

Part I
Introduction

1 The Problem

Air and water have long been prototypes of free goods, available in unlimited quantities with no price attached to their use. The Rhine River, with its fairy tales and romantic songs, is an example. It has been used as a common property resource in a manner similar to the ozone layer and the oceans. Natural resources have been employed in economic activities without consideration of the long-run effects on the life-supporting systems of the planet or the potential losses to future generations. The joint outputs of consumption and production activities have not been factored into the calculation of the economic system. In short, the environment, as the set of natural conditions defining the human living space, has not been taken into consideration by economic theory.

Since the late 1960s and the early 1970s, we have become increasingly aware of environmental disruption. The environment has fallen from the paradise of free goods to the realm of scarcity:

Since the 1970s, the Los Angeles Times publishes a daily smog report in which the local level of pollution concentrations is noted, such as carbon monoxide and nitrogen oxide. Other newspapers have followed.

There was no oxygen in the atmosphere when the earth came into existence; rather, it took 3 billion years for oxygen to appear through the photosynthesis of slowly evolving plants. Today, the photosynthesis of phytoplankton in the oceans supplies about 70 percent of the oxygen demand of the earth. Scientists are concerned with pollution of the oceans.¹

Since the 1990s, natural scientists have been worried about the depletion of the ozone layer, the increased carbon dioxide concentration in the atmosphere, and global warming.²

Numerous experiments and epidemiological data suggest that there is a relationship between air and water pollution and a variety of illnesses.³

From the economist's point of view, the environment has become a scarce commodity. Scarcity means that competing uses exist for a given good and that

¹ National Oceanic and Atmospheric Administration (NOAA) of the United States (2002).

² See Stern 2007, Unep 2007.

³ On data compare Holgate (1999).

not all demands for its use can be satisfied. The environment is used as a public-consumption good, as a provider of natural resources, and as a receptacle of waste. Since the demand for different uses is greater than the supply, some of the competing uses have to be reduced or eliminated. The challenge is to determine which potential uses deserve priority.

Environmental use poses an allocation problem. That is the message of this book. In chapter 2, we study the basic structure of this allocation problem. In the past, the environment was used as a common-property resource at a zero price. This was especially true of its role as a receptacle of waste. This institutional setting of a zero price implies an overuse of the environment and a decline in environmental quality. It also causes private and social costs of production and consumption to diverge. Commodity prices do not indicate the true opportunity costs of economic activities, and so pollution-intensive activities become too large relative to an allocation optimum. Sector structure is distorted in favor of the pollution-intensive sector, and too many resources of production are attracted to the pollution-intensive sector. The solution to the environmental problem lies in reducing the divergence of private and social costs and introducing an institutional framework for market economies such that all costs of economic activities are attributed to the individual unit.

After introducing the economic dimension of the environmental problem in part I, we analyze its static allocation aspect in part II. Policy implementation is discussed in part III. The spatial aspect of the environmental problem including the international dimension is examined in part IV. Finally, in part V, we consider the intertemporal allocation problems including uncertainty.

Throughout the book, the same basic model is used. The underlying assumptions with respect to the production side are presented in chapter 3. Emissions are interpreted as joint products of output. Also it is assumed that factors of production are used for abatement. For simplicity, a two-sector model of the economy is considered. The transformation space, that is, the production possibilities with respect to private goods and the public-good environmental quality, is analyzed. It is shown that there is a tradeoff between the production of private goods and environmental quality. A higher environmental quality results in fewer private goods, and concomitantly, more private goods can be obtained only at the cost of a lower environmental quality.

In chapter 4, optimal environmental allocation is defined so that a frame of reference for environmental policy is established. The implications of the optimum are studied. We can indicate how the price mechanism has to be corrected in order to take into account environmental quality. We can specify how a shadow price for pollutants, that is, an emission tax, has to be set. Also we can show that if a correct emission tax is chosen, the optimum can be reached with a competitive equilibrium.

Chapter 5 focuses on the public-goods approach to the environmental problem. If environmental quality is a public good, property rights cannot be defined and government intervention becomes necessary. The problem arises as to how the government determines environmental quality. The social-welfare function, benefit-cost analysis, and the aggregation of individual preferences are studied

as alternative approaches. According to the Lindahl solution, a Pareto-optimal allocation of the environment requires individualized prices of environmental quality to be differentiated according to the individual's willingness to pay. The individual, however, can take the position of the free rider and not reveal his or her true preference. Therefore we have to investigate institutional arrangements which will reveal and aggregate individual preferences.

