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Chapter 5

**The Economic Evaluation
of Environment and Environmental Costs**

Preface

Economists usually apply the Theory of Social Costs to the analysis of the specific damage to the environment that results from the activity of human beings. Since the term 'social costs' in itself indicates that the effects on the environment of economic agents that work outside the market will be negative, we shall need, in order to analyze environmental disruption and ecological damage in greater detail, to clarify the exact character of these social costs and decide who should bear the burden that they impose.

In this chapter, we take up the issue of the occurrence of costs as they concern the environment and the burden of the cost that the related agencies should share. We deal as well with the issue of the economic evaluation of the environment, especially as it is related to the idea of sustainable development.

1 Social cost and social expense of environmental pollution

Social cost is not the same as social loss: the concept of social loss is simply concerned with value in use, while the concept of social cost is related to the value of what is lost and the price that must be paid for it (Yoshida, 1980: 121-135).

According to Ken-ichi Miyamoto, the social cost includes an absolute irreversible loss that cannot be compensated for after a problem has occurred. It is difficult to estimate such a loss in terms of a price (Miyamoto, 2007: 119).

William Kapp, the advocator of the notion of social cost, said that the term has two meanings: the first signifies the social loss itself and the second expresses the costs involved in efforts to prevent such occasions of social loss from occurring (Kapp, 1963).

Since this definition indicates that the prevention cost does not in itself involve social loss, Shun-ichi Teranishi sought to distinguish social cost from prevention cost by proposing the concept of "Social Expense" (Teranishi, 1984: 592-611). This contributed to the decision to impose costs on the potential polluter to encourage him to take prevention measures and compensation for any losses that might result from pollution.

Thus, when we seek to analyze the real nature of environmental disruption and damage, we must distinguish three separate strands of enquiry: the first, an analysis based on use value; the second, an analysis of the concept of price; the last, an analysis of the actual expense. We also need to consider the various

levels of damage suffered by the environment as the result of human activity (Teranishi, 1992).

Of these levels of damage, we note first those that are specific to certain particular occasions of regional pollution. In Japan, for instance, the Minamata disease, the Itai-itai disease and the Yokkaichi air pollution incident are typical cases of diseases that resulted from pollution and that caused extensive damage not only to human health but also to such regional properties as agricultural products and fisheries, while air pollution and the contamination of rivers is not confined to local areas but spreads widely and leads to a large-scale trans-boundary pollution.

The second level relates to the obstruction or loss of such amenities as sunlight and a view of the landscape, while the third has to deal with problems suffered by the natural ecosystem and the balance of biodiversity in forests, wetlands and un-reclaimed land.

As well as these three concerns, the problems of the global environment include the destruction of the ozone layer, which affects the whole globe and all who share it in common, air pollution and the consequent disturbances that lead to climate change.

When the problem of pollution is analyzed at the regional level from the viewpoint of the theory of social loss, we need, first of all, to decide what social loss actually amounts to. What this requirement entails is that the causes should be made perfectly clear, while at the same time we need to consider the methods of compensation, reconstruction, reproduction and prevention. We should consider these methods from the standpoint of their value in use, not from that of the price. Our discussion in Chapter 3 of the notion of "capability-deprivation" reflects such a viewpoint.

After this, we need to analyze the state of social loss, and only then, on the basis of our findings, should we evaluate social loss in terms of the price.

If we consider the issue in terms of the concept of cost, we shall judge compensation and the reconstruction of damaged property as part of the negative cost, whereas the prevention cost will fall under the heading of positive cost (Teranishi, 1997: 4-5).

While the term "positive cost" embraces the broader meaning of cost, the present book speaks of this cost as an "expense", which enables us to distinguish between the negative cost and the positive cost. When the polluter cannot bear the burden of the negative cost, he attempts to transfer his responsibility to other economic agents. The polluter tries to internalize the positive cost by saving resources or by reducing waste, which, for the purposes of rationalization, he converts into an investment. As an "expense" on the

side of the positive cost, the polluter partially makes use of subsidies and advantageous tax rebates.

What is important to notice here, however, is that while the negative cost is obviously not the same thing as the positive cost, they are nonetheless closely related. If we can establish a system and impose strict rules for the payment of the negative cost with regard to damage compensation and environmental reconstruction, this will act as a strong incentive for the polluter to think more seriously about the importance of prevention, which will involve him in positive costs.

On the basis of a discussion of the theories of social loss and social cost, we shall then need to examine the actual expenses that are incurred by damage to the environment.

2 Classification of social cost and social expenses

Teranishi classifies social expense incurred by damage to the environment according to three categories: the expense for restoration work, the expense required for the prevention of any recurrence of damage, and the expense for negotiation and legal disputes in court. These classifications are based on criteria laid down for compensation of generated pollution damage and damage reduction (Teranishi, 1997: 2-8).

The damage compensation

We need to take up first the issue of damage to the human body and dangers to human life, as well as cases of damage to property. Concrete examples of compensation include compensation for damage to health (direct compensation, care costs, medical expenses) and compensation for damage to agricultural products and to fisheries. This includes compensation for damage to the farms themselves, for when farmland is contaminated, crops cannot be grown.

When a compensation system for victims has been set up, they should be able to appear in public; but it all depends on the system design. To establish this design, we shall need the regime-actor analysis that we discussed in the previous chapter.

Nevertheless, financial compensation has its limitations: mental care, a genuine apology and the restoration of social relations are no less indispensable.

