

The Economic Value of Ozone Layer Destruction in Life Cycle Impact Assessment

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Abstract. The problem of ozone layer destruction (ODP) is becoming more and more serious, which caused great damage to humans and the environment. And in life cycle impact assessment (LCIA) methods, the ozone layer loss environmental problem is considered. Therefore, This paper attempts to clarify the specific economic valuation application of ozone layer destruction in LCIA. We studies the economic valuation of ozone layer destruction in the three methods of Ecotax, Ecovalue08 and BEPAS weight system. Through research and analysis, we propose a new monetary valuation result, which adapts to the LCIA method of China. The research results are: The economic value of ozone layer destruction is \$2.15 in the inert construction waste life cycle environmental impact assessment system.

1. Introduction

Ozone layer destruction refers to the destruction of ozone in the stratosphere by chemicals in the atmosphere (such as chlorofluorocarbons), which makes the ozone layer thinner and even the phenomenon of emptying of the ozone layer[1]. After the ozone layer is depleted in a large amount, the ability to absorb ultraviolet radiation is greatly weakened, resulting in a significant increase in the amount of ultraviolet light B that reaches the surface of the earth, which brings various harms to human health and the ecological environment. There have been widespread concerns about human health, terrestrial plants, aquatic ecosystems, biochemical cycles, materials, and tropospheric atmospheric composition and air quality[2]. With the severity of the ozone layer destruction, in the life cycle impact assessment process, the environmental impact of the ozone layer destruction appears as an environmental factor that often needs to be considered, and its economic valuation is often used to express its loss level. Therefore, it is particularly important to study the economic valuation of ozone layer destruction in the LCIA method.

There are many economic valuation studies for ozone layer destruction[3-6], but there is no uniform method and result. And in LCIA, ISO 14044:2006[7] generally recommends not weighting and states that "weighting should not be used for LCA studies that are intended to be used for public disclosure of comparative assertions." This kind of advice is often overlooked, and the comparison can reflect the high degree of subjectivity brought about by weighting. But because of the great controversy of the weighting method, its research has become the focus. In this paper, we study the monetary valuation of ozone layer destruction in the three methods of Ecotax, Ecovalue08 and BEPAS weight system. Through research and analysis, the social willingness to pay method is used to obtain a new economic valuation of ozone layer depletion. Here we have the following three purposes: studying the economic value of ozone layer depletion in the three methods of Ecotax, Ecovalue08 and BEPAS weight system. A new economic valuation of ozone layer depletion is proposed to improve the



research of this subject - inert construction waste life cycle environmental impact assessment system[8]. Thereby promoting the economic valuation of ODP in the development of LCIA.

2. Methods

Based on the life cycle impact assessment model, this paper studies the economic valuation of ozone layer destruction. According to the LCA theoretical framework proposed by the International Organization for Standardization (ISO), the life cycle impact assessment is mainly composed of three links: classification, characterization and weighting [7]. This paper focuses on the economic valuation of ozone layer destruction in the weighting process of Ecotax, Ecovalue08 and BEPAS weight system. The specific research process is as follows:

