Are We Running Out of Resources?
By James Gwartney, Richard Stroup, Russell Sobel, and David Macpherson

> *People think of the Earth as having a certain amount of oil the way you might have a certain amount of money in your bank account...but in reality, the ultimate amount available to us is determined both by economics and technology.*
>
> —*Daniel Yergin*[1]

For centuries, various social commentators have argued that the world is about to run out of vital minerals and various sources of energy. Economic growth and the technological advances that help to fuel it have accelerated the use of many natural resources. Population growth has added to the rate of resource use. As the quotation from Daniel Yergin above indicates, most people think that continual use of resources that are available in finite quantities will lead to their depletion. But he goes on to claim that depletion can be put off for a long—even an indefinite—period. This feature explains why this is the case.

Forecasts of Resource Exhaustion: the Historical Record

In sixteenth-century England, fear arose that the supply of wood—widely used as a source of energy—would soon disappear. Higher wood prices, however, encouraged conservation and led to the development of coal. The wood crisis soon dissipated.

In the middle of the nineteenth century, fear arose that the United States was about to run out of whale oil, at that time the primary fuel for artificial lighting. As the demand for whale oil increased, many predicted that all the whales would soon be gone and that Americans would face long nights without light. Whale-oil prices rose sharply from $0.23 per gallon in 1820 to $1.42 per gallon in 1850. The higher prices motivated consumers and entrepreneurs to seek alternatives, which included distilled vegetable oils, lard oil, and coal gas. By the early 1850s, coal oil (kerosene) had won out. A little later, petroleum replaced coal as the primary resource used to produce kerosene. As for whale oil, by 1896 its price had fallen to $0.40 per gallon, and even at that price few people used it.

As people switched to petroleum, dire predictions about its future exhaustion arose almost immediately. In 1914, the Bureau of Mines reported that the total U.S. supply of oil was 6 million barrels, an amount less than the United States now produces every two years. In 1926, the Federal Oil Conservation Board announced that oil would be depleted in the United States within seven years. The Interior Department predicted in 1939 that petroleum supplies in this nation would run out within 20 years. And in 1949, the Secretary of the Interior proclaimed that the end of oil supplies was near.[2]

Perhaps the modern predictions having the most impact were those from *The Limits to Growth*, a book published in 1972. The forecasts of the book were given front-page publicity in *The New York Times* and major national magazines. Basing their predictions on large multi-equation computer models, the authors of *the Limits to Growth* forecast that prior to 2013 "the world would run out of aluminum, copper, gold, lead, mercury, molybdenum, natural gas, oil, silver, tin, tungsten, and zinc." Of course, this did not happen. Why?

Looking at data on oil reserves and usage rates in Exhibit 1 will help to explain why these predictions have consistently been wrong. The exhibit indicates that proved reserves are 60 billion barrels and the annual usage rate is 6 billion barrels. Based on these figures, when will the world run out of oil? After dividing the proved reserves by the annual usage rate, these data suggest that the world will run out of oil in about ten more years! Is this right? Many use figures like these to argue that this will be the case. Before you jump to this conclusion, however, it should be noted that Exhibit 1 is missing a crucial piece of information; the year of the figures. The data of Exhibit 1 are not for today, they were for 1920. Whoops! The rough estimation that the world would run out of oil in 10 years was clearly inaccurate.

Exhibit 1: The world's proved oil reserves and annual usage rate

World oil reserves (barrels)	World oil use (barrels per year)	Estimated number of years to depletion
60 billion	6 billion	?

Source: U.S. Energy Information Administration, http://www.eia.gov/

Let's take a look at some additional data on oil, but this time we'll include the year. Exhibit 2 contains data on proved oil reserves and annual usage rates for 1920, 1970, 2000, and 2013. To make things easier, the estimated number of years till oil depletion has already been calculated. In 1920 it looked like the world would run out of oil in just 10 more years, but this did not happen. By 1970 the proved reserves and usage rates were much higher than in 1920. Nonetheless, as the widespread media coverage of the predictions provided by the *Limits to Growth* illustrate, in 1970 many thought we would run out of oil in about 32 years. Thus, if the popularized predictions had been correct, the world would have run out of oil shortly after the turn of the century. But once again, the forecasts were wrong. In fact, even though the annual consumption rate of oil continued to rise, by 2000 the predicted length of time until depletion had increased to 38 years. The most recent figures indicate that the world has enough oil for at least 50 more years.

Interestingly, the number of years until resource exhaustion has been *increasing, not decreasing*. We use more oil each year, but we also discover an even larger amount.

