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by

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Clem Tisdell²

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The *Economics, Environment and Ecology* set of working papers addresses issues involving environmental and ecological economics. It was preceded by a similar set of papers on *Biodiversity Conservation* and for a time, there was also a parallel series on *Animal Health Economics*, both of which were related to projects funded by ACIAR, the Australian Centre for International Agricultural Research. Working papers in *Economics, Environment and Ecology* are produced in the School of Economics at The University of Queensland and since 2011, have become associated with the Risk and Sustainable Management Group in this school.

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The Nature of Ecological and Environmental Economics and its Growing Importance due to Economic Growth and Development

ABSTRACT

Most ecological and environmental resources are scarce. Ecological economics and environmental economics are concerned with ways in which these resources can be better managed to reduce economic scarcity or more generally, administered to achieve particular objectives most economically. The way in which environmental impacts from economic activity can add to economic scarcity is illustrated and the importance of accounting for opportunity costs in assessing environmental changes is stressed. Growing concerns in recent decades about environmental issues have been reflected in important international political initiatives relating to the environment and development. These initiatives are identified and the general sources of environmental change (natural and human-induced) are considered with most attention being given to the relationship between economic growth and the environment. Subsequently, changing views of economists about the relationships between economic growth, the stock of natural resources and the state of the environment are outlined and discussed. The views of classical and neo-classical economics are briefly examined but most attention is given to the views of neo-Malthusians and their concerns about the sustainability of economic growth. The extent of environmental change as a result of global economic growth and development has undoubtedly contributed to the growing importance of ecological and environmental economics.

Keywords: economic scarcity; environmental change; global environmental arguments; neo-Malthusian economics; opportunity costs; sustainable economic development; sustainable economic growth.

JEL Classifications: Q01, Q50, Q56.

1. Scarcity and Environmental Economics

Economic scarcity is an important problem because people as a whole want more goods and services (commodities) than can be supplied by the limited resources available to them. Economics searches for social mechanisms and for types of decisions that can help reduce scarcity relative to the limited availability of resources.

As part of economics, ecological and environmental economics is also concerned with finding ways in which economic scarcity can be reduced. Its main concern is about how this can be achieved by better managing ecological and environmental systems. If such systems are well managed, they can help to reduce economic scarcity and add to human well-being. If poorly managed they can add to economic scarcity and make human-beings less well off than they otherwise could be. For example, air and water pollution and other adverse environmental spillovers can add to economic scarcity if they are not appropriately managed.

2. An Example of How Environmental Spillovers Can Add to Economic Scarcity

Red tides (and ocean blooms of various kinds) occur periodically in the China Sea. These environmental effects have been attributed to the run-off of nutrient-enriched water from the land. Red tides and ocean blooms result in a reduction in seafood production. Seafood becomes scarcer as a result. This nutrient enrichment may have several sources. These include the heavy application of artificial fertilizer on agricultural land, the disposal of human sewage, and wastes from animals. This problem may be reduced by using less fertilizer or

finding methods to ensure that it is utilized more efficiently and by adopting improved methods for treating human and animal wastes.

3. The Importance of Opportunity Costs in Environmental Assessments

While these environmental spillovers could be reduced by the methods mentioned, it is necessary to take into account the costs of remedying these. Less use of fertilizer may reduce agricultural production, more efficient use of fertilizer may involve some extra cost, and better treatment of human wastes will also involve costs. These costs need to be compared with the value of increased benefits obtained from marine areas as a result of such actions. This involves cost-benefit analysis. When this analysis is done, it may not be economic to eliminate all the negative environmental spillovers from the land on the marine environment. It all depends on the exact calculations. A difficulty is that the cost-benefit calculations are often hampered by lack of knowledge about the environmental and ecological relations involved.

If, for example, a strategy is available to reduce nutrient run-off at a cost of ¥1 million and there is an increase of ¥0.5 million in aquatic production (or benefit), this is an uneconomic strategy because costs exceed benefits. However, if the increase in economic benefit in the aquatic area is ¥2 million, this strategy is economic. Benefits exceed costs. Note that the costs of reducing nutrient run-off includes the net value of agricultural production lost by reducing fertilizer use, if reduced fertilizer use is a part of the strategy being assessed. In other words, costs include **opportunity** costs which include **economic benefits forgone** to achieve an environmental goal.

