Global Challenges: Environment

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Abstract Presently, environmental problems have become more of a global nature and the associated risks are defined as a major threat to mankind and are already an important factor adding up to global instability. World Community responds to the challenges by altering international, regional, and state policies. A major global economic trend is the shift of the world economy and international business to sustainable development and a green economy path. Business perception of sustainable development has significantly evolved over the recent decades and ESG factors have become indispensable to business strategies.

1 Introduction

Now environmental problems have become more of a global nature and the associated risks are defined as a major threat to mankind and are already an important factor adding up to global instability. The negative trends associated with economic development and globalization have resulted in efforts to switch from the growth paradigm to that of green economic development, to design new concepts of global development including a category of the environment in economic theories. Ecological components have become an integral part of new theories and strategies—sustainable development, green economy, circular economy, and others, suggesting that economic and social development should maintain the system of a self-supporting environment. providing for economic and social development while maintaining the system.

The environmental component is gaining an increasingly important role in the global economy, trade and investments, labor migration, R&D, scientific cooperation, and information exchange. The transformation of the world economy is largely fueled by the deep penetration of ESG approaches into business activities. Business perception of sustainable development has significantly evolved over the recent decades and ESG factors have become indispensable to business strategies. At the

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A. Bulatov (ed.), *World Economy and International Business*, Contributions to Economics,
https://doi.org/10.1007/978-3-031-20328-2_11

same time, despite significant progress, claims of the predominance of progressive trends in the practical activities of companies seem premature, although the situation is changing dynamically.

1.1 Theoretical Aspects of Environment, Sustainable Development, and Rational Nature Management

In the broad sense of the word the environment is around us, we live there, we interact with it on a daily basis, and it has a direct impact on our development and our future.

The concept of the environment emerged in biology in the mid-1800s. In 1866, E. Haeckel (1834–1919), a German zoologist, was the first to define ecology as the biological science exploring the relationship between organisms and the environment. At the same time, he perceived the environment as a combination of living and inanimate elements of nature. An invaluable contribution to the theory of interaction between a human being and the environment was made by the American geographer, who wrote that nature takes revenge on man for ill-considered actions. L. Mechnikov, the Swiss geographer and sociologist of Russian origin, claimed that the mechanism of interaction with the environment was viewed as the adaptation of society to this environment.

In 1972, in the Club of Rome, an international think tank, the American spouses D. and D. Meadows together with the Norwegian J. Randers created a model of the environment in its dynamic development and presented their report "The Limits to Growth". According to the report in view of excessive anthropogenic pressure, the biosphere may go into a state incompatible with the survival of civilization. Together with further reports of the Club of Rome, it laid the foundation for the most modern approaches to the interpretation of the sustainable development concept. In 1987 the International Commission on Environment and Development released its report "Our Common Future", thus taking another important step on this path. The report proved the necessity and likelihood of sustainable triune development, combining natural, social, and economic components, as the only real direction of the civilization's further development.

The environment is usually viewed as nature surrounding us, although, in essence, it is the combination of three spheres—natural, anthropogenic, and social:

- natural sphere (natural environment), part of which remains untouched by human activity. As of today, it accounts for about 1/3 of the land and it has not lost its main properties—self-healing and self-regulation. However, these are mainly the areas with harsh conditions (wetlands in the north, high-altitude areas, glaciers, etc.) that don't support human life. The other part of the natural sphere, mastered and changed by man as a result of active interaction, on the contrary, has consistently expanded and continues to do so. The sphere of nature is often viewed as identical to the entire environment, which is not entirely correct:

- anthropogenic sphere (anthropogenic environment) comprises populated areas and structures created by human: buildings, industrial facilities, labor sites, artificial coverings, railways, dams, etc. This is primarily the result of economic activity which is characterized by waste accumulation, contamination, and pollution. A type of anthropogenic sphere can be called the natural environment, consciously or unconsciously changed by human activity—"cultural landscapes" such as agroecosystems (pastures, arable land, vineyards), reservoirs, ponds, forest plantations, parks, reclamation systems, etc.:
- social sphere (social environment) includes the relations between people and their groups, as well as between people and material and cultural values created by them with an impact on a person. "Pollution" of the social environment, which is characterized by constant contact with a person, is also dangerous for people. For instance, the social environment can act as a limiting factor hindering the development of people's abilities useful to society.

The natural sphere does not only serve as our cozy home, but it can also pose threats. The biggest danger lies in the global threats that are relevant to the entire natural environment or its significant part: global climate change, desertification, water problem, the problem of the oceans, deforestation, shortage of cultivated land, problems of poverty, hunger, and other equally dangerous problems.

The natural sphere can maintain stable living conditions. Therefore, life on Earth can be supported only given the stable self-sustaining state of the entire natural sphere. Hence, the main danger lies in the limiting capacity of the natural sphere. Today, it is not even the scarcity of natural resources or degradation of the natural sphere, that is undoubtedly critical, but the exponentially expanding impact of our civilization on this sphere. It should degrade until the cause of degradation vanishes—a civilization that does not know how to normalize its impact on the natural sphere.

Therefore, if we want to ensure sustainable development, i.e., to meet current needs without jeopardizing the future of generations to come, governments have not only to facilitate economic and social progress but preserve the natural sphere as a sustainable self-sustaining system. However, the modern world is characterized by ever-increasing burden on the natural sphere inflicted by rapid population and economic growth which ultimately leads to its degradation. This is the essence of the global problem associated with rational nature management (environmental management) and sustainable development.

