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The New Geological Epoch, “Anthropocene,” as a Result of Human Economic Activity

Abstract

The impact of human economic activity on the environment and its irreversible changes. An interdisciplinary approach to the development of the economic system has been used in this paper due to the fact that the subject of the study goes beyond the functional economic sciences, and economics in general. The study is aimed at investigating the interaction of man, as an economic agent, and the environment. It has led to the study of research papers devoted to natural science, in particular, to changes in geological epochs, sustainable development and economic processes from the position of their influence on the environment. This allowed us to synthesize new economic knowledge about the importance of economic activity in the formation of the new geological epoch, “Anthropocene”. Based on the results of the study, the influence of human economic activity on the environment in the light of the geological, technocratic and economic development of society has been proved. The scientific results which were obtained can be used in reforming national economic systems by adapting them to leading world concepts on sustainable development.

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1. Introduction

On January 30, 2014, UN Secretary-General Ban Ki-moon made a speech at the inauguration of the Scientific Advisory Board in Berlin where he noted: “That model [of development] is unsustainable. We have entered a new era, which has been given the name “Anthropocene.” Human activity is now having a direct and measurable impact on the planet’s life support systems. We have to weigh the social, economic and environmental dimensions of sustainable development equally, under a single agenda.” In 2015, the UN chief urged the use of the scientific potential in defining the new model of human development).

This quote is the basis for the formation of new paradigms of social development and, accordingly, the transformation of the development of science. Man’s economic activity is of decisive importance in the process of the transition to the new geological epoch of the “Anthropocene.” It is man who is at the center of climate change and is responsible for the further functioning of the Earth.

We agree with Professor Will Steffen of the Australian National University Climate Change Institute. The Anthropocene defines that the human impact on the environment is so significant that the Earth entered a new geological epoch. Humankind has become so large and active that it now rivals some of the great forces of Nature. What are the consequences of the Anthropocene for the future of mankind in the twenty-first century and beyond? Can we become active and efficient conductors of the Earth system that is our life support system? The answer to these and other urgent issues is possible through the search for new approaches to human economic activity that require new paradigms for the development of economic science, the concepts of the formation of economic relations, and the integration along with new knowledge about the ecological condition and the development of civilization.

Thus, the economic activity of humans and economic relations as a whole are interconnected processes that take place in the environment. In particular, this relationship is connected with the following issues: firstly, man (in the early human development epoch) used economic benefits first to ensure his life and then for economic enrichment. This, in its turn, affected the state of the interaction system between economic and natural systems; secondly, natural conditions affect the economic activity of man and his economic enrichment. With the development of economic relations, these relationships have become critically exacerbated, which influenced the process of human life support.

Therefore, the basis of transformation processes in socioeconomic relations is the interaction of economic and natural processes with each other. Thus, the search for alternative theories of economic relations should be based on the study of the relationship of these systems.

2. Current Scientific Research Analysis

The development of this is possible only on condition that there is a theoretical rationale and a study is performed on all the components of the impact of human economic activity on the environment, and the impact of the current state of the environment on the development of economic systems as the basis for human life support. So, we should agree with the founders of the doctrine of the “Anthropocene”, Will Steffen, Jacques Grinevald, Paul Crutzen and John McNeill, who said, “Climate change has brought into sharp focus the capability of contemporary human civilization to influence the environment at the scale of the Earth as a single, evolving planetary system. Following the discovery of the ozone hole over Antarctica, with its undeniably anthropogenic cause, the realization that the emission of large quantities of a colourless, odourless gas such as carbon dioxide (CO₂) can affect the energy balance at the Earth’s surface has reinforced the concern that human activity can adversely affect the broad range of ecosystem services that support human (and other) life” (Steffen et al. 2011). Grinevald (2007) believes that such consequences can cause a “crisis in the biosphere.” In addition, this was repeatedly indicated in the reports of international organizations and programs (Intergovernmental Panel on Climate Change (IPCC), 2007; MEA (Millennium Ecosystem Assessment), 2005; NRC (National Research Council 1981).

In the context of the influence of the economic component on environmental problems, the impact of human economic activity is the primary reason why we are moving to a new geological epoch, the Anthropocene. After all, as indicated in the research of British scientists, “Humans have changed the Earth in both positive and negative ways. The key challenge for the future is to ensure that the negative changes do not outweigh the positive ones. Optimizing human influences within an ever- (and inevitably) changing Earth System of huge complexity has many dimensions – scientific, social, economic and ethical – that interact with and should help to steer decision-making towards more sustainable and equitable choices” (Oldfield et al. 2013).

