# Malignant growth and retroactive heterotrophicity in modern urban agglomerations

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## ABSTRACT

By 2030, 60% of the global population will live in urban agglomerations (UN, 2005) and will continue drawing energy and other resources such as fresh water from distant areas. Odum (1989) describes cities as heterotrophic, parasitic ecosystems since they since they consume more energy than they produce. Walled medieval towns drew their energy resources from the surrounding farms, and even Amazonian tribal settlements depend on gardens and game outside the village. But modern cities now display retroactive heterotrophicity that extends back in time 300 million years as they tap fossil fuels that have their origins in carboniferous swamps and ancient oceans. As global energy consumption is expanding at a rate of at least 2.3% per year, requiring increasing exploitation of hitherto undeveloped ecosystems, this heterotrophicity has all the characteristics of a malignant process. The most significant characteristic of malignancy is uncontrolled growth, and that is displayed in global energy use by urban populations.

Although the human population's rate of growth may be slowing by comparison with the mid-twentieth century, it has shown a pattern of rapid, uncontrolled growth for thousands of years, especially since the beginning of the industrial revolution (Hern, 1990). The global population continues to grow at a rate of well over 1 percent per year, which means that it will double some time during this century.

The most visible manifestation of human activity, especially as seen from outer space, is the increasing concentration of human populations in large urban agglomerations (Fig. 1).

Fig. 1 Earth at night from space (NASA)

Tokyo, for example, now has a population of about 35 million, and others such as Mexico City (19 million), New York/New Jersey (19 million), and São Paulo (19 million; Fig. 1) are close behind (UN, 2005). Fifty percent of all human beings now live in cities, and the UN projects that 60% of all people will live in these urban settings by 2030. These urban agglomerations on every continent have been growing at rates of from 5% to 13% per year during the past century. The USGS now refers to such an agglomeration as a “gigalopolis” (USGS, 2007). (Figure 1)

Image: Saopaulo copan.jpg

Figure 1. São Paulo, Brazil

Examples of this rapid, uncontrolled growth abound on all continents. A study of LandSat photographs by Masek, et al (2000; Foresman, 2000), for example, showed that the Washington-Baltimore metropolitan area was expanding at the rate of 22 square kilometers per year from 1973 through 1996 (Fig. 2).

