Chapter 16: Resources and the environment

Natural resource concepts

There are different forms of resources:

1. **Nonrenewable resources**
   Nonrenewable resources exist in a fixed quantity on the earth. When it is consumed, it is gone forever. The availability of nonrenewable resources is often measured with the level of **current reserves**. It is the known quantity of the resource that can profitably be extracted at current prices using the existing technology.

   The quantity of reserves can change due to four things:

- Discovery of new stock → raises reserves
- Depletion of existing stock → lowers reserves
- Changes in the price of the resource. → increase in the price raise the reserves
- Changes in technology

   An example of a nonrenewable resource is oil. This resource plays a very important role in the world today. If the usage of oil continues to rise at the same rate as it does now, then all the oil will be gone in 43 years.

   The **peak oil** is the date when world production reaches its maximum. Economists have estimated that this peak will be reach in the year range 2020-2030.

2. **Renewable resources**
   Renewable resources are replenished by natural process and thus can be used repeatedly. The amount of people using the resource may not affect the resource. However, it could also be the case that if too much of the resource is used at once, it is not able to renew itself in the future.

   This process can be shown mathematically. The resource stock is defined as S, the quantity of the resource harvested is defined as H and the quantity that grows is defined as G. Together these lead to:
   $\Delta S_t = S_{t+1} – S_t = G_t – H_t$

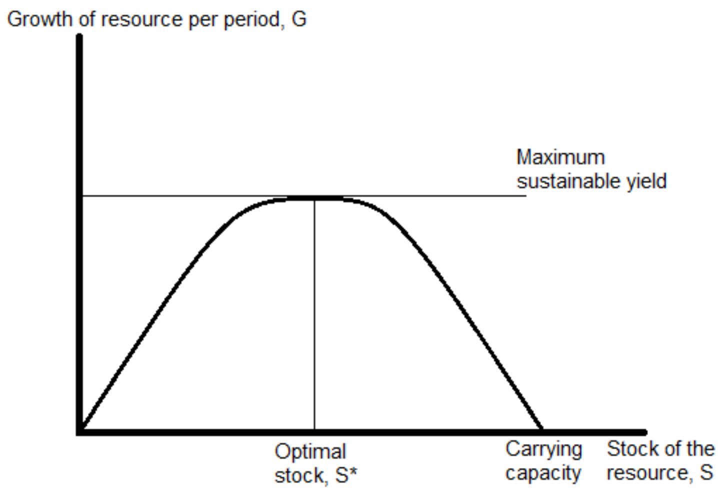
   This formula shows that the growth of the resource depends on the existing stock, S, and on the carrying capacity. The **carrying capacity** is the largest quantity of the resource that would exist in nature if humans never harvested the resource.

   This relationship can also be shown graphically with G on the vertical axis and with S on the horizontal axis. The growth per period and the stock per period show an inverted-U curve relationship.

   The turning point, peak is called the **maximum sustainable yield**. It is the largest quantity of the resource than can be harvested per time without diminishing the quantity of the resource available for use in the future.

   The relating amount of stock of the resource is called the optimal stock, S*. A resource that has not been used at all will equal the carrying capacity. If harvesting occurs then the stock will decline. If harvesting is higher than the maximum sustainable yield, then the stock will fall below S*.

   Once the stock of a resource has fallen below S*, restoring cannot be done by simply reducing the harvest to equal the maximum sustainable yield. An example of a resource that experiences overharvesting is fish.



An aspect of resources that is very important in economic analysis is the degree of property rights. The degree of property rights over a resource determine how it is used. Resources that do not have property rights typically have very high rates for use.

When resources are overexploited because they have no property rights we are in a situation which we call the **tragedy of the commons.** A solution to this tragedy is to establish property rights. Another solution is resource control by the government or some other authority. The authority can take into account the negative externality that results from the use of the resource.

The most tragic case of the tragedy of the commons occurs when resources are not under any kind of control of any single government. Some examples of such resources are the ocean and the atmosphere.

