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The Issue of Climate Change: Causes, Consequences and Countermeasures

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ABSTRACT

The article discusses the issues surrounding the definition of the term “climate” and the causes of global warming. It is proposed that the term “climate” originates from the Greek word “klima,” meaning “inclination,” and is associated with the angle of sunlight falling on the Earth’s surface or the tilt of the Earth’s rotational axis relative to its orbital plane. This concept, however, may be more applicable to “weather” on a daily, monthly, or yearly scale. Therefore, the author suggests extending the term to encompass all “inclinations” (deviations) that drive the development of natural processes and their components, including climate. The significant contribution of the greenhouse effect to global warming, along with its adverse consequences, is highlighted. This is evidenced by a sharp rise in air temperatures in Polar Regions and the near absence of warming in the equatorial zone. It is noted that the increase in atmospheric CO_2 concentration is primarily driven by the unprecedented rise in hydrocarbon extraction and consumption, particularly in the metallurgical industry and related sectors, which currently contribute approximately 80% of global GDP. Among these sectors, arms production and trade, predominantly conducted by state enterprises, stand out as the most profitable economic industry. This industry, however, thrives on perpetual conflicts fueled under various pretexts. Consequently, resolving global warming largely hinges on addressing the issue of peace on Earth.

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One of the most pressing challenges facing humanity today is global climate warming. Fluctuations in average air temperature are directly contributing to changes in the moisture-holding capacity of the atmosphere [1]. For instance, the rise in temperature increases the atmosphere’s capacity to hold moisture, intensifying atmospheric circulation processes, which in turn lead to an increase in precipitation levels. This phenomenon has been linked to the growing frequency of typhoons, thunderstorms, wildfires, and widespread flooding. Such events are now observed almost universally across the globe, resulting in significant damage and loss of human life. The destruction of buildings and even entire residential areas has become increasingly common due to these extreme weather phenomena.

In this regard, the issue has increasingly become the focus of attention for scientists and experts in every country, public figures, as well as leaders of major global powers such as the United States, China, and Russia. We are discussing climate change, energy challenges, and global transformations. However, what exactly is “climate”?

According to the “Geographical Encyclopedic Dictionary” published in 1988, climate is defined as “...the long-term pattern of weather in a given area, one of its most significant geographical characteristics. Climate is the result of climatic processes continuously occurring in the atmosphere and the active layer” [2].

The primary characteristics of climate are determined by the influx of solar radiation, the circulation of air masses, and the nature of the underlying surface. Among the geographical factors influencing the climate of a specific region, the most critical are the latitude and altitude of the area, its proximity to the sea, the features of orography and vegetation cover, the presence of snow and ice, and the degree of atmospheric pollution. These factors complicate the latitudinal zoning of the climate and contribute to the formation of local variations [3].

According to S.I. Kostin, “Climate is defined as the systematic sequence of atmospheric processes occurring in a given area as a result of the interaction between solar radiation, atmospheric circulation, and physical phenomena taking place on the underlying surface. This interaction determines the characteristic weather patterns for that area. Quantitatively, climate is usually characterized by average values and extreme measurements of climatic elements—such as air temperature and humidity, cloud cover, precipitation, and wind—derived from long-term observations. Significant contributions to the description of a climate are made by data on air masses entering the area, including their physical properties, origins, and frequency of occurrence” [4].

A.S. Monin defined climate as “a statistical regime of short-period oscillations (with periods less than a few decades) in meteorological fields” [5]. Later, he further elaborated that “climate refers to the statistical ensemble of states traversed by the AOS system (Atmosphere-Ocean-Land) over periods spanning several decades” [5].

According to B.P. Alisov, "Climate, in a broad sense, can be defined as the aggregate of all external influences on the Earth's surface—radiational, hydrothermal, and mechanical. In a narrower sense, climate is understood as one of the physical-geographical characteristics of a locality, determined by its geographical position and represented by the multi-year regime of solar radiation, terrestrial radiation, air and soil temperature, moisture, and wind" [6]. These definitions, as observed, do not fundamentally differ from one another, with variations primarily in phrasing. However, N.A. Yasamanov highlights that these definitions lack consideration of the role of the biosphere in the formation and evolution of climate [3].