The property-rights approach described in chapter 6 represents the counterpoint to the public-goods discussion. If property rights can be adequately defined, optimal allocation will be attained through private decisions, and government intervention will be necessary only in order to define and secure property rights. In fact, it is conceivable that property rights could even be established through private bargaining without any government intervention. The Coase theorem (1960) shows that under specific conditions the allocation result is independent of the attribution of property rights. The salient point is that property rights must be assigned. It may not be feasible to make the free-rider problem disappear in determining optimal environmental quality by defining property rights, but in any case new property rights have to be set up for the use of the environment as a receptacle of waste.

In part II, the static allocation aspect is discussed from a theoretical point of view. In part III, policy aspects are studied. From a pragmatic standpoint, we may start from the assumption that environmental policy has set an environmental-quality target. The problem, then, is to determine how this target can be transformed to the emission behavior of the polluters. In chapter 7, we use the theoretical framework of our model to consider how producers react to an emission tax. First, we use partial equilibrium analysis for a given commodity price and for perfect competition. We also look into the question of whether a monopolist can shift the emission tax. Finally, we use a general equilibrium framework in which the emission tax also affects relative price and in which the demand side of the economy is taken into consideration. In chapter 8, we contrast regulation through permits, emission taxes, pollution licenses, the bubble concept, cost sharing, and liability as mechanisms for translating quality targets into individual behavior. The advantages and the disadvantages of different policy instruments are reviewed. In chapter 9, we develop the idea that the merit of a specific policy instrument depends on the casuistics of the environmental problem. Solid waste, emissions from mobile sources, environmental accidents, vintage damages, pollutants in consumption goods, and externalities in land use are considered.

In chapter 10, we study some issues of the political economy of environmental scarcity. The basic principles of a rational environmental policy are developed such as recognizing the opportunity costs, attributing them to the decentralized units, having a long-run orientation in preventing future damages, securing continuity in the policy approach, and not neglecting the interdependence among pollutants and among environmental media. We then discuss why these rational principles are not adhered to in environmental policy in the real world.

In part IV, we introduce the spatial dimension of the environmental system to our analysis. In reality, environmental systems are defined over space. We

may distinguish among global systems, such as the ozone layer; international environmental goods, such as the quality of the Mediterranean Sea; trans-frontier pollution systems, such as the international diffusion of acid rains; national environmental media and regional assets as subsystems of nations, such as the air region of a metropolitan area. In chapter 11, the interrelation between environmental endowment, competitiveness, and trade is highlighted. We look into the problem of how environmental abundance or scarcity affects comparative advantage, the terms of trade, and trade flows. Since environmental policy must be embedded in an international context, the trade repercussions of environmental policy are of utmost importance.

The issue of transfrontier pollution is studied in chapter 12. We look at institutional solutions for transnational spillovers and incentives to cope with free-rider behavior. How do a noncooperative and a cooperative solution differ? Can side payments help in bringing about a cooperative solution? Global environmental media are studied in chapter 13. In the past, they have been used as open access resources with no scarcity prices being charged for their use. The noncooperative and the cooperative solutions are analyzed. The role of side payments is discussed. Elements of a workable permit system are developed.

In chapter 14, regional environmental allocation is analyzed. Should all areas of a country strive for an identical environmental quality, or should the quality targets be differentiated among regions? Should policy instruments be uniform for a nation, or should they be different for different areas? What are the implications of an environmental policy that is established by autonomous regional authorities compared to a nationally formulated environmental policy?

In part V, the time and risk dimension of environmental allocation is examined. The environment will be used not only by the present generation but also by future generations. Pollutants such as DDT may accumulate over time so that future generations will inherit our stock of pollutants. Or, on the positive side, succeeding generations will enjoy the benefits of abatement capital and abatement technology which we have invented. In chapter 15, we determine the optimal intertemporal allocation of environmental use and its implications. The problem is to decide which stock of pollutants can be safely passed on to future generations if we take their well-being into consideration. In this context, the optimal time path of an emission tax is studied. In chapter 16, we deal with the problem of economic growth; here we are interested in the extent to which environmental quality targets may represent a brake on economic growth. Also the interrelationship between growth and natural resources is investigated. Finally, in chapter 17, we study the use of the environment in its different functions when damages in the future are uncertain. The implications of such a risk on the optimal environmental quality to be reached and on the policy instruments are discussed. Moreover, other problems relating to risk management such as irreversibilities and approaches to allocate the costs of risk reduction to the decentralized units of an economy are described.