Resources are important to economic analysis because they are used in the production of output.

The **resource intensity (I)** of production is the amount of a resource required to produce a unit of output. This concept helps us to examine how economic growth, population growth and resource growth are related. With R defined as resource consumption, the resource intensity is:

$I = R/yL \quad \rightarrow \quad R = IyL$

In terms of growth rates this can be written as:
$R_g = I_g + y_g + L_g$

Natural resources in economic analysis

The economy faces a trade-off between the present and the future regarding nonrenewable resources. In the debate about the relationship between natural resources and economic growth is often referred to the concept of sustainable development.

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own standards. However, this definition has led to a great debate. There are many that critique this definition.

Even though there are several problems associated with this definition, there is need for some sort of way to assess whether a path of resource use will lead to a major disaster.

If we want to incorporate natural capital into national income we use a measure that is called green GDP. **Green GDP** is equal to GDP minus the value of natural capital that has been depleted or destroyed in that year.

To measure this one has to determine the quantity that is depleted in a given year. It is very hard to put a value on depletion. To calculate this we will use the **in-ground price** of the resource. This price reflects what the resource sells for minus what it costs to extract.

When adjusting national income for resource depletion it is very important that one uses the correct prices. The prices today must reflect the resources' value to future generations.

Resource prices are not only important in calculating green GDP, they are also important in the substitution and technological progress. When the price of a resource is high this creates incentives to search for substitutes or for a technological fix.

There should be a relationship between the scarcity of the resource in the future and its price today. A lower supply will increase the resource price. The in-ground price of resources grows over time at the rate of interest since suppliers prefer money today rather than money in the future.

It is often very difficult or even impossible to determine the in-ground price of a resource. In that case one should focus on the price of the resource itself. Actual prices that we observe do not have to equal the prices that we expect. The actual path of resource prices will combine all the expectations of people with the effects of unexpected events.

Even though theory suggests a mechanism linking current resource use to future resource prices, this relationship is not found in historical data. The data provides evidence that anyone who held back on producing natural resources in order to wait for higher prices in the future was making a mistake.

Current prices of resources overstate the value of natural resources to future generations. Data suggests that natural resource prices have fallen over time. This means that the world is not running out of natural resources yet.

Our level of income is not sustainable. There are two reasons for this:

1. *Substitutes;* there are many possibilities to substitute the fixed resource for other resources. If a specific resource input becomes too expensive a firm can substitute this resource for another cheaper resource. The firm's ability to substitute a specific good is reflected in the **price elasticity of demand**. It is the percentage change in the quantity of a good demanded divided by the percentage change in the good's price. Generally, price elasticities of demand are smaller in the short run than in the long run.
2. *Technological progress;* this may help to overcome the negative effects of depletion. Technology allows the substitution of resources that are not in short supply for resources that are scarce. New technologies may ease resource constraints that were slowing economic growth.