First of all, this is the basis for identifying and developing priority areas for the development of economic science in ensuring the security of mankind; secondly, the development of a new economic doctrine would be aimed at preserving the environment. The achievement of this requires an interdisciplinary study, the synergy of which will enable us to obtain new economic knowledge.

An analysis of the current situation regarding waste volumes in Ukraine showed that about 1.25% of the country's territory is occupied by landfills. According to (Mykhailenko 2008), about 35 billion tons of solid waste are concentrated on domestic dumps, and every year, as Mikhailenko (2008) states, "12 thousand unauthorized waste spoils have been created in the country because there is simply no land for garbage." Fig. 1 shows data on the volume of generated waste in the country in recent years.

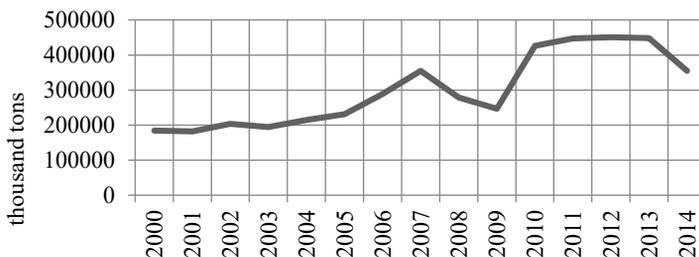


Figure 1. Dynamics of waste generation volumes in recent years in Ukraine

Source: Official site of the State Statistics Service of Ukraine.

The volume of waste generation increased significantly in 2013 compared to 1995, i.e., by 271,718,000 tons or by 154.04 %. The largest amount of waste for the period 1995–2013 was in 2012 – 450,727,000 tons; however, this indicator is more or less the same as in 2013, with a difference of only 2,609,000 tons or 0.58 %. It is obvious that the smallest amount of waste was created in 1995, i.e., 176,400,000 tons. It means the dynamics of the volumes tend to increase, which causes the problem of the accumulation of waste, the use of large areas for its disposal and the search for tools for the effective management of waste.

The analysis of scientific research on the problems of the human impact on the environment in the context of the emergence of the theory of the Anthropocene shows that most of the issues are considered in the papers of scientists who are representatives of natural sciences.

Aspects of an economic nature are considered only in the works of Gibson-Graham and Roelvink (2009), Cameron and Gibson (2005), Gudeman (2001), Brown (2012), Meadows et al. (1972), and Herman (1994). These pieces of research substantiate the impact of human economic activity on the environment, becoming the basis of the Anthropocene; however, nowadays, it is necessary to prove not only the influence, but the interrelation of man's economic activity with the environment and the development of new economic postulates in the Anthropocene environment. This, in its turn, determines interdisciplinary research based on the works of the researchers of global change and the founders of the theory of the Anthropocene.

Interdisciplinary research is necessary to prove the impact of human economic activity on the environment. The concept of the Anthropocene was suggested almost

twenty years ago by the Nobel Prize winner Paul Crutzen (Crutzen 2000), and was introduced to describe quantitative changes in the relationship between mankind, as a biological species, and the global environment. However, the issue of human influence on the environment was raised long before its determination as a new geological epoch. Back in 1873, this issue was investigated by the Italian geologist and Catholic priest Antonio Stoppani. The first scenario of global warming was described in 1896 by Arrhenius (Arrhenius 1896). Significant interest in the problems of the human impact on the environment was shown in the works of Marsh in the book "Man and Nature" (Marsh 1874) and "The Earth as Modified by Human Action." Another significant early work was "Man as a Geological Agent" by Sherlock (Sherlock, 1922). A significant contribution to the development of the doctrine of man's impact on the environment was made by the Austrian geologist Eduard Suss, who introduced the concept of the "noosphere." A breakthrough in this direction was carried out by Ukrainian scientist Vladimir Vernadsky in the work "Biosphere and Noosphere" (Vernadsky 1945). The idea of man as a new geological force was presented in the work of Osborne, "Our Plundered Planet" (Osborn 1948), while Lovelock (1988) substantiated the global conceptual basis of the human impact on biogeochemical cycles.

Anthropocene is a neologism in the scientific terminology; however, taking into account the mentioned above, we have to agree with Steffen that the idea of the Earth's natural epoch, in which "mankind, notably 'civilized man' is not completely new and was mooted long before the rising awareness of the global environment in the 1970s" (Steffen et al. 2011).