For example, in the Minamata case, compensation was allocated as follows: 4,800 million JPY(\$48 million) for fishery compensation; by the end

of March, 2000, 125,500 million JPY(\$1255 million) for two officially recognized victim patients (consolation money, medical costs, care costs and so on); 56 billion JPY(\$560 million) for non-recognized patients' relief (24,500 million JPY for medical operating expenditure, 31,700 million JPY for compensation for 10353 patients who were reconciled with the government in 1995); 49,700 million JPY(\$497 million) for the prevention of environmental pollution (mercury, sludge disposal); 12,600 million JPY (\$ 126 million) for regional restoration. In this way, a total of at least 250 billion JPY(\$2.5 billion) has been spent on compensation (Yokemoto 2007).

The reduction of environmental damage

A certain amount of expenditure is allocated for measures to reduce the extent of damage that has actually been generated: these include the construction of dykes to prevent floods caused by rising sea levels, the equipping of houses situated around an airport with soundproofing as a countermeasure against intolerable noise.

Restoration

Measures to restore the environment include the removal of cadmium from contaminated farmland, the removal of sludge polluted by mercury, and the restoration of land contaminated by organic chlorine solvent and radioactivity.

When environmental destruction is irreversible and reconstruction is impossible, we should consider compensatory funding. This does not call for simple restoration, since we have to consider how to restore the social value of contaminated land. This is a subject of degree: the degree of necessary purification; the degree of polluter's responsibility. A number of other countries besides Japan are addressing this issue (see Chapter 7).

Prevention

Preventative expenditure pays for anti-pollution measures that can be applied to an identified source of contamination to ensure that the contamination does not occur over and over again.

One example of this is the technological development of apparatus for smoke desulfurization and end-of-pipe technology for the treatment of liquid waste, while the development of cleaner production processes contributes to the saving of energy for materials already in use. Since this technology enables the user to make a profit, the prevention cost cannot be counted as a social loss.

Transaction costs and administrative costs

The US Superfund was designed to pay for the purification of contaminated land, whereby the percentage of the cost of negotiation and disputes over who should bear the burden ought to be almost the same as the cost of the restoration of the land. In addition, the fund provides for such administrative costs as the monitoring of the steps taken during the decontamination process.

This cost occurs in accordance with the institutional design to determine the proportion of responsibility and to decide how social disputes are to be settled. And, as Kapp explained many years ago, we are thus led to the conclusion that in order to reveal their origin the study of social costs must always be an institutional analysis (Kapp, 1963: 186).

We shall here take the Itai-itai disease as our example and look at the numerical value of the social cost. The Itai-itai disease is well known as one of the four major instances in Japan of serious damage to human health due to the contamination of public land and water. In medical terms, this disease is known as osteomalacia, an exceptionally painful softening of the bones due to kidney damage by cadmium and consequent decalcification. The Itai-itai disease first broke out in the basin of the Jinzu River in Toyama Prefecture around 1900, and reached its peak during World War II.

Ultimately, the government recognized 195 patients (six current survivors) as direct victims, while 404 required observation (one current survivor). They were all women who had borne children and were more than 40 years old, two of the conditions that render women susceptible to the development of osteomalacia. Rice and drinking water polluted by wastewater from Mitsui Mining & Smelting Kamioka Mining industry, which lies 50km upstream of the victims' village, had affected their kidneys, resulting in a loss of calcium, a condition that may cause osteoporosis, extremely painful fracturing of the bones. While not all patients manifested signs of osteomalacia, the Itai-itai disease, many of them suffered from proteinuria, a condition that is caused by defective kidney function, brought on by cadmium poisoning.

The causes and conditions of Itai-itai disease can be characterized as follows:

- [1] The pollution of the environment and consequent damage to human health as a result of the entry of heavy metal (cadmium) through contaminated soil and water into the people's food supplies.
- [2] The site of the environmental pollution (in the soil and water) was that of the residential area where the people's health was damaged, while the health of people affected began to worsen at the same time.

- [3] In Japan, metal pollution is typically caused by the mining industry; in Japanese history, public pollution [kogai in Japanese] indicates metal pollution [also kogai in Japanese].
- [4] Cutting down on costs needed to protect the environment and a lack of appropriate technologies led to an increase in levels of pollution. In particular, the technology used for the crushing of minerals discharged a massive amount of cadmium into the river.
- [5] Indifference on the part of the company to the effects of their activities and to any damage that might result from them.

In the case of the Itai-itai disease, the patients brought a suit for compensation for the damage that they had suffered and in 1972 they won their suit. What followed — and we wish to emphasize this here — is that the agreed-on countermeasures to cope with generated pollution and the restoration of polluted farmland that were reached after that court case of 1972 to prevent similar occasions of pollution have now been in operation for more than 40 years, and that these days the water quality of the Jintu River has greatly improved; indeed, it has nearly returned to its former natural state (see Chapter 7).

Yet when we look at the payments made by the polluter, Mitsui Mining & Smelting, we find the company's reduction of the original agreed-upon sums to be remarkable: [1] Itai-itai disease compensation (8 billion JPY=\$80 million); [2] land restoration (13 billion JPY=\$130 million), [3] compensation for reduced rice crop income (12 billion JPY=\$120 million), [4] countermeasures against already generated pollution (20 billion JPY=\$200 million). These reductions are due to the company's strategy of minimizing the area to which they are applied and the company's ability to avoid taking responsibility for what they had done.

At present, Japan has few nonferrous metal mines apart from those run by its refineries, and a great deal of its metal resources depend on imports from Asia and South America, whose countermeasure policies with regard to metal pollution are neither the same as nor as stringent as those adopted by Japan. Even so, while Japan's cleaning and restoration of land contaminated by metal may be better than that of some of its suppliers, its restoration practices remain imperfect, and rice that does not meet the criteria set by WHO's cadmium limitation policy has been appearing in the shops time and time again. Japanese people living in urban areas, especially the elderly, have as much as ten times more cadmium in their kidneys as citizens of other countries. We should take note, therefore, that the Itai-itai disease is not simply a local

problem, and we should do far more than we have done to cleanse contaminated land and restore it to its former unpolluted state.

