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Climate, Complexity, and Problem Solving in the Roman Empire

Joseph Tainter

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Human history, as written traditionally, leaves out the important ecological and climate context of historical events. But the capability to integrate the history of human beings with the natural history of the Earth now exists, and we are finding that human–environmental systems are intimately linked in ways we are only beginning to appreciate. In *Sustainability or Collapse?* researchers from a range of scholarly disciplines develop an integrated human and environmental history over millennial, centennial, and decadal time scales and make projections for the future. The contributors focus on the human–environment interactions that have shaped historical forces since ancient times and discuss such key methodological issues as data quality. Topics highlighted include the political ecology of the Mayans; the effect of climate on the Roman Empire; the “revolutionary weather” of El Niño from 1788 to 1795; twentieth-century social, economic, and political forces in environmental change; scenarios for the future; and the accuracy of such past forecasts as *The Limits to Growth*.

ROBERT COSTANZA is Gordon Gund Professor of Ecological Economics and Director of the Gund Institute for Ecological Economics at the Rubenstein School of Environment and Natural Resources at the University of Vermont.

LISA J. GRAUMLICH is Executive Director of the Big Sky Institute for Science and Natural History and Professor of Land Resources and Environmental Sciences at Montana State University.

WILL STEFFEN is Director of the Centre for Resource and Environmental Studies and Director of the ANU Institute of Environmental at the Australian National University and Chief Scientist at the International Geosphere-Biosphere Programme, Stockholm.

“Costanza, Graumlich, and Steffen have assembled an amazing group of scholars from the bio-physical and social sciences and the humanities, together, they take a long look back or as to what the future holds forward. ‘The resulting book promises the first consideration of what promises to develop into a natural study of human-environment interactions routine for a complex and dynamic system. We can perhaps grudgingly from this standpoint, while vaguely aware, seem to come.’”

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Climate, Complexity, and Problem Solving in the Roman Empire

Joseph A. Tainter and Carole L. Crumley

1Global Institute of Sustainability and School of Human Evolution and Social Change, Arizona State University, Tempe, AZ 85287, U.S.A.
2Department of Anthropology, University of North Carolina, Chapel Hill, NC 27514, U.S.A.

ABSTRACT

The Roman Empire was established in northwestern Europe in the last two centuries B.C. and the first century A.D. during a warm, dry era known as the Roman Warm Period or the Roman Climatic Optimum. In northwestern Europe the Romans disrupted earlier systems of production, exchange, and political relations to establish Mediterranean production systems oriented toward markets and government revenues. Being based on solar energy, the Empire as a whole ran on a very thin fiscal margin. The end of the Roman Warm Period would have introduced uncertainty into agricultural yields just as the Empire was experiencing a concatenation of crises during the third century A.D. The Roman response to these crises was to increase the complexity and costliness of the government and army, and to increase taxes to pay for the new expenditures. This undermined the well-being of the population of peasant agriculturalists, leading to a reduction in the government’s ability to address continuing problems. The Western Roman Empire collapsed while in the process of consuming its capital resources: productive land and peasant population. The experience of the Roman Empire has implications for the IHOPE project, and for problem solving in general, in two areas: (a) the relationship of hierarchy to heterarchy, and local to global, in addressing environmental and social problems, and (b) the development of complexity, costliness, and ineffectiveness in problem solving.

INTRODUCTION

The Roman Empire has been studied for centuries by those who see in it lessons for their own time. We are among those who perceive in the Empire a case study whose value is timeless. Where once the Roman Empire was studied to draw political or moral conclusions, we will show that it can yield fresh lessons in such contemporary
problems as climate change, government insolvency, the evolution of institutions, and the relationship of heterarchy and hierarchy in problem solving.

**OVERVIEW OF THE ROMAN EMPIRE**

For an agrarian empire activated by solar energy, the territory most efficiently administered would have been the Mediterranean Basin and fringing lands. This is because travel and transport by land was up to 56 times more costly than by sea (Jones 1964). As the Romans pushed into northwestern Europe and the interior of Anatolia, they conquered peoples who were less developed economically than those of the Mediterranean littoral, and at the same time incurred higher costs in administration. The cost of the Rhine garrisons, for example, may have equaled the tax revenues of Gaul north of Provence, leaving the central government with no net profit on the region (Drinkwater 1983, p. 65).

