THE COMING CHAOS

Oil, Electricity, Agriculture, Population, Tribulation, Survival

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Abridged

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PREFACE

The following pages have more to do with meditation than with measurement: the days to come are not always easy to quantify. To a large extent it is a matter of crystal-gazing, or at best of comparative studies. Basically the topic involves consideration of hypotheses and thought experiments, even if human behavior on a large scale has so many variables that it is at times on no higher level of predictability than the weather.

To some extent, whatever complexities exist in the story can be reduced by focusing on Americans, not as villains but as a group of people who are typical of modern industrial society, who have great influence, and about whom there is considerable information. To be even more precise in my terms and definitions, and in view of the similarities, I should add my own country and say "Americans and Canadians," but that would be a cumbersome term.

The focus is also on what might be called cultural issues, or perhaps even spiritual ones, although the latter term is not meant in any particularly religious sense. Not that explaining one's "position," compared to anyone else's, is of any great importance: the future will do whatever it wants to do, no matter how much it is analyzed or by whom. Nevertheless, I hope my initial prejudices and presumptions are obvious enough to explain a few odd twists in the path of the tale.

Those who do not see the coming centuries as a continuation of the present are sometimes accused of preaching gloom and misery, but it might be argued that instead of talking about the minutiae of science or economics, one might start thinking about practical ways of dealing with the future. Perhaps that concern for practicality is a good reason for choosing the title of "survivalist," even if others use the word in a disparaging sense. Surely, however, being a survivalist is better than trying to conjure up proofs that the problems do not exist.

It is not even certain that returning to the ancient ways of life, if such is to be the case, would be so unfortunate. Humans were "uncivilized" for a very long time, and they seem to have done well enough. They lived in a less crowded world, and for them the land, the sea, and the sky were still beautiful. Perhaps there will come a day when, like our early ancestors, we can move at a slower pace, watching the forest, or the waves of the ocean, or the eternal cycles of the sun, the moon, and the stars.

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1: SYSTEMIC COLLAPSE

Oil is everything. That is to say, everything in our modern world is dependent on oil. From oil and other hydrocarbons we get fuel, fertilizer, pesticides, lubricants, plastic, paint, synthetic fabrics, asphalt, pharmaceuticals, and many other things. On a more abstract level, we are dependent on these fossil fuels for manufacturing, for transportation, for agriculture, for mining, and for electricity. When oil goes, our entire industrial society will go with it. There will be no means of supporting the billions of people who now live on this planet. Above all, there will be insufficient food.

Perhaps the most common response to the "peak oil" problem is: "The oil isn't going to disappear overnight. We have plenty of time to prepare." Unfortunately, the fact that the decline in oil is a curve, not a vertical line, makes it difficult to comprehend. What matters is that the serious damage will be done long before we get to those tiny remaining drops in the distant future — if we decide it is even economically feasible do so.

A good deal of debate has gone on about that "peak," the date at which the world's annual oil production will reach (or did reach) its maximum and will begin (or did begin) to decline. The exact numbers are unobtainable, mainly because individual countries give rather inexact figures on their remaining supplies. The situation can perhaps be summarized by saying that at least 20 or 30 major studies have been done, and the consensus is that the peak is somewhere between the years 2000 and 2020. Within that period, a middle date seems rather more likely. (The data are discussed in more detail in Appendix One.)

After the "peak" itself, the next question is that of the annual rate of decline. Earlier estimates tended to hover around 3 percent, which would have meant production would fall to half of peak production by about 2030. More recent estimates tend to put the rate of decline at about 6 percent, which would mean production will fall, rather ominously, to one half shortly after 2020.

The argument about the peak of oil production will probably go on for a few more years. It should have ended in the 1950s, when M. King Hubbert made his predictions, or at least in 1986 and 1991 when Gever et al. described the situation; after all, there is not much change in the data from one decade to another (Gever, Kaufmann, & Skole, 1991; Hubbert, 1956). Perpetual doubt about the imminent decline in oil production is far less useful than a genuine response to the event.

In 1850, before commercial production began, there may have been 2 trillion barrels of usable, recoverable oil in the ground. By about the year 2010, half of that oil had been consumed, but perhaps as much as 1 trillion barrels remain. A trillion may sound like a great deal but is not really so impressive in terms of how long it will last; in any case, the estimates for recoverable reserves are constantly reduced over the years. At the moment about 30 billion barrels of oil are consumed annually, and that is probably close to the maximum that will ever be possible. When newspapers announce the discovery of a deposit of a billion barrels, readers are no doubt amazed, but they are not told that such a find is only two weeks' supply.

As the years go by, new oil wells have to be drilled more deeply than the old, because newly discovered deposits are deeper. Those new deposits are therefore less accessible. But oil is used as a fuel for the machinery and for the exploration. When it takes an entire barrel of oil to get one barrel of oil out of the ground, as is increasingly the case with new wells, it is pointless to continue drilling.

Coal and natural gas are also not as plentiful as before. Coal will be available for a while after oil is gone, although previous reports of its abundance were highly exaggerated. Coal, however, is highly polluting and cannot be used as a fuel for most forms of transportation. What's more, coal mining requires large amounts of oil (mostly in the form of diesel fuel) and electricity to be extracted, making its production dependent on oil also. As for natural gas, it is not easily transported, and it is not suitable for most equipment.

In terms of its effects on daily human life, the most significant aspect of fossil-fuel depletion will be the lack of food. "Peak oil" basically means "peak food." Modern agriculture is highly dependent on fossil fuels for fertilizers (the Haber-Bosch process combines natural gas with atmospheric nitrogen to produce nitrogen fertilizer), pesticides, and the operation of machines for irrigation, harvesting, processing, and transportation.

Without fossil fuels, modern methods of food production will disappear, and crop yields will be far less than at present. We should therefore have no illusions that several billion humans can be fed by "organic gardening" or anything else of that nature.

The Green Revolution involved, among other things, the development of higher-yielding crops. These new varieties could be grown only with constant irrigation, as well as with large inputs of fertilizer and pesticides, requiring fossil fuels. In essence, the Green Revolution was little more than the invention of a way to turn petroleum and natural gas into food.

Much of modern warfare is about oil, in spite of all the rhetoric about the forces of good and the forces of evil (Klare, 2002). The real "forces" are those trying to control the oil wells and the fragile pipelines that carry that oil. A map of American military ventures over the last few decades is a map of petroleum deposits. When the oil wars began is largely a matter of definition, though perhaps 1973 would be a usable date, when the Yom Kippur War — or, to speak more truthfully, the vulnerability resulting from the decline in American domestic oil — led to the OPEC oil embargo.

Alternative Energy

Alternative sources of energy will never be very useful, for several reasons, but mainly because of a problem of "net energy": the amount of energy output is not

sufficiently greater than the amount of energy input (Gever et al., 1991). With the problematic exception of uranium, alternative sources ultimately don't have enough "bang" to replace 30 billion annual barrels of oil — or even to replace more than the tiniest fraction of that amount.

At the same time, alternative forms of energy are so dependent on the very petroleum that they are intended to replace that the use of them is largely self-defeating and irrational. Petroleum is required to extract, process, and transport almost any other form of energy; a coal mine is not operated by coal-powered equipment. It takes "oil energy" to make "alternative energy."

The use of unconventional oil (shale deposits, tar sands, heavy oil) poses several problems besides that of net energy. Large quantities of natural gas and water are needed to process the oil from these unconventional sources. The pollution problems are considerable, and it is not certain how much environmental damage the human race is willing to endure. With unconventional oil we are, quite literally, scraping the bottom of the barrel.

More-exotic forms of alternative energy are plagued with even greater problems (Younquist, 2000, October). Fuel cells cannot be made practical, because such devices require hydrogen obtained by the use of fossil fuels (coal or natural gas), if we exclude designs that will never escape the realm of science fiction; if fuel cells ever became popular, the fossil fuels they require would then be consumed even faster than they are now. Biomass energy (from corn or wood, for example) requires impossibly large amounts of land and still results in insufficient quantities of net energy, perhaps even negative quantities. Wind and geothermal power are only effective in certain areas and for certain purposes. Hydroelectric dams are reaching their practical limits. Nuclear power will soon be suffering from a lack of fuel and is already creating serious environmental dangers.

The current favorite for alternative energy is solar power, but proponents must close their eyes to all questions of scale. The world's deserts have an area of 36 million km^2, and the solar energy they receive annually is 300,000 exajoules (EJ), which at a typical 11-percent electrical-conversion rate would result in 33,000 EJ (Knies, 2006). Annual global energy consumption in 2005 was approximately 500 EJ. To meet the world's present energy needs by using thermal solar power, then, we would need an array (or an equivalent number of smaller ones) with a size of 500/33,000 x 36 million km^2, which is about 550,000 km^2 — a machine the size of France. The production and maintenance of this array would require vast quantities of hydrocarbons, metals, and other materials — a self-defeating process. Solar power will therefore do little to solve the world's energy problems.

The quest for alternative sources of energy is not merely illusory; it is actually harmful. By daydreaming of a noiseless and odorless utopia of windmills and solar panels, we are reducing the effectiveness of whatever serious information is now being published. When news articles claim that there are simple painless solutions to the oil crisis, the reader's response is not awareness but drowsiness. We are rapidly heading toward the greatest disaster in history, but we are indulging in escapist fantasies. All talk of alternative energy is just a way of evading the real issue: that the Industrial Age is over.

Petroleum, unfortunately, is the perfect fuel, and nothing else even comes close. The problem with flying pigs (as in "when pigs can fly") is not that we have to wait for scientists to perfect the technology; the problem is that the pig idea is not a good one in the first place. To maintain an industrial civilization, it's either oil or nothing.

The Problem of Infrastructure

Most schemes for a post-oil technology are based on the misconception that there will be an infrastructure, similar to that of the present day, which could support such future gadgetry. Modern equipment, however, is dependent on specific methods of manufacture, transportation, maintenance, and repair. In less abstract terms, this means machinery, motorized vehicles, and service depots or shops, all of which are generally run by fossil fuels. In addition, one unconsciously assumes the presence of electricity, which energizes the various communications devices, such as telephones and computers; electricity on such a large scale is only possible with fossil fuels.

To believe that a non-petroleum infrastructure is possible, one would have to imagine, for example, solar-powered machines creating equipment for the production and storage of electricity by means of solar energy. This equipment would then be loaded on to solar-powered trucks, driven to various locations, and installed with other solar-powered devices, and so on, ad absurdum and ad infinitum. Such a scenario might provide material for a work of science fiction, but not for genuine science — and most certainly, not in the context of the next few years.

It is not only oil that will soon be gone. Iron ore of the sort that can be processed with primitive equipment is becoming scarce, and only the less-tractable forms will be available when the oil-powered machinery is no longer available. Copper and other metals are also in decline. Metals were useful to mankind only because they could once be found in concentrated pockets in the earth's crust; they are now becoming irretrievably scattered among the world's garbage dumps.

The infrastructure will no longer be in place: oil, electricity, and asphalt roads, for example. Partly for that reason, the social structure will also no longer be in place: intricate division of labor, large-scale government, and high-level education. Without the infrastructure and the social structure, it will be impossible to produce the familiar goods of industrial society.

Without fossil fuels, the most that is possible is a pre-industrial infrastructure, although one must still ignore the fact that the pre-industrial world did not fall from the sky in a prefabricated form but took countless generations of human ingenuity to develop. Furthermore, pre-industrial society had a very much smaller population to support, but the world's current population cannot be supported by a pre-industrial economy.

Fossil fuels, metals, and electricity are all intricately connected. Each is inaccessible — on the modern scale — without the other two. Any two will vanish without the third. If we imagine a world without fossil fuels, we must imagine a world without metals or electricity. What we imagine, at that point, is a society far more primitive than the one to which we are accustomed — and also far more primitive than the one our great-grandparents knew.

Arable Land

With "low technology," i.e. technology that does not use fossil fuels, crop yields diminish considerably. David Pimentel explains that the production of so-called field or grain corn (maize) without irrigation or mechanized agriculture is only about 2,000 kilograms per hectare. That is less than a third of the yield that a farmer would get with modern machinery and chemical fertilizer (Pimentel, 1984; Pimentel & Hall, 1984; Pimentel & Pimentel, 2007).

Yields for corn provide a handy baseline for other studies of population and food supply. At the same time, corn is an ideal crop for study because of its superiority to others: it is one of the most useful grains for supporting human life. For the native people of the Americas, it was an important crop for thousands of years (Weatherwax, 1954). Corn is high-yielding and needs little in the way of equipment, and the more ancient varieties are largely trouble-free in terms of diseases, pests, and soil depletion. If it can't be done with corn, it can't be done with anything. Of course, in reality no one would live entirely on corn; the figures here serve merely as a basis of comparison with other crops in a mixed diet.

A hard-working (i.e. farming) adult burns about 1 million kilocalories ("calories") per year. The food energy from a hectare of corn grown with "low technology" is about 9 million kilocalories (Pimentel, 1984). Under primitive conditions, then, 1 hectare of corn would support only 9 people.

Those figures are rather idealistic, however. We are assuming that people will follow a largely vegetarian diet; if not, they will need much more land. We need to allow for fallow land, cover crops, and green manure, for inevitable inequities in distribution, and for other uses of the land. We must account for any rise in population. Finally, most other crops require more land than corn in order to produce the same yield. On a global scale, a far more realistic ratio would be 4 people to each hectare of arable land.

The average American house lot is about a tenth of a hectare, including the land the house is sitting on (Mason, 2010). Those who expect to get by with "victory gardens" are therefore unaware of the arithmetic involved. Perhaps some of the misunderstanding is due to the misconception that humans live on "vegetables" in the narrow sense of the word (e.g., in the sense of "green vegetables"). In reality, it is not "vegetables" but grains that are the present foundation of human diet. During the Neolithic Era, our ancestors took various species of grass and converted them into the plants on which human life now depends. Wheat, rice, corn, barley, rye, oats, sorghum, millet — these are the grasses people eat every day. It is members of the grass family that are used in raising the pigs and cows that are killed as other food. A diet of green vegetables would be slow starvation; it is grains that supply the thousands of kilocalories that keep us alive from day to day. There are reasons to question the benefits of a diet of cultivated grains (Diamond, 1987; Ferguson, 2003), but at least over the next several decades it will largely be the localized production of grains that will support those who survive the collapse of civilization.

In the entire world there are about 15 million km^2 of arable land (Bot, Nachtergaele, & Young, 2000; CIA, 2010). This is about 10 percent of the world's total land area. The present world population (in 2010) is approaching 7 billion. Dividing the figure for population by that for arable land, we see that there are about 470 people per

km^2 of arable land. On a smaller scale that means about 5 people per hectare, more than the above-mentioned ideal ratio of 4:1. In fact, most of the world's 200-odd countries have more than 7 people per hectare; these countries, in other words, are already beyond the limits of the number of people who can be supported by non-mechanized agriculture.

The UK, for example, has a population-to-arable ratio of slightly more than 10 people per hectare. What exactly is going to happen to the 6 people who will not fit onto the hectare? But many countries have far worse ratios.

Population

The world's population went from about 1.7 billion in 1900 to 2.5 in 1950, to nearly 7 billion in 2010. It has been said that without fossil fuels the population must drop to about 2 or 3 billion (Youngquist, 2000, October). The above figures on arable land indicate that in terms of agriculture alone we would not be able to accommodate the present number of people.

Another calculation about future population can be made by looking more closely at the rise and fall of oil production. The rapid increase in population over the last hundred years is not merely coincident with the rapid increase in oil production. It is the latter that has actually allowed (the word "caused" might be too strong) the former: that is to say, oil has been the main source of energy within industrial society. It is only with abundant oil that a large population is possible. It was industrialization, improved agriculture, improved medicine, the expansion of humanity into the Americas, and so on, that first created the modern rise in population, but it was oil in particular that made it possible for human population to grow as fast as it has been doing (Catton, 1982). If oil production drops to half of its peak amount, world population must also drop by half.