Thus, the study is based on the theoretical underpinning of the impact of human economic activity on the environment, and on the work of both economists and naturalists. We consider that this will allow us to obtain new synthesized economic knowledge that will be used as the basis for developing a new economic doctrine and which will provide an opportunity to develop a mechanism for managing the economic and environmental security of economic entities, and its information space, which is based on the synthesis of accounting and economic analysis.

3. Statement of Basic Material. Background of the Development of the Idea of a New Geological Epoch

The collision of human activity with nature occurred many times in the past on a sub-global scale, which led to a new paradigm of integrated socio-ecological systems. Globally, this paradigm challenges humanity, which must become an active vehicle for our own life support system. We are the first generation with knowledge of how our actions affect the environment, and thus, the first generation with the power and responsibility to change our relationship with the environment.

Some researchers, such as Richardson, Strager and Rosing, believe that the Anthropocene idea can be rejected by various representatives of the socio-economic forces. "The Anthropocene, gaining popularity in the masses, can stimulate a similar reaction as Darwin's theory" (Richardson et al. 2014). We cannot agree with the scientists, because the perception of the concept of the Anthropocene in the minds of the different economic agents can take quite a long time. However, the problems caused by the ecological crisis have already threatened the existence of specific components of the natural environment, resulting in an interest in these problems by society, countries and international organizations, on the one hand, and the economic development due to the reduction of natural resources and, accordingly, the possibility of real sector of the economy, affects the interests of the private sector, on the other. In general, we can say that the urgent problem of the economic and environmental development of society caused by human economic activity affects the interests of all social and economic agents.

The term "Anthropocene," unlike other geological epochs (the previous era was the Holocene), describes human activity from a completely different point of view, i.e., the Earth is moving to a qualitatively new geological epoch, the cause of which is not a natural transformation, but the economic activity of man. As the name suggests, the defining feature of this era is the emergence of human action as a critical force in a range of biophysical systems, in particular, the accelerated development of entrepreneurship, the population doubling, including in cities, and increasing oil consumption (Meeting the challenges of the anthropocene, 2007).

The consequences of human economic activity on biophysical systems have become so wide and deep that in some papers (Meeting the challenges of the anthropocene 2007, p. 17) the human-dominant ecosystem is talked about, which is the reason for the transition to the new geological epoch, Anthropocene. Moreover, it should be noted that such changes and transformations in the environment are caused not by man as a being, but by man as an economic agent. After all, man as a being is a part of the environment, and man as an economic agent uses and influences the condition of the environment, and this influence can be determined not only as a positive factor but a negative one as well that leads to a dichotomy of the relationship between man as an economic agent, man as a being and the environment.

Considering the economic activity of man through the prism of concepts, i.e., man as a physical being and man as an economic agent, it should be stressed that all these are based on the motives and needs of man. With the development of society, human needs and, accordingly, the motives for the economic activity of man have changed. We agree with the economist-anthropologist Peter Brown that "the Western tradition has become globally important. The idea that a person is special and is not a part of nature and, therefore, is not subject to its rules, controls and restrictions, has gained 'acceptability'. This led to absurd ideas, for example, that we can manage 'pests' without consequences for ourselves" (Brown 2012).

In general, man as an economic agent should be viewed as a combination of an individual and the needs that motivate his/her economic activity. Economic activity aimed at meeting human needs affects the use of natural resources, modifying natural conditions via anthropogenic impact on the environment.

A characteristic feature of the modern world, formed by the industrial revolution, is man's world domination based on his growing dependence on energy. Pimm, Racell, Giteman and Brooks argue that "the pressure on the environment from growing human activity is sharply increasing. Over the past 50 years, people have changed the world's ecosystems faster and more intensively than in any other similar period in human history" (Pimm et al. 1995).

In general, we can say that man as an economic agent is a tandem of man as a human being and a number of motives and needs that were developed by mankind during the corresponding socio-economic transformational epochs. Fig. 2 is an attempt to visualize the functioning of man as an economic agent and the current trends in the transformation of its economic consciousness in ensuring the sustainable development of society and civilization.

