20-30% in the global cooling 4,200 years ago. That may not sound disastrous, but it would have been enough to make farming in the area unviable.

The evidence on the ground suggests that this is exactly what happened. Agricultural villages disappeared, to be replaced by the temporary camps of pastoralists, whose herds grazed on wild plants which required less rainfall than farmed crops. It is not surprising, then, that this hitherto unobserved demographic change coincides with the collapse of the Akkadian empire, which controlled the area until 4,200 years ago.

Change and decay

So climate change helped to intensify agriculture, and thus start civilisation. But an equally intriguing idea put forward at the meeting is that the spread of agriculture caused climate change.

In this case, the presumed culprit is forest clearance. Most of the land cultivated by early farmers in the Middle East, Europe and southern China would have been forested. When the trees that grew there were cleared, the carbon they contained ended up in the atmosphere as carbon dioxide, a greenhouse gas. Moreover, one form of farming—the cultivation of rice in waterlogged fields—generates methane, another greenhouse gas, in large quantities. William Ruddiman, of the University of Virginia, explained to delegates his theory that, in combination, these two phenomena had warmed the atmosphere prior to the start of the industrial era by as much as all the greenhouse gases emitted since.

Dr Ruddiman's hypothesis is grounded on recent deviations from the regular climatic pattern of the past 400,000 years. This pattern is controlled by what are known as the Milankovitch cycles, which are in turn caused by periodic changes in the Earth's orbit and angle of tilt toward the sun. One effect of the Milankovitch cycles is to cause regular and predictable changes in the atmospheric concentrations of carbon dioxide and methane. These changes can be followed by studying ice cores taken in Antarctica.

According to Dr Ruddiman, the changes seen in the cores are as regular as clockwork until about 8,000 years ago. At that time carbon dioxide levels begin to rise at a point when they ought to start falling. About 5,000 years ago there is another upward deviation, this time in methane levels. The former, he contends, coincides with the beginning of extensive deforestation associated with the spread of agriculture into Europe and China. The latter coincides with the invention of "wet rice" farming. In combination, he calculates, these upward deviations make the atmosphere about 0.8°C warmer than it would otherwise be at this point in the Milankovitch cycles, independently of any greenhouse warming caused by industrialisation. That has been enough to keep parts of Canada that would otherwise be covered in glaciers, ice-free.

Of course, this is a difficult hypothesis to test. But Dr Ruddiman does have a test of sorts. Three times in the past 2,000 years, there have been periods of cooling (most recently, the "little ice age" of the 17th and 18th centuries). These, he notes, followed the three largest known periods of plague, when the human population shrank in various parts of the world. The first period was a series of plagues that racked the Roman empire from the third to the sixth centuries. The second was the Black Death and its aftermath. The third was the epidemic of smallpox and other diseases that reduced the population of the Americas from some 50m to about 5m in the centuries after Europeans arrived, and which coincided with the little ice age. In each case, a lot of previously farmed land turned back into forest, sucking carbon dioxide out of the atmosphere and cooling the climate. As environmentalists are wont to observe, mankind is part of nature. These observations show just how intimate the relationship is.

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