Relocalization: A Strategic Response to Climate Change and Peak Oil

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(**Note - This is a guest post by Jason Bradford, Phd in Biology and friend of TOD. In this post Jason writes on the important topic of relocalization within the broader context of ecological economics. Not only are these topics he cares about, but he is actively implementing these principles as the founder of Willits Economic Localization (WELL) in Willits, CA - Thanks for living by example Jason).*

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Introduction

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I am not giving dates of when these indicators of a shift from global to the more local will occur, except to say sometime during the 21st century, likely during the first half even. My initial point of view is not from any particular group with a political or social agenda, but as a scientist who makes deductions based on the laws of physics and ecology.

However, information from the natural world does eventually have political and policy implications that I am aware of, and have opinions about. The ability of a culture to accept information and respond timely and rationally will likely hinge on the entrenched mindsets of the populace, institutional norms, and their ability to willingly change expectations, organizational structures, and behaviors. Perhaps with prudent planning, measures of quality of life or conditions of happiness may not decline.

People may be scared or shocked and depressed by predictions of change that could lead to environmental and social disruption, but for the most part I see indifference, and that is more concerning. How people respond emotionally to facts and deductions is important too, but ultimately if people and institutions are unable or unwilling to accept information because it makes them feel badly or goes against current norms then positive change is not possible. The greatest hope, in my opinion, rests in the ability to honestly accept the reality of a difficult situation and then make the best of it before it becomes a crisis.

This is why I want to draw attention towards a global movement forming to challenge the existing economic and political systems in light of energy constraints, threats from pollution, degradation of ecosystems, the social costs of mass consumerism, and a living arrangement designed around automobiles. I am referring to the strategy of "relocalization" as promoted by the Post Carbon Institute, a think tank, media outlet, and networking and support organization for local citizens' groups around the world.[i] The crises we face require altering some of the basic operating assumptions of global consumer culture, politics and finance.

Relocalization may be a new term, but conceptually it has long roots. Some related recent precursors include E.F. Schumacher[ii], Ted Trainer[iii], Garrett Hardin,[iv] and Wendell Berry[v] as well as what are called the "anti-globalization" movement, the "slow food" movement, the "voluntary simplicity" movement, the "back to the land" movement, "new urbanism," and the "environmental movement." In general, common themes include decentralization of political and economic structures, less material consumption and pollution, a focus on the quality of relationships, culture and the environment as sources of fulfillment, and downscaling of infrastructural development.

Purpose

This paper will describe relocalization (also sometimes referred to by the related but not always identical terms "economic localization" or simply "localization"[vi]) by contrasting it with what we have now. It is crucial to understand the basic assumptions of our current economic and social arrangements, and to develop a new set of premises for guidance. I will argue that the premises behind relocalization are sound, being grounded in good science and common sense. By contrast, the assumptions of most dominant economic and social models only hold for a short historic period and have led to our current environmental and resource predicaments. Many proponents of current economic policies may be well intended, but often we end up with unsound rationalizations to justify short-term, often individual interests. What has been lost is a sense of the common good, future generations' needs, and non-human welfare.

The case for relocalization will be made in the context of responding sensibly to two problems facing societies right now: climate change and peak oil and gas. Both problems are a result of our dependency on fossil fuels, but some solutions to one will only exacerbate the other. This is why a new approach, that of relocalization, is necessary.

Relocalization is based on a systems approach that doesn't solve one set of problems only to make another problem worse.

Ecological Economics

During the era of cheap energy, which roughly corresponds to the entire 20th century, the study of economics became divorced from an understanding of how human systems are connected to systems of planetary ecology. Not surprisingly, the nearly free energy available from fossil fuels, and the rapid technological advances they fostered, made people in modern industrial societies believe they were no longer constrained by tangibles like food, energy, water, and the weather. We are now entering an age of disillusionment. The hubris of our recent past is being revealed and many are searching for a more honest and realistic reckoning of our place on Earth.

A helpful place to look for such honesty is the discipline called Ecological Economics.[vii] A conceptual model based on Ecological Economics is useful both to comprehend the current economic system and its vulnerabilities, and to guide the development of a sustainable alternative.

Predominant economic thinking usually distorts or fails to fully understand the fundamental interconnectedness of "the economy" and "the environment." In recent decades economists have begun to give more attention to the environmental or ecological dimensions of human productive activity. But even so, their formulations are typically partial or misguided from a vantage point that takes the global environment seriously.