For an agrarian empire, the highest net returns are realized in the conquest phase, when the accumulated surpluses of the subject peoples are appropriated. These surpluses are the stored accumulation of past solar energy, transformed into the production of precious metals, works of art, and peasant populations. As have many empire-builders, Rome found her conquests initially to be highly profitable. In 167 B.C., for example, the Romans captured the Macedonian treasury, and promptly eliminated taxation of themselves. When Pergamon was annexed in 130 B.C. the state budget was doubled, from 25 million to 50 million denarii. (The denarius, discussed below, was a coin initially of very pure silver.) After he conquered Syria in 63 B.C., Pompey raised it to 85 million denarii. Julius Caesar relieved the Gauls of so much gold that its value in Rome fell 36 percent (Lévy 1967, pp. 62–65).

Once these accumulated surpluses are spent, the conqueror must assume responsibility to garrison, administer, and defend the province. These responsibilities may last centuries and are typically financed from yearly agricultural surpluses. The concentrated, high-quality resources available at conquest give way to resources derived from dispersed subsistence agriculture, which yields little surplus per capita (about 1/2 metric ton per hectare, and a yield of 3 to 4 times the seeding rate, in Roman and Medieval Europe [Smil 1994, pp. 66, 74]). Costs rise and benefits decline. When fresh problems arise, they must be met by taxing the populace, and if tax rates are insufficient they will likely be raised. Paying for continuity in such a system depends on establishing a bureaucracy to aggregate the small surpluses of individual producers. Empires can be supported in this way because, in an agrarian landscape, there are a lot of people to tax. Because of these constraints, imperial taxation systems tend to be elaborate and costly (Tainter et al. 2006).

Even the first emperor, Augustus (27 B.C.–A.D. 14), complained of fiscal shortfalls, and relieved the state budget from his own wealth. Facing war with Parthia and the cost of rebuilding Rome after the Great Fire, Nero (54–68) began
in A.D. 64 a policy that later emperors found irresistible. He debased the primary silver coin, the denarius, reducing the alloy from 98 to 93 percent silver (Figure 5.1). It was the first step down a slope that resulted two centuries later in a worthless currency and an insolvent government.

Figure 5.1 depicts an extraordinary data set. It is the only glimpse we have into the year-to-year fiscal status of an ancient government. Since 90% of government revenue came from agricultural taxes (Jones 1964), it is clear both that the government ran on a very thin margin in good times, and that over the long-run such a complex imperial system could be sustained on solar energy only if no crises emerged that would require extraordinary expenditures.

Crises, of course, are normal and inevitable. In the half-century from 235 to 284 a concatenation of crises nearly brought the Empire to an end. There were foreign and civil wars almost without interruption. The period witnessed 26 legitimate emperors and perhaps 50 usurpers. Cities were sacked and frontier provinces devastated. The Empire shrank in the 260s to Italy, the Balkans, and North Africa. By prodigious effort the Empire survived the crisis, but it emerged at the turn of the fourth century A.D. as a very different organization.

In response to the crises, the emperors Diocletian and Constantine, in the late third and early fourth centuries, designed a government that was larger, more complex, and more highly organized. They doubled the size of the army. To pay for this the government taxed its citizens more heavily, conscripted their labor, and dictated their occupations. Villages were responsible for the taxes on their

Figure 5.1  Debasement of the denarius to a.d. 269. Data from Cope (1969, 1974, and unpublished analyses on file in the British Museum); King (1982); LeGentilhomme (1962); Tyler (1975); and Walker (1976, 1977, 1978); see also Besly and Bland (1983, pp. 26–27) and Tainter (1994, p. 1217).
members, and one village could even be held liable for another. Despite several monetary reforms a stable currency could not be found (Figure 5.2). As masses of worthless coins were produced, prices rose higher and higher (Figure 5.3). Money-changers in the east would not convert imperial currency, and the government even refused to accept its own coins for payment of taxes.

