sociated with the availability and flow of energy through the world's nations account best for the current inconstant state of world affairs.

Currently the discourses regarding the issue of energy availability are embedded in two contested narratives. One argues that alternative, renewable sources of energy – solar, wind, water, nuclear, and fusion – will be available in time to replace our dependence on fossil fuels. The other argues that the supply of fossil fuels – oil, gas, and coal – that constitute almost all of the energy upon which the world's nations rely, will be available for an arguably long time – decades, generations, centuries – to come.[4] Faith in this second narrative forestalls research and development of the renewable sources supported in the first narrative. And the second narrative does not take into account the unpleasant reality that without adequate sources of renewable energy we will experience a social, cultural, and technological collapse long before fossil fuels are exhausted utterly and renewable energies are available to replace them. Such a collapse could be sufficiently sudden to threaten the survival of the world's civilizations and the human species, *Homo sapiens*, itself. It is far from certain that alternative sources of renewable energy will be able to rescue us. If they do not, the globalization so many authorities predict will be de-globalized quickly.

The epistemological foundation for this prognosis is a simple and observable scientific reality. In only 250 years *Homo sapiens* have managed to deplete significantly fossil fuels that took 3.5 billion years to create! It will not take another 250 years to exhaust the remaining fossil fuels beyond a point of no return. At this moment – and for the foreseeable future – there are no alternative sources of energy in sufficient quantity or quality to replace them. Without these renewable energies the current excitement about the emergence of a new world order will fade quickly. The disturbances and unrest that affects the world's nations are harbingers that will only worsen as the current sources of fossil fuel energy are depleted or too expensive to acquire and the development of new alternative sources of energy are inhibited by extant political, social, and cultural constraints.

With this prognosis in mind we present an alternative to prevailing globalizing hypotheses. We hypothesize that a *subliminal anxiety* over the world's energy supply and the environmental effects caused by the sudden reversal of photosynthetic processes implicit in fossil fuel energy extraction are inducing uncertainties, conflicts, and dialectical relationships in a spatial milieu of *liminality* that is defined by energy boundaries.

Boundaries and Liminality

Most of us think of a boundary as a border or limit around or between entities, such as that which separates one nation from others. This kind of boundary is porous; people and goods can cross it without necessarily evoking changes that incur deleterious effects on social life. However, the idea of a boundary used in the natural sciences is quite different. Natural scientists identify different boundaries – global, planetary, environmental, climatic, and others – and argue that once an entity crosses a boundary it changes qualitatively, perhaps, irreversibly.

For example, 32° Fahrenheit (zero centigrade) establishes a boundary between water and ice. Above 32° F one can swim in the water. Below 32° water freezes and one may be able walk on the ice. Thirty-two degrees Fahrenheit represent a boundary above and below which the molecular structure and dynamics of water and ice change dramatically. That boundary allows reversibility when the temperature warms or cools. Other natural boundaries may not be reversible.

Some anthropologists have considered the role played by socially bounded networks of people in social and political change and relationships. In these circumstances socially bounded networks adapt to changing social and political circumstances and may evolve into more differentiated and specialized social organizations (Cohen 1969; Kurtz 2008). Other anthropologists (see below) address how social and cultural entities become inserted into liminoid states that are circumscribed by symbolic boundaries. Liminality occurs after an entity crosses a limen (threshold) and persists until the entity resolves dialectical relations that are evoked in the liminoid state. Once these dialectics are resolved the entity can cross the symbol boundary (limen), re-emerge and re-engage normal socio-cultural relations.

Liminoid states have been identified in a variety of circumstances. In some tribal societies adolescent children experience symbolic death after crossing the limen. Then they are subjected to rituals of rebirth after which they exit liminality and re-enter society as adults (Van Gennep 1960 [1908]). Pilgrimages may install participants in a liminoid symbolic realm devoid of mundane structures that allow statuses to homogenize, engage the 'communitas' of shared experiences, and provide renewed reengagement in worldly institutions momentarily left behind (Turner 1979). In World War I soldiers enculturated with nineteenth century values underwent symbolic (and real) death in the trenches before reemerging into a less romantic twentieth-century industrialized world (Leed 1979). Pagan Indians in sixteenth-century central Mexico were inserted into a liminoid state and exploited and defined as non-human by the Spanish conquistadores. They were humanized (but not less exploited) only after they were baptized into a syncretistic Mexican Christianity (Kurtz 1982). Finally, a fictional historical report from the year 2373 CE looks back to a liminoid 'second dark age' that began in the twenty-first century – our cultural present! – and engulfed the entire world. The report describes the collapse of a non-globalized western civilization that failed to exit the liminoid state in which it now exists. The cause of the collapse was climatic catastrophes fueled by irresponsible political-ideological fixations that denied climatic change from the burning and depletion of fossil fuels (Oreskes and Conway 2013).[5]

The idea that nations – or the entire world – can exist in a liminoid state is not a far-fetched anomaly. Nations caught in liminoid states between alternative energy sources have been recorded historically. In the West, liminality is associated with the 'dark (or middle) ages' between the tenth and fifteenth centuries CE (Turner 1979). In Asia the Tokugawa era, 1600–1867 (Reischauer 1946), represents a liminal phase in Japan's development (also see Abilov 2011). Each entity displayed relative cultural differences. But each also represented similar feudal systems adapted to a mature agricultural techno-energy system that, after reaching the limits of its evolutionary potential, was transformed into industrial nations dependent on the exploitation of fossil fuels.

Turner argues that liminal entities exist betwixt and between social and cultural realities and 'experience disjunctions in the flow of natural and social processes' (Turner 1979: 53). We hypothesize that the current disjunctions that characterize our contemporary globalizing civilizations are the product of our current existence in a provocative global liminality. Globalization currently represents a liminoid condition within which human populations are attempting to resolve the dialectic of declining and developing sources of energy. Threats to globalization exist in this dialectic. If we fail to produce alternative sources of energy to the fossil fuels upon which the world's industrial technology depends we will cross environmental and ecological boundaries that cannot be reversed easily, if at all. Under these conditions the future of human societies and *Homo sapiens* themselves become dire. If we secure sources of energy that are environmentally benign and in sufficient quantity to meet the needs of the Earth's growing populations the energy boundary will become less significant and globalization will simply be another phase in the general evolution of human social organizations.

The logical outcome of that evolution will be the development of a new world order constituted of some kind of republic or confederation ruled by a government of the united states of the world (Grinin and Korotayev 2012; Drobot 2012). Carneiro (1978) predicts that this government will be in place by 2300 CE.[6] Hopefully, a future hegemonic world government will manage the energy grid upon which this presumed new world civilization will depend more effectively than the fractious governments that represent our current world order.

Boundaries and the Evolution Paradigm

Anthropologists have explored the evolution of human societies and cultures (Fig. 1) more than other sciences. Most emphasize the critical relationship between energy and the work that drives the technology that results in the evolution characterized by the differentiation and specialization of human social organizations that adapt to maintain human lives and identities in different environments (White 1949, 1959; Steward 1955; Goldschmidt 1959; Sahlins and Service 1960; Cohen 1968; Adams 1975; Bodley 2012,[7] among others). Anthropologists also have addressed the idea of 'boundary' in the evolution paradigm. But they rarely identify the implications of the boundary concept.