Nearly 40 years have passed since Hirobumi Uzawa published his work on the social cost of automobiles (Uzawa, 1974). Since then, more studies have appeared, and it is now generally recognized that traffic accidents and greenhouse gases emissions, air pollution, noise and vibration are all equally negative aspects of automobile use.

Naomi Kamioka has reviewed these previously conducted studies of the damage caused by automobiles and at present is himself carrying out research into the minimum value that can be shown by the numerical value. He believes that currently the user bears only one-third of the social cost and that the non-burden cost is equivalent to 100 JPY for every 1km traveled by the automobile. Users pass on their responsibility to the next generation. They indirectly alter the climate and damage the health of others to whom they often cause physical and mental distress while handing over their responsibilities to the tax authorities and the health insurance companies. Kamioka's analysis shows that those who use and misuse automobiles make up their deficits by depending indirectly on tax revenue. If such a great quantity of tax revenue needs to be spent on cleaning up after the automobile, as indeed is the case, then users should pay much more so that in urban areas the non-user can take a bus free of charge while the misery of traffic jams can be easily avoided. This is the blue print for public transportation reform (Kamioka, 2002: 109, 127).

3 The principle of payment and institutional design

As for any payments that may be required to cope with environmental pollution, the questions one asks are of what kinds of cost should be borne, who should bear them, and how much they should amount to. That is to say, these are problems of principle about payment and the design of the system that will assess the payment structure.

The following three questions are considered to be the criteria we must consider when investigating the principle of payment.

- [1] Is it possible to reduce levels of pollution and improve the environment?
- [2] Does the system meet the criteria of a fair society and the needs of social justice?
- [3] Is the system likely to be economically efficient in the long run?

3-1 Principle of Pigouvian tax

Pigouvian tax

A market failure can give rise to an environmental problem. To internalize the cost incurred by the external problem, the economist A. C. Pigou proposed that a tax should be imposed on the cause of the external problem. Consequently, this is known as the Pigouvian tax.

The amount of Pigouvian tax is determined as follows. Consider a case where the social marginal cost and the private marginal cost are estranged. A Pigouvian tax is a tax on the difference between the social marginal cost and the private marginal cost at the optimal level of production, $E^*E' = t$, so as to equate the private marginal cost with the social marginal cost, to raise the market price with tax from p^m to p^* , and to restrain the production amount from q^m to the optimal level q^* (Ueta, 1996: 119).

Pigou takes the example of the social cost (forest fires from sparks emitted by railway trains) and the private cost (the transportation costs of running railway trains). To minimize the harmful effects of an excessive service, we impose a tax on the service. As an example of external diseconomy and taxation, Pigou cites carbon dioxide and garbage as a diseconomy and the levy imposed on carbon dioxide and garbage as the taxation response. It is the environmental tax that minimizes the effect of the emission of those "bad agents" that have added a burden to the environment. The environmental tax is expected to reduce the occurrence of such a diseconomy. Although many people think that the tax is to be used to improve the environment, that view is a misunderstanding: it is a tax on the external causes of whatever damage has been done to the environment to be paid for by the instigator of the damage.

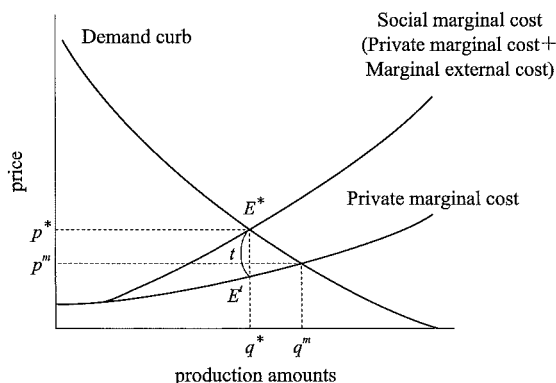


Figure 5-1 Image of Pigouvian tax (Field, 1994: Figure 4-3 modified).

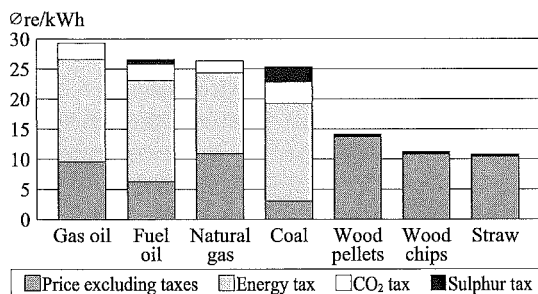


Figure 5-2 Fuel prices in Denmark.

To assist our understanding of how a Pigouvian Tax works, a good example is Denmark's introduction of an energy tax, a CO₂ tax and a sulphur tax. Without tax, the prices of such forms of renewable energy as wood chip and straw are higher than those of fossil fuels such as coal, gas oil and heavy oil, which emit more CO₂. By introducing a tax, the relative prices of renewable energy like wood chip will therefore become lower than that of coal.

When we impose a tax on the difference between the social cost and the private cost, the social cost will internalize the cost of coping with the problems that have been caused by external agents and pressures. The Pivian Principle suggests that the focus does not exist in a use value that impairs its usability but in the price itself. But Pivian's principle does not make clear which type of expenditure is included in the cost of any previous damage compensation paid to the transaction cost.

The present interpretation of the Pigouvian taxation principle takes it that emissions are determined at the intersection of the social marginal reduction cost curve and the social marginal damage cost curve, where optimum pollution level is achieved. Part of the damage compensation and part of the prevention expenditure are included, but the irreversible absolute loss is not guaranteed.

The Pigouvian tax aims at prior price revision. As a matter of fact, the costs of reconstruction are not included. Coase's theorem, which we discuss next, is, like the PPP of OECD, a type of the Pigou Principle of taxation.