With the rise in taxes, the population could not recover from plagues in the second and third centuries. There were chronic shortages of labor. Marginal lands went out of cultivation. Faced with taxes, peasants would abandon their lands and flee to the protection of a wealthy landowner. By A.D. 400 most of Gaul and Italy were owned by about 20 senatorial families.

From the late fourth century the peoples of central Europe could no longer be kept at bay. They forced their way into Roman lands in western Europe and North Africa. The government came to rely almost exclusively on troops from Germanic tribes. When finally they could not be paid, they overthrew the last emperor in Italy in 476 (Boak 1955; Russell 1958; Jones 1964, 1974; Hodgett 1972; MacMullen 1976; Wickham 1984; Williams 1985; Tainter 1988, 1994; Duncan-Jones 1990; Williams and Friell 1994; Harl 1996).

LOCAL EFFECTS: THE ROMAN EMPIRE IN GAUL

To bring this broad overview to a local level, we focus on Gaul, a part of the Roman Empire that both of us know well. Crumley directs a long-term project in Burgundy (e.g., Crumley and Marquardt 1987), while Tainter is preparing a synthesis of the Roman period in the lower Rhône Valley. Gaul figured prominently

![Figure 5.2](image-url)  Reductions in the weight of the follis, A.D. 296 to 348. Data from Van Meter (1991, p. 47).
in the political, military, and economic history of the Empire, not least because of its proximity to the Rhine frontier.

Gaul was important to the Empire’s economy and the government’s finances. About 15% of the army’s budget went to the Rhine garrisons (Drinkwater 1983, p. 65). While the Romans found Gaul productive, its agricultural output is variable. Over Burgundy, for example, three climatic regimes converge: the Atlantic (Greenland High), the Continental (Siberian High), and the Mediterranean (Azores High). These combine with terrain to produce a fourth climatic zone in central France, the Mountainous Zone over the Massif Central. The continental regime is characterized by summer dominant rainfall and cold, dry winters. The oceanic regime is cool and wet in the summer but mild and wet to dry in the autumn, when it receives most of its rain. The Mediterranean regime is hot and dry in the summer, receiving most of its rain in the winter (Crumley and Green 1987, pp. 28–32; Crumley 2003, pp. 141–142).

Between approximately 300 B.C. and A.D. 300, northwestern Europe experienced a prolonged period of warm and dry weather that is termed the Roman Warm Period or the Roman Climatic Optimum. The Azores high pressure system dominated much of western Europe during this period. The Mediterranean regime produced hot, dry summers and winter rains. The Romans expanded into southern Gaul in the second century B.C., and the remainder in the first. They brought with them Italian crops and production systems. Spatially diffuse Celtic systems of multiple-species agriculture and pastoralism gave way in many areas to intensive commercial production. It is in this period that we hear of grapes growing in southern Britain (Crumley 1993).

Figure 5.3  Denarii per modius of wheat in the early fourth century A.D. A modius was about nine liters. Data from Jones (1964, p. 119).
The end of this warm period is of interest (Denton and Karlén 1973; Gunn et al. 2004). Beginning in the second century A.D., ice rafting increased in the North Atlantic (Bond et al. 2001, p. 2131), signaling a transition in northwestern Europe toward conditions that were increasingly cool, moist, and variable. This change would have affected Italian-style agriculture practiced in northwestern Europe. As Crumley (2003, p. 142) has noted, “There would have been increasing instances of crop failure (due to late spring frosts and/or cool, damp summers characteristic of the temperate European pattern) and ruin at harvest (hailstorms) or upon storage (blight).”

The Romans had found in Gaul a mixed pattern of agriculture and husbandry that was tied to environmental variation. Diversity in production was linked to exchange systems and the institution of clientage. The system was flexible, appropriate to local conditions, and resilient. In many areas the Romans replaced native production systems with nonresilient, inflexible, cash cropping that was linked hierarchically to urban markets and the needs of the state. Outside of the Mediterranean zone for which it was developed, such a system lacked the productive flexibility that the changing climate required (Crumley 1987). As agricultural production became less certain, so did taxes.

