A

Approaches to Define Environmental Debt in the Framework of Sustainable Development

Tetyana Pimonenko and Olena Chygryn
Economics, Entrepreneurship and Business Administration Department, Sumy State University, Sumy, Ukraine

Synonyms

Ecological debt; Green debt

Definition

Environmental debt refers to the accumulation of past environmental impacts of natural resource depletion and environmental degradation, owed to future generations (OECD 2018). The environmental cost accumulation represents an environmental debt. Environmental debt incurred by past generation indicates the responsibility of the current generations for environmental effects that would have to be borne by future generations (Ljungman 1998).

Introduction

Firstly, the term "ecological debt" was defined in the paper in 1985, in a yellow booklet with the title "Women in movement" made by the German ecofeminist. Then, the first papers in which scientists paid attention to the problem of meaning and accounting the environmental debt were "Miljoskulden" (Jernelöv 1993) and "Deuda ecologica" (Robleto and Marcelo 1992). Noticed that these two papers described two different point of views on environmental debts. Robleto and Marcelo's report describes environmental debt on the global level: specifically, in the context of ozone depletion and the resulting costs to health. From the other side, Jernelov explained environmental debt for the national level: "the restoration costs for techno-economic environmental harms and the capital required to pay for recurring repair efforts" (Jernelöv 1993; Warlenius et al. 2015).

The experts from Accion Ecologica (1999) defined environmental debt as "the debt accumulated by northern industrial countries towards third world countries on account of resource plundering and use of environmental space to deposit wastes." In 2009, the Centre for Sustainable Development at Ghent University (Paredis et al. 2008) proposed as a working definition: the ecological damage caused over time by a country in other countries or to ecosystems beyond national jurisdiction through its production and consumption patterns; the exploitation or use of

© Springer Nature Switzerland AG 2019
W. Leal Filho et al. (eds.), *Responsible Consumption and Production*, Encyclopedia of the UN Sustainable Development Goals, https://doi.org/10.1007/978-3-319-71062-4_64-1

ecosystems (and its goods and services) over time by a country at the expense of the equitable rights to these ecosystems by other countries (Hali et al. 2013).

The scientists in the paper (Assessing 2009) assumed that in ongoing world tendency the key problem is regional disparities on reducing the environmental threat and the so-called "ecological debt." Thus, they defined ecological debts as a regional disparity in reducing the environmental threat.

Environmental Debt from the Different Point of Views

Since 1995, the ecological debt concept has been developing. Thus, the huge number of scientists and experts try to define and estimate environmental debt using the different methods and approaches. In this case, a range of synonyms has already appeared (ecological debt, climate debt, ecological footprint, carbon debt, etc.). Firstly, it connects with the different objects, principles of accounting, and nature of appearance.

From the general point of view, environmental debt consists of two parts: "environmental" and "debt." In the English Dictionary, environment means: the circumstances, objects, or conditions by which one is surrounded; the complex of physical, chemical, and biotic factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival; the aggregate of social and cultural conditions that influence the life of an individual or community; the position or characteristic position of a linguistic element in a sequence; computer interface from which various tasks can be performed; a programming environment (Environment 2018). From the other side, in the dictionary, debt means: the fact that you have been influenced or helped by someone or something – usually singular; the state of owing money to someone or something; an amount of money that you owe to a person, bank, company, etc. (Debt 2018). Thus, a simple definition of the environmental debt is as follows: the owing and overusing of natural conditions and resources by the society's activities.

In 1991 the experts of Accion Ecologica in the report wrote

> the responsibility that the industrialised countries have for the gradual destruction of the planet caused by their production and consumption patterns. Patterns characteristic of the present development model that is being spread throughout the world and which is threatening local economies. The Ecological Debt includes the illegitimate appropriation of the atmosphere and of the absorption capacity of the planet. The Ecological Debt is the obligation, and responsibility that the industrialised countries of the North have with the countries of the Third World, for the looting and use of natural goods: petroleum, minerals, forests, biodiversity, and marine resources; to the cost of human energy of their people and of the destruction, devastation, and contamination of their natural heritage and sources of sustenance. (Acción Ecológica 1999; Paredis et al. 2008.

Thus, the abovementioned definition consists from the two parts. In the first part, the authors underlined that developed countries were the key factor of environmental debt generating and the Earth was the creditor. In the second part, the authors wrote that the developed countries were the main factor of environmental debt generating, but the creditors were the third countries.

Aurora Donoso from Accion Ecologica indicated that the consequences of ecological debt make the negative impact on society through the people displacement and culture's death: "The Ecological Debt is the obligation and responsibility that Northern, industrialized countries and their institutions and their allies in the Southern countries have to the countries and peoples of the Third World, for the looting and use of its natural goods; at the cost of the human energy, displacement of its peoples and for the destruction, devastation, and pollution of its natural heritage, culture, and sources of sustenance" (Donoso 2002; Paredis et al. 2008).