Coase's theorem

Coase's theorem states that if a rule of damage compensation responsibility were to exist, the minimization of social cost could be achieved regardless of which side is judged to bear the responsibility. The important point of

Coase's theorem is that it doesn't matter whether the environmental rights are judged to belong to the victim or to the polluter. At the point where the final social efficient distribution can be achieved, it really makes no difference.

It thus seems that the possession of rights will affect the next transaction, and it is assumed that resource distribution will achieve the desired effect. But the point of Coase's theorem that has attracted people's attention is that the possession of rights does not relate to optimum distribution (Kuriyama and Manaki, 2008: 89).

What we have to take note of, however, are the assumptions and conditions of this theorem. Although Coase sets out to criticize Pigou's theorem, his own theorem takes Pigou's theorem for granted, and he therefore suggests that the focus of his theorem does not consist of the use value but resides in the price. The aim of the economics is for transactions to attain their maximal social value.

Consequently, the question to be decided is whether, for example, the value of fish lost is greater or less than the value of the products that the contamination of the stream has made possible (Coase, 1960: 2). For Coase, it all comes down to a question of weighing up the gains that would accrue from eliminating these harmful effects against the gains that accrue from allowing them to continue (Coase, 1960: 26). He looks at this subject solely from the viewpoint that the lost value can be compensated for in monetary terms; he pays no attention to the irreversible loss.

The second thing that we should like to say about Coase's theorem is that it can only be applied in the case where the correct distribution is clearly defined, and where the negotiations are conducted without any disagreement: in short, that the transaction cost is zero. In reality, however, these conditions can never actually obtain.

Significantly, Coase's theorem also assumes that if the transaction cost is recognized, the distribution rights will affect the result of the resource distribution. In short, Coase's theorem consists of two central propositions: "compensation in terms of the price" and "the transaction cost". Coase's theorem is only really applicable in cases where the right is clearly defined and negotiation is easy, as it is, for example, in eastern Hokkaido, where the dairy farms and the fishing industry cooperate to their mutual benefit over the treatment of waste-water.

We shall now compare the relative efficiency of the Pigouvian tax with that of Coase's theorem. Suppose that there are two persons, A and B. A is a victim and B is a polluter. The horizontal axis indicates the amount of emission, while the vertical axis indicates the amount of cost. The marginal

damage curve (MD) is upward sloping, while the marginal reduction cost curve (MC) is downward sloping. MD and MC cross at x^* and p^* . What Coase's theorem sets out to show is that in the case where the victim A has the right for p^* , the damage compensation will be guaranteed until x^* . In the case where the polluter B has the right for p^* , the damage compensation will also be guaranteed until x^* .

There will, indeed, be damage costs and reduction costs, but they will be offset because of the existence of compensation in price. We should notice a contrast between the two cases over the amount of pollution: in the case of the Pigouvian tax, p^* is imposed only on polluter B, whereupon B reduces the production to x^* . When the marginal reduction cost exceeds p^* , the emission is allowed to continue by paying p^* . In this way we can achieve the same result from both Coase's theorem and the Pigouvian tax, provided, of course, that the initial conditions are equal.

Coase's solution can be interpreted as an improvement where direct negotiations are undertaken, while the solution provided by Pigouvian tax method is more suitable for cases where the transaction cost is expensive owing to a market failure (Shibata, 2002: 158).

We must point out, however, that Coase requires that various kinds of condition should be satisfied, such as the existence of ownership and the nonexistence of transaction costs and asymmetric information. Moreover, the marginal damage cost curve (MD) and marginal reduction cost curve (MC) need greater clarification.

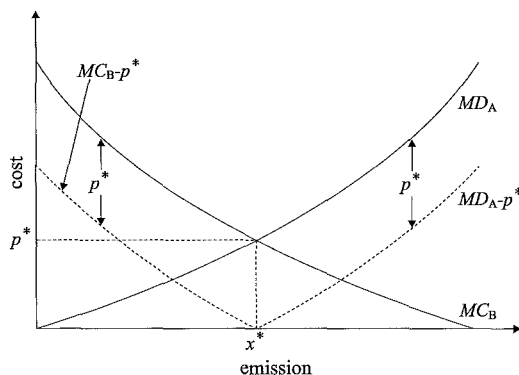


Figure 5-3 The Pigouvian Tax and Coase's theorem (Kolstad, 1999: Figure 7-2 modified).

The PPP of the OECD

The well-known principle that the original polluter must pay to clean up the mess — the PPP of the OECD (the Polluter Pays Principle) — states that a cost should be imposed to pay for damage prevention and to control equipment. Yet while the spirit of PPP does not rule out compensation for damage, the polluter is not obliged to pay compensation and does not therefore bear the total cost of the pollution (OECD, 1975).

The PPP of the OECD aims to sustain reasonable distribution while improving the balance of international trade, and, on this basis, it collects the optimum surcharge as the means to prevent pollution, but it does not impose compensation except where the damage is excessive. Nor does it investigate whether the PPP is to be applied to the whole of the damage relief or to any restoration of the environment (Miyamoto, 2007: 236). We can therefore say the PPP aims at a “certain level of prevention”, and treats compensation and restoration work as exceptions.

Although Beckerman says that “... the marginal damage to the victims cannot exceed how much it would cost them to avoid the damage, otherwise they would already have avoided it” (Beckerman, 1975: 50), we must surely take into account the nature of the damage, how and where it occurred, since people are bound to be ignorant of what it would have cost to prevent the damage in the first place, even if they could have foreseen it.

What we have to understand about the PPP is that it established the principle that the primary polluter pays; but it does not care whether this cost adds to the consumer's burden in the form of a price increase or is internalized by reducing the production cost. We should not, therefore, overestimate the PPP as a payment principle.

