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# Pollution, Air

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The economy extracts natural resources from the environment to be used as inputs in production processes (the *source function* of the environment). The output of these production processes may be either produced inputs for yet other production processes or final products to be directly consumed. Yet these produced inputs and final products are not the entirety of the output; there are also residual by-products of these processes (waste).

Just as the economy extracts natural resources from the environment, the economy in turn dumps many residual by-products, or waste, back into the environment (the *sink function* of the environment). There is waste at each stage of the economic process: waste from extracting and refining natural resources, waste emanating from production processes, waste in the marketing of products, and waste in the sphere of consumption. Wastes may be solid, airborne, or waterborne. Air pollution describes airborne wastes that can harm the environment and human health due to their accumulation in the atmosphere, their concentration geo-spatially, and/or their synergistic effects when combining with other wastes.

There is an interesting relationship between the total natural resources utilized and the total waste produced by the economy. That is, they are ultimately equivalent. This is due to the first law of thermodynamics, which states that matter-energy can neither be created nor destroyed; only the form of matter-energy can change. Of course, it is more complicated than a simple equality. Natural resources are frozen in the form of capital goods during the depreciation process (and capital goods from previous periods are at differing stages in the depreciation process), and there is a time element in the consumption of many final products as well. At a fundamental level, however, the equality holds.

## RESOURCES AND POLLUTION

Some wastes are recyclable or reusable and others are not. The fact that all waste is not recyclable or reusable is due to the second law of thermodynamics, which states that any utilization of matter-energy decreases the total available matter-energy. In other words, some of the forms into which matter-energy is transformed can no longer be accessed. This is also known as the entropy law, and put differently means that not all the forms into which matter and energy are transformed are recyclable or reusable. That waste which is not recycled or reused is dumped into the environment.

The environment has an assimilative capacity, which is the ability of the environment to transform waste into harmless (or even beneficial) forms. This assimilative capacity, however, is not infinite. Waste at some level is not only incapable of being assimilated, but will damage or even destroy the assimilative capacity itself.

It is not simply the level of *homogeneous* waste in relation to the assimilative capacity that needs to be considered, but additionally what specific *types* of waste are being emitted. Some types of waste (e.g., mercury) are not assimilable in any

quantity, and at some stock level can result in various detrimental effects, including damage to the assimilative capacity itself. In addition, it is not sufficient to simply look at each type of waste and the quantity of it emitted in isolation, one must consider also its synergistic effects. The *combinations* of different forms of waste have effects that are more damaging than the sum of the component waste products independent of one another. A classic case here is sulfur dioxide and nitric oxide resulting in acid precipitation (acid rain, fog, and snow).

The qualities and quantities of waste globally along with spatial considerations concerning the local *concentration* of wastes are crucial. And it is not simply the case that the assimilative capacity detoxifies or degrades waste instantaneously, or even within some set time period. There are *cumulation* effects that have to be dealt with. So in assessing the ability of the assimilative capacity to deal with industrial and other waste, combination effects, concentration effects, and cumulation effects all need to be carefully considered.

Furthermore, nothing guarantees that all waste that is *capable* of being recycled or reused *is* being recycled or reused. All waste, whether recyclable or not, which is dumped into the environment, may impact on the assimilative capacity. Therefore, when considering the quantities and qualities of wastes confronting the assimilative capacity, only those residuals may be exempted that are *actually* recycled. Generally speaking, the technologies do not yet exist to capture and recycle airborne emissions.

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## EVOLUTION OF AIR POLLUTION REGULATION

In the United States, early air pollution laws were enacted locally in Chicago and Cincinnati. These were smoke control laws that addressed only smoke emissions from coal burning. Before 1948, there was almost no real government intervention in the environment, which means that there was, by default, a market approach to natural resource use and environmental protection.

An early recorded disaster resulting from air pollution occurred in Belgium in 1930. A thermal inversion occurred in an area characterized by concentrated industry with substantial amounts of sulfur dioxide emissions and discharges of particulate matter. Air circulation, which requires horizontal or vertical air currents, is one of the keys to the dispersal of air pollution. If there is no horizontal wind movement, then vertical air currents will usually disperse the pollutants due to the fact that atmospheric temperature is inversely related to height. The temperature falls by 5.4 degrees Fahrenheit every thousand feet above the Earth's surface. So normally, the warm polluted air, being lighter, will rise and disperse into the cooler air.

However, if the temperature decrease is less than 5.4 degrees Fahrenheit per thousand feet, warm air, unable to rise because of the existence of even warmer air above it, hovers over the source of the pollution, trapping concentrated pollutants in the lower stratum. This phenomenon is called thermal inversion.

The thermal inversion in Belgium in 1930 resulted in sixty-three deaths and five thousand people becoming seriously ill. A similar episode occurred in Donora, Pennsylvania, a small industrial town thirty miles south of Pittsburgh, in 1948. Twenty people died and six thousand became ill. Thermal inversion combined with pollution and fog killed four thousand and caused numerous respiratory illnesses in London in 1952.

In the United States, the Donora incident led to a greater awareness of the problem of air pollution, and eventually to the Air Pollution Act of 1955. Although this act did little more than authorize and provide limited funding for research, it served as the basis for future amendments to the Act. The Clean Air Act of 1963 authorized the Public Health Service to take corrective action in addressing problems of interstate air pollution, and 1965 amendments gave the federal program the authority to curb auto emissions. The first standards for motor vehicle emissions were applied in 1968.

The Air Quality Act of 1967 strengthened the powers of state and local as well as federal authorities to set and enforce standards on a regional basis. This paved the way for the Clean Air Act of 1970, which was the first legislation to call for uniform air quality standards based on geographic regions.

The newly created Environmental Protection Agency (EPA) was given the authority to enforce two sets of standards: primary and secondary. Primary air quality standards concern the minimum air quality necessary to keep people from getting ill. These standards are based on proven harmful effects of individual pollutants. Secondary standards are intended to promote the general public welfare and prevent damage to plants, animals, and property in general. Within each geographic region, states determine how these standards are to be met.

## MARKET APPROACHES TO AIR POLLUTION

Direct regulation or standards have been criticized on a number of grounds and have given rise to market approaches. Pollution taxes have been used, which it has been argued gives firms an incentive to reduce their emissions and is a lower cost method than command and control. The problem with such taxes or fees is identifying and calculating the social costs, and even if that is possible, there is no guarantee that they will reduce emissions to levels consistent with assimilative capacity.

These problems resulted in the market permits and emissions trading approach, which entails a market in pollution rights. The government makes some maximum allowable emissions standards, but then auctions off pollution permits to the highest bidders. Firms could purchase in the original market directly from the government or in secondary markets from other firms or individuals who purchased directly from the government, or in secondary markets themselves. Only after having acquired the *right to pollute* could a firm discharge polluting emissions. Here there is a tax incentive: The firm pays to reduce emissions and to seek ways of producing that pollute less, but the difference is that the total amount of pollution is fixed. In this sense, the market permit approach combines the strengths of both direct regulation and market approaches.

The market permits approach is not without its critics however. Many see the practice as government auctioning off clean air to the highest bidder. These issues are becoming particularly important as scientific evidence about problems such as global climate change becomes more reliable and available.

**SEE ALSO** *Externality ; Global Warming ; Greenhouse Effects ; Pollution ; Pollution, Noise ; Pollution, Water*

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*Mathew Forstater*

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