

## Earth, and Humankind's Role in its History

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Earth Day was last Tuesday, so this morning I would like to review a little of Earth's history, and of humankind's brief role in it. I will also touch on the future of Earth and of humankind.

We have all seen pictures of Earth from space showing it as a magnificent blue and white marble floating in space. Although not visible from space, the Earth is teeming with millions of life forms from the tiniest microbe to the largest elephant or whale. In recent decades we have discovered that some forms of life exist from the upper reaches of the atmosphere to deep in the ground, and down to the depths of the deepest oceans.

This layer of life is commonly called the biosphere. It seems thick to us, but when compared to the diameter of the Earth, it is comparable in thickness of the skin on an apple, and we are reminded that both are relatively thin and fragile. The biosphere is probably the most complex structure in the universe. Some have suggested that it be viewed as a sort of super life form and have called it Gaia, after the Greek goddess.

How did Earth get to be this way? And how does humankind fit into the picture?

The Earth formed, along with the Sun and the rest of our solar system, about 4.5 billion years ago by the coalescing of cosmic dust. At that point the universe was already about 10 billion years old.

The long wall behind me is about 45 feet long, so let's visualize the history of the Earth displayed along it. If the formation of the Earth took place at the front corner, then every 10 feet along the wall represents about a billion years, and the present era is located at the back corner of the room. Let's add a few key events in the history of Earth on this imaginary chart to put things in perspective.

The simplest forms of life first appeared on Earth about 3 billion years ago; that would be about 1/3rd of the way back from the front corner. So, some form of life has been present on Earth for an exceedingly long time. However, the story of life on Earth is not one of unending progress and growth in complexity. The fossil record shows that life has nearly been extinguished at least six times.

The last major extinction event occurred 65 million years ago when a large meteor struck off the coast of the Yucatan Peninsula. That impact produced what amounted to a nuclear winter, and led to the sudden demise of 90% of all species, including the dinosaurs. On our time chart that would be a point about 8 inches from of the back wall.

Contrary to Hollywood movies there were no humans around to experience that event. However, there were small mammals, some of which survived to evolve into primates and eventually

modern man, us, Homo sapiens. We made our appearance a mere 250,000 years ago. On our wall chart the period of human existence on Earth is a line about 3/100ths of an inch long. That is comparable to the thickness of a human hair! Thus, our history is quite insignificant compared to the history of Earth up to this point, so how important could we possibly be to the future of the Earth?

In order to answer that question, we need to zoom in and focus on that tiny sliver of time during which humankind has existed, that 250,000 year period. For 96% of that time man lived as a hunter-gatherer; it was only a mere 10,000 years ago that we discovered how to domesticate plants and animals. Those discoveries were crucial because they lead to animal husbandry and agriculture, which ultimately facilitated the creation of numerous civilizations, including the present world-wide civilization of which we are a part.

The next part of our story is best viewed from the vantage point of energy. All life requires energy; food is not optional. As long as we remained hunter-gatherers the multiplication of our species was severely limited by the availability of energy in the form of wild foods. With the advent of animal husbandry and agriculture, the door was opened to ten thousand years of steady growth and expansion; we had more food, i.e., more energy, so we could feed more people and animals, including draft animals to do heavy work, so civilizations arose. This situation persisted until the early nineteenth century when we learned to combine the energy in coal with the inventions of the industrial revolution. That led to a perceptible acceleration in the growth of the human population. Next we discovered new sources of energy, oil and natural gas. They quite literally threw gasoline on the population flame; there followed a burst of growth for which there seems to be no end in sight.

This explosion in human population is depicted on this graph [see attachment] which shows world population from the time of Christ at your far left to the year 2050 on your far right. The blue line shows that the population growth was very gradual until we began using fossil fuels with reckless abandon in the mid-1900s; then population growth exploded as you can see. World population was about 1 billion in 1900, today it is about 6.5 billion, and, barring some spectacular catastrophe, it will pass 9 billion in 2050. In other words, we expect to add about ten times the current population of the US in only 40 years; many of the people in this room will live to see if that transpires

The growth in our consumption of fossil fuels, i.e., our use of energy, is also shown on this graph as a red line. You probably cannot see that curve because it lies pretty much right on top of the blue population curve. In other words, the two factors, energy consumption and population growth, have gone hand-in-hand for thousands of years.

Today's world population could not possibly survive as hunter-gatherers. Massive human intervention is needed to produce the exponentially increasing quantities of food we consume, and that intervention requires exponentially increasing quantities of arable land, fresh water, various metals, energy, etc. Since we live on a finite planet, it is obvious that our resources are finite, and exponential growth cannot proceed indefinitely, but is resource depletion at all imminent? Should we be concerned?