A characteristic feature of modernity is the greening of economic development. If the major goal of the economy at the industrial stage is its rapid growth accompanied by increased consumption, which implies increased degradation of the environment, especially ecosystems, then the post-industrial economy is predominantly characterized by tertiary sector (services) growth, and the expansion of the secondary sector is led by knowledge-intensive, rather than material- and energy-intensive industries. It slows down (but does not prevent) the growth of post-industrial economy demand for raw materials and fuel and raises the chance of post-industrial countries for rational environmental management. General government expenditure in the EU on environmental protection amounted to 0.9 % of GDP in 2020 (Eurostat, 2022).

According to the IMF, the developed countries reduce natural resource consumption to their GDP (the coefficient of natural intensity) by 1.2% per annum. Although this figure lags behind their economic growth (about 2%), the result is a slowly growing demand for natural resources in this group of countries. Along with that, it should be noted that in the previous centuries developed countries drastically increased the consumption of natural resources and at the moment their share is still substantial. For example, the share of OECD member states in primary energy consumption was 39% in 2020 (BP, 2021).

Industrializing and pre-industrial countries particularly face the degradation of the natural sphere and in some cases intensified degradation. As a result, primary energy consumption in less developed countries rose by almost 28% from 2010 to 2019, while in developed countries it stayed flat (BP, 2021). Moreover, the environmental management in most states of this group is greatly determined by industrialization and rapidly growing population, both causing rise in natural resources consumption, which was first pointed out by T.Malthus in his model more than two centuries ago.

An important aspect of rational nature management is its adaptability in different parts of the world, where irrational nature management causes damage to local geo-ecosystems. It requires in-depth knowledge of geo-ecosystems development laws and significant investments, which in the contemporary context can be provided mainly by post-industrial states. As an example, we can trace the condition of the old industrial area of the Ruhr in Germany, which until recently was one of the most polluted areas of the world. The Rhine and Ruhr rivers, as many researchers noted, resembled gutters. However, today, with a reduction in coal mining, the Ruhr area has turned into a thriving post-industrial area, the rivers have been completely cleaned, and high-tech industries are actively developing. This is a vivid example of rational environmental management. At the stage of post-industrialization, the economy should become an eco-economy ("green economy") and shift from a growth paradigm to a sustainable development one. Only in this case, one can ensure the rational use of natural resources within the sustainable development concept.

However, there are serious objections to this concept. In principle, the idea of sustainable development is humane and noble. But some scientists believe that this concept is more of a slogan rather than a scientific nature. The task of reducing resource consumption at the global level is appropriate, but it can be completed only in the long term upon industrialization of less developed countries. It should rather be about a more rational use of natural resources.

The indicators, characterizing the degree of environmental management rationality, are largely debatable and have not received unambiguous recognition in world practice. In particular, they include the Environmental Performance Index (EPI) and the Environmental Sustainability Index (ESI) developed *by* Yale and Columbia Universities, the system of indicators of sustainable development of the United Nations Commission on Sustainable Development, and the OECD system of environmental indicators. These indices evaluate countries by various indicators of the state of the environment. Another reading is the World Bank's "genuine savings" indicator, which adjusts the amount of savings in GDP for losses from the depletion of natural resources and pollution (see Table 1).

Table 1 "Genuine savings" in some countries, % of GDP

	2000	2005	2010	2015	2017	2019
USA	9.3	3.0	0.9	5.1	6.0	2.9
Germany	10.2	10.1	–	12.1	14.4	13.3
Sweden	14.0	18.6	20.5	17.9	18.1	18.6
Japan	18.0	14.6	15.3	2.9	7.6	6.9
China	26.8	31.8	35.1	30.3	19.0	24.5
India	12.2	18.6	24.2	19.8	19.9	15.1
Brazil	6.3	8.0	5.2	3.2	5.6	7.4
South Africa	4.5	0.3	−3.4	2.3	1.3	−0.8
Russia	−13.4	1.5	4.5	10.9	7.9	8.0

Source World Bank: Little Green Data Book, 2001–2013, 2017; World Bank Open Data

Comparing this table with Table 3, we can conclude that in all the countries mentioned in these tables, the rate of "true savings" was noticeably lower than that of gross savings, and in some years several countries even experienced a negative rate of "true savings".

1.2 Major Environmental Challenges

Nowadays the pace of world economic development surpasses the ability of the environment to cope with the impact caused by human activity. Researchers define the contemporary time as a new geological epoch—Anthropocene, when the impact of anthropogenic factors has become the main engine of environmental change.

Major interrelated groups of environmental problems are the depletion of resources, destruction of components, and pollution of the environment leading to climate change and waste problems.

1.3 Depletion of Resources

Overexploitation and extremely irrational consumption of natural resources lead to their depletion. The global production of raw materials more than doubled from 1990 to 2017 and it is projected to double again by 2060. The intensity of natural resource use, including freshwater, forests, surface soil, fisheries, fossil fuels, and minerals at the global level surpasses the natural recovery pace. The use of many of those resources has already reached all-time highs, which leads to price increase

and additional market volatility. Our today's economy is only 8.6% circular,[1] which means that the main share of used resources is not recycled (CGRI, 2021). The rise in consumption is partially offset by the higher efficiency of natural resources use. The average resource productivity of the G20 countries, which account for 75% of global material use, grew by some 40% from 2000 to 2017, but this will not be sufficient to make up for the global increase in the materials used. Achieving new targets of the clean energy transition will be very mineral intensive to meet the growing demand for clean energy technologies. It will require an increase in production of minerals, such as graphite, lithium, and cobalt by nearly 500% by 2050 (World Bank, 2020).

