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FRAMEWORK OF THE FUTURE

An NPG Forum Paper
by Walter Youngquist

DR. WALTER YOUNGQUIST: A GEOLOGIST'S PERSPECTIVE ON THE HUMAN PREDICAMENT

A Tribute by Leon Kolankiewicz

Several years ago I gave a presentation called "Geo Destinies in the Coming Age of Geo Scarcity." It was, of course, inspired by the seminal research and writing about depletion of the petroleum and minerals geologist Walter Youngquist. At the outset of my talk, I extolled his landmark 1997 book *Geodestinies: The Inevitable Control of Earth Resources Over Nations and Individuals*.

Geodestinies was one experienced earth scientist's refutation of the patent nonsense and magical thinking peddled by so many science-challenged mainstream (neoclassical) economists over the years, to wit, that innovation, technology, and free markets would ensure that there is essentially no limit to economic and population growth – even on a finite planet with dwindling natural capital. Professor Julian L. Simon was the most famous and ubiquitous of these gurus of growth. Yet another is MIT's Robert M. Solow, winner of the 1987 Nobel Prize in Economics, who said in a 1974 lecture that: "The world can, in effect, get along without natural resources, so that exhaustion is just an event, not a catastrophe." Depletion? Big deal! The price signal in a free market will always spur innovation and substitution so that progress can continue its inexorable ascent, forever.

Not so fast, responded Youngquist and a bevy of dissident physical and life scientists. The expanding human enterprise of the last two centuries, since the Industrial Revolution, is utterly reliant upon a host of renewable and non-renewable natural resources as well as crucial ecosystem services. No water, no food. No oil, no food – at least not in the abundance and variety that we now take for granted. It is delusional, argued the "limits" camp, to believe that human ingenuity is so omnipotent that it can simply wish and will resources into being.

Walter Youngquist's vast store of knowledge and his insights on oil, gas, and mineral resource depletion were derived less from abstract theories and arcane equations in dusty academic libraries and more from authentic experience on the ground as a petroleum geologist. Yet his scholarly bona fides shine as well. He received his Ph.D. in geology from the University of Iowa. Youngquist is an emeritus member of the American Association of Petroleum Geologists, as well as a Fellow of the Geological Society of America and the American Association for the Advancement of Science (AAAS).

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The professional baseball catcher and homespun philosopher Yogi Berra once famously said: "Predictions are always difficult, especially about the future." Probably true. Nevertheless, enough facts and trends are already emerging so that, to a considerable extent, the framework in which humanity will have to live is becoming apparent. The subsequent views here only relate to the next hundred years or so. The more distant future for humanity is so vague as to preclude significant conclusions.

There are several circumstances that will be most important in the future. Perhaps the first is the departure of fossil fuels in their abundance and the way we now use them. Most important of the three – coal, oil and natural gas – is oil. No other substances coming into common and widespread use have so rapidly and profoundly changed the world in so many ways as has the use of fossil fuels, especially oil. For thousands of years, centuries came and went with little differences. But beginning about 1750, the use of coal provided the basis for the start of the Industrial Revolution, which continues to this day.

Underlying all activity is energy. Without energy nothing happens. Here arises the important concept of EROEI – energy returned on energy invested. What energy is produced beyond the energy needed to produce the energy is energy surplus. The modern world is built on an energy surplus. Cities – with all their infrastructure, health care, education facilities, and factories – are all a product of an energy surplus. Widespread use of fossil fuels, especially oil, inaugurated a time of a high EROEI, but worldwide the EROEI is rapidly deteriorating from an average of 40:1 to an estimated 17:1 by 2020. Unless some new energy source is discovered there seems no solution to this vital problem. It probably takes an EROEI of at least 7:1 to maintain world economies as we have them now. A declining EROEI has a critical importance in its negative effect on agricultural productivity, now supporting some 7.4 billion people. Recent rapid growth in population is a result of the multiple effects of a high EROEI we have enjoyed.

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Walter was a friend, colleague and admirer of the late ecologist Garrett Hardin, author of the influential 1968 essay in the journal *Science* "The Tragedy of the Commons," and many other hard-hitting tracts. I have a photo showing Youngquist standing alongside Hardin and the late geologist L.F. "Buzz" Ivanhoe, of the Colorado School of Mines, three giants of the biological and earth sciences. Youngquist collaborated on several energy studies with electrical and systems engineer Richard C. Duncan, Ph.D, creator of the "Olduvai Theory" and director of the Institute on Energy and Man.

