

COMPLEXITY, COLLAPSE, AND SUSTAINABLE PROBLEM-SOLVING

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Summary

Sustainability is a value-laden concept that provokes veneration, confusion, and political conflict. Human sustainability arises from the long-term success of problem-solving institutions. One constraint to sustainability is the tendency of problem-solving to grow complex, costly, and cumbersome. This chapter describes several unsustainable societies; sketches an understanding of sustainability that addresses its value-laden and transient nature; shows how sustainability is grounded in problem-solving; demonstrates through historical cases how long-term trends in problem-solving lead either to sustainability or collapse; and employs these historical lessons to clarify our own problem-solving efforts.

1. The Dilemma of Sustainability

Sustainability is a human dilemma. Ecosystems cannot care whether they degrade, lose species, or leak nutrients, yet we fight costly political battles over just such things. To sustain nature we sometimes erect systems of management so cumbersome that the management effort itself is unsustainable. Basic terms like “sustainability” and “degradation” have quite different meanings. Many argue that the idea is relative, value-laden, and irretrievably vague. It is no surprise that sustainability evokes such a mixture of veneration, opposition, and confusion.

In the absence of clear definitions and limiting conditions, sustainability is a concept that carries myriad social, political, personal, or even commercial meanings that we project upon it. Today we can buy wood from sustainably-managed forests. Tomorrow, no doubt, we will be offered such trivialities as sustainably-produced toothpaste. The concept sags under the many purposes we ask of it. As long as this condition persists, politicians can endorse sustainability as a concept while denying that it calls for concrete action, or define the terms of the sustainability debate as consumption and employment *vs.* sacrifice and unemployment. It is necessary to be intellectually rigorous about sustainability and life support.

Confusing matters further, *unsustainability* is beyond most people’s experience. We are, after all, the most successful of mammalian species. It is a paradox to predict that our present way of life may prove unsustainable, for we can make such a prediction only as a function of today’s knowledge and values. Kenneth Boulding once noted that all predictions are that nothing changes. His point was not that literally nothing changes—else why predict?—but that predictions always proceed on the assumption that the constraints that govern conditions today will do so for the duration of the prediction. So it is with a prediction that our way of life is either sustainable or otherwise. We assume, in such a prediction, that nothing in our way of life changes. Technological optimists dismiss predictions of unsustainability by reference to cases where human ingenuity has overcome constraints. Optimism in turn must be tempered by the many examples of societies that in the past proved to be unsustainable—that dramatically collapsed notwithstanding the ingenuity of their people. We have little immediate experience of unsustainability, but, as discussed below, we know that past people did experience it, and this suggests that it can happen again.

In industrialized nations, concern for sustainability goes beyond the immediacy of life-support systems. These nations have the privilege to debate the merits of preserving

aesthetic landscapes, or mature forests, or other things that contribute to emotional rather than economic or physical needs. Such concerns generate deep, polarizing conflict that extends to expensive litigation and ramifies throughout national politics. The money spent in industrial nations on environmental *debates* would pay many fundamental expenses in poorer nations.

This chapter addresses such dilemmas. It has five purposes: (a) to illustrate unsustainability in history; (b) to sketch an understanding of sustainability that both clarifies and addresses its relative and value-laden nature; (c) to show that sustainability or collapse is fundamentally grounded in the success or failure of problem-solving institutions; (d) to develop an understanding, through historical cases, of how problem-solving institutions come in the long-run to succeed or fail; and (e) based on these points, to clarify the status and future of our efforts to sustain life-support systems as well as the other things that we need or value.

2. Unsustainability: Historical Collapses

Collapse has been universal and recurrent, which the following cases have been selected to illustrate. Later in this chapter, I discuss cases of collapse that provide lessons for today, including the Third Dynasty of Ur, the Abbasid Caliphate, and the Western Roman Empire.

2.1. The Western Chou Dynasty

China's first historical dynasty, the Shang (c.1766–1122 BC), ran a well-integrated empire. Yet they were defeated at the climactic battle of Mu-yeh, and the Western Chou Dynasty (ca. 1122–771 BC) succeeded to the rule of China. The Chou campaigned to expand their empire to the east and south. They achieved some success, and established an eastern administrative center at Loyang. The Western Chou also fought frequently with northern nomadic peoples. Yet, within a few centuries their power started to decline. The royal house began to lose authority as early as the tenth century BC, and by the ninth century their expansion may have stopped. They were weakened by the wars with the nomads, and by the burden of sustaining large defensive forces. Rebellions challenged Chou expansion in the south. The numbers of state officials continuously grew. In the later Western Chou there may have been widespread population decline. The penultimate ruler, King Hsüan (827–782 BC), planned a census, but the royal advisor pointed out that if it showed the population to have declined, the royal court would lose the respect of its vassals.

