Oil and War: An Earth Sciences Perspective

by
Amos Nur
Dept of Geophysics, Stanford University

France-Stanford Conference
April 7, 2003

Extrapolating the future of the world's oil supply has always been an uncertain and contentious enterprise for earth scientists and economists alike. Confusing the issue is the multifaceted nature of the oil business. As a natural resource, oil is finite: we consume it millions of times more quickly than it forms in the earth. The natural distribution of oil reserves is extremely heterogeneous, as is its current rate of consumption, with consumption and production bearing little geographic relationship to one another.

Perhaps most importantly, oil is essential to modern culture. In today's world, energy consumption--which is dominated by oil--is an extricable part of an affluent lifestyle. There is a distinct, worldwide correlation between a high standard of living and high oil consumption per capita [Figure 1]. (Some countries--like Saudi Arabia, Kuwait, Indonesia, and the United Arab Emirates--have low per-capita incomes while using more energy than the world average, but this is simply by virtue of local availability; these are major oil producers). Not one rich country in the world uses less than the world average amount of oil.

Less-developed countries, like China and India, naturally wish to improve the standard of living for their citizens. If these countries require more energy to improve their living conditions, and if oil is the dominant source of energy in the world, then the question arises: is there enough oil to fill the future demand? If all poor nations--especially India and China, which together make up almost half the world population--want to become more affluent, is there enough fossil energy available now--or is there

enough alternative energy available soon enough--to enable them to make that move? That is where experts disagree.

Many economists assert that there is plenty of oil and plenty of gas. Economist Steve Hanke from Johns Hopkins said in *Forbes* in 1996, "No mineral, including oil, will ever be exhausted." He argues that the oil supply is simply a function of market forces; if oil becomes less available, the price of oil will go up, and more oil will be produced at the higher prices. If oil prices grow prohibitive, people will simply use less.

However, oil is fundamentally different from every other mineral resource, for two reasons: First nearly all its uses are consumptive. Unlike most minerals and water, which can ultimately be recycled and reused when prices make it profitable, oil is destroyed in its use. Second, oil is not a luxury item, but a necessity in the modern world. To argue that people will use less oil, one must assume that either (a) people will accept a demotion in their standards of living, (b) people will develop more efficient oil-burning technology, or (c) people will turn to alternative energy sources.

Option (a) seems unlikely, especially if some countries experience more severe oil shortages than others. Options (b) and (c) require that new technologies be developed (probably by rich nations) and made affordable to all nations before oil prices reach critical levels. To know whether these options are viable, we must understand how much oil we have left, how long it will last, and how it will be distributed as it begins to decline.

M. King Hubbert, who was a very prominent earth scientist--ahead of his time in many ways--wrote a report to the National Academy of Sciences in 1956, focusing on the finiteness of fossil energy, and especially oil. He predicted that the period of worldwide commercial oil production – the so called 'oil era' - would last only a couple hundred years [Figure 2]. In his report, he asked the question, where do we currently stand on the oil production curve, in this short episode in human history where we use fossil energy? Are we near the peak? Are we in decline? And what are the implications of this important but finite resource to our future?

Attempting to answer these questions, M. King Hubbert set forth a mathematical model of oil production in which the ratio of oil remaining to be discovered in any given region, divided by the amount of oil that has already been discovered, dwindles exponentially over time. Perhaps the simplest model of the discovery and production of a finite resource over time, this ratio predicts that the rate of oil production over time would follow a bell-shaped curve. According to this model, production starts very slowly, as it did in the beginning of the oil era, about 110 years ago. It then rises to a peak, and because the resource is finite, begins to decline.

In his report to the National Academy of Sciences, Hubbert applied his model first to oil production in the lower 48 United States [Figure 3]. He used available production data in barrels of oil per year, up to 1954, along with an estimate of the total recoverable oil, to estimate what would happen in the future. Which way would the curve go? How long would USA production continue to rise?

Interestingly, the curve is not very sensitive to the estimate of total recoverable oil. Assuming 150 billion barrels of recoverable oil in the lower 48 states, Hubbard's production curve peaked in 1960 at 2.8 billion barrels per year. Assuming 200 billion barrels, the peak would come just 11 years later, in 1971, at about 3 billion barrels a year. Then production would begin to decline, simply because the amount of oil in the United States is finite.

Hubbert's report provoked a great deal of criticism from the oil industry and from economists. Economists at the time--and many of them today--considered this a pointless exercise. The resource, they argued, would be produced at the rate that society demanded it, not according to a simple equation. Furthermore, the United States could import oil from other countries, and this availability of foreign oil would affect domestic production. Hubbert's equation was too simple – it was argued - to account for these variables.