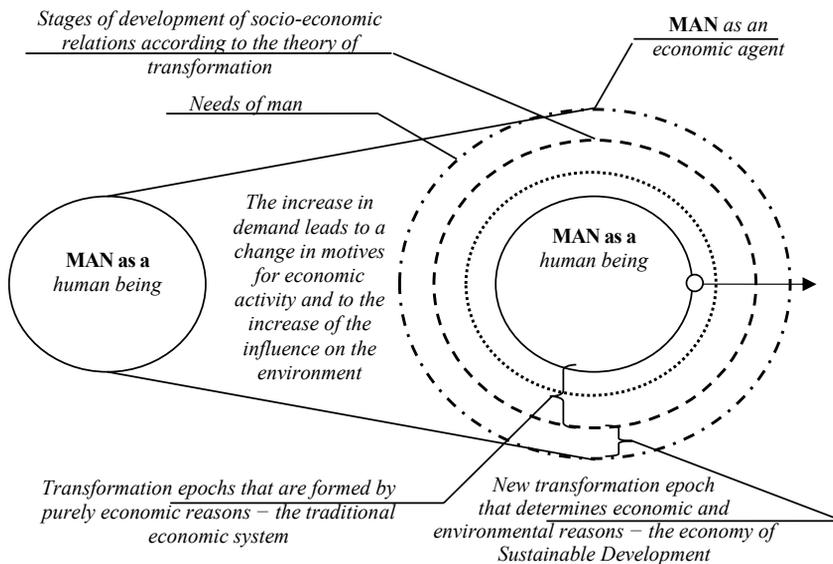


Figure 2. Human as an Economic Agent

Source: authors' own elaboration.

Man is both a component of biophysical systems as well as a factor which influences them. They are constantly interacting and inextricably linked with each other: human actions affect the biophysical system, changing its initial state and causing reversible and irreversible transformations; biophysical forces and their changes affect human well-being, and people react in turn to these forces. As an environmental issue, the Anthropocene epoch raises the importance of understand-

ing the nature of this interactive connection, new challenges for scientific research arise. In addition, the management of human systems which do not take into consideration the role of basic biophysical systems cannot claim success in the long term. The task that is set before us is to develop a science of related human-biophysical systems.

“The observation that human and biophysical systems are linked is not novel. Our aim here, however, is to argue that business as usual in scientific endeavors will not produce answers to the most urgent questions about coupled systems. In order to meet the challenges of the Anthropocene, we need to develop models and methods that are capable of illuminating the interactions between biophysical forces and anthropogenic drivers. Two scientific responses to this need are possible: one that is easier to pursue but somewhat limited and another that is more difficult but essential if we are to succeed in addressing our most pressing environmental problems.” (Meeting the challenges of the anthropocene 2007).

The second option is to transform business and enterprise management systems and, as a result, modify the information management space of economic systems at all levels. The transformation of the information space is associated with the need to develop a new methodology of accounting and economic analysis which will enable scientists to sort out the challenges of the Anthropocene as well as to reflect information links between man and biophysical systems and to influence them as well as their consequences.

4. The Evolution of Human Interaction with the Environment

The history of interaction between people and the environment has continued for a long time and began long before the appearance of modern man. It originated in the time of the ancestors of a modern man – hominids. It is worth noting that the beginning of the human-environment interaction also illustrates the inextricability of the relationship between man and the environment, because a change in man, his role in the ecological system and the nature of his impact on the environment, is a consequence of the functioning of biophysical systems. The beginning of the interaction was not caused by any invention of mankind. Man as a physical being, mastering fire, he only adapted to the existing conditions of existence and used only those tools that the environment provided him with. Developing along with the environment, adapting to its changes, man as a physical being has mastered more and more instruments, increasing the power of his influence on biophysical systems.

For nearly two million years, mankind and his ancestors have influenced the environment in various ways, but always by modifying natural ecosystems to gain an advantage in life support. Their knowledge was probably obtained empirically,

by observation, slowly becoming more efficient with a slight change in their environment, but they were never able to completely transform the ecosystems around them. Of course, they could not change the chemical composition of the atmosphere or oceans at the global level; thus, significant developments became possible only after the industrial revolution.

In the natural sciences, the geological epoch, which lasted until the beginning of industrialization, is called the Holocene. It was characterized by human influence on the environment only in terms of the use of fire, the development of agriculture and the partial use of fossil fuels. However, human impact on the environment can be seen at the local, regional and even continental levels, but people of the pre-industrial era did not have the technological or organizational means to dominate nature.

Pre-industrial people were still far from the modern civilization as we understand it today; however, they discovered some of the energy-intensive fossil fuels on which modern civilization is built. Having mastered fire, our ancestors had a powerful monopolistic tool, unavailable to other species. This advantage directed the movement of mankind towards the Anthropocene epoch. The remains of coal from the hearths show that the first use of fire by our ancestors, *homo erectus*, occurred nearly two million years ago. The use of fire was preceded by the development of stone tools and the manufacture of weapons, which was another important step towards the Anthropocene epoch.

