Consumption of Natural Resources

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Concern over "consumption" and eventual exhaustion of non-renewable "natural resources" has become accepted dogma in much of Western culture, justifying opposition to development, calls for a return to a "simple" life, and an imperative for "sustainable" development. The argument is that 1) we are consuming this material (iron, copper, coal, water, oil ...) at some rate (usually with potentially-infinite exponential growth thrown into the argument); 2) the supply of this material is finite and is the present reserve; 3) we will therefore run out of this material in the year (Today's date + 15 to 30 years, depending on the material in question, and occasionally much more). This argument was put forth as an economic argument by Malthus in 1798 (concerning crops) and is widely embraced today. It was wrong in 1798 and continues - despite its popularity and apparently selfevident nature - to be wrong. The classic Malthusian viewpoint is that there is a fixed supply of material being consumed and that this amount imposes an absolute limit to growth. This belief is underpinned by several misconceptions about natural resources and reserves. Much of the problem stems from confusing the terms *resource, reserve* and *supply. Supply* of a material is the amount on/in the Earth. *Reserves* refers to the amount producible under present economic condition in current facilities. *Resources* is the amount that has been concentrated enough to attract attention and includes not only reserves but also more speculative categories. *Supply estimation* is based on the composition of meteorites or average concentration in various types of rocks. Resource estimation is a remarkably speculative but enjoyable endeavor, based on knowledge of the overall distribution of geological provinces and current understanding of what kinds and amounts of deposits they are likely to contain. *Reserve estimates* are based on economic analyses of particular mines or well-fields and include only that material which can be extracted at a profit under present economic conditions (ore). Reserves can be estimated quite accurately, supply and resource are much more speculative.

As an example of the above definitions, consider iron. The supply of iron includes iron in iron ores, iron mineralization (unusually high or convenient concentrations of iron), and iron disseminated in "ordinary" rocks, such as the iron oxides coating sand grains. Iron *resources* includes iron mineralization and iron ore: rocks chemically indistinguishable from ore that are unprofitable to mine are in this category - including rock that would be mineable were the price higher, rock that would be mineable if there were better transportation available, and rock that could be rained if labor, equipment, or fuel costs were lower or zoning or tax laws were different - as well as rocks that have lower concentrations of iron or are more difficult to extract. *Reserves* includes only rock in operating mines that can be mined at a profit today: a rock that is a reserve one day can become a resource the next and vice versa. Iron mines do not close because there is no ferruginous (iron-bearing) rock left; they close because the owners would (or did) lose money extracting it.

A financial analogy would be that reserves are cash on hand; resources are cash, bank accounts, and accounts receivable; supply is total potential income. Budgeting that limits all future purchases to those that can be met with cash on hand is foolish; social planning that limits development to that which can be accomplished with reserves on hand is foolish as well.

There are several other points to be made on the issue of *consumption* of *natural* resources. First, "natural resources" are produced by humans to fulfill the needs and wants of other humans at a profit. We do not get iron from some pile of iron ingots or rolls, but rather from finding, digging, crushing and chemically-treating rocks. Natural resources are not natural: they involve much human effort, by geologists, miners, mine engineers and others. Natural resources are resources only because of the demand and because they can be produced at a profit. Second, most materials are not consumed but transformed. To use the iron example, iron ore is converted from an oxidized to a metallic state in blast furnaces. At the end of the day, there is still as much iron and oxygen as there was at the beginning, but there is some in different forms. Only the fuels can properly be said to be consumed; other materials can be recycled, now or later, when conditions warrant it. When the economic conditions are right for a junk car to be melted to produce iron, it will probably be recycled. This is why gold and silver have been recycled for thousands of years, but wood generally has not been recycled.

The "time to exhaustion" computed using the above line of reasoning tends to produce remarkably stable numbers. For most of this century, we have been "about to run out of oil" in about 15 years. For copper, this number has usually been 20 or 30 years. The cause is, as you probably suspect by now, economic. Exploring

for a material costs money today. Due to the time required to develop a mine or an oil field, the profits will not be available until some time in the future, if the enterprise is ever profitable. Mineral exploration will be funded only if the expectcd return is as high or higher than competing investment opportunities (except for subsidized projects undertaken for security reasons). As the reserves and near-reserves of a material become larger, further exploration for the material becomes less attractive economically.

We have always been using materials (consuming natural resources?) to make our lives better and will until the end of time. This has been true since the Paleolithic Age, when there was not an inexhaustible reserve of flint (i.e., continued expansion of tool making would exhaust the available supply of flint), to today, when there are not inexhaustible reserves of metals, water, land or energy. If you are still not convinced that Malthus was wrong, ask yourself, what have we actually run out of.

There are physical limits to our growth, but those involve the mass of the earth and stars. The limits to worry about, because they are near and we can and must do something about them, are ourselves, our imagination, and our choices.

It is impossible to avoid using materials: the question is how and for what purposes. Will we use them wisely, or will we turn our backs on them and, in doing so, turn our backs on future generations? Should we consign people to a poverty they wish to avoid in order to preserve materials? People first, or planets first? Should we avoid using earth resources for the sake of the earth, or should we make these decisions based on the effect on humans?

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