However, in 1993, (NAMES?) revisiting Hubbert's prediction in light of nearly forty more years of data [Figure 3]. Their data closely and

remarkably matched Hubbert's prediction. Production from the lower 48 United States peaked in 1971; the year Hubbard predicted assuming 200 billion barrels of total resource. Actual peak production was 3.4 billion barrels per year, rather than the predicted 3.1 billion barrels, but it has been declining ever since. The correspondence was remarkable.

In his report in 1964, Hubbert also applied his same reasoning to the world as a whole [Figure 4]. Estimating the total oil recoverable on earth to be somewhere between 1.3 trillion and 2.1 trillion barrels, he calculated when and at what level global production would peak, and the rate at which it would decline. Using the low estimate of world reserves, his curve peaked in 1990 or so, at approximately 24 billion barrels of oil a year. Using the more generous assumption, world production peaked in 2000, at approximately 35 billion barrels a year. In fact current annual world production is around 27 billion barrels. Is the world at or near its peak in production?

If so, how is that peak manifested? The United States is certainly not the only country that is beyond or nearing its peak production. The United Kingdom, with its North Sea reserves discovered only in the early 1970s, reached its maximum production in 1985 or 1986, only fifteen years after the United States. In Norway, it is estimated that production will peak sometime between 2000 and 2007. In both Vietnam and Brazil, production is expected to peak by the end of the first decade of this century. In India, production may already be declining, and in China, despite immense exploration efforts production has managed only to stay level for the past 25 years. As each country nears its peak, and as consumption continues to rise, an increasing number of countries have to import more and more oil.

The map in Figure 5 shows the lopsided geography of the earth's large oil reserves. Obviously, most of the world's oil reserves are in the Persian Gulf area of the Middle East: in Saudi Arabia, Iraq, the United Arab Emirates, Kuwait, and Iran. Together, those five nations straddle approximately two-thirds of the oil reserves on earth, and they currently

produce two-thirds to three-quarters of the world's oil. These nations all still produce significantly more oil than they consume, along with only five other smaller but important producers: Venezuela, Libya, Nigeria, Qatar and Russia.

Consumption of oil is also geographically uneven, and in addition bears little relation to the geography of production, with the result that the major oil consumers of the world are also the major oil importers. Very shortly after Hubbert made his prediction, the U.S. became a net importer of oil, and it now imports approximately 60 percent of its annual consumption. In the year 2000, the U.S. brought in approximately 4 billion barrels, which according to the U.S. Department of Energy, will rise to 5 billion barrels by 2010.

The outlook is even more extreme for developing nations, since their struggles to improve their standards of living involve a rapidly increasing need for energy. While in 1995, each American used 25 barrels of oil per year, in India; each person on average used half a barrel of oil per year, or one fiftieth of the U.S. consumption. China now uses a little over one barrel per person per year, Brazil uses about 3.3, and the world average is about five barrels per person per year. So Indian citizens consume oil on average at only one tenth the average global rate, and Chinese citizens at one fourth. As these countries are actively struggling to climb up the standard-of-living slope, they must increase their energy use. Thus their current energy imbalances will only grow, as they are forced to import more and more oil from abroad.

But how much oil is available worldwide for these countries to import? The population of China alone is 1.2 to 1.3 billion, one fifth of the world population as a whole. To bring the Chinese populace even to the world average per capita oil consumption of five barrels per year would require world production to increase by twenty percent.

Certainly, market forces play a large part in the oil industry. As the supply of oil becomes more limited and the demand increases, the price of

oil will necessarily rise, which, according to economists, will cause the demand to drop; people will be less willing to use oil if it is expensive. Historically, however, oil demand has been remarkably insensitive to price fluctuations. During the late 1970s and early 80s, there was a steep increase in the price of oil. However, during this time, as oil prices tripled, world consumption decreased by only ten percent. Clearly other issues heavily offset market forces.

One issue is the way oil consumption is integrated into society. If demand for oil is to decrease, there are only two options: demand for energy must decrease, which seems unlikely if developing countries continue to struggle to improve their economies, or alternative energy sources must replace part of the oil. However, adequate practical alternatives to oil do not yet exist, and developing them will take time and money. In the meantime, barring major societal changes, oil must continue to fill the gap, causing consumption to remain relatively high, even in the face of rising prices.

Another issue that makes this more than a mere market equation is that oil is inherently an international commodity. As prices rise, where will consumption decrease? What countries will respond first to the decreased supply? Alternatively, if oil is a limited resource, who will get the lion's share of it?

If we divide the total amount of oil available today in worldwide conventional reserves by world population, we get a number between 200 and 300 barrels per person: the amount of oil each person would have if oil were distributed freely and equally, like air. That amount of oil would last an American only eight years at today's consumption level. An Indian citizen would make it last more than 400 years, a Chinese citizen, 200 years, assuming, of course, the Indian and Chinese standards of living remain low. What will happen when the United States has consumed its "share" of the oil? How will other countries react when they realize that is what is happening?