Of course, this calculation of population on the basis of oil is largely the converse of the calculation on the basis of arable land, since in industrial society the amount of farm production is mainly a reflection of the amount of available oil.

If we look further into the future, we see an even smaller number for human population, still using previous ratios of oil to population as the basis for our figures. But the world a hundred years from now might not be a mirror image of the world of a hundred years in the past. The general depletion of resources might cause such damage to the structure of society that government, education, and intricate division of labor will no longer exist. In a milieu of social chaos, what are the chances that the oil industry will be using extremely advanced technology to extract the last drops of oil? Even then we have not factored in war, epidemics, and other aspects of social breakdown. The above-mentioned figure of 2 or 3 billion may be wildly optimistic.

Overpopulation is the overwhelming ultimate cause of systemic collapse (Catton, 1982). All of the flash-in-the-pan ideas that are presented as solutions to the modern dilemma — solar power, ethanol, hybrid cars, desalination, permaculture — have value only as desperate attempts to solve an underlying problem that has never been addressed in a more direct manner. American foreign aid has always included only trivial amounts for family planning (Spiedel, Sinding, Gillespie, Maguire, & Neuse, 2009, January); the most powerful country in the world has done very little to solve the biggest problem in the world.

The reasons for this evasion of responsibility are many, including the influence of certain religious groups with the misnomer of "pro-life"; the left-wing reluctance to point a finger at poor people, immigrants, or particular ethnic groups; the right-wing reluctance to lose an ever-expanding source of cheap labor (and a growing consumer market); and the politicians' reluctance to lose votes in any direction (Kolankiewicz & Beck, 2001, April).

Overpopulation can always be passed off as somebody else's problem. It is the fundamental case of what Garrett Hardin calls "the tragedy of the commons" (1968, 1995): although an oversize family may have a vague suspicion that the world will suffer slightly from that fecundity, no family wants to lose out by being the first to back down. Without a central governing body that is both strong and honest, however, the evasion is perpetual, and it is that very lack of strength and honesty that makes traditional democracy an anachronism to some extent.

For all that might be said about their politics and economics, it is the Chinese who have made the greatest effort at dealing with excess numbers. Even their efforts cannot be considered an absolute success, however. Since 1953, the year of the first proper Chinese census and approximately the start of concerns with excessive fertility, the population has gone from 583 million to over 1.3 billion. For that matter, since the official starting of the one-child campaign in 1979 the population has grown by over 300 million (Riley, 2004, June).

Discussion of overpopulation is the Great Taboo. Politicians will rarely touch the issue. Even the many documents of the United Nations merely sidestep the issue by discussing how to cater to large populations, in spite of the fact that such catering is part of the problem, not part of the solution.

To speak against overpopulation is an exercise in futility. How likely is it that the required massive change in human thinking will ever take place? Even in "developed" countries, to broach the topic of overpopulation is often to invite charges of racism and elitism. And after living in one or two "developing" countries, I must say that there seems something both naïve and presumptuous in the common liberal American belief that people in such countries are waiting to be "enlightened" to American ideals. On the contrary, my own impression is that inhabitants of poor countries are generally quite determined to hang on to their present systems of politics and religion, no matter how archaic and oppressive those systems may seem to outsiders, and would prefer that any proselytizing go in the opposite direction. Instead of dreaming of ways to reduce a population of several billion to a reasonable number overnight, therefore, it might be more sensible to think in terms of the medical system of triage: let us save those who can be saved.

Like so many other species, humanity expands and consumes until its members starve and die. The two basic, reciprocal problems of human life have still never been solved: overpopulation and the over-consumption of resources. As a result, the competition for survival is intense, and for most people life is just a long stretch of drudgery followed by an ignoble death. It is ironic that birth control, the most important invention in all of human history, has been put into practice in such a desultory manner. There is still no intelligent life on earth.

In view of the general unpopularity of birth-control policies, it can only be said euphemistically that Nature will decide the outcome. Even if his words owe as much to

observation of the stages of collapse as to divine inspiration, it is St. John's Four Horsemen of war, famine, plague, and death who will signify the future of the industrial world. Nor can we expect people to be overly concerned about good manners: although there are too many variables for civil strife to be entirely predictable, if we look at accounts of large-scale disasters of the past, ranging from the financial to the meteorological, we can see that there is a point at which the looting and lynching begin. The survivors of industrial society will have to distance themselves from the carnage.

The need for a successful community to be far removed from urban areas is also a matter of access to the natural resources that will remain. With primitive technology, it takes a great deal of land to support human life. What may look like a long stretch of empty wilderness is certainly not empty to the people who are out there picking blueberries or catching fish. That emptiness is not a prerogative or luxury of the summer vacationer. It is an essential ratio of the human world to the non-human.

Elements of Collapse

The systemic collapse of modern civilization, then, has 10 elements, each with a somewhat causal relationship to the next. (1) Fossil fuels, (2) metals, and (3) electricity are a tightly-knit group, and no industrial civilization can have one without the others. The decline in fossil-fuel production is the most critical aspect of the collapse. As those three disappear, (4) food and (5) fresh water become scarce; grain and wild fish supplies per capita have been declining for years, water tables are falling everywhere, rivers are not reaching the sea. Matters of infrastructure then follow: (6) transportation and (7) communication — no paved roads, no telephones, no computers. After that, the social structure begins to fail: (8) government, (9) education, and (10) the large-scale division of labor that makes complex technology possible. (I exclude from these elements such uncertainties as anthropogenic global warming. Rather peripheral matters such as epidemics will be discussed in passing.)

After these 10 elements, however, there are actually four other parts, forming a separate layer. They are in some respects more psychological or sociological, and are not as easy to delineate, but we might call them "the four Cs." The first three are (1) crime, (2) cults, and (3) craziness — the breakdown of traditional (as opposed to despotic or arbitrary) law; the ascendance of dogmas based on superstition, ignorance, cruelty, and intolerance; the overall tendency toward anti-intellectualism; and the inability to distinguish mental health from mental illness. After that there is a final and more general part that is (4) chaos, which results in the pervasive sense that "nothing works any more."

2: POST-PEAK ECONOMICS

Almost everything in the global economy is either made from oil or requires oil to manufacture it or operate it. As the price of oil goes up, so will the price of everything else. This rise is referred to as "stagflation" — stagnant incomes combined with price inflation. The hardest hit will be those who have lost their jobs, followed by those with limited disposable income, which means those most likely to have debts: car payments, house mortgages, credit cards, student loans. But everyone will find that a dollar just doesn't stretch.

That will be Phase One: economic hardship. Besides stagflation, the major issues will be unemployment and a falling stock market. While money is still real, it will be everyone's obsession: as in Weimar Germany, it will take the proverbial wheelbarrow of money to buy a loaf of bread. The world of Phase One can be depicted as shoddy, dirty, and disorganized.

Phase Two, much longer, will be genuine chaos. It will be characterized by the disappearance of law and order and capable government. As these fade away, money will have no use as a medium of exchange. When there is no more faith in money, it will be replaced by barter. From economic hardship of a financial kind we will pass to economic hardship of a physical kind: manual labor and a scarcity of basic goods. The world of Phase Two will be a different picture: shocking, horrifying, and deadly.

Phase One has already begun to some extent, to judge from four related events. (1) In 1970, US domestic oil production went into a permanent decline. (2) Global oil production per capita reached its peak in 1979 (BP, 2010). (3) Retail gasoline prices in the US, which had been fairly steady for 20 years, suddenly doubled from 2002 to 2008 (EIA, 2009, January). (4) Finally, around 2005 the energy required to explore for, drill, and pump a barrel of oil often exceeded the energy gained from it (Gever et al., 1991).

Phase Two can, to some extent, be envisioned by looking at comparable events in the past. One of the best comparisons is with the events that unfolded when the Soviet Union collapsed in the 1990s. Within a short time, people simply gave up using money and switched to other items of exchange. One of the most popular items was bottles of homemade vodka (Orlov, 2005). It seems that vodka was valued because it was easy to carry, of great practical value, and rather fixed in exchange value (since, presumably, it was either real vodka or it wasn't).

But there are many cases similar to that of the Soviet Union. One might, for example, consider Argentina in 2001 (Aguirre, 2005, October 29). Or we might consider the American Civil War — after that time, Confederate dollars were literally just paper.

In other words, at one point the money problem will be everything, and a few decades later, the money problem will be nothing, because there won't be any. Money is only a symbol, and it is only valuable as long as people are willing to accept that fiction: without government, without a stock market, and without a currency market, such a symbol cannot endure (Soros, 1998). Money itself will be useless and will finally be ignored. Tangible possessions and practical skills will become the real wealth. Having the right friends will also help.

It's important to remember the old clichés around the general idea that "money only exists as long as people have trust in it, whereas a currency that becomes suspicious simply dies." More specifically, money only exists as long as there is a government to produce the money and then to keep it alive. When a government utterly loses its power over the country, the money simply melts like snowflakes on a hot metal stove.

Will life be better or worse in a world without money? That's hard to say. When I lived for several years in a rural community in central Ontario, Canada, there seemed to be advantages to the rather casual and offhand bartering that went on. If one person left a gift on a neighbor's porch, and a few days later the neighbor left some other item on the first person's porch as a gesture of appreciation, it was not even clear if such behavior could be considered barter.

There are parallels between the Great Depression of the 1930s and the present oil crash, but there are also important differences. The Great Depression was caused by over-speculation in the stock market, which led to the 1929 panic (Galbraith, 2009). The rapid sellout of stocks caused the collapse of many businesses. These businesses laid off many workers. The workers then had insufficient income to buy whatever was available, even though prices were low. The Great Depression, in other words, had an amazingly artificial cause, although the ensuing suffering was by no means artificial.

The oil crash is different. Its cause is not artificial; in fact, its cause has a rather uncertain relationship to the abstractions of economics. And although many people will lose their jobs, there will be no reduction in the prices of goods, at least in Phase One.

The Great Depression was a time of deflation. The basic cause was massive over-speculation, a great bubble that just burst. The problem today, on the other hand, is that our Commodity Number One, which is petroleum, is beginning to run out. That means that virtually all other commodities will likewise run out.

The era of the Great Depression, however, closely resembles the coming years in other respects. In particular, the poverty of that earlier time, and many other aspects of daily life, will be repeated in the events of future years — although that would be putting it mildly (Broadfoot, 1997).

In terms of the exigencies of daily life, part of the solution is to give up the use of money well ahead of time, instead of letting the money economy claim more victims. "Money economy" is not a tautology: materials and products were distributed or traded over very long distances long before money was invented; sometimes the process was simple barter, and at other times these matters were handled by a formal governing procedure.

Barter would allow people to provide for their daily needs on a local basis, without the dubious assistance of governments or corporations. Such a way of doing business, unfortunately, is illegal if the participants are not paying sales tax on their transactions. Politicians disparage the age-old practice of barter as "the underground

economy" or "the gray economy," but their own income is dependent on taxes. The transition would not be simple: there are so many rules, from building codes to insurance regulations to sales- and income-tax laws, that make it difficult to provide oneself with food, clothing and shelter without spending money. Nevertheless, as the economy breaks down, so will the legal structure, and laws will become rather meaningless.

All that is certain about barter at the present time is that sales tax is not being paid, and that a "crime" is therefore being committed. The money economy requires that a large portion of one's income be paid out in various forms of legalized extortion: taxes, insurance, and banker's fees (such as mortgages), all of which are justified in our minds largely by the fact that they have been imposed for centuries.

Also at the moment, taxes alone consume a great deal of our income, especially if we consider that there are, in a sense, taxes on taxes: I am taxed on what I buy, but the price for that object has been raised to cover taxes that were paid in the process of making and delivering that object. Only a small piece of paper is required to make a list of all the benefits one receives from these various forms of extortion.

There are also plain old bubbles, foolish speculation, that cause some huge rises and falls in the prices of things. The most obvious one is housing. Another may be gold — although there are at least some plausible arguments for buying gold, beginning with the fact that it is a fairly hazard-free medium of exchange, at least in comparison with any form of currency.

Although inflation characterizes Phase One of economic collapse, inflation and deflation are never a case of either-or. The two can happen side by side, and usually have. Certainly today there are some things that are cheap, some things that are expensive.

The big inflationary items of today are food, oil, and gold. But they are not all the same case. Oil prices are rising because we are running out of oil. Food prices are also rising because we are running out of oil. In fact, anything is rising if it is connected to oil. Gold, however, is not directly connected to oil; it has value primarily as a preserver of wealth, even if that desire for wealth preservation is partly driven by oil fears.

Inflation has to some extent been just a bogeyman in previous years (Greider, 1998). It was always the big financiers who did the most complaining about inflation, because they were the ones who had the most to lose — their financial holdings thereby had less value in a fundamental sense. For the person who had no savings at all but whose wages were rising, inflation was really not a big issue. Nevertheless, in the twenty-first century inflation will matter, and very much so — until the big finale. The difference between the present and the past is that high prices are no longer connected to high wages.

We must certainly get rid of the old concept of inflationary-deflationary cycles. Toynbee and Spengler spoke of cycles of empires, but when we have all returned to living a simpler life there will be cycles neither of inflation nor of empires.

The economic problem of peak oil is occurring when people in many countries have already gone through decades of being battered by other economic problems. One serious issue is globalization: for many years, big companies have been getting their work done by sending it out to whatever countries have the poorest people and the most repressive governments (Greider, 1998; Martin & Schumann, 1997; Thurow, 1996). The result is that people in the more-developed countries lose their jobs. Even when the official unemployment levels are low, the figures are misleading; large numbers of the

employed are no longer working at well-paid, permanent jobs. Many are now working part-time, and others have given up hope of work. These factors are not counted in the official unemployment figures.

Closely related to the problem of globalization is that of automation, which increases production but decreases payrolls. Economic disparity is therefore a characteristic of our times. For many years there has been a widening gap between the rich and the poor in the US. While most incomes have either fallen or not changed, the top five percent of families have seen their incomes increase considerably (US Census Bureau, 2010, September 16).

As a result of all these vagaries within the capitalist system, government services are perpetually being cut. The common expression is that "money is tight these days," although very few people ask why that is the case. Taxes continue to rise, but the individual receives little in return. But the days of globalization and automation are coming to an end.

In a sense, of course, all money is "funny money," because it is only a symbol of events occurring in the real world, and often it is a very inadequate symbol. The stock market can multiply a symbol in order to create imaginary wealth, but the symbol then fails to reflect reality. On a smaller scale, there is the question of what "one dollar" represents in the material world. If a "constant dollar" differs from a "current dollar," for example, then the word itself is so fluid that it is not really adequate as a measure of anything tangible.

3: THE END OF ELECTRICITY

The first really distinct sign of systemic collapse will be the increasing frequency of blackouts (Duncan, 2000, November 13; 2005-06, Winter). Throughout the world, electricity comes mainly from coal, natural gas, nuclear power plants, or hydroelectric dams, and all of them are bad choices. Most US and Canadian electricity is produced by fossil fuels, and in the US that generally means coal. The first problems with electricity will serve as an advance warning, but the greatest danger will occur years later as the production of fossil fuels and metals is itself reduced by the lack of electrical power.

The US and Canadian grid is a hopelessly elaborate machine — the largest machine in history — and it is perpetually operating at maximum load, chronically in need of better maintenance and expensive upgrading. Every part of these two countries will be in some danger of outage over the next few years, due to inadequate supplies of electricity (NERC, 2008). Texas may be in the greatest danger, whereas Quebec (with the advantage of hydroelectric dams) may be the safest area. But most Americans and Canadians still cannot think of a failure of electricity as anything more than a momentary aspect of a summer storm. In other parts of the world, the future is already here: the lights fade out daily after four or five hours, if they come on at all. Actually Americans and Canadians are in far better shape than the citizens of other countries. Thanks to political bungling, even "civilized" Britain will apparently be losing 40 percent of its electrical power in the next few years (Booker, 2008, June 10; Harrabin, 2009, September 11).