In all definitions, it is noted that the term "climate" originates from the Greek word "klima" (klimatos), meaning "inclination," i.e., the tilt of solar rays falling on the Earth's surface. However, this inclination changes throughout the day, month, and year, making the term "climate" as "inclination" more applicable to defining "weather." Only A.S. Monin associates climate-inclination with the tilt of the Earth's rotational axis relative to the plane of its orbit. However, such a definition also limits its applicability to a duration of one year, which does not fully align with the concept of climate.

It is possible that the ancient Greeks, under this term, understood not only the tilt of solar rays or the Earth's axis but also all tilts (deviations) on the Earth's surface, including orbital deviations (eccentricity), precession, and others. Here, it is worth noting that our world is structured in such a way that the development of all phenomena and their components, even the smallest ones, is based on deviations. For instance, even the DNA of identical twins has a 0.1% difference.

Another definition of climate is provided by M.Y. Arushanov: "Climate is an open thermodynamic system that changes periodically, maintaining a state of stationarity or near-stationarity with a constant entropy production value over certain time intervals" [7]. He considers this definition to be formalized "within a physical framework," arguing that other definitions lack a foundation in physics.

However, if the term "climate" is removed from his definition, it becomes difficult to understand the subject of discussion. A term and its definition should be clear to all. Therefore, it is reasonable to supplement Arushanov's definition after the word "system" with the wording from Alisov's definition: "of the Earth's surface, formed under the influence of radiational, hydrothermal, mechanical, and other impacts," and continue the text accordingly.

In the book "The Climatic Spectrum of Planet Earth" by M.Y. Arushanov, published in 2010 (where the content of the aforementioned article was presented in the section "Formalization of the Concept of Climate"), it was noted that "...up until 1978, the invariability of solar luminosity was considered an indisputable fact. As a result, the concept of the 'solar constant' was introduced. This misconception became one of the main reasons for the critical attitude toward studies that linked weather and climate changes to variations in solar activity" [8].

However, such a statement does not correspond to reality, as evidenced by the hypotheses of Simpson (1934), Shelley (1963), Flint (1963), and others, which linked climate change to variations in the solar constant [9]. A.S. Monin also wrote about fluctuations in the solar constant back in 1972, referencing the works of Epik (1953), Mitchell (1966), Bernard (1968), and others [10]. Furthermore, the value of the solar constant is "confined within the range of 1368–1377 W/m² (with the maximum deviation—ranging from 1322 to 1428 W/m²—falling well within the limits of measurement errors and possibly having a purely random nature...)" [5]. According to Arushanov, the intensity of solar radiation fluctuates within an even narrower range of 1363–1367 W/m² (Figure 1).

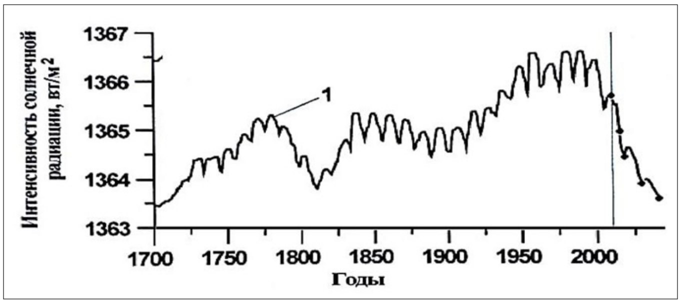

Figure 1: Dynamics of Solar Radiation Over the Past 300 Years [7,8].

Moreover, despite the close correlation between variations in the "solar constant" and the Wolf number, the graph for the period from 1700 to 2000 shows a nearly uniform increase in the solar constant, which does not align with the trends of the Wolf numbers (Figure 2) [8]. The latter indicates the absence of any directed changes in solar activity.