In an area as large and diverse as the Roman Empire, many climatic regimes affected production, from the Greenland High to the rains of east-central Africa that feed the Nile. One might conclude that government revenues would hardly be affected by agricultural problems in only one region. Production elsewhere would compensate. But during the crisis of the third century A.D., the government’s fiscal status experienced a pronounced downturn. The precious-metal content of the silver currency began its final plunge, reaching a nadir of 1.5% in 269 (Cope 1969). The debasements (Figure 5.1) produced such inflation (Figure 5.3) that the government could no longer fulfill its procurement needs with money. Soldiers were particularly affected. Apparently their pay in coinage no longer sufficed to buy supplies. By the time of Diocletian (284–305) the state was so unable to rely on money that it collected taxes in the form of supplies usable directly by the government and the military. Soldiers now received much of their pay in supplies, and would for the next century. With transport costly, it was desirable to have these supplies produced near military bases.

Thus, by the late third century, local production mattered. If local production was inadequate, not only might soldiers not be paid, they might not have enough to eat. Discontent among the Rhine garrisons was to be avoided. For most staples, no doubt the government had back-up sources, and Roman officials would not hesitate to seize grain supplies even if peasants went hungry. Thus we should not overemphasize the local effects of climate change on the government’s ability to maintain the frontier. It was, rather, another of the multiple problems that the government faced at this time.

The crises of the third century affected Gaul profoundly. A raiding party of Franks crossed Gaul into Spain in 262, sacking Tarraco. There is a great increase
in Gallic coin hoards from 259/260 onward. Significantly, many hoards were never recovered. Some fine silver treasures were also buried at this time, including temple treasures. These surely would have been recovered had the depositor been able to do so (King 1990, p. 174; Watson 1999, pp. 33–34). The rural population declined, either killed or captured by barbarians, starving, or deserting their fields to join bands of brigands. Town populations fell also, sometimes to the size of the Celtic villages that preceded the Empire (Boak 1955, pp. 19, 26, 38–39, 55–56, 113; MacMullen 1976, pp. 18, 183; Rostovtzeff 1926, p. 424).

Vienne, for example, shrank from 200 to 20 hectares, Lyon from 160 to 20, and Autun from 200 to 10 (Randsborg 1991, p. 91). Paris contracted to the Île de la Cité (Williams 1985, p. 20).

Gaul north of Provence, along with Spain and Britain, broke away from the Roman Empire in 260 and remained independent until 274. Troops were withdrawn from the Rhine for the final battle with the Empire in 274, which left the frontier weakened (Watson 1999, pp. 93–94). An assortment of Vandals, Franks, Burgundians, Alamanni, and others broke through in the years 274–276, sacking Trier and many other towns (King 1990, p. 176; Watson 1999, pp. 95–98, 102). Cities across the Empire built new fortifications at this time, including Rome itself.

Part of Diocletian’s reform was to ensure that the Empire had the fiscal resources to pay for a government and military that were larger and more complex. Diocletian developed an Imperial innovation: Rome’s first government budget. Each year calculations were made of anticipated expenses, and a tax rate established to provide the revenue. Just to establish the tax system was an immense affair, requiring a complete census of people and land across the Empire. The tax rate was established from a master list of the Empire’s resources, broken down province by province, city by city, household by household, field by field. Diocletian’s successors revised the rates ever upward. Taxes apparently doubled between A.D. 324 and 364 (Williams 1985, pp. 118–125; Jones 1974, p. 82).

During the late Empire there was substantial abandonment of arable, and formerly cultivated, land. This problem first appeared in the late second century, perhaps due to plague, and was a subject of Imperial legislation from before Diocletian’s time to that of Justinian (527–565). Aurelian (270–275) held city councils responsible for the taxes due on deserted lands. In some eastern provinces under Valens (364–378), from one-third to one-half of arable lands were deserted.