The use of electricity worldwide rose 54 percent from 1990 to 2005, while the production of energy rose only 34 percent (BP, 2010; Duncan, 2000, November 13; 2005-06, Winter; EIA, 2008, December 31), so it will not always be possible to meet the demand for electricity. The result will be widespread power shortages, some of these deliberately imposed, some of them not.

It is easy to assume that the only issue with fossil-fuel depletion is the problem of what to put in our automobiles. But that view is incorrect. The effect on the production of electricity will be a problem of at least equal seriousness. If we have unavoidable world-wide blackouts and brownouts, then the final result will be a sudden and catastrophic chain reaction. Fossil fuels and electricity are tightly integrated. We cannot have one without the other. Without fossil fuels, we can produce no (or not much) electricity. Conversely, without electricity, we lack the "nervous system" (a useful analogy, since nerves work by ion transfer) to control any equipment that uses fossil fuels.

The problem of electricity, therefore, is one more factor to be tossed into the synergistic muddle of fossil-fuel depletion. Perhaps what we should be thinking of is not

the familiar slope of fossil-fuel depletion depicted in most studies, but a figure consisting of a relatively gentle slope that continues for only a few more years and then becomes a steeper curve downward, as collapse enters what may be called a second phase, perhaps roughly simultaneous with the economic Phase Two signified by the disappearance of government and currency. When fossil fuels are inadequate for maintaining electricity, the further results will be manifold. Fossil-fuel production itself will cease, and so will a great deal else.

It is not only fossil fuels and electricity that form a tightly integrated group, but a triad: fuels, electricity, and metals. Without fossil fuels and electricity, we cannot produce metals. For now let us focus on the first two of the three, but we should never forget that the production of metals is also a vital issue.

When we no longer have enough energy to channel into necessary electricity production, the game is over. Yes, we can divert some energy sources away from other uses towards the production of electricity, but such a diversion causes its own problems. For better or worse, the sources of electricity are mainly hydrocarbons, and will continue to be so for the foreseeable future; as these hydrocarbons reach the down-slopes of their production curves, electricity will follow a fairly similar curve.

The only remaining question is how quickly the various events will unfold. That in turn must be subdivided into questions on such matters as the supplies of the sources (oil, natural gas, coal, hydroelectricity, nuclear power, etc.); on global production of goods and services; on global population; on the amount of electricity generation; and on the chances of deliberately conserving electrical power.

We must not forget the above-mentioned chain reaction — the feedback mechanism. As less fuel (or any other source of energy) is available to produce electricity, there is less electricity to produce fuel. As less electricity is available to produce fuel, there is less fuel to produce electricity. The end is swift.

The answers are also complicated by the fact that the global data are not reflected in more-localized data. For some countries, blackouts and brownouts have been a way of life for years. But no country should assume that it is safe. In the US, the main energy source for electricity is coal, and there have been several reports that coal in the US is not as abundant as once assumed (Höök & Aleklett, 2009, May 1; Smith, 2009, June 8). The remaining coal is of poor quality and difficult to extract.

Richard C. Duncan emphasizes the fragility of electricity in the several versions of his "Olduvai" essay. An important addition to his 2005-06 version is his emphasis on "proximate" versus "ultimate" causes of systemic collapse. ". . . Permanent blackouts . . . will be the *proximate (direct, immediate)* cause of the collapse of industrial civilization. In contrast, [there will be] many *ultimate (indirect, delayed)* causes. . ." (2005-06, Winter, p. 9; emphasis in the original).

Duncan also points out that the importance of electricity is overlooked because it is not the underlying giant problem of "the limits to growth." As any science-minded person knows, electricity is not even a source of energy, it is merely a carrier of energy. Fossil fuels are the primary sources of energy in our industrial civilization. Yet electricity is subtle, and its importance is easily underestimated. It is "end use" that is significant:

> Electricity wins hands down as our most important end-use energy. To wit: I estimate that 7% of the world's oil is consumed by the electric power sector, 20%

> of the world's natural gas, 88% of the coal, and 100% each for nuclear and hydroelectric power. The result is that electric power accounts for 43% of the world's end-use energy compared to oil's 35% (Duncan, 2005-06, Winter, p. 4).

There are always many problems with the use of electricity. It is certainly costly. Duncan notes that, according to the International Energy Agency, the worldwide investment funds required for electricity from 2003 to 2030 will be about $9.66 trillion (2005-06, p. 4). That sort of money is simply not available. Duncan also mentions that electric power systems are "complex, voracious of fuel, polluting, and require 24h-7d-52w maintenance and operations" (2000, November 13, p. 2).

Personally, I think of the great blackout of August 14, 2003, when a large part of northeastern North America came to a halt; Congress later called for up to $100 billion to renovate the power grid, but the money was spent on wars instead (Leopold, 2006, October 17). I remember that day very well. No gasoline, because the pumps required electricity. Still, many Torontonians came up to cottage country, where I was living, to wait out the troubles. There were no bank machines working, so it was cash only. There were big sales of batteries and candles, and of bottled water.

But that was only one day, with a few serious problems on following days. Independent generators kept hospitals and restaurants going. Water trucks solved a problem for cities that did not have gravity-fed reservoirs. But what if the problems had continued for a much longer time — perhaps forever — so that those clumsy attempts at rectification were no longer operating?

4: AS THE LIGHTS GO OUT

When fossil fuels begin to run low, the first really noticeable sign of the times will not be made of cardboard and propped up in front of an empty gas pump. The sign will be the flickering bulb in the ceiling, because electricity will, in most cases, be the weak link in the triad that includes fossil fuels and metals.

As the lights go out, so does everything else. There will come a time when the house or apartment will be largely non-functioning. Not only will there be darkness throughout the dwelling between sunset and sunrise, but all the sockets in the wall will be useless. The "four major appliances," stove, refrigerator, washer, and drier (if anyone still owns such things), will be nothing more than large white objects taking up space, so there will be no familiar means of cooking food or preserving it, and no practical means of doing laundry. There will be no heating or air-conditioning, because these are either controlled by electricity or entirely powered by it. For the same reason, the plumbing will not be working, so clean water will not be coming into the house, and waste water will not be leaving it. For those living in high-rise apartments, there will be many stairs to climb because the elevators will not be operational.

And that is only one's own habitation. The entire country will be affected, the whole world will be affected. Computers will cease to operate, and computers have insinuated themselves into almost every device we use. There will be no long-distance communication: no telephones, no Internet, no electronic transmission of data from anywhere to anywhere.

Eventually money will largely cease to exist, because there will be no electronic means of sending or receiving it, and no way of balancing accounts. ATMs will cease to operate. In fact money nowadays is generally not reckoned as coins or bills, but as data on a screen, and the data will no longer be there.

Modern medicine will vanish. Doctors will not have the modern means of taking care of their patients. Pharmacies will be closed, so drugs will not be available. Medicare will not be depositing funds into doctors' bank accounts. Hospitals will be burdened with the sick and dying, and there will be no means of taking care of the sick. With refrigerating not working, hospitals will not even be able to take care of the dead. There will not even be a means of removing and burying the bodies.

The police will be immobilized, because they will have no means of sending or receiving information. Since police forces anywhere have only enough personnel to deal with fairly average crises (but not enough to deal with the great majority of minor crimes), their duties will be limited to protecting the rich and powerful. Eventually they

will find that they are powerless to do anything but stay home and protect their own families.

For anyone, it will be impossible to jump into a car and get help, because cars require gasoline, and the gas pumps are run by electricity. In any case, the oil wells and the refineries will have ceased operation. The biggest "vicious circle" will have taken place: no electricity will mean no fossil fuels, and no fossil fuels will mean no electricity.

"As the lights go out" is largely a figure of speech, of course, because the incandescent or fluorescent light bulbs in a house will not be the major concern: in the daylight hours, one does not need light bulbs. But the flickering of bulbs will nevertheless act as an early-warning system — the canary in the coal mine, so to speak. During a severe storm, it is the flickering of light bulbs that indicates that it is time to get to whatever emergency supplies have been put aside: bottled water, canned food, and in winter warm clothing. The unsolved problem may be that the concept of "emergency" is usually regarded in terms of a short period of time. There is always the spoken or silent refrain of "until the authorities arrive." But those authorities will be waiting for other authorities to arrive, and those at the top will have made their own separate plans long ago.

Nevertheless, it must be said that there is a great deal that can be done. Of all the resources one can accumulate, the most important are those that are stored inside one's own head: knowledge, skills, wisdom. "Knowledge" is perhaps not the right word, though, because to have read or heard a particular fact does not automatically grant the ability to deal with particular issues.

Even more important than mere "knowledge" is practice. For example, I used to read a great many books on vegetable gardening, but when I owned and ran a market garden for several years I would occasionally mumble, "Why isn't this information in the books?" And there were several answers to that question. In the first place, the books were badly written. Secondly, it is not the overall principles that count, but the minutiae. Thirdly, those particulars often cannot be put into writing or even into speech: "I can't explain it, I can only show you" is an expression I sometimes heard. A good gardener knows a thousand tiny tricks that lead to success, and it is those particulars that matter, not the general statement that one does not sprinkle seed in a snowstorm (Actually the "simple life" takes a lifetime to learn, and one should really have the guidance of the previous generation.)

The skills needed for country living are rarely the same as those needed in the city, although anyone who has built up experience in what the books call "home repair and improvement" will be ahead of those whose knowledge consists of more ethereal matters. Hunting and fishing are not taught in academia.

When I say, "As the lights go out, so does everything else," I mean "everything in the city." What matters is not to be in the wrong place at the wrong time. Living in the city will certainly be a case of the wrong place at the wrong time. There will be no food and no water, and no means of dealing with the victims of famine and disease. When there is an inkling that the electrical power everywhere is about to fail, the answer is to be well outside the city limits. One should either be living in the country or at least have some property in the country and a well-tested means of getting there.

Even a plan of that sort involves a few caveats. "Property" in the modern world is nothing more than a convenient legal fiction. If a gang of outlaws moves in next door, or

even if there is a single oppressive neighbor to be dealt with, then the whole concept of "property" can vanish into thin air. I have known several cases in which people gave up house and land because they could not deal with troublemakers. What will it be like when the troublemakers are doing something more unpleasant than a little trespassing? So it is good to own property, but it is better to realize that ownership, in the modern sense of the word, might be nothing more than a scrap of paper.

Getting out of the city means knowing the roads — not the main highways, but the back roads. Cars will be less common in the future, but it is worth remembering that in a sudden emergency the main roads could become jammed, partly because of the volume of traffic but also because of accidents. Vehicles might even be abandoned, either because they are out of gas or because the passengers have discovered that it is quicker to walk. Knowing the back roads, and even knowing alternative routes among those back roads, means freedom of choice in one's movements.

The last matter is that of community. As mentioned above, the concept of property can be illusive, but there is more to consider in the question of who lives in the general area. Neighbors who take pleasure in noisy dogs, loud radios, or heavy drinking can make proximity unpleasant nowadays, but such people may not prevail in the kind of "natural selection" that will take place, where common decency will be everyone's concern. In any case, the greatest blessing of the post-petroleum age will be the demise of all-terrain vehicles, electronic amplifiers, and the other technological marvels with which people now ruin one another's enjoyment of "cottage country."

Even then, the trouble of having a neighbor may be less than the trouble of not having one. It has often been said that the loner might find it hard to cope. There are not many who have both the practical skills and the personality traits for complete independence; such people would have to be not only self-reliant but also living very far from any populated area if they are not to risk being outnumbered by evil-doers. Without a family, a band, a tribe, there might be no means of distributing the tasks to be done.

It is not reasonable to expect a perfect neighborhood. Within the happiest band of jungle-dwellers there is gossip, discontent, jealousy, manipulation. Troubles and troublemakers can be dealt with in such a way that the community itself does not fall apart. In a primitive community, ostracism, for example, can be an effective means of resolving a problem. A community leader who lacks what we now call "managerial skills" can be replaced by one who does a better job. It is largely a myth to say that country people are nicer than city people; in any setting, neighbors are merely human, with common desires and antipathies and fears. What is important is not to wish for angelic neighbors but to have enough daily contact with them to anticipate how they will respond in a difficult situation.

5: CRIME IN THE POST-PEAK WORLD

As humanity plunges into the age of declining resources, what will be the future of crime? The particular problem of which I am thinking might be called, more specifically, "future violence," since other acts that are now considered criminal may seem trivial in later days. The topic is a huge and nebulous one, and the following notes can barely raise the questions, let alone provide the answers. Even a brief and random search of the available texts, however, may reveal a few patterns. Some of the information about this topic, incidentally, comes from anonymous sources at the grassroots level, indicating the extent to which those in high places sometimes evade responsibility.

There can certainly be a good deal of nastiness to human behavior. One reason for violence is that it can be one of life's greatest pleasures: fighting can be quite an emotional relief, and as primary a need as eating or sleeping; many men have come home from war and spent decades boring the next generation with tales of conquest (Kaplan, 1994, February). An anonymous police officer, in an essay entitled "The Thin Blue Line," claims that man is by nature cruel, always looking for opportunities for selfishness and evil, and that it is wiser to accept that the day will come when that evil must be faced (Deputy W., 2009, January).

A rise in criminal behavior apparently began a few decades ago. In the foreword to Green's *Crime and Civil Society*, Judge Alan Taylor says, with reference to the UK, that there has been a great increase in crime over the years, but that much of it goes unreported (Green, Grove, & Martin, 2005). Even in the case of natural disasters, the extent of crime seems to be misreported in the press. A witness to the Hurricane Katrina disaster in 2005 mentions that problems of law enforcement were often ignored, and that the news media were often denied information about incidents. Police officers were angry about the frequent cover-ups, and about the falsification of statistics (Anonymous, 2007, February).

It seems that the future will be a world in which there will be little difference between crime and warfare (Kaplan, 1994, February). Even at present, war is often no longer between state and state, but closer to the medieval world in which the state as such did not exist. In that ancient world, mercenaries often fought on their own behalf, to such an extent that the distinction between armies and the populace was unclear, and the rules of engagement were often nonexistent.

But how do we define that "failed state" of which Kaplan and others often speak? Kaplan later incorporated his essay into an entire book called *The Ends of the Earth: From Togo to Turkmenistan, from Iran to Cambodia — A Journey to the Frontiers of*

Anarchy (2001). The area he describes, in other words, stretches out over more than a quarter of the circumference of the Earth.

The US itself is characterized by declining natural resources, high unemployment, severe income inequity, colossal private and public debt, and unrestrained warmongering. American government at all levels does not even bother hiding its corruption, its unrepentant dishonesty, its conflicts of interest, and the slick salesmanship of its electoral process. The general populace, meanwhile, is stunned into apathy and silent obedience. Is that or is that not a description of a failed state?

No doubt the police will be overburdened in the coming decades, in view of the fact that even now the police force is inadequate for accommodating present levels of crime. In a condition of true social collapse, there will be greater opportunities for crime, while conversely the police force will be unable to increase in numbers, partly because the money to do so will be unavailable.

It is probably a good guess to say that fuel supplies will be tightly rationed, perhaps almost unavailable to those who do not constitute "authorities," but eventually even those people will be facing a shortage. The sight of police cars sitting in a police-station parking lot, with no fuel to put the cars on the road, would be quite funny if it were not so foreboding. And a police force trying to operate during a lengthy breakdown of the electric-power grid might not be able to do much of anything.

When the economy collapses, and many are facing unemployment, a point is reached at which everyone is concerned about food, water, and shelter, and about the protection of the immediate family. Eventually any available weapon will be put to use in that one goal of survival. If at the present time there are only enough police officers to deal with the more-important crimes, in the future it will become apparent to such officers that they too need to be at home and protecting their own families (Deputy W., 2009, January).

The observer of the Hurricane Katrina disaster has little positive to say about any authorities who became involved in that event. His impression was that the best plan was to form a group and divide the various tasks. One irony was that those who were better prepared were threatened by the less-prepared, whose attitude was that the former must have unfairly done better. Later, when authorities actually arrived, they were likely to go beyond the letter of the law and demand unreasonable obedience even from those who had no wish or need to be "saved" (Anonymous, 2007, February 13).