3-2 The payment capacity principle

This principle proposes that polluters who have the capacity to pay for the damage they cause should be required to bear the cost. The principle accepts, however, that when a polluter who is asked for urgent payment is unable to bear the cost of the damage then some other agency should provide financial support.

This principle would, for instance, justify the financial aid afforded by Japan to the former Soviet Union for the dismantling of old Soviet nuclear submarines. Yet should this state of affairs continue for a long time, it is highly probable that the polluter will not be motivated to reduce the pollution on his own initiative.

3-3 The benefit principle

This principle proposes that people who receive a benefit from an expense should be required to bear part of the cost. This principle is especially suitable for cases of positive cost. It implies that the parties who receive a benefit from environmental conservation are required to bear the cost of it jointly with other agencies (see the "forest environmental tax").

3-4 The responsibility principle

Japan has its own PPP — a combination of "the principle of the potentially responsible party" and "the joint compensation system" — which states that the party who is responsible for the expense incurred by pollution is required to bear the cost (Teranishi and Yokemoto, 2006b: 217). At the same time, the charge levied to pay for the 'environment volunteer' (a person who volunteers to work at some environmental task) will be a civic initiative charge and will be recognized as a volunteer responsibility: this is related to the commitment of Agency, an idea of Sen's that we looked at in Chapter 3 (Yokemoto, 2007: 1920).

Japan's "PPP"

Whereas the PPP of the OECD states that its intention is not to internalize all pollution costs, the Japanese government's interpretation of "the rule of the polluter's payment" is a much broader one, one that involves the search for legal responsibility. It therefore includes both "the cost of environmental restoration to prevent accumulative pollution" and "the costs for victim relief".

Chapter 3 of Japan's "White Paper on the Environment (1975)" commented on the PPP as follows: "There are many costs for environmental protection, such as construction and maintenance costs for anti-pollution facilities, recovery costs, costs for compensation, prevention costs, and administrative costs".

While the PPP of the OECD is usually applied only in cases of costs for anti-pollution facilities, in Japan polluters have to take responsibility for restoration and recovery costs and any costs that are imposed for compensation. (Environmental Agency, 1975: Chapter 3, "The charge of environmental conservation", 74.)

The pollution-related Health Damage Compensation Law of 1970 and the Anti-pollution Company Sharing Law of 1970 arose from this principle, and the Japanese PPP includes damage compensation, damage reduction, restoration, reconstruction and prevention. It also includes the administrative costs of the Environment Agency itself, as well as the monitoring costs and the budget of local governments. This was the first time in the world that the

range of the PPP was opened up in this way.

Yet the rule of the PPP has not always been fully carried through and these two laws in particular are sometimes modified in the process of its application. Instead, various subsidies are paid to the polluter. And, in 1988, the pollution-related Health Damage Compensation Law cancelled the recognition of new patients because air pollution had decreased and the air quality had improved. But since 2007, however, with the reconciliation of the Tokyo air pollution suit, a system has been established throughout the whole metropolitan area of Tokyo to support the medical costs of patients who are suffering from asthma; and it was decided that the costs should be borne by the Tokyo metropolitan government, the Japanese government, the automobile companies and the Metropolitan expressway. The burden of 6 billion JPY(\$60 million) provided by the government comes from the pollution health damage fund, but of the 51 billion JPY(\$510 million) of the fund balance, the bulk of the remaining 45 billion JPY(\$450 million) is given by private enterprises and by the auto-makers.

This supposes that a system that involves the country as a whole — local governments, automakers, fuel-makers and auto-users — will combine to carry the burden of relieving the victims of air pollution, but since the medical costs relief system has the character of social security, the public burden ratio will grow greater than that of the victim relief system, which has the character of civic reliability.

The principle of the potentially responsible party

This principle stipulates that when a polluter is hard to locate or has no financial capacity, the landholder and the appropriate financial institution will endeavor to find the responsible party and require him to pay.

In 1980, the US established the Superfund, which determines the responsibility for the restoration costs and can require the polluter to cleanup, but that when the Environmental Protection Agency (EPA) has to carry out the cleanup, the cost is paid for by the Superfund. The Superfund can later compel the polluter to pay the costs.

The chief characteristics of the system are as follows:

- [i] Under the terms of strict liability, the polluter will be held responsible for the pollution regardless of intention or accidental fault.
- [ii] Under the terms of joint liability, the polluter will be held responsible for the pollution, regardless of what kind of contribution the polluter made to the outcome.

- [iii] The current landowner as well as the previous landowner will be asked to take their share of the responsibility.
- [iv] Since those with responsibility for the pollution cover a wide range, the financial institution that financed the polluter also runs the potential risk of being asked to take some share of the responsibility.

This system leads to a number of problems: it entrusts the compensation to the decision of an individual civil trial, and because the responsibility for the restoration and the burden of the cost is focused, the court case frequently becomes a debate between the potentially responsible parties themselves, as well as a further contest between the potentially responsible parties on the one hand and the Environmental Protection Agency on the other, so that consequently the costs of the trial mount up and become huge, with the result that the cleanup is late.

One effective outcome, however, is that the company that causes the pollution has to pay for compensation and cleanup. The Netherlands and Germany specify a hierarchy of those responsible and establish the condition of the relationships between the parties, and we in Japan need to do the same. Yet even when the identity of a potentially responsible party has been established, detailed investigation is still required to provide the incentive to treat the land so as to reduce the pollution damage, and this will also result in an increase in transaction costs.

The joint compensation system

An EC green paper (1993) submitted that when no specific party can be determined and the range of the pollution is not clear, the civil liability system is not effective. A more effective answer in this case is the joint compensation system, which is supported by an ante from the specific industry. The principle of the joint compensation system combines the realms of private and public responsibility.