The main resource problem is freshwater scarcity. There is no global water shortage as such (see chapter "Resources of World Economy: Natural Resources"), but in most cases, its use is extremely irrational, or it is highly contaminated which is caused by population growth-inflicted pollution. Globally, approximately 80% of wastewater is released without adequate treatment. Some 1.2 billion people are suffering from severe water shortages or scarcity in agriculture. The water shortage problem mainly affects the population of developing countries, almost half of them live in Asia and Northern Africa (United Nations, 2019). Water problems are closely interlinked with food resources and food availability problems, as water is a key resource for food production.

1.4 Destruction of Components

The problem of resources is closely linked to the destruction of the natural environment: the spread of deserts on fertile lands, the salinization of soils, the death of coral reefs turning oceans into lifeless space, and the reduction in forest areas (see 10.2). Forests, in their turn, play an exceptional role in biodiversity, their reduction significantly adds up to the ongoing loss of biodiversity, since forests serve as habitats for most species. At the moment, the global rate of species extinction is at least tens to a hundred times higher than the average over the past 10 million years, when it was mostly caused by natural factors, and it is still growing. Some experts believe that the biodiversity shrinkage problem requires the most complicated solution among other environmental issues.

1.5 Pollution of the Environment

Pollution affects human health and has serious economic consequences. Air pollution by fine particulate matter alone caused about 6.4 million premature deaths in 2019.

[1] According to Eurostat, the circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible.

The global cost of health damage by air pollution was USD 8.1 trillion in 2019 or 6.1% of the global GDP. Low- and middle-income countries are most affected (World Bank, 2022).

Pollution underlies the problems of global warming and ozone layer depletion. The ozone layer protects the Earth from ultraviolet radiation, its thinning could have a serious impact on human health and the environment. It is the only global environmental problem that has been successfully managed by humankind since the reason for the depletion of the ozone layer is only one kind of substance—chemicals, mostly chlorofluorocarbons. However, it will take several decades for the atmosphere to completely get rid of them.

The most ambitious, difficult to resolve, and potentially the most dangerous problem for humanity is global climate change. Climate change is driven by many factors, however, such changes over the last fifty years can't be explained by natural causes only. There is a scientific consensus as to the main cause of contemporary global warming, which is greenhouse gas (GHG) emissions generated by human activities. GHG emissions have raised the Earth's global average temperature by more than 1°C since the pre-industrial time. The main anthropogenic effect is the enhancement of the greenhouse effect by emissions of GHG, mainly carbon dioxide, methane, ozone, nitrous oxide, and chlorofluorocarbons. Carbon dioxide (CO_2) is the biggest contributor to climate change, accounting for about 80% of the warming effect, while methane contributes about 16%. Other GHGs caused by human activities are emitted in smaller quantities.

The key sectors generating emissions are energy consumption, including power and heating, transportation, buildings, manufacturing, and construction, which are responsible for 76% of human caused global GHG emissions. Other sources are agriculture (livestock farming and fertilizers usage), some industrial processes, deforestation, and land-use changes (WWF, 2022). The top ten emitting countries are China, the USA, the EU, India, and Russia.

It is most alarming that global warming affects almost all countries and is happening faster than scientists expected, which considerably complicates the adaptability of ecosystems. Close intercorrelation of the environmental components leads to changes in some parts while affecting the other parts. Global warming is already causing serious consequences and aggravating other global problems: reduction in resources, including freshwater, further destruction of other environmental components, including deforestation, desertification, and salinization of soils.

The environmental impacts of global warming are rising sea levels and acidity of oceans, threats to ecosystems and loss of biodiversity, extreme meteorological events, mass migrations and increased risks to water supplies. NASA data shows, that from 1901 to 2018 global mean sea level rose by about 20 cm, the fastest pace over the past 3,000 years, and it is mostly caused by melting polar ice caps and heat extension of the World Ocean's upper layer. The Arctic is warming twice faster than any other part of the earth, and its sea ice is shrinking by more than 10% every 10 years (WWF, 2022). By 2100, the sea level will rise by another 0.6–1.1 m if GHG emissions continue to increase at high rates (Forbes, 2021), which will have a serious impact on the coastal regions.

The problem is not just the warming, but the disruption in the climate balance, i.e., changes in the circulation of air and water. This leads to a bigger number of extreme weather events: hurricanes, typhoons, droughts, flooding, which may become more frequent and intense. In 2021 natural disasters alone caused economic losses of $270 billion (Swiss Re Institute, 2022).

Another implication is a negative impact on lives and health, as global warming leads to the proliferation of the most dangerous human infections and the northward spread of insects causing crop damage. The emergence of new diseases, transmitted between animals and humans, including coronaviruses, is linked to habitat loss, environmental degradation, and climate change (UNEP, 2020). Climate change may become a leading cause of death around the world, about 40 mln people could die because of changes in temperatures until the end of the century even with moderate mitigation of emissions (UNDP, 2022).