Energy boundaries (see Fig. 1)[9] establish a theoretical relationship between the energy on one side of the boundary and the work it allows on the other side. As energy ascends in quantity and quality on one side of the boundary it induces more work and a positive systemic feedback. This results in the differentiation and specialization of institutions and social organizations that constitute the evolution of human societies and cultures. If energy descends in quantity and quality on one side of the boundary it induces less work and triggers a negative feedback – devolution – in the differentiation and specialization of social organizations that constitute human societies. In short, if we run out of energy the Second Law of Thermodynamics prevails and social evolution reverses, devolves, and affects seriously the survival of *Homo sapiens*.

Fig. 1. Evolution of Social Organizations[8]

Few authorities, including anthropologists (Price 1995 and Bodley 2012 are exceptions), address the role energy is currently playing in the evolution of a globalizing world. This is curious since, as noted above, anthropology has a historical concern with the relationship between the evolution of social organization and the energy harnessed by human technologies. The future well-being of humankind will depend on whether *Homo sapiens'* insatiable demand for energy can be sustained. Anthropology's concern with the evolution of social organization provides a backdrop to address these issues.

Anthropology and Energy

Leslie White argued over sixty years ago that anthropology ought to be identified as a special science, harder than softer, because of the unique relationship between energy, technology, and culture. For White that relationship constituted a thermodynamic system that provided the nexus for his *basic law of cultural evolution*. The law postulates that, 'Other factors remaining constant, culture evolves as the amount of energy harnessed per capita per year is increased or as the efficiency of the instrumental means of putting the energy to work is increased' (White 1949: 368–369). The release of the nuclear energy of the atom and the presumed efficiency of new technologies derived from that event impelled White's prediction that the evolution of culture would give rise to a 'single political organization that would embrace the entire planet and the whole human race' (*Ibid*.: 389).

Most anthropologists who work with the evolutionary paradigm impute some explanatory power to the idea that evolution is related to the energy that human beings harness with the technology by which they exploit environmental niches to thrive and survive. For example, the populations that inhabit urban industrial state formations have access to considerably more energy than the populations of nomadic foraging bands. For millennia human populations relied on a hunting and gathering technology to harness the energy of wild plants and animals. One result of this was a low population growth and an institutionally commingled, relatively undifferentiated and unspecialized social organization of nomadic hunters and gatherers (Fig. 1). The 'agriculture revolution' evolved roughly between 12,000 and 6,000 BCE. The populations that participated in the evolution of this 'revolution' relied largely on energy derived from domesticated plants and animals.[10] This adaptation required people to settle down in villages that gradually evolved into cities and, ultimately, state formations managed for better or worse by powerful centralized governments that specialized in the extraction and exploitation of their agrarian and non-agrarian sectors.

The energy sources provided by domesticated plants animals were complemented by an increasing reliance on energy from wind and water. By 6000 BCE, agricultural societies crystallized around techno-energy systems upon which contemporary agriculturalists still rely: irrigation, plows with draft animals, beasts of burdens, wagons, sailing ships, wind and water mills and attendant infrastructures: ports, roads, potable water, sewage systems, bridges, and canals. Had the evolution of social organization ceased at this time the agricultural stage of evolution might have existed in perpetuity because the energy derived from plants and animals is sustainable and renewable.[11]

But human ingenuity and curiosity altered that outcome. People were challenged increasingly to invent new things and make new discoveries. By 1400 CE, an incipient industrial technology related to textiles and handicrafts was developing in southern Europe and elsewhere in Asia (Reischauer 1946; Turner 1979; Abilov 2011). The first decades of this evolution relied heavily on energy provided by fire wood, wind, water and, increasingly, coal. The 'industrial revolution' based on energy harnessed predominantly from fossil fuels – coal, oil, gas – prevailed by 1750 AD and has infused all aspects of human life and work since.

As we know, but until recently did not think much about, energy derived from fossil fuels is neither sustainable nor renewable. Some scholar and pundits representing various media proclaim that the decline of fossil fuels will be replaced by new sources of energy, solar, wind, nuclear fission, and fusion (Ridley 2010). This belief is inattentive to a heretofore unthinkable evolutionary condition: these alternative sources of energy are not available currently and may not be in sufficient kind, amount, and time to supply energy for the world once fossil fuels are depleted.

This is the sword of Damocles suspended over humankind and its civilizations. Unless new sources of energy are harnessed human civilizations will succumb to the entropy of the Second Law of Thermodynamics and vanish along with, ultimately, the human species.[12]

Today there is wide disagreement among scientists – most of whom are not anthropologists (again, Price 1995 and Bodley 2012 are exceptions) – regarding the consequences of the relationship between energy, human societies, and the future of the human condition (Hirsch 2006; Tverberg 2012; Yergin 2011; McKay 2012; Monbiot 2012; Zittel *et al.* 2013, among many others). New factors have been introduced into the evolution equation that neither White nor other anthropological evolutionists thought of in the mid-twentieth century; global warming from CO_2, methane, and other greenhouse gases emitted by fossil fuels rank high on that list. There was no need to think on these matters. It appeared that the sources of energy were endless, salubrious, and that sociocultural evolution would continue in perpetuity. Events that were unthinkable fifty years ago have forced consideration of the possibility of a world devoid of energy.[13] That would be a world within which human beings and many other forms of life could not survive. This possibility is associated with ideas that energy-oriented anthropologists, such as White, had no good reason to ponder: *energy boundaries*, *peak energy*, and an explosive population growth. These evoke the dialectical elements of our global liminality that will influence, perhaps determine, the future of the world's civilizations and population.

Energy Boundaries and Peak Energy

Currently all the nations of the world are integrated to some degree into a techno-energy system that relies on fossil fuels: oil, gas and coal. These fuels are the equivalent of the 'Higgs boson's' function of holding the universe together; fossil fuels are the current glue of globalizing civilizations. Without them the industrial revolution could not have occurred. Without them or viable alternative sources of energy globalization will become unglued and its evolutionary potential foiled.

The dialectic of energy sources defines the world's current liminality. But the exact nature of energy boundaries and their consequences is controversial. Consider, for example, the variety of opinions and heated debates among scientists, politicians, and lay people concerned with the same problems: energy availability, global warming as a consequence of burning fossil fuels, and the carrying capacity of earth in the face of degrading planetary conditions, such as a decline in biodiversity. Boundaries related to these issues represent *tipping points* based on a value provided by a known or configured determination. For example, a tipping point for oil is reached when 51 per cent of the earth's oil is used up. After that conditions change irreversibly as the remaining 49 per cent is drained away. Unlike the flexible 32 °F boundary between water and ice, the tipping point for oil, indeed all fossil fuels, cannot be reversed. The oil that has been consumed cannot be replaced. The existing technology that relies on oil becomes useless. Civilizations suffer, ultimately irreparably. Global liminality deepens and its dialectical relations revert to internecine political conflicts over available energy.