It almost goes without saying that Walter has long been deeply troubled by the human population growing unsustainably and exponentially, outstripping the capacity of natural resources ranging from oil to freshwater aquifers to support this growth. In this, he follows in the footsteps of another legendary geologist, M. King Hubbert – the "oracle of oil," who initially predicted the phenomenon of what is now called "peak oil." Hubbert's "peak oil" theory predicted first a domestic and then a global peak, followed by an inevitable decline, in the production of hydrocarbons – the life-blood of industrial, globalized civilization.

As a freshman at Virginia Tech four decades ago, I vacillated between majoring in forestry & wildlife management or geology. I took, enjoyed, and aced three undergraduate-level classes in geology, but I ultimately turned away from this major because I realized it would mean going to work for an oil or mining company. At that idealistic and innocent – no, naïve and sanctimonious – stage of my life, I wanted to "save the Earth" and not subject it to further violation and exploitation. Fortunately, long ago I recognized the error of my thinking: my various little hypocrisies and inconsistencies. Over the years, I grew increasingly grateful for the breakthroughs and backbreaking work of geologists, engineers, miners, and drillers in enabling the energy-intensive, mobile, wide-ranging lifestyle I and millions of others enjoyed.

Yet I also became increasingly aware of the dire warnings issued by of some of these same far-sighted geologists – for whom a million years is but the blink of an eye – that the era of fossil-fueled energy abundance and economic affluence that is now cresting is but a fleeting phase in the vast sweep of geologic and human history. What will replace it? Collapse into chaos, war, suffering, and die-off – or a relatively benign transition to an enduring and humane future powered by renewable, post-carbon energy sources? The answer is not at all yet clear.

One of the most attentive and astute of thinkers and writers on the compelling topic of human and civilizational survival is Walter Youngquist, whose command of geology has given him a long-term perspective and a sense of the ages often lacking in other analysts and writers. His lengthy career has provided a wealth of experience, and these insights have fueled the significant contributions he has made to NPG's library of publications. Dr. Youngquist's works have enriched readers with a deeper understanding of fossil fuel depletion, and provided us with an ecological window into the ever-shortening Era of Oil-Driven Affluence that some are now enjoying – an era which he warns is coming to a close.

Dr. Youngquist advised NPG that this paper, *Framework of the Future*, may be the final chapter in his work for the NPG Forum series. So it is with gratitude and the deepest respect that we thank him for his significant contributions to this organization – and to the fields of earth science and geology. His voice is one of a kind, a legend among scientists and environmentalists alike, and he has helped greatly in the mission to preserve a livable American future.

Leon Kolankiewicz is a wildlife biologist and environmental planner with a professional career spanning more than three decades. He has written frequently for NPG and is a member of our Advisory Board.

With use of fossil fuels, no longer was energy – in very limited amounts, provided only by human and animal power – in control of how humans lived. The first use of coal was in the steam engine, used initially to de-water the ever-deeper British coal mines. It then was gradually employed in many other ways. Use of coal in Great Britain inaugurated the Industrial Revolution. The last British coal mine was closed in 2015, symbolic of the fact that oil is now the dominant fossil fuel in use today.

The major change in energy sources came about in 1859 when the Drake well was drilled near Titusville, Pennsylvania. Oil has a greater energy density, weight for weight, than coal – and it leaves no problem of ash disposal when burned. It can be used in many more ways than coal, first in the internal combustion engine. Use of oil in this way, and in the form of various chemical derivatives, was the basis for the Agricultural Revolution whereby one person could farm large acreages – providing abundant food for many people who, in turn, could migrate and form cities and pursue a variety of occupations.

Abundant food and improvement in health services was the basis for the spectacular growth in human population, projected by the United Nations to grow from the present 7.4 billion to 11 billion by the year 2100, a year many people now living will see in their lifetime.

Based on fossil fuels, the world became industrialized providing many things previously unknown. One significant aspect of this newly emerged civilization was the much greater increase in mobility of both commerce and people. Roads, paved with the refinery residual product of oil, asphalt, spanned much of the world. Personal transport, by now approximately one billion vehicles, became common. A huge truck and automobile manufacturing industry now employs many people, as does electronics in many forms.

