Sustainability and the Ehrlich equation

A sustainable activity is one that is capable of going on for an indefinite period of time.

Unfortunately, the term *sustainable* has been widely abused, as illustrated by the commonly-used contradiction *sustainable growth*: growth can never be truly sustainable in a finite world.

The quantity of resources we use and our impact on the environment effectively depend on three main factors:

Population

how many of us there are consuming resources and creating waste

Affluence (consumption)

the average amount of goods and services we each use

Technology

how inefficiently/harmfully we produce these goods and services

The Impact is the combination of all three factors and it can be summarised by what is known as the Ehrlich or IPAT equation:

I = P x A x T

A simple example illustrates the concept of sustainability: If reliable rainfall adds 100 litres of rainwater to a tank every day, it is sustainable to use up to 100 litres of this water per day. If the tank is large and is full to begin with, for a while it may be possible to use considerably more than 100 litres per day. However, if the daily input from rainfall remains only 100 litres, even starting with a full 10,000-litre tank, one can't use more than 100 litres per day sustainably. The tank will eventually run dry.

Human prosperity relies on a number of resources and an environment that is ecologically healthy. Even during the early development of mankind, people consumed some resources. From time to time this may have been locally unsustainable, but the impact was only local or, at worst, regional.

Conversely, since the industrial revolution, human activity, resource consumption and environmental impact have grown relentlessly. We are now depleting many resources on an industrial scale, and using those that are nominally renewable at a greater rate than they can be replenished.

As this continues, the resources become exhausted, and in some cases irreversible damage is done to the environment and its ecosystems.

In the natural world, species that live unsustainably and exceed the carrying capacity of their environment eventually experience a rapid and often catastrophic crash in numbers. If we don't take measures to prevent it, sooner or later this will happen to us.

It is self-evident that excessive levels of personal consumption and inefficient or dirty technology are unsustainable.

It is clearly impossible to be sustainable by dealing with just one or two of the IPAT factors in isolation. If any of the inputs to the equation is out of line — *too much individual consumption, inappropriate technology or too many people* — the whole edifice of sustainability will collapse.

The key message spelt out by IPAT is that, even with very modest lifestyles and very good technology, human activity will still be unsustainable if the population is too large.

The IPAT relationship has another important message: Provided none of the individual factors are too extreme, there are many alternative versions of sustainable future available to us. Let's suppose that the most environmentally-friendly technology possible is developed and put into practice (sadly, not a foregone conclusion). Sustainable options will range from the maximum possible number of people living at subsistence levels to a very much smaller population living very comfortably. So long as the total impact of P x A x T is not excessive, any of these alternatives would be sustainable.

Our choice

We have the choice whether to live on a very crowded planet with people at minimum subsistence standards of living, or to opt for smaller populations and enough resources for everyone to aspire to a good quality of life — and more space for other species.

For future generations to have a good quality of life, it is essential that we humans ensure that all three factors in the IPAT relationship are addressed.

Technology

Technology can be defined as *"the practical application of science to commerce or industry"*, or *"the discipline dealing with the art or science of applying scientific knowledge to practical problems."* In the context of sustainability, technology is the way that we convert natural resources into real goods and services that we can eat, drink, wear, live in, travel on, etc.

Resource-efficient technology gives the greatest benefit for the smallest input of resources over the full lifecycle of the "product". This applies to the resources needed to make the goods in the first place (e.g. how much iron ore and energy go into making a steel bridge), the resources needed to use the goods (e.g. how much fuel a car consumes relative to the distance it travels), and the resources implicated at the end of an item's useful life (e.g. how much energy is required to recycle pulp from old newspapers).

Technology uses a wide range of scarce or potentially-scarce resources, including many that are non-renewable, such as rare metals and fossil fuels. Others may be renewable but only to a limited extent. For example, sustainably-managed forestry is only sustainable in quantities that can be supported by the land available without resort to non-renewable inputs.

In many cases, it isn't obvious to the consumer what resources go into making a particular product — cornflakes, for example. Some manufacturers have already invested heavily in improving the resource-efficiency of their technology and supply chains. Others could still do much better. But even with the best available technology, an industrial way of life is inevitably resource-intensive.

The environmental impact of waste is a consideration for many types of technology. This applies to the waste from manufacturing processes themselves, packaging, products that are surplus to requirements (such as excess food), and items that are worn out, broken-down, technologically obsolete or otherwise no longer useful. Finally, what happens to the

manufacturing equipment itself when it is no longer required?

Many companies are now making major efforts to minimise waste and to recycle end-of-life materials and equipment. Indeed, some are designing their products to be easier to recycle and to be less harmful if they do end up in the environment. But this is not always easy, and recycling often incurs additional energy demand.

The overall message is that whereas industrially-developed technological economies still need to improve the efficiency of the technology they employ, the law of diminishing returns applies. It will become increasingly difficult to manufacture and supply goods using progressively smaller amounts of resources:

- technology can only ever improve as far as the laws of physics allow
- renewable resources, including energy, are only renewable to a limited extent and are often expensive to harness

Using the best available technology will help reduce human impact on the environment, but technology on its own is not enough to make us sustainable.