Thus, by using the opportunities provided by the environment, man was able not only to achieve a quantitative increase in population, but also to obtain a source for the further qualitative development of his abilities, each of which gave new opportunities to influence elements of biophysical systems. According to the development of abilities, human needs appeared and modified, which ultimately led to the creation of economic relations and the formation of man as an economic agent.

The development of man as a physical being, caused by the use of fire and changes in his physical capabilities, led to a rapid growth of his mental activity, which led to the need for information exchange. Accordingly, these factors subsequently allowed the development of speech, and later of writing, which facilitated the process of accumulating knowledge and the social transfer of information from generation to generation. This was a factor in the development of human civilization, from being subordinate to the environment, man took control. All this led to a change in the initial state of the environment and, in particular, to the formation of the new geological Anthropocene epoch.

Mastering fire became the starting point not only for the development of mankind as a biological species, but also civilization. This was the starting point that allowed people to influence their environment. Of course, the force of the impact of modern mankind and primitive man cannot be compared, but it cannot be said that the results of human activity at that time did not have destructive consequences, since the use of fire led to a change in landscapes, the destruction and devas-

tation of territories, and the loss of animals. Given the size of the human population at that time, the results of human activity, although not positive, did not have global consequences and left the environment able to recover.

Returning to Fig. 1 it can be mentioned that the changing needs of man as a physical being prompted him to find more tools to influence the environment, and the development of economic relations is also a logical continuation of the continuous process of increasing and modifying the needs of man.

“The first significant use of fossil fuels in human history came in China during the Song Dynasty (960–1279) (21, 22). Coal mines in the north, notably Shanxi province, provided abundant coal for use in China’s growing iron industry. At its height, in the late 11th century, China’s coal production reached levels equal to all of Europe (not including Russia) in 1700. But China suffered many setbacks, such as epidemics and invasions, and the coal industry apparently went into a long decline” (Steffen et al. 2011).

While the Chinese coal industry began to decline in coal production for a number of reasons, the European coal industry began to grow from the 13th century. As the use of coal increased, so did the size of London. Coal became the main and most efficient fuel in the city due to its high energy capacity. By 1600, the City of London burned about 360,000 tons of coal per year (Brimblecombe 1987).

Thus, the humanity of the pre-industrial era really influenced the environment. Most of the changes were made on the basis of knowledge that was obtained as a result of observation or trial and error. Such changes were the result of attempts to facilitate the task of hunting, gathering and, as a consequence, farming. Pre-industrial humankind could not significantly change the ecosystem, but at that time there were no corresponding technologies that would allow it to be done and quickly affect the environment. Any impact was local and such that it was completely negated by natural changes in climatic conditions.

Throughout the entire Holocene, and with an increasing transition to agriculture, humanity increased its influence on the environment. Only after the industrial revolution began did this influence turn into a serious threat to global biogeophysical cycles on the Earth. In recent years, there has been an unprecedented level of global economic, cultural and political interconnectedness of mankind that has shaped the global social system of mankind, which is a key feature of the Anthropocene.

The original concept, which was conceived by Crutzen and Stoermer (Crutzen and Stoermer 2000), puts beginning of the Anthropocene in the early stages of the industrial revolution. Thus, the influence of man as a result of the industrial revolution goes far beyond the high concentrations of atmospheric CO₂ and their consequences. They include the depletion of resources and environmental pollution, as well as many other consequences: social, economic and political, associated with the rapid growth of mankind and the spread of globalization. In addition, economic and social consequences can be interrelated or run one after another.

“The industrial revolution that began in Britain in the 1700s, or the thermo-industrial revolution of the nineteenth century of Western civilization, marked the end of agriculture as the dominant form of human activity that had characterized the Holocene period” (Grinevald 2007). This was undoubtedly one of the major transitions in the development of human activity. The reasons for the transition of mankind to industrialization are also conditioned by the relationship between man and the environment: on the one hand, growing human needs, and on the other, environmental changes, which led to the search for new instruments of influence and, accordingly, this led to further changes.

Some scientists single out a material factor, such as the raw materials base (wood and coal), while others point to the existence and the development of social and political structures that rewarded risk and innovation. Separate issues related to legal regimes contributed to the birth of the banking system and market culture. Whatever the reasons for the formation of the market environment, the transition took place rather quickly, and individual countries (in particular, England) became industrialized, the transformation of other countries took place as well.

Industrialization has become the main direction of human development due to the extensive use of fossil fuels: first coal, and then oil and gas. Even today, mankind is not oriented to alternative sources of energy, but to sources whose restoration does not require time (wind, water, solar energy) or 100–200 years (plant energy).

