**Anticipating Societal Collapse; Hints From the Stone Age**
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-research suggests that prehistoric societies demonstrated reduced resilience just prior to collapse
-while the nature of human societies has changed significantly since earlier times our modern forms may likewise exhibit similar signals
-there do exist parallels between collapsing societies to draw upon

-archaeological evidence suggests that the Puebloan society of the Mesa Verde region (circa 800-850 years BP) experienced growing societal stress due to a century of drought, political turmoil, and violence that led people to amass in a relatively productive agricultural area
-this movement strained the region's carrying capacity and sociocultural traditions leading to growing conflicts
-even prior to the Great Drought (that may have been the final straw for the society) a growing number of settlements were being abandoned
-certain happenings in modern-day Syria echo the Puebloan story as one of the greatest droughts in almost 1000 years has made subsistence farming almost impossible and led to massive migration into cities where cultural clashes are on the rise
-demographic collapse has been documented in the resource-challenged societies of Easter Island and the 15th century Greenland Norse

-a common thread tends to be the speed with which change occurs
-while extreme events (e.g., epidemic, rapid drought) cannot be reasonably foreseen, a gradual loss of resilience that creates fragility might be predictable and signal a need to prepare
-while risk factors have traditionally included social, political, and economic factors, new research is suggesting "that the risk of societal collapse might also be measured directly from observed dynamics that signal a loss of resilience." (p. 10734)
-systems theory proposes that subtle changes in a complex system's dynamics as it approaches a tipping point may suggest a loss of resilience
-complex systems experience natural fluctuations in their conditions with recovery from small perturbations occurring relatively quickly when their resilience is high; this recovery, however, slows considerably when systems resilience is low (see Figure 1)
-when resilience is low and near a tipping point, the possibility of "an avalanche of self-propelling change" increases
-slowing resilience prior to a tipping point has been found for a number of systems (i.e., population, climate, ecological)
-this research suggested that a societal shift/tipping point may be forewarned by a measurable loss of resilience

-Downey et al (2016) argue that they found evidence of this signalling about 8000 years BP

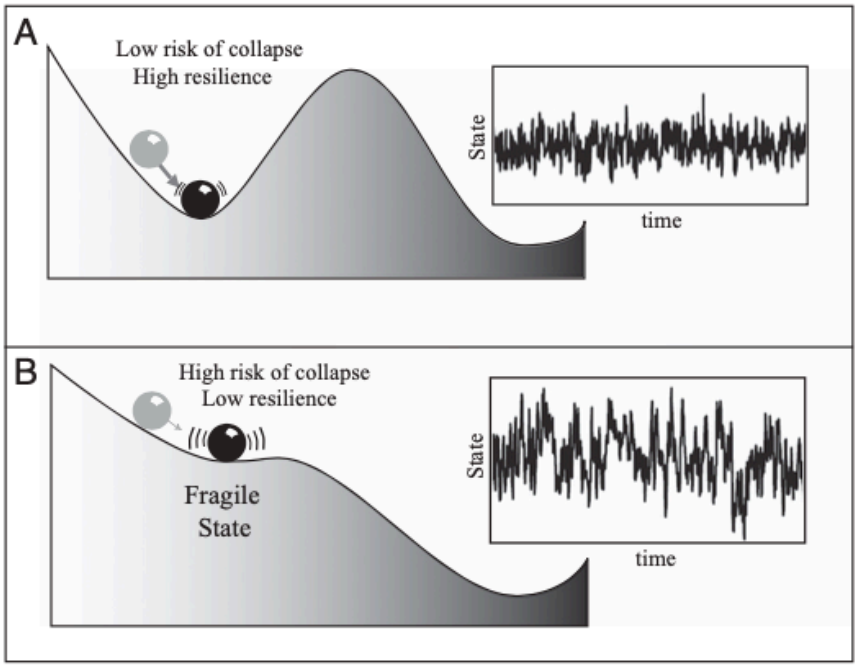


**Fig. 1. Indicators of the loss of resilience in the vicinity of a tipping point. (*A*) Far from a tipping point, the state of the system (the ball) is resilient: the basin of attraction is large and perturbations will not easily drive the system toward an alternative state. (*B*) If a system is close to a tipping point the basin of attraction will be small, and a perturbation may easily push the system into an alternative basin. Note that the actual state of the system by itself does not reveal such fragility. However, dynamics around the equilibrium differ from those when the basin of attraction is large (as in *A*). In the fragile state (*B*), the recovery rate from a small perturbation is smaller (arrow), and as a result the fluctuations in a stochastic environment will tend to be larger and more time-correlated, as shown in the *Insets* (modified from refs. 22 and 23).**

-agricultural societies that originated in the Tigris-Euphrates region spread east and west replacing foraging societies
-the populations of these societies did not show a steady increase but aggressive growth followed by collapse with the densities just prior to collapse exhibiting rising variance and temporal correlation, suggesting declining resilience
-while overexploited lands and deforestation may have played a role in the collapse of these farming communities, there was evidence of 400-1000 year boom-bust cycles
-a similar cycle was found after colonisation in South America

-one interpretation of this is that it reflects a classic user-resource cycle but one would think a society would notice the decline of conditions and move or shift strategies prior to collapse
-some suggest that societies resist change until it is too late for a smooth transition
-this would be due to: the ‘sunk-cost effect’ where people refuse to abandon property or beliefs; the ‘bystander effect’ where others’ behaviour is copied when in doubt; vested interests/elite fight to maintain status quo arrangements
-these mechanisms that prevent change likely become stronger the more complex a society becomes and systems become more elaborate

-while it would be easy to suggest that a society could avoid collapse by adapting in time, it might be that this is made much more difficult–if not impossible–if a gradual loss of resilience ensures it
-if this is so, systems science may be able to scan for resilience indicators