Scientists defined environmental debt through indicating the third countries as the key players in the creditors role. Martinez-Alier et al. (2003) wrote: "ecological debts may be very broadly

defined. They include pollution, 'theft' of resources and disproportionate use of the environment (. . .) Ecological debt is the debt accumulated by Northern, industrialised countries towards Third World countries on account of resource plundering, unfair trade, environmental damage and the free occupation of environmental space to deposit waste. A particular and interesting aspect of it is carbon debt, as a consequence of greenhouse gas emissions." (Martinez-Alier 2002b; Paredis et al. 2008).

The expert Simon A. from Christian Aid supposed that ecological debt as the same as carbon debt. In this case, Simon defined carbon debt: "Those countries that are using more than their fair share of the climate, and adding more to the damaging effects of global warming, are running up a debt to those countries that are using less than their fair allocation" (Simms 1999; Paredis et al. 2008).

Lyulyov et al. (2015) assumed that ecologization of transport system lead to decreased CO_2 emissions and as a consequence decreased environmental debt.

On the other hand, the authors in the papers (Prokopenko et al. 2017; Cebula et al. 2017) highlighted that all countries should develop the alternative energy resources and green building with a purpose to decrease the consumption of energy resources as a way to decrease countries' environmental debt.

Thus, Christian Azar and John Holmberg in the work (Azar and Holmberg 1995) used the following term "generational environmental debt (GED)" and defined as an offer of compensation for the damage which have done that we cannot repair at a lower cost.

Global Footprint Network (GFN) proposed to define the term ecological footprint as the human activities which left pressure on the earth. The experts from GFN indicated that the costs of the ecological overspending are becoming more evident day by day, in the form of deforestation, drought, water scarcity, erosion, biodiversity loss, and the build-up of carbon dioxide in the atmosphere. However, the authors in the paper (Cranston et al. 2010) wrote that ecological footprint analysis represents only the resource consumption and wastes arising from the activities of a specific population. If one country (China) were to export a product to another country (USA), then the resources and wastes associated with that product will be attributed to the USA environmental footprint and not to the Chinese one. This can be demonstrated via a simple equation for the "consumption footprint" (Cranston et al. 2010; Loh 2002; Loh and Goldfinger 2006; Cranston et al. 2010).

$$\mathrm{NEF} = \mathrm{PF} + \mathrm{Imports} - \mathrm{Exports}$$

where NEF – national environmental footprint; PF – product footprint; the imports and exports are converted into a footprint equivalent basis.

At the same time, GFN proposed the similar approach to estimate environmental footprint:

$$\mathrm{EFC} = \mathrm{EFP} + \mathrm{NEFT} = \mathrm{EFP} + \mathrm{EFI} - \mathrm{EFE}$$

EFC – ecological footprint of consumption; EFP – ecological footprint of production; NEFT – net ecological footprint of trade; EFI – ecological footprint of import; EFE – ecological footprint of export.

In this case, according to the experts from GFN, the results of EFC highlight the ecological impact of each country. Thus, a country has an ecological reserve if its Footprint is smaller than its biocapacity; otherwise, it is operating with an ecological deficit. The former countries are often referred to as ecological creditors, and the latter ecological debtors. According to the reports of GFN, most countries, and the world as a whole, are running ecological deficits. The world's ecological deficit is referred to as global ecological overshoot (Data 2018).

The expert Andrew Simms highlighted that ecological debt is a logical consequence of applying long-established norms on the equality of people in law, and scientific knowledge emerging over time about the natural limits of the world around us (Simms 2001).

It should be underlined that the meaning of ecological debt relates from the point of views: economic, political, social, finance, technical, etc. Thus, from the political point of view, the acknowledgment of an ecological debt was conceived as a way of establishing social justice between human beings (Azam 2013). Noted, that the developed countries are exhausting all types of resources (renewable and non-renewable) and spending not huge money for that as the emerging countries.

From the economic point, Martinez-Alier in his work (Martinez-Alier 2002b) indicated that the environmental debt was an economic concept that arises from the distribution of two types of conflicts. The first conflict is the ecologically unequal exchange, which can be defined as "the fact of exporting products from poor regions and countries, at prices which do not take into account the local externalities caused by these exports or the exhaustion of natural resources, in exchange for goods and services from richer regions" (Martinez-Alier 2002b; Ecological 2015). Making research Arne Jernelov calculated the environmental debt for Sweden in 1992 and 1993. In his work (Jernelöv 1993), he assumed that the environmental debt was defined as the costs for restoring previous environmental damage to an acceptable level, provided that the damage was reparable. In economic terms, it can be seen as the replacement cost for the part of the damaged environmental capital which is possible to recreate. In this case, Jernelov did however not deal with resource depletion. Furthermore, Jernelov's estimates included more items than many previously made environmental accounting exercises (Lindmark 1998).

The second conflict arises in the tendency of wealthy countries to disproportionately utilize environmental space without paying for it. This tendency primarily refers to the use of carbon sinks and is an important factor in the accrual of carbon or climate debt. Based on Martinez-Alier's understanding, ecological debt can therefore be described as the cumulative result (or stock) of ecologically unequal exchange (flows), plus carbon debt (Ecological 2015).