Crime-fighting in the future will be further complicated by the ambiguity of the "bad guys." Powerful weapons are not of much use when it is not clear at whom one should be shooting, and this enigma has been around for decades. American soldiers in Vietnam were often plagued by not knowing who constituted the enemy. An Iraqi friend of mine tells me that the lengthy fighting in his country is mainly "street fighting," block by block. The trend is certainly toward urban warfare and away from the more-clearly defined battlegrounds of earlier times.

The police in western society hold a position that is in many ways paradoxical or ambiguous, and they themselves may be most aware of the problem. There is a common belief that modern democracies are blessed with law and order, but sometimes the reality is otherwise: if my house is robbed, the police will arrive eventually and take notes, but that may be all they will do. Over the years I have been affected by various crimes, either

as victim or as witness, and I have heard similar accounts from friends and neighbors: in most of those cases there was no arrest, nor was stolen property returned.

The main function of the police, we are often told, is to preserve the "peace." But exactly whose "peace" is it that they are preserving? Perhaps "preserving the peace" simply means ensuring that the common people do not disturb the basic structure of society — even if they have to be beaten into such peacefulness. It often seems that the point of a crime investigation is not to come to the aid of the victim, but merely to see who is trying to rock the boat. In most cases the suspect is nobody worth worrying about. Such matters as ordinary assault and robbery do nothing to damage the walls of the empire, so the police will simply add the case to the files and forget about it.

The police themselves are not entirely to blame for their inability to aid society. They can be held accountable if they believe that any political ignorance on their own part is justifiable as political neutrality, but greater problems are caused by irrational laws and an overburdened judiciary. When governments deliberately lie about crime figures, and when the courts are perpetually buffeted by the shifting winds of politics, even the most enlightened and well-meaning police officer is in a difficult situation.

The questionable role of the police becomes most obvious in the evolution of what is called the "surveillance society," of which the UK is a good example. The miracle of modern communications has its nefarious side: the electronic utopia of the future would be one of transponders, closed-circuit television, helicopters, and forbidden zones, or perhaps less-anachronistic variations thereof. For whose good is this being done? Who is being protected from whom? Fortunately the problem contains its own solution: technophilia is a disease for which time is the best remedy. As fuel, metals, and electricity go into decline, such weaponry will no longer be available for use against the general population.

When it is far too late, we may realize how much we have lost. In the modern world, many people ridicule their own inherited political ideals, but they may be suffering from a misunderstanding of the difference between those ideals and the present conditions. Democracy, equal rights, civil liberty, the "rule of law," and so on, cannot be explained clearly in less than a few hundred pages. The people who disparage those ideals are generally those who have enjoyed living in that world since the day they were born, and they are unaware of the reality of life under other regimes except as temporary vacationers at an American-owned hotel.

6: THE POST-OIL COMMUNITY

The story of the imminent collapse of industrial civilization rarely appears in the conventional news media, or it appears only in distorted forms. Ironically, the modern world is plagued by a lack of serious information. Today's news item is usually forgotten by tomorrow. The television viewer has the vague impression that something happened somewhere, but one could change channels all day without finding anything below the surface. The communications media are owned by an ever-shrinking number of interrelated giant corporations, and the product sold to the public is a uniform blandness, designed to keep the masses in their place (Bagdikian, 2004; McChesney, 2004). But the unreality of television is only the start of the enigma. The larger problem is that there is no leadership, no sense of organization, for dealing with the important issues.

One might consider as an analogy the Great Depression. During those 10 years, everyone lived on a separate island, lost, alone, and afraid. It was a "shame" to be poor, so one could not even discuss it with the neighbors. The press and the politicians largely denied that the Depression existed, so there was little help from them. In general, it was just each nuclear family on its own — for those who were lucky enough to have a family (Broadfoot, 1997).

As the oil crisis worsens there will be various forms of aberrant behavior: denial, anger, mental paralysis. There will be an increase in crime, there will be extremist political movements. Strange religious cults will arise, and "fundamentalists" are already on the rise everywhere (Catton, 1982; Thurow, 1996). The reason for such behavior is that the peak-oil problem is really neither about economics nor about politics. Nor is it about alternative energy; there's no such thing. It's about geology. It's about humanity's attempt to defy geology. But it's also about psychology: most people cannot grasp the concept of "overshoot" (Catton, 1982).

We cannot come to terms with the fact that as a species we have gone beyond the ability of the planet to accommodate us. We have bred ourselves beyond the limits. We have consumed, polluted, and expanded beyond our means, and after centuries of superficial technological solutions we are now running short of answers. Biologists explain such expansion in terms of "carrying capacity": lemmings and snowshoe hares — and a great many other species — have the same problem; overpopulation and over-consumption lead to die-off. But humans cannot come to terms with the concept. It goes against the grain of all our religious and philosophical beliefs.

When we were children, nobody told us that any of this would be happening. Nobody told us that the human spirit would have to face limitations. We were taught that

there are no necessary boundaries to human achievement. We were taught that optimism, realism, and exuberance are just three names for the same thing. In a philosophical sense, therefore, most humans never become adults: they cannot understand limits.

Perhaps there is really nothing irredeemable in all this. We live in a "consumer" society, and we are all under the wheels of the juggernaut of capitalism. But if we look beyond civilization, both spatially and temporally, we can find many cultures with an outlook based more on the seasons of the year, rather than on an ever-expanding, ever-devouring "progress."

It's easy to say, "Let form a community and deal with the post-oil economy." An ad-hoc social group of any sort often sounds like a great thing to be starting, but often they don't work. What happens is roughly as follows. (1) Each member has a vague dislike of most other members: after all, they may have nothing in common except the one thing the group came together for. (2) Most people don't want to do any work to help the organization: administration (typing, filing, phoning) is boring. (3) At meetings, most people don't speak, since they're afraid of starting a big argument, but they'll gather privately and complain for weeks afterwards. (4) Everyone assumes that when officers have been elected, the other members can all forget about the organization; for the rest of the year, if there are any problems, then "They" should fix them. (5) When everything starts to fall apart, some rather manipulative person jumps into the vacuum and establishes a dictatorship; soon afterward, the membership is down to zero.

Why do these problems occur, and how will people form viable groups in the future? To answer these questions properly, we first must realize that the ideal political system is not a "political" matter at all, but a psychological one. What I mean is that it is not a conscious, cerebral decision; it is a matter of the hard-wiring of our nervous system. And I say that as one who does not believe in evolutionary psychology or sociobiology, or any other of those ant-like portrayals of human mentality. Humans and their ancestors spent over a million years living in small groups, hunting and gathering. To judge from primitive societies that still exist, those groups had neither perfect dictatorship nor pure democracy, but something in the middle, a sort of semi-anarchic but functional process of majority rule; chiefs who didn't perform well got the cold shoulder (Ferguson, 2003, July/August; Lee, 1968; Harris, 1990).

The group was small enough that each person knew every other person, and the rather clumsy democracy could work because both the "voters" and the "politicians" were visible. It has only been in a tiny fraction of the lifespan of humanity — the period called "civilization" — that political units have been created that are far too large for people to know one another except as abstractions. Small groups have their problems, but in terms of providing happiness for the average person, the band or village has always been more efficient than the empire.

The maximum practical size for human association may be Robin Dunbar's number of 150 (1992), but we might need to be rather flexible about that — perhaps somewhere between about 20 and 200. Roman soldiers, for example, were organized into "centuries," and modern Hutterite communities have between 60 and 160 members. The same was true long before the Romans: a Paleolithic pack included about 20 or 30 people, whereas in Neolithic times a village might have a population of 150 or more (Starr, 1991).

But a close look at a half a dozen types of human groups is all that is necessary to get a good intuitive grasp of the sorts of numbers that are workable. Groups larger than that of the band or the small tribe simply do not do as well in providing for the happiness of their individual members. A social group of a million or a billion may have military advantages but is more likely to operate as a tyranny than as a democracy — China is the obvious case. Larger groups are not necessarily unworkable, but they involve a greater risk of the loss of social cohesion.

It is the problem of "individualism" versus "collectivism" that will hit Americans rather hard in the future. Americans are loners. After years of living and working with people from various eastern cultures, I am convinced that if you put a group of Asians on a desert island, they would get together and build a boat. If you put a group of Americans on a desert island, they would start arguing about property rights. The weakness of individualism could be seen during the Great Depression of the 1930s: the average person was isolated, lost, and afraid. It was a "shame" to be poor, so one could not even discuss the problem with one's neighbors. The news media and the government largely denied that the Depression existed, so there was little help from them (Broadfoot, 1997).

Closely related to the problem of individualism is that of the lack of ideological unity. The basic premises of any major discussion seem to be absent. In a typical crowd of Americans, half will deny that any of the aspects of systemic collapse even exist, and most of the other half will say, "Well, I believe . . ." and proceed to spout whatever nonsense their brains have been filled with. If politicians never say a word about overpopulation, resource consumption, or any other real issue, how can the average person be blamed for mental laziness? But perhaps there's something to be said for intellectual responsibility. Certainly no one can say that informative books aren't available — a good collection can be put together, at a dollar apiece, by roaming the second-hand stores, since interest in serious reading seems to have declined over the years.

The individualist mentality has always been typical of Americans. There is a sort of frontier mentality that still pervades much of American life. In certain ways, this has been beneficial: freedom from the obligations of the "old country" has provided much of the motivation for those who came to what was called the "New World." The beneficial side of individualism is self-sufficiency, which made it possible for pioneers to survive in the isolation of the wilderness. But individualism will not be as useful a response in the future as it was in pioneer times. In fact individualism might just be more beneficial in good times than in bad, in times of prosperity rather than in times of hardship. There are, admittedly, a few people who have both the skills and fortitude for independent living, but for the great majority the future will require a sense of community.

The most obvious negative effect of individualism can be seen in today's false democracy: political leaders can tell the most remarkable lies, and the response is silent obedience. It is hard to understand such a thing happening in "the land of the free and the home of the brave" until we realize that most Americans have little means of behaving otherwise. They are probably lacking in family or friends with whom they can share information or compare ideas, and they are therefore entirely dependent on the news media for their comprehension of human society. A solitary evening in front of a television set is not likely to promote healthy social relationships.

One cannot throw a “tribe” together simply by sitting down and having a community chat in the course of one afternoon in a suburban living room (The fact that we don’t instantly recognize something so obvious is in itself evidence of our inability to form a “tribe.”) Primitive cultures may be organized into any of a number of social groupings, and those groupings in turn are often parts of a larger group — there is a pyramidal structure. But there are two characteristics that are found in these primitive cultures. In the first place, the group is always quite ancient; any group of that sort has been forming and reforming for generations, and one might say that the group is as old as humanity. Secondly, any genuine social group in a primitive society consists of members who are all tied by the bonds of either blood or marriage. Everybody is everybody else’s cousin, so to speak. We may laugh at rural communities for what we regard as their “incestuous” behavior, but sometimes having close ties is precisely what keeps people alive.

In any large-scale disaster, in which help is needed quickly, group members get chosen from whoever is useful: the most knowledgeable, those with the best social skills, or perhaps just the nearest. In the long run, however, what will prevail will be the family, as it always has done. In a primitive society, most social divisions begin with the family, although more important is not the nuclear family but the extended one. Nuclear families are somewhat temporary, whereas the extended family is timeless. From the family comes the idea of descent from those in the past, and it reaches outward in the present to all the aunts and uncles and so on. The family may be traced through the fathers, or through the mothers, or both.

If the family is large enough, and descent is reckoned through a very distant ancestor, anthropologists may refer to it as a clan; the ancestor may be mythical, though, perhaps even taking the form of an animal or a god. If several clans (called moieties if there are only two) live together, or at least associate with one another in some way such as intermarriage, the larger group is called a phratry. If the community is large enough, with formal concepts of social rank and leadership, it may be labeled a tribe. (There is no definition of “tribe” that suits all scholars, but often there is the notion of a group larger than a mere band, with a more-elaborate social structure and a more formal leadership.) But always the foundation of these social groups is the mating of a man and a woman, and the children that come from that bond.

The terms describing systems of kinship have enormous variation in meaning from one society to another, but in all cases these labels signify the ties from one individual to another, beginning with the husband and wife and extending out in all directions. The ties are always either those of blood or marriage, but marriage makes one an honorary member of that society. Each tie is emotional, not just some sort of business relationship.

The traditional social group, then, is characterized both by its antiquity and by its kinship patterns. Such patterns would certainly not be characteristic of a group of suburbanite refugees lost in the wilderness and suffering from shock and fatigue. It would be an understatement to say that such an ad-hoc clustering of humans would face psychological challenges unlike those of people who had been living deep in the jungle since time immemorial.

It should be obvious that those who live in the country will be better prepared than those who live in cities. A city is a place that consumes a great deal but produces

little in terms of life's essentials. A city without incoming food or water collapses rapidly, whereas a small community closely tied to the natural environment can more easily adjust to technological and economic troubles. Even out in the country, however, the present housing patterns often resemble the gasoline-induced sprawl of the suburbs. Paradoxically, many "rural" areas have become "urbanized," in the sense that they are doing their best to imitate the worst aspects of large cities. For those who choose a "Neolithic" farming life rather than the "Paleolithic" life of foragers, more useful would be something resembling a traditional village, with the houses at the focus and the fields radiating from that point — we can read Thomas Hardy's novels to get a feeling of how this used to be.

"Something resembling a traditional village" is different from the real thing. In a genuine "traditional village," people have known one another for generations, and a crowd of pale-skinned visitors is not likely to be received with open arms. If these urban refugees show up flashing their useless credit cards all over the place, and demanding assistance, but they have no practical skills and do not even have the muscles for basic manual labor, it is unlikely that they will be welcomed in any long-settled community. These refugees will have to develop their own communities, and they will have to overcome the problem of their inadequate social skills. But some may learn. In spite of themselves, a few will learn.

If a post-oil community actually got underway, one thing to be avoided, for the most part, would be the issue of "division of labor" — dividing up jobs or professions: farmers, carpenters, etc. In most primitive societies, most people were good at most things. There was a vague division along the lines of sex (male, female) and age (adults, children), but that was about it, and even that was by no means absolute. Any future community would have to behave in the same manner as most primitive societies. And it would certainly be a "primitive society": if no one in the community had ever produced a crop of beans successfully, there would be little point in worrying about an elaborate division of labor.

The new tribalists will be living on a planet that has lost its familiar borders. Long before the twenty-first century reaches its end, what we now think of as the geopolitical face of the world will have been transformed considerably. The "booming economies," relatively speaking, will be those with an adequate ratio of population to arable land — in Canada, in the US, in parts of Africa, in parts of Latin America, and in a somewhat amorphous area that stretches from the Baltic across to what is now the Mongolian People's Republic (not Chinese Mongolia) (CIA, 2010). The tables will often be turned in the social and political strife that now affects much of the world, so that both the land and the government will be returned to the farmers. The great irony, in other words, is that many countries that have suffered politically and economically have ended up with good population-to-arable ratios, and these ratios will be an advantage in terms of the future of agriculture.

By the end of the present century, the human population will be much smaller than it now is. The 200-odd nations of the present day will be only a dim memory. Grass will be growing everywhere, and the long miles of cracked highways will be merely a curiosity. Starlight will once again appear over the cities at night. Humans were not designed to live in groups of such immense size as we see today, nor were they given the physiological equipment to deal with the over-stimulation of crowded living-spaces. It is

also true, for various reasons, that the sight of green trees is more pleasing than that of gray machines. It is not just a platitude to say that we are out of touch with Nature.