The discussion of this type of economic analysis can be extended and more precise models of the relationship involved are available. Also economic policies to rectify such problems could

be outlined and assessed. For example, should polluters have to pay to pollute and should they be permitted to generate adverse environmental spillovers? Or should they be paid to reduce their adverse spillovers? What type of environmental policies are best? How should they be designed? I'll not pursue these issues here but I want to point out that economic models do provide insights into the issues that arise in trying to deal optimally with environmental problems

What I want to consider now is evidence of the growing global importance of environmental economics as demonstrated by international political initiatives and developments in academic thought by economists and others.

4. International Political Initiatives and Growing Concerns about Environmental Issues

Global concern and political efforts to address growing environmental problems have only become significant in recent times. There are many reasons for this. Until recently, the predominant view was that there are no limits to economic growth and economic growth is an effective means to reduce scarcity. There was a widespread belief that **any** type of economic growth is desirable and sustainable. This is a naïve point of view. While economic growth can have positive consequences and while it can reduce the incidence of poverty and improve standards of living, as has happened in China, some types of economic growth have undesirable effects and can be unsustainable. The well-being of humans depends **on the nature of economic growth.**

With growing levels of economic production and population globally, the ecological and environmental footprint of humankind has increased tremendously. The consequences include large losses of biodiversity (including loss of ecosystems), and growing concerns

about increasing greenhouse gas emissions. These are predicted to lead to climate change and rising sea levels and so on. Furthermore, as the incomes of individuals rise they tend to want improved environmental conditions. Since China began its major economic reforms in 1978, Chinese incomes have risen substantially, on the whole. Therefore, we could expect to see more political concern in China about environmental issues now than at the end of the 1970s when China's market reforms began. This has in fact, happened as, for example, is evidenced in the Twelfth Five-Year Plan for the period 2011-2015.

Major international political initiatives designed to come to grips with the problem of sustainable development were not taken until the last few decades of the 20th century. The initial prime-mover was the first United Nations Conference on the Environment and Development held in Stockholm in 1972. At this conference, a group of developing nations expressed the concern that economic development might prove to be unsustainable, for instance, if inadequate account was taken of the environmental effects of economic growth. Following this conference, the matter continued to be pursued in the international political arena. For example, in 1980, the *World Conservation Strategy* was drawn up by the International Union for the Conservation of Nature in 'consultation' with UNEP (United Nations Environment Program) and WWF (Worldwide Fund for Nature) and in 1991 (just prior to the second UN Conference on the Environment and Development), an updated document, entitled *Caring for the Earth*, was published by IUCN in consultation with UNEP and WWF.

A significant parallel development was the establishment by the UN of the World Commission on Environmental Development (WCED). This commission (which was chaired by Gro Brundtland, a former Prime Minister of Norway) produced a report on the environment and development which was published in 1987 and entitled *Our Common*

Future. As in the case of the IUCN documents mentioned above, it stressed the importance of achieving sustainable development and maintained that this requires ecological and environmental factors to be taken into account when developing policies for economic development.

The WCED was fairly optimistic in its assessment of the prospects for achieving sustainable development. It argued that continuing economic growth and sustainable development are compatible. While this may be so, it is also the case that in some circumstances economic sacrifices have to be made by current generations to sustain the welfare of future generations. For example, growth in current output is measured by the rate of growth of gross domestic product (GDP) may have to be restrained to benefit future generations. For instance, in order to reduce the speed of global warming, it is likely to be necessary to reduce the current rate of use of fossil fuels. This can add to costs and reduce the current growth of GDP. Ensuring greater sustainability of economic development is, as a rule, not initially costless to current generations but it will benefit future generations and may at a later time, also benefit current generations.

The publication of *Our Common Future* was a prelude to the second UN Conference on Environment and Development held in Rio de Janeiro in 1992. This was an important conference because:

1. It raised awareness globally that if proper attention is not paid to the effects of economic growth on the environment, economic growth may prove to be unsustainable or less sustainable than otherwise.

2. It emphasized that some of the effects of economic growth on the environment are global, for example, global warming, and therefore, are of global concern. Addressing these effects requires the cooperation of all nations.
3. Frameworks were established for developing global environmental policies to curb some negative features of economic growth.