From the financial point of view, environmental debt could be indicated as the opportunities to reduce or cancel the countries' financial debts so as to reverse the flow of money and thus do justice by way of financial compensation. It should be highlighted that financial debt could be cancelled by the political decisions, so the environmental debts couldn't be cancelled, because time is irreversible, as the definitive destruction or exhaustion of many nonrenewable resources shows (Azam 2013).

Furthermore, if ecological debt is the result of unfair enrichment, it should not be taken into consideration as an ordinary financial instrument for the economies of the center of the capitalist world-system. Thus, comparison with financial debt is misleading, however inspiring it might have been as a means of wielding ecological debt as a weapon in social debates on global injustice. Consequently, despite the possibility of designing ecological debt as a quasi-contract resulting from unjust enrichment, it is far more useful as a tool to advance in struggles for social change than in compensatory terms (even though compensation can occasionally be phrased in terms of ecological debt in several concrete cases of environmental injustice) (Manzano et al. 2016).

The scientists Pickeringa and Barryb in the work "On the Concept of Climate Debt: Its Moral and Political Value" wrote that climate debt and carbon debt were the same terms and analyzed as a part of a broader ecological debt. In addition, they propose to define it as a commonly conceived as both intergenerational – accrued by current people and owed to future generations – and international – accrued by the populations of some countries and owed to the populations of other countries (Pickeringa and Barryb 2012).

The authors in the paper (Melnyk et al. 2018) indicated that ecological factors (including environmental debt) influence on macroeconomic stability of country. That is why it is necessary to decrease environmental debt not only with global needs but also with the economic target to achieve the macroeconomic stability.

At the same time, Nicola Bullard assumed that: "in accounting terms, climate debt is just one-line item in the much larger balance sheet of ecological

debt, but it can be broken down into understandable and measurable parts. One part of the climate debt relates to the impacts of the excessive emission of greenhouse gases that cause global warming: extreme and frequent climate events, floods, droughts, inundations, storms, loss of arable land and biodiversity, disease, landlessness, migration, poverty, and much more. In UN terms, these very real human impacts are sanitised and lumped together under 'adaptation' costs" (Bullard 2010).

Bullard (2010) highlighted that the second part of climate debt is the cost for reorientation of the civil society to green mind. Accordingly, the third past – emission debt or carbon debt.

The Belgian scientist Erik Paredis wrote that the environmental debt of country A consists of:

1. The ecological damage caused over time by country A in other countries or in areas under the jurisdiction of other countries through its production and consumption patterns
2. And/or the ecological damage caused over time by country A to ecosystems beyond national jurisdiction through its consumption and production patterns
3. And/or the exploitation or use of ecosystems and ecosystems goods and services over time by country A at the expense of the equitable rights to these ecosystems and ecosystem goods and services of other countries or individuals (Paredis et al. 2008.

Some of the scientists defined the environmental debt on the basis of an acknowledgment of the rights of the earth and historical nature conditions. Besides, mostly the scientists proved that environmental debt as a concept should account for both historical and ongoing injustices levied on the peoples (Warlenius et al. 2015).

The Ecological Debt Concepts

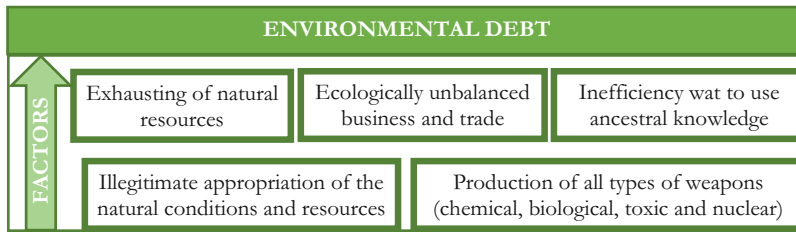
According to the experts from Accion Ecologica, the ecological debt began in the colonial period and is increasing year to year through the ways and mechanisms as presented in Fig. 1:

1. Exhausting of natural resources
2. Ecologically unbalanced business and trade
3. Inefficient way to use ancestral knowledge
4. Illegitimate appropriation of the natural conditions and resources
5. Production of all types of weapons (chemical, biological, toxic, and nuclear)

Thus, the scientists in the works (Donoso 2002; Paredis et al. 2008) accordingly explained that the extraction of natural goods, such as petroleum, minerals, marine, forest, and genetic goods in order to support Northern industry, which is destroying peoples' ability to survive. And trade is also ecologically unbalanced, as these goods are exploited and exported without taking responsibility for the social, cultural, and environmental damage involved.

The illegitimate appropriation of the atmosphere, and of the carbon absorption of oceans and vegetation, by polluting the atmosphere with disproportionate carbon emissions from industrialized countries, is the main cause of the greenhouse effect and of the degradation of the ozone layer.

Another reason of accumulation the environmental debt is the production of chemical,



Approaches to Define Environmental Debt in the Framework of Sustainable Development, Fig. 1 The key factors which from and increase the environmental debt. (Compiled by authors)

biological, toxic, and nuclear weapons, substances, and residues, which are sold and duped in Third World countries (Donoso 2002; Paredis et al. 2008).