In the worst case scenario of temperature rise of more than 3°C, the world economy may contract by 18% by 2050. The most vulnerable countries are in Asia: China may lose nearly 24% of its GDP in the worst-case scenario, whereas the US losses may be close to 10% of GDP, and Europe's almost 11% (Swiss Re Institute, 2022). In the twenty-first century, the anthropogenic impact will increase and further warming is expected. By the end of the century, the rise in temperature may reach 4°C, which might lead to even more severe consequences.

The complexity of the warming problem can also be explained by its long-term nature. The atmosphere retains GHG for many decades and centuries and the consequences will be felt for a long time given the interrelation of natural processes. For this reason, the international community faces the challenge of maintaining the global temperature rise this century below 2°C, thus mitigating the most negative consequences of global warming.

Waste, especially dangerous waste, has become an outstanding issue. Depletion of resources and waste generation are closely interlinked. In 2016 the global municipal solid waste only was estimated at more than 2 billion tons, while just 13,5% was recycled. Waste generation may grow by 70% by 2050. Plastic waste is another acute problem, some 50% of the plastic is used only once, while 90% is not recycled and a substantial share is dumped into seas and oceans affecting marine life. Electronic waste is the fastest-growing segment (World Bank, 2022).

1.6 "Ecomigration" and Conflicts

The problem of limited natural resources and others in combination with political and social problems have already led to increased migration and international conflict risks due to extreme weather events, reduction in available natural resources and other climate-induced effects, primarily in less developed countries.

This gave rise to the term "ecomigrants", describing people leaving their countries due to environmental problems. Most researchers estimate the number of environmental migrants at 20–25 million people. The Intergovernmental Panel on Climate

Change (IPCC, 2014) estimates that 200 million people may migrate from their place of origin by 2050. The examples are the migration caused by the advance of deserts in China, Libya, Morocco, and Tunisia, soil erosion in Turkey, and migration of the Honduras, and Nicaragua citizens to the USA as the result of Mitch hurricane. The number of internally displaced citizens is far bigger.

Limited water resources, exacerbated by climate change, are already contributing to conflicts in many parts of the world. The UN Security Council highlights the relationship between water risks and conflict within and between countries. For example, a record drought in Syria pushed rural farming families into cities and ended in a civil war. Disputes about the lands and water between the rural citizens of Kazakhstan and Kyrgyzstan aggravated when in 2013 the citizens of Kyrgyzstan blocked the channel carrying water to the farmers on the Kazakh side of the border.

As a result, in the last decade, economic risks were overtaken by environmental threats. Environmental risks, including climate action failure, extreme weather, and biodiversity loss, were identified as the top three most severe global risks over the next 10 years by World Economic Forum in 2022. Climate change is still perceived as the most serious threat to humanity.

Environmental problems are closely connected with growing inequality in the distribution of economic growth benefits. In the last two to three decades, the main population increase and the fastest economic growth have been witnessed in developing countries which face the most serious problems associated with food supply, housing, employment, and medical care. The combination of these factors leads to extensive exploitation of the environment. Developed countries usually capitalize more on the benefits of the Earth's pressures and suffer less from their consequences (UNDP, 2022). Developed countries invest a lot in the environment, and last year the same trend was also seen in the fastest-growing developing economies. Less developed countries do not enjoy the same opportunity; therefore, the development issues are environmentally imperative and require joint efforts of the World community.

1.7 Responses of the World Community to Environmental Challenges

The acute and complex nature of global environmental problems contributed to the implementation by the World community of the growing responses to new challenges. The responses at the international level have been triggered by the failure to solve the global environmental problems at the national level; by the need to coordinate the interests of various states and necessary engagement of the developing countries; high costs to resolve problems; the stronger position of MNEs and bigger impact of the environmental risks on the international and national security.

As a response to the problem the World community extended research activity in this area, included and focused on the environmental component in the new strategy of mankind's development, put the environmental protection issues on the agenda

of the international negotiation process, and altered the strategies of international business, regional integration alliances, and states.

In the twentieth century, especially during its second half, several important research proved the gravity of the environment and its role in further development of mankind: reports to the Club of Rome and the concept of sustainable development (chapter "Resources of World Economy: Real Capital"). It was envisaged that the concept realization would gradually ensure adjustment of the uncontrolled industrial development of the countries. Later, the green economy concept, similar to the concept of sustainable development, was shaped, which, according to UNEP, "increases the living standards of people and social equality, while considerably lowering risks for the environment and its depletion" (UNEP, 2011).

The results of the first research shaped the agenda of international conferences to address the environment. The first UN World Conference on the environment in Stockholm in 1972, brought up the need to change the situation for the first time at the world level, and UN Conference on the environment and development (Rio de Janeiro, 1992 and subsequent conferences of 2002 and 2012), where the concept of sustainable development was approved and recommended for enacting by the states, were the most important.

Relevant international organizations were established, and many international treaties were concluded. It was followed by regional agreements, multiple laws in many states, and setting ministries and authorities responsible for the environment. Since the 1990s environmental issues have become the focus of practically all international multilateral associations—UN system organizations, OECD, G7 and G8, G20, regional economic agreements, states, business circles, and NGOs. Non-profit organizations such as World Wild Fund, Greenpeace, Global Green Growth Institute, and others play even more active roles.

Environmental issues have become an integral part of practically all major international treaties and agreements, from WTO negotiations to a whole system of international environmental agreements. It is accompanied by a growing number of agreements, expanding geography and scope of coverage, and implementation of new mechanisms.