The tax system of the late Empire seems to have been to blame, for the rates were so high that peasant proprietors could accumulate no reserves. At Antaeopolis, Egypt, ca. 527, tax assessments in kind and money totaled one-fourth to one-third of average gross yields. At Ravenna, ca. 555, the situation was similar, with a tax:rent ratio of 57:43 (Wickham 1984, p. 11). If 50% of the yield went to seed and subsistence (Smil 1994, p. 74), then tax amounted to one-half to two-thirds of the surplus (or in bad years, all of it). If barbarians
raided, or drought or locusts diminished the crop, farmers either borrowed or starved. Eventually their lands passed to creditors, to whom they became tenants. Whatever crops were brought in had to be sold for taxes, even if it meant starvation for the farmer and his family. Farmers who could not pay their taxes were jailed, sold their children into slavery, or abandoned their homes and fields. In times of famine, farmers flocked to cities, where stores of grain were to be had. The state, moreover, always had a backup on taxes due, extending obligations to widows or orphans, even to dowries. It is no wonder that the peasant population failed to recover from plagues in the second and third centuries. Conditions did not favor the formation of large families.

Under these circumstances it became unprofitable to cultivate marginal land, as too often it would not yield enough for taxes and a surplus. And so lands came increasingly to be deserted. Faced with taxes, a small farmer might abandon his land to work for a wealthy neighbor, who in turn would be glad to have the extra labor.

The tax system of the late Empire could not accommodate the fluctuations in yield that would have afflicted Gaul in this period. The resulting fiduciary chaos reflects perennial tensions between social and political systems under local control and those at a distance, often pitting systems that value individual and group differences (hierarchies) against those that value more egalitarian and networked relations (heterarchies). Such differences in management structure and style have implications for the movement of information, for the diversity of solutions to problems, and for internal and external security.

Heterarchies are systems (or subsystems) in which each element possesses the potential of being unranked (relative to other elements) or ranked in a number of different ways (Crumley 1979, p. 144; Ehrenreich et al. 1995). For example, widely shared local knowledge in an agrarian economy allows individuals and communities more effectively to manage changes in environmental and economic conditions, while decisions made at a distance and with little detailed information, exacerbate local circumstances (Scott 1998). Similarly, strongly networked societies have incentives to cooperate and avoid the need for costly coercion. In general, heterarchical, networked societies, while doubtless with problems of their own, are more resilient to local environmental challenges than societies with marked social, political, and economic inequities (Crumley 2001, 2003, 2005). This understanding parallels the role of diversity in biotic communities (Holling et al. 2002, p. 21).

Heterarchy poses knowledge that is local (i.e., contextualized) and behavior that is consensual against hierarchies, whose knowledge is distant and decontextualized and whose approach to action is coercive. Diocletian’s tax system was a massive exercise in hierarchy. Tax rates were set each year in anticipation of the government’s needs. This was a distant, centralized process that ignored local knowledge, and could not take into account variable conditions. Taxes had to be paid regardless of fluctuations in yields. Delinquent taxes were remitted
occasionally in the early and middle fourth century, but so frequently after 395 that it appears there was a general agricultural breakdown in the West (Boak 1955, p. 52). In Gaul, rebellious bands called the bagaudae persisted for decades at a time. In the mid fifth century a deputation of property owners and municipal authorities invited the Burgundians to occupy some of their lands (Isaac 1971, p. 127). “[B]y the 5th century,” concludes Adams (1983, p. 47), “men were ready to abandon civilization itself in order to escape the fearful load of taxes.”

On the last day of 406 an alliance of Vandals, Suevi, and Alans crossed the frozen Rhine and virtually overnight a major part of Gaul was lost. In time some of these people moved on to Spain or North Africa, while others remained in Gaul as nominal Roman allies. Rome was able eventually to reestablish a measure of control over Gaul and Spain. In 429, however, the Vandals crossed to North Africa and took Carthage in 439. Rome’s North African food supply was gone forever.