When, in 1997, the Russian tanker *Nakhodka* discharged oil into the Sea of Japan, the payment made by the International Oil Pollution Compensation Funds (IOPC Fund) was an example of the workings of the joint compensation system. Since the fund is kept well stocked, it can cope with emergencies quickly and can provide compensation where an individual is unable to provide the full cost.

Yet various problems inevitably remain over who contributes to the fund and who exactly operates it, as well as how to decide on the level of the cleanup and how to prevent the possible opportunities for acts of "moral

hazard", those calculated risks that people may take knowing them to be in some way unethical or dangerous.

In the case of the Nakhodka, the ship's owner and the IOPC Fund were asked to pay 36 billion JPY(\$3.6 billion) and agreed that they would pay 26100 million JPY(\$ 261 million). It is worth noting, however, that Japan paid 6 billion JPY(\$0.6 billion) out of its IOPC Fund.

3-5 Public expenditures

When public money is expended on environmental conservation, the public must be informed of what is being done and their cooperation must be sought. Since the range of today's environmental infrastructure has been enlarged to take in both the sewage system and public parkland, we need to examine them as public works projects.

Yet while the cleanup of the environment is supposed to go hand in hand with the construction of the infrastructure, the Anti-pollution Company Sharing Law actually enables this public expenditure to be used as a means to reduce the polluter's burden.

When the cleanup of the environment is financed by public funds, this increases the danger that the polluter may take unscrupulous risks (the issue of "moral hazard") and it reduces the polluters' incentives to manage environmental conservation in an honest way. This is similar to the situation of the financial market in which banks rely on the safety net of deposit insurance. Yet just as should be the case with the financial market, the recognition of responsibility and the disclosure of information about who is guilty of the pollution ought ideally to lead at the same time to the improvement of the polluter's management.

Things are ordered better in the US, where, under the terms of the "Superfund Act" and the "Resource Conservation and Recovery Act" funds are promptly provided for cleanup of pollution, while the search for the polluter proceeds simultaneously.

Since 50% or so of the new apartment buildings in Japan are located on old factory sites, the Soil Contamination Countermeasures Act, which came into force in 2003, requires preliminary investigation of the site. The new act divides a polluted area into an "area requiring cleanup" and an "area not requiring cleanup". In reality, most of polluted areas fall into the latter category and cleanup is not required unless the ground water is to be used for drinking. Critics of the act say that it will simply increase the area designated as polluted, while likely to reduce the area to be cleaned up.

However, the new accounting standards, which were due to be introduced

in March 2011, require that on evaluating the assets of designated sites the costs of the cleaning up of such hazards as Asbestos, PCBs and other land pollutions should be carefully calculated.

Let us, to conclude the present chapter, consider the responsibility of the government in all of this. In cases where state owned companies are the direct polluter, it is obvious that the government has prime responsibility for the pollution. It is more difficult, however, to assess the government's responsibility in such cases as the Minamata disease. That is to say, in cases where the government neglects the victims while failing to stop the expansion of pollution, how are we to specify the extent to which the government bears responsibility for the outcome?

The judgment handed down by the Supreme Court of 2004 in the "Minamata Disease Kansai Lawsuit" acknowledged the responsibility of both national and prefectural governments, and thus supported the judgment already delivered by the Osaka High Court. The Supreme Court judged that Kumamoto Prefecture's failure to exercise its authority for prefectural regulation of fisheries and the national government's failure to exercise its authority over two laws concerning water quality control was a violation of the State Redress Act article 1 paragraph 1. The Supreme Court therefore concluded that after January 1960 both prefectural and national governments had a responsibility to compensate victims who had suffered from the Minamata disease.

This suggests that we need a new compensation policy that will take into account the responsibility of the government. One way would be to establish a fund for Minamata victims with investments not only from such major polluters as Chisso and the Japan Chemical Industry Association but also from both national and prefectural governments: that is, no matter what kind of policy is introduced, we need to add to it the responsibility of governments whose job it is to oversee the polluters.

In the case of asbestos and its lethal effects, the scandal is that the government "knew of" the damages and "could have taken" measures, but "did nothing" for a long time (Center for Mesothelioma, Pneumoconiosis and Asbestos, 2009). It has been said that a 100 thousand people will be dying of asbestos poisoning in 40 years' time.

4 An Economic Evaluation of the Environment

There are many ways to evaluate such types of environmental damage as the depreciation and deterioration of the environment due to the inappropriate usage of natural resources. One of these ways is based on a utilitarian point of view and evaluates the damage as if it could be traded in the market. We call this the "Imputed Environmental Cost".

This approach includes the Contingent Valuation Method (CVM), the Maintenance Valuation Method and the User-Cost Method. In this chapter, we shall for the moment only discuss the CVM and offer a cost-benefit analysis. The reader interested in other methods of economic evaluation of the environment should please consult Table 5-2.

4-1 The Contingent Valuation Method (CVM)

Before we can discuss sustainable development, we have to confirm how we are to measure and evaluate the two apparently contradictory concepts, "development" and "protection".

The Contingent Valuation Method (CVM) is a method that asks people directly about their Willingness to Pay (WTP) or Willingness to Accept Compensation (WTA), and, in this respect, WTP and WTA are closely related to the ideas such as the Compensating Surplus and the Equivalent Surplus.

We should be careful when choosing either WTP or WTA, because they are deeply dependent upon the economic structure current at the time when we have to make a choice between them.

The reason why CVM is now widely accepted is that CVM is a method that can evaluate the passive value of the ecological condition of the environment. The CVM has been especially employed in the US, thanks to that country's democratic traditions and reliance on the market economy. The

Table 5-1 WTP and WTA (Kuriyama and Managi 2008: 149).