Exceeding the determined value of a natural or physical boundary may result in irreparable changes: forests die, nature burns, deserts replace grasslands, glaciers melt, polar ice is compromised, food production suffers, positive technological change ceases, oceans rise, coastal cities and island nations are inundated (see Price 1995; Gore 2006; Bodley 2012). In other circumstances the change may become dire only when the lack of the resource related to that boundary begins to impact the efficiency of the technology upon which the well-being of human societies depends. This could occur if the oil and gas reserves upon which the world's nations currently rely are depleted sufficiently to force an increasing reliance on coal reserves. Burning coal would trap more CO_2, methane, and other greenhouse gases in the atmosphere causing increased heating of the planet and hasten a climatic catastrophe.

The boundaries that are relevant to this paper are related to the hypothetical consequences of the tipping points for the fossil fuels upon which the nations of the world rely. The boundary limit for each source of energy is debatable. But, despite current claims by energy cartels – big oil, big gas, big coal – of windfall sources of new fossil fuels, the boundaries indicated in Fig. 2 are projections, not especially optimistic but reputable we think, of the energy resources that remain available for extraction.

Type of Reserve	1990 *	2001 **	2010 ***
Oil	35	36	46
Gas	52	58	59
Coal	200	202	118

*	Price (1995)
**	Dresselhaus & Thomas (2001) http://docencia.izt.uam.mx/hcg/231236/material_adicional/AlternativeEnergy.p
***	World Coal Institute http://www.worldcoal.org/coal-society/coal-energy-security/

Fig. 2. History of years left of fossil fuel reserves

Fig. 2 represents projected reserves of the fossil fuels upon which the nations of the world rely today. They vary as circumstances change, *viz* the bubble in shale oil and natural gas production by hydraulic fracturing in North America and elsewhere. But none of these energy sources is increasing; each ultimately will be depleted. Dire consequences for humankind will occur prior to exhaustion of the fuel, when the source of each fuel either is too costly to extract, beyond the reach of extraction technologies, or when the technologies, such as fracking, incur so much ecological damage they are no longer viable. The tipping point for these fuels will come sometime prior to the years indicated. But there are other factors to consider in this equation.

The tipping point begins when the energy source 'peaks'; that is when 'peak oil', 'peak gas' and 'peak coal' begin to become depleted beyond replacement (Fig. 3).

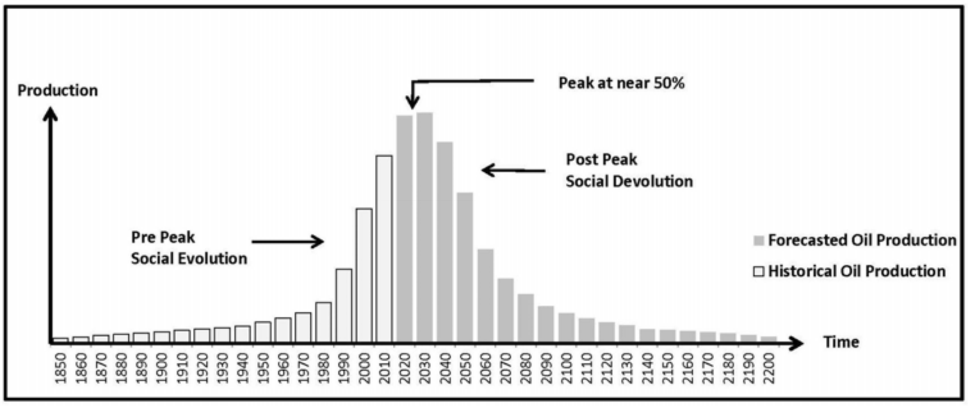


Fig. 3. Peak Oil

'Peak oil'[14] is the term most commonly used to identify the point at which oil reaches its tipping point and begins its descent (Fig. 3). When the peak is reached, 50 per cent availability, the tipping point is initiated and oil begins its descent toward exhaustion due to depletion, cost, or accessibility. Fig. 4 suggests that new discoveries of oil may extend the reliability of the resource. But it will extend the time before peaking and declining only by a few years. This scenario holds equally for 'peak gas' and 'peak coal'. There are consequences of 'peaking' that may not be immediately obvious.

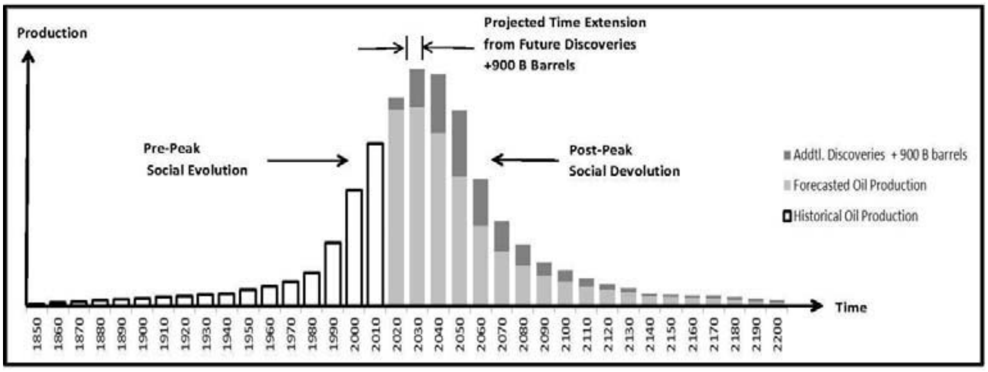


Fig. 4. Peak Oil Forecast + Additional Discoveries

Once oil availability is in crisis, a greater demand will be exerted on gas and coal. When this occurs, gas and coal will be exploited more rapidly to compensate for the loss of oil. That will cause those energy sources to peak earlier than now projected. The reserves will decline faster as each source is depleted. This could be postponed as blips in availability and/or accessibility occur, such as that caused by current fracking technologies. Ultimately coal will be the fossil energy of final availability. It will likely be a sulfur-laden grade that is considerably dirtier and more polluting than that burned currently. Even though coal will have a markedly reduced life expectancy from that projected by

Fig. 2, the CO_2 and other greenhouse gases expelled into the environment from burning inferior grade coal will linger, exacerbate global warming, and impel humankind toward an imminent ecological catastrophe. Discovery of additional sources of energy, such as gas, may extend the duration of the availability of oil (Fig. 4). But that simply delays the inevitable depletion of that resource and exacerbates ecological damage.

Some projections suggest that the world will be in an oil crisis around 2020. Still others contend that oil already has peaked and we are on the downward slope of Fig. 3. Of course, there are those, usually representing energy cartels, who contend that none of these fuels is anywhere near peaking; 'We will be oil independent of foreign reserves – even an "energy exporter"' – the oil cartels' mantra intones (Hirsch 2006).[15] As noted, these discoveries merely extend temporarily the peaking of these energy sources. And this mantra stifles discussion, research, and investment in alternative and renewable energy sources.