The Western Empire was by this point in a downward spiral. Lost or devastated provinces meant lower government income and less military strength. Lower military strength in turn meant that more areas would be lost or ravaged. By 448 Rome had lost most of Spain (Barker 1924, pp. 413–514). In 458 the Emperor Majorian (457–461) remitted all taxes in arrears (Wickham 1984, p. 19). After the fall of Majorian in 461, Italy and Gaul had little connection. The Empire shrank to Italy, Raetia, and Noricum. The most important ruler in the West was no longer the Roman Emperor but the Vandal King, Gaiseric (Ferrill 1986, p. 154; Wickham 1981, p. 20).

IMPLICATIONS FOR THE IHOPE PROJECT

While the end of the Western Roman Empire presents many enduring lessons, as generations of scholars can attest, we wish to emphasize two in particular. The first lesson concerns the relationship of hierarchy to heterarchy, and global to local, in solving environmental and social problems. We see in the case of Roman taxation what happens when information about environmental capacity is decontextualized. Diocletian’s distant, inflexible tax system exemplifies what Scott has called “environmental and social taxidermy” (1998, pp. 93, 228)—an attempt to order administratively that which is inherently flexible and changing. Administrative systems impose categories on the social and environmental realities of local life. Inevitably these categories—in the Roman case designed to accommodate all circumstances from Britain to Egypt—winnow the variability of local conditions. Once administrators establish such categories, they then try to force social reality to conform to them (Scott 1998). Hierarchical systems tend to commit themselves to specific structures and solutions, establishing brittleness where flexibility may be required. For peasants living on small margins, the consequences can be disastrous.
Local, contextualized environmental information is well integrated into heterarchical organization, which is better able to incorporate varieties of experience. Heterarchical systems operate either by consensus or by ad hoc consensual leadership. While the process of adjusting to new circumstances in heterarchy is unavoidably slow, it derives its legitimacy from consensus. Those who have participated in developing a heterarchical consensus are intrinsically committed to implementing it and will experience strong social pressures should they fail to do so (McIntosh et al. 2000, p. 31; Crumley 2003, pp. 138–139).

Today’s approach to understanding environmental problems—on the part of both policy makers and scientists—has been largely hierarchical: authoritative, distant, and too often decontextualized. Our tendencies to develop abstract, aggregated models and to formulate international agreements exacerbate this problem (McIntosh et al. 2000; Crumley 2000; Tainter 2001). The upper levels in any hierarchical system act only on aggregated, filtered information and respond slowly to signals from below. The local information that is important in environmental conservation and productivity cannot be developed from a distance. There is wisdom in the exhortation of the environmental movement to think globally but act locally. Even well-meaning academic exercises may unintentionally harm the very people they are designed to assist, if they are pursued exclusively at an abstract, aggregated level. We are concerned that conventional, abstract modeling will no more be able to accommodate the flux of local circumstances than could Diocletian’s tax system. While we certainly do not recommend that abstract, aggregated modeling not be pursued, it is important to proceed in awareness of what this approach overlooks. Just as all news is local and all politics are local, all environmental problems are local to the people whose sacrifices will be needed to effect solutions.

This is not to deny a role for distant, abstract analysis. Global change is, of course, global, and some aspects of it must be addressed in a decontextualized, aggregated manner. We recommend that within the IHOPE project, modeling will proceed simultaneously, and in concert with, locality-based studies of how people perceive their environments, transmit information, respond to external interventions, and recognize and accommodate change. IHOPE’s approach should be neither hierarchical nor heterarchical exclusively, but a synthesis of both. This is challenging, but to attempt less is to fail in advance.

The second lesson concerns the evolution of complexity in problem-solving institutions, which the Roman Empire illustrates well. Complexity increases as systems differentiate in structure and increase in organization. Humans employ complexity as a response to problems. Much complexity and costliness in human societies emerges from resolving problems that range from mundane to vital. As the problems that institutions confront grow in size and complexity, problem solving grows more complex as well. Think of the attacks of September 11, 2001, and the growth of bureaucracy and regulation that followed. Much of the
The immediate response to the attacks was to increase the complexity of public institutions, by establishing new agencies, absorbing existing agencies into the federal government, and exerting control over behavior from which a threat might emerge. As seen in this example, we resort to complexity to solve problems because changes in organization can often be implemented quickly.