Within the WTO framework environmental issues and their impact on trade currently play a growing role despite the lack of special agreements on the environment. Sustainable development and environmental protection have become one of WTO goals. At the moment some WTO agreements embody environmental clauses. Members are entitled to deviate from GATT rules to protect the environment subject to compliance with main WTO principles. Currently, 46 WTO members, which account for the bulk of the global trade in environmental goods, are engaged in negotiations over the agreement to liberalize trade in key environmental goods, such as clean and renewable energy sources. Under their commitments, most APEC economies have already reduced tariffs for environmental goods to 5% or even lower.

Signing and implementing special international environmental agreements (IEAs) with focus on acute environmental problems have become an important achievement of the global community. Currently, there is a network of over 1,300 multilateral environmental agreements, by far surpassing any other area of international law.

The most important agreements include agreements on greenhouse emissions (the UN Framework Climate Change Convention, 1992, the Kyoto Protocol, 1997, and the Paris agreement), on the protection of the ozone layer (the Vienna Convention for the Protection of the Ozone Layer, 1985, and the Montreal Protocol, 1987), on trade in endangered species (the Convention on International trade in Endangered Species of Wild Fauna and Flora CITES, 1975), on the trade in hazardous waste (The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1992), on preserving wild flora and fauna species (The Convention on Biological Diversity, 1993), on trade in hazardous chemicals and pesticides (the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, 1998), on persistent organic pollutants (the Stockholm Convention on Persistent Organic Pollutants, 2001). The Minamata Convention on Mercury, 2013, the first to regulate the production and trade of heavy metals, is one of the latest important international environmental agreements. Negotiations over agreements to address other global environmental problems are in progress.

The Paris agreement, one of the major international agreements addressing the problem of climate change, was adopted by 196 countries in Paris in 2015. The ambitious goal is to limit global warming to well below 2°, preferably to 1.5°C, compared to pre-industrial levels. Countries submitted their national plans to achieve climate neutrality by 2050. For the first time, the developing countries undertook obligations to make voluntary contributions to reducing emissions. The developed countries pledged to provide financial aid to less endowed and more vulnerable countries.

Many states have changed their economic strategies and policies in line with the green agenda. Climate policy has received special attention at all levels. Its implementation is stimulating the energy transition—the transformation of the energy system through a shift from fossil fuels to alternatives, including not just renewable energy but nuclear power and hydrogen energy as well. In this respect, the solution to environmental, primarily climate issues, is increasingly intertwined with energy policy. In the past, it was mainly the specific feature of the EU policy, while now, other countries are also adopting corresponding policies. Over 170 countries have set targets to develop renewable energy sources (), and over 30 on hydrogen (Hydrogen Council, 2021). Over 140 countries have announced or plan to achieve net-zero emissions targets by 2050 or 2060: those countries account for about 90% of global CO2 emissions. More regions, cities, and companies are setting carbon neutrality targets. In some countries, COVID gave a new impetus to the implementation of environmental policy, including the climatic component.

Thus, the pressure of the environmental protection factor on the world community is growing. Recognizing the objectivity and the lack of alternatives to the green development path (given the survival of mankind, not self-destruction or military conflicts), the foundation for the advance of the green economy targets on the international level tends to be national and business interests and the economic potential of countries. Despite more efficient use of resources and other achievements, while promoting green economy agenda large developed and politically strong countries

continue their policies with aggressive consumption of global resources, causing further degradation of the environment. Such consumption standards are copied by rapidly developing countries, such as China, whose impressive economic achievements were attained at the cost of colossal environmental costs. Environmental reasons are often used as pressure factors against other countries, which are unable to quickly transform their economies and policies for economic reasons and due to the inertia of their development.

1.8 Impact on World Economy and International Business

Responses of the World community to environmental challenges accelerated the process of deep changes in the world economy and international business. At the core of this process is the energy transition accompanied by the transformation of all the elements of the world economy.

The positive impact of the economic transformation is ensured by the cost-cutting capacity of the so-called "brown economy".[2] Research confirms that the costs to protect the environment are considerably lower than those associated with its deterioration. For example, the expenses to prevent deforestation and forest degradation amount to €1 billion, but they could save the EU economy at least €3.2 billion annually (European Commission, 2021). At the same time in case this process slows down future costs for the "greening" of the economy could become much higher due to the so-called lock-in effect.[3]

The share of the green sector in the economy is on the rise and amounts to 3–6%. The green sector now is roughly equivalent to the fossil fuel one. Although the market share is relatively small, over the last few years its pace has exceeded any other sector of the world economy. According to forecasts, the environmental markets will become the leaders in the twenty-first century.

One of the major fast-growing segments is the global alternative energy market, with real production growing 10–20 times faster than expected. Even though the share of renewable energy in the global energy mix in 2020 was estimated at 6% (see chapter "Resources of World Economy: Real Capital"), it accounted for 90% of generating a capacity increase in the world (IEA, 2021). The main growth region is the Asia Pacific market, its share in 2020 already amounted to 35% (Allied Market Research, 2021). A relatively new nascent market is the hydrogen energy market.

An important trend is the integration of the environmental component practically in all global industries: automobile, agriculture, tourism, and others. The global market share of electric cars reached in 2021 almost 9% of global car sales and the global electric car park stood at 16 million (IEA, 2022).

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[2] "Brown economy"—a traditional economy with a high grade of environmental pollution.