For example, in discussions of sustainability, the relationship between the economy and the natural environment is often framed as a "balance." This connotes the idea that somehow more of the economy means more of the environment too. After all, if two things are in balance, they are of equal weight. But any empirical study of what economic growth means today discovers that it intrudes on the environment[viii] Wealthy and purportedly environmentally-responsible nations are sometimes touted as examples of how economic growth and stewardship of the planet go hand in hand.[ix] However, while local measures of air quality, forest cover, and water cleanliness may be high, the damage is simply occurring elsewhere. All wealthy nations are importers of much of their environmental carrying capacity, whether it is raw materials or finished industrial products, and these imports are possible because of fossil fuels used to mine, harvest, manufacture and transport goods. Wealthy nations protect their own environment while outsourcing the harm caused by over consumption to other places.

In the Ecological Economics model, the Human Economy is a subset of the Earth System, and therefore the *scale* of the Human Economy is ultimately limited. The Human Economy depends upon the *throughput* or flow of materials from and back into the Earth System. Just pick up any trinket in your possession and ask: What is it made of? Where did these materials come from? How much energy was used? What happens to the waste products?[x] Limits to the size of the Human Economy are imposed by the interactions among three related natural processes:

1. The capacity of the Earth System to supply inputs to the Human Economy (Sources),
2. The capacity of the Earth System to tolerate and process wastes from the Human Economy (Sinks), and
3. feedbacks caused by too much pollution.

For example, mining coal makes available a "source" of energy for industry that produces pollution, including sulfur dioxide, which causes acid rain. Too much acid rain degrades built infrastructure, and overwhelms the capacity of natural "sinks" such as forests, killing them or slowing their growth. This damage to forests not only affects our ability to use them for lumber. The loss of highly functioning ecosystems also creates new costs to society that were previously done "free of charge" through ecological processes. Air and water filtering, climate stabilization, and species interactions that moderate outbreaks of pests and disease are all "ecosystem services" that are compromised when we damage those ecosystems. Now, instead of benefiting from free ecosystem services, the human economy must provide these services itself through expensive technologies such as pollution control devices, flood control walls and canals, pesticides and medicines, and so on.

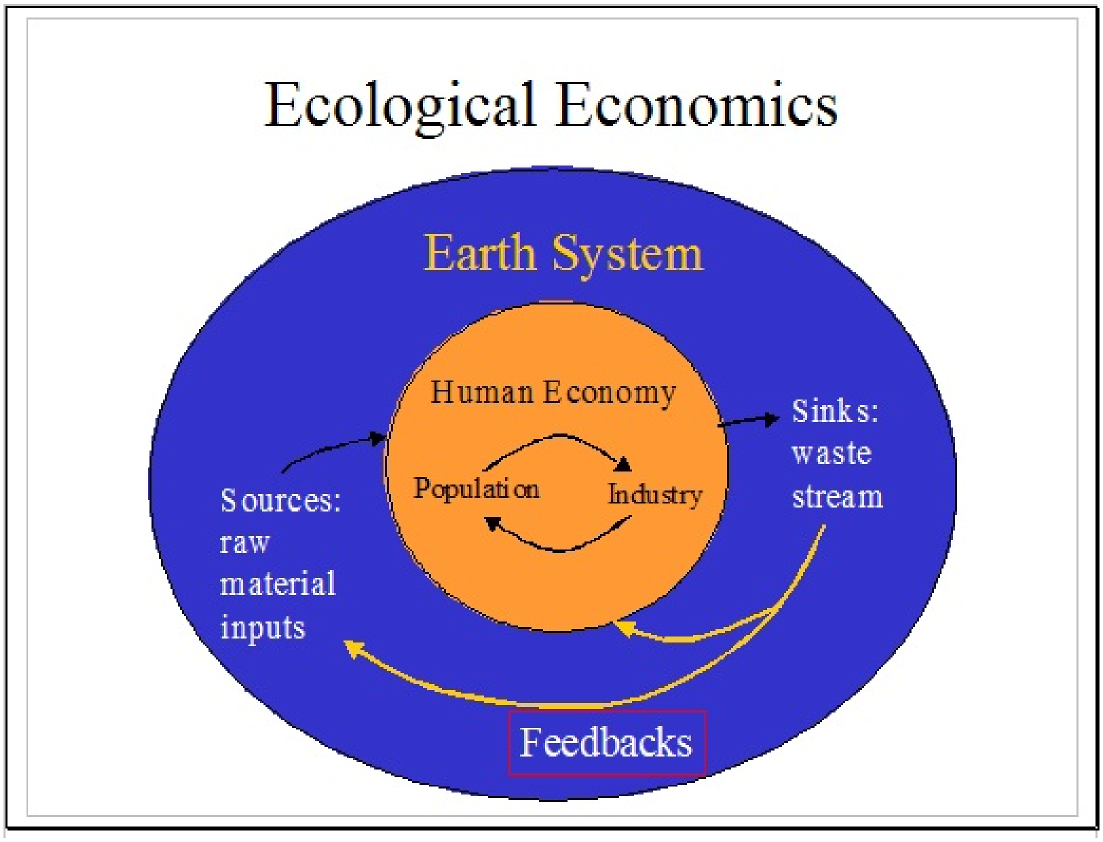

Fig. 1. The Ecological Economics Model of the relationship between the Human Economy and the Earth System highlighting the importance of sources, sinks, feedbacks and scale.[xi]

The current Human Economy is clearly unsustainable because it relies heavily on non-renewable raw material sources, the use of which produces tremendous pollution, leading to many negative feedbacks that impair ecosystems and disrupt climate. In contrast, a sustainable economy would need to run on the income from solar energy and not degrade ecosystems through the build up of wastes or the mining of nutrients.