Complexity has great utility in problem solving, but it also costs. The evolution of complexity is a benefit–cost relation. The costs of complexity may be measured in energy, metabolic rates, labor, money, time, or any other unit of accounting. At the time a problem arises, increments to complexity may seem small and affordable. It is the continual accumulation of complexity and costs that becomes detrimental. As a benefit–cost function, complexity in problem solving can reach diminishing returns and become ineffective. In their complex phase, institutions may lack the fiscal reserves to address new challenges, whether the new challenges are hostile neighbors or environmental perturbations. A society that has adopted much costly complexity may lose resilience and become vulnerable to challenges that it could once have overcome, and even become more likely to collapse.

It is important not to think of complexity as inherently detrimental in human societies. In the early phases of problem solving, increasing complexity is typically effective, giving increasing returns and creating synergistic effects and positive feedbacks among such variables as population, agricultural production, political organization, fiscal strength, and military strength. In the Roman Empire of the late third and early fourth centuries A.D., increasing complexity allowed the government to resolve the multiple crises described above—at least for the short term. The problem with complexity comes when additional expenditures fail to produce proportionate benefits. A society entering this phase is weakened fiscally, in that resources must be allocated to activities that are needed just to maintain the status quo; it is also weakened in its legitimacy, because the support population is alienated by high taxes that produce few discernable benefits. Collapse becomes a matter of mathematical probability, as inevitably an insurmountable crisis will emerge (Tainter 1988, 2000).

Rising complexity in problem solving drives resource consumption. Problems occur in the present but environmental damage may be deferred. Thus the link between benefits and costs is often hidden, and contemporary decisions may have little connection to whether an effort fails or succeeds (Tainter 2000). Once environmental problems are evident, their resolution usually requires still more complexity and expenditure, the predicament in which we find ourselves today (Allen et al. 2003).

For humanity today, a number of major problems are clearly on the horizon and will manifest themselves increasingly over the next generation or two. In addition to questions of climate change and other environmental transformations, there are rising costs of energy, the growing costs of security, decaying infrastructure in many nations, aging populations and the problem of funding...
retirement pensions, increasing requirements in education driven by competition and technological changes, increasing reluctance of governments to tax, and so on. Addressing any of these problems would require societal expenditures that are large, but perhaps within the capacities of industrial nations. The challenge will be to address all of them simultaneously without reducing accustomed standards of living.

A major problem faced by the late Romans was that increasing complexity and expenditures were undertaken just to maintain the status quo. No new lands were conquered and no major new resources acquired. The benefit–cost ratio of Imperial rule declined, reducing its legitimacy. Toward the end the Empire sustained itself by consuming its capital resources: productive land and peasant population.

Many of the problems noted above fall into the same category of undertaking higher costs merely to maintain the status quo: energy costs, security, replacing infrastructure, funding retirement pensions, and paying for education. Much money will be spent restoring the environmental damage caused by previous economic activity and mitigating the effects of climate change. Given budgetary constraints in every nation, funding for much of this activity will be inadequate and some problems may not be addressed at all, unless there are major redirections of national and international priorities. If addressing the problems we foresee should cause the industrial standard of living to stagnate or fall, existing forms of government may lose legitimacy. Societies may polarize around “progressive” factions favoring an environmental restoration agenda, and “conservative” factions arguing that environmental conditions are irrelevant to prosperity. This bifurcation is, of course, already evident, and is exacerbated by special interests comprised of people who benefit from the status quo. A worthwhile undertaking for IHOPE’s modeling efforts would be to assess the costs and benefits of addressing the problems that are foreseeable in our future. Will addressing these problems bring continuing growth in the complexity of industrial societies? How will the costs and benefits of addressing emerging problems intersect with the fiscal capacities of future economies, and with competing demands for public and private funds? Will addressing these problems require a reduction in accustomed standards of living or a reconceptualization of them? We all hope that our future will not be like that of the Roman Empire—so constrained by the costs of problem solving as to impoverish and alienate the very people on whom the future depends.

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REFERENCES


