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**HUMAN - ENVIRONMENT RELATIONSHIP – HISTORICAL PROGRESSION**

Human history has traditionally been cast in terms of the rise and fall of great civilizations, wars, specific human achievements, and extreme natural disasters (e.g. earthquakes, floods, plagues). This history tends to leave out, however, the important ecological and climatic context and the less obvious interactions which shaped and mediated these events. Socio-ecological systems are intimately linked in ways that we are only beginning to appreciate. Furthering the research agenda on such systems poses great methodological challenges. Events can be selectively chosen from the past to support almost any theory of historical causation.

Human societies respond to environmental (e.g., climate) signals through multiple pathways including collapse or failure, migration and creative invention through discovery. Extreme drought, for instance, has triggered both social collapse and ingenious management of water through irrigation. Human responses to change may in turn alter feedbacks between climate, ecological, and social systems, producing a complex web of multidirectional connections in time and space. Ensuring appropriate future responses and feedbacks within the human-environment system will depend on our understanding of this past web and how to adapt to future surprises. To develop that understanding, we need to look at multiple time and space scales.

At millennial timescales different cultural elements (social and political structure, traditional practices, and beliefs, to name a few) enable or constrain responses. Even global-scale events (climate change, major volcanic activity, etc.) do not affect all regions at precisely the same time or with the same intensity. Models (conceptual and computational) of how societal characteristics and environmental conditions affect the resilience of socio-ecological systems are needed. Processes important for the study of resilience, vulnerability, or sustainability include: the degree of rigidity of social, economic, and political networks; the diversity of biophysical resources and of human resourcefulness; the development of complexity, costliness and ineffectiveness in problem-solving; and the cyclical expansion/contraction and geographical shift in the centre of accumulation with periodic declines and ―dark ages‖ when external limits to social reproduction are reached. Simple, deterministic relationships between environmental stress, (for example, a climatic event), and social change are inadequate. Organizational, technological and perceptual mechanisms mediate the responses of societies to environmental stress, and there are also time-delays to societal responses.

More recent changes in the human-environment relationship, such as accelerated globalization and global environmental change, have deep roots in humanity’s relationship with nature over the past millennium. While we often associate the term ―global change‖ with the greenhouse gas warming evident in the last decade, socio-ecological changes at continental and global scales were put in motion over at least the past 1000 years (e.g. many European landscapes looked much like they do today far earlier than this). Important phenomena include a rise in human population, the strengthening of nation states, the global transfer of inventions and values, the beginning of industrialization and the rise of global communications, and associated with these the dramatic modifications of land use and biodiversity, hydrological and energy flows, and key ecological processes.

The last 1000 year period is also interesting because it’s a period when broad swings in temperature as well as clusters of extreme weather events arguably changed the trajectory of history. The fourteenth century in Europe saw the end of the Medieval Warm Period. Particularly during the period from 1315–1317 Western Europe witnessed a combination of rainy autumns, cold springs, and wet summers that led to crop failures and a dramatic slowdown in urban expansion. These early Europeans were further subjected to the last major locust invasion (1338), the ―millennium flood‖ (1342), and the coldest summer of the millennium in 1347. From 1347 to 1350 the ―Black Death‖ devastated populations. The clustering of extreme events in the fourteenth century fundamentally undermined social order and was a key factor in a major wave of anti-Semitic pogroms and systematic discrimination. In the same period, agricultural land was abandoned and forests increased. Many would argue that it also led to the end of the feudal system, improved land and employee rights and, through the enlightenment period, paved the way for the modern age. The Little Ice Age affected food availability in many parts of Europe, leading to the development of technological, economic and political strategies as ways to reduce vulnerability. The exceptional 1788-1795 ENSO event reverberated around the world in places as far afield as the first British colonial settlement in Australia, the Indian monsoon region, Mexico and western Europe. Thus, the present nature and complexity of socio-ecological systems are heavily contingent on the past; we cannot fully understand the present condition without going back centuries or even millennia into the past. An important implication is that societal actions today will reverberate for centuries into the future in climatic and many other ways.

Turning to the more recent past, the 20th century witnessed several sharp changes in the evolution of socio-ecological systems, at both global (two world wars and the Great Depression) and regional (e.g. the failure of Soviet farming, its reliance on grain from the U.S., and subsequent collapse as a polity) discontinuities. Variations in the growth rate of carbon dioxide (CO2) in the atmosphere occurred in response to both climatic controls over land-atmosphere-ocean fluxes (for example, CO2 increases more rapidly in El Niño years because of climate effects on terrestrial ecosystems) and political events (the growth rate slowed during the 1970s oil shock and after the breakup of the Soviet Union because of changes in fossil fuel use). The 20th century also marks the first period for which instrumental records of many environmental parameters have become available and for which detailed statistical records of many human activities have also been collected.

The most remarkable phenomenon on Earth in the 20th century was the ―Great Acceleration, the sharp increase in human population, economic activity, resource use, transport, communication and knowledge–science–technology that was triggered in many parts of the world (North America, Western Europe, Japan, and Australia/New Zealand) following World War II and which have continued into this century. Other parts of the world, especially the monsoon Asia region, are now also in the midst of the Great Acceleration. The tension between the modern nation-state and the emergence of multinational corporations and international political institutions is a strong feature of the changing human-environmental relationship. The engine of the Great Acceleration is an interlinked system consisting of population increase, rising consumption, abundant cheap energy, and liberalizing political economies.

Globalization, especially an exploding knowledge base and rapidly expanding connectivity and information flow, thus acts as a strong accelerator of the system. The environmental effects of the Great Acceleration are clearly visible at the global scale—changing atmospheric chemistry and climate, degradation of many ecosystem services (e.g., provision of freshwater, biological diversity, etc.), and homogenization of the biotic fabric of the planet. The Great Acceleration is arguably the most profound and rapid shift in the human–environment relationship that the Earth has experienced.

Towards the end of the 20th century, there were signs that the Great Acceleration could not continue in its present form without increasing the risk of crossing major thresholds and triggering abrupt changes worldwide. Transitions to new energy systems will be required. There is a growing disparity between the wealthy and the poor, and, through modern communication, a growing awareness by the poor of this gap, leading to heightened material aspirations globally—a potentially explosive situation. Many of the ecosystem services upon which human well-being depends are depleted or degrading, with possible rapid changes when thresholds are crossed. The climate may be more sensitive to increases in carbon dioxide and may have more inertia than earlier thought, raising concerns of abrupt and irreversible changes in the planetary environment as a whole.

From the past, we know there are circumstances in which a society is resilient to perturbations (e.g., climate change) and there are circumstances in which a society is so vulnerable to perturbations that it will be unable to cope. The evolutionary biologist and bio-geographer Jared Diamond identifies what he considered to be the 12 most serious environmental problems facing past and future societies—problems that often have led to the collapse of historical societies: 1. Loss of habitat and ecosystem services; 2. Overfishing; 3. Loss of biodiversity; 4. Soil erosion and degradation; 5. Energy limits; 6. Freshwater limits; 7. Photosynthetic capacity limits; 8. Toxic chemicals; 9. Alien species introductions; 10. Climate change; 11. Population growth; and 12. Human consumption levels. More importantly, Diamond, and several others before him, have emphasized that the interplay of multiple factors is almost always more critical than any single factor. Societies on the edge become brittle and lose resilience (including the ability to adapt social values to new circumstances) making them more susceptible to the impacts of potential perturbations of several kinds, including climate change, political corruption, war, and terrorism. In addition, what happens to any society is an emergent phenomenon, the result of individual decisions and conflicts in combination with environmental factors.