Following the rapid growth in the amount of energy used by mankind, there have been rapid changes in all spheres of activity, and changes in the environment have also acquired a rapid character, giving more opportunities for the development. “The invention (some would say refinement) of the steam engine by James Watt in the 1770s and 1780s and the turn to fossil fuels shattered this bottleneck, opening an era of far looser constraints upon energy supply, upon human numbers, and upon the global economy. Between 1800 and 2000 population grew more than six-fold, the global economy about 50-fold, and energy use about 40-fold (27). It also opened an era of intensified and ever-mounting human influence upon the Earth System” (Steffen et al. 2011). All of the above is not only intended to illustrate the rapidity of the impact of mankind on the environment in the process of his evolution, but to draw attention to such an important resource as information used by mankind. It is the intensification of the process of cognition, the process of information exchange, that gives mankind the opportunity to expand spheres of influence on the environment and make the consequences of human activity global. Accordingly, the process of rapid industrialization could not but affect the environment. Deforestation and conversion to agriculture were extensive in the midlatitudes, particularly in the northern hemisphere. Only about 10% of the global terrestrial surface had been “domesticated” at the beginning of the industrial era around 1800, but this figure rose significantly to about 25–30% by 1950 (Lambin et al. 2006). Human transformation of the hydrological cycle was also evident in the accelerating number of large dams, particularly in Europe and North

America (Vorosmarty et al. 1997). The flux of nitrogen compounds through the coastal zone had increased over 10-fold since 1800.

Thus, the development of economic relations under the conditions of industrialization caused an impact on the environment. It is difficult to establish the exact date for the transition of different peoples to the Anthropocene epoch. It is clear that in 1750 the industrial revolution had just begun, but in 1850 it had almost completely transformed England and spread to many other countries of Europe and North America. Thus, we can assume that the year 1800 can be reasonably chosen as the beginning of the irreversible changes in the environment due to the economic activity of man, i.e., man as an economic agent.

5. The Great Acceleration as a Result of Stimulating Economic Relations

From the middle of the 20th century, the second stage of the development of the Anthropocene begins. It is called the Great Acceleration since it is exactly after the Second World War that the rapid growth of all spheres of human activities begins. The Great Acceleration took place in the intellectual, cultural, political and legal context, in which the increasing influence on the surrounding environment was not much taken into consideration when aiming to achieve important strategic decisions.

The beginning of the Great Acceleration was probably delayed for half a century, interrupted by the World Wars and the Great Depression. The genesis of this phenomenon became obvious in the period between 1870 and 1914. The growth of the population and the economic growth began to rise at this particular time. The Industrial Revolution gathered momentum and spread rather quickly, starting in England and a series of countries in Europe, before moving to North America, Russia and Japan. The groundwork for the postwar revival of this process was followed by the invention of the car and the airplane.

However, the Great Acceleration really began only after 1945. During the three decades between 1914 and 1945, the Great Acceleration was determined by changes in policy and the world economy. The following events were significant at this time: the First World War, the Great Depression and the Second World War. They slowed down the population growth, and froze the integration and growth of the global economy. “The growth of human activity since the mid–20th-century and the global scale impact on the different aspects of the planet’s ecosystems associated with it marks the second stage of the Anthropocene – the Great Acceleration” (Keeling and Whorf 2005).

The main transformation relating to the housing of people is the sharp increase in the urban population. The city slowly becomes the main place of residence for

people. In 1890, about 200 million people lived in cities all over the world, but by 2000, this index had increased to 3 billion (amounting to half the human population). According to a report on the status of urbanization in the world published by the McKinsey Global Institute (Dobbs 2011), there is a tendency for urban populations to increase.

“The lessons absorbed about the disasters of world wars and depression inspired a new regime of international institutions after 1945 that helped create conditions for resumed economic growth. The United States in particular championed more open trade and capital flows, reintegrating much of the world economy and helping growth rates reach their highest ever levels in the period from 1950 to 1973” (Steffen et al. 2011).

Global problems of environmental protection were largely ignored (Intergovernmental Panel on Climate Change (IPCC), 2007).