Two important policy initiatives arose from the 1992 Rio de Janeiro Conference:

1. It resulted in the eventual establishment of the *Convention on Biological Diversity*. This came into force in 1993.
2. It established the *United Nations Framework Convention on Climate Change* (UNFCCC) which came into effect in 1994. This convention set up the Intergovernmental Panel on Climate Change (IPCC) to provide scientific information about greenhouse gas emissions and it became the basis for the negotiations of the Kyoto Protocol which came into effect in 2005. This protocol was intended to limit global greenhouse gas emissions. It expires this year (2012). It was agreed at the eleventh hour (December, 2012) in Doha that the period of operation of this protocol will be extended.

These policy initiatives (summarised in Table 1) will not be assessed now but will be discussed later in these lectures. Enough has been said to indicate that there has been increasing political concern in recent decades about the sustainability of economic growth and the interconnection between economic growth and the environment. However, in the last few years, global economic crises have resulted in these issues assuming secondary importance given the high levels of unemployment in many developed countries. This is

evident from the lack of substantial outcomes from the 3rd UN Conference of Environment and Sustainable Development held in 2012.

Table 1 Chronology of some important international initiatives relating to the environment and development

Year	Initiative
1972	1 st UN Conference on Environment and Development held in Stockholm
1980	IUCN, UNEP and WWF publish the <i>World Conservation Strategy</i>
1987	Report entitled <i>Our Common Future</i> of the UNs World Commission on Environment and Development published
1991	IUCN, UNEP and WWF publish <i>Caring for the Earth</i> – a successor to the <i>World Conservation Strategy</i>
1992	2 nd UN Conference on Environment and Development held in Rio de Janeiro
1993	Convention on Biological Diversity came into effect
1994	UN Framework Convention on Climate Change came into effect
2005-2012	Kyoto Protocol on greenhouse gas emissions is in operation
2012	3 rd UN Conference on Environment and Sustainable Development held in Rio de Janeiro. Also known as Rio +20 or ‘Earth Summit 2012’

5. General Sources of Environmental Change

The causes of environmental change can be divided into three general categories. These are:

1. Those changes due solely to natural causes.
2. Those alterations due mainly to human activities.
3. Those variations due to a combination of human and natural causes.

In the distant past, changes to the natural environment (such as changes in climate and sea-level) were attributable solely to natural causes. However, as human populations have increased and as mankind's capacity to alter natural environments has magnified, human actions have increasingly become the drivers of environmental change.

Consider the following examples. In the last couple of thousand years, North Africa has become drier naturally and this has forced a change in land use. Also, it has been claimed that desertification has been naturally occurring in the upper reaches of the Yellow River over a long period of time. It is possible, however, that land-use practices added to this problem. By altering land-use practices, it may be possible to retard the rate of desertification. However, it may be impossible to stop it completely. Furthermore, there are limits to the economics of countering natural environmental change.

Today, however, human beings are themselves an important source of environmental change. Some of these human-induced changes are clearly visible but others have to be inferred. Since the commencement of settled agriculture, humans have destroyed very large areas of forests and natural grasslands. Europe was once almost completely forested and China was much more forested than today. These losses continued in the Americas and Australia after European settlement. They continue in many parts of the world today. For example, in the Amazon in Brazil forest is disappearing to grow crops and rear beef cattle, and in Indonesia, forests are being cleared to grow oil palm. These are all indicators of the heavy environmental footprint of humankind in recent times. Even before settled agriculture, humans were already having visible environmental impacts. Some early civilisations hunted several wild species to extinction and use of fire burns in the countryside changed landscapes. The Maoris in New Zealand hunted the moas (large flightless birds) to extinction. It is also

probable that in early times, Australian Aborigines hunted several large species of animals to extinction and they undoubtedly changed landscapes by their use of fire.

Furthermore, since the Industrial Revolution (which became well established in the 19th century in Britain), an 'invisible' form of human-induced environmental change has become increasingly important. This is the rise in the concentration of greenhouse gases in the atmosphere, brought about to a large extent (but not entirely) by the increasing use of fossil fuels. This is predicted to result in major climate change and rising sea levels.