It is easy to juggle these data and dates and take refuge in numbers that comply with your current beliefs. But if we put the projections into a generational context urgency may appear to be more immediate and intimidating. Those are many who think energy shortages will not occur for at least 100 years (U.S. Energy Information Administration 2013). A century sounds like a long time. But 100 years from now will be the time when the great grandchildren of some of those alive today will be growing up. And the world which those children confront may not be as cordial as that which we inhabit. Additionally, as Price (1995) points out, by the time the generation that will exist a couple generations from now realizes that energy has 'peaked' and disaster is unavoidable the next generation already will be on the way. Thinking in terms of incremental dates – 50, 100, 200, 300 plus years hence – allows governments and energy cartels to push back yearly projections until it is too late to do anything to rectify an impending catastrophe. Once the world is relegated to the use of coal – clean coal is a coal-industry myth – CO_2 emissions will cross climatic boundaries and set in motion irreversible changes in climate condition and ocean acidity. This will compound the lack of energy that could eventually render the planet unlivable. Whether wind, solar, hydraulic, biofuels, and nuclear energies can solve the problem is moot. When energy shortages become critical, the major nations of the world could be at war over the last accessible fossil fuel reserves. Population is the final element in this equation that has implications for globalization.

Population

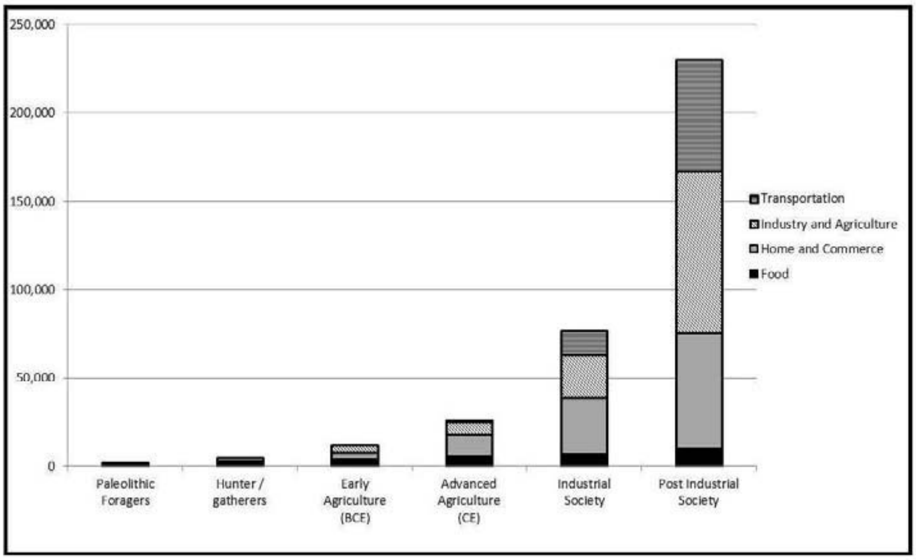
In mid-2013 the earth's population exceeded 7.0 billion people. Despite the fact that the rate (percentage) of population growth has slowed since around 1980, sheer population growth is projected to level off somewhere between 9.0 and 12.0 billion by 2050 (UN World Population Prospects 2012).[16] That is less than two generations from now. A brief and generalized history of population growth on earth (see Bodley 2012) puts the implications of this growth in sharper perspective.

From the appearance of modern *Homo sapiens* around 200,000 BCE to about 4000 BCE, *about 196,000 years*, human population grew slowly, persisting largely in a steady state. Around 4000 BCE, the advent of the Neolithic agricultural revolution caused a dramatic spurt in population growth *relative* to that which existed previously. But that growth leveled off and a steady state was reestablished that lasted until about 1400 CE, *a span of 5400 years* (see Fig. 7). At that time an incipient industrialization in Europe and elsewhere (Abilov 2011) resulted in a gradual growth in population for the next three hundred and fifty years, until about 1750 CE. By 1750 CE industrialization had taken root in Europe and world population began its growth toward the 9.0 to 12.0 billions of people that are projected to inhabit planet Earth by 2050 CE, *about 35 years hence*.[17]

The demographic evaluation of these processes relies largely on paleontological, archaeological, historical, and census data. These data inductively suggest the hypothesis that changes in the ratio of human fertility to mortality account for human population growth. This proposition is most explicit in accounting for the historical growth of human population prior to1750 CE. A reconsideration of the fertility-mortality proposition in the context of the evolution paradigm suggests an alternative hypothesis.

The surge in population that began around 1750 CE correlates to the increasing reliance of the 'industrial revolution' on fossil fuels. This suggests a correction to the fertility-mortality hypothesis: work created as a derivative of the amount of fossil fuel energy harnessed by an industrial technology accounts better than the fertility-mortality ratio for *the growth* of earth's population.

According to Leslie White, socio-cultural evolution occurs in part as 'the amount of energy harnessed per capita per year is increased' (White 1949: 368–369). This proposition can be measured in terms of the per capita consumption of dietary caloric energy – kilocalories or Kcals – related to the various technologies by which humans capture and use energy. The comparisons in Fig. 5 demonstrate this relationship and identify four factors that capture and consume the per capita energy necessary for human survival: food,[18] home and commerce, industry and agriculture, transportation (Cook 1971).



Energy in KCal	Paleolithic Foragers	Hunter / gatherers	Early Agriculture (BCE)	Advanced Agriculture (CE)	Industrial Society	Post Industrial Society
Transportation				1,000	14,000	63,000
Industry and Agriculture			4,000	7,000	24,000	91,000
Home and Commerce		2,000	4,000	12,000	32,000	66,000
Food	2,000	3,000	4,000	6,000	7,000	10,000
Total consumption / person	2,000	5,000	12,000	26,000	77,000	230,000

(1 Kilo Calorie = 1 Food Calorie)
Adapted from E. Cook (1971)

Fig. 5. Daily Consumption of Energy in Kilocalories

Hunters and gatherers, the base line for the evolution paradigm, consume about 5000 Kilocalories per capita daily to satisfy their culturally determined wants and needs. By the time the agricultural revolution gave rise around 5000 BCE to urban state formations dominated by powerful central governments per capita consumption of energy had increased to 12,000 kilocalories daily. By contrast, individuals who labored in the nineteenth century industrial societies and, subsequently, contemporary (post)industrial societies consumed 77,000 and 230,000 kilocalories daily respectively to satisfy their culturally determined needs and wants.

These data suggest that the relationship between population growth and per capita energy consumption substantiates the hypothesis that population growth is caused largely by the amount of work that is created by the energy captured and consumed by a population.[19] Energy consumed by foragers is minuscule compared to that harnessed and consumed by industrial populations. The growth of this population does, however, have implications for how work, on the one hand, and fertility and mortality rates, on the other, may impact globalization.