Exhibit 2: Historical data on oil reserves, use rate, and depletion date, (1920, 1970, 2000, 2013)

World oil reserves (barrels)	World oil use (barrels per year)	Estimated number of years to depletion	Year
60 billion	6 billion	10 years	1920
531 billion	16.5 billion	32 years	1970
1 trillion	26 billion	38 years	2000
1.65 trillion	32.8 billion	50 years	2013

Source: U.S. Energy Information Administration, http://www.eia.gov/

The data of Exhibit 2 should calm down anyone worried that the world might soon run out of oil. Moreover, the figures highlight a fundamental characteristic of resources: they are not static. Available resources change all the time. Markets and human ingenuity constantly lead to the discovery of additional resources.

Why Have the Forecasts of Resource Crises Been Wrong?

The incentives generated by markets provide the means for the expansion of supply, and thus they explain why the forecasts of resource exhaustion have always been wrong, when markets are allowed to work. Think about what happens when a resource becomes scarcer. This might happen because of either a reduction in supply or an increase in demand. In either case, the price of the resource will rise. In turn, the higher price will cause (1) users of the resource to cut back on their usage, (2) suppliers to figure out how to supply more of it or perhaps to recycle, and (3) both users and potential suppliers to search for substitutes. Each of these factors will tend to increase future supply relative to demand. The larger the initial increase in the price of a resource, the greater the incentive to cut back on usage, expand the future supply, and develop substitutes.

These adjustments will keep usage rates of the resource pretty much in line with the expected future supply. With time, they can often bring relief in the form of a lower future price. The key point is this: Although the price of a resource may increase sharply during some periods, the structure of incentives accompanying the price increase makes depletion highly unlikely and provides the seeds for future reversal.

As analysis of resource crisis forecasts indicates, we have seen these forces work again and again. Think about the actions producers, resource users, and consumers will take when oil prices go up. The higher prices will provide petroleum producers with a stronger incentive to search for and find new fields. They will also provide them with a greater incentive to use technology to extract a larger share of the oil from existing fields. Up to 70 percent of the oil can now be extracted from highly productive wells that in prior decades would have yielded much less. When sustained price increases are large enough, generating expectations they will be sufficient to cover the higher-cost production methods, it becomes economical to produce petroleum products from exceedingly abundant, but less-rich petroleum resources. These include oil shale and tar sands and, indeed, such production has already begun.

On the demand side, higher oil prices also provide users with a strong incentive to reduce their consumption of petroleum. Electric power–generating firms will search for, and some will shift to, alternatives like natural gas and nuclear power. Manufacturers of plastics and other products that use petroleum as a resource will face higher costs and will seek to shift to substitute resources and cut back on their future use of petroleum. For their part, consumers will use less of the oil-intensive products and adjust their behavior accordingly, purchasing more fuel-efficient cars and trucks, commuting less, and finding other ways to economize on oil-intensive products.

These adjustments, and many more on both the supply and the demand sides of the crude oil market, will tend to reduce demand over time, increase supply, and thus moderate price increases. This has happened for oil and other resources many times, and these constructive pressures will continue to do so whenever resource scarcities change and market forces are permitted to work.

Proved Reserves and Running Out of Resources

Geologists use the term **proved reserves** to mean the specific mineral deposits that have been shown by scientific examination and cost calculation to be extractable and deliverable to the market at current prices and level of technology. As we have demonstrated, proved reserves have often been used by doomsday forecasters to calculate the future time when we will run out of a resource. But this is a misapplication of the concept. Proved reserves are quite different than the total quantity of a resource in the ground. Put simply, proved reserves are the verified quantity that can be extracted, given investors' expectations of developing technologies and expected prices.

For producers, proved reserves are like an inventory of cars to an auto dealer. They are the quantity that can be available quickly for sale. Just as it is costly for an auto dealer to hold more inventory, it is costly for a firm to discover and sufficiently research a mineral deposit to qualify it as proved reserves. Producers who buy or develop proved reserves do not want to pay for them farther in advance than needed, just as an auto dealer wants to have cars available in stock but not too far ahead of the time they can be sold.

As with inventories, it is costly to develop and hold proved reserves for lengthy time periods. If it takes an auto dealer five weeks from the time of a new car order to receive the cars, the dealer may want something close to a ten-week supply of cars, relative to expected sales, on the car lot and available for customers to see and buy. Similarly, if it takes two years, say, for a user of iron ore to replace iron ore reserves that they have used, then a fouryear supply of those reserves might be a desired amount to have available. Just as inventories are a poor indicator of the total future supply of a good like cars, proved reserves are a poor indicator of the total future supply of a mineral resource. Proved reserves will always be a small fraction of what they could be simply because it is costly to prove and hold reserves.

Are Resources Becoming Scarcer?

If the scarcity of a resource increases relative to demand, its price will rise. If a resource is increasing in supply relative to demand and it is becoming less costly to supply, its price will fall. Therefore, resource price trends provide information about how the scarcity of various resources is changing.