This model can also be understood in the classical terms of different forms of *capital*. The Earth System can be viewed as the Natural Capital and all other forms of capital are nested within and dependent upon it. Population can be thought of as Human Capital, referring not just to population size, but also to people's education, skill sets, norms, standards and laws. Industry can be more broadly thought of as the tool sets people use, including their homes and transportation networks, which are also known as Built Capital. Ecological Economics views Human Capital and Built Capital as *subsets* of Natural Capital. Furthermore, these different forms of capital cannot easily be substituted for one another but are instead complimentary.

In the common framework of what is called neoclassical economics (think of Alan Greenspan), these different forms of capital are viewed as potential substitutes for one another. With this line of thinking, less Natural Capital is not so bad as long as you have plenty of Built Capital and/or Human Capital. These different forms of capital are called "factors of production." Production can remain high and Natural Capital can be exhausted as long as enough Built and Human Capital are around. Of course, at its theoretical extreme this would result in a rather absurd world: cars and drivers with no gas, ovens, kitchen utensils and cooks with no food, and chair lifts, ski instructors and season passes with no snow.

Relocalization is based on an ethic of protecting the Earth System--or Natural

Capital-- knowing that despite our cleverness, human well-being is fundamentally derived from the ecological and geological richness of Earth.

Overshoot

If the scale of the Human Economy is too large relative to the Earth System, the Human Economy is in a state of *overshoot*. This means that the environmental load of humanity on the planet is greater than the long-term ability of the planet to support it. Overshoot means we are above *carrying capacity*. This environmental load will eventually be reduced through declines in some combination of population, resource consumption and pollution. Either we tactfully manage to reduce our environmental load, or resource constraints and pollution will limit it for us unpleasantly.[xii]

The concept of overshoot can be confusing. You may ask: How can a population go beyond the carrying capacity of the environment to support it? Won't a population simply increase until it reaches carrying capacity and then stabilize? Isn't the human population projected to stabilize this century? Sophisticated modeling of resource, pollution, and consumption dynamics provides answers to these questions that support the reality of overshoot.