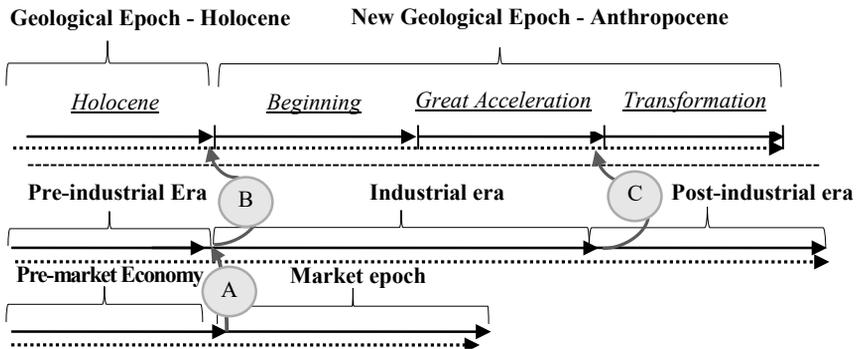
The originators of the Anthropocene conceptual foundation, Hibbard, Crutzen, Lambin, Liverman, Mantua, McNeill, Messerli, and Steffen W. point out that “the human activity changed after the Second World War. Though the consequences of human activity for the environment were noticeable even before the middle of the 20th century, this influence began to stand out obviously from the variability of the Holocene epoch from the middle of the 20th century. The changes were so fundamental that the period from 1945 till 2000 was named the Great Acceleration” (Hibbard et al. 2006).

Steffen (Steffen et al. 2011) argued that humanity is now entering a third stage of the Anthropocene. A special feature is the increase in understanding of the human impact on the environment at a global scale, and the first attempts to create a global control of the system in order to manage humankind’s relationship with the various ecosystems on the planet. We agree with this point of view, because the development of the present-day economic science goes beyond the solution of purely economic issues. In turn, the theory of sustainable development is accepted as being of the highest priority at the international level today.

6. Geological Changes through the Prism of Technocratic and Economic Transformation

Some scientists argue that the focus only on environmental problems will no longer have the necessary effect, and that the problem resides in the combination of several large-scale problems in various sectors (for example, environment protection, demography, pandemics, or political instability). Climate change itself serves as an example of the complex combinations of various factors. Crises of different systems (economic, social, political, ecological) can coincide or start at the same time as each

other, so there is a need to look beyond narrow, sector-wide approaches for the development of more coordinated and effective institutes which can have an impact on processes at such a level. The interconnection of different systems can be observed clearly enough when studying the transformation of society by technocratic approach as well as by periodization of the economic development (Fig. 3).



*A – the formation of a market economy is a factor for the beginning of industrialization;
B – the beginning of industrialization, i.e., the beginning of the new geological epoch, Anthropocene;
C – the transition to the post-industrial era, i.e., the formation of the alternative economic concepts of ecological directions*

Figure 3. The Influence of Economic Activity of Human Beings on the Environment through the Prism of the Geological, Technocratic and Economic Development of Society

Source: authors' own elaboration.

On the basis of the information given above, we can see that human economic activity, which is associated with the transition to a market economy, determined the development of science and manufacturing; it also marked the arrival of industrial society. Industrialization, in turn, required an increase in amounts of natural resources used and substantial influence on the environment (run-offs, airborne emissions, pollution of water and land resources). It became the precondition for the change of the geological epoch, and the transition to the new geological Anthropocene era, in particular. The specified processes made man's interaction with the environment substantially more complicated. That is why knowledge is necessary for the management of present-day interactions between the man and the environment.

Perhaps it is premature to speak about a complex global society; however, the current situation demonstrates dynamics in this direction. Science can help to lead the the global society, which is developing, to a greater awareness of the consequences of its development, and guide it toward a responsible, rational use of the natural resources on which it depends. The capacity of systematic self-organization on a global scale also allows mankind to use natural resources and knowledge for self-organization.

Thus, the relationships between geological epochs and sub-stages, the technocratic and economic approaches to transformation, have been determined based on the research findings of scientists on the issues of the transition to a new geological epoch and the theories of the transformation of socio-economic systems. The conclusions drawn about the global influence of man, in his capacity as an economic agent, on the environment and its irrevocable modification require the search for new, alternative economic systems. A new economic system that allows for the harmonization of the functioning of man as an economic agent for the environment should be based on the principles of sustainable development, which is the mainstream of the economic theory, and has become the leading conception in international and national policy. That is why, returning to Fig. 2, the stage of transformation in the study of the geological development and post-industrial society should be a transition to a new alternative economic system. The theory of sustainable development should become a higher priority, as long as it is oriented to harmonizing economic, ecological and social goals of humanity, and its principal aim is the life support of future generations.

Sustainable development works towards an integrated approach to managing the economic and environmental security of both the entire system and individual elements. This is due to the aims of sustainable development, and its principal aim is the life support of future generations. Achieving the specified aims determines the parameters of transforming and developing a theoretical and methodological background of managing the economic security of enterprises as the main agents of the economic system.