Later, the ecological debt concept appeared as a key outcome of the Earth Summit in 1992. This concept was formed on the way of prevalent campaigns for external debt cancellation. The main forces of running this concept were the Ecuadorian NGO Accion Ecologica (AE), which presented the statement No More Plunder: They Owe Us an Ecological Debt in Johannesburg in 1999. Furthermore, that year the volunteers from Friends of the Earth International (FOEI), while gathered in Quito, launched a campaign on environmental debt. These two organizations developed HGOs network in founding the Southern People's Ecological Debt Creditors Alliance (SPEDCA), the aim of which was to push for the "international recognition of the environmental debt, historical and current" (Paredis et al. 2008).

In 2002, an alliance of environmental "debtors" support the arguments for recognition of the concept of ecological debt, the European Network for the Recognition of the Ecological Debt (ENRED), was also formed.

Thus, the ecological debt concept focuses on the lack of political power of poor regions and countries. The debt arises from:

- Exports of raw materials and other products from relatively poor countries or regions being sold at prices which do not include compensation for local or global externalities
- Rich countries or regions making disproportionate use of environmental space or services without payment (for instance, to dump carbon dioxide).

Environmental debt usually designates a public debt a country has toward other countries (foreign debt) but can also be used to calculate a debt (or liability) from a company (private debt) or a debt a nation has toward future generations (Ecological 2015).

Paredis et al. (2008) and Rice (2009) proposed that ecological debt concept base on five theoretical blocks:

- The biophysical accounting systems already exist and can be readily tied in to the ambitious project of measuring trade flows in non-monetary, ecological terms
- the theories of ecological economics
- The environmental justice and human rights
- The historical injustices and restitution
- A broad, ecologically oriented world-system analysis framework (Paredis et al. 2008; Rice 2009; Ecological 2015)

According to the abovementioned blocks, the environmental debt could be emphasized as follows:

1. Environmental debt as a biophysical measure
2. Environmental and climate debt as legal instruments
3. Environmental debt as a distributional principle

It should be noticed that environmental debt is a part of environmental justice. As the scientists in the report (Warlenius et al. 2015) of Environmental Justice Organisations, Liabilities and Trade indicated that

> environmental justice is a broader concept than ecological debt, focusing more generally on the unequal distribution of ecological burdens and benefits. It has its origin in struggles against the dumping of toxic waste in minority (mainly African-American) communities in the US in the early 1980s, and was therefore originally aligned closely with environmental racism). Since that time, environmental justice has spread beyond the US contexts of its origin and is now widely used by activists and academics alike to call attention to how the distribution of ecological burdens follows general patterns of power distributions. Ecological debt, on the other hand, is more often used as an indicator of the cumulative, or net sum, of historical environmental injustices. Although not a defining condition of its usage, it primarily focuses on historical geographical inequalities, as between specific countries or more generally between the global North and South. Environmental justice can also be geographically oriented but is more likely to

focus on categories such as race, gender or class. (Warlenius et al. 2015)

The Methods to Estimate Environmental Debt

The complexity of environmental debt provoked the using of different approaches and methods to estimate it. Some of the scientists make assessments on the basis of the amount of emissions. Neumayer (2000) allocated the "historical emissions debt" consisting on the difference in emissions of actual historical emissions (from a specific date in the past) and equal per-capita emissions (current emissions).

The most spread approach is to calculate the value of the environmental and social externalities associated with historic resource extraction and adding an estimated value for the share of global pollution problems borne by poor countries as the result of higher consumption levels in rich ones (Srinivasan et al. 2008).

According to Paredis et al. (2008), the environmental footprint could be presented as: environmental damage; use of equitable rights. Thus, the environmental damage involved pollution, degradation, and extinction. Moreover, it could be on the global, continental, national, regional, and local levels. In this case, the monetary assessment of environmental damage could be through indicators of pollution, exhaustion, and degradation. The experts showed that the most effective way to estimate the abovementioned indicators is Driving Forces, Pressures, State, Impact and Response model (DPSIR model), which also used by Eurostat and the European Environment Agency (EEA) for analyzing environmental problems and developing appropriate indicators (Paredis et al. 2008). The different components of the DPSIR model are (Paredis et al. 2008):

1. Driving forces: Underlying factors of environmental problems, i.e., social, demographic, and economic developments in societies and the corresponding life styles and overall levels of consumption and production patterns. These are usually analyzed according to basic sectoral trends, in energy generation, transport, industry, agriculture, and tourism, for example.
2. Pressures: The human interferences or activities directly affecting the environment, i.e., pollution, depletion, damage. The pressure component of the model gives information on emissions, application of chemical and biological agents, the use of land and other resources.
3. State: The current condition of the environment. The state gives information on the level, quality and/or quantity of physical and chemical phenomena in a given area at a given point in time.
4. Impact: The effects of changes in the environment on human health and the economic and social welfare of a society.
5. Response: Efforts of society (different actors) to solve the problems. The response component refers to the reaction of the government, institutions, groups of people, and individuals to undesired impacts on the environment. Responses can address the different components of the chain.

From the other side, the use of equitable right relates on the types of the ecosystems and services. The monetary assessment of equitable rights could be done through the ecological footprint and environmental space. The environmental debt could be estimated through four key elements: carbon debt, biopiracy, waste export, and environmental liabilities (Redclift and Woodgate 2010).