There are also other obvious indicators of human impacts on natural environments, such as very large losses in natural genetic material and biodiversity due to human activities.

Human impacts on natural environments have increased at an accelerating rate with the passage of time. This can be attributed to rising levels of economic production globally. This reflects growing global population, greater output (income) per head and new technologies (such as fossil fuel technologies) developed during the Industrial Revolution and following it. The acceleration in human impacts on the environment appear to have been particularly rapid in the last 300 years or so (see Figure 1).

Ehrlich (1989) suggested that the adverse impact on the natural environment of socio-economic change might roughly be a multiplicative function of the level of human population (P), economic consumption (production) per head (A), and the extent to which environmentally damaging technology is adopted. Therefore, he represented the extent of environmental damage by the formula:

$$I = P.A.T$$

where I is a measure of the amount of environmental damage caused. While this formula is merely indicative rather than precise, it highlights important variables (of the type discussed above) that contribute to environmental deterioration.

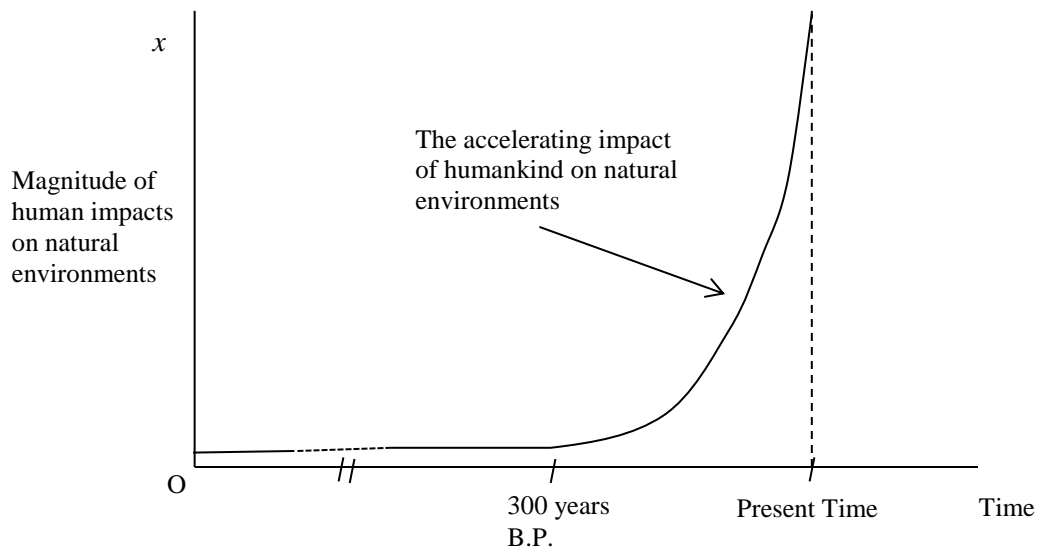


Fig. 1 An impression of the dynamics of the magnitude of human impacts on the natural environment. This magnitude accelerated in the last 300 years or so

A continuation of this acceleration in human impacts on the natural environment does not seem to be compatible with sustainable economic development. Will human beings change their behaviour so that a more sustainable form of economic development is achieved? No one is sure of the answer to this question.

6. Early Views of Economists about the Relationship between Economic Growth, Natural Resources and the State of the Environment

The question of whether there are significant limits to economic growth and limits to rising standards of living was debated by economists in the latter part of the 18th century and into the 19th century. However, by the close of the 19th century (the first part of it) the prevailing view was that the possibilities for economic growth were unlimited. The only significant restriction was on the rate of economic growth which (according to prevailing opinion) depended on labour availability, the accumulation of man-made capital and technological progress.

In 1798, Thomas Robert Malthus argued that population growth combined with the diminishing marginal productivity of land might result in an increase in per capita income being unsustainable. Malthus (1798) hypothesised that in the absence of specific restraints, human population tends to increase until per capita incomes fall to subsistence levels. As population increases, more marginal land is brought into production and land already used for agriculture is farmed more intensely and the **extra** yields obtained are reduced. As a rough rule, Malthus claimed that population tends to increase as a geometrical progression (GP) but production only rises as an arithmetical progression (AP). Marx and Engels rejected the view of Malthus arguing that nothing is impossible to science and that technological progress will enable the rate of growth of production to outpace the rate of growth of population (see Engels, 1959, p. 204. This was first published in 1844).