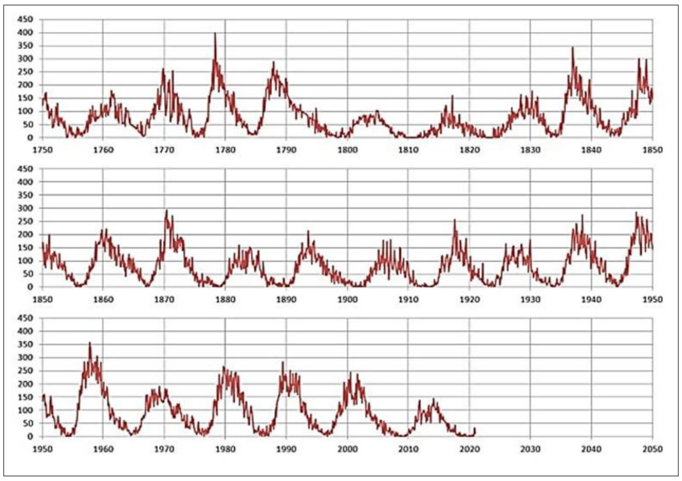

Figure 2: Average Monthly Wolf Numbers

Regarding other factors, the following should be noted:
Starting with astronomical factors, these include the tilt of the Earth's axis relative to its orbital plane, axial precession, and orbital eccentricity. The tilt of the Earth's axis varies between 22.068° and 24.568° over a period of 41,000 years. An increase in the axial tilt leads to higher annual totals of solar radiation in high latitudes, potentially causing a reduction in polar ice, while a decrease in the tilt has the opposite effect.

The Earth's orbital eccentricity fluctuates between 0.0007 and 0.0658 (currently at 0.017) with a primary cycle of 100,000 years. This affects the duration of the seasons. For the same amount of solar radiation received by each hemisphere during winter and summer seasons, the perihelion produces a shorter but warmer season, while the aphelion results in a longer but cooler season. An increase in eccentricity magnifies the differences in seasonal durations. Currently, the perihelion occurs in early January, and the aphelion in July, resulting in milder summers and warmer winters.

The precession (P) of the Earth's axis has a periodicity of 21,000 years and can manifest in the following positions:
- P = 0: The moment of the vernal equinox at perihelion and the autumnal equinox at aphelion; the durations of winter and summer are equal.
- P = 90°: The moment of the winter solstice at perihelion and the summer solstice at aphelion; winter is short and warm, while summer is long and cool.
- P = 180°: The moment of the vernal equinox at aphelion and the autumnal equinox at perihelion; the durations of summer and winter are equal.
- P = 270°: The moment of the winter solstice at aphelion and the summer solstice at perihelion; winter is long and cold, while summer is short and warm [9].

It should be noted that the development of glaciation requires a specific combination of factors: The Earth's axial tilt at its minimum, the eccentricity of the Earth's orbit at its maximum, and the precession angle approaching 90° or 270°. At present, the Earth's axial tilt is 23.7° (near its maximum), the orbital eccentricity is 0.017 (close to its minimum), and the precession is at 99.5°. These current values indicate a trend toward global warming. This alignment of astronomical factors may have contributed to the end of the Little Ice Age and the subsequent rise in global temperatures, which continues to this day. Furthermore, the early 20th century experienced an acceleration in warming, likely influenced by the increasing concentration of CO_2 in the atmosphere (Figure 3).

As is well known, permanent gases (such as nitrogen and oxygen) do not emit thermal radiation, while variable gases (such as H_2O, CO_2, and ozone) exhibit strong thermal emission and significantly influence the thermal regime of the "Earth-atmosphere" system. M.L. Arushanov notes that the "greenhouse effect" is characterized by the difference between the average surface temperature of the Earth, 288 K, and its effective temperature, which currently results in a greenhouse effect magnitude of 33 K. Evidently, if accurate, this figure is strikingly significant.

It is well established that heat exchange comprises both radiative and convective components. In the traditional understanding of the "greenhouse effect," radiative heat exchange dominates in the atmosphere. However, according to Arushanov, convective heat exchange prevails in the troposphere, which serves as the basis for dismissing the likelihood of catastrophic consequences from global warming. He argues that even with a doubling of CO_2 concentration, no significant temperature increase will occur.

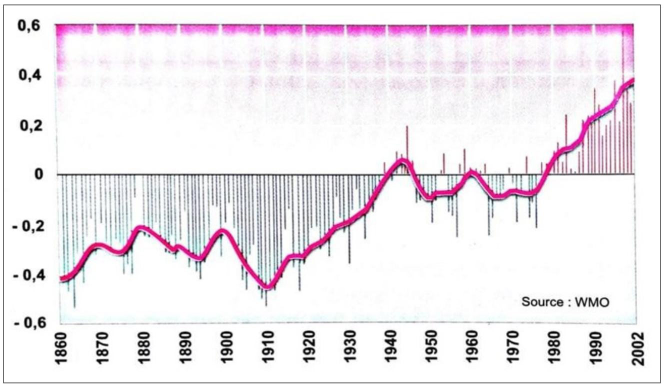

Figure 3: Changes in the Annual Global Mean Air Temperature (Deviation from the 1961-1990 Average) [3].