In the future, where we live is where we will live for the rest of our lives. Without gasoline and diesel fuel, movement from one place to another will be limited. Not only will the fuel be lacking, but even the roads to drive on will become less common. Anyone who has driven past a construction site should suspect that modern roads are not as durable as those of the Romans. Asphalt is a form of oil, and shortages will mean that paved roads will not be repaired. As the chaos intensifies and municipal governments watch their budgets disappearing, the maintenance of paved roads will be further reduced. When those roads are not repaired, it will take little time for them to become cracked and unusable, and they will often be blocked by smashed and abandoned cars whose owners have lost the ability — or the sheer willpower — to keep them running. In any case, the main roads will generally be going in the wrong directions: from one city to another, exactly where most people will not want to go. Any intelligent person would stay away from the cities, and instead go up into the hills, well away from populated areas, further on, to greener pastures.

There will then be only three methods of travel: on foot, in a non-motorized boat, or on the back of a horse, a donkey, or some other animal. The speed by any of these three methods is about the same: about 40 km per day, for those who are physically fit (Stenton, 1970). For short distances, one means of transport may be quicker than another, but the longer the distance we take into consideration, the less it seems that walking is to be despised. Certainly the history of bicycles is not likely to go on for much longer: even where paved roads are usable, bicycles will be hard to repair without the industrial infrastructure to provide the spare parts and the servicing.

In spite of all these troubles, I think there is hope for those who will be living in future centuries. A vision of a better world is always with us, and that vision will sustain us. Even as we lie asleep at night, we imagine a less crowded planet, a less noisy one, a less busy one. Such dreams tell us the obvious truth that daily life should not be a fast-paced interminable struggle of each person against every other.

7: WHERE TO LIVE

As various parts of the world collapse, one big question is, "Should I start packing my bags?" There is probably no perfectly rational way for choosing a place to live. Nevertheless, if we are brave enough, or if we have already done some traveling, the factors listed below may be those we want to consider. Unfortunately a great deal of writing repeats certain misconceptions about emigrating to a "tropical paradise," and we must therefore also look at this matter further on.

By far the largest issue is that of time frame. The systemic collapse of modern civilization will consist, as I have said, of two distinct phases, and the border between the two will be marked by the disappearance of money as a means of exchange. Each phase will entail separate considerations.

During Phase One, governments, law, and money will still exist in roughly their present forms, and these will be some of the matters to consider in choosing a place to live. What I am listing below as the issues of economic stability, cost of living, and average income are therefore relevant to Phase One. Even during that first period, however, the more-permanent issues of arable land, climate, and family and friends will be very important.

Phase Two will be that in which societal collapse has advanced further, and much of the world starts to resemble the Middle Ages. At that point I doubt that people will be concerned about the finer points of pension schemes or tax shelters. The list of qualities to consider in a place to live will then be much shorter, and the trivial will be discarded.

We should remember that the readily available information on other countries is mainly geared to tourists, but what such people experience on a 10-day package tour bears little resemblance to long-term residence in a country. Most tourists live in a silly and artificial world, and their lives are not entwined with those of the local people. In fact tourists are often hated because they regard other countries as their personal playground, and the citizens of that country as their servants. Even an "eco-tourist" daily consumes far more resources than a native, and vast amounts of fossil fuel are burned up in the airplane trips there and back.

Population Density

The tropical paradise is somewhat mythical. Thailand, for example, has positive and negative aspects. Perhaps in the more rural areas of that country it would be possible to live fairly cheaply. Public transport is usually available, at least for now, so a car might

not be necessary. There would be no need for heating fuel or firewood in winter. Food would be cheap and good. But Thailand in general can be quite unpleasant because of its heat, and also because of problems with noise, with environmental destruction, and above all with overpopulation.

The issue of overcrowding, in Thailand and elsewhere, must also be considered in terms of other issues of societal collapse. If, in the future, the world economy has a "bang" that is much worse than the one that started in 2007, I think I would want to be living in a country that has a good deal of uninhabited and undeveloped land where I could be somewhat independent of a money-based economy. In plain English, wherever I live I want to be able to head for the hills. For the same reason, I have no intention of living in a city.

One thing is certain: without motorized transportation, the crowding in the world's cities will ensure that they eventually become death traps. Modern business methods only intensify the weakness: while business-management experts take pride in the cost-effectiveness of "just in time" inventory, they ignore the fact that "just in time" is only a step away from "just out of time." During the Second World War, Leningrad turned to cannibalism when the city was besieged by the Germans (Salisbury, 2003), and such events were far more common in ancient times.

Population per Unit of Arable Land

More important than population density in the absolute sense is the ratio of population to the amount of land that can be used to produce crops. Eventually most people will be producing their own food, or at least relying on food grown nearby. A society based mainly on primitive subsistence farming can have, at the very most, no more than 9 people per hectare of arable land, i.e. 900 people per km^2, and many countries are already well over that density; a more-realistic ratio would be 400 people per km^2. A major question therefore is: Which countries have a fair amount of arable land?

The following 30 countries (in rank order) have the best ratios: Australia, Kazakhstan, Canada, Niger, Russia, Lithuania, Latvia, Ukraine, Argentina, Guyana, the US, Belarus, Hungary, Zambia, Paraguay, Bulgaria, the Central African Republic, Togo, Turkmenistan, Sudan, Moldova, Finland, Romania, Denmark, Estonia, Mongolia, Namibia, Uruguay, Mali, and Chad. Roughly speaking, the worst areas for this ratio are the Middle East, most of southern and eastern Asia, the islands of the Pacific, and Western Europe (CIA, 2010).

In terms of agriculture there are also related factors to consider, such as temperature, precipitation, and soil degradation. Of the 30 countries listed above, Kazakhstan, Mongolia, Namibia, Mali, and Chad are quite dry. Most of central and eastern Europe has serious problems of soil degradation, but these areas should not necessarily be discounted — they have shrinking population, for example, and that will be an advantage to those who remain (Bot et al., 2000).

One might be tempted to suggest a sour-grapes theory of the population-to-arable ratio: one could argue that countries with better ratios are merely indicating poor living conditions of some other sort, such as bad politics or economic troubles. To a large extent this is true, but there are important exceptions. The UK and the Republic of Ireland, for

example, are very similar in geographic respects, but the UK has three times the population-to-arable ratio; from the standpoint of subsistence farming, the Republic of Ireland would be a far more habitable country.

From my own point of view, arable land is the most important consideration, either for the sake of growing one's one food, or at least for being close to an area where food is produced and distributed. Political matters are perhaps in second place, while everything else would be far down the list. Nevertheless, I can see how other people would have other priorities.

Climate

To some extent the choice of climate is rather a personal matter, depending on what one is used to. Extremes of climate, however, mean that life could become uncomfortable without our accustomed access to central heating or air conditioning. One would ideally be living about halfway between the equator and the poles, but the catch is that many other people have already had the same idea.

Political Freedom

There are many countries where the concept of civil liberty is completely absent. In fact there are many other big political issues that should be considered: political equality, democracy, the whole concept of "the open society." (See also "Political Corruption," below.) One should not underestimate the pleasures of living in a country with a relatively sane form of government — at least for as long as governments last.

Economic Stability

Countries that rely heavily on exports can be quickly damaged by changes in the world market. A small country is generally in trouble if its income is based on a narrow range of goods or services. Excessive private and public borrowing often leads to debts that cannot be paid. Monoculture and foreign ownership have ruined many countries, even if the facts are rarely printed in newspapers. Modern economics is a complex subject, and when disaster occurs it seems that no one even knows who to blame.

Cost of Living

The cost of living in a foreign country is obviously important, especially for people who hope to have jobs there, but also if they have fixed incomes, or just fixed savings. The odd thing, though, is that the cost of living doesn't really vary all that much from one country to another, contrary to popular belief. A hamburger is always a hamburger, it seems. The cost of living in Moscow is three times as high as in Asunçion, Paraguay, but generally the range is much less (Mercer Human Resource Consulting, 2006). Life out in the countryside may be cheaper, but not greatly, and only relatively: there are no more rural paradises where goods and services can be bought for pennies. Along with the cost of living, one must also look at a country's rate of price inflation, which can easily make a dent in income or savings. The best way of dealing with the cost

of living in any country is, quite simply, to reduce one's dependence on money — by learning to grow food and do carpentry and so on.

Average Income

Average income (commonly expressed as GDP/capita) is a serious issue for anyone planning to get a job in a distant country and expecting to be paid a local salary. Average income is also a consideration for anyone planning to hire local workers. However, any figure for average income is meaningless unless it is correlated with cost of living, and if both are defined in terms of international dollars or some other universal frame of reference. Making sense of such figures is not always easy.

There is not a great deal of correlation between a country's cost of living and its average income. There is, however, some tendency for countries with high costs of living to have incomes that are even more unusually high. In a poor country such as Malawi, for example, both the cost of living and the average income are low; in Luxembourg, on the other hand, while the cost of living is somewhat high, the average income is quite remarkable. One reason why people like to move to the US is that the high cost of living is offset by the very high average income. Most countries in Europe, on the other hand, present a bad combination of both high cost of living and low average income.

Crime Rates

For those dreaming of escape to distant places, the unfortunate irony is that cheap property and high crime rates often go together. That's true street-by-street, but also country-by-country. It's hard to beat the odds on that one, but perhaps it can be done. And by high crime rates I don't necessarily mean organized crime. A more common question may be the far more subtle issue of whether one will have as neighbors a group of people who persist in minor acts of theft and similar infractions — what is euphemistically referred to as "having an uneasy relationship with the law." Even borderline illegalities can ultimately become heartbreaking for the victims.

Political Corruption

Political corruption is a situation in which every day is pervaded by the question of "who you know." Although there may be laws and regulations, from the federal to the institutional level, the actual decisions get made, sometimes in secret, on the basis of who has informal power over whom. Daily life is controlled by "families" and petty "mafias," perhaps without the guns and glamour of their Hollywood counterparts. There are many forms of corruption, including cronyism (favoritism toward friends), nepotism (favoritism toward family members), bribery, embezzlement, graft, influence-peddling, patronage (not always illicit), kickbacks, and electoral fraud. To a large extent corruption is correlated — both as cause and as effect — with poverty, illiteracy, lack of democracy, and lack of freedom of speech and of the press. From the point of view of retirement, perhaps the biggest question about a corrupt country is: What would happen to one's bank account after the next palace revolution?

Immigration Laws

Many countries have laws stating that foreigners cannot retire there permanently unless they offer proof of a guaranteed monthly income, a lump-sum deposit, or an investment of some sort. Having family members already living in the country is an advantage. For those who intend to keep working for a living, having a high-demand profession can make a big difference. Sometimes such laws are rather vague and open to varying interpretation, and getting an application processed may be complicated, time-consuming and expensive. Within the European Union, it's generally easy for citizens of one country to move to another, but the even there the rules are somewhat variable and subject to change.

There are certainly exceptions, but in general it might be said that immigration laws are getting tighter these days. It's no longer a case of picking a place on a map and packing a suitcase. Most governments are realizing that immigration is often not beneficial to a country. There are seven billion people in the world, and most of the blank spaces on the map are not really habitable.

Language

Learning a language does not require mental ability, only opportunity (e.g., living there) and determination. Making an effort to learn some of the local language is a good way to make life in a new country more comfortable. Learning a few words of a language, in fact, is one of the principal means of becoming accepted in any society. But obviously the language of the country, or (on the other hand) the likelihood of encountering people who speak one's own language, will have many effects on one's daily life.

Friends and Family

Determined loners may be exceptions, but most people would want to consider the choices or necessities of any family members or close friends. If these people are also willing to move, so much the better. If they cannot or will not move, then one's own choices may be restricted. In any case, it may simply be safer to stay in the old, familiar locality, living next to people one has known for years. Even if they are not perfect, it is at least possible to have an idea of what can be can expected from them, whereas strangers in a distant land may offer too many unpleasant surprises.

Ultimately it may be impossible to give up one's present social network. Homesickness can be truly crippling, although those who have previously led a nomadic life may have developed emotional strengths. The move itself can be painful: besides the emotional strain of traveling to a distant land, there is the problem of selling most of one's possessions before moving to another country, and then buying replacement possessions upon arrival — and perhaps giving up two years later and moving back home again. Sometimes a little perseverance can solve or prevent such problems.

Going Native

In poorer countries, attempting to copy the way of life of the natives is not a good idea. For example, it is commonly said that a westerner cannot really live comfortably in Thailand for less than about $10,000 a year, and that's the minimum. Most native workers there, on the other hand, live on about $2,000 a year. What it amounts to is that westerners in Thailand would go mad if they tried to live the arduous life that is lived by most natives. Native life in modern times is really just manual labor at starvation wages. If a foreigner moves to a "tropical paradise" at 60 years of age, then to go native that person would have to start by being dead for the previous 20 years.

I would say, also, that if it costs $10,000 to live in Thailand, then I would rather live in a modern western country such as Canada, which would probably cost about $15,000 for the same standard of living, but without the disadvantages. In general I have many doubts about putting on shorts and sandals and moving to tropical paradises. I'm sure there are westerners who find such countries pleasant, but my own preference would be for open spaces and a more-northern climate.

Finding Reasons

There really is no simple answer to the question of where to live. We must each weigh all of the factors, but the measurements themselves can become a personal or intuitive matter. F. H. Bradley once said, "Philosophy is the finding of bad reasons for what we believe upon instinct," and love of country has equally non-rational forces that cannot easily be ignored. We always look for evidence that the best country is the one in which we were born. Thoreau said, "Though all the fates should prove unkind, / Leave not your native land behind." My own home, Canada, is not entirely "native" to me, since I didn't choose it until age 16, after living in Germany, the UK, and the US, but after so many years in Canada I will always look for reasons for keeping it as my base of operations. That does not mean it is not a land that can be both geographically and economically trying. Similar paradoxes are true for everyone else in every other country.

We should not lightly dismiss the importance of the emotional ties to our native land, even if we have only been "native" to such a land for only a few years. In any case, such ties are not entirely irrational. Our reasons for putting down roots in a particular country may be somewhat accidental, but if we examine ourselves more closely we may find that when we have stopped our youthful wanderings there is a curious match between personality and landscape.

We must nevertheless remember that the reluctance to leave can be fatal. History is filled with stories of people who failed to heed warnings. The usual cry is, "It can't happen here. This is a civilized country."

8: THE WIDENING SPIRAL

As mundane as it may seem in our "advanced" civilization, "peak oil" basically means "peak food." Farmers are invisible people, and middle-class city dwellers choose to pretend that the long lines of trucks bringing food into the city at dawn every day have nothing to do with the white-collar world. Perhaps it is a mark of the civilized person to believe that the essentials of food, clothing, and shelter have no relevance to daily life. Yet if the farmers stopped sending food into the great vacuum of the metropolis, the great maw of urbanity, the city would rapidly crumble, as Britain discovered during the transport strike of the year 2000 (McMahon, 2006, August 21). The next question, then, is: Where does all this food come from?

Is there such a thing as sustainable agriculture, or is "sustainable agriculture" a contradiction of terms — an oxymoron? To keep a piece of land producing crops, it is necessary to maintain a high level of various elements. The most critical are phosphorus (P), potassium (K), and especially nitrogen (N). These elements might be abundant in the soil before any cultivation is done, but they are removed to some extent whenever crops are harvested.

Writing early in the twentieth century, F. H. King (n.d.) claimed that farmers in China, Japan, and Korea were managing to grow abundant crops on about one tenth as much cultivable land per capita as Americans, and that they had done so for 4,000 years. If they kept their land producing for all those centuries, what was their secret? The answer, in part, is that most of eastern Asia has an excellent climate, with rainfall most abundant when it is most needed. More importantly, agriculture was sustained by the practice of returning almost all waste to the soil — even human excrement from the cities was carried long distances to the farms. Various legumes, grown in the fields between the planting of food crops, fixed atmospheric nitrogen in the soil. Much of the annually depleted N-P-K, however, was replaced by taking vegetation from the hillsides and mountains, and by the use of silt, which was taken from the irrigation canals but which originated in the mountains. The system, therefore, was not a closed one, because it took materials from outside the farms.