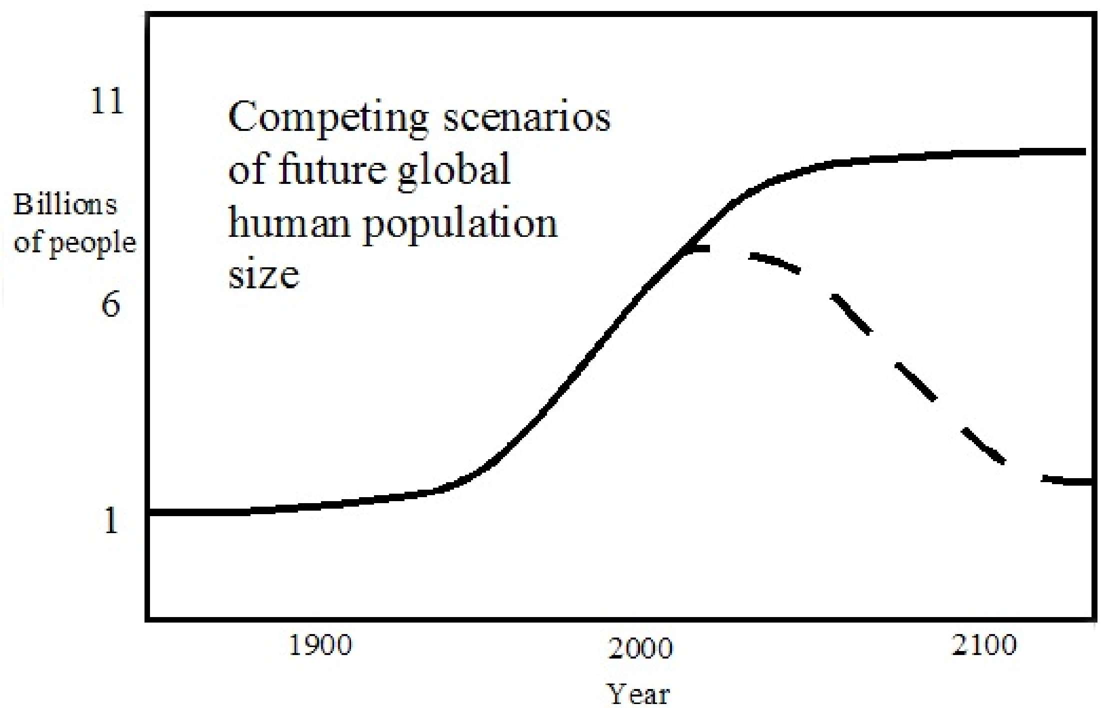

Fig. 2. Human demographic models of population show a plateau this century (solid is approximate historic and demographic projected), whereas systems models show a decline (dashed). The difference exists because human demographic models do not include negative feedbacks from either resource scarcity or pollution, whereas systems models do.

Population biology is the science of how population size changes due to factors such as mating patterns, resource availability, environmental quality, and interactions with other species, such as disease, competition and predation. *Homo sapiens* can be studied and modeled just like any other species with respect to these factors, though the high variance among people with respect to consumption and waste amounts complicates the analysis.

Population overshoot happens in a few different ways:

1. Resource windfall and drawdown,
2. Release from negative species interactions,
3. Demographic momentum, and
4. Fluctuating carrying capacity

These mechanisms of overshoot are not exclusive, and in fact, they can feed positively on one another. Here is one example of how these mechanisms have interacted (1-3) using the current human population, and what the results may be sometime this century (4):

1. People discovered a dense and versatile energy source with fossil fuels, especially oil. The use of fossil energy freed up resources, especially land and labor. Without the need to feed draft animals to power equipment, more land was available to grow food for humans.
2. With fossil-fuel powered equipment, fewer humans were needed for manual labor, enabling extended educational opportunities and a shift of resources into fields such as public health and medicine. Increased attention to public health and medicine, and corresponding technologies like vaccines, antibiotics and sanitation, increased human life expectancy.
3. A rapid increase in the human population led to a surge in the number of people within the reproductive window of life, who then reproduced also, leading to an even larger population.
4. As this population became very large it began to impact the world around it substantially. Toxic emissions built up that harmed the basic life support systems humans depend on, eventually making it more and more difficult to provide essentials, such as food. As food production declined, so too did the population.

Experts in the field of human demography project that the human population will stabilize around the middle of the 21st century.[xiii] Most people accept this analysis from population experts without knowing the underlying assumptions. Unfortunately, most studies of human population are akin to most studies of the human economy. The broader environment is not factored into models of growth. If you have ever asked yourself, "How are we going to feed 9 billion people when the soils are eroding, the aquifers are depleting, the climate is changing, deserts are expanding and oil and natural gas are going to be in short supply?" then you have stumbled upon this disconnect between most human population models and the physical world. Biologists studying any population would include those environmental factors in their models, whereas human demographers do not.

However, models exist that do incorporate the human population and our well-being into a dynamic study of resource availability, pollution levels and even climate change and the fate of ecosystems. The classic example is the World3 model developed by the authors of "Limits to Growth," where the baseline scenario shows human population declining after 2020.[xiv] Another model is GUMBO from the University of Vermont's Gund Institute of Ecological Economics.[xv] These models are not perfect, and are not presented as predictions, but they at least begin with the right premises and tell us what to be careful about.

Relocalization starts from the premise that the world is a finite place and that humanity is in a state of overshoot. Perpetual growth of the economy and the population is neither possible nor desirable. It is wise to start planning now for a world with less available energy, not more.

Peak Oil and Implications for a Transportation-Dependent Economy

Much of the relocalization movement was sparked by concerns about "peak oil."[xvi]

Petroleum is a fossil fuel derived primarily from ancient deposits of dead algae and so is in essence "ancient sunlight." The age of oil deposits can be determined from analysis of decaying radioactive isotopes and most are 10's to 100's of millions of years old. The biological origin of fossil fuels is clear from its association with "fossils" and the ubiquity of certain kinds of carbon chains.

Given that oil is finite, then at some point in time less is going to be available to us than in the past. That is the meaning of peak oil. It doesn't mean oil "runs out," but it does mean the cheap and easy oil is gone, and that what remains is more costly to produce, both energetically and financially, and is extracted at a progressively slower rate. The rate of decline of oil after peak is difficult to predict, but scenarios range from 1% to 8% per year. The peak may be somewhat "flat" (a plateau), giving a slow initial decline, which accelerates over time towards the higher end of the depletion rate range. How human societies respond to the post-peak environment will likely be as important a factor as geology in determining what is available to societies. Do we cooperate or fight over dwindling resources like cats in a sack?

Going back to the Ecological Economics model, peak oil is a "source" issue. Several source problems face the human economy, including peak natural gas[xvii] and peak water. Greater expansion of the human economy requires greater inputs, and, aside from the ecosystem services provided by nature, oil is probably the single most important economic resource on the planet.