The answer to both questions is a clear and resounding, YES.

Consider just the question of how we will feed an additional 3 billion people over the next 40 years. From an over-all point of view, world food reserves have been diminishing for the past 35 years and are projected to vanish in two or three years; that's not promising. The UN recently reported that it did not have sufficient funds this year to purchase food to feed the hungry because of recent price increases for grains; that is not encouraging.

The fact is that world-wide nearly all the arable land is now in service; that is a major problem. In addition, fresh water that would otherwise be used for crop irrigation is currently being diverted to service human populations; an expansion of agricultural water resources by 50% appears completely out of the question. Furthermore, a sharp increase in agricultural productivity would require a sharp increase in fossil fuel consumption for manufacturing fertilizers, herbicides, and pesticides, as well as for transportation. Let's consider the fossil fuel situation further because it is the least understood by the public at large.

The fossil fuels are aptly named because they are relicts of the distant past. Coal is the residue of plant matter compressed and cooked deep in the Earth eons ago. Oil and natural gas are the remains of tiny marine animals similarly processed by nature eons ago. The fossil fuels are very unevenly distributed around the Earth. For example, as you are probably aware, the US and China have large amounts of coal, and Russia and the Middle East have large amounts of oil and natural gas.

The fossil fuels, especially oil and natural gas, are essential to humankind as feed stocks for manufacturing fertilizers, herbicides, and pesticides. They are also the starting material for many pharmaceuticals. In spite of these critical uses, humankind has thus far used fossil fuels mainly as fuels, i.e. we have burned them to generate heat to run power plants or to power vehicles. This is a dreadful waste of an essential resource, but that is what we have done. It is a little like growing grain and using it to power vehicles instead of feeding the hungry. We wouldn't be foolish enough to do that now would we!?

So, how do we stand on reserves of fossil fuels? You have probably heard it said that the US has 200 years of coal left, so how many centuries worth of all the fossil fuels do we have left altogether? That is the wrong question. It doesn't matter when we will burn the last lump of coal or the last barrel of oil. What matters is, when will supplies start to fall short of demand? Since demand will inexorably increase as world population increases over the coming decades, and underdeveloped countries strive to industrialize, the real question is when will supplies peak and start dropping? Now, that is a question we can answer, and we are not talking centuries, we are talking years.

We are accustomed to thinking of the fossil fuels as three distinct substances, but effectively they are one. In today's economy one cannot extract, transport, or utilize coal, oil, or natural gas without using oil. In fact, it is almost impossible to do, or make, anything without oil. Our dependence on oil is more than an addiction, oil is the life blood of the world economy; it can no more function without oil than we can live without blood. So, the real question becomes, when

will world oil production peak? Now, that is real easy to answer – it already has peaked, or will do so within a year or two!

That may come as a surprise to most of you. In fact, many of you will probably consider it impossible. But I can say it with considerable confidence because many petroleum geologists have been predicting just that for several decades. If you have been reading the Goodloe Greens – News and Action Bulletin which we have been emailing you since last fall, you will remember that in recent months several leading oil company executives have publicly acknowledged that peak oil production was imminent, and you will also remember that an energy monitoring institute in Germany reported categorically last fall that peak oil occurred in June of 2006, nearly two years ago.

Likewise, the experts predict natural gas extraction to peak in about one decade, coal extraction to peak in three or four decades ahead. Determining specifically when the peaks will occur is a lot like predicting when a recession will begin, it can't be determined for certain until one has some historical perspective, but it doesn't really matter anyway; an error of a few years one way or the other doesn't matter that much in the grand scheme of things.

What then is in store for us? The history of US oil production gives us some clues. US oil production doubled between 1940 and 1970 at which point it peaked. Since then it has dropped back to the 1940 level over a 40 year period, and continues to drop a few percent a year. We simply import more to make up the difference, and to cover our economic growth. World oil production will follow a similar trend; it certainly will not stop suddenly, although it is subject to the disruptive effects of war and other geopolitical events.

World production has actually oscillated in a narrow range for the past several years; it is probable that it will soon start to decline by a few percent a year such that it decreases by 50% over the next four decades. In the mean time, everything that depends on oil in any way is going to increase in price. The cost of oil will probably go up much faster than its availability goes down. After all, how do you price a commodity approaching exhaustion? The price of oil has risen by a factor of 10 over the past decade; a continued rapid rise seems inevitable.

Let's return now to the question of what we will do with the 3 billion new folks we are expecting over the next 40 years. It is impossible for me to believe that we have the arable land, water, or petrochemicals necessary just to feed them. This is not a question of money; one simply cannot buy or make these finite resources with money. Malnutrition, sickness, and starvation seem inevitable. Resource wars seem highly likely.