What have resource prices been telling us? During the past century and more, ending in 2000, the real price of most mineral resources fell. A classic study by Harold Barnett and Chandler Morse illustrates this point.[3] Using data from 1870 to 1963, Barnett and Morse found that the real price of resources declined during that long period. A later study by William Baumol and Sue Anne Batey Blackman buttresses this view. They cite a composite mineral price index, corrected for inflation and published by the U.S. Geological Survey, showing a decline in the price index from 185 in 1905 to 100 in 2000. Thus, the real price of minerals fell, on average, by 46 percent in 95 years, even as the use of those minerals expanded.[4]

Rapid rises in prices of oil and other commodities in the 1970s led to widespread anxiety that the world was running out of major resources. In 1980, economist Julian Simon argued that this run-up was temporary and that, over time, prices were likely to fall. Simon offered a $1,000 bet that any raw materials selected in 1980 would be priced lower ten years later after adjustment was made for inflation. Environmentalist Paul Ehrlich took up the bet. He and his associates chose five metals (chrome, copper, nickel, tin, and tungsten), put $200 on each, and bet that the inflation-adjusted prices in 1990 would be higher.

Simon easily won the bet. During the decade, the real prices declined not only for the bundle but also for each of the five minerals chosen by Ehrlich. In 1990, Ehrlich wrote a check to Simon to pay off the bet. (The wager became famous after an article about it appeared in *The New York Times*.)

In 2005, a student and a professor at Michigan State University analyzed whether Simon would have won the bet had it extended over the entire twentieth century. Using U.S. Geological Survey price data for basic metals, they examined the change in prices from 1900 to 1999. "The person who took Simon's position would have won over the entire century," wrote David McClintick and Ross B. Emmett. "If someone invested $200 at 1900 metals' prices in each of these five metals, the inflation-adjusted value of the same bundle of metals in 1999 would have been 53-percent lower."[5] Of course, resource prices did not go down during every decade of the twentieth century, but they went down during most decades and for the century as a whole. Thus, history suggests that it is not too smart to bet on rising resource prices.

Summarizing: When resources are allocated by markets, increased scarcity leads to higher prices. The higher prices will strengthen the incentive for (1) users to reduce their consumption, (2) suppliers to search for ways to expand future supply, and (3) both producers and users to search for substitutes. All of these adjustments will increase future supply relative to demand and make it highly unlikely that the resource will be depleted. Changes in prices provide information on the relative scarcity of various resources. The trend in the price of most resources has been downward for at least a century, indicating that the relative scarcity of most resources has been declining.

This article is excerpted from the principles of economics text, Economics: Private and Public Choice*, 15th edition, (Cengage Publishing, 2015) by James Gwartney, Richard Stroup, Russell Sobel, and David Macpherson.*

James Gwartney holds the Gus A. Stavros Eminent Scholar Chair at Florida State University, where he directs the Stavros Center for the Advancement of Free Enterprise and Economic Education.

Richard Stroup is Professor of Economics Emeritus at Montana State University, as well as a Senior Fellow at the Property and Environment Research Center (PERC) and a Visiting Professor in Economics at North Carolina State University.

Russell Sobel is Professor of Economics and holder of the James Clark Coffman Distinguished Chair in Entrepreneurial Studies at West Virginia University.

David Macpherson is the E.M. Stevens Professor of Economics at Trinity University and was previously the Director of the Pepper Institute on Aging and Public Policy as well as the Rod and Hope Brim Eminent Scholar of Economics at Florida State University.

---

[1] Daniel Yergin, chairman of Cambridge Energy Research Associates, quoted in "Why We'll Never Run Out of Oil," by Curtis Rist, Discover Magazine (June 1999), www.discovermagazine.com/1999/jun/featoil.

[2] Predictions are cited from Wallace Kaufman, No Turning Back (New York: Basic Books, 1994), 24; and from Charles Maurice and Charles Smithson, The Doomsday Myth, 10,000 Years of Economic Crises (Stanford, CA: Hoover Institution Press, 1987), 12.

[3] Harold Barnett and Chandler Morse, Scarcity of Growth: The Economics of Natural Resource Availability (Baltimore: The Johns Hopkins University Press for Resources for the Future, 1963). See also Julian L. Simon, The State of Humanity (Cambridge, MA: Blackwell Publishers, 1995), Part III, Natural Resources.

[4] Quoted by Sue Anne Batey Blackman and William J. Baumol, "Natural Resources," in The Concise Encyclopedia of Economics, 2nd ed., ed. David R. Henderson (Indianapolis, IN: Liberty Fund, Inc., 2007), available online at http://econlib.com/library/Enc/NaturalResources.html

[5] David McClintick and Ross B. Emmett, "Betting on the Wealth of Nature," PERC Reports (September 2005), www.perc.org/perc.php?subsection=5&id=588.