In their waning years, the Western Chou faced a number of concurrent problems: drought and famine, perhaps earthquakes, injustice and incompetent administration, encroachment of nomads, loss of population, vagrancy, and general disintegration of the social order. Finally an allied force of several northern Jung groups invaded the district of the capital city, Hao. In 771 BC the last Western Chou ruler, King Yu, was killed and the city sacked.

China disintegrated with this event. During the period of the Eastern Chou dynasty (770–256 BC) the complex government and territorial unity of the Western Chou were

gone. The collapse of the Western Chou dynasty marked the end of Chinese unity and the beginning of protracted fragmentation. Over 500 years of conflict followed. Later Chinese looked back on the Western Chou period as a golden age.

2.2. Old Kingdom Egypt

Old Kingdom Egypt (2686–2181 BC) was a centralized state headed by a king with qualified supernatural authority. The government was run by a highly-organized, literate bureaucracy. Initially, the government had substantial income from crown lands and mobilized large labor forces. It virtually monopolized some essential materials and imported luxuries. The government undertook to increase productive capabilities, expand the frontiers, and maintain supernatural relations.

The Old Kingdom experienced some of the problems encountered later by the Western Chou. The provinces showed strong feudal characteristics. The political authority of the king declined as the power of provincial rulers and the wealth of the administrative nobility rose. Royal finances were weakened as crown lands were divided. Monuments were built at royal expense and tax-exempt funerary endowments established. Pharaohs, the last ruler of the Sixth dynasty, built a splendid tomb in the face of sharply declining royal power.

In 2181 BC the Sixth Dynasty ended and the Old Kingdom collapsed. What followed is sometimes referred to as the Egyptian Dark Age. In the First Intermediate Period, national unity was disrupted, and several independent and semi-independent statelets emerged. There were many rulers and generally short reigns.

The collapse generated a pessimistic literature, which reveals a breakdown of order and disregard for law. There were conflicts between districts and foreign incursions into the Nile delta. Anarchy and revolutions led to looting, killing, and plundering of royal tombs. Royal women were clothed in rags and officials suffered insults. Foreign trade dropped. Peasants carried shields as they tilled their fields. There were recurrent famines and life expectancy declined.

With the Eleventh Dynasty, beginning in 2131 BC, the Middle Kingdom was established. Order and unity began to be restored. Yet it was not until about 1870 BC that local and regional independence were totally suppressed, and Egypt fully reunited.

2.3 The Hittite Empire

The Hittites are a little-known people of Anatolia. Their political history begins about 1792 BC with the conquests of Anitta. The building of the Hittite Empire was an uncertain affair, but the Hittite position was cemented by their great ruler, Shuppiluliumash, who came to the throne ca.1380 BC. During this and successive reigns the empire was established firmly in Anatolia and Syria. The Hittites successfully challenged Egypt for domination of Syria, concluding a treaty with Rameses in 1284 BC.

In the early thirteenth century BC, the Hittites and Egypt were the premier powers in the region. The Hittite empire included most of Anatolia, Syria, and Cyprus. Yet, with the exception of Egypt, they encountered troubles in nearly all directions, including the Assyrians to the southeast, the Kaska to the east, and little-known peoples in western Asia Minor and Cyprus. Their written records decline toward the end of the thirteenth century BC, then finally cease.

With the collapse of the Hittite empire there were major but little understood catastrophes across the region. Excavated sites in Anatolia and Syria are consistently found to have burned about this time. In the central Anatolian plateau, life was disrupted for a century or more after 1204 BC. There were no urban settlements. A major demographic decline came with the political collapse. It seems that the area was thinly populated, or used by nomads.

2.4. Mycenaean Greece

Mycenaean society can be distinguished archaeologically by about 1650 BC. It was characterized throughout central Greece by homogeneity in art, architecture, and political organization. The region was divided among a number of independent polities, each centered on a fortified palace/citadel complex, and headed by a single ruler. Mycenaean palaces served as political and economic centers, and much of the Linear B writing (an early form of Greek script) was devoted to accounting. Mycenaean administration was particularly complex. All classes of persons had strictly allotted roles. All raw materials and manufactured goods, people, and animals were meticulously scrutinized and recorded.