What then are we to do? Clearly any solution must first of all involve a rapid decrease in population growth; actually a reversal, a shrinkage, is desirable. Some studies have pegged the sustainable population of the Earth at 1 billion; that is a plausible initial goal, but how do we get there in a humane way? The right to procreate is a universally accepted right in free societies. However, it has been effectively curtailed by China's totalitarian regime. Can a democracy such as India voluntarily adopt such a policy? It hasn't so far. Can democracy, as an institution, even survive the coming challenges? In any event, curbing population growth quickly enough to do any

good is problematical in itself. It is not obvious that we can succeed at this, but we need to start trying.

What else can we do? Clearly, we need to reduce our consumption of fossil fuels in order to make them last longer. We need to power down, to make our energy use more efficient, and to eliminate frivolous uses. We have already shown that we can do that to a significant degree following the OPEC oil embargo of 1973, and especially after the Iranian Revolution of 1979 which suddenly dropped world oil production. Much, much more can be done in this area. What ever we can accomplish here will buy us time to develop alternative sources of energy.

We do not have time today to discuss all the possible renewable energy sources, so let's focus on just the two that are already commercially feasible – wind turbines and solar thermal generators. Usable wind and solar power are widely distributed across the Earth (much more so than fossil fuels), and each exists in sufficient quantity to replace all our present power consumption. Currently, wind power is the most advanced and is extensively used in Europe. In the US only 1% of our total energy budget currently comes from wind and solar sources combined; that needs to change rapidly. For example, we need to build and install about 1.5 million wind turbines and a few thousand solar thermal generating plants!

That alone is a fantastic undertaking which will require huge amounts of energy, resources, and capital, all of which are in short supply. And this is only one of many things we need to do. Some of the experts say that it cannot be done; others say it cannot be done quickly enough to ameliorate the disastrous consequences of the peak oil phenomenon. No one really knows, but we must try, and we need to get moving now.

You may have noticed that I have not mentioned global warming or climate change. That was intentional because I agree with those experts who think that the consequences of the peak oil phenomenon will be more immediate and more serious early on than those due to climate change; the major consequences of climate change are probably decades or even a century away, while the serious consequences of fossil fuel depletion are already upon us, or imminent. In addition, both problems require basically the same response, a) curb population growth, b) power down, and c) convert to renewable energy sources. Thus, if we survive peak oil, we will probably have mitigated climate change as well.

Let's return now to our master wall chart. As I said earlier, the life of humankind on Earth is a line 3/100 th of an inch long in the back corner. If you look for the two or three hundred year interval during which humankind has discovered and exhausted the Earth's fossil fuels, you will need a microscope to see it on this time scale. Whether humankind will exist beyond that time remains to be seen. But, if we do survive the next few decades, what are our long term prospects?

As it happens, the Sun is middle aged, and is expected to burn much as it does today for an additional 4.5 billion years. At the end of that time it will begin to expand dramatically as it turns into a red giant star. As it expands it will engulf the planet Mercury, and turn the Earth, and us, to toast, if we are still around. In reality, many more meteors are likely to hit the Earth before then,

any one of which could bring humankind's Earthly adventure to an abrupt end, so it is highly unlikely that humankind will survive to be toasted by the expanding Sun.

At this point I see some of you shaking your heads in disbelief. You can accept my description of the history of the Sun and Earth, but you cannot believe my description of the imminent resource depletion problem, or that it threatens our very existence. You are certain I have been out in the sun too long, or perhaps it is the moonlight that has warped my mind!

In truth, what I bring you is good news. Since we discovered the fossil fuels, and what we could do with them, we have been on an energy binge that has lasted for several generations. It is "only human" that we would assume that our current energy affluence would continue. However, this party can't possibly be sustained on a finite planet. The only people who believe that one can have perpetual growth in a finite world are economists who worship a Golden Calf called GREED. We have been warned about them many times in the past.

The bad news is that we suffer from affluenza, the sick quest for affluence brought on by consuming too much cheap energy over several generations. The good news is that we now are beginning to recognize the binge we have been on, and to realize that the party is over. We know many things we can do to alleviate the hangover which is coming: we need to reduce the world population substantially, we need to power down, and we need to transition to renewable energy sources.

The transition will not be painless - we cannot just tell people "everything is fine - go to the mall." What we really want - home, hearth, family, community, cannot be bought at the mall. If humankind is going to survive additional thousands of years, until the next large meteor strikes the Earth, we will have to stop worshipping the Golden Calf and start building a very different civilization; one that is actually built on our principles.

We stand on a threshold. We face the End Times or a New World Order, the choice is ours.