Oil is critical for at least two reasons: energy density and versatility.

The energy output of a single person doing manual labor over a period of days gives about 200-300 British Thermal Units (btus) per hour. A single gallon of gasoline contains about 150,000 btus of potential energy, roughly equivalent to 500 to 750 hours of hard human labor.[xviii] The energy density of oil has not simply permitted a life of leisure and travel for those with access to it —it has in fact greatly expanded the short-term carrying capacity of the human population. By harnessing the energy of oil (and other fossil fuels), our species has been able to out compete others for space and resources. The expansion of industrial agriculture and "green revolution" technologies are based on oil and natural gas feed stocks and energy. Construction of large dams, water diversion systems, and pumps for ground water and water delivery to fields and cities depend upon plentiful fuel. Land, water and other resources that in the past had been available to a diversity of species are being funneled towards the appetite of one—hence the biodiversity crisis.

Oil is versatile because it is a liquid, making it is easier to extract and transport than coal and natural gas. Oil is more readily available as a fuel for a global market because it can be put into pipelines and tankers without requiring special treatment. Natural gas, by contrast, needs to be cooled and pressurized for tanker travel, and coal needs to be pulverized into slurry to be piped, or put on freight cars or barges for long-distance transport.

Because oil can be delivered anywhere, modern transportation systems have become reliant on it. A few buses and cars use natural gas, and some trains run on electricity, but the vast majority of transportation applications on the planet, over 90%, use oil in the form of gasoline, diesel or kerosene (jet fuel).

Consequently, modern economies are extremely vulnerable to shortages in transportation fuels for a few reasons.

The relative stability of the oil market over the past several decades has led to the development of "just-in-time" delivery of products, and commercial linkages across the globe. Local and regional warehouses are uncommon now, with stores and businesses relying on frequent shipments to maintain a low overhead. Before the era of cheap transportation, each town and city had a full complement of craftspeople who relied on each other. Nowadays, businesses are connected through vast transportation networks, with a manufacturing company in California, for example, relying on components shipped in from Asia and Europe.

The food economy is perhaps the finest example of the insecurity that is now bred into normal societal infrastructures. Markets selling food are typically restocked daily with only a few days supply available in the store, leading many people concerned about peak oil to reason: no fuel, no trucks; no trucks, no food. The shifts in agricultural practices over the past thirty to forty years make it difficult to quickly switch to a less transportation-intensive food system. Many agricultural regions are overly specialized to serve global markets. For example, a place where fifty years ago granaries, dairies, vegetable farms and ranches coexisted is now dominated by premium wine grapes.

As modern economies have become addicted to oil, they now find themselves in an ecological trap.

Cheap petroleum-fueled transportation has increased the geographic range over which economies can import resources not available locally, a phenomenon called “scope enlargement.” The beneficiaries of scope enlargement were able to increase local carrying capacities by overcoming the limitations of local ecologies. Unfortunately, this situation now makes us very vulnerable since a fundamental concept of ecology is Liebigs Law of the Minimum, which states that the growth of a population will be limited by whatever single factor of production is in short supply, not the total amount of resources. The expression “for the want of a nail” captures Liebigs Law, and is exemplified historically by the practice of 19th century nations importing guano from South America and Pacific islands to shore up local agriculture.

Potential shortages of guano supplies were supplanted in the 20th century by fossil-fuel based fertilizers. Some argue that our economy has a nearly unlimited ability to find substitutes for scarce resources, like fertile soil. More realistically, for many resources no substitutes exist. As an obvious example, living beings require a certain proportion of mineral nutrients to thrive. We can’t substitute elemental phosphorus for some other atom in the DNA structure of bacteria, fungi, plants and animals--no matter how much Human Capital we have. Nothing can replace simple water either.

Cheap energy makes adaptation to resource scarcity possible, by pumping water from deeper wells or extracting nitrogen out of the air, for example, but expensive energy can make substitutions unworkable.

Because oil possesses a unique combination of attributes, finding suitable substitutes is no easy task. Current products such as ethanol, biodiesel and hydrogen are under consideration to wean us from polluting and increasingly scare oil. However, nearly all of these fail the test of Energy Returned on Energy Invested (EROEI).[xix] For an energy source to be useful to society, it must deliver more energy than it takes to find, harvest and distribute the source. Our economies have become addicted to energy sources like oil with EROEIs of 100:1 to 20:1, whereas biofuels, tar sands, and many renewable energy technologies range from about 10:1 to 1:1 or less. If a fuel has an EROEI of 1:1 it may be useless because as much energy goes into producing the fuel as the fuel delivers. A complex society will probably require substantial EROEI profit ratios, such as 5:1 or greater. Energy policies need to be devised based on sound EROEI analyses, which are currently difficult to find, and in any case it is probably wise to restructure our society to be less dependent on high EROEI energy sources.