Malthus' view that populations increase in proportion to the means of subsistence has some applicability in population biology. However, we now know that human populations do not necessarily increase in proportion to the means of subsistence. With a sufficient increase in per capita incomes and altered economic situations in society, **demographic transition**

occurs: birth rates fall and although longevity tends to rise, the rate of population increase tends to fall. In fact, the level of population may **eventually** become stationary or fall, as has happened, for example, in Japan.

Although the matter is more complicated than is illustrated, the type of relationship depicted by curve ABC in Figure 2 may prevail. In this figure, y_1 is the subsistence level of income. The rate of increase of the level of population goes up if income per head increases in the range $y_1 < y_2$, it declines for values of y greater than y_2 , if income can be sustained at those levels for long enough. Eventually, population levels may become stationary ($y = y_3$) or decline ($y > y_3$). Even so, there can be a large rise in the level of population as y increases from y_1 to y_3 . Consequently, many scholars are still concerned about the ‘population problem’. While the rate of growth of world population has slowed, it is still positive, and is a problem. Note, that if the above theory is true, it may be possible to relax China’s one-child policy once Chinese incomes become sufficiently high. In that case, the natural rate of increase of China’s population would be low.

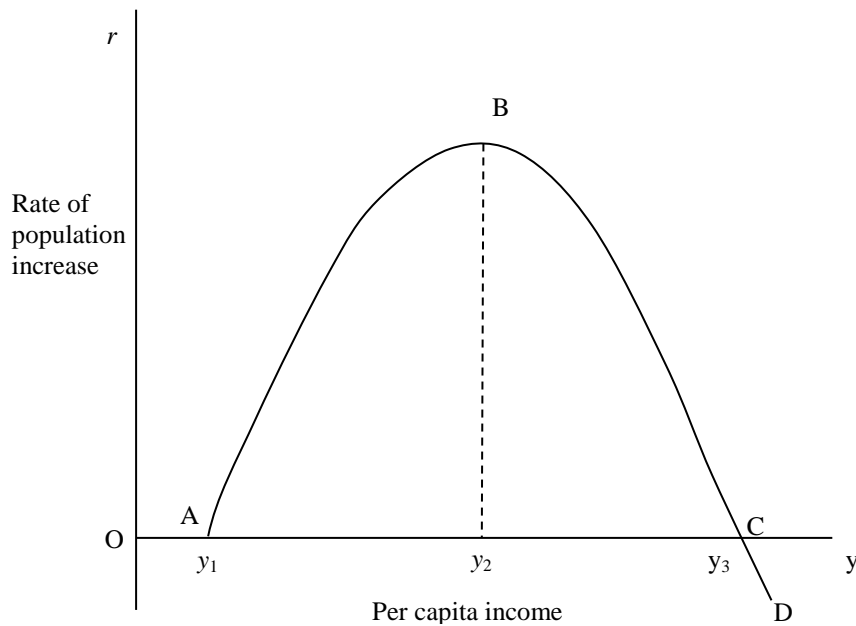


Fig 2 Hypothetical relationship between the level of per capita income and the rate of population increase

Apart from the type of concerns raised by Malthus, there was also some mention in the literature of the 19th century that the exhaustion of non-renewable resources might become a problem for continuing economic growth. For example the British economist, William Stanley Jevons, (1816-1882) was concerned in the 19th century that Britain's coal reserves were being depleted. Globally, however, coal reserves remain very large.

Despite these concerns, there was no mention in this early literature that environmental degradation could become a barrier to sustainable economic growth. It was left to so called neo-Malthusians to raise this and other issues in the last few decades of the 20th century. Nevertheless, most classical economists were aware that the availability of natural resources could limit the sustainability of economic growth although many thought that technological progress would be able to more than offset natural resource constraints on economic growth.

7. Economic Optimism about Sustainable Economic Growth Prevails in the Closing Decades of the 19th Century and for most of the 20th Century

The European powers (and several of their colonies and former colonies – the USA, Canada, Australia, South Africa) experienced substantial long-term economic growth in the 19th century and for most of the 20th century. It appeared that the possibilities for economic growth were unlimited. Lack of the availability of natural resources was no longer seen as possible impediment to economic growth nor was the prospect that poorer quality natural resources might have to be used as economic growth continues.