Air travel, once only a dream, rapidly became a reality. The speed of this development is phenomenal. The first flight of heavier-than-air machines, carrying just one person in 1906, has now evolved into multiple-engine aircraft carrying millions of people on short local flights and on intercontinental flights of 8,000 miles or more at speeds of as great as 500 miles per hour. This could never have been visualized a century ago.

Now we have a huge mechanized agricultural industry and huge industrialized economies, all of which makes for a previously unknown dilemma for humanity. The dilemma comes from the fact that the fossil fuels supporting all of this are finite, and are being depleted at an increasingly rapid rate. Worldwide we now use approximately 93 million barrels of oil a day. The peak of oil production is now in sight, and is certain to occur this century. This will be a monumental event, with huge related changes to both lifestyles and economies, and bring about the end of economic growth – the God of most economists and politicians.

There is now an increasing hopeful belief that fossil fuels can be easily replaced by alternative energy sources, leading of which are solar and wind, both undependable intermittent sources. Other alternative energy sources – including tides, waves, hydropower, and geothermal – are site specific. Atomic energy has been shown to have many problems. And the end product of all alternative energy sources is electricity, which is not nearly so versatile in its uses as is oil and its many derivatives. Roads cannot be paved with electricity. Petrochemicals, important to agriculture, cannot be made from electricity.

The use of oil has transformed the world. Its depletion to the point where it can only be used for high value end products will similarly transform the world, but with many negative effects in contrast to the many positive effects brought with the use of oil. Oil is the lifeblood of today's civilization.

This is the human dilemma. We have built a world based on fossil fuels, largely oil, and moving on to much less energy-dense and much less versatile alternative sources in the face of an ever-growing population is a challenge before us, the scale of which has never before been encountered in the course of all human history. If there is a solution to this problem it is a greatly reduced and much less affluent population. A major aspect of this dilemma is the present size of human population. It is doubtful the 7.4 billion people here now, and the billions more expected, can be sustainably supported in any decent standard of living beyond the time of the widespread use of fossil fuels – a brief bright blip in human history.

The end of the time of fossil fuels will bring highly visible changes in economies and lifestyle. The end of the time of use of fossil fuels looms to most people as a chief concern for the future, but a much more serious problem is regarding water supplies. Civilization existed for thousands of years without oil, but it could only exist for a few days without the use of water.

Although most of the world's crops are sustained by rainfall, a significant amount is produced by exploitation of underground aquifers – groundwater. Their use is essentially worldwide. Yet, without exception, no nation is managing its groundwater resources sustainably. In the western Great Plains of the United States, the Ogallala aquifer is the sole source of water for many communities and is fast becoming depleted – to the point where it is no longer a viable water source. These communities may soon no longer exist. In north Texas, some 15,000 square miles of agricultural land has had to be abandoned as the Ogallala aquifer is totally depleted.

The 21 million wells drilled in India and heavy use of groundwater in the North China Plain have markedly drawn down water tables in these areas and negatively affected agricultural production. These countries cannot afford to lose water supplies as populations continue to grow – especially India, projected to have 1.66 billion people by 2050, surpassing even China. A related effect of aquifer depletion is the subsidence of the overlying land surface. In portions of the San Joaquin Valley of California, the land surface has dropped 29 feet. Beneath Beijing, China the land surface is also subsiding from aquifer over-pumping and subsequent collapse. The same but more severe problem affects Mexico City and environs. Once collapsed, a groundwater aquifer is lost forever.

The miracle of increased agricultural production through the widespread use of fertilizers, selective plant breeding, and abundant water supplies is about maxed out. Agricultural production nearly everywhere has leveled off, and in some places it is declining. The rise in agricultural production was a one-time event. As population increases, in the few areas now with agricultural surpluses for export, domestic demand is increasing and exports are decreasing – an ominous trend. With some 27 countries now dependent on importing food supplies to feed their growing populations – when food is no longer available to import, what then? That time will arrive in the not-too-distant future.

Widespread famines have occurred in the past, and famine may again stalk the land. This makes the point that in the future, food supplies will be an increasing concern for all countries. Production of food will be the number one priority above all others. Cities may show a decrease in population as more and more people will have to return to farming the land. But arable land is in limited supply and may not be able to accommodate the numbers of people attempting to return to farming pursuits.