Ecological footprint calculations involve the several steps. The land area appropriated per capita is broken down into different categories of ecological space: biodiversity land; bio productive (including arable, forestry, and pasture) land; bioproductive sea; built or degraded land; energy land (Cranston et al. 2010). Furthermore, the experts from GFN created special online platform (What 2018) where everyone could calculate the own footprint. The platform was called "What is your Ecological Footprint?". Link: http://www.footprintcalculator.org/signup.

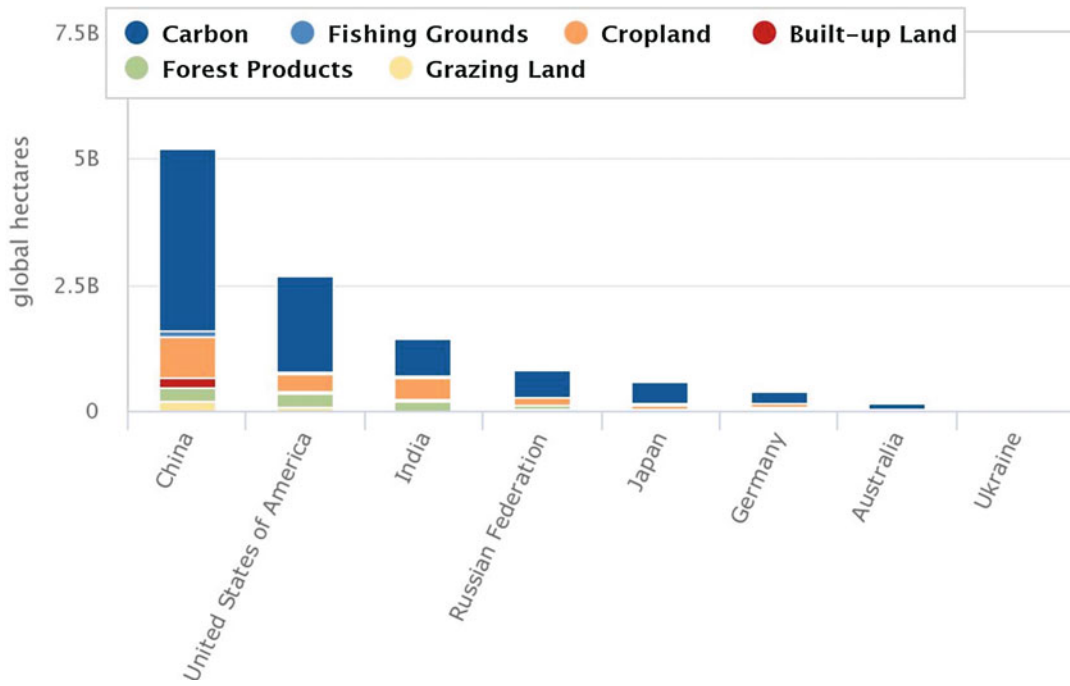
According to the official report of GFN in 2017, the key debtors (with huge footprint) were the countries as follows: Australia (need 5.2

additional planets); USA (5 additional planets); South Korea (3.4 additional planets); Russia (3.4 additional planets); Germany (3.2 additional planets). Furthermore, the official data from GFN website showed that in 2014, Chine and USA has the biggest ecological footprint, – more than 5B and 2.5B global hectares, respectively. The ecological footprints by countries are shown in Fig. 2 (National 2018).

It should be underlined that scientists in the paper (Paredis et al. 2008) noticed that ecological footprint was the simple way to describe society the consequences of their activities. Moreover, the methodology is understandable and often used in the research by scientists. On the contrary, they allocated the weakness sides of such method to estimate environmental debt as follows: the high degree of aggregation. They assumed: "the ecological footprint can be considered to be an indicator for use of the ecosystem earth or the biosphere at the expense of others. More specification is possible through the use of the components of the footprint, i.e. 'cropland footprint', 'grazing footprint', 'forest footprint', 'fishing ground footprint' and 'energy footprint'. These may be interesting for studying space-related aspects of ecological debt, although differences remain, especially about the translation of CO_2 to global hectares." (Paredis et al. 2008). Another key problem is time frame, and as a consequence the historical aspects of ecological debt. As an example, they noticed: "global time series until 1960 have been made in WWF 2002. More detailed analysis has been conducted for Austria in Haberl et al. (2001) . . .".

Some of scientist proposed to estimate environmental debt through the economic and ecological indicators of environmental space. Paredis et al. (2008) proved that the concept of environmental space can be used as an indicator for the aspect "use at the expense of equitable rights" of ecological debt. It should be noticed that the Dutch scientists Hans Opschoor proposed this concept under the principles of sustainable development.