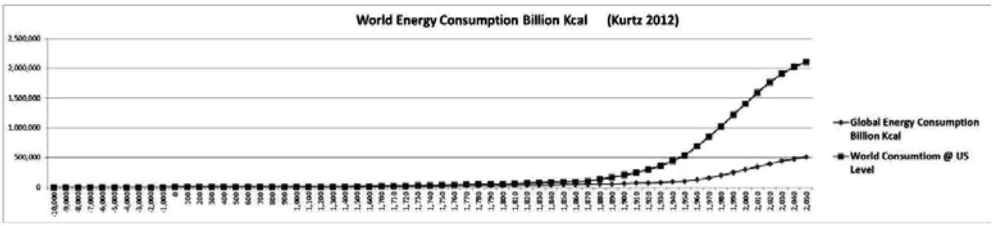


Fig. 6. World Energy Consumption

Shortly after 1750 CE (Fig. 6) the United States began to outstrip other nations in their consumption of fossil fuel energy. From about 1850 CE until about 1970, the exploitation of fossil fuels by the United States, the world's largest consumer of energy, increased dramatically compared to world demand. But after 1980, about the time that the rate of population growth worldwide began to level off, the energy exploitation by the United States also leveled off (Fig. 7).[20]

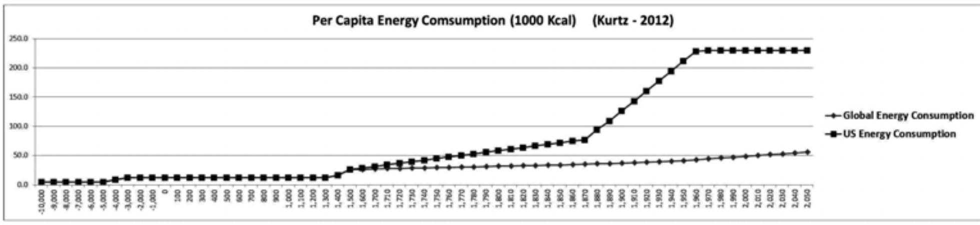


Fig. 7. Per Capita Energy Consumption

Still, the population continued to grow from about 160,000,000 in 1960 to about 317,000,000 now (U.S. Census). To explain this we can again refer to that segment of Leslie White's basic law of cultural evolution which asserts that culture evolves 'as the *efficiency* of the instrumental means of putting the energy to work is increased' (White 1949: 368–369, italics ours). Although the United States consumes most energy per capita in the world it has struck a balance with the global energy consumption because the efficiency of its technology has been sufficient to meet human needs without increasing its exploitation of fossil fuels.

The efficiency of the technology that has influenced the development of the United States also, to some extent, has had an impact on other developed nations. Fig. 8 shows that between 1975 and 2000 the population in the nations of the developed world at large grew largely proportionate to the increasing worldwide exploitation of fossil fuels.[21]

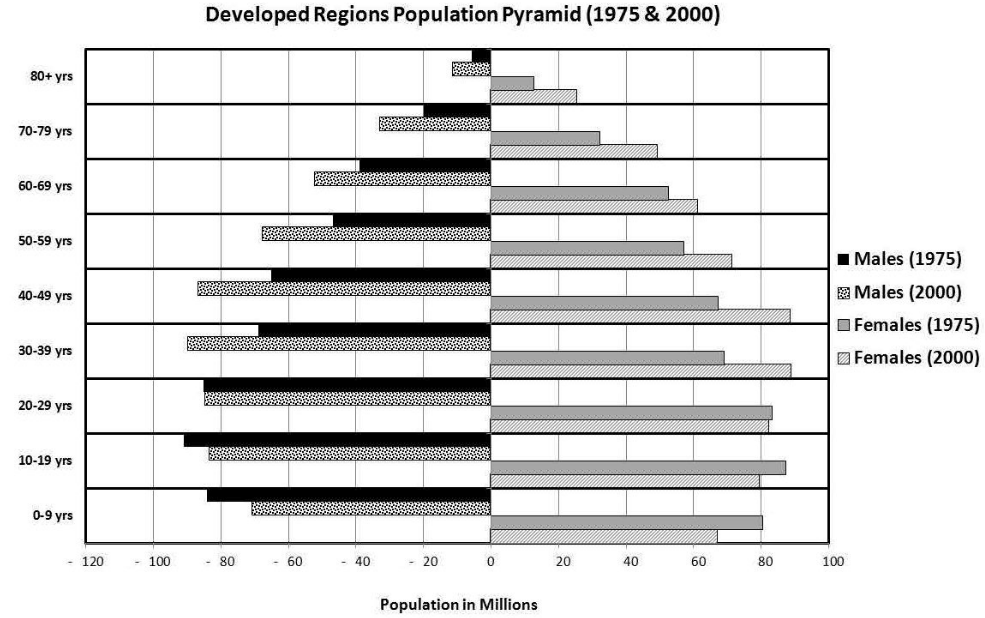


Fig. 8. Developed Regions Population Pyramid (1975 & 2000)

The gender/age population cohorts for the pyramid related to nations in the developed world in 1975 (white) and 2000 (black) are relatively stable and adapted to the benefits derived from the consumption of energy that currently drives the post-industrializing technology of the worlds' developed nations. The distribution of males and females in that pyramid and the relationship of fertility and mortality are relatively stable, in balance,[22] and population growth has not been excessive; the work created by available energy is synchronized with the population.

The population growth in the developing world requires a different explanation.

The gender/age population cohorts in developing nations (Fig. 9) for the years 1975 (white) and 2000 (black) respectively are disproportionate.

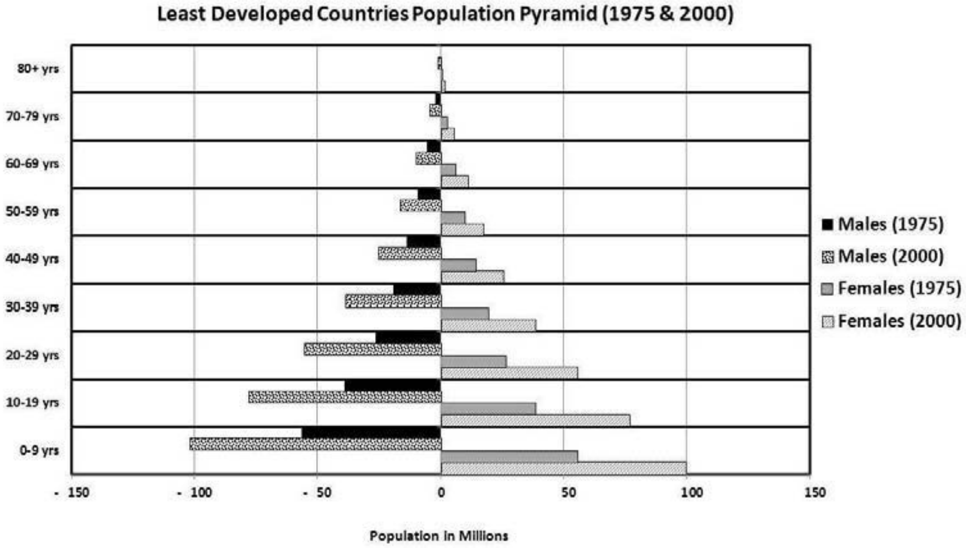


Fig. 9. Least Developed Countries Population Pyramid (1975 & 2000)

Source: Population Growth over Human History (2006). URL: http://www.globalchange.umich.edu/globalchange2/current/lectures/human_pop/human_pop.html.

Fertility trumps mortality in developing nations as the share of females of child bearing age is larger there than in the developed nations. Despite the leveling of the population growth rate since 1980, the increase in population, which already is several times that of the developed world, will likely increase until at least 2050 (http://esa.un.org/wpp/unpp/p2k0data.asp), perhaps beyond (see Endnote 16), and work created by the available energy is not synchronized with population growth. But it is relative to the condition of poverty in which most of these populations live.