	Environment improvement	Environment degradation
WTP	Maximum amount of money of willingness to pay for the improvement of environment	Maximum amount of money of willingness to pay for the stop environment degradation
WTA	Minimum amount of money of acceptance for the stopping of environmental degradation	Minimum amount of money of willingness to accept for environmental degradation

Table 5-2 Typical "Economic Evaluation of the Environment"
(Kuriyama, 2003: 68).

Classification	Revealed preference	Revealed preference	Expressed valuation	Expressed valuation
Method	Travel-cost	Hedonic	CVM	Conjoint
Contents	Demand model number of trips a recreationist takes	Evaluation based on the rent and wages environment impacts	Questionnaire on WTP, WTA on environmental change	Preference of multiple option of environmental policy
Application	Recreation, Tourism,	Amenity, water quality, noise	Use value and Non-use value	Use value and Non-use value
Merits	Required information is small	Information cost is small	Range of application is wide	Evaluation on each attribution
Problems	Application is limited to recreation	Limited to regional Affected by multicollinearity	Cost for information is high, affected by bias	Cost for information is high, affected by bias

method is now being gradually accepted in Japan, where it is used to evaluate the validity of public investments.

Even given the usefulness of CVM, however, we still need to focus on the implications of its theoretical aspects. Amartya Sen has already pointed out that owing to the difference between private goods and environmental goods the use of Compensating Surplus and Equivalent Surplus in CVM does not guarantee "Independence of Choice" (Sen, 1995). That is to say, we cannot ignore the choices of others when we try to evaluate environmental goods. The point that Sen wished to stress is closely related to the problems of the CVM, and that different person with different aims can interpret WTP and WTA in widely different and subjective ways.

Moreover, the evaluation depends to a tremendous degree on the individual distribution of endowment, income and power. Since a number of empirical studies also doubt the validity of WTP, we should not use WTP as a target index of "Sustainability" (Faucheux, 1997).

Teranishi is another critic who has wondered what CVM can actually achieve (Teranishi, 1999: 35-40). He claims that it is doubtful whether we can apply CVM to damage that we cannot evaluate in monetary terms. He also claims that the meanings assigned to CVM's related costs such as "substitution costs", "recovery costs" and "maintenance costs" are too vague to be truly useful.

Table 5-3 Summary Table of CBA and MCM (Janssen and Munda, 1999: 837-852).

	Cost benefit analysis	Multi-criteria method
Rational hypothesis	Maximization of economic efficiency	Evaluation of preference of decision maker, based on multi-criteria
Information	Environmental evaluation is necessary	Qualitative and quantitative analysis
Preference	Based on market	Based on preference of decision maker
Sustainability	Substitution of natural capital and artificial capital	Applicable to weak sustainability and strong sustainability

4-2 Cost Benefit Analysis

Cost Benefit Analysis (CBA) is a method that evaluates the costs and benefits of a policy or project preparatory to any final decision-making. CBA is not, of course, the only method for decision-making: there are, for example, the Multi-criteria method (MCM), the Environmental Impact Assessment (EIA), and the referendum.

Although MCM can estimate the weight of alternatives, it lacks a proper theoretical background, whereas CBA, by contrast, is supported by the theories of welfare economics. While a referendum cannot be reduced to a matter of individual choices between alternatives, it may reflect degrees of preference. Table 5-3 is a summary of the difference between CBA and MCM.

Hanley (1999: 824-836) summarizes the procedural conditions that the CBA has chosen to adopt: the CBA seeks to

- [i] Define a project or policy and specify beneficiaries
- [ii] Grasp the impact likely to be felt from the project
- [iii] Evaluate costs and benefits in monetary term, estimate producer surplus and consumer surplus, and estimate the WTP should the project be related to public goods.
- [iv] Offer a discount of costs and benefits, along with a present monetary evaluation of costs and benefits.

In accord with the compensation principle, the CBA supports projects of which the aggregated benefits exceed the aggregated costs; the project enables

Pareto improvement through monetary transfer.

Although the CBA assumes 1), that the social welfare function weights individual benefit and loss equally, and 2), that the benefit and the loss are inter-temporally transferable, this is not always so: projects and policies sometimes cause effects that are irreversible, and this irreversibility may violate the original assumptions made by the CBA.

And, again, since the effects that result from a project are complex and uncertain, and because such uncertainty means that we cannot deduce information that is any more than merely probable, then the CBA amounts to no more than a sensitivity analysis or a scenario analysis. That is to say, it can only make statements that are probabilistic.

Moreover, even if the inter-temporal discount in a CBA can be justified in the sense of its inter-temporal efficiency, it cannot be justified in the sense of its inter-temporal fairness. The choice of an inter-temporal discount greatly affects the results of the CBA.

In the decision-making process, therefore, we shall always need to combine the CBA with other methods: amongst such other methods, we may note the EIA, referendum, and decision-making by a "Citizens Jury".

Let us now take a look at the "CBA Manual" published by the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT, 2003). We believe that this manual particularly overestimates the benefits and underestimates the costs. With regard to the construction of highways, for instance, the manual counts the following effects as benefits:

- [i] Travel time savings
- [ii] Travel cost saving
- [iii] Reduction in traffic accidents

Yet when adding up the costs the manual only takes account of the costs for construction and maintenance. It has nothing whatever to say about the "the Social Costs of Automobile Transportation", such as air pollution, the destruction of the landscape, or the negative effects on urban planning. It is especially remarkable that in order to overestimate the benefits, it makes quite unrealistic assumptions.

For example, the manual assumes that the drivers are all full-time workers with a monthly salary of 350,000 JPY (\$3,500) and that the benefit that accrues from the time saving is 2,802 JPY (\$28)/hour during business hours and 2,287 JPY (\$23)/hour while not at work. The estimation of the time saving is calculated under the entirely unrealistic assumption that the workers sell their

free time.