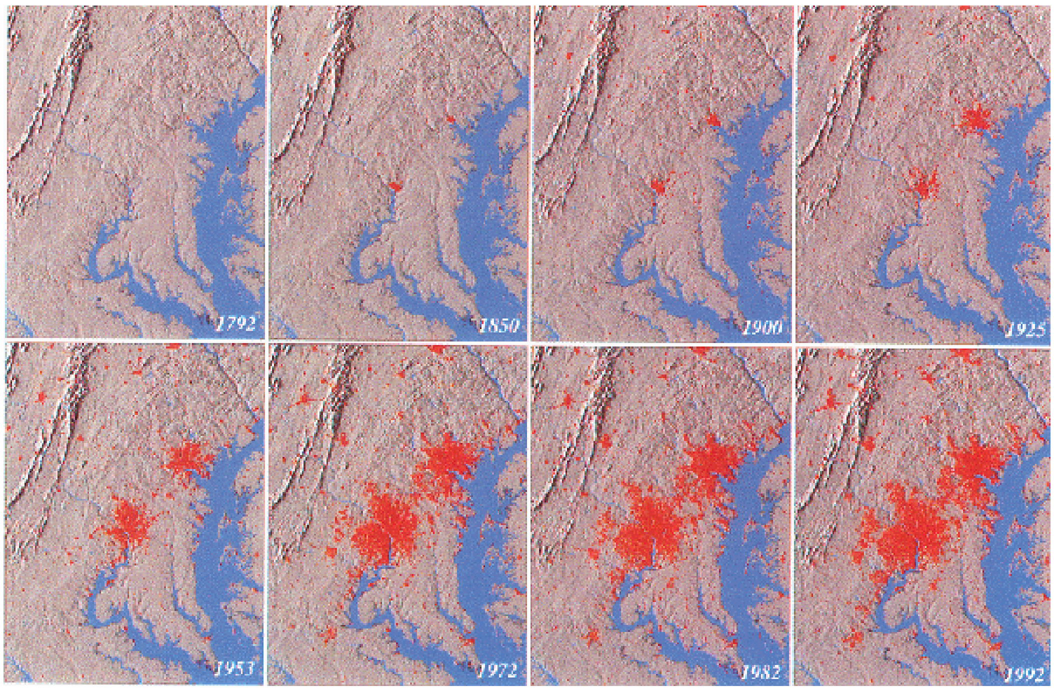
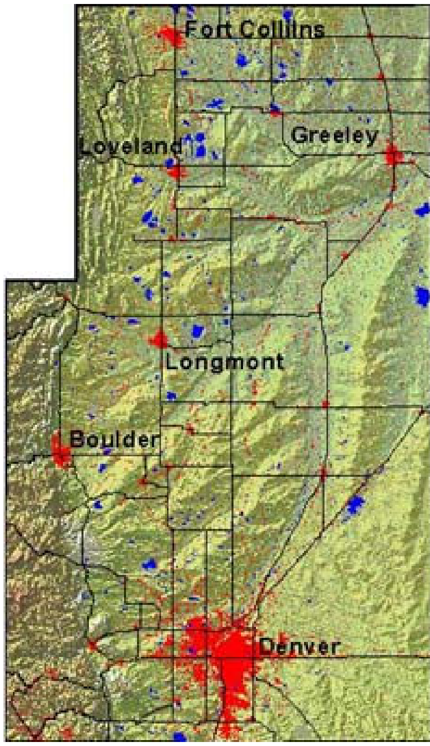
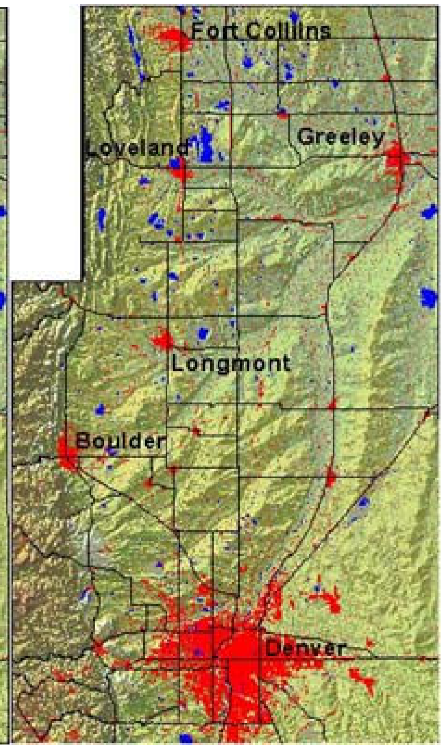



**Figure 2. Growth of Baltimore-Washington Metropolitan Area 1792 – 1992**

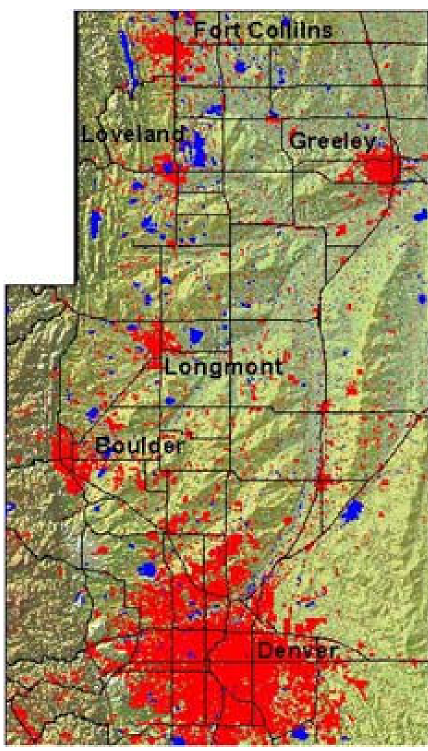
Another vivid example of rapid, uncontrolled growth in the United States is the growth of the population of front range communities of Colorado from 330,000 in 1900 to over 3.5 million at the present (USGS 2008; Figs. 3-6)