In the U.S., a high EROEI energy source permits about 1% of the population to feed the other 99%. In places without widespread access to fossil fuels for agriculture, such as Afghanistan, over 90% of the working population is engaged in growing food. Agriculture is, in essence, a means of capturing solar energy through investment in planting, maintenance and harvesting. While the Afghan agricultural system looks inefficient from a labor point of view, it is actually far more efficient from an EROEI perspective than U.S. agriculture. The extensive use of fossil fuels in industrialized food systems makes them energy sinks. Highly industrialized food systems require about 10 times more energy to grow, harvest, process and distribute the food than is contained in the food itself—an EROEI of 1:10.[xx]

Climate Change and Need to Eliminate Fossil Fuel Use

While peak oil is a "source" problem, climate change is a "sink" problem.

During the most recent ages of geologic history, Earth has cycled between ice ages and intervening warm periods. These cycles are primarily driven by orbital variations, both with respect to the angle of tilt of the Earth towards the Sun and the shape of Earth's orbit around the sun.[xxi] Carbon dioxide fluctuated as a result of how ecosystems responded to changes in Earth's temperature, which then amplified those changes. In systems theory, this is known as a positive feedback loop.

Currently, carbon dioxide and other greenhouse gas concentrations are rising not because of orbital changes, but from the use of fossil fuels and landscape changes usually caused by human activities. The pre-industrial level of carbon dioxide in Earth's atmosphere was 280 parts per million (ppm) and is now about 380 ppm. Fossil fuels are ancient deposits of carbon and hydrogen chains that are being liberated from storage through combustion. The burning of fossil fuels (oxidation) not only releases stored energy, but increases the concentration of carbon dioxide in the atmosphere. Carbon dioxide allows visible light from the sun to pass through to the Earth's surface, but reflects infrared light (also known as heat) back to Earth that would otherwise go out into space. This is why climate change is sometimes called "global warming." The general tendency is for Earth to become hotter, on average, because of the "greenhouse" effect induced by the "blanket" of extra carbon dioxide. If our eyes were sensitive to infrared light we could see the changing color of the sky, which might serve as a constant reminder of the problem.

Consider that 100 ppm is what separated the ice age from the warm, stable climate of the past several thousand years, and that the temperature transition from ice age to a warm climate took about a thousand years. By comparison, over the past 30 years nearly half the energy used in the history of the industrial revolution has been consumed, and global average temperatures are rising about 100 times faster than during transitions out of ice ages.

Changes in greenhouse gas concentrations are only partly responsible for the changes in temperature between an ice age and today. Much of the rise in temperature as an ice age ends is due to the loss of ice sheets and their influence in cooling the planet through enhanced reflection of sunlight. The current rate of change in the chemistry of Earth's atmosphere and oceans is only comparable to a few previous mass extinction episodes over the past several hundred million years that appear to be related to radical, rapid climate change.[xxii] The rate of change is perhaps more important to the climate system and life on Earth than is the amount of change. A slow rate of change is akin to gently applying the brakes to stop at a light, while a fast rate of change is akin to hitting a brick wall. Both take the vehicle and a passenger from 60 to 0 mph, only one does it more quickly.

Nobody really knows what this means for the climate system, the acidity of the oceans, the physiology of plant growth, and many aspects of the global ecosystem. Policy-makers ask scientists how much pollution can be tolerated before "dangerous interference" occurs. Unfortunately, answering how much is too much is not possible, and in all probability we have already passed some very dangerous thresholds that will only become apparent as the future unfolds.

There are many reasons why a precise answer to "how much is too much" is not possible. Consider that for any factor that goes into a model, scientists (1) work with what they know, (2) try to incorporate plausible ranges for what they know they don't know, and (3) obviously exclude what they don't know they don't know. Some would argue that because we can't be sure climate models are correct, we should do nothing. Would "do nothing" skeptics be as cavalier about uncertain dangers if the food being served their children had *possibly* been contaminated by a deadly poison? What you don't know can kill you. Given the stakes, many advocates for energy policies leading to a curtailment of greenhouse gas emissions take a precautionary stance.[xxiii] After all, if the U.S. is so concerned about security that it is willing to spend about half a trillion dollars a year on the military, what is it worth to help secure our climate?

Computer power limits the ability of models to capture many of the details of climate change. For example, models can't scale to the future climate of a single town, making it difficult, perhaps, for local officials to understand the implications of global models. Nor can models usually identify critical thresholds in a complex system with much accuracy. Systems can remain remarkably stable over long periods under stress until something snaps, like a balloon expanding until it pops. The Earth system has been remarkably tolerant of the stresses it is under, but when something finally gives it will probably be "loud." Recent studies of the pace of change in Greenland and Antarctic ice sheets underscore the fact that thresholds can be difficult to detect, and that current models may often underplay the true threats of climate change.