It may appear to be an anomaly. But the economics of having and rearing children among impoverished populations which constitute the core of the developing world and most people on earth is very different from that which transpires in the developed world. Having and rearing children in the developed world is expensive; children often are dependent upon parents into adulthood. Conversely it is considerably less costly for families in the developing world to have and rear children. And those children that survive can begin at a very early age to augment their families' incomes through begging, selling trinkets or sweets, shining shoes, washing windshields at stop lights, and the like.[23] But this work is not sufficient to impel the impoverished out of poverty.

The potential fertility and reproduction by young females in developing nations connotes an undesirable population growth in these impoverished cohorts. Whether the projection of the earth's population growth stabilizes at 9.0 or 12.0 billion by 2050 the age cohorts in the developing nations will result in vastly more people relying on sources of energy that are being depleted instead of increasing proportionate to population growth.

The population growth the world is confronting is not sustainable if the current exploitation of fossil fuels continues and the creation of alternative sources of energies does not increase. The intersection of population growth and declining sources of fossil fuels has critical implications for the success of the projected globalization of the world's nations. Eventually global population growth will exceed the world's available fossil fuel energy. Planet Earth will survive the exhaustion of its fossil fuels: 'Save the Planet' is a bumper sticker cliché. But Earth might also be devoid of *Homo sapiens*.

Solution to the population problem and energy crisis in general will be political and not necessarily peaceful or pretty. These politics will transpire as part of the dialectic of energy in the global liminality characterized by energy boundaries imposed, on the one side, by the depletion of fossil fuels and on the other side, by the development of alternative sources of energy to the fossil fuels. The political decisions and practices that will determine the outcome and future of humankind – and globalization – are integral to the energy dialectic in which the nations of the world now exist.

Discussion

This paper considers the relationship between globalization and the sources of energy upon which the worlds' nations rely. The social scientists, humanists – experts of one persuasion or another – that are concerned with globalization largely ignore the implications for globalization of an energy crisis. They consider mainly the political, economic, social, and cultural implications and problems that might be associated with globalization. But the 'new globalized world order' they project is not a done deal. It will rely ultimately on the amount and kind of energy that is available to that 'order'. This paper builds from anthropological theories regarding the role of energy in the evolution of human social organizations to suggest a correction to these attitudes.

We identify three factors that we think reside at the heart of this crisis: breaching energy boundaries, peaking and tipping of energy reserves, and population growth. How extreme the energy crisis is depends on one's understanding of and agreement with the massive array of contradictory information (scientific and otherwise) replete in print and throughout the World Wide Web. This paper barely dents the available information. Its argument lies somewhere between the pessimism of 'peaknics'[24] and environmentalists that a world energy crisis is imminent and the optimism of the energy lobby that there is no crisis. We think the threats to our supplies of energy are sufficiently real that if they are not taken more seriously and quickly by the governments of the world nations human civilizations could collapse and *Homo sapiens* become extinct.

Most scenarios of a future world depleted of energy are meat for science fiction. But there are two facts regarding energy which should give pause to those who foresee globalization as a utopian new world order. First, since about 3.5 billion years ago the emergence and evolution of life on Earth has been the result of and sustained by photosynthesis. Photosynthesis is the process by which light energy produced by the Sun converts carbon dioxide (CO_2) and water (H_2O) into sugar ($C_6H_{12}O_6$), traps carbon atoms in solid form, and release free oxygen (O_2). These sugars, in conjunction with other biological and geological processes, are converted and stored in plants and some algae. As those plants and algae decayed over the last 3.5 billion years the sugar which they trapped was transformed into the carbon based fossil fuels that we rely on today: oil, gas, and coal. Energy produced from fossil fuels is in general terms the exact opposite of photosynthesis. The trapped sugars are forced to react with the free oxygen (O_2) to produce water (H_2O) and CO_2 and release the solar energy originally trapped in the sugar (fossil fuels). Second, *over the last 250 years – a nanosecond in cosmic time – those 3.5 billion years of accumulated fossil fuels have been depleted to an arguable finiteness – between a few decades and a few centuries depending on the source of the data – before they are exhausted ut-*

terly.[25] Other than these two facts everything regarding the implications of energy that is or may be available for our species to exploit is open to question.

No one knows precisely the current reserves of fossil fuels. Fig. 2 represents the moderate to least optimistic projections through 2010 of the present reserves of these fuels. The most optimistic projections of those fuels in 2013 retain oil reserves at their current rate and projects reserves of coal and gas at 417 and 167 years respectively (U.S. Energy Information Administration 2013). In this projection the energy glass is more than half full. In Fig. 2 the glass is barely half full. But one can go to the Internet and find out just about any assessment of fossil fuel reserves and the status of alternative sources of energy that pleases their ideology. The inability of human beings to be cognizant of a potential energy crisis may be one reason why we are not doing much to alter the outcome of such a crisis.

Oreskes and Conway (2013) provide the factual history of the human failure in the twenty-first century to be aware of the consequences of their indecisions regarding the use of fossil fuels. We add that this indecision also may be due partly to the time frame involved. Three and a half billion years is an incomprehensible period of time for most people to grasp. Two hundred and fifty years is barely perceivable, but we, the authors, are old enough to have a pretty good grasp on the sensibility of a century within which dire consequences for humankind for ignoring warnings of an energy crisis may come to pass.

Homo sapiens' exploitation of the 3.5 billion year accumulation of fossil fuels due to photosynthesis has been a dance macabre in slow motion. Only now, near the end of the 250 years of depletion of those fuels, has the tempo picked up such that some are beginning to realize the hole into which we have danced ourselves. Whether the worlds' civilizations and our species can survive another 100 years – four generations of *Homo sapiens* – is something we ought to think about seriously.

Homo sapiens are neither infallible nor so endowed by a divine creator that they are immune to the fate of other animals that are becoming extinct all around us at an alarming rate. Chomsky's allusion in the headline to this paper to the lethal component of the evolution of our intelligence, for which arrogance may be an appropriate synonym, may trump our misguided faith that our divine endowments will spare us from these extinctions. Still, we may be special enough to resolve the dialects of energy in our liminoid state and emerge with reliable sources of energy that will ensure the future of planet Earth. On the other hand, we may not.

Ridley (2011) argues optimistically and compellingly that we will overcome any problem that threatens us because of our innate creativity and ability. We have done it before and we will do it again according to Ridley. Price (1995) at the other extreme provides an equally compelling argument that *Homo sapiens* as well as their civilizations could become extinct. Price presents a lucid and mechanical analysis of how the exhaustion of our fossil fuels and lack of alternative fuels will induce starvation, social strife, and disease that will result in the extinction of *Homo sapiens*. Looking back from the future, Oreskes and Conway (2013) present a more cautious middle road consequence of ignoring the crisis. Through flukes of fate the Earth begins to recover in the twenty-fourth century from the collapse in the late twenty-first century induced by political inaction. Surviving populations (those in Australia and Africa were wiped out) emerge from their liminoid state 300 hundred years later and begin to regroup and rebuild.