These three countries are, in any case, problematic as sources of agricultural "wisdom." King remarks that "the first days of travel in these old countries force the over-crowding upon the attention as nothing else can" (p. 23). In a chapter on Tientsin, he cites a Scottish physician's description of a common solution to over-crowding: "In times of famine the girls especially are disposed of, often permitted to die when very young for lack of care. Many are sold at such times to go into other provinces" (p. 331). As for the

hard labor and low remuneration, King says of a Japanese rice farmer that "it is difficult for Americans to understand how it is possible for the will of man, even when spurred by the love of home and family, to hold flesh to tasks like these" (p. 209). The "miracle" of growing so much food on so little land was largely due, therefore, to neither technology nor topography, but to the fact that starvation was the only alternative.

In some societies, agriculture meant slow but inexorable burnout, as was the case for most of Europe. In other cultures (e.g., China, Japan, and Korea) the response was to recycle intensively. As much as possible, vegetable compost and human and animal excrement had to be reclaimed, and other loss was made up by importing soil and vegetation from the wilderness. Even for those cultures a growing population exacerbated the problems.

World agriculture faces the problem of a reduction in arable land, but there is also the problem of water. The natural availability of water has always been one of the most critical factors in farming. Most of the western US receives only 50 cm or less rainfall annually. But low precipitation is a problem in parts of every continent. In a real survival situation, what are the chances that anyone would be able to pick up a plastic hose and get an endless supply of clear cold water? Not very great. Even wells, cisterns, and ponds would be useless if their water flow had been controlled by electricity. When water must be pumped by hand or carried in buckets, it becomes a precious commodity.

But the world's food problems cannot be solved merely by devising a method to increase agriculture. The world's human population is now approaching 7 billion, while the amount of arable land is not great. Massive inputs of artificial fertilizers and pesticides only replace one problem with others: poisoned water, eroded soil, and insufficient humus. Even the world's present arable land is rapidly disappearing under cities and highways. Nor can we extend that land by pumping more water from underground, because the aquifers cannot be made to yield more water than they receive.

There may be something resembling sustainability, depending partly on one's definitions, but it would have little to do with the simplistic concepts that are usually put forward. In the first place, there is nothing "natural" about agriculture. Agriculture has only been practiced for less than one percent of the entire history of our genus, and in that sense it is still an experiment with uncertain results. To plow the earth is to "go against Nature," since it means disturbing the soil, the intricate, complex surface of the planet. The slightest and shallowest disturbance causes chemical and biological losses of various sorts. It has even been said that agriculture is "the worst mistake in the history of the human race" (Diamond, 1987, May), and that the Paleolithic practice of foraging, with a greatly reduced population, may be the only way of life that can be extended for millennia (Ferguson, 2003, July/August; Lee, 1968). Nevertheless, with such a large global population it is certain that agriculture will continue for at least the next few decades, and in the absence of fossil fuels the majority of humans will be working their individual plots of land.

In spite of the dangers of perpetual growth in agricultural production, in some countries one can drive for days without seeing an end to cultivated land (or asphalt and concrete). Almost no attention is paid to the final consequences of such practices, and the relentless quest for money makes it unlikely that serious attention will ever be paid. Even on a theoretical level, the permanent feeding of humanity is not simple. Any long-term

solution would require paying as much attention to restoration of the land as has previously been paid to its cultivation.

Secondly and more importantly, to maintain a somewhat-permanent balance between population and cultivation would require a considerable reduction in the former. It is foolish to say that the gap between food and population can be met by increasing the production of food. The error, a rather obvious one, is that an increase in food is inevitably followed by a further increase in population, which in turn leads to another shortage of food. Since the dawn of the human race, people have been trying to find ways to increase the food supply; often they have succeeded. Perhaps the biggest innovation of all was agriculture itself, the discovery that one can deliberately put seeds into the ground and foster their growth, rather than going off into the jungle to look for plants growing in the wild. That particular revolution led to a great increase in human population. The original problem, however, simply recurred. The solution (some means of increasing food) always leads straight back to the original problem (an excess population).

But these two forces do not act merely in a circular fashion. It would be more exact to say that they act as an ever-widening spiral. If we double the food supply, and thereby induce a doubling of human population, the new problem (that of excessive population) is not entirely identical to the original problem, because as the spiral widens it creates further dangers.

At some point, we push the planet Earth to the point where it can no longer maintain that spiral. We can convert great quantities of petrochemicals into fertilizers and pesticides, we can draw water out of the deepest aquifers and even desalinate the oceans, but at some point we have to face the fact that the Earth is only a small rock, small enough that it can be encircled by a jet plane in a matter of hours. We are squeezing both our residential areas and our farmlands beyond endurance. The greatest danger of such a spiral is that when it breaks, it will do so in a far more destructive way than if the problem had been solved earlier. When the human race suddenly finds itself unable to manage the reciprocity of overpopulation and food production, there will be no more choices left to make.

9**:** WORLD FOOD SUPPLIES

Only about 10 percent of the world's land surface is arable, whereas the other 90 percent is just rock, sand, or swamp, which can never be made to produce crops, whether we use "high" or "low" technology or something in the middle (Bot et al., 2000; CIA, 2010). In an age with diminishing supplies of oil and other fossil fuels, this 10:90 ratio may be creating two serious problems that have been largely ignored.

The first is that humans are not living only on that 10 percent of arable land, although that 10 percent is more densely populated than the rest. Humans are living everywhere, while trucks, trains, ships, and airplanes bring the food to where those people are living. When the vehicles are no longer operating, the people living in outlying regions will probably start moving into those "10 percent" lands where the crops can be grown.

The other problem with the 10:90 ratio is that with "low technology," i.e. technology that does not use petroleum or other fossil fuels, crop yields diminish considerably. With non-mechanized agriculture, corn (maize) production is only about 2,000 kilograms per hectare, less than a third of the yield that a farmer would get with modern machinery and chemical fertilizer (Pimentel, 1984). If that is the case, then not only will almost 100 percent of the people be living on the productive 10 percent of the land, but there will be much less food available for that 100 percent.

Oddly enough, if other crops are substituted for corn, there is usually no enormous difference in the number of kilocalories per hectare. Beans (as "dry beans") produce about half the yield of corn. Root crops (turnips, carrots, beets, etc.) are impressive in terms of their bulk — mass — per hectare, yet they do not differ greatly from corn in kilocalories per hectare.

Actually there is a third problem that arises from the first two. This is the fact that if 100 percent of the people are living on 10 percent of the land, then the land may have so many people, roads, and buildings on it that a good deal of that land will be unavailable for farming. This problem of disappearing farmland is not a new one, of course; for centuries it seemed only common sense to build our cities in the midst of our paradises.

Let us play with some of these numbers and see what happens. These are only rough figures, admittedly, but greater accuracy is impossible because of the question of how one defines one's terms, and even more by the fact that everything on this poor planet is rapidly changing. The present population of the Earth is now (2010) approaching 7 billion, and the number is rapidly increasing every day. That number

should be large enough to make us seriously consider the consequences (What other large mammal can be found in such numbers?) When I was born, in 1949, there were less than 3 billion, and it amazes me that this jump is rarely regarded as significant. These 7 billion people live on the land surface of the Earth, which is about 150 million km^2 in area, but the arable land is only about 15 million km^2. The ratio of people to km^2 is therefore about 470:1, or less than 5 per hectare.

Are those numbers a matter for concern? I would think so. As we saw earlier, with pre-industrial technology a hectare of corn would support, at the utmost, only 9 people, or in other words 1 km^2 would support no more than 900 people.

That number probably does not closely resemble reality. Beside the problem of roads and buildings taking up space, allowances would have to be made for fallow land, and perhaps for the production of green manure (crops grown as compost). One would have to ensure that the land was both logically and equitably distributed. The 9:1 ratio is also assuming no increase in population, although famine and the attendant decrease in fertility will take care of that matter very soon. A separate issue is the question: After decades of agri-business, how much of the world's supposedly arable land is really as fertile and healthy as in earlier times?

The average entire house lot in the US is about 1,000 m^2. That is one tenth of the minimum amount of land required to feed 9 people. But even if every square meter of our planet's "arable portion" were devoted to the raising of corn or other useful crops, we would have serious trouble trying to feed an average of 9 people from each hectare of arable land.

Given such figures, one should beware of writers who are liberal in their use of such words as "alternative," "sustainable," and "transition." Simple arithmetic is all that is needed to show that such terminology is not applicable to the situation.

Nor am I convinced when proponents of "organic gardening" claim they can grow unlimited amounts of food merely by the liberal application of cow manure. Writers on "low-tech" agriculture (not to mention any farmers of the old school) generally say that if cow manure is used on a hectare of farmland, for the first year of crop production at least 100 tonnes are necessary, and after that about 20 tonnes per year might be adequate. However, cows take up land: one cow requires over a hectare in pasturage, and that is in addition to the hay, grain, and other foods that the animal is given (Lappé, 1991). The "organic" gardener also conveniently ignores the fact that the grass that feeds the cows is probably produced with synthetic fertilizer, which will be in short supply.

The use of cows to keep a garden in production would multiply the necessary land area enormously. There would also be no mechanized equipment to deliver the manure. The knowledge of animal husbandry, under primitive conditions, could certainly not be learned overnight. But I can say from experience that reality hits when the sun is going down and the shovel is getting heavy.

Many of the false figures that appear in discussions of the future are the result of armchair gardening of the worst sort. Growing a tiny patch of lettuce and tomatoes is not subsistence gardening. At least from a "Neolithic," agricultural perspective, to support human life one must be growing grains and similar crops high in carbohydrates and protein, and these foods must be in quantities large enough to supply three full meals a day, every day, for every person in the household. We must also consider that in chaotic times it will certainly not be possible to stroll over to the tap and use a hose to pour

unlimited amounts of water over one's plants; on a large garden, the water is whatever the sky decides to send.

There may be an odd solution or two. There are parts of the Earth where population is actually decreasing in absolute numbers, as people mistakenly come to believe that country living is too hard. Well, yes, being squeezed out by multinationals is definitely too hard, but I'm talking about subsistence agriculture, not trying to survive by picking beans for a dollar an hour.

We should not we totally discount the practicality of animal husbandry. There are many parts of the world that are not suitable for agriculture, but the same land might produce wild grasses or other vegetation that in turn could feed domesticated animals. Under primitive conditions the density of human population in such areas would have to be very low, and the danger of over-grazing would always be there, but the truth is that there are large parts of the world that supported a pastoral life for centuries.

The only solution that will last a million years, of course, is a return to foraging, and that will especially be true for those who choose to live in that non-arable 90 percent. Hunting and fishing have become unfashionable hobbies, but for the physically fit these skills could be a lifesaver in the next few decades.

I don't have much patience with cobbled-together happy endings, but I think there are answers for those who are single-minded enough to go after them. Any sane person would be living in the country, not the city. Important skills include using a hoe, a gun, and an axe. Finally, getting a reputation as a good neighbor is, for most people, better than becoming a hermit; the locals might not actually adopt an amicable newcomer, but they might be willing to help when there's trouble.

10: THE COMING FAMINE

Humanity has struggled to survive through the millennia in terms of Nature balancing population size with food supply. The same is true now, but population numbers have been soaring for over a century. Oil, the limiting factor, is close to or beyond its peak extraction. Without ample, free-flowing oil, it will not be possible to support a population of several billion for long. Famine caused by oil-supply failure alone will probably result in about 2.5 billion above-normal deaths before the year 2050; lost and averted births will amount to roughly an equal number.

Over the next few decades, there will be famine on a scale many times larger than ever before in human history. It is possible, of course, that warfare and plague will take their toll to a large extent before famine claims its victims. The distinctions, in any case, can never be absolute: often "war + drought = famine" (Devereux, 2000, p. 15), especially in sub-Saharan Africa, but there are several other combinations of factors.

Although, when discussing theories of famine, economists generally use the term "neo-malthusian" in a derogatory manner, the coming famine will be very much a case of an imbalance between population and resources. The ultimate cause will be fossil-fuel depletion, not government policy (as in the days of Stalin or Mao), warfare, ethnic discrimination, bad weather, poor methods of distribution, inadequate transportation, livestock diseases, or any of the other variables that have often turned mere hunger into genuine starvation.

The increase in the world's population has followed a simple curve: from about 1.7 billion in 1900 to about 6.1 billion in 2000. A quick glance at a chart of world population growth, on a broader time scale, shows a line that runs almost horizontally for thousands of years, and then makes an almost vertical ascent as it approaches the present. That is not just an amusing curiosity. It is a shocking fact that should have awakened humanity to the realization that something is dreadfully wrong.

Mankind is always prey to its own "exuberance," to use Catton's term. That has certainly been true of population growth. In many cultures, "Do you have any children?" or, "How many children do you have?" is a form of greeting or civility almost equivalent to "How do you do?" or, "Nice to meet you." World population growth, nevertheless, has always been ecologically hazardous. With every increase in human numbers we are only barely able to keep up with the demand: providing all those people with food and water has not been easy. We are always pushing ourselves to the limits of Earth's ability to hold us (Catton, 1982).

Even that is an understatement. No matter how much we depleted our resources, there was always the sense that we could somehow "get by." But in the late twentieth century we stopped getting by. It is important to differentiate between production in an "absolute" sense and production "per capita." Although oil production, in "absolute" numbers, kept climbing — only to decline in the early twenty-first century — what was ignored was that although that "absolute" production was climbing, the production "per capita" reached its peak in 1979 (BP, 2010).

The unequal distribution of resources plays a part. The average inhabitant of the US consumes far more than the average inhabitant of India or China. Nevertheless, if all the world's resources were evenly distributed, the result would only be universal poverty. It is the totals and the averages of resources that we must deal with in order to determine the totals and averages of results. For example, if all of the world's arable land were distributed evenly, in the absence of mechanized agriculture each person on the planet would still have an inadequate amount of farmland for survival: distribution would have accomplished very little.

We were always scraping the edges of the earth, but we are now entering a far more dangerous era. The main point to keep in mind is that, throughout the twentieth century, oil production and human population were so closely integrated that every barrel of oil had an effect on human numbers. While population has been going up, so has oil production.

Future excess mortality can therefore be determined — at least in a rough-and-ready manner — by the fact that in modern industrial society it is oil supply that determines how many people can be fed. An increase in oil production leads to an increase in population, and a decrease in oil production leads to a decrease in population.

In round numbers, global oil production in the year 2008 was 30 billion barrels, and the population was 7 billion. The consensus is that in the year 2050 oil production will be about 2 billion barrels. The same amount of oil production occurred in the year 1930, when the population was 2 billion. The population in 2050 may therefore be the same as in 1930: 2 billion. The difference between 7 billion people and 2 billion is 5 billion, which would therefore be the total number of famine deaths and lost or averted births for that period. (A more-precise measurement would entail looking at the number of survivors in each year and then determining what might be called the "temporary carrying capacity" for that year, based on the remaining oil, but the grand total would be roughly the same.)

We can also determine the number of famine deaths and lost or averted births on an annual basis. In the 42 years from 2008 to 2050, the average annual difference in population will be 5 billion divided by 42, or a decrease of about 120 million people per year.

Many of those annual 120 million will not actually be deaths; famine will cause a lowering of the birth rate (Devereux, 2000; Ó Gráda, 2007, March). This will sometimes happen voluntarily, as people realize they lack the resources to raise children, or it will happen involuntarily when famine and general ill health result in infertility. In most famines the number of deaths from starvation or from starvation-induced disease is very roughly the same as the number of lost or averted births. In Ireland's nineteenth-century famine, the number of famine deaths was 1.3 million, whereas the number of lost births was 0.4 million. The number of famine deaths during China's Great Leap Forward (1958-

1961), however, was perhaps 30 million, and the number of lost births was perhaps 33 million.

The "normal," non-famine-related, birth and death rates are not incorporated into the above future population figures, since for most of pre-industrial human history the sum of the two — i.e. the growth rate — has been nearly zero: 2,000 years ago the global population was about 300 million, and it took 1,600 years for the population to double. If not for the problem of resource-depletion, in other words, the future birth rate and death rate would be nearly identical, as they were in pre-industrial times. And there is no question that the future will mean a return to the "pre-industrial."