<u>Growth and the environment</u>

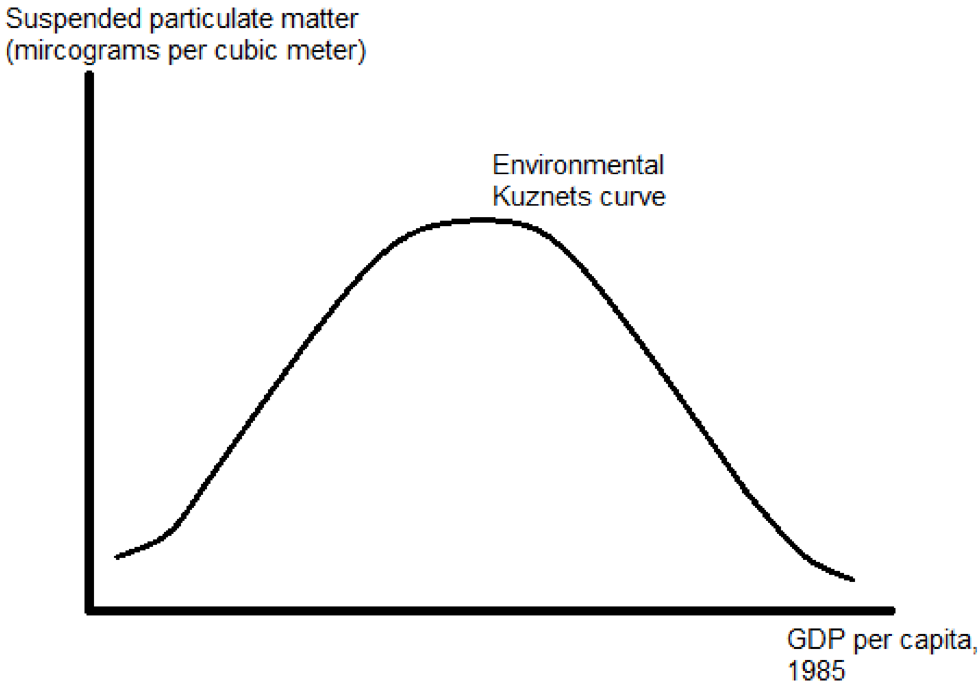
A clean environment is seen as a resource. When we pollute, this resource is used up. Pollution has both renewable and nonrenewable components.

A key difference between the environment and other resources is that there are no property rights involved in the environment. No one can claim the environment. This means that the tragedy of the commons is acute in this case.

Another important thing to note is that people suffering from pollution are not the same ones as the people who benefited from the activity that created pollution.

The relationship between pollution and economic growth is shown by the **environmental Kuznets curve.** This curve shows an inverted-U relationship between the level of economic development and the level of environmental pollution.

Economic development is measured by GDP per capita and environmental pollution is expressed as the suspended particulate matter.



A clean environment is seen as a luxury good; as people become wealthier and richer they are willing to spend more on the good. As a country becomes richer it is willing to pay more to get rid of pollution. In poor countries there are lower costs of pollution.

There is a difference in the value that rich and poor people place on pollution. Inhabitants of rich countries put a higher value on reducing pollution that people in poor countries. This is the result of higher wages leading to more money to spend for rich people.

The negative effects of additional units of pollution rise with the quantity of pollution that already exists in the environment. If a polluting industry is moved from a high-pollution country to a low-polluting country, the overall damage of pollution will be reduced.

This process of moving polluting industries has raise a debate in today's trade negotiations.

When pollution is a global problem then the reduced emission of a country will only lead to a very small benefit for the country.

Global warming is the rise in temperature of the atmosphere near the earth. In the period 1880-2010 the global temperature has risen.

Current global warming is a result of the accumulation in the atmosphere of greenhouse gases. These gases absorb thermal radiation coming from the earth that would otherwise dissipate into space. The most significant greenhouse gas is CO_2.

There is a significant, strong relationship between GDP per capita and CO_2 emission. Without a change in policy, economic growth in poor countries will lead to an acceleration of CO_2 emissions.

Global warming is an important worldwide concern because of its effects on economic activity, health and habitability. However, it is very difficult to reduce the process of global warming. Studies which calculate future emissions and temperatures are very uncertain.

It is also very difficult to determine what effect global warming will have on economic activity. Studies show that the most sever effects will be found in the tropics. This is because this area is already the hottest and it has many poor countries with no resources to adjust to changes in the climate.

Many argue that we have to control global warming. The most significant attempt to this has been the Kyoto protocol. This as an agreement signed in 1997 signed by most countries in the world. The protocol stated that developed countries should reduce their greenhouse emissions by an average of 7% below their level of 1990 by the year 2012.

Raising the price of emissions could encourage firms to find substitutes or look for low-emission technologies. A policy to accomplish this goal is a **carbon tax**. A carbon tax is a tax on CO_2 emission.