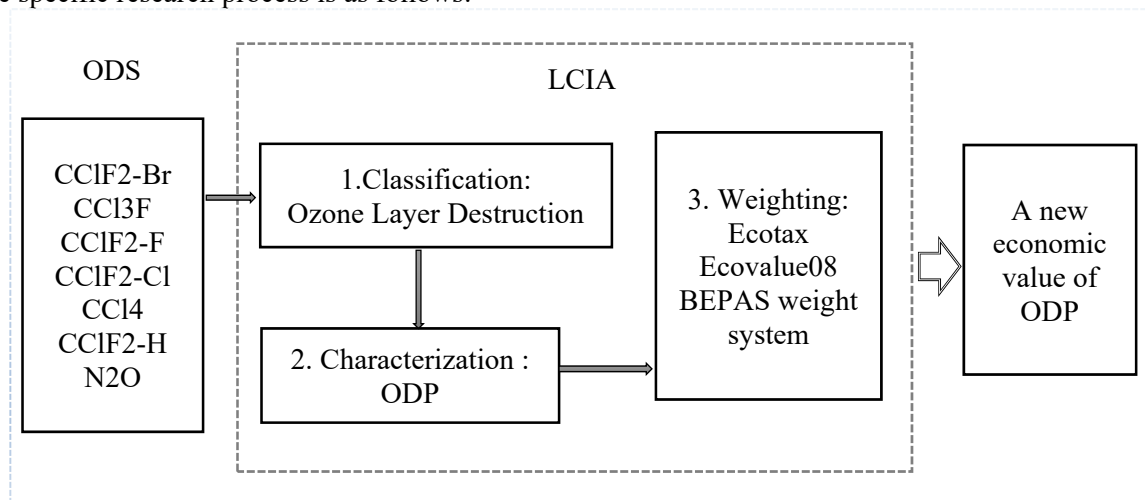


Figure 1 Research process framework

2.1. Classification and characterization

Classification is the first step in the impact assessment phase of LCA. It is the process of classifying inventory parameters and assigning them to specific impact categories, which is the process of matching inventory analysis results with corresponding environmental impact types[9]. Since this paper only studies the environmental impact type of ozone layer destruction, the classification of environmental impact types of the system is not carried out here.

Characterization means that because a variety of pollutants may cause the same type of environmental impact, for each specific type of environmental impact, this type of representative pollutant (environmental impact type indicator) should be determined. Based on the substance, the various substances that cause the type of environmental impact are standardized and converted into equivalent values[10], which make the various types of pollutants comparable to the same type of environmental impact. Characterization is indicated by factors that cause environmental emissions of certain types of environmental impact.

The main cause of ozone depletion and the ozone hole is manufactured chemicals, especially manufactured halocarbon refrigerants, solvents, propellants, and foam-blowing agents (chlorofluorocarbon (CFCs), HCFCs, halons), referred to as ozone-depleting substances (ODS)[11]. It is usually measured by the ozone depletion potential (ODP). In the characterization, the same is true for the ozone layer destruction. There are many kinds of ozone-depleting substances that cause this environmental impact. In order to uniformly calculate the environmental impact potential, it is usually expressed in CFC-11 equivalent (eq. CFC-11) [3]. Precisely, ODP of a given substance is defined as the ratio of global loss of ozone due to the given substance to the global loss of ozone due to CFC-11 of the same mass. Table 1 shows the ozone depletion potential of common compounds.

Table 1. The ozone depletion potential(ODP) of common compounds[12]

compound	R No.	ODP
CClF ₂ -Br		7.90
CCl ₃ F	R-11	1.00
CClF ₂ -F	R-13	1.00
CClF ₂ -Cl	R-12	1.00
CCl ₄		0.82
CClF ₂ -H	R-22	0.05
N ₂ O		0.017

2.2. Weighting

During weighting, different environmental influences are weighted relative to each other so that they can be summed to get a number to represent the overall environmental impact. The weighting assessment is to determine the weight of each environmental impact, and then aggregate into a total environmental impact value[13]. And the so-called weight is the relative severity of the response to different environmental impacts. Commonly used weighting methods are agency method, technology elimination method, monetization method, authoritative target method, expert group method, etc[14]. The following three types of LCIA methods are used to calculate the ozone layer destruction economic valuation.

2.2.1. Ecotax. In Ecotax[3], Sweden bans the use of ozone-depleting substances in principle, but can apply for exemptions. If such an exemption is obtained, the user must pay the appropriate tax. Therefore, the stratospheric ozone depletion factor is calculated based on the fees charged from the exemption from the use of ozone-depleting substances. Regardless of its ozone depletion potential, the cost per kilogram of ozone-depleting substance is 1200 SEK. Therefore, the economic valuation of all ozone-depleting substances is 1200 SEK/kg.