In fact, economic growth models were developed in the 1950s that effectively assumed that there was no need to specifically consider natural resources as an element of economic growth. The rate of accumulation of (man-made) capital was seen as the most important generator of economic growth. Other things held constant, the higher the rate of savings from incomes and its investment in the accumulation of capital, the higher economic growth. The main constraint on the accumulation of capital and economic growth was seen to be the savings rate, not the availability and quality of natural resources.

These models were developed by neoclassical economists, but were also consistent with the view of Marx that continuing capital accumulation could lead to economic prosperity for all. However, Marx (1999) also believed that while the capitalist economic system would result in considerable economic growth, the distribution of income would be unequal and unfair under this system. It would not result in prosperity for all; it would impoverish the workers. He hoped that this problem could be rectified by the establishment of communism. It is clear that in their early stages, communist government in the former USSR, and in China and elsewhere put a lot of emphasis on savings and capital accumulation as a source of economic growth.

Another important factor allowed for in economic growth models developed in the 1950s was technological progress. It was seen an important contributor to economic growth. Other things held constant, the rate of economic growth was predicted to increase with the rate of technological progress. No account was taken of whether technical change was environmentally friendly or not.

These models all suggest that, given enough savings (and consequently continuing capital accumulation) and sufficient technological progress, the scope for continuing economic growth is unlimited. According to this approach, economic growth can proceed independently of the state of the natural world.

8. The Concerns of Neo-Malthusians about The Sustainability of Economic Growth

Commencing about the mid-1960s, some economists and other scholars began to question the validity of the type of growth models just discussed. They argued that they failed to take account of environmental and natural resource constraints on economic growth. They have been described as neo-Malthusians but they do not necessarily subscribe to the model of Malthus. However, in common with Malthus, they are of the view that there are limits to economic growth.

The following are prominent features of neo-Malthusian models:

1. Environmental degradation (including emissions of pollutants) associated with economic growth can limit sustainable development. This had not previously been emphasised.
2. Natural resource depletion, natural resource dispersion as a result of economic activity, the need to depend on more marginal (less productive) natural resources for

production, and human transformations of the biosphere and its landscapes with subsequent losses of ecosystem services and biodiversity could all limit the possibilities for economic growth.

3. The level of economic production and the nature of economic activity is interconnected with the state of the natural environment. This interdependence must be taken into account.
4. High levels of population combined with high levels of per capita production can be quite damaging to the sustainability of economic growth because this results in higher levels of economic production which puts extra strains on natural resources and on environmental systems. Population growth can be an economic problem even if Malthus' theory of population growth does not apply.

9. The Neo-Malthusian Perspective

As mentioned above, neo-Malthusians are of the view that there is significant interdependence now between the functioning of economic systems and the performance of natural resource and environmental systems. This is illustrated by the diagram in Figure 3 which is based on Kenneth Boulding's (1966) view that life on Earth is analogous to that on a spaceship. It is a closed system which relies on limited resources in finite supply and which produces wastes.