The fate of our species and civilizations may be determined by our misplaced energy priorities. The depletion of our photosynthesis induced energy sources with no alternative energy sources available in sufficient kind and amount to meet human needs is the real threat to our species. *Homo sapiens* could survive a warmer planet. But they cannot survive on a planet devoid of the energy sources that enable human societies to work and meet their basic needs and survive. The continual abuse of these resources may leave no human civilization to globalize.

The human race has dug a deep hole for itself regarding the future of the energy supplies we need to survive. We may still be able to dig ourselves out. And a globalized world government may indeed be the future steward of our resources and do better for humankind than those governments to which we now, often reluctantly, pay homage. But time is not in our favor. If the world stopped its emission of CO_2 and other polluting gases today global warming would continue, perhaps for centuries. Instead of a unified globalized world comprised of a single government that will respond intelligently to global energy needs a more likely scenario is one of increasing conflict among tribalized nations over access to energy resources. *Homo sapiens* may well be in a liminal space from which there is no exit.

For hundreds of thousands of years human being relied of energy that ascended along a boundary derived largely from plants and animals. Gradually that boundary also incorporated energy supplied by wood, wind and water. The evolution of social organization that began about 300 years ago in the mid-eighteenth century (*circa* 1750) relied increasingly on an energy boundary consisting of fossil fuels that were harnessed and put to work by an increasingly more efficient industrial technology. The energy derived from fossil fuels will someday peak and begin an inevitable descent along its boundary. If the descent of fossil fuel energy along that boundary is not interdicted and replaced with alternative sources of energy and technologies sufficiently non-polluting to harness and convert that energy to work human social organizations will gradually, and then more rapidly, begin to devolve correlative to the descent of fossil fuel along that boundary. If fossil fuels are exhausted and not replaced with other sources of reliable energy, human societies and cultures, as well as our species, may become extinct.

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NOTES

[1] The citations referring to globalization in print and on line are too numerous to mention here, but a good source for international points of view on globalization is the *Journal of Globalization Studies.*

[2] Some might argue that climate change and water shortages are more critical considerations than energy. Water requires energy to be pumped as well as purified for drinking. The adverse affects of

climate change – greenhouse gases, heating of the planet, mega-storms, nature fires, shifting weather patterns – are all products of our exploitation of fossil fuels and expelling CO_2 into the atmosphere.

[3] Those who disbelieve this accounting should consider the global social, cultural and institutional problems that require resolution to establish a less tumultuous world: political conflict, rebellions, warfare, economic instability, expanding unemployment, capitalist greed, terrorist proliferation, ethnic prejudice, nativistic religious revivals, widening class inequality, deepening poverty, judicial chicanery, kinship ambiguity, gender phobia, epistemologies of faith trumping those of science with regard to ecological and environmental problems, such as climate change, a warming planet, surfeits of mega-killing storms, fires, floods, and maelstroms, among others.

[4] An advertisement from the natural gas industry currently running *ad nauseam* on American television commercials announces that natural gas will provide 'a secure energy future for generations to come!' Print media is replete with claims that fossil fuels will be available for many more decades and centuries.

[5] This account was published in *Daedalus*, the official journal of the American Academy of Arts and Sciences. The authors are historians of science and the article is fictional. But it is not an 'amazing pulp' science fiction. Its projections convey a reasonable future possibility and express that subliminal anxiety underlying the energy crisis we are confronting.

[6] The evolution of a world government is not a science fiction and need not take as long as Carneiro (1978) predicts. The infrastructure of this government already exists in the framework of the United Nations. The major impediment to this reality is the lack of power invested in the offices that constitute the structure of a world government. The structure has the offices necessary for a central authority, the Secretary General and attendant bureaucracies. But no office has the power to tax and thereby support fully other institutions, a world court or standing army for example, with legitimate jurisdiction over all world nations (see Kurtz 2004 for the significance of an 'office' in political evolution).

[7] Thanks to Jerry Hanson for alerting me to Bodley's excellent work.

[8] Unless identified otherwise each graph is original and relies on data collected and processed by Manuel Fustes and Donald V. Kurtz.

[9] To clarify Fig. 1, Column 1 identifies the approximate time when various energy sources became important to human populations. Column 2 depicts the sources of major energy upon which human populations rely. Column 3, 'energy boundaries', relates to the 'work' in column 4 that is a consequence of the energy produced in column 2. Column 5 establishes the various technologies that harness the sources of energy in Column 2 and enable the increasing institutional differentiation and specialization in social organizations in the funnel-shaped Column 6 that are adapted to the various preceding techno-energy systems. The various models by which anthropologists have depicted general evolution also are shown in Column 6.

[10] A few populations that participated in this 'revolution' occupied grass land niches amenable to pastoral adaptations. They relied primarily on domesticated animals and were to some greater or lesser degree nomadic.

[11] Hardin's (1968) account of the *Tragedy of the Commons* challenges the assumption that reliance on renewable sources of energy would allow human populations to grow and thrive in perpetuity. He argues that human greed in conjunction with population growth would make survival of our species and civilizations problematic.

[12] Leslie White was correct when he said that according to the Second Law of Thermodynamics 'the cosmos as a whole is breaking down structurally and running down dynamically'. But his commitment to the power of the idea of culture led to the mistaken assertion that, 'in a tiny sector of the cosmos

... in living systems, the direction (of the Second Law) is reversed (and) matter becomes more highly organized and energy more concentrated ... (because) culture is (the) means of carrying on the life processes of ... Homo *sapiens*' (White 1949: 367ff.; parentheses added). The Second Law will prevail.

[13] A Canadian ex-ambassador to a near east country and current member of the board of directors for Shell Oil asserted that there was at least 200 years of oil left and not to worry if that estimate was wrong because there are a host of alternatives in the wings that can take up the slack (John Wood, foreign service agent, personal communication, 2013). This kind of assessment is wide spread.

[14] M. King Hubert (1969) coined the idea of 'peak oil theory' when he argued that sometime in the future oil would 'peak' and then decline.

[15] ExxonMobil thinks that 'peak oil is garbage', and OPEC denies peak oil theory and sees no sign of oil peaking (Hirsch 2006: 13).

[16] On the other hand, other sources show world population growth increasing to 10,853,800 to the year 2100 (URL: http://www.populationinstitute.org/resources).

[17] This history is well-known. The World Wide Web is replete with figures, graphs, and tables that show with minor variations this pattern of population growth.

[18] The per capita energy consumed as food in Fig. 5 refers to consumption by human beings and domesticated animals. We added waste as a factor to be considered. Throughout prehistory human populations wasted an often incalculable amount of food. That practice continues in the United States, especially among the affluent (Rathje and Murphy 1992), where, in general, '160 trillion BTU of energy were embedded in wasted food in 2007... approximately 2 per cent of annual energy consumption in the United States' (Cuellar and Webber 2010: 6464).

[19] Hardin (1968) suggests a similar analysis of the relationship between caloric consumption, work, population growth, and their consequences for the survival of humankind.

[20] In compliance with acceptable theoretical practice in Fig. 7 we leveled the several minor perturbations in energy consumption the United States experienced between 1970 and the present.

