Long-term forecasts suggest rapid population growth, environmental change and resource limits. **Andrew Bloodworth, Gus Gunn** and **Paul Lusty** look to the writings of Malthus and question whether 'the power of population is indefinitely greater than the power in the earth to produce subsistence for man' in relation to minerals supply.

Malthus revisited?

Although mineral resources are non-renewable and unevenly distributed, global supply has so far kept up with demand. However, mankind is now moving into an era of unprecedented population growth and environmental change. As demand continues to rise and the need to mitigate and adapt to environmental change becomes more pressing can the abundant mineral supply we have enjoyed be sustained?

The United Nations forecast that global population will be 8.9 billion by 2050; an increase of 30 per cent on current levels. Median forecasts predict that the UK population may reach 71 million by 2033. This major demographic change is likely to be accompanied by substantial growth rates in the emerging economies. PricewaterhouseCoopers predict that the GDP of the 'E7' countries (Brazil, Russia, India, China, Indonesia, Mexico, Turkey) will be 25 per cent greater than the G7 countries by 2050.

Population increase and economic development will continue to drive mineral resource use on an upward path. Consumption of copper by the 20 most populous nations is estimated to rise from 12 million tonnes in 2007 to 24 million tonnes in 2025. Global production of platinum-group metals increased by 113 per cent between 1980 and 2008. Massive growth in the use of electric and hybrid vehicles will be accompanied by equally high levels of demand for the rare earth elements needed to manufacture their batteries and propulsion units.

There are limits to growth and the media enjoy scare stories about mankind running out of vital raw materials, including recent items on 'peak metals', 'peak phosphate' and crises in rare earth supplies. Many are based on flawed assumptions regarding finite resources and a misunderstanding about the meaning of the term 'reserves' *(see opposite)*. There are echoes of the 18th century economist Malthus and his 'Essay on the Principle of Population' in much of this coverage. Malthus did not consider the impact of science and technology in massively extending the size of our resource base, or the role of science in developing new substitutes for old materials. As global population grows and more people aspire to improved standards of living, then we must use science and technology to continue finding primary materials from the Earth. We must also use the same endeavour to optimise recycling of materials already in the human environment and maximise resource efficiency — to do more with less. This needs to be done without compromising our environment. Above all, we must break the link between resource use and carbon. Thus, an alternative Malthusian view might be that limits to growth are set by the response of our environment to the greenhouse gases emitted as a consequence of resource use, rather than the physical exhaustion of the resources themselves.

Reverend Thomas Robert Malthus published 'An Essay on the Principle of Population' *in 1798. He suggested that continued population growth would soon exceed the capacity of the Earth to provide food and other resources.*

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It is vital to break the link between resource use and greenhouse gas emissions.

Dynamic reserves:
The Earth is finite and it is appealing to consider useful minerals as a fixed stock within the crust. However, the assumption by many commentators that *mineral available for use* equals *current reserves* divided by consumption is flawed. Reserves are dynamic entities and represent only a small proportion of crustal resources. Science-driven exploration and development continually replenishes reserves from previously uneconomic or undiscovered resources. Thus reserves fail as an indicator of long-term availability as their definition depends on current science, technology and economics.