Consider China [Figure 6]. In 1978 oil production in China appeared to be taking off. The Daquing oil field was discovered in 1950, followed quickly by only a few other fields. As production rose, the Chinese view was that China would become - oil production-wise - the next Saudi Arabia. China is, after all, a very large country, with many sedimentary basins that might hold oil. The oil was not discovered yet, but they expected it to be.

However, after 1978, production leveled off and has remained near three million barrels a day for the last two decades, in spite of prodigious efforts to find and produce more oil.

Until 1993, China still managed to export oil, but today, they import at least a third of their consumption. Some projections suggest that in another 10 years they will be where the U.S. is today; they will be importing 60% or so of the oil they use. But with only so much oil left in the world, what will be available for China?

In an article in *Foreign Affairs* in the 1996, Kent Calder says:

> *"For nearly 15 years...energy has had remarkably low priority in global policy councils. The time has come for a reevaluation, and nowhere is one more urgent than in the Pacific. Major changes in East Asian energy patterns are creating both danger and opportunities for troubled trans-Pacific relations chronically oriented toward the past".*

In the last decade or so, some political scientists, and even a few economists, have become aware that the problem of the oil supply goes far beyond market forces to the point growing military conflicts between nations will undoubtedly arise over access to oil, and in fact already have.

In fact some historians believe that some of the major conflicts of World War II were already about oil. One reason Hitler pushed his army to Baku was to control the Caspian Sea region, the nearest major oil producing region to Germany. The same motivation may have encouraged him to send

his troops to North Africa, to get to the Middle Eastern oil. That wasn't the complete story in either case, but it was certainly an important aspect of Germany's strategy, especially since Germany, like most of Europe, didn't have any oil. Their only source at the time, Romania, wasn't enough to supply the need for the 1000-year Reich they were envisioning.

An even clearer case during World War II was Japan. Probably the main reason the Japanese made their bold effort to destroy the US Pacific fleet was to secure free access to Sumatra, then the main source of oil in the Far East.

Buying oil a-la-market forces is the peaceful option, and the Japanese could have bought oil, but they feared the possibility of an embargo. Invading the producing region would have they hoped ensured control over production.

Could it happen again? If China for example became desperate enough to secure a source of oil by force –the Caspian region that is virtually unprotected today is an obvious possible target. That is not to say that China will necessarily invade the Caspian Region to secure oil, but surely some Chinese leaders are not blinder to this option than we are.

In fact it is probably not completely far-fetched to suggest that we have already entered a global war about oil. The situation with Iraq and the rest of the Middle East, depending how we manage it, may be a precursor to a larger global conflict and the Gulf war of 1991 can be viewed as an early skirmish in this conflict. Michael Klare suggested shortly after the World Trade Center attack that the motives behind Osaama Bin Laden's terror network were less religious and more about power and economics:

> *"...the true center of the conflict is Saudi Arabia, not Afghanistan or Palestine, and...Bin Laden's ultimate objective includes the imposition of a new Saudi government, which in turn would control the single most valuable oil deposit on the face of the earth".*

As already discussed above Saudi Arabia has a quarter of all the oil in the world. The Gulf region has two-thirds of the world's oil. According to Klare, Bin Laden does not think that the Muslim world will conquer the United States, or even Europe. What really concerns him is what will happen when the Royal family in Saudi Arabia is pushed from power, just like the Shah was pushed out of Iran. Who is going to control Saudi Arabia after that? The attack on the Twin towers according to this interpretation was aimed at demonstrating to the Saudi ruling family that the USA is vulnerable and cannot be as reliable a protector as it makes it's other nations believe.

Oil is not just finite, but already dwindling. If, as some experts argue, the near future sees a period of increased pumping and decreased prices--an oil glut--this will simply hasten the approach of the shortage. There is only so much oil under the ground, and when it is gone, it is gone. Will there be time to develop other sources of energy before countries begin to panic and attempt to control the dwindling supply? The world may be paralyzed by global conflict long before we can reach our ideal of a balanced range of sustainable energy sources available to a growing number of people with growing demand that are environmentally friendly.

This problem of dwindling energy thus poses one of the most serious global issues we face today. All other reasons for exploring new sources of energy - global warming, pollution abatement, ozone depletion - pale in comparison. For example we are going to have huge trouble because of oil Figure 1long before we are seriously affected by global warming.

This is not to say we shouldn't work on global warming, but we need to allocate our limited resources for research and study a little differently. The question is not whether it is good or bad to use fossil energy; the question is, how can we manage the transition?