Furthermore, he states that an increase in surface temperature intensifies evaporation and cloud formation, which "leads to an increase in the planet's albedo and the reflective capacity of the Earth's atmosphere. Ultimately, this results in a greater amount of solar radiation being reflected into space by clouds, thereby reducing the Earth's surface temperature to its original level. The functioning of this natural system is one of the clearest examples of self-organization (self-regulation) in atmospheric processes" [8]. If this is the case, why does this self-regulation not manifest today, despite the rising concentration of CO_2?

Furthermore, the area simultaneously occupied by convection on the Earth's surface cannot cover a vast portion of the planet. For example, cloud fields in the Northern Hemisphere occupy areas of 0.25–4 million km² in over 70% of cases, and only occasionally reach 5 million km² [11]. On the remaining territory, radiative heat exchange predominates. It is also noted that a significant portion of CO_2 entering the atmosphere should dissolve in oceanic waters.

If this is the case, how can the continuous increase in atmospheric CO_2 concentration over more than a century be explained?

When evaluating the contribution of anthropogenic factors to global temperature changes, Arushanov, citing the work of Kruchenitsky, noted that the observed trend of temperature increase over the past 150 years appears to be illusory and of a fluctuating nature [12]. But is this truly the case?

First, warming has been occurring since the end of the Little Ice Age, encompassing a much longer period than 150 years. Second, a sharper rise in global warming began at the start of the 20th century, coinciding with an increase in CO_2 concentration (see Figure 3). Third, the rise in CO_2 concentration and global warming are proceeding without notable fluctuations. Fourth, the contribution of greenhouse gases to the formation of global temperatures, according to H. Abdusamatov, is 2.1 W/m² [8]. However, this contribution is considered an order of magnitude smaller than that of natural factors. For comparison, the contribution of albedo is 10.3 W/m², tropical cyclones contribute 4.4 W/m², and the greenhouse gases' contribution of 2.1 W/m² is not insignificant, aligning with contemporary warming trends.

It is also noteworthy that the amplitude of the solar constant during its 11-year cycle reaches only 1.3 W/m², significantly less than the contribution of greenhouse gases to atmospheric warming. All this substantiates the anthropogenic nature of contemporary warming, which persists despite a sharp decrease in solar activity since the late 20th century. This decline in solar activity was the basis for a prediction of a sharp cooling at the start of the 21st century, which ultimately did not materialize.

It should be noted that there are many other factors contributing to climate change. Among these is the shifting position of the Earth's poles. However, the equatorial bulge of the planet naturally counteracts such shifts. Evidence for this lies in measurements from latitude stations tracking the position of the poles, which remain within a range of 25 meters—variations that could reasonably be attributed to the limitations of measurement accuracy.

Another contributing factor often cited is the tectonics of lithospheric plates. Movements and interactions of these plates can influence ocean levels, further affecting climatic conditions. This geological activity underscores the complexity of the mechanisms driving climate change beyond anthropogenic influences.

In the mid-20th century, several researchers, including D.D. Ivanenko and M.U. Sagitov, began to develop the hypothesis of Earth's expansion [3]. It is well known that Earth has a layered structure, implying that it was initially in a molten state. Through gravitational differentiation, the core, mantle, and crust were formed. Consequently, the primary crust would have covered the entire Earth. During the process of Earth's expansion, the continental crust fragmented into pieces—continents—that began to drift apart, creating ocean floors in between.

As noted by V.A. Magnitsky, this hypothesis resolves many shortcomings of other theories, aligns with geophysical data (such as expansion due to heating), and provides plausible explanations for various geological features. Examples include the formation of mid-ocean ridges with central rift valleys, the development of the Red Sea, and more.

However, Magnitsky also highlighted limitations of the Earth expansion hypothesis:

- Given that oceanic areas are 3-4 times larger than continental areas, Earth's expansion would require its radius to double.
- How could the expansion have been so uneven that continents concentrated in one hemisphere?
- Why did Earth remain stable for billions of years without experiencing significant expansion, only to undergo such a massive increase in volume 200 million years ago?

These challenges indicate that while the hypothesis offers intriguing explanations for certain geological phenomena, it requires further investigation and refinement to address its inconsistencies.