Although climate models have these limits, they also do an incredible job accurately modeling the past climate. For example, when comparing images from weather satellites to the most advanced climate models, one can even see how well models match the actual formation and movement of storm clouds around the globe. One of the tests climate modelers perform to decide whether human-induced changes in the atmosphere are causing climate change is to run climate models for the 20th century *as if* we hadn't burned so much fossil fuel. The rise in global temperatures and the shifts in rainfall patterns seen during the 20th century can be accurately modeled only when fossil fuel induced greenhouse gas emissions are included.

Beyond any reasonable level of doubt, natural variations in solar radiation and the shape of the Earth's orbit around the sun do not account for recent climate change. Climate change is a problem with known causes related directly to known human behaviors such as driving cars, flying in airplanes, heating and cooling homes and businesses, manufacturing products, mining, harvesting, pumping water, removing wastes, and producing food using big machines, among others. The most pressing question of our time is: How can societies function without pumping more greenhouse gases into the atmosphere? If we don't make answering this question our top priority there's a good chance the planet may become uninhabitable for the current generation of children.

While we can't know future threats precisely, scientists do agree that creating a carbon-cycle neutral economy should be the dominant task occupying our minds. This is exactly what Relocalization aims to do.

Relocalization: A Strategic Response to Overshoot

Economic and population growth was made possible by the synergies permitted by cheap energy. The limits of productivity in one locality (i.e., Liebigs Law) could be overcome by importing something in excess elsewhere. A global economy advocating that each place seek its comparative advantage and specialize in what it produced for the market place required that money, governance, and even customs be more homogenized worldwide. As free trade agreements became the norm and social barriers to trade were reduced, the power of resource synergies permitting more economic growth became apparent to more and more people in the world. Most only saw its benefits and few worried about the long-term liabilities it imposed.

There are a few flawed assumptions behind globalization, but one in particular is glaring: the assumption that transportation costs will always be low, both in terms of fuel availability and the environmental externalities associated with their use.[xxiv] If that assumption is false—and certainly peak oil and climate change makes it appear false—then localities should not be specializing to trade globally. For example, I live on the edge of premium wine country. There are far more grapes here than the local population can eat, but we lack just about every other kind of food production in sufficient quantity. As long as we can sell our wine to a global market and buy the other stuff we need this situation seems reasonable. But a peak oil perspective makes us feel vulnerable, and a climate change perspective calls this irresponsible.

Because all localities that have bought into the global market place have specialized to some extent, all could face shortages of some set of basic goods. In the past, global trade was for luxury items, like silk or spices, or key resources that permitted basic items to be made at home more efficiently, like organic fertilizer and metals. The loss of a trade partner would be problematic, but probably not catastrophic.

Relocalization advocates rebuilding more balanced local economies that emphasize securing basic needs. Local food, energy and water systems are perhaps the most critical to build.[xxv] In the absence of reliable trade partners, whether from peak oil, natural disaster or political instability, a local economy that at least produces its essential goods will have a true comparative advantage.

When many analysts consider peak oil or climate change they start from the position of "keep the current system going at any cost." Rather than envision an alternative that doesn't have the same liabilities, these "solutions" only perpetuate a problem.

A classic case of this kind of thinking is the Department of Energy sponsored "Hirsch Report."[xxvi] The Hirsch Report is great for understanding the economic consequences of peak oil given how integrated the global economy is. But its call for a crash program to develop new sources of liquid fuels using non-conventional fossil fuels without any broader context, such as what this would do to soils, air, and water are misguided. A wise perspective would at least acknowledge that these choices involve painful tradeoffs.

Relocalization takes a different perspective altogether. Instead of working to keep a system going that has no future, it calls us to develop means of livelihood that pollute as little as possible and that promote local and regional stability. Since much of our pollution results from the distances goods travel, we must shorten distances between production and consumption as much as we can.

Summary

Responding appropriately to the problems of climate change and peak oil and gas requires an understanding based on a systems perspective. From this angle, clear limits exist for the ability of our society to maintain growth in both resource consumption and pollution. However, most of our economic and social norms do not recognize these limits, and therefore find it difficult to respond to current threats.

Relocalization recognizes the liabilities of fossil fuel dependency and promotes greater security through redevelopment of local and regional economies more or less self-reliant in terms of energy, food and water systems. Many social benefits might accrue to a relocalized society, including greater job stability, employment diversity, community cohesion, and public health.

The laws of physics and ecology will drive economic incentives that begin to unwind some forms of global trade. However, as the "Stern Review Report"[xxvii] on climate change and the "Hirsch Report" on peak oil make clear, the market alone will not make this happen quickly enough or smoothly. Given our advanced state of ecological debt and the long social lag times involved in changing so many fundamental patterns of behavior, only sound and consistent government policies can succeed in setting up the right incentives for rapid, sustained change.