The combination of the passing of the time of widespread use of fossil fuels (especially oil), the depletion of water supplies and resulting reduction in agricultural production, and depletion of nonrenewable Earth resources – both metal and nonmetal – will ensure the arrival of turbulent times by the end of this century, if not before. The result affecting all humanity cannot now be visualized, but it will surely involve a reduction in world population and a permanent lower standard of living for all – especially for those in the current industrialized countries.

World demographics are changing. Millions of people are on the move as never before. Some are fleeing the ravages of war, others from impoverished lands unable to feed them, and some simply to get a better life for themselves and their children.

How and when this mass movement of people will play out can hardly be predicted. Much of it is due to the simple fact that the world now has too many people to adequately support in any decent standard of living. E.O. Wilson of Harvard has called continued

population growth "the raging monster upon the Earth." It continues at the astounding rate of 243,000 people a day!

This continued growth in world population exacerbates nearly all other problems. Albert Bartlett clearly made the point, stating that all problems of the future would be more easily mitigated if not solved by a smaller population. Yet for the most part discussion of the need for population reduction is carefully avoided by nearly all political bodies. The United States has no population policy, nor has the matter ever come up for serious political discussion.

Another concept that is never brought up is that of the limits to growth. Growth is the idol that nearly all economists worship – there must be continued growth in sales and profits. Consumers must consume more. The Federal Reserve Board of the United States is committed to continued growth in the economy, and strives by means of low interest rates to stimulate growth. If a company does not grow, it is shunned by investors.

A no-growth, steady state economy is unimaginable to most economists – a notable exception being Herman Daly, who has long advocated a steady state economy. The idea is ignored. But an economy that continues to grow must consume more and more natural resources, only to exacerbate the increasing rate of a decline in both quantity and quality of these resources.

With the technology now available, we are plundering the Earth as never before. We are sacrificing the future for the greater prosperity of today that some economies currently enjoy. We leave a much degraded resource base on which all future generations must exist, an important fact in the framework of the future. This situation combined with continued population growth precludes a prosperous future. It was a great ride while it lasted – for the fortunate people in the industrialized world able to procure worldwide the resources necessary for "the good life" some have enjoyed.

One striking feature of the future is, with the passing of the time of fossil fuels, especially oil, there will be a great decrease in mobility. Airline travel will be a thing of the past. Grapes from Chile will no longer arrive in the United States in January. As asphalt supplies decrease because of the decrease in oil production, maintaining the now 3.8 million miles of paved roads in the United States will be prohibitively costly. The only recently completed 46,000 mile U.S. Interstate Highway System will deteriorate, as well as the similar system completed in China. Millions of miles of paved roads throughout the world will deteriorate. The result will be a reduction in trade. Supplying the cities with foodstuffs from distant sources will no longer be possible. The average fare on U.S. dinner tables now travels a total of about 1,500 miles to get there.

Activities will also become more local, and communities will become more inter-dependent as resources for existence can no longer be derived from distant sources. How foodstuffs can be transported to regions even now in short supply is not known, but increasingly each country will have to depend on what they can produce. This circumstance will perhaps become chaotic for some countries as they face the fact that they must reduce population to levels sustainable on local resources, especially food. That this will be done voluntarily is very unlikely, which may mean that the historical times of reduction of population by famine will again occur.

Beyond the twenty-first century, and perhaps earlier, it will be a far different and much less affluent world than what we now have. In only a brief moment of time, we have plundered the planet of its nonrenewable resources – and degraded its renewable resources for an affluent present for some of us, ignoring the needs of future generations. Whatever finally emerges will be the framework of the future. Stresses from a growing population and depletion of supporting Earth resources are gradually becoming apparent. Industrial civilization is a one-time event. We have enjoyed very unusual times, much different from the norm, never to be repeated.

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Dr. Walter Youngquist has worked both as a petroleum geologist and a minerals geologist in the United States and abroad. He has visited more than 70 countries, observing the ongoing problem of continued population growth and declining supporting Earth resources. A Fellow of the Geological Society of America and the American Association for the Advancement of Science, he is the author of *GeoDestinies* and several NPG Forum papers.

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