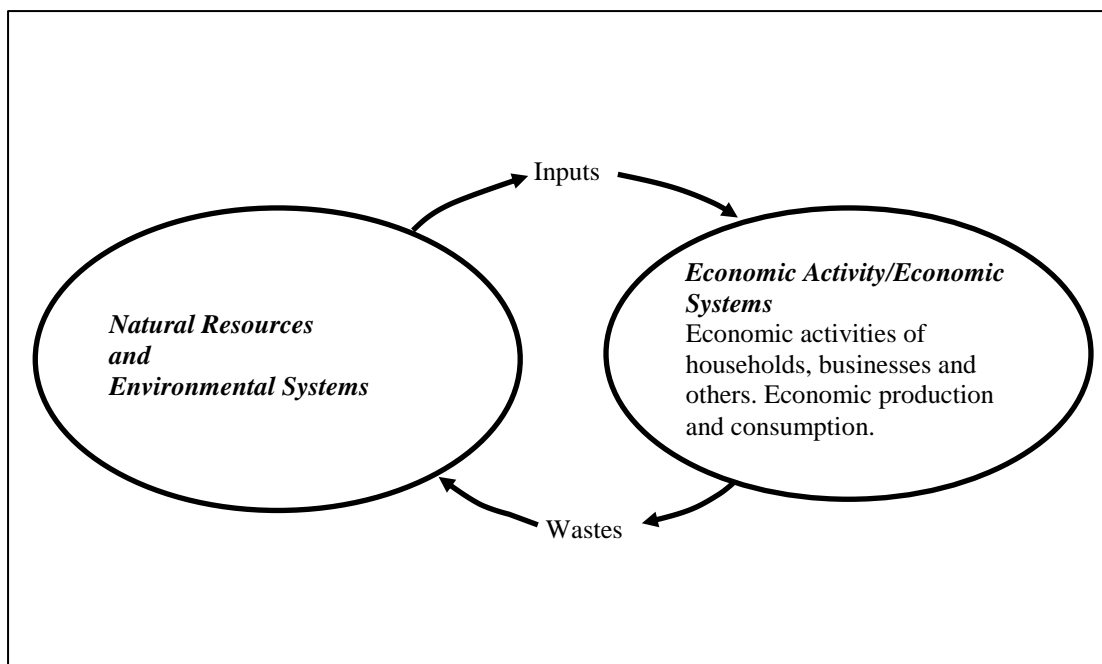


Fig. 3 A simplified representation of the interdependence between the operation of economic systems, natural resource stocks and environmental systems.

Figure 3 indicates that available natural resources and environmental resources provide inputs for the operation of economic systems. These are often combined with other resources, such as labour, to produce economic commodities. Many of the inputs supplied by natural systems are **essential** for supporting the life of humans. Without such resources, life could not exist, and if they are depleted or reduced significantly in quality, they are likely to support less life, including human life.

Boulding's idea that life on Earth is like that on a spaceship is not quite accurate because the Earth's existing resources are being continually supplemented by energy from the sun. However, human beings are continually depleting resources (such as fossil fuels) that have accumulated in the past due to natural processes which relied on solar energy. These resources are basically non-renewable.

In terms of Figure 3, most neo-Malthusians are concerned that expanding economic activity (economic growth) has reached the stage where it is using such large quantities of natural resources and creating so much waste that continuing economic growth is being jeopardized. However, the type of potential threats to sustainable development are not fully captured by Figure 3. These threats include the following:

1. Natural resource depletion and use of natural resources at a rate which exceeds their natural rate of replenishment.
2. Natural resource transformation and its degradation by human activity. This can result in loss of valuable natural ecosystems, unwanted landscape changes, and unwelcome biodiversity loss.
3. Wastes from expanding economic activity cause pollution of water, land and air and degrade these resources in most cases. As the volume of these wastes increases, the ability of natural systems to assimilate them tends to decline.
4. A long-term economic growth problem, raised by Georgescu-Roegen (1974), is that economic production and activity results in the entropy or dispersion of natural resources. For example, metal production depends on the use of concentrated deposits of minerals. When these metals are used in producing economic goods, they become spatially dispersed. While some metals may be recycled, there is always some loss due to corrosion and it is unlikely to be economic to recycle small quantities of the metal in scattered places. Consequently, a large part of the natural resources incorporated in economic products is lost forever. This loss may be reduced by measures that mandate that products be produced in a way that makes recycling easier and by other measures, such as those adopted in Germany

10. Concluding Observations

It can be seen that concern has increased at the international political level that continuing economic growth may prove to be unsustainable because of natural resource depletion and degradation of some natural resources (for instance, water supplies) and unfavourable environmental changes. While some political attempts have been made to address these issues on a global scale, they have not been completely addressed as yet because of various types of social conflict. The views of economists and other scholars about the sustainability of economic growth have changed during the last 300 years or so. After a long period of optimism about the prospects for continuing economic growth, neo-Malthusians started questioning, beginning in the mid-1960s, the prospect for continual unlimited economic growth. As a result, courses in environmental economics (as well ecological economics) started to be offered by universities. By the end of the 20th century, many universities were offering such courses. Nevertheless, not all economists are neo-Malthusians and views differ about the sustainability of economic development. These different views will be considered in a subsequent paper.

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