Nevertheless, it will often be hard to separate "famine deaths" from a rather broad category of "other excess deaths." War, disease, and other factors will have unforeseeable effects of their own. Considering the unusual duration of the coming famine, and with Leningrad (Salisbury, 2003) as one of many precursors, cannibalism may be significant; to what extent should this be included in the calculation of "famine deaths"? In any case, it is probably safe to say that an unusually large decline in the population of a country will be the most significant indicator that this predicted famine has in fact arrived.

These figures obliterate all previous estimates of future population growth. Instead of a steady rise over the course of this century, as generally predicted, there will be a clash of the two giant forces of overpopulation and oil depletion, followed by a precipitous ride into an unknown future.

If the above figures are fairly accurate, we are ill-prepared for the next few years. The problem of oil depletion turns out to be something other than a bit of macabre speculation for people of the distant future to deal with, but rather a sudden catastrophe that will only be studied dispassionately long after the event itself has occurred. Doomsday will be upon us before we have time to look at it carefully.

The world has certainly known some terrible famines in the past. In recent centuries, one of the worst was that of North China in 1876-79, when between 9 and 13 million died, but India had a famine at the same time, with perhaps 5 million deaths. The Soviet Union had famine deaths of about 5 million in 1932-34, purely because of misguided political policies. The worst famine in history was that of China's Great Leap Forward, 1958-61, when perhaps 30 million died, as mentioned above.

A closer analogy to "petroleum famine" may be Ireland's potato famine of the 1840s, since — like petroleum — it was a single commodity that caused such devastation (Woodham-Smith, 1962). The response of the British government at the time can be summarized as a jumble of incompetence, frustration, and indecision, if not outright genocide.

The above predictions can be nothing more than approximate, but even the most elaborate mathematics will not entirely help us to deal with the great number of interacting factors. We need to swing toward a more pessimistic figure for humanity's future if we include the effects of war, disease, and so on. The most serious negative factor will be largely sociological: To what extent can the oil industry maintain the advanced technology required for drilling ever-deeper wells in ever-more-remote places, when that industry will be struggling to survive in a milieu of social chaos? Intricate division of labor, large-scale government, and high-level education will no longer exist.

On the other hand, there are elements of optimism that may need to be plugged in. We must not forget the sheer tenacity of the human species: we are intelligent social

creatures living at the top of the food chain, in the manner of wolves, yet we outnumber wolves worldwide by about a million to one; we are as populous as rats or mice. We can outrace a horse over long distances. Even with Stone-Age technology, we can inhabit almost every environment on Earth, even if most of the required survival skills have been forgotten.

Specifically, we must consider the fact that neither geography nor population is homogeneous. All over the world, there are forgotten pockets of habitable land, much of it abandoned in the modern transition to urbanization, for the ironic reason that city dwellers regarded rural life as too difficult, as they traded their peasant smocks for factory overalls. There are still areas of the planet's surface that are sparsely occupied although they are habitable or could be made so, to the extent that many rural areas have had a decline in population that is absolute, i.e. not merely relative to another place or time. By careful calculation, therefore, there will be survivors. Over the next few years, human ingenuity must be devoted to an understanding of these geographic and demographic matters, so that at least a few can escape the tribulation. Neither the present nor future generations should have to say, "We were never warned."

11: LEAVING THE CITY

One thing my wife and I learned from seven years in rural Ontario was that country living doesn't always mean freedom from money issues. Of all our expenses, the greatest and most persistent was the car, even though we had bought it for cash: insurance, gasoline, maintenance, and repairs were always costly. The average American spends nearly $6,000 a year on a car (AAA, 2010; US Bureau of Labor Statistics, 2010, March); when I mention this to my friends, I get howls of protest, but I wonder how many of them keep daily accounts. People who live in the country nowadays are actually more hooked on automobiles than those who live in the city, since there are long stretches of highway between one's home and other destinations such as shops or a job. In fact, one of the biggest problems of the truly poor in the countryside is that they may have no means of getting to a job even if it is offered to them. For everyone, the obvious alternative to the automobile would be horses, but how can horses survive at the present time, with the roads dominated by high-speed cars and trucks?

Besides the car, our biggest costs were electricity, the telephone, food (in spite of our chickens and our huge vegetable garden), property taxes, and house repairs (although some of these were more like renovations and might therefore be classified as equity rather than expenses). It was a good thing we had paid cash for the house and land, because if we had been paying off a mortgage we would really have had trouble making ends meet. I should add that at first we were not as frugal as we might have been: we had a fair amount of money because we had sold our house in Toronto, but because we had so much money we spent it too freely.

We did not expect money-making to be the principal issue in country living, but such was the case. Although we ran a 5,000-m^2 market garden as efficiently as possible, a profit always seemed to elude us. As time went by, we began to realize that there were not many people in the area who had financial security. Most of the people we met were living either on pensions or on welfare, or something similar. The pensioners were sometimes elderly poor people living on nothing but payments from the government. There were only a few people living on company pensions, which provided a higher standard of living. One group of people who had a reasonable income were the few trades people that the area could support — carpenters, plumbers, mechanics, and so on. The other large segment of the population was the cottagers, the Torontonians, who were likely to show up only in the summer, but these people didn't have to deal with the problem of earning a local income.

Most people under retirement age, however, were barely surviving, partly because the entire area pretty well closed down during the winter. The main industry was "tourism," which is sometimes little more than a euphemism for "poverty."

My suggestions that people rediscover their rural origins didn't get very far. The young disliked country living and were rather ashamed of it. The middle-aged took the attitude, not that "anything worth doing is worth doing well," but that it is worth doing only with heavy machinery. I remember seeing two large brand-new trucks going down the road one day with a grand total of four people, merely to eat at a local restaurant — not a big crime, just a vignette. The most knowledgeable people were in their eighties, but the following generations wanted to be part of what they considered the modern world: they were willing slaves to the urban economy that was slowly killing them.

After we bought the property, we seemed to find more and more work that needed to be done to make the place livable, and most of it had to be done before the approach of the first winter. We knew very little ourselves about repairs and renovations, and at the same time we had very few names to work with, so we ended up hiring people without getting multiple estimates for the work to be done. As a result, we were sometimes charged too much money, but we were unable to realize that fact until much later.

I would even say that some of those "improvements" should have been left undone. For example, we spent a good deal of money for gutters to be installed around the metal roof of our mobile home, not realizing that a slippery metal roof would result in avalanches of melting snow in the spring, and that those avalanches would simply tear the gutters away.

On the positive side, we finally learned many things about house repair and renovation. In particular we learned how to do a number of carpentry tasks. I even did a bit of plumbing, at least to the extent of replacing old faucets. Electricity, however, remained for me a rather esoteric subject, probably because I found it both dangerous and expensive. Electricity was also unreliable, and violent summer storms would often mean looking for candles and matches.

We learned a great deal about heating with wood. We not only managed to operate a wood stove properly, but we gradually went through the entire process of cutting down trees, sawing them into lengths, splitting the pieces, stacking and storing them, and so on. I became quite adept at using a chain saw, although I found that using such a machine on a long-term basis requires a good knowledge of maintenance, including sharpening the chain, cleaning the entire machine, and recognizing common problems.

As a long-term "survival skill," operating a chain saw is rather dubious, of course. How will people operate such things as the world's petroleum runs out? Oil production in 2030 will be less than half that of the year 2000. In any case, according to at least one expert on the subject, after calculating the money required to operate a chain saw, and the time involved in maintaining the equipment, one may find that it's better to use a more old-fashioned device.

I think using a bow saw to put together a winter's supply of firewood might require many long weeks of labor, but there may be some sense to the theory. Certainly modern bow saws are quite good. The blades are of hardened steel, which means they cannot be re-sharpened and must be discarded eventually, but they last a long time, and buying a lifetime's supply of such blades would be easy enough.

I even bought some antique timber saws, those gigantic devices, often several feet long, that our ancestors used for dealing with logs. I learned how to set the teeth (bend them to certain angles), using tools that I had made myself, and how to sharpen them properly. I soon concluded that I didn't have the ancestral muscles for such saws. Part of the problem, however, may have been that even after I had done my best to polish the steel surfaces they were not really smooth, since rust had caused pitting. Much later I heard that such timber saws can be bought brand new, and that a new timber saw will cut firewood much more quickly than a bow saw. (Of course, there's far more to the story than that: somehow it's forgotten that the native people of North America lived for thousands of years without chain saws.)

We learned that there are many other ways of dealing with firewood and heating problems. A smaller house needs less firewood, and so does one with fewer and smaller windows. Good insulation is an enormous help. Another trick from the old days is to use less firewood by sealing off unnecessary rooms in winter. For similar reasons, the stove must be located in the room that will be used the most in the daytime.

We learned many things about vegetable gardening that we didn't know before, although the locals were not of much help, since they lived mainly on supermarket food. We discovered the importance of starting with good soil (which we didn't have), and the importance of keeping an eye on dates and on weather. We learned to identify and defeat many species of harmful insects. We also tried a great many crops and developed a good idea of what crops worked in that area and which ones didn't.

We gained a good knowledge of grains. Corn is by far the best grain to grow, since the yield per unit of land is quite high, and it requires very little in terms of equipment for growing, for harvesting, or for processing. By "corn," however, I mean the older varieties once grown by the native people, not modern corn, which is susceptible to insects and diseases. The other grain that did well was rye, mainly because of the sandy soil.

Our experience with raising chickens was quite educational in two senses. The first is that I learned something about the construction of buildings with frames made of 2x4s, and as part of that learning experience I did everything with non-electric tools except for the somewhat tedious task of cutting chipboard.

I built the first chicken coop with a poured concrete-slab foundation and a "shed" roof (i.e. one slope rather than two), and the outside was made of board-and-batten (vertical boards, with the intervening gaps covered by thin strips). The roof was covered with roll roofing.

For the second coop, I deliberately used entirely different methods, partly so that I could gain further experience. The foundation was of concrete piers rather than a solid slab, the roof had two slopes (and hence two gables), and the outside of the walls was covered with chipboard, which in turn was covered with vinyl siding, all of it admittedly not very "traditional" but perhaps "transitional." The roof was covered with the same material as the first coop, but in the form of shingles rather than rolls. For the most part, I preferred what I did on that second coop, although I now think concrete piers are very difficult to build and position neatly without preformed molds and pre-mixed concrete.

The second and rather odd thing that we learned, or seem to have learned, about chickens is that our long hours of acquiring an education in modern poultry-raising may have taken us somewhat in the wrong direction. Just as we were closing down our entire

chicken operation, I began reading a few articles which seemed to indicate that from a survivalist perspective it would be better to get away from modern methods. These methods are designed to maximize production of either eggs or meat.

But our chickens — eventually totaling fifty — were living mainly on purchased feed, which was expensive to buy and transport, and out of that feed they ate only the types of grain they liked, and simply left the rest to rot. They were also living in highly fortified buildings with well-fenced yards, all of which protected them from foxes, raccoons, and weasels, but their isolated existence meant they were not roaming the fields in search of vegetation and insects which could have provided free food.

It may well be the case that a better approach to poultry may be a less-modern one. The chickens raised in more-primitive cultures, in other words, may be relatively unproductive but might have greater resistance to diseases and predators, and the actual varieties of chickens worth considering may be smaller and hardier birds that are closer to the ancestral types.

Perhaps above all, we learned that it is possible to live with some independence from modern civilization. On the two hectares that were ours by law, but in reality belonged more to Nature, the seasons followed one another, even if we were sometimes too busy to notice. In spring the river roared and bellowed and foamed along its banks, and in winter that same river was a tranquil study in black and white. None of that will ever change. But I cannot entirely regret the fact that there are other things that will change one day: the cars will be gone, and so will the money economy.

APPENDIX ONE: ENERGY

The Triad

Modern industrial society is composed of a triad of fossil fuels, metals, and electricity. The three are intricately connected. Electricity, for example, can be generated on a global scale only with fossil fuels. The same dependence on fossil fuels is true of metals; in fact the better types of ore are now becoming depleted, while those that remain can be processed only with modern machinery and require more fossil fuels for smelting. In turn, without metals and electricity there will be no means of extracting and processing fossil fuels. Of the three members of the triad, electricity is the most fragile, and its failure will serve as an early warning of trouble with the other two (Duncan, 2000, November 13; 2005-06, Winter).

Often the interactions of this triad are hiding in plain sight. Global production of steel, for example, requires 420 million tonnes of coke (from coal) annually, as well as other fossil fuels adding up to an equivalent of another 100 million tonnes (Smil, 2009, September 17). To maintain industrial society, the production of steel cannot be curtailed: there are no "green" materials for the construction of skyscrapers, large bridges, automobiles, machinery, or tools.

But the interconnections among fossil fuels, metals, and electricity are innumerable. As each of the three members of the triad threatens to break down, we are looking at a society that is far more primitive than the one to which we have been accustomed.

Oil

Most major studies place the date of "peak oil" somewhere between 2001 and 2020 (Campbell, 2004, 2009; Gever et al, 1991; Oil Drum, 2010, February 4; Oxford University, 2010, March 23; Petrole, 2010, March 25; Simmons, 2006; Youngquist, 2000, October; 2008). For years the main anomalies have been some American government forecasts: those of the Energy Information Administration (EIA) of the US Department of Energy, and those of the US Geological Survey. However, Robert L. Hirsch of the US Department of Energy in 2005 produced "The Inevitable Peaking of World Oil Production," the famous "Hirsch Report," which begins with the sentence, "The era of plentiful, low-cost petroleum is reaching an end." He goes on to say that "oil production is in decline in 33 of the world's 48 largest oil-producing countries" (Hirsch,

2005, October, p. 5). The EIA's 2009 "Sweetnam Report," in fact, shows world oil beginning a permanent decline in 2012, although the wording is somewhat ambiguous (EIA, 2009, April 7). Colin Campbell (2009, November 16) has responded to this report. Another anomaly has been that of the International Energy Agency, which has tended to follow US figures, but they may be revising their claims (Macalister, 2009, November 9).

Recent estimates of the annual rate of decline, after the "peak" date, tend to put it much higher than before, with about 6 percent as the consensus (Foucher, 2009, February 25; Höök, Hirsch, & Aleklett, 2009, June; Oil Drum, 2010, February 4; Poston, n.d.).

Unconventional oil will not make a great difference to the final production numbers. By far the largest deposits of usable unconventional oil are the Canadian tar sands. The popular belief that "there's enough oil there to last a hundred years" is a good example of a modern half-truth. There are probably about 175 billion barrels of reserves (usable oil after processing), but there are two serious problems. The first is the rate of extraction: by the year 2020 it may be possible to increase production to 1.5 billion barrels a year; at such a slow rate of production, the reserves would indeed last a hundred years, but such figures are dwarfed by those for conventional oil, and by the annual demands for oil. The second problem is that processing the tar sands requires enormous quantities of water and natural gas: the environmental damage is unparalleled, and it might be impossible to supply such quantities anyway (Foucher, 2009, February; Hall, 2008, April 15).

One reasonable description of past and future global oil production is Campbell and Laherrère's 1998 *Scientific American* article, "The End of Cheap Oil," which serves as a sort of *locus classicus*. Their main chart seems to indicate an annual rate of increase of about 4 percent from the year 1930 to 2000, and an annual rate of post-peak decline of slightly over 3 percent, which would mean that around 2030 oil production will be down to about half of the peak amount (Campbell & Laherrère, 1998, March). The chart is based partly on the bell-shaped curves that M. King Hubbert used in the 1950s when making accurate predictions of American and global oil decline (Grove, 1974, June; Hubbert, 1956).

More-recent predictions of the annual rate of post-peak decline tend to range from about 4 to 9 percent (Foucher, 2009; Höök, Hirsch, & Aleklett, 2009, June; Oil Drum, 2010, February 4; Poston, n.d.). The average estimate might be 6 percent, and even that is ominous, resulting in a fall to half of peak production perhaps shortly after 2020. These predictions of larger decline rates take into consideration the fact that advanced technology is used to maximize productivity, which in turn has the ironic result that when the decline actually occurs it is swift. It is not the gentle slope depicted in Campbell and Laherrère's 1998 article, but something that looks more like a cliff.