The scientist Rochol in the work (Rochol 2001) assumed that of the environmental space concept based on two principles:



Approaches to Define Environmental Debt in the Framework of Sustainable Development, Fig. 2 The ecological footprints by countries in 2014. (Resourses: National Footprint Actions 2018)

- "On the simple fact that the Earth can only sustain a certain amount of pollution and use of resources. If we want to avoid a climate disaster, we can only put a certain amount of CO_2 into the air. If we want to preserve the forests, we can only fell a certain amount of timber. If we want future generations to have the same chances as we do, we have to reduce the use of non-renewable resources to the absolute minimum."
- "... the equity principle: Every person in the world should have the same right to use resources of the Earth" (Rochol 2001; Paredis et al. 2008).

Noticed that using of these two principles allow to make assessment of natural resources which are used and have been available for every person in the world. Paredis et al. (2008) called it as environmental space. Besides, they proved that concept of environmental debt could be defined as the "...the overconsumption of environmental space, both in the past and in the future" (Paredis et al. 2008).

At the same time, Paredis et al. (2008) explained that "Environmental debt would, for example, result from the amount of CO_2 industrialised countries have put into the air that is now causing global warming."

The scientists in the work "National contributions to observed global warming" (Matthews et al. 2014) proposed to estimate the environmental damage through the carbon debts for each country.

Paredis et al. (2008) under the scope of Energy/Climate module, defined the term carbon debt as follows: used to indicate all aspects of ecological debt resulting from the emissions of CO_2 from fossil fuel combustion. Based on the findings of the core research, an attempt will be made to operationalize the carbon debt concept, with a methodology for quantification and a few preliminary components of a framework to deal with this debt in practice (Paredis et al. 2008).

They highlighted that the carbon debt of country A consists of:

- "Over-emission of CO_2 by country over time with respect to a sustainable level; i.e. emission levels that overshoot the absorption capacity of the atmosphere and are thus causing ecological impact in other countries and ecosystems beyond national jurisdiction"
- "Over-emission of CO_2 by country A overtime at the expense of the equitable rights to the absorption capacity of the atmosphere of other countries or individuals" (Paredis et al. 2008.

Another approach to estimating environmental debt through the assessment of binding CO_2 in growing biomass was proposed by the scientists Jernelov through the using of a cost of 0.1 SEK per kg CO_2 (Jernelöv 1993; Lindmark 1998).

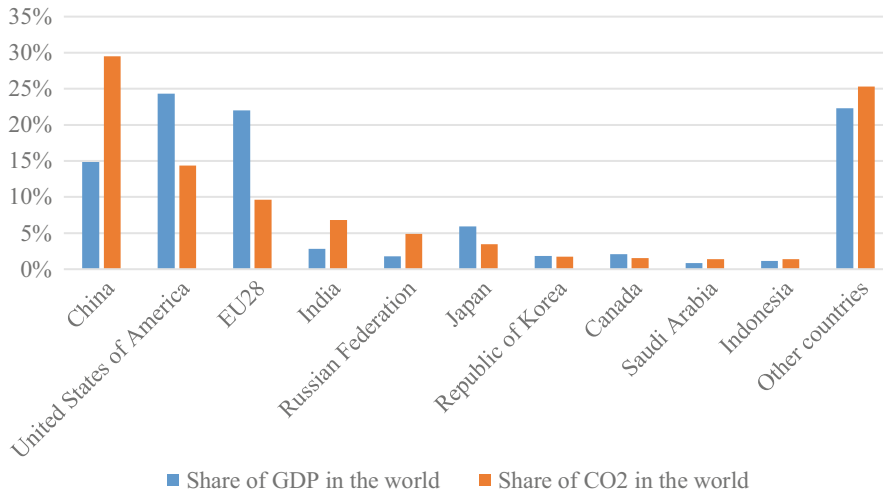
Thus, according to the databases, the following countries such as China, the USA, India, Russian Federation, and Japan occupied the first five places in CO_2 emissions in the world (Table 1). In such direction, Ukraine occupied the 26th place of CO_2 emission in the world.

Thus, China generates only 14.84% of the world GDP, but it produces 29.51% of CO_2 emission in the world. The same situation is with India and Russian Federation. Their CO_2 emission in percentage is twice higher than their share of GDP in the world. Unfortunately, the same situation can be seen in Ukraine. Although, the situation in Lithuania is vice versa. Their CO_2 emissions is twice less than their share in the world GDP. It is necessary to underline that in the USA and in the most EU countries, the share of world GDP is higher than share of the world CO_2 emission (Fig. 3).

Thus, the different approaches to estimate the environmental debt showed the practically the same results. Besides, it should be noticed that the historical background, complexity of term, and objects of estimation justify the huge approaches to define terms "environmental debt."