Currently, the question of Earth's expansion and its causes has found support in geophysical evidence. Regarding the scale of this expansion, it is necessary to include not only the area of the continents but also the shelves and continental slopes. The average depth of the lower boundary of the continental slope is approximately 4 km. According to the hypsographic curve, 60% of Earth's surface lies above a depth of 4 km, corresponding to an area of 306×10^6 km². The radius of a sphere with such a surface area is just over 4900 km.

This calculation suggests that Earth's radius has increased by approximately 1471 km. If this expansion occurred over 200 million years, it would imply an annual growth rate of 0.7–0.8 cm—an entirely plausible and reasonable figure. This gradual rate aligns with geological and geophysical observations, offering a measurable framework for understanding Earth's expansion over geological timescales.

The formation of mid-ocean ridges with rift valleys in the oceans, contrary to explanations established in global tectonics, can be attributed to the processes of continental fragmentation and their subsequent drift apart. As continents move away from each other, increased pressure on the edges of oceanic plates may cause them to subside. This, in turn, could lead to isostatic uplift of the ocean floor at the site of the rift, resulting in the creation of mid-ocean ridges [3]. Such processes may also contribute to a rise in sea levels, which could exacerbate global warming. This interrelation highlights the complex dynamic between tectonic activity, oceanic changes, and climatic effects, emphasizing the need for further exploration of these interconnected systems.

In conclusion, contemporary global warming is predominantly driven by anthropogenic factors, particularly the increase in atmospheric CO_2 concentration. This is evidenced by the specific pattern of warming, which is almost negligible in equatorial regions but rises significantly toward the poles, with increases of 5–8°C. In contrast, an increase in solar constant, for understandable reasons, would primarily lead to maximum temperature rises at the equator. Calculations show that a 1% change in the solar constant would alter the average annual temperature by 2°C at the equator and by only 1°C at the poles [10]. This discrepancy underscores the critical role of greenhouse gases in shaping the current warming trends and their disproportionate impact across different latitudes.

Discussing this issue, it is impossible not to address M.L. Arushanov's perspective. While passionately attempting to prove the dominant role of solar radiation in climate fluctuations, Arushanov considers global warming to be the result of artificially created anthropogenic atmospheric pollution. He further states: "Nature, guided primarily by the physical laws of self-organization, failed to refine the mechanism for self-regulating the moral aspect of Homo sapiens, where the pursuit of profit often overrides all ethical norms. As the saying goes, 'there's always a black sheep in the family".

"The 'brilliant' idea of Californian 'craftsmen' to further promote the notion of an 'impending catastrophe' serves as evidence of this. Nevertheless, Nature, staying true to its principal rule—balance—has marked a part of humanity for whom moral criteria remain paramount. Ultimately, for that part of humanity that is guided by the 'authority' of truth rather than the truth of authority, life will indeed be challenging" [8].

As human needs have steadily increased, so has the impact on the environment. Natural resources were extracted and consumed in significant quantities, with waste being returned to nature. However, the environment's ability to regenerate itself could no longer keep pace, leading to various ecological problems. Notably, climate changes began to emerge at the beginning of the last century. Specifically, an analysis of the dynamics of coal, oil, and natural gas production from 1910 to 2023 reveals a substantial increase in their economic and industrial importance to humanity. However, this growth has brought severe consequences, such as ecological crises and climate change.

At the beginning of the 20th century, the volume of fossil fuel extraction was relatively low. In 1910, coal production was approximately 1.5 billion tons, and oil production amounted to only 50 million tons. The extraction of natural gas was limited to a few billion cubic meters. These figures rose sharply due to the industrial revolution and increasing energy demands. By 2023, coal production reached 8 billion tons (Global coal demand is expected to grow by 1% in 2024 to an all-time high of 8.77 billion tonnes), oil 4.5 billion tons, and natural gas about 4 trillion cubic meters annually [13]. This growth led to a significant increase in the concentration of carbon dioxide (CO_2) in the atmosphere.

Today, CO_2 emissions from fossil fuel combustion are a primary driver of the enhanced greenhouse effect. Among fossil fuels, coal generates the highest CO_2 emissions: burning 8 billion tons of coal in 2023 released approximately 15 billion tons of CO_2. Similarly, 4.5 billion tons of oil burned in transportation and other sectors produced nearly 14 billion tons of CO_2. Although considered a relatively "cleaner" energy source compared to coal and oil, natural gas combustion—amounting to 4 trillion cubic meters annually—resulted in the emission of about 8 billion tons of CO_2 (see Figure 4).

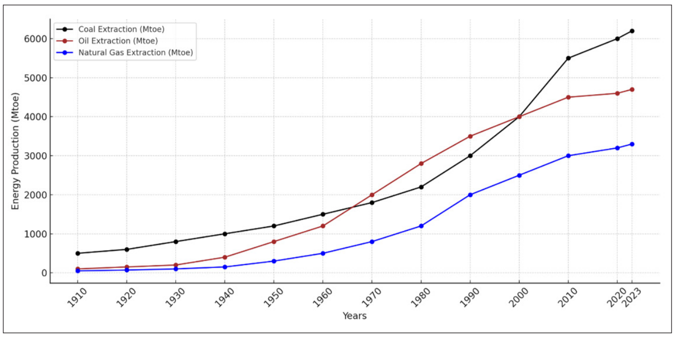

Figure 4: Global extraction of Coal, Oil and Natural Gas (1910-2023).

Note: MTOE stands for Million Tonnes of Oil Equivalent

These fuels have a direct impact on climate change, contributing to a 1.2°C increase in global temperatures since the early 20th century. As a result, sea levels have risen, droughts have intensified, water resources have diminished, and extreme weather events have become more frequent. The significance of these fuels extends beyond energy production, particularly in the industrial and military sectors. Coal is a crucial raw material in steel production, with a large portion of the 1.9 billion tons of steel produced in 2023 being derived from coal. Steel is essential for manufacturing military equipment, including tanks, ships, and weapons. Oil, used as aviation fuel, is a strategic source for military transport and logistics. Natural gas is utilized in high-temperature materials and military energy systems.

Currently, although the majority of climate specialists consider human activity as the primary cause of global warming, there are still those who, like M.L. Arushanov, deny the role of the greenhouse effect in global warming. The authors of such views may, perhaps, cater to governments and oligarchs, who are always eager to profit by burning as much fuel as possible at the expense of the environment, and attempt to explain the warming with natural causes.

In the European Union (EU), it is considered that 33% of fuel and energy resources are used for transportation, 26% for industry, and 25% for household and municipal needs [1]. However, this ratio raises doubts. For example, in 2018, the volume of pig iron production in the world amounted to 1.2 billion tons, steel – 1.8 billion tons, totaling 3 billion tons. It is known that for producing 1 ton of pig iron, 1.5-2.0 tons of iron ore and 1.0-1.2 tons of coke are required, totaling 4-5 tons of raw materials and fuel [14,15]. They point out that a significant portion of fuel and energy resources is spent solely on the production of pig iron and steel – raw materials for the ferrous metallurgy industry, most of which is used for weapons production. This sector has large, difficult-to-control volumes due to its high profitability and government support. Currently, over 50 countries produce weapons, and their geography continues to expand. This is clearly evidenced by the data on arms exports, which amounted to over 22.8 billion USD in 2020. The main arms exporters are the USA ($9.37 billion), Russia ($3.2 billion), France ($1.99 billion), Germany ($1.23 billion), Spain ($1.2 billion), and others. Over the past 20 years, arms exports have totaled over $520 billion [16]. It is very difficult to determine how much weaponry is produced for domestic use. As of 2020, the world's countries had 98,396 tanks, 34,606 combat aircraft, 12,653 attack helicopters, more than 1,000 various combat ships, 166 nuclear submarines, 346 non-nuclear submarines, about 40 aircraft carriers, and 13,810 nuclear warheads, etc., all of which require constant maintenance and colossal expenditures, including fuel [17]. Adding to this the fuel costs of endlessly conducted military exercises, one can imagine the share of fuel and energy resources spent on military purposes. All of this has a significant impact on the CO_2 balance in the atmosphere. Additionally, all metallurgical processes are sources of pollution in the form of dust, carbon oxides, and sulfur oxides [18].

Arming and political instability pose significant threats to both peace and nature. Moreover, in these wars, it is mostly not the soldiers fighting but the civilians who die. According to statistics, during World War I, only 5% of the casualties were civilians, while in World War II, this reached 48%, and today nearly 90% of war victims are civilians, the majority of whom are women, the elderly, and children [19]. Was there really a great necessity for the recent forced relocation of Palestinians, which became the cause of the Palestinian-Israeli war?

To this day, it remains unknown who financed and continues to finance ISIS and other groups in various countries, who arms them, and who funds terrorists. Who, under the guise of democratization, creates armed oppositions? The answer is clear: they are created under the pressure of arms manufacturers and traders. Moreover, the production of weapons is primarily carried out by state-owned enterprises.

Currently, weapon production is carried out in many countries. However, the main producers are the USA, the EU, Russia, China, and other developed countries. Due to the massive scale of weapons production, metallurgy and industries using its products contribute to about 80% of global GDP [20]. They are also the main consumers of energy resources and, consequently, the primary suppliers of greenhouse gases into the atmosphere and the main contributors to modern warming and its consequences, such as flooding, destruction of settlements, and loss of lives, especially in the USA, EU, Russia, and China.

Wars and competitive military industries also have an impact on the environment. The natural balance of the atmosphere is disturbed, and the amount of CO_2 in the air continues to increase (Figure 5).

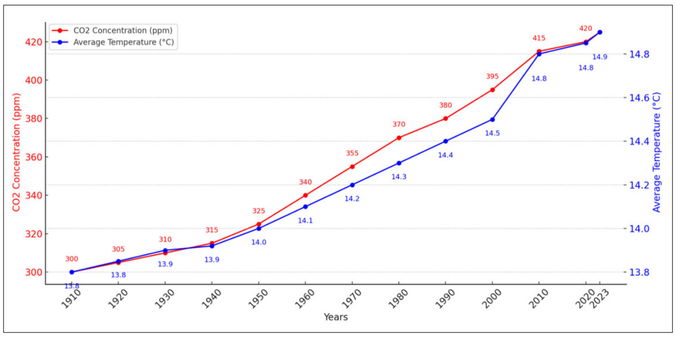

Figure 5: Atmospheric CO_2 Concentration and Global average Temperature (1910-2023).

In the future, the extraction and use of fossil fuels will be influenced by global ecological policies and technological development. Currently, 80% of global energy demand is still met by fossil fuels. If this trend continues, by 2050, the concentration of CO_2 in the atmosphere could reach 500 ppm, potentially causing sea levels to rise by 0.5–1 meter. This would lead to coastal areas being submerged, a decline in agricultural production, and a threat to global food security.

Thus, from 1910 to 2023, the increase in coal, oil, and natural gas extraction has contributed significantly to economic and industrial development. However, this process has exacerbated global ecological and climatic problems. In the future, transitioning to renewable energy sources, reducing dependence on fossil fuels, and strengthening decarburization policies will be crucial for humanity's sustainable development. International cooperation and strategic planning will play a decisive role in this process.

Global climate change is one of the most significant environmental challenges facing humanity today [21]. The large-scale extraction and consumption of fossil fuels, including coal, oil, and natural gas, has led to a significant increase in CO_2 concentrations in the atmosphere. This has caused global temperatures to rise by 1.2°C since the early 20th century, leading to rising sea levels, reduced agricultural productivity, and an increase in extreme weather events. These changes threaten global food security and disrupt the ecological balance of our planet.

The main drivers of climate change include the increase in greenhouse gases and human activities, particularly the operations of industrial and military production sectors. Metallurgy and the military industry, which constitute a large portion of the carbon footprint, directly contribute to the intensification of the greenhouse effect. The production and use of military technologies, in particular, require large amounts of energy and raw materials, which in turn result in increased emissions of harmful substances into the atmosphere. Therefore, it is necessary to accelerate large-scale research on climate change at both global and regional levels, focusing on identifying its causes and consequences. It is crucial to promote the use of solar and wind energy, the production of biofuels, and the expansion of areas dedicated to green energy [22-25]. Additionally, efforts are being made to increase CO_2 capture in oceans, develop geothermal energy, and use hydrogen as a clean energy source [23,26].

In the future, international cooperation and coordinated political measures will be required to mitigate the consequences of climate change. Reducing dependence on fossil fuels, expanding renewable energy sources, and implementing strategies to reduce carbon emissions are key directions for ensuring sustainable development for humanity. Supporting innovative technologies and scientific research aimed at climate adaptation and the development of sustainable energy systems is of critical importance.