[3] A situation when the choice of one technology prevents a further switch to a different technology due to additional costs.

The share of the environmental sector in international trade is growing as well. Its estimates vary depending on the classification since there is no consensus over it. International trade in environmental goods and services increased almost fourfold from 2000 to 2020 (IMF, 2022). In 2020 international trade in environmental goods alone totaled $1.33 trillion (UNCTAD, 2021), which accounted for some 8% of the international trade in goods and about 11% of manufactured goods trade. Top exporters of environmental goods in 2019 were the EU-27 (with a share of 39%), China (21), the US (8), Japan (7), Republic of Korea (4) (UNCTAD, 2021). However, the trend of growing share of environmental goods is accompanied by the rise in the trade of environmentally hazardous products, for example, dangerous waste, and rare species of animals and plants.

A special role in the implementation of the green economy strategy is attributed to investments, as they determine the future of the world economy. Over recent years, there has been a particular focus on the environmental component in world investment. The principal investment area is energy transition, which increased three-fold since 2010 up to $755 billion in 2021. Investors are actively reallocating their investments from fossil fuel production; companies are opting out of its use. Driven by active state policies and decreasing costs due to new technologies renewable energy has become the main investment area. In many countries renewable energy has become the cheapest source of energy (since 2010 the solar energy cost has fallen by 85%) (IRENA, 2021a).

The costing analysis estimates of the energy transition by 2050 vary considerably, from $73 trillion (Stanford University) to $125 trillion (UNFCCC) and up to $131 trillion (IRENA, 2021a), i.e., they are comparable to the global GDP or even higher, which determines annual expenses of $2.5–4.5 trillion. Therefore, the cost is high but feasible, especially given that price decline of renewable energy and other clean energy sources exceeds the forecast, which will allow us to save trillions of dollars (Piskulova, 2022). Most investments are needed for the decarbonization of the electricity supply as well as for transport and buildings (UNFCC, 2021).

COVID gave a new impetus to green investments. Globally, the green stimulus to overcome the economic crisis in money terms is estimated at over $1.8 trillion (to compare: to overcome the financial and economic crisis of 2008–2009 financial stimulus made up $650 billion) (Finance for Biodiversity Initiative, 2021).

A special role in the realization of SDG is played by FDI. In 2015–2019 average announced capital expenditure on greenfield FDI projects in eight main sectors amounted to $134 billion per annum, with a focus on renewable energy. Greenfield FDI in renewables exceeded flows into fossil fuels for the first time (FDI Intelligence, 2022). The progress in SDG investment is evident in transport infrastructure, telecommunication, food and agriculture, climate change mitigation, ecosystems, and biodiversity. At the same time, global investments in SDG remain far from the target to meet the $2.5 trillion annual financing gap for developing countries (UNCTAD, 2020).

Public and private development banks, central banks, sovereign wealth funds, commercial and investment banks, pension funds, insurers rating agencies, and stock exchanges are allocating more and more funds to finance sustainable development

projects. Climate investment funds, such as Green Climate Fund and Global Environmental Facility, have become an important source of finance in the climate sphere, especially in developing economies. The global green bond market has seen substantial growth as well. In 2021 the market experienced its largest growth to just over half a trillion and could reach $1 trillion by the end of 2022 to reach $5 trillion by 2025 (Climate Bonds Initiative, 2022).

"Greening" is becoming an important part of the international innovation business, where the share of environmental activities in the twenty-first century alone increased from 7% to over 10%.

A big emphasis is laid on seeking a solution to the climate change problem, which requires major scientific and technological breakthroughs. Now there are many technologies to facilitate the energy transition (renewable energy, green hydrogen, modern bioenergy) and their combination can allow for realizing the ambitious plans (IRENA, 2021a, 2021b).

Increased financing is also stimulated by state policies. Green innovations are becoming an integral part of state innovation strategies (Brazil, Canada, China, Finland, Germany, Japan), energy strategies (Austria, Australia, Norway, Portugal, Switzerland), water and transport strategies (Israel), green growth strategies or plans (Belgium, Denmark, Hungary, Ireland, Republic of Korea, Luxemburg, South Africa, Sweden).

The environmental factor stimulates the research, scientific and information exchange between the countries. The depth and scale of environmental problems mean that even the most developed states for a variety of reasons are incapable of carrying out costly and diversified research requiring the concentration of all mankind's efforts; thus, cooperation is the only feasible path. The following "couples" of countries and territories led by the number of joint inventions: USA-China, USA-India, USA-Canada, Taiwan-China, USA-UK.

However, international trade and FDI can play a negative role in the environment by increasing demand, expanding production, and generating more waste. For example, trade in wild animals and plants leads to the contraction of biodiversity. Estimates attribute global trade to nearly one-third of the species threatened with extinction on the global level (UNCTAD, 2021).

1.9 Business and ESG

The transformation of the world economy and international economic relations is largely driven by the deep penetration of environmental, social, and governance (ESG) approaches in business, primarily MNEs. ESG components are a set of standards for business operations, considering social and environmental factors. They may include the effectiveness of resources used, the discharge of waste, carbon emissions, labor relations, the relationships with people and institutions in the communities, the practices of legal and decision compliance, etc.

The role of businesses, primarily MNEs, in the transformation of the world economy and the realization of a sustainable development strategy is of a dual nature due to their economic and political power as well as their goals.