2.2.2. Ecovalue08. Among the Ecovalue08[4], photochemical oxidants that will help form ground-level ozone are represented by VOC. The VOC values obtained from the Beta database include the effects of VOCs on respiratory diseases and crop damage. The min/max values are related to different assumptions of mortality estimates and ozone damage thresholds (corresponding to alternatives that produce the highest and lowest estimates). Health effects are assessed using conditional value assessment methods and crop losses are assessed based on market prices. Thus, the minimum economic valuation of the Forming of tropospheric ozone is 3 SEK, and the maximum value is 8SEK.

2.2.3. BEPAS weight system. In the BEPAS weight system research proposed by Xing Wu and Xiaodong Li [6], a weight system is established based on the environmental tax perspective, and the social willingness to pay method is used to weight the environmental impacts. It pointed out that China has made specific plans to reduce ozone-depleting substances (ODS) and has received funding from the Multilateral Fund. However, China has not introduced a CFC tax. Therefore, it is only possible to estimate indirectly the willingness to pay for the destruction of the ozone layer. According to the World Bank's Beijing office, by the end of 2002, China had launched 113 projects with a total investment of 202074.17 USD, aiming to reduce the ODS of 105064.54 ton[5]. Therefore, the average investment required to reduce ODS per unit is 1.92 USD, resulting in an economic valuation of ozone depletion.

3. Results and Discussion

3.1. Results

Through the above part 2 study, we obtained the economic valuation of the ozone layer damage in the above three LCIA methods as shown in Table 2 below.

Table 2. The economic value of the ozone layer destruction in Ecotax, Ecovalue08 and BEPAS weight system

LCIA methods	time	country	method	Economic value
Ecotax	2002	Sweden	social willingness to pay	1200 SEK/kg CFC-11
Ecovalue08	2008	Sweden	individual willingness to pay	Min 3 SEK/kg VOC Max 8 SEK/kg VOC
BEPAS weight system	2002	China	social willingness to pay	1.92 USD/kg ODP

3.2. Discussion

Through the above research, we found that the willingness to pay (WTP) method was the most common monetary method for the economic valuation of ozone layer destruction. But the above three methods are also different, Ecovalue08 considers the individual willingness to pay[4], while Ecotax and BEPAS weight system are the social perspective to calculate the willingness to pay for ozone layer destruction[3,5,6]. In addition, there are national factors that affect valuation. Whether it is the exemption tax from ODS stipulated in Ecotax or the VOC value obtained by Ecovalue08 from the Beta database, the Swiss scope is considered[3,4]. But the BEPAS weight system is a social willingness to pay from a Chinese perspective[5,6]. It is also worth noting that for the economic valuation of the ozone layer destruction, the time value should also be considered. The monetary methods of different periods are based on the time value of the time, and it need to be updated and improved continuously.

In order to obtain an economic value of the ozone layer destruction in the for our inert construction waste life cycle environmental impact assessment system, this paper also adopts the environmental tax perspective to calculate the social willingness to pay from the perspective of China. Since China signed the Montreal Protocol on Substances that Deplete the Ozone Layer, it has been strongly supported by the Multilateral Fund, and the ODS reduction industry plan is steadily advancing. In 2006, the Executive Committee of the Multilateral Fund approved \$47.5 million in funds for the Chinese industry plan, 169 new contracts, \$53.64 million in completed funds, and a total of 25,000 tons in ODS production and consumption reductions[15]. The economic valuation of each unit of ozone layer destruction is \$2.15.

4. Conclusion

Based on the LCIA process, this paper make a research of classification, characterization and weighting for the ozone destruction. The focus is on an in-depth study of the economic valuation of the ozone layer destruction in the three life cycle impact assessment methods (Ecotax, Ecovalue08 and BEPAS weight system), and discover the impact of methods, countries, and time values on economic valuation. Finally, using the social willingness to pay method, a new ozone layer destruction economic valuation of \$2.15 was obtained, thus perfecting the inertial construction waste life cycle environmental impact assessment system. This research above is also conducive to the development of the economic valuation of the ozone layer destruction environmental impact in the future LCIA methods, this has great research significance.

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