Mycenaean art and architecture are widely admired. The palaces had frescoes and bathrooms. Artisans produced carved gemstones, metalwork, pottery, inlay, and items of ivory, glass, and faience. Roads and aqueducts were built, and Mycenaean wares were traded about the Mediterranean.

Around 1200 BC troubles began. Most of the palaces were destroyed. In the following century, there was instability, repeated destruction of political centers, and population movement. Fortifications were built across the Isthmus of Corinth and elsewhere. At the citadels of Mycenae, Tiryns, and Athens, wells were cut at great labor through solid rock. Uniform Mycenaean pottery gave way to local styles. Metalwork became simpler. There is no further trace of the crafts workers and artisans. Trade declined sharply. Writing disappeared from Greece for at least 450 years.

The number of settlements declined precipitously. While there seems to have been some movement of people to less troubled areas, there was still population decline of 75 to 90 percent. Even areas that escaped devastation, such as Athens, ultimately experienced political collapse. After the initial round of catastrophes there was a period of stability and rebuilding, but, by 1050 BC, what was left of Mycenaean society was gone.

2.5. The Classic Maya Collapse

The Lowland Classic Maya have long been puzzling. They were one of the few early complex societies that did not develop in semi-arid conditions, and they underwent a rapid, dramatic, and justly famous collapse between about AD 790 and 890.

The tropical rainforest of the southern Lowlands had been extensively cleared and planted by the first centuries AD. Intensive agricultural systems and hydraulic engineering efforts were under way. There were major fortifications, formal public architecture, and social differentiation. Public architecture became truly monumental, and the site of Tikal emerged as a major center.

Throughout the Classic era (ca. 250–1000 AD), these patterns intensified. There was continued growth in population, agricultural development, sociopolitical complexity, architectural elaboration, and conflict. Classic monuments and art styles reached their maximum extent in the sixth century. Major centers emerged which may have been regional capitals.

These trends culminated in the Late Classic (ca. 600–800 AD). There was homogeneity across the southern Lowlands in the style and iconography of monuments. A standardized lunar calendar, the most accurate of its time, was adopted throughout the region within a ten-year period.

Major Mayan sites, once thought to have been vacant ceremonial centers, are now known to have been cities. Tikal held a population of perhaps 49 000, with defensive earthworks and moats up to 9.5 kilometers to a side. Ancient Sumerian cities may also have held about as many people.

At its height, the Lowlands population averaged about 200 persons per square kilometer, which made it one of the most densely populated areas for a non-industrial society. Late Classic populations were approaching an upper limit, for population peaked, in various localities, between the sixth and ninth centuries AD. Across the southern Lowlands, 60 percent of all dated monuments were built in a period of 69 years, between AD 687 and 756. An expanded building program thus had to be supported by a static population, many of whom appear, from their skeletal remains, to have been in poor health.

The Maya collapse was rapid. In AD 790, nineteen centers erected dated monuments. In 810, twelve did so. In 830 there were three. AD 889 is the date of the last certain stela with full calendrical inscriptions. There is no evidence for construction at Tikal after 830. Power decentralized during the collapse, and new centers proliferated along the peripheries of the central southern Lowlands.

With the collapse, many aspects of social complexity were lost: administrative and residential structures, building and maintaining temples, stela carving, manufacture of luxury items, and Classic calendrical and writing systems. The elite class for which these things were created, ceased to exist. The most startling aspect of the collapse is an

enormous loss of population. Estimates range from a decline of one million in a century, to a loss of 2.5 million over 75 years. Either scenario indicates a demographic disaster.

2.6. Teotihuacán and the Valley of Mexico

Teotihuacán was the largest native city in the New World (and in AD 600 the sixth largest in the world), with a population of roughly 125 000. Its central feature, the Street of the Dead, holds over two kilometers of monuments. There are more than 75 temples, including the pyramids of the Sun and the Moon. The former is the largest structure in pre-Columbian America, measuring 210 meters along each axis and 64 meters high. It holds an estimated 1 million cubic meters of material. The city contained more than 2000 residential compounds, and hundreds of craft workshops in obsidian, pottery, jade, onyx, and shell. There were hundreds of painted murals. Networks of drains carried off rainwater.