In any case, an easy or painless transition is highly unlikely. But nobody is guaranteed an easy life and sometimes during our greatest challenges we also find a profound sense of purpose, and a focus on what makes life worthwhile, such as meaningful work, camaraderie and beauty.

[i] http://www.postcarbon.org/

[ii] http://www.schumachersociety.org/

[iii] http://socialwork.arts.unsw.edu.au/tsw/

[iv] http://www.garretthardinsociety.org/

[v] http://www.brtom.org/wb/berry.html

[vi] See for example: http://www.baylocalize.org/

[vii] A college-level text book by Herman E. Daly and Joshua Farley titled "Ecological Economics: Principles and Applications" (2004, Island Press) exists. Also look for popular books by Herman Daly, Brian Czech and Richard Douthwaite.

[viii] See measures like the Ecological Footprint (http://www.footprintnetwork.org/) and the Genuine Progress Indicator (http://www.redefiningprogress.org/projects/gpi/)

[ix] See recent reviews of the "Environmental Kuznets Curve" such as http://www.ecoeco.org/publica/encyc_entries/Stern.pdf

[x] A great book that leads the reader through this process for several consumer items is: John C. Ryan and Alan Thein Durning, "Stuff: The Secret Lives of Everyday Things." New Report No. 4, January 1997, Northwest Environment Watch, Seattle.

[xi] This graphic was developed based on the principles discussed in Chapter 2 of Daly and Farley "Ecological Economics: Principles and Applications" (2004, Island Press)

[xii] The book "Overshoot: The Ecological Basis of Revolutionary Change" by William R. Catton, Jr. gives a thorough overview of ecological and social mechanisms and consequences of overshoot.

[xiii] A great place to review standard population projections and the underlying assumptions is through the United Nations Population Division web site: http://www.un.org/esa/population/unpop.htm and http://esa.un.org/unpp/

[xiv] Donella Meadows, Jorgen Randers and Dennis Meadows, "Limits to Growth: The 30-Year Update." Chelsea Green Publishing, White River Junction, VT, 2004.

[xv] http://www.uvm.edu/giee/research/publications/Boumans_et_al.pdf

xvi Literally dozens of books, websites and article about peak oil exist. Richard Heinberg, "The Party's Over: Oil, War and the Fate of Industrial Societies." New Society Publishers, Gabriola Island, BC, 2005 (second edition) is highly recommended. On the web try: http://www.energybulletin.net/ and http://www.theoildrum.com/

xvii Much less has been written specifically about natural gas, but see: Julian Darley, "High Noon for Natural Gas: The New Energy Crisis." Chelsea Green Publishing, White River Junction, VT, 2004.

xviii For a slim but comprehensive book on energy and conversion factors see: John G. Howe, "The End of Fossil Energy and the Last Chance for Sustainability." McIntire Publishing Services, Waterford, ME, 2005 (second edition).

xix An important book covering EROEI and agriculture is John Gever, Robert Kaufmann, David Skole and Charles Vorosmarty, "Beyond Oil: The Threat to Food and Fuel in the Coming Decades." Ballinger Publishing Company, Cambridge, MA, 1986. The website http://www.eroei.com/ is a good online reference.

xx A comparison of the energy balance of different food systems is provided by David Pimental and Marcia Pimental, eds, "Food Energy and Society." University Press of Colorado, revised 1996.

xxi http://en.wikipedia.org/wiki/Milankovitch_cycles

xxii Dozens of references are possible for climate change. A good recent book, written by a scientist, is: Tim Flannery, "The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth." Atlantic Monthly Press, NY, 2005. On the web see this site run by climatologists: http://www.realclimate.org/

xxiii http://en.wikipedia.org/wiki/Precautionary_principle

xxiv In addition to the Limits to Growth series, a few books do a fine job discussing both "source" and "sink" problems with fossil fuels, including: Thom Hartmann, "The Last Hours of Ancient Sunlight: Waking Up to Personal and Global Transformation," Jeremy Leggett, "The Empty Tank: Oil, Gas, Hot Air, and The Coming Global Financial Catastrophe," James Howard Kunstler, "The Long Emergency: Surviving the Converging Catastrophes of the Twenty-First Century," and David Holmgrem, "Permaculture: Principles and Pathways Beyond Sustainability."

xxv Books addressing the benefits of a local economy focused on basic needs include: Richard Douthwaite's, "Short Circuit: Strengthening Local Economies for Security in an Unstable World," and Michael Shuman's, "Going Local: Creating Self-Reliant Communities in a Global Age."

xxvi http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf and http://en.wikipedia.org/wiki/Hirsch_report

xxvii http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm