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ORIGINAL PAPER

Interconnections Between Sustainable Development, Climate Change and Agriculture

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Abstract:
The current era is marked by global warming, mainly due to anthropogenic activities, which makes society face two major problems: on the one hand, the need to drastically reduce greenhouse gas emissions in order to stabilize the level of their concentration in the atmosphere in order to prevent anthropogenic influence on the climate system and to allow natural ecosystems to adapt naturally, and on the other hand the need to adapt to the effects of climate change, given that these effects are already visible and inevitable due to inertia, climate change, regardless of the outcome of emission reduction actions. Any violation of the relations between the economy and the environment generates, sooner or later, economic, social and ecological dysfunctions, with profound harmful effects on the individual and human society. The article makes connections between global warming, as a result of the greenhouse effect, the contribution of agriculture to climate change and the possibilities of sustainable development in the conditions of triggering the global climate emergency.

Keywords: *greenhouse gas emissions; global warming; environment; sustainability.*

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Introduction

The content of sustainable development is expressed through a set of coordinates compatible with each other, through them ensuring the unity of interests between present and future generations (Siemianowska E., et al, 2017: 7). In the specialized literature there are different opinions, but which have in common the three-dimensional unity of the economic, social and ecological. Thomas Sterner (2017: 918-922), analyzes the content of sustainability through the prism of unity between economic and ecological. The economic and ecological influence the process of economic growth by affecting the natural resources and biodiversity; the social superimposed on the ecological ensures the rational use of natural resources, the conservation of biodiversity, respect for nature, through culture and education.

Academician N.N. Constantinescu (2004: 37), added to these three dimensions the technical one, considering that the optimal level corresponds to that development that can be supported by these coordinates. For this, the model must be operational in all subsystems that are limited to these four dimensions of sustainable development, from energy, transport, agriculture, industry to investment, human communities and biodiversity conservation. A broader view of the content of sustainable development refers to the dynamic unity of the following coordinates: economic, ecological, technical-technological, social-human, political, cultural, legislative and spatial (natural - state, regional, global) (Baker, 2012 7).

Economic development depends on the natural environment of the human being, its quality and, consequently, any reckless, irrational economic activity usually causes disorders in nature and in the economy. Any violation of the relationship between the economy and the environment generates, sooner or later, economic, social and ecological dysfunctions, with profound harmful effects on the individual and human society (Rafiq, S. Et al .., 2016: 348-365).

Therefore, if the sustainability of growth can be understood as a non-decreasing path of consumption, or GDP, or another indicator of economic well-being, in the case of sustainable development, to build in time, a non-decreasing path declining welfare, not only economic, but also environmental and social sustainability is needed. Thus, achieving sustainable development depends on the government's ability to ensure economic growth compatible with social equity and the conservation of ecosystems through an appropriate compromise between the economy, society and the environment.

The problem of climate change is one of the great challenges of humanity, which society will have to face both now and in near future. Rising temperatures, melting glaciers, droughts and increasingly frequent floods are signs that climate change is indeed happening (Reynolds and Wenzlau, 2012: 12). It is also known that due to human activities, high concentrations of greenhouse gases in the atmosphere intensify the natural "greenhouse effect", thus causing the Earth's temperature to rise. Concentrations of greenhouse gases, especially carbon dioxide (CO2), have increased by 70% since 1970. In the last century, the temperature in Europe has risen by almost 1 ° C, faster than the global average, the fastest growing in the last 50 years. Although it does not seem to be dramatic, this trend has had a significant impact on many physical and biological systems (water, habitats, health), which are becoming increasingly fragile (Dogan, E., Seker, F., 2016: 14646– 14655).

Climatic conditions have become variable: temperatures have reached extreme values; in northern Europe, rainfall and snowfall have increased significantly, causing more frequent floods; in contrast, in southern Europe, rains have dropped considerably

and droughts are more frequent. Economic losses caused by extreme weather events have increased significantly in recent decades. These climate changes will continue for decades, even if emissions stop at this time, due to the constant accumulation of gases in the atmosphere. The impact of climate change will gradually worsen globally (ICPA, 2014: 1). Although society is making global efforts to reduce greenhouse gas emissions, the global average temperature continues to rise, which necessitates urgent action to adapt to the effects of climate change (Chel, A., Kaushik, G ., 2011:, 91-118).

The current era is marked by global warming, mainly due to anthropogenic activities, which makes society face two major problems: on the one hand, the need to drastically reduce greenhouse gas emissions in order to stabilize the level their concentration in the atmosphere to prevent anthropogenic influence on the climate system and to allow natural ecosystems to adapt naturally, and on the other hand the need to adapt to the effects of climate change, given that these effects are already visible and inevitable due to inertia of the climate system, regardless of the outcome of emission reduction actions (Vermeulen et al., 2012: 195-222).

The greenhouse effect and global warming

Climate is changing because of the current way of people's life, especially in richer and more economically developed countries. Power plants, as well as the cars and planes we travel by, the factories that produce the goods we buy, the farms that process the food we eat, all play a role in the process of climate change by emitting "the greenhouse effect". The atmosphere is the transparent and protective shell of our planet. It lets in sunlight, but it retains heat. Without the atmosphere, the heat of the sun, reflected from the Earth's surface, would immediately return to space. The lack of a "greenhouse effect" would make the global average temperature of -18 ° C, compared to + 15 ° C at the present moment. Therefore, the atmosphere acts like the glass walls of a greenhouse: it allows access to visible light and absorbs much of the infrared energy, keeping the heat inside.

Global warming has become a key issue on the international agenda in recent decades. The global average temperature has risen steadily, despite global efforts to halt this trend. Rising greenhouse gas (GHG) emissions from human activities have made a major contribution to warming, with an alarming impact on the planet's climate patterns, human lives and economic development. Regional and local climate change are affecting ecosystems and causing extreme weather events such as droughts, floods and other natural disasters. Rising temperatures pose an increased risk of damage, and so the need to solve this problem is increasingly pressing; efforts must be orchestrated at all levels - local, regional and international.

Climate change - including rising temperatures, changes in rainfall and reduced ice and snow - have caused a wide range of observable effects, such as:

• loss of biodiversity: the survival of certain species will be threatened, or they will disappear due to the disappearance of habitat, changing ecosystems and increasing ocean acidity;

• sea level rise: caused by melting glaciers and thermal expansion of the oceans, both increasing the risk of flooding;

• extreme meteorological phenomena: more frequent extreme meteorological phenomena, which cause heat waves, large fires in wild areas, intensification of floods and droughts, stronger hurricanes;

• threats to human health: the spread of disease and declining air quality, as well as possible deaths from devastating heat waves.

The "greenhouse effect" is a natural, beneficial phenomenon, due to the greenhouse gases existing in the atmosphere: Water vapor; Carbon dioxide (CO2); Nitrogen dioxide (N2 O); Methane (CH4); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs). Since the industrial revolution of the eighteenth century, human society has been producing incessantly and in increasing quantities of greenhouse gases. As a result, their concentration in the atmosphere is now the highest in recent years and makes the greenhouse effect stronger. This has led to rising temperatures on Earth, leading to climate change. Carbon dioxide is the main greenhouse gas, most of it remaining in the atmosphere for about 100 years. In some areas, however, it can remain for thousands of years. Some of the carbon dioxide in the atmosphere is natural, coming from decaying plants and animals. Carbon dioxide is released into the atmosphere when fossil fuels (oil, coal and natural gas) are burned, which are the most common source of energy today. This gas is essential for breathing: we inhale oxygen and exhale carbon dioxide, while trees and plants absorb it and produce oxygen. That is why the forests of the planet are so important. They help absorb some of the excess CO2 we generate.

But cutting of trees, deforestation and burning of forests are taking place in many parts of the world. Tropical forests are disappearing much faster than other forests, with a rate of 10 million hectares per year. When forests are cut down, carbon dioxide is released into the atmosphere. The atmospheric concentrations of this greenhouse gas exceeded for the first time, in 2014, the threshold of 400 ppm (parts per million) in the northern hemisphere, according to data provided by the World Meteorological Organization (WMO). Globally, the concentration of carbon dioxide should have reached this symbolic threshold in 2015 and 2016, according to WMO. Deforestation is estimated to cause about 20% of global greenhouse gas emissions, so stopping this process is a top priority. Methane (CH4) is not as abundant as CO2, but it is more efficient in the process of retaining heat, which makes it a very strong GHG.

It is released when organic matter rots in an oxygen-free environment. 60% of the methane that currently exists in the atmosphere is man-made; it comes from the areas where waste is stored, from animal farms, from the burning of fossil fuels, from the water treatment in which the waste is discharged, as well as from other industries. Nitrogen oxide (N2O) is another naturally occurring greenhouse gas, but people have increased it by about 17% since the industrial age, due to chemical fertilizers, fuels, forest burning or of fields after harvest. Halocarbons (combinations of fluorine, bromine, chlorine, carbon and hydrogen) naturally exist in very small amounts. The main products resulting from human activity are CFC11 and CFC12 (used as coolants in other industrial processes). Their concentration has decreased in recent years as a result of international conventions on the protection of the ozone layer (MADR, 2015: 5). Ozone (O3) is produced and destroyed continuously in the atmosphere as a result of chemical reactions under the action of ultraviolet radiation. In the troposphere, human activities have led to an increase in the amount of O3 by releasing CO, N2O and other substances that react chemically and produce O3. Water vapor is considered an important greenhouse gas. Human activities have little direct influence on the amount of water vapor in the atmosphere. Indirectly, people have the potential to substantially affect the amount of water vapor by changing the climate: a warmer atmosphere contains more water vapor.

Agriculture, the responsible party for climate change

Agriculture emits greenhouse gases into the atmosphere, although on a smaller scale than other economic sectors. The main greenhouse gases associated with agricultural production are:

• N2O, nitrous oxide - released into the atmosphere from agricultural land, mainly due to the microbial transformation of nitrogen-containing soil fertilizers. N2O emissions account for more than half of total agricultural emissions;

• CH4, methane - its emissions are largely due to organic fertilizers from the digestive processes of ruminants (mainly cows and sheep);

• CO2, carbon dioxide - comes from energy consumption on the farm, agricultural products and the variation of carbon stocks in the soil resulting from land use and change in land use. Both CH4 and N2O emissions occur from the storage and spreading of animal fertilizers.

Agriculture, as a source of GHGs, differs significantly, depending on agricultural practices and environmental and climatic conditions, such as soil characteristics and temperature. Although greenhouse gas emissions from agriculture have declined recently due to changing agricultural techniques and low animal numbers, agriculture is still responsible for the highest N2O and CH4 emissions.

Methane is a much more dangerous gas than carbon dioxide in terms of the influence of global warming. It is estimated that the effects of CO2 in 100 years can be "achieved" in just 10 years of the same amount of methane, in short periods methane is tens of times more dangerous than carbon dioxide. And the sources of methane production are very diverse, 60% of them being attributed directly to humans.

In recent decades, the growth of food animals, especially cattle, has increased exponentially, which also means an increase in the amount of methane from the processes that take place in the intestines of these herbivores. Globally, about 1.5 billion cows are raised on farms, which are responsible for producing about 100 million tons of methane annually (about 10-15% of total methane emissions).

The need for cheaper food has favored intensive agriculture in which certain plants are used. Rice cultivation, for example, is estimated to produce between 50 and 100 million tons of methane per year due to the decomposition of organic matter in fertilizers under anaerobic conditions. In fact, the accumulation of manure in populated areas or their treatment leads to the production of large amounts of methane.

In the last half century, the use of nitrogen-based fertilizers has increased exponentially. The problem is that nitrogen oxides can retain 300 times more heat per unit volume than carbon dioxide. In this way the areas treated for a long time with these fertilizers incorporate more heat.

Therefore, it is easy to understand that human industrial activity, which has grown exponentially in the last century, is responsible for accelerating global warming. Even if the greenhouse effect is greatly influenced by natural factors, from volcanic activity to solar cycles, the "contribution" of human beings does nothing but accelerate the phenomenon of irreversible increase in global temperature.

In this context, an important objective in the field of agriculture and rural development is to maintain a low level of greenhouse gas emissions generated by the agricultural sector. Agriculture generates almost 15% of greenhouse gas emissions in our country, if we do not consider the change of land use and forestry. Although this percentage is higher compared to the EU-27 average (10%), the intensity of emissions (greenhouse gas emissions per unit of agricultural production) in Romanian agriculture

is among the lowest in the region. In order to maintain a low level of greenhouse gas concentrations in the atmosphere generated by the agricultural sector, it is necessary to support farmers to keep the soil covered, use land management techniques that contribute to maintaining carbon in the soil, and to create facilities and the use of modern equipment for the storage and application of manure, including the encouragement of the production and use of renewable energy. The expansion of forested areas to increase carbon sequestration is also a necessity in terms of meeting global climate change targets. At the same time, the promotion of consultancy and knowledge transfer services on climate change issues among farmers will contribute to the goal of maintaining a low level of greenhouse gas concentrations in the atmosphere. (MMAP, 2015: 50).

Climate variability influences all sectors of the economy, but agriculture is the most vulnerable sector given the dependence on weather during the vegetation period of crops, as well as increasing the duration and intensity of dangerous weather in the context of global warming. The wide diversity of cultivated species and varieties offers a major potential for adaptation to diversified climatic conditions at regional / local level or from one agricultural year to another. Romania has important agricultural resources with a used agricultural area of 13.3 million ha (representing 55.8% of Romania's territory). Most of the agricultural area used is arable (8.3 million ha) followed by pastures and hayfields (4.5 million ha), permanent crops (0.3 million ha) and family gardens (0.2 million ha). (INS).

The effects of climate change are significantly reflected in the changes regarding the main environmental variables (air temperature and precipitation), the impact on the growth and development of agricultural plants being more and more obvious. In Romania, the changes in the climate regime are framed in the global context, but with the particularizations of the geographical region in which our country is located. Agricultural areas in our country are affected by frequent drought (approx. 7 mil ha), temporary excess water (approx. 4 mil ha), water erosion and landslides (approx. 6.4 mil ha), compaction (approx. 2.8 thousand ha) etc. It is noted that drought is the limiting factor that manifests itself on the largest agricultural area. In this context, the data indicate that the most vulnerable agricultural areas to water shortage in the soil are those in Dobrogea, southern Romanian Plain, southeastern and eastern Moldova, and western Tisa Plain. These areas are mainly used in agriculture (about 80% of the total, of which about 60% are arable land) and forestry (about 8%), especially the Danube Meadow (MADR, 2008: 54).

Mitigating the impact of climate change is based on the following considerations: sequestration of increased amounts of CO2, reduction of GHG emissions, increased production of renewable resources and green energy. In other words, changes in future climate change can have significant effects on crops and are determined by the interaction between local climatic conditions, the severity of climatic parameters predicted by future scenarios, the effect of CO2 growth on photosynthesis and plant genetic type (ANM, 2014: 9 -10). Current and future climate projections show that all regions of the world will be affected by global warming, while amplifying regional differentiations in the evolution of the main environmental variables, mainly thermal and precipitation resources, as well as the complex effects of extreme weather events. local level. Adaptation to climate change will thus be able to benefit from the experience gained from responding to extreme climate events by implementing adaptation plans and mitigating climate risks. Given the limitation of basic natural

resources, an important element in developing agricultural management strategies is to improve knowledge and capacity for better management of climate variability through the analysis of historical climate data and the assessment of risks and opportunities.

Undoubtedly, in the conditions of using the current technical and technological mode of production characterized by its destructive, polluting character, agriculture is an important polluting factor of the natural environment. Only as the process of sustainable development is fully consolidated and affirmed, the expansion and affirmation of the new technical and technological mode of production, neo-factorial and non-polluting, the improvement of domestic and international market mechanisms, by spatially enlarging the organic agriculture the intensity of the polluting side of agriculture will decrease, thus ensuring the condition of practicing an agriculture that does not affect the bases of the ecological balance and that will enhance the ecological and production function of the natural environment.

The analysis of the biunivocal relationship between human activity and the natural environment, in this case between agricultural activity and the natural environment, shows the need to develop and implement a unitary policy towards the environment, to ensure the rational exploitation of natural resources used in agricultural activity. Only on such a unitary vision can a sustainable agriculture be built, through which to ensure the reconciliation between economy and ecology.

On the support of a sustainable agriculture, the food security of the population with healthy, ecological and high-quality products is ensured, the protection and long-term improvement of the natural resources is guaranteed. Synthetically, the sustainable development of agriculture has a viable character, it responds to both economic and ecological requirements, it ensures the harmonization of the human-nature relationship.

Conclusions

To prevent the most severe impact of climate change, the United Nations Convention on Climate Change (UNFCCC) was signed in which it was agreed to limit the average increase in surface temperatures to less than 2 ° C. To achieve this, global greenhouse gas emissions should be peaked as soon as possible and declining rapidly thereafter. Global emissions should be reduced by 50% compared to 1990 to 2050 levels before carbon neutrality is achieved before the end of the century. The EU supports the UNFCCC target and, by 2050, aims to reduce greenhouse gas emissions by 80-95% from 1990 levels. These high levels of reduction consider the reductions required by developing countries. The main sources of man-made greenhouse gases are: burning fossil fuels (coal, oil and gas) in electricity production, transport, industry and households (CO2); agriculture (CH4) and land use change, such as deforestation (CO2); waste filling (CH4); use of fluorinated industrial gases. To reduce emissions, the EU has enacted legislation to increase the use of renewable energy, such as wind, solar, hydropower and to improve the energy efficiency of a wide range of household equipment and appliances. Thus, the EU is committed to reducing emissions across the EU by at least 40% from 1990 levels. This is a mandatory target. The European Energy Union, which aims to ensure that Europe has safe, accessible and green energy, has the same goal.

As a result of what scientists have been able to determine over time, the subject of climate change has grown in political circles, especially since 1988 when a group of scientists met in Geneva to inaugurate IPCC (Intergovernmental Panel on Climate

Change), which was from the beginning legitimized by two international organizations, WMO (World Meteorological Organization) and the UN. (Bizdadea C., 2019).

` The latest IPCC report was presented to the public in 2018 under the title "Special Report on the Impact of Global Warming by 1.5C Above the Pre-Industrial Temperature Level and Scenarios for Global Greenhouse Gas Emissions". The main conclusions of this report, which aroused lively public excitement and increased interest in climate issues, are as follows:

• The report projects that if the temperature growth rate of 0.2 ^{o} C per decade continues (as a result of both past and present emissions), the average global temperature will reach 1.5 ^{o}C C between 2030 and 2052.

• To limit heating to 1.5 ^{o}C, global net CO2 emissions must be reduced by 45% compared to 2010 by 2030 and to zero by 2050.

• What is needed for such a limitation to +1.5 ^{o}C: a rapid and abrupt transition of the entire global economy, to transform the way energy is used and its sources, the way agricultural systems are organized and the type and quantity of food, and the materials we will consume. In other words, a radical and abrupt change in human civilization, as we know it today.

Climate emergency means, as the EU resolution and the Paris Agreement say, reducing emissions by 55% by 2030 and to zero by 2050. But is it possible to achieve these targets? Given the current energy mix and consumption, the world should accelerate the development of green energy sources (no emissions) by 9 times the rate observed in 2018 and 15 times that observed in the last decade; at the same time, new sources of carbon emissions must cease immediately, at present (given that fossil energy consumption continues to increase by 150 megatons in oil equivalent) per year. (The Economist).

Even if we currently had viable green alternatives to energy production available that could scale up energy consumption, in practice the vast majority of global civilian infrastructure is built on and for burning fossil fuels; the scale of the changes needed is simply titanic, because we currently extract 15 billion tons of fossil fuel (Smil, 2019: 10-14) (with a carbon content of 10 billion), which currently accounts for almost 90% of world consumption. energy, which we have seen growing, and 75% of electricity consumption.

The European Parliament, meeting of 29 November 2019, adopted its resolution on "declaring climate emergency in Europe and in the world"; the declaration also calls on the European Commission to ensure that all legislative proposals are fully aligned with the goal of limiting global warming below the threshold. of +1.5 ^{o}C and to reduce carbon emissions by 55% by 2030 and by 100% by 2050 (when Europe is to be climate neutral).

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