In conclusion, preventing global warming and addressing environmental issues require not only technological solutions but also social responsibility, political will, and international cooperation. Through the joint efforts of all countries and sectors, it is possible to ensure the ecological sustainability of our planet.

References

1. Pronin YN (2014) The Paradoxes of the Struggle for Clean Air. Gazpronin https://gazpronin.ru/GazPronin2013.shtml.
2. Treshnikov AF, Alayev EB, Alampiev PM, Voronov AG (1988) Geographic Encyclopedic Dictionary: Concepts and Terms. Moscow: Soviet Encyclopedia 432.
3. Kamalov BA (2022) On the "Climate" and the Main Cause of the Increase in CO2 Concentration in the Atmosphere, Problems of Atmospheric Physics, Climatology, and Environmental Monitoring: Proceedings of the IV International Scientific Conference Stavropol: Publishing House of SFU 39-45.
4. Kostin SI (1955) Fundamentals of Meteorology and Climatology. Leningrad: Gidrometeoizdat 394.
5. Monin AS (1982) Introduction to the Theory of Climate. Leningrad: Gidrometeoizdat 242.
6. Alisov BP, Poltaraus BV (1974) Climatology. Moscow, MGU Publishing 299.
7. Arushanov ML (2021) Objective Construction of the Concept of 'Climate' Hydrometeorology and Environmental Monitoring. 1: 11-19.
8. Arushanov ML (2010) The Climatic Spectrum of Planet Earth. Tashkent: UzGIMET 160.
9. Sergin VY, Sergin SY (1978) Systematic Analysis of the Problem of Large Climatic Oscillations and Glaciation of Earth. Leningrad: Gidrometeoizdat 280.
10. Monin AS (1972) Earth's Rotation and Climate. Leningrad: Gidrometeoizdat 112.
11. Mazin IP, Shmeter SM (1983) Clouds, Structure and Physics of Formation. Leningrad: Gidrometeoizdat 280.
12. Kruchinitsky GM (2007) Global Temperature: Potential Accuracy of Measurements, Stochastic Disturbances, and Long-Term Changes, Optics of the Atmosphere and Ocean. 20: 1064-1070.
13. (2024) International Energy Agency, France. IAE https://www.iea.org/reports/coal-2024/executive-summary.
14. World crude steel production from 2012 to 2023. Statista https://www.statista.com/statistics/267264/world-crude-steel-production.
15. Voskoboynikov VG, Kudrin VA, Yakushev AM (2005) General Metallurgy. Moscow: Academ book 768.
16. The world's largest exporters of weapons and military equipment. https://svspb.net/sverige/eksport-vooruzhenija.php#.
17. List of all countries by military power 2020. https://gidnenuzen.ru/spisok-vseh-stran-po-voennoy-moschi-2020.
18. Bolshina NP (2012) Ecology of metallurgical production. Novotroitsk: NF NUST "MISiS": 155.
19. Muradov ShO (2006) Fundamentals of Ecology. Tashkent: Chinor-ENK 392.
20. Kamalov BA (2024) The Relationship between Energy and Climate Warming. International Journal of IG Min Research 6: 413-415.
21. Kamalov BA, Toshpulatov AM (2022) Who or what is the main culprit of Global Warming? Geografik Tadqiqotlar, Innovatsion G'oyalar va Rivojlanish Istiqbollari 28-30.
22. Jabeen S, Malik S, Khan S, Khan N (2021) Comparative Systematic Literature Review and Bibliometric Analysis on Sustainability of Renewable Energy Sources. International Journal of Energy Economics and Policy 11: 270-280.
23. Koriyev MR, Abdujabborov AA (2022) Alternative energy resources of Uzbekistan and possibilities of their effective use. Dera Natung Government College Research Journal 7: 20-31.
24. Kuo YF, Chen JC (2023) Technological advancements in bioenergy: A focus on biomass resources. Renewable Energy 198: 153-165.
25. Yang H, Li S (2023) Impact of renewable energy consumption on carbon emissions: Evidence from industrial sectors. Energy Reports 9: 235-247.
26. Amine ME, El-Hadad A (2022) Sustainable hydrogen production and consumption in green energy systems. Journal of Cleaner Production 352.
27. Kamalov BA (2024) About the Problem of Climate Warming. IgMin Res 2: 926-928.
28. Kamalov BA, Boymirzaev KM (2012) On the Tectonics of Lithospheric Plates. Mining Herald 1: 57-62.