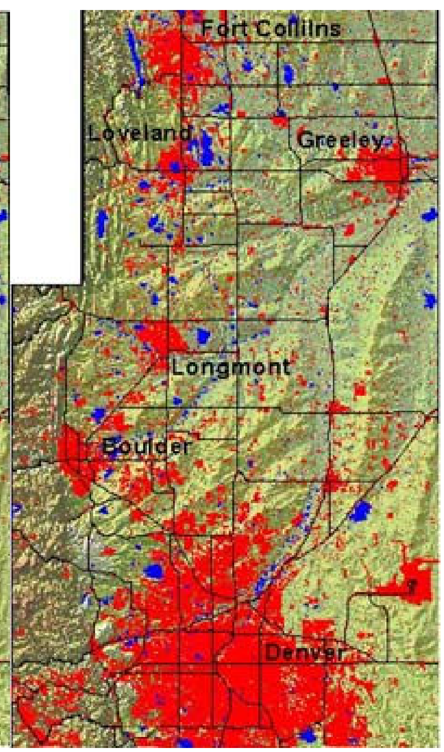

**1937**




**1957**




**1977**




**1997**

Figures 3 – 6   Colorado Front Range 1937-1997

Another prominent characteristic of the human species of great consequence is its capacity for increasing energy use. Odum (1989) has characterized cities as heterotrophic, parasitic ecosystems because they produce no energy and depend on external sources of energy (and water).

This principle applies to all human communities. Whereas medieval communities and tribal settlements as far back as the Neolithic relied on energy sources such as cultivated fields and forests just beyond the formal boundaries of the community, these were energy sources that were being produced by solar energy occurring at approximately the same time as the community existed. The heterotrophic communities and the energy sources were contemporaneous. This was true even for the Roman Empire, which drew its energy needs from distant colonies (Tainter, 1988). Even Amazon villages of Native Americans have depended on cultivation of gardens outside the settlement and the hunting of animals far from the village.

But in 14th century Britain, coal came into use as a principal energy source because deforestation of that island made it impossible to maintain the functions of cities with wood as fuel (Freese, 2003). That amounted to a step back 300 million years to the carboniferous swamps in the Mississippian and Pennsylvanian periods in the Paleozoic era for energy. Once the industrial revolution began in the late 18th and early 19th century, the dependence on modern cities and economies on fossil fuels was cemented (Figs. 7 & 8).

Fig. 7  Open pit coal mine, Wyoming

Fig. 8  Mars Ice island, Beaufort Sea Alaska. Oil exploration rig

From this point, both the human population and energy use expanded at an increasing rate of increase during the 19th and early 20th centuries. Demographic estimates of a current human population growth rate of 1.2 – 1.4% may be accurate, or they may underestimate growth by the absence of accurate data from the highest fertility populations, but they nonetheless indicate that human population growth is rapid and uncontrolled. So is the growth in global energy consumption, which was estimated at 2.3 percent per year in 1995 by the US Energy Information Administration (EIA, 1998). The EIA now estimates that, while the current rate of energy consumption is increasing at about 2.3 per cent per year in OECD countries, it is increasing at the rate of growth of 5.2 per cent per year in non-OECD countries (EIA, 2007). Applying this rate of growth to the 1995 global energy consumption of 363 quadrillion ($3.63 \times 10^{17}$) British Thermal Units (BTU's) per year, the global energy consumption would double by 2025. The 5.2 percent annual increase in energy consumption among non-OECD countries, however, indicates that energy use will double among those countries in a little over 13 years from now. The EIA estimates that world energy consumption will increase by at least 50 percent from 2005 to 2030. Nearly all this energy is being consumed by inhabitants of cities (Brunner and Rechberger, 2002).

Aside from the question of whether the global energy consumption can continue to double every 13 – 30 years without limit or whether there is enough fossil fuel energy on the planet for this to happen, there is clearly no way that growth in this kind of energy consumption can be controlled except exhaustion of traditional energy sources at some point in the future.

The history of energy consumption by heterotrophic human communities as well as its current status is best described as "rapid, uncontrolled growth." That is the main characteristic of a malignant process (Anderson, 1961; Hanahan and Weinberg, 2000; Perez-Tamayo, 1961; Ruddon, 1987). In general, energy use of the human population has doubled 36 times since the appearance of the species in the Pleistocene (Hern, 1999). This energy consumption is also now retroactive, as it has been since the 14th century, since it relies on exploitation of energy sources that originated in the capture of the sun's radiation by plants as much as 300 million years ago.

Urban agglomerations in all parts of the globe display all the classic characteristics of malignant processes. These include urban morphology and growth patterns that can be compared mathematically with malignant neoplasms via fractal geometry (Batty and Longley, 1994; Batty, 2005; Hern, 2008).

## CONCLUSION

Modern human communities, especially megalopoli containing tens of millions of inhabitants, are characterized by malignant, retroactive heterotrophicity within the global ecosystem.

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