From a broader perspective it can be said that, as oil declines, more energy and money must be devoted to getting the less-accessible and lower-quality oil out of the ground (Gever et al, 1991). In turn, as more energy and money are devoted to oil production, the production of metals and electricity becomes more difficult. One problem feeds on another.

It should also be remembered that the quest for the date of peak oil is in some respects a red herring. In terms of daily life, it is important to consider not only peak oil in the absolute sense, but peak oil per capita. The date of the latter was 1979, when there were 5.5 barrels of oil per person annually, as opposed to 4.3 in 2009 (BP, 2010).

The problem of the world's diminishing supply of oil is a problem of energy, not a problem of money. The old bromide that "higher prices will eventually make [e.g.] shale oil economically feasible" is meaningless. This planet has only a finite amount of fossil fuel. That fuel is starting to vanish, and "higher prices" will be quite unable to stop the event from taking place (Hanson, 1999).

Coal

The energy content of US coal has been going down since at least 1950, because the hard coal (anthracite and bituminous coal) is becoming depleted and must be replaced by subbituminous coal and lignite. Anthracite production in the US has been in decline since 1990. For those reasons, the actual energy output of all US coal has been flat since that same date. New technologies and mining methods cannot compete against the problems of lower-quality ore and more-difficult seams.

Actual production in the US might reach a plateau of 1400 Mt annually and stay there for the rest of the century. That will happen, however, only if there is massive development of the reserves in Montana, and if serious problems of transportation and the environment can be dealt with. Otherwise, US production will peak around 2030 (Höök & Aleklett, 2009, May 1).

The US has almost 30 percent of the world's coal reserves, while China has only the third-largest reserves, totaling 14 percent, but China accounts for 43 percent of the world's production (Höök, Zittel, Schindler, & Aleklett, 2010, June 8). With its enormous growth in consumption, it is unlikely that China's coal supply will last until 2030 (Heinberg, 2009; 2010, May).

Worldwide, coal production is estimated to peak around 2020, to judge from historical production and proved reserves. Estimations based on a logistic (Hubbert) curve give almost the same result. Even if we assume, with great optimism, that ultimate reserves will be double the present proved reserves, such amounts would only delay the peak by a few years; even then, if extraction rates increase accordingly, the duration of the reserves will remain about the same (Höök, Zittel, Schindler, & Aleklett, 2010, June 8).

Hydroelectric Power

The first problem with hydroelectricity is that all the big rivers have been dammed already; also, the dams silt up and become useless after a few years (Youngquist, 2000, October). Decentralization, i.e. putting dams on smaller rivers, would solve nothing; on the contrary, decentralization leads to inefficiency — that is why the small hydro generators were closed down in the first place. The damage that the dams cause to wildlife and farmland is considerable. In addition, the end product is only electricity, which is not a practical substitute for the fossil fuels now used in transportation. The final problem is that as fossil fuels and metals disappear, there will be no means of making the parts to repair old generators or to build new ones.

Nuclear Power

Nuclear power presents significant environmental dangers, but the biggest constraints involve the addition of new reactor capacity and the supply of uranium. Peak production of uranium ore in the US was in 1980. Mainly because the US was the world's largest producer, the peak of global production was at approximately the same date (Energy Watch Group, 2006, December; Storm van Leeuwen, 2008, February). Statements that uranium ore is abundant are based on the falsehood that all forms of uranium ore are usable. In reality, only high-quality ore serves any purpose, whereas low-quality ore presents the unsolvable problem of negative net energy: the mining and milling of such ore requires more energy than is derived from the actual use of the ore in a reactor. The world's usable uranium ore will probably be finished by about 2030, and there is no evidence for the existence of large new deposits of rich ore. Claims of abundant uranium are generally made by industry spokespersons whose positions are far from neutral, who have in fact a vested interest in presenting nuclear energy as a viable option (Storm van Leeuwen, 2008, February). One must also beware, of course, of the myth that "higher prices" will make low-grade resources of any sort feasible: when net energy is negative, even an infinitely higher price will not change the balance. For all practical purposes, the nuclear industry will come to an end in a matter of decades, not centuries.

Global Energy and Electricity

Global production of energy for the year 2005 was about 500 exajoules (EJ), most of which was supplied by fossil fuels. This annual production of energy can also be expressed in terms of billion barrels of oil equivalent (bboe) (BP, 2010; Duncan, 2000, November 13; 2005-06, Winter; EIA, 2008, December 31). In 1990 this was 59.3 bboe and in 2005 it was 79.3, an increase of 34 percent.

However, the use of electricity worldwide rose from 11,865.4 terawatt-hours in 1990 to 18,301.8 in 2005 (BP, 2010), an increase of 54 percent. Since the use of electricity is rising much more quickly than the production of energy, it is uncertain whether in the future there will be sufficient energy to meet the demand for electricity. If not, there could be widespread brownouts and rolling blackouts (Duncan, 2000, November 13; 2005-06, Winter). When electricity starts to go, so will everything else.

Alternative Energy and Infrastructure

To understand the problem of infrastructure entirely, we need to look at it as a loop, a matter of bootstrapping — the metaphors are numerous. To what extent, indeed, is it possible to raise oneself off the ground by pulling on one's own bootlaces? The various answers to such a question can provide support either for or against the use of alternative sources of energy. The question of the "bootstrapping" of alternative energy may be either ontologically profound or utterly naïve, depending on how it is phrased, but actually it is rarely asked. At the risk of playing the devil's advocate, however, I might point out two cases.

The first is somewhat general: many of the devices using advanced technology for alternative energy (e.g., solar-power devices, wind turbines) operate at their present levels of efficiency only because of the use of alloys that include rare-earth metals.

Without fossil fuels, it would therefore be necessary to use (e.g.) solar-powered devices — or devices ultimately powered by other devices similarly powered — to roam the earth in search of these materials. Other solar-powered devices would then do the mining and milling. Further devices of a similar nature would be used to manufacture solar-powered equipment from these metals, and these last devices would then continue that technological cycle. All of this, of course, would have to be in place worldwide in the few years before fossil fuels have largely vanished. Although from what might be called a philosophical perspective there is nothing wrong with such a scenario, it seems obvious that one is leaving reality far behind.

A second, less bizarre example might be one mentioned earlier: Would it not be possible to solve the original problem of the "manufacture, transportation, maintenance, and repair" of equipment by establishing a worldwide grid annually carrying 500 EJ of electricity that could be delivered wherever it was needed? If so, then one might well imagine large trucks rolling along the highways, their wheels powered by large batteries. The answer, unfortunately, is that a battery for any large vehicle would have unsolvable problems of weight, longevity, temperature, and so on. There is also the much bigger question of where the 500 EJ would be coming from in the first place.

APPENDIX TWO: RESOURCES

Other Minerals

Global depletion of minerals other than petroleum and uranium is somewhat difficult to determine, partly because recycling complicates the issues, partly because trade goes on in all directions, and partly because one material can sometimes be replaced by another. All that is fairly certain is that there is not enough usable copper, zinc, and platinum on the planet Earth, even with improved recycling and better technology, for the world's "developing countries" to use as much per capita as the US (Gordon, Bertram, & Graedel, 2006, January 31).

Figures from the US Geological Survey indicate that within the US most types of minerals are past their peak dates of production. Besides oil, these include bauxite (peaking in 1943), copper (1998), iron ore (1951), magnesium (1966), phosphate rock (1980), potash (1967), rare earth metals (1984), tin (1945), titanium (1964), and zinc (1969) (USGS, 2005). The depletion of all minerals in the US continues swiftly in spite of recycling.

Iron ore may seem infinitely abundant, but it is not. In the past it was ores such as natural hematite (Fe_2O_3) that were being mined. For thousands of years, also, tools were produced by smelting bog iron, mainly goethite, FeO(OH), in clay cylinders only a meter or so in height. Modern mining must rely more heavily on taconite, a flint-like ore containing less than 30 percent magnetite and hematite (Gever et al, 1991). Iron ore of the sort that can be processed with primitive equipment is becoming scarce, in other words, and only the less-tractable forms such as taconite will be available when the oil-powered machinery has disappeared. With the types of iron ore used in the past, it would have been possible to reproduce at least the medieval level of blacksmithing in future ages. With taconite it will not.

Grain

Annual world production of grain per capita peaked in 1984 at 342 kg (Brown, 2006, June 15). For years production has not met demand, so carryover stocks must fill the gap, now leaving less than two months' supply as a buffer. Rising temperatures and falling water tables are causing havoc in grain harvests everywhere, but the biggest dent is caused by the bio-fuel industry, which is growing at over 20 percent per year. In 2007,

88 million tons of US corn, a quarter of the entire US harvest, were turned into automotive fuel.

Fish

The world catch of wild fish per capita peaked in 1988 at 17 kg; by 2005 it was down to 14 kg (Larsen, 2005, June 22). The fishing industry sends out 4 million vessels to catch wild fish, but stocks of the larger species are falling rapidly, so the industry works its way steadily down the food chain. Larsen notes in particular that "over the past 50 years, the number of large predatory fish in the oceans has dropped by a startling 90 percent. Catches of many popular food fish such as cod, tuna, flounder, and hake have been cut in half despite a tripling in fishing effort."

The losses in the production of wild fish are made up by aquaculture (fish farming), but aquaculture causes its own problems: inshore fish farms entail the destruction of wetlands, spread diseases, and deplete oxygen. Although her study is otherwise excellent, Larsen omits the fact that millions of tonnes of other fish must be turned into food every year for use in aquaculture. The FAO dismisses these as "low-value/trash fish" (2006).

Arable Land

Land may be unsuitable for agriculture for many reasons (Bot et al., 2000). The climate may be too dry, too wet (not well drained), too hot, or too cold. There may be too much rain or too much snow. The terrain may be too mountainous. The soil may be nutrient-poor or polluted.

Soils may be naturally infertile for several reasons. They may have a low organic content; generally these are very sandy soils. There may be toxic levels of naturally occurring aluminum, resulting in acidity. There may be a deficiency in available phosphorus if it is bound to ferric oxides (Fe_2O_3). Soils may be vertic (consisting of cracking clays), saline, sodic, or just too shallow.

The rest constitutes the world's "potential arable land." To judge from the FAO *Soil Map of the World*, it would appear that the potential arable land is 38,488,090 km^2, less than a third of the world's total land area. This figure refers both to the land now being utilized for agriculture, and to the remaining land (net potential arable) that might be used in the future. The utilized arable land constitutes about 15,000,000 km^2. (Bot et al. [2000] estimate 14,633,840 km^2. The CIA [2010] estimates 10.57 percent of a total land surface of 149,000,000 km^2, therefore presumably about 15,749,300 km^2.) It would appear, then, that only about 38 percent of the world's potential arable land is actually being used, and that there is a "land balance" (the cultivable but non-cultivated land) of 62 percent. (All of this is based on the assumption that any increase in cultivated land will happen without irrigation, since water is already in short supply.)

Bot et al., however, point out that for several reasons the figures from this map may be unrealistic. In the first place, a great deal of the land now being used is degraded, although the extent and degree of degradation of arable land is not entirely certain. The UNEP *Global Assessment of Soil Degradation* does not distinguish arable from non-arable land, but 41 countries have over 60 percent of their land (both arable and non-

arable) severely degraded. Degradation is caused by deforestation, by overgrazing, by over-exploitation of vegetation (e.g., for firewood or timber), and by industrial activities (pollution). Agricultural activities themselves lead to soil degradation. Secondly, the unused arable land in developing countries is more than half forest. Cutting down forest would cause its own problems: the forest is in itself a valuable resource, and cutting it down would lead to wind and water erosion. Thirdly, much arable land is already being used for grazing. A more realistic estimate may be that the "land balance" is only somewhere between 3 and 25 percent.

What, then, constitutes the extent of "potential arable land"? On the positive side, there are parts of the world where the area of cultivated land might be increased. To do so, however, it would be necessary to destroy forests or other wilderness. Also on the negative side is problem of soil degradation in the land that is now being cultivated. But that is not a straightforward matter: some land is very degraded, some is not so degraded, and the amount of land in each degree of severity varies from one country to another. At what point is land so degraded that it should no longer be labeled "arable land"? And the next question is: What is the net result of the positive and the negative? It would seem that the two roughly balance each other out.

Fresh Water

Fresh water is declining in many countries around the world, particularly Mexico, the western US, North Africa, the Middle East, Pakistan, India, China, and Australia. If there is no population crash in the next few years, by the year 2025 about 2 billion people will be living with extreme water scarcity, and about two-thirds of the world will be facing water shortages to some extent (UN Environment Program, 2007). In Saudi Arabia and the adjacent countries from Syria to Oman, the annual water supply per capita fell from 1,700 m^3 to 907 m^3 between 1985 and 2005. In the countries of the Gulf Cooperation Council, most fresh water is supplied by desalination plants.

The diversion of water for agriculture and municipal use is causing rivers to run dry. The Colorado, the Ganges, the Nile, and the Indus are now all dry for at least part of the year before they reach the sea. In previous years, this was also true of China's Yellow River; whether better management will prevail remains to be seen. The Amu Darya, once the largest river flowing into the Aral Sea, now runs dry as its water is diverted for the cultivation of cotton (Mygatt, 2006, July 26).

Most countries with water shortages are pumping at rates that cannot be maintained. The shallower aquifers could be replenished if pumping were reduced, but the deeper "fossil" aquifers cannot be rejuvenated when their levels are allowed to fall. Among the latter are the US Ogallala aquifer, the Saudi aquifer, and the deeper aquifer of the North China Plain (Brown, 2008).

Agriculture uses more than 70 percent of the world's fresh water and is mainly responsible for the depletion of aquifers of both types (UN Environment Program, 2007). World grain harvests tripled between 1950 and 2000, but only with increases in irrigation. The US depends on irrigation for a fifth of its grain production; in parts of the grain-producing states of Texas, Oklahoma, and Kansas the water table has fallen more than 30 meters, and thousands of wells have gone dry (Brown, 2008). The situation is worse in China, where four-fifths of the grain harvest depends on irrigation. The fossil

aquifer of the North China Plain maintains half of China's wheat production and a third of its corn. As a result of the depletion of water, Chinese annual grain production has been in decline since 1998.

All this excess use of water is leading to political strife. While the seas have long been generally subject to international laws, it is only in recent decades that there have been major international problems with the world's fresh water. Because of falling water levels, new wells are drilled to greater depths than the old, with the result that the owners of the old wells are left without water. The result is a cycle of competition in which no one wins.

A similar competition exists with the world's rivers. Sixty percent of the world's 227 largest rivers have numerous dams and canals, and there are not many other rivers that are entirely free from such obstructions (UN Environment Program, 2007). Most countries sharing a large river with others are in the midst of violent struggle or about to become so. For example, India's Farakka Barrage, completed in 1975, diverts water from the Ganges into its Indian tributary, thereby depriving Bangladesh of water (Smith & Vivekananda, 2007, November). Egypt and Sudan signed a treaty in 1959 allocating 75 percent of the Nile's water to the former and the remainder to Sudan, with no provisions for the other countries through which the river flows, and Egypt has threatened military action against any of those countries if their irrigation projects reduce the flow (Elhadj, 2008, September).

It is not only military strength that settles issues of water distribution: countries with more water can produce more grain and thus influence the economies of less fortunate countries. It takes a thousand tonnes of water to produce a tonne of grain. In the short term it may therefore seem more sensible for water-poor countries to stop depleting their water by producing grain, and instead buying it from water-rich countries (Brown, 2008; UN Environment Program, 2007). Between 1984 and 2000, at a cost of about $100 billion, Saudi Arabia foolishly tried to produce its own grain but then gave up and switched to importing it. Buying grain has its own negative side-effects, however, in terms of national security, foreign exchange, and lost local employment (Elhadj, 2008, September). The biggest question of national security, however, may be: What will happen when the grain-exporting countries themselves start running out of both grain and water?

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