4-3 The CBA and measures to deal with global warming

Since the problem of global warming is riddled with uncertainty while having irreversible features whose effects may well be catastrophic, the CBA should not be used as a preliminary to any decision-making process that might be based solely upon it. And since the CBA has many other methodological and ethical problems when it comes to making choices to do with the discounting rate and resource allocation, we should therefore apply a better method and one that is more appropriate. In our planning to cope with global warming, for instance, we should use the EIA: the EIA offers a sustainability approach, and, along the lines it proposes, we should set an acceptable rise of temperature as well as an acceptable rise of sea level (Azar C and K. Lindgren, 2003: 245-255). That is to say, it will not be until sustainable development is guaranteed that we shall be able to weigh the environment and economy in a properly balanced way.

Nevertheless, some people continue to argue that the CBA is an effective tool for at least a short-term response to global warming (D. W. Pearce, 2003: 362-384)

In Pearce's view, the following would be the immediate advantages:

- [a] While the figures are necessarily uncertain, it is possible to estimate the aggregate and marginal social costs of greenhouse gases emissions.
- [b] The marginal social cost estimates have a role to play in appraising climate-change policy, and especially in determining whether 'too much' or 'too little' abatement is being considered.
- [c] Marginal social-cost estimates are models that suggest quite wide ranges of estimates.
- [d] A few early models incorporate adaptive behavior, most being based on the 'dumb farmer syndrome'.
- [e] Those generally more recent models that take into account adaptive behavior show marked reductions in social-cost estimates relative to those without such behavior.
- [f] Recent models suggest a range for the marginal social costs of carbon, without equity weighting, of 3 to 6 pounds (\$2 to 4) ton Carbon. Equity weighting, using a marginal utility of income elasticity of unity, raises this range to levels from 3 to 15 pounds ton Carbon (\$2 to 8).
- [g] There is increasing evidence that the correct approach to discounting in the global-warming context is to use a time-varying discount rate.

Borrowing estimates from recent US work, the 3 to 16 pounds ton Carbon range should be multiplied by around 1.8 to give a range 4 to 25 pounds ton Carbon.

- [h] A UK government document opts for a central estimate of the marginal social cost of carbon at 70 pounds ton Carbon. The value here seems pessimistic, indeed, but this is because the government used the model that includes adoptive actions.

In contrast, the “Stern Review” defines the term “Social Costs of Carbon Dioxide (SCC)” and shows that in a BAU scenario a ton of Carbon costs approximately \$85 (N. Stern, 2006).

It is obvious that if the discount rate is set low, then the SCC is easily overestimated:

$$V = \sum_0^T \frac{\partial D_t}{\partial E_t} (1 + S)^{-t}$$

Where D and E are instantaneous damage and emission at period t and S is a social discount rate.

The Stern Review assumes a social discount rate of 0.1%. Stern gives two reasons for insisting on the low percentage: firstly, from his ethical viewpoint, he considers that it is not acceptable to discriminate between generations; secondly, his estimation is based on the probability that human beings might become extinct.

On the other hand, Nordhaus makes use of a value built on the real interest rate and the index of the private sector's consumption as a discount rate. Considering the question of externality and other factors, however, we should use a much lower discount rate (Amano, 2008: 92).

Yet when we use data from the market, we need to be careful of the following disadvantages: (Dietz et al., 2009: 375–376)

- [1] The market is imperfect and contains distortions.
- [2] The market only reflects the preferences of the rich.
- [3] The inter-temporal market trade is possible only over a decade.
- [4] Decision-making in the market reflects individual interests, not social interests.
- [5] The market cannot handle a global change that is a consequence of ethical decisions.

A third method aired in the “Stern Review” is a comparison of the

marginal reduction cost and the social cost of CO₂ emissions. This method does not require a rigorous model since it only compares the expected costs and benefits of the additional reduction of CO₂ over a long-term prospect.

A preliminary test discussed in the Stern Review estimates the social cost of Carbon emissions in a BAU scenario at \$85 ton CO₂. This value is relatively higher than it is generally reported to be, since here the risks have been adequately taken into account. In any case, this is not the outlier.

We can consider another scenario in which the CO₂ density is limited to 550ppm. When we compare this improved case to that of the BAU, we can see that the former benefits to the rate of 2.3–2.5 trillion dollars; this is the difference of social cost between two scenarios multiplied by the amount of CO₂ in the BAU scenario. Of course, the amount of profit can change in the future (Stern, 2007: 344–345).

Summary

The economic evaluation of the environment is a fundamental problem in environmental economics, and in this chapter we have concentrated initially and in the main on the Theory of Social Cost and the costs incurred for damage compensation, reduction of damage, recovery and prevention, and the costs of the transactions.

We have extended the discussion to take in the principle of how costs are assigned and how we might design a viable constitution for dealing with the various problems that the Theory of Social Cost seems to entail. We have looked at several of the principles that have been proposed for such a constitution: [1] the Pigouvian tax principle, the Coase theorem, and the PPP in OECD countries, [2] the Payment Capacity principle, [3] the Benefit principle, [4] the Japanese “PPP” and the joint compensation system, and, [5] Public expenditure. Given that these principles offer different solutions, we need to examine the following questions:

- [1] Is the application of one’s chosen principle likely to reduce the pollution and improve the environment?
- [2] Is one’s principle fair?
- [3] Is one’s principle efficient in the long term?

These three questions are closely related to the three key ideas of environmental policy that underpin the whole argument of this book: the ideas of “sustainability,” “capability” and “governance”.

We have also looked at two typical methods for the economic evaluation of the environment: the CVM and the CBA. It is important to understand the implications and limitations of the evaluation of the environment when carried out in strictly monetary terms. An estimation of social costs for climate change is now especially attractive, and we anticipate more theoretical and empirical studies along these lines.