As can be seen from the above, the relationship between the operation of environmental and socio-economic systems of society, which are interrelated and interact via the prism of the activities of man as an economic agent, has been defined as a result of the undertaken study. The necessity to consider man as an economic agent through the system of development of his/her needs has been grounded. The influence of man's economic activity on the environment through the prism of geological, technocratic and economic development of society has been proved.

7. Conclusion

The following results of the research were obtained:

1. The cooperation of man with the environment through the prism of enterprise has been defined by studying the consequences of his economic activity and the formation of the new Anthropocene epoch. It has been proved that the economic activity of enterprises, which has an impact on the state of the natural environment, is caused by the functioning of man as an economic agent due to his / her motives

and needs, which were developed by humanity during the certain socio-economic transformational epochs. The cooperation of enterprise with the environment is a complicated system, which has opposite effect, because the results of man's economic activities, which have an impact on the biosphere, determine its modification that changes the properties of the environment of its functioning, which, in turn, transforms the motives and needs of man. That is why sustainable development is an alternative economic theory, which was formed as a result of the transformation of the system of motives and needs of man as an economic agent.

2. The change of motives and needs of man as an economic agent is a precondition for the transformational processes in economic systems of different levels (micro, macro and international levels). The influence of man's economic activity on the environment through the prism of the geological, technocratic and economic development of society has been determined. It has been proved that the transformation of the specified systems is interdependent, as crises of different systems (economic, social, and ecological) can coincide with or start at the same time as each other. That is why the focus only on environmental problems will no longer have the necessary effect, and the problem resides in the combination of several large-scale problems in various sectors. Therefore, there is a need to look beyond narrow, sector-wide approaches for the development of more coordinated and effective tools, which can have an impact on challenges that occur, which, in turn, are united and coexist harmoniously in theory of sustainable development.
3. This research is a confirmation of the undeniable human impact on the environment and its changes. The results of the study should become the basis for the development and transformation of the state policy of Poland, Ukraine and other countries of Central and Eastern Europe. We should also note that the ecological orientation of the state policy of only one country will not bring any results, because the resolution of environmental problems in the new Anthropocene geological era requires common efforts. In this context, it is logical to form a united political platform for the development of intergovernmental policies of the countries of Central and Eastern Europe which are similar in terms of historical, cultural, psychological and climatic conditions, and therefore the implementation of such a policy will have less opposition in each of the countries.

It should be noted that countries such as Poland, Ukraine, and the Czech Republic, among others, were raw materials and production appendages of the Soviet Union, and after the collapse, they inherited production capacities that were outdated and environmentally ineffective. While Poland was able to modernize its economy and reach a new level, Ukraine was not able to achieve significant success, and in conditions of hostilities and the occupation of state territories, it became environmentally dangerous. In such conditions, the countries of one region must form an intergovernmental environmental policy aimed at overcoming the negative effects of human economic activity and create new approaches to economic activity in a new geological era.

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Streszczenie

NOWA ERA GEOLOGICZNA “ANTROPOCEN” JAKO WYNIK LUDZKIEJ DZIAŁALNOŚCI GOSPODARCZEJ

Uzasadnienie wpływu ludzkiej działalności gospodarczej na środowisko i jej nieodwracalną transformację. W pracy wykorzystano interdyscyplinarne podejście do rozwoju systemu gospodarczego. Wynika to z faktu, że przedmiot badań wykracza poza funkcjonalne nauki ekonomiczne i ekonomię jako całość. Celem badania jest zbadanie interakcji człowieka jako czynnika gospodarczego z otoczeniem, które określiło badanie prac o tematyce przyrodniczej, w szczególności zmiany epok geologicznych, zrównoważonego rozwoju i procesów gospodarczych z punktu widzenia wpływu na środowisko. To pozwoliło zsyntetyzować nową ekonomiczną wiedzę o znaczeniu działalności gospodarczej w tworzeniu nowej ery geologicznej, antropocenu. Zgodnie z wynikami badań wpływ działalności gospodarczej człowieka na środowisko jest uzasadniony przez pryzmat rozwoju społeczeństwa geologicznego, technokratycznego i gospodarczego. Uzyskane wyniki naukowe mogą być wykorzystane w reformie krajowego systemu gospodarczego, jego adaptacji do wiodących na świecie koncepcji zrównoważonego rozwoju.

Słowa kluczowe: zrównoważony rozwój, działalność gospodarcza człowieka, transformacja, “antropocen”, rozwój technokratyczny.