Teotihuacán exerted compelling influence throughout Mesoamerica. Its leaders could mobilize labor at unprecedented levels. The population and resources of the Valley of Mexico and beyond were thoroughly reorganized. Exotic materials were imported from locations up to hundreds of kilometers distant. Tens of thousands of people were relocated to Teotihuacán and its vicinity. For 600 years or more, 85 to 90 percent of the population of the eastern and northern Valley of Mexico lived in or near the city.

In Teotihuacán's later phase, military themes became prominent in art. The flow of some goods into the city was reduced. Around AD 700 Teotihuacán abruptly collapsed. The political and ceremonial center of the city, the Street of the Dead and its monuments, was systematically burned. In Mesoamerica, such an act signified defeat and subjugation. The population dropped within 50 years to no more than one-fourth of its peak level. This remnant population sealed off doorways, and partitioned large rooms into smaller ones. In its emptiness, post-collapse Teotihuacán must have resembled medieval Rome. Population declined also in the rural areas of the Basin of Mexico, from perhaps 250 000 to around 175 000. A period of political fragmentation lasted for centuries.

2.7. Monte Alban and the Valley of Oaxaca

Monte Alban, in the Oaxaca Valley south of the Basin of Mexico, was a political center roughly coeval with Teotihuacán. The city and its walls were built on a mountaintop, a large section of which was leveled to build a community and an arena of public architecture. The city contained pyramids, temples, ballcourts, stelae, and frescoes. There was craft production in obsidian, shell, and other commodities. Monte Alban was the political center of Oaxaca, and experienced its major growth between AD 600 and 700. Its collapse came at roughly the same time as that of Teotihuacán, and the two events were probably connected.

The collapse of Monte Alban came after a period of rapid regional population growth. At the collapse the population of the city itself dropped from about 30 000 persons to between 4000 and 8000. Its role as a major administrative center was over by AD 700.

2.8. Huari and Tiwanaku

Between 200 BC and 700 AD Peruvian societies developed extensive irrigation systems and agricultural terracing, in conjunction with a growing population. Cities were built which were the capitals of regional states. These shared a heritage of technology and common ideology, but were divided by local art styles, separate governments, and competition for land and food. Out of this competitive background two polities emerged: Huari in the north and Tiwanaku in the south. Huari is the better known.

The Huari Empire dominated almost the entire central Andes and much of the adjacent coastal lowlands. The empire imposed economic, social, and cultural changes on the areas it dominated. Major urban centers were established in each valley. Goods and information were exchanged across the central Andes on an unprecedented scale.

Much of the high-altitude (3800m.) Lake Titicaca Basin, where the city of Tiwanaku is located, was transformed under central management into an artificial agricultural landscape. There were massive public reclamation and construction projects, which required large, coordinated labor forces. The basin contains at least 190 square kilometers of raised agricultural fields. Tiwanaku itself may have held between 20 000 and 40 000 persons, and below it were smaller cities and tertiary settlements.

Both states collapsed ca. AD 1000–1100. In the Lake Titicaca Basin the Tiwanaku collapse brought political decentralization and simplification. The fall of Huari had widespread consequences. All cities of the southern highlands were abandoned and their populations returned to the countryside. The north Peruvian coast was apparently depopulated. As with the collapses of Rome, the Western Chou, Teotihuacán, and Monte Alban, the fall of Huari brought an era of smaller, contending states.

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Biographical Sketch

Joseph Tainter studied anthropology at the University of California and Northwestern University, where he received his Ph.D. in 1975. He has taught at the University of New Mexico and currently directs the Cultural Heritage Research Project, Rocky Mountain Research Station, Albuquerque, New Mexico. Research on the evolution of sociocultural complexity led to the publication of his book *The Collapse of Complex Societies* (1988). In addition to authoring many articles and monographs, he is co-editor of the books *Evolving Complexity and Environmental Risk in the Prehistoric Southwest* (1996) and *The Way The Wind Blows: Climate, History, and Human Action* (2000). Dr. Tainter's work has been used in the United Nations Environment Programme (Kenya), the European Joint Commission and the National Nutrition Institute (Italy), the Beijer Institute (Sweden), the Center for International Forestry Research (Indonesia), as well as throughout the United States and Canada. He has been invited to present his research to the Getty Center for the History of Art and the Humanities and the International Society for Ecological Economics. Dr. Tainter's biography is included in *Who's Who in Science and Engineering*, *Who's Who in America*, and *Who's Who in the World*.