The international production of MNEs encompasses almost all countries and economic activities, stimulating globalization. The aim of businesses to maximize their profits encourages the unlimited expansion of operations and relocation of MNEs capacities to regions with better economic and political conditions to minimize environmental costs. MNEs are using more and more resources and polluting the environment, incurring bigger responsibility for planetary environmental problems and objectively contradicting the sustainability of development. In developing countries, big corporations are often in control of resources. As an example, the modern mega-mining activities of MNEs associated with commodification and seizure of land in the Global South cause large-scale pollution and water contamination. Inequalities and human rights violations are further exacerbated, in particular through the proliferation of advanced technologies of concern (e.g., the use of GMOs). The corporate monopoly in many spheres, including mass media, greatly influences national policy-shaping.

At the same time, the increasing role of major companies, primarily MNEs, in the world economy and in political arena makes it impossible to implement the sustainable development strategy without their involvement. MNEs control about half of the world's industrial production; they account for the biggest share of international trade and investments and are major generators and users of the newest technologies.

The global capital of MNEs in the world economy shapes and controls the organization, location, and distribution of resources, production, and consumption to a considerably larger extent compared to state and national companies. MNEs are the main global producers and exporters of environmental goods and services, objectively contributing to the realization of a sustainable strategy. At the core of MNEs activities are long-term production ties, and global value chains under their control account for 50–80% of global trade. Investment decisions by big companies can create global demand, impact employment and technological progress, enhance productivity and efficiency, and promote social and environmental standards along the value chain.

Over the recent decades, the attitude of businesses to sustainable development has significantly evolved, ESG factors have become increasingly predominant in business strategies. In 2021 at the World Economic Forum more than 60 corporations with a market capitalization of over $4 trillion, pledged to adopt a new set of ESG reporting norms. As of the end of 2021, most of the 30 biggest companies in some sectors made net-zero pledges, including the largest US and European oil and gas firms, utilities, and banks. At Climate Action 100 +, an investors group of 500 companies with over $47 trillion in assets under management, demanded that 160 world major companies, representing 80% of industrial emissions, should publish strategies to reduce emissions by 45% by 2030 and to reach net zero by 2050 (KPMG, 2021).

The attitude has changed mostly due to government regulation, lower environmental and social risks, increased competitive advantages resulting from the improved image, reducing costs, higher capitalization, and winning new markets.

An important factor in the greening of MNEs' activities is state regulations based on international agreements. The responsibility of the business for the environment is stipulated in many international documents, including the Declaration of the UN conference on the environment in Stockholm in 1972, the report "Our common future", principles of the Rio de Janeiro declaration on the environment and development, and other subsequent documents.

Embedding ESG in the business strategy is now essential to minimize regulatory and legal risks. McKinsey analysis shows that about 1/3 of corporate profits are at risk caused by state interventions. The risk can reach 60% in the automotive, aerospace and defense, and tech sectors, where government subsidies (among other forms of intervention) are prevalent. Risks may be reduced with companies' better involvement in ESG goals by lower loan and credit risks and higher credit ratings as well. Most companies carrying out the goals do not experience a drag on value creation but have higher equity returns.

An important factor contributing to the changes is the improved company's reputation in the eyes of the public, employees, consumers, and other companies including investors, insurance, auditor, and credit rating agencies. The impact of this factor is increasing due to the quick development of modern types of communication, including social networks. Setting environmental and social goals increases staff motivation. Studies show that positive social impact correlates with higher job satisfaction.

Improvement of the reputation contributes to higher capitalization of companies. Analysis revealed the increase in financial value on account of adopted corporate and social responsibility, which was noted by almost half of 250 major corporations (KPMG, 2013). The increase in capitalization depends on the scope of activity: in the traditionally "dirty" industries, the greening of production leads to higher equity prices.

ESG may increase the competitive advantages of businesses due to the changes in consumer preference, cost reduction, and shifts to more sustainable businesses. Since introducing its "pollution prevention pays" (3Ps) program in 1975 the company 3 M has saved $2.2 billion due to preventing pollution using improved manufacturing processes, redesigning equipment, and recycling and reusing waste from production (McKinsey, 2019). New digital technologies are used to reduce costs. For example, a leading European minerals company used a digitally enabled energy control tower with a cloud-enabled data platform and AI for an integrated energy management solution. As a result, it reduced energy consumption by 5–10% and is on track to save costs of €8–9 million a year (BCG, 2021).

Sustainable business may lead to winning new markets. Examples of new opportunities are hybrid and electric vehicles, currently produced by many automobile companies. Finnish company Neste, operating in petroleum refining for over 70 years, now generates more than 2/3 of profits from renewable fuels and sustainability-related products (McKinsey, 2019).

Company Total's investments in renewable energy projects

Total's plan for renewables is to invest $500 m a year in clean energy technologies. That figure is about 3% of the French oil major's total capital expenditure, with plans in place to ramp that up to 20% over the next 20 years. Over the past 10 years, it has made several strategic investments, which included $1.4bn being spent on acquiring a 60% stake in US solar firm SunPower in 2011.

Total is aiming to become a global integrated leader in solar power and has 1.6 gigawatts (GW) worth of capacity, and plans to increase that to 5GW over the next five years.

In 2016, it purchased French battery manufacturer Saft for $1.1bn and bought Belgian green power utility Lampiris for $224 m. Total acquired a 74% stake in the French electricity retailer Direct Energie for $1.7bn in 2018, propelling the company forward into being one of the top utility providers in France.