Approaches to Define Environmental Debt in the Framework of Sustainable Development, Table 1 CO_2 emissions and share of the world GDP by the country (Created by the authors on the basis (World Development 2017; CO_2 time 2017; Pimonenko et al. 2018))

Countries	GDP, bln $	% GDP in the world	CO2, kton (Gg) per year	% CO2 in the world	CO2 per 1$ of GDP
China	11007.72	14.84%	10641788.99	29.51%	1034.39
USA	18036.65	24.32%	5172337.73	14.34%	3487.14
India	2095.40	2.83%	2454968.12	6.81%	853.53
Russian Federation	1331.21	1.80%	1760895.31	4.88%	755.98
Japan	4383.08	5.91%	1252889.87	3.47%	3498.37
Germany	3363.45	4.54%	777905.50	2.16%	4323.72
Iran	–	–	633749.58	1.76%	–
Republic of Korea	1377.87	1.86%	617284.88	1.71%	2232.15
Canada	1550.54	2.09%	555400.90	1.54%	2791.74
Saudi Arabia	646.00	0.87%	505565.10	1.40%	1277.78
Indonesia	861.93	1.16%	502961.30	1.39%	1713.72
Brazil	1774.72	2.39%	486229.08	1.35%	3649.98
Mexico	1143.79	1.54%	472017.79	1.31%	2423.20
Australia	1339.14	1.81%	446348.29	1.24%	3000.21
South Africa	314.57	0.42%	417160.99	1.16%	754.08
United Kingdom	2858.00	3.85%	398524.37	1.11%	7171.46
Turkey	717.88	0.97%	357157.41	0.99%	2009.98
Italy	1821.50	2.46%	352885.93	0.98%	5161.72
France	2418.84	3.26%	327787.26	0.91%	7379.28
Poland	477.07	0.64%	294879.37	0.82%	1617.84
Ukraine	90.62	0.12%	228688.17	0.63%	396.24
Lithuania	41.17	0.06%	12478.11	0.03%	3299.44
World	**74152.48**		**36061709.91**		**2056.27**



Approaches to Define Environmental Debt in the Framework of Sustainable Development, Fig. 3 Comparison the share of CO_2 and GDP in the world by the countries. (Created by the authors on the basis (World Development 2017; CO_2 time 2017; Pimonenko et al. 2018))

Cross-References

- Business Environment – Emerging External and Internal Pressures for Sustainable Production
- Carbon Footprints of Organizations and Products
- Circular Economy
- Environmental Accounting: Concept, Methodology and Application
- Lean Manufacturing and Sustainable Development
- Life Cycle Approach
- Material Footprint
- Sustainable Packaging

References

Acción Ecológica (1999) No more plunder, they owe us the ecological debt! Bulletin of Acción Ecológica 78 (October) 1999. Acción Ecológica, Quito

Acción Ecológica (2000) Trade, climate change and the ecological debt. http://www.deudaecologica.org

Assessing Environmental Management Capacity: Towards a Common Reference Framework (2009) Report for the joint environment and development task team on governance and capacity development for natural resource and environmental management. www.oecd.org/env/workingpapers

Azam G (2013) Une dette écologique ? Revue du MAUSS 42(2):30–40. https://doi.org/10.3917/rdm.042.0030

Azar C, Holmberg J (1995) Defining the generational environmental debt. Ecol Econ 14(1):7–19

Bullard N (2010) Climate debt: a subversive political strategy. Climate Justice Now. https://www.tni.org/es/node/10897

Cebula J, Prokopenko O, Chayen S, Pimonenko T (2017) Wind energy in Israel, Poland and Ukraine: features and opportunities. Int J Ecol Dev 32(1):98–107

Christine M (2015) Which countries are in ecological debt? World Economic Forum. https://www.weforum.org/agenda/2015/08/which-countries-are-in-ecological-debt/

CO_2 time series 1990-2015 per region/country (2017). http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2015&sort=des9

Cranston GR, Hammond GP, Johnson RC (2010) Ecological debt: exploring the factors that affect national footprints. J Environ Policy Plan 12(2):121–140. https://doi.org/10.1080/15239081003719193

Data and Methodology of Footprint (2018) Global footprint network. https://www.footprintnetwork.org/resources/data/

Debt (2018) Learner's dictionary. http://www.learnersdictionary.com/definition/debt

Donoso A (2002) An alliance to stop the destruction of southern peoples livelihoods and sustainability. Speech delivered at the Indonesian Peoples' Forum, Bali, 24 May–5 June 2002

Ecological debt: history, meaning and relevance for environmental justice. (2015) EJOLT Report. 18. http://www.ejolt.org/2015/01/concept-ecological-debt-value-environmental-justice/

Environment (2018) Merriam-Webster, Incorporated. https://www.merriam-webster.com/dictionary/environment

Ghent University. http://www.ecologicaldebt.org/What-

Goeminne G, Paredis E (2010) The concept of ecological debt: some steps towards an enriched sustainability paradigm. Environ Dev Sustain 12(5):691–712

Haberl H, Erb KH, Krausmann F (2001) How to calculate and interpret ecological footprints for long periods of time: the case of Austria 1926–1995. Ecol Econ 38(1):25–45.

Hali H, Lorek S, Rodríguez-Labajos B (2013) Ecological debt. http://www.ejolt.org/2013/05/ecological-debt/

Jernelöv A (1993) Mer om miljöskulden. Report 1993:3, Miljövårdsbered- ningen, Ministry of the Environment (Miljö- och naturresursdepartementet), Stockholm

Lindmark M (1998) Towards environmental historical national accounts for Sweden methodological considerations and estimates for the 19th and 20th centuries. https://www.diva-portal.org/smash/get/diva2:572457/FULLTEXT02.pdf

Ljungman L (1998) Economic and environmental accounting for forestry: status and current efforts planning and statistics branch. http://www.fao.org/docrep/005/AB600E/AB600E00.htm#TOC

Loh J (2002) Living Planet Report. WWF (World Wide Fund)-International, Avenue de Mont-Blanc, CH-1196 Gland, Switzerland. www.panda.org

Loh J, Goldfinger S (eds) (2006) Living Planet Report. WWF, Gland, Switzerland.