The **IPAT equation** shows clearly:

- We need to reduce our individual **consumption**
- We need to stabilize our **populations** at a sustainable level

Technology will continue to improve, but it is irresponsible to rely on technology that hasn't yet been practically proven. Some new technologies that few of us even dreamed about a decade or two ago are already in widespread use; others, long considered to be "just round the corner", still seem no nearer to fruition — a prime example being technically- and economically-viable nuclear fusion power.

However important it undoubtedly is to develop more efficient and appropriate technology, the inescapable conclusion is that this on its own will be insufficient to assure us a sustainable and prosperous future.

Affluence (consumption)

Many environmental campaigners exhort us to adopt simpler lifestyles in order to save the planet. They are, of course, correct. Many of the goods and services we use do relatively little to enhance our lives, while having a disproportionate impact on the environment.

Unfortunately, many people do not see fit to moderate their own lifestyles for the sake of posterity. These include "enviro-sceptics", who do not acknowledge that an anthropogenic environmental and resources crisis is looming, and "techno-fixers", who believe that better technology is a panacea for all environmental problems.

Although Population Matters stresses the importance of population size, we do also believe that individuals in economically-developed countries need to moderate their lifestyles, and that these countries as a whole must be more frugal in their use of resources in order to protect the environment. One way to achieve this might be to apply the Contraction and Convergence[1] concept proposed as an equitable basis for rich countries to restrain their consumption in an increasingly resources-constrained environment.

It is completely unsustainable for the whole world population to enjoy high-consumption western lifestyles. Global Footprint Network[2] data show that approximately three planet earths would be needed to support the existing world population at the present per-capita consumption levels of the UK. It is

unrealistic to expect better technology to overcome a deficit on this scale.

Clearly, it is unethical for rich countries to insist on maintaining consumption levels that are impossible for other peoples to attain. Even if this were not the case, it is still unrealistic to maintain the status quo longer term. Not only are large disparities between rich and poor almost always linked with human rights deprivation, but also, very often, they eventually lead to conflict.

Reduced levels of personal consumption are a necessary step towards sustainability, but we would need to return to minimum-subsistence lifestyles for this to be sufficient on its own. For a decent quality of life the other two factors in the **IPAT equation** must also be taken into account:

- the most environmentally efficient **technology** needs to be made available and applied on a worldwide basis.
- **population numbers**, globally and for individual countries, need to be stabilised and fall to levels which can be supported at decent standards of living for everyone.

Even within individual nations, too wide a spread between rich and poor makes it very difficult to moderate consumption. The combination of celebrity culture and mass consumer marketing encourages people to aspire to lifestyles beyond the resources available. We do not advocate poverty as a way of life; on the other hand, there is evidence that once people's basic needs have been met, relative affluence (their perception of themselves as being better or worse off than others) usually has more effect on their sense of well-being than does their absolute standard of living.

Population size

Every person consumes resources, and therefore has an impact on the environment. However modestly we live, we still have to eat, we need access to fresh water and inevitably we create some wastes. Complex industrial societies consume a wide range of resources and generate large amounts of waste.

The more resources that a community consumes per head of population, the greater its impact and therefore the smaller the total population size that is sustainable:

- people take up space and consume resources that are needed for other living species
- therefore, fewer people would mean more habitat for wildlife and fewer species being driven to extinction

In the early days of humankind, people banded together to ensure survival. More people meant better ability to defend the community and more brainpower to solve problems. This may be one of the reasons why so many cultures have a deeply inbuilt bias favouring fertility and birth.

In the twenty-first century, however, most human populations are too large, rather than too small. Finite amounts of land, water and energy resources have to be shared out between increasing numbers of people, and the amount available for each individual gets smaller.

More people means:

- more food and water are required to sustain the population
- more land is required on which to grow food
- more raw materials are needed to provide clothing, shelter and other manufactured goods
- larger amounts of energy are required for cooking, heating and industrial activity

- greater demand for resources increases the likelihood of conflict
- there is less margin to survive changes in the environment, be they climate change or natural disasters such as earthquakes and flooding

It is still possible for communities to be too small. If numbers are too small, there may be too few people to undertake major projects, or for culture, art and science to prosper. However, we believe that present populations far exceed this minimum in most countries of the world.

There is, therefore, an urgent need to stabilize populations and gradually reduce them to numbers consistent with decent lifestyles for all.

Read more about Carrying Capacity and BioCapacity and Ecological Footprint. These concepts and tools play an important part in helping us quantitatively to understand the relationship between our numbers and our sustainability.

Decision time

The **IPAT equation** shows that we have a choice about the world our descendants will inherit:

- a high population, crowded world with a low quality of life and low life expectancy or
- a less populous world with a good quality of life for all.

The choice is ours.

References

Accessed April 2016

[1] http://www.gci.org.uk/index.html

[2] http://www.footprintnetwork.org/en/index.php/GFN/page/public_data_package