BCG (2021). Climate Innovation: Diversification and Green Business. https://medium.com/bcg-digital-ventures/climate-innovation-diversification-and-green-business-models-ec24d4bcb7f4;

Murray J. How the six major oil companies have invested in renewable energy projects. 16 Jan 2020. https://www.nsenergybusiness.com/features/oil-companies-renewable-energy/

MNEs themselves initiate the usage of voluntary environmental instruments (certifications, non-financial reporting, etc.) which can improve existing weaknesses of environmental regulation and the quality of environmental management institutions in developing economies (Shvarts et al., 2015). Several voluntary instruments have been developed in the areas still not covered by national and international regulations. Initially, some of them were voluntary, but later became compulsory instruments of state and international policies. Common principles are high environmental standards, the principle "from cradle to grave" (responsibility for the entire life cycle of a product) and "closed-loop" production, i.e., cyclical production, including waste recycling and their use in the new production, etc. For example, General Mills works to ensure that its ESG principles apply "from farm to fork to landfill" (McKinsey, 2019). Starting 1990s corporate codes on social and environmental issues are widely used.

Practically all MNEs have introduced changes to the management structure, they actively participate in international environmental initiatives, and set up organizations promoting the ideas of the green economy. An important role is played by initiatives within the UN framework, World Business Council for Sustainable Development, UN Global Compact, which developed rules of responsible business practices, Principles of responsible investments for the global investors' network, Coalition for an Environmentally Responsible Economy (CERES), The Task Force on Climate-Related Financial Disclosures (TCFD) and others (Tables 2 and 3).

MNEs are increasingly integrating sustainability into requirements across GVC. Investment decisions and supplier selection are now being weighed on ESG concerns. A Bank of America institutional investor survey confirms that climate change is a top concern for 72% of institutional investors. In the last years, global ESG-oriented

investing rose substantially, in 2016–2020 from $23 trillion to $35 trillion, reaching more than 1/3 of assets under management in major economies. In 2025 they may reach $53 trillion (Global Sustainable Investment Alliance, 2021).

It is worth noting that only real environmental protection measures contribute to the improvement of corporate reputation. Some companies unreasonably positioned their products as environmentally clean, which later did not meet the expectations, with subsequent damage to the company's reputation and even the idea of greening production as such. A classic example is Volkswagen, which admitted to cheating on emissions tests by using software that reduced the level of emissions during the tests.

Despite the significant progress it seems premature to claim that those progressive trends have become prevailing in the business activities of the companies, although the situation is dynamically changing. Business operations, first those of MNEs, continue to cause enormous and increasing damage to the environment. This is caused by many factors, in particular the lack of appropriately formulated goals and insufficient support at the state level, lack of relevant information and education, the inertia of thinking at the company management level, and other reasons.

Table 2 Development of environment-related technologies (patents) share in all technologies, %

	1990	2000	2018
World	6.69	7.03	10.26
OECD countries	6.67	7.11	10.91
EU-27	7.61	7.75	12.90
USA	6.08	5.64	9.47
Non-OECD countries			
BRICS	9.95	5.92	8.41
China	9.86	3.67	8.35
India	4.62	4.49	8.50
Russia	9.26	12.46	8.86

Source OECD statistics (2022). https://stats.oecd.org/Index.aspx?DataSetCode=GREEN_GROWTH#

Table 3 Global sustainable assets under management, $ billion

	2016	2018	2020	2025
Total assets under management	81,948	91,828	98,416	–
Total sustainable investments under management	22,872	30,683	35,301	53
Share of sustainable investments (%)	27.9	33.4	35.9	–
Increase in sustainable investments (compared to prior period)	–	5.5%	2.5%	–

Source Global Sustainable Investment Review 2020. Global Sustainable Investment Alliance, 2021. http://www.gsi-alliance.org/wp-content/uploads/2021/08/GSIR-20201.pdf

2 Conclusions

1. This chapter examines global environmental problems, some of which are extremely difficult for humanity to solve. In recent years, the World community has undertaken concerted efforts to combat these problems at all levels. However, those efforts are not yet sufficient to solve the most complex and urgent problems—such as climate change and loss of biodiversity—for objective and subjective reasons, including the need for unprecedented investments and breakthrough technologies in several areas, difficulties faced by developing economies (especially resource-based economies) and social and cultural motives.
2. Presently, the global economy, international trade, investments, and scientific and technical cooperation are undergoing fundamental changes, and the environmental component is increasing its role and share in all the elements of the global economic system; according to forecasts, in the twenty-first century, it will be dominant in all those elements.
3. The deep changes are associated, among other things, with deep penetration of ESG approaches into business activities. The new approaches are mostly driven by government regulation, lower environmental and social risks, increase in competitive advantages due to improved image, reduced costs, higher capitalization, and winning new markets. At the present stage, the ESG strategy is increasingly consistent with the achievement of the main goal of any business—to maximize profits. However, this chapter cautions against an overly optimistic assessment of MNEs environmental orientation. Despite significant progress, claims of the dominance of progressive trends in the company's practice seem premature, business operations continue to cause increasing damage to the environment, although the situation is changing dynamically.
4. While environmental problems require deep awareness and more active urgent actions, it is necessary to carefully assess the potential of developing economies, which do not always have the investment and technological capacity to rapidly restructure their economies. To evaluate these opportunities more research is required.

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