Lyulyov O, Chortok Y, Pimonenko T, Borovik O (2015) Ecological and economic evaluation of transport system functioning according to the territory sustainable development. Int J Ecol Dev 30(3):1–10

Manzano JJ, Cardesa-Salzmann A, Pigrau A, Borràs S (2016) Measuring environmental injustice: how ecological debt defines a radical change in the international legal system. J Polit Ecol 23(1):381–393

Martin JF (2002) La Luzerne. Résultats des essaies variétaux. ICS. www.icsagri.com

Martinez-Alier J (2002a) The environmentalism of the poor: a study of ecological conflicts and valuation. Edward Elgar Publishing

Martinez-Alier J (2002b) Ecological debt and property rights on carbon sinks and reservoirs. Capital Nat Social 13(1):115–119

Martinez-Alier J (2002c) The environmentalism of the poor. A study of ecological conflicts and valuation. Edward Elgar Publishing Ltd, Cheltenham

Martinez-Alier J, Simms A, Rijnhout L (2003) Poverty, development and ecological debt. Leaflet

Matthews H, Graham T, Keverian S, Lamontagne C, Seto D, Smith T (2014) National contributions to observed global warming. Environ Res Lett 9(1):1–9

Melnyk L, Sineviciene L, Lyulyov O, Pimonenko T, Dehtyarova I (2018) Fiscal decentralization and macroeconomic stability: the experience of Ukraine's economy. Probl Perspect Manag 16(1):105–114. https://doi.org/10.21511/ppm.16(1).2018.10

National Footprint Actions (2018) Global footprint network. data.footprintnetwork.org/#/compareCountries?type=EFCtot&cn=231,230,185,110,351,100,79,10&yr=2014

Neumayer E (2000) In defence of historical accountability for greenhouse gas emissions. Ecol Econ 33(2):185–192.

OECD (2018) Glossary of statistical terms. https://stats.oecd.org/glossary/detail.asp?ID=820

Paredis E, Lambrecht J, Goeminne G, Vanhove W (2004) VLIR-BVO project 2003. Elaboration of the concept of ecological debt. Final report. Centre for Sustainable Development (CDO), Gent

Paredis E, Goeminne G, Vanhove W, Maes F, Lambrecht J (2008) The concept of ecological debt: its meaning and applicability in international policy. Academia Press, Gent

Pickeringa J, Barryb C (2012) On the concept of climate debt: its moral and political value. Crit Rev Int Soc Pol Phil. https://doi.org/10.1080/13698230.2012.727311

Pimonenko T, Lyulyov O, Chygryn O, Palienko M (2018) Environmental performance index: relation between social and economic welfare of the countries. Environ Econ 9(3):7–16. https://doi.org/10.21511/ee.09(3).2018.01

Prokopenko O, Pimonenko T, Dado J (2017) Net zero house: EU experience in ukrainian conditions. Int J Ecol Econ Stat 38(4):46–57

Redclift MR, Woodgate G (eds) (2010) The international handbook of environmental sociology. Edward Elgar Publishing

Rice J (2009) North – South relations and the ecological debt: asserting a counter-hegemonic discourse. Crit Sociol 35(2):225–252

Robleto ML, Marcelo W (1992). Deuda ecologica. Santiago de Chile: Instituto de Ecologia Politica

Rochol M (2001) From environmental space to ecological debt – a European perspective. Speech delivered at the conference 'Globalisation, ecological debt, climate change and sustainability', Republic of Benin, 27–30 Nov 2001, 8 pp

Simms A (1999) Who owes who? Climate change, debt, e quity and survival. Christian Aid. http://www.deudaecologica.org

Simms A (2001) Ecological debt – balancing the environmental budget and compensating developing countries. The New Economics Foundation. http://wedocs.unep.org/bitstream/handle/20.500.11822/8232/-Ecological%20Debt%20-%20Balancing%20the%20Environmental%20Budget%20and%20Compensating%20Developing-20012252.pdf?sequence=2

Srinivasan UT, Carey SP, Hallstein E, Higgins PA, Kerr AC, Koteen LE, Norgaard RB (2008) The debt of nations and the distribution of ecological impacts from human activities. Proc Natl Acad Sci 105(5):1768–1773. https://doi.org/10.1073/pnas.0709562104

Warlenius R, Pierce G, Ramasar V (2015) Reversing the arrow of arrears: the concept of "ecological debt" and its value for environmental justice. Glob Environ Chang 30:21–30

What is Your Ecological Footprint? (2018) Global footprint network. http://www.footprintcalculator.org/signup

World Development Indicators (2017) DataBank. Retrieved from: http://databank.worldbank.org/data/reports.aspx?source=2&series=NY.GDP.MKTP.CD&country=UKR