[21] Data upon which Figs 8 and 9 rely may be accessed at: Population Growth over Human History (2006). URL: http://www.globalchange.umich.edu/globalchange2/current/lectures/human_pophuman_pop.html.

[22] The gender balance between males and females in the 20 to 29 age cohort in 1975 may be accounted for by the use of birth control technologies by females in that cohort.

[23] Images are common in developing nations of children begging, shining shoes, selling chewing gum, candies, and other things, dancing to a father's off-key guitar strums, rummaging in garbage dumps, stealing, picking pockets, and so forth. They are poignant testimony to these circumstances.

[24] I thank John Driggers for introducing me to this term.

[25] Oreskes and Conway put this occurrence differently. In the factual section of their fictional depiction of the collapse of western civilization they point out that, 'By 2012, more than 365 billion tons of carbon had been emitted into the (Earth's) atmosphere since 1751 (as a result of burning fossil fuels). Staggeringly, more than half of these emissions occurred after the mid-1970s (and) between 1992 and 2012 total CO_2 emissions increased by 38 per cent' (Oreskes and Conway 2013: 45, parentheses added).

REFERENCES

Abilov, S. 2011. *Industrial Revolution and the Great Divergence between East and West.* Washington, D.C.: Rethink Institute.

Adams, R. N. 1975. *Energy and Structure: A Theory of Social Power.* Austin, TX: University of Texas Press.

Annual Energy Outlook with Projections to 2040. 2013. United States Energy Information Administration. URL: http:/www.eia.gov/forecasts/aeo/index.cfm.

Bodley, J. H. 2012. *Anthropology and Contemporary Human Problems*. Lanham, MD: Altamira Press.

Carneiro, R. L. 1978. Warfare as a Mechanism of Political Expansion. In Cohen, R., and Service, E. R. (eds.), *Origins of the State* (pp. 205–223). Philadelphia, PA: Institute for the Study of Human Issues.

Cohen, Y. A. (ed.) 1968. *Man in Adaptation: The Cultural Present.* Chicago: Aldine Publishing Company.

Cohen, Y. A. 1969. Social Boundary Systems. *Current Anthropology* 10(1): 103–126.

Cook, E. 1971. The Flow of Energy in an Industrial Society. *Scientific American* 225(3): 134–144.

Cuéllar, A. D., and Webber, M. E. 2010. Wasted Food, Wasted Energy: The Embedded Energy in Food Waste in the United States. *Environmental Science Technology* 44: 6464–6469.

Dresselhaus, M. S., and Thomas I. L. 2001. Alternative Energy Technologies. *Nature* 4114: 332–337.

Drobot, G. A. 2012. The Issue of Global Governance in the Context of International Relations Theory. In Grinin, L. E., Ilyin, I. V., and Korotayev, A. V. (eds.), *Globalistics and Globalization* (pp. 300–308). Volgograd: 'Uchitel' Publishing House.

Goldschmidt, W. 1959. *Man's Way: A Preface to the Understanding of Human Society.* New York: Holt, Rinehart and Winston.

Gore, A. 2006. *An Inconvenient Truth: The Planetary Warming and What We Can Do About it.* Emmaus, PA: Rodale.

Grinin, L. E., and Korotayev, A. V. 2012. The Coming Epoch of New Coalitions. In Grinin, L. E., Ilyin, I. V., and Korotayev, A. V. (eds.), *Globalistics and Globalization Studies* (pp. 350–365). Volgograd: 'Uchitel' Publishing House.

Hardin, G. 1968. The Tragedy of the Commons. *Science* 162(3859): 1243–1248.

Hirsch, R. L. 2006. Peaking of World Oil Production: An Overview. *Atlantic Council Workshop on Transatlantic Energy Issues.* October, 6: 1–39.

Hubert, M. K. 1969. Energy Resources. In *National Academy of Sciences-National Research Council, Committee on Resources and Man, Resources and Man: A Study and Recommendations* (pp. 157–242). San Francisco, CA: W. H. Freeman.

Kurtz, D. V. 1982. The Virgin of Guadalupe and the Politics of Becoming Human. *Journal of Anthropological Research* 38(2): 194–210.

Kurtz, D. V. 2004. The Evolution of Politics and the Transition from Political Status to Political Office. *Social Evolution and History* 3(2): 150–175.

Kurtz, D. V. 2008. Social Boundary Networks and the Vertical Entrenchment of Government in Early State Formations. *Social Evolution and History* 7(1): 131–153.

Leed, E. J. 1979. *No Man's Land: Combat and Identity in World War I.* Cambridge: Cambridge University Press.

McKay, A. 2012. Seven Myths Used to Debunk Peak Oil, Debunked. *Transition Voice.* URL: http://www.transitionvoice.com/2012/05/. Archived May 4, 2012.

Monbiot, G. 2012. We Were Wrong on Peak Oil. There's Enough for US All. *Common Dreams: Published in the Guardian, UK, July 3.* URL: www.commondreams.org/view/2012/07/03-5.

Oreskes, N., and Conway, E. M. 2013. The Collapse of Western Civilization: A View from the Future. *Daedalus, the Journal of the American Academy of Arts and Sciences* 142(1): 40–58.

Price, D. 1995. Energy and Human Evolution. *Population and Environment: A Journal of Interdisciplinary Studies* 16(4): 301–319.

Population Growth over Human History. 2006. URL: http://www.globalchange.umich.edu/globalchange2/current/lectures/human_pop/human_pop.html.

Rathje, W., and Murphy, C. 1992. *Rubbish: The Archaeology of Garbage.* New York: Harper Collins Publisher.

Reischauer, E. O. 1946. *Japan: Past and Present.* New York: Alfred A. Knopf.

Ridley, M. 2011. *The Rational Optimist: How Prosperity Evolves.* New York: Harper Perennial.

Sahlins, M. D., and Service, E. R. (eds.). 1960. *Evolution and Culture.* Ann Arbor, MI: University of Michigan Press.

Steward, J. 1955. *Theory of Culture Change: The Methodology of Multilinear Evolution.* Urbana, IL: University of Illinois Press.

Turner, V. 1979. *Process & Performance & Pilgrimage.* Concept Publishing Company. New Delhi.

Tverberg, G. E. 2012. Oil Supply Limits and the Coming Financial Crises. *Energy* 37(1): 27–34.

Van Gennep, A. 1960 [1908 in French]. *The Rites of Passage.* Chicago: University of Chicago Press.

White, L. 1949. *The Science of Culture.* Toronto: Farrar, Straus and Giroux.

White, L. 1959. *The Evolution of Culture.* New York: McGraw Hill.

World Coal Institute. n.d. *Coal & Energy Security*. URL: http://www.worldcoal.org/coal-society/coal-energy-security/.

Yergin, D. 2011. There Will Be Oil. WSJ. com. *Life and Culture: The Saturday Essay* (pp. 1–6). URL: http://online.wsj.com/article/.html. Accessed 6/12/2012.

Zittel, W., Zerhausen, J., and Zerta, M. 2013. Fossil and Nuclear Fuels – The Supply Outlook. *Energy Watch Group / Ludwig-Beolkow-Foundation / Reiner-Lemoine-Foundtion.* www.Energywatchgrop.org.