GLOBAL WARMING: CAUSES, CONSEQUENCES, AND IMPACT ON CENTRAL ASIA

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Abstract: This article analyzes the main causes of global warming, particularly greenhouse gas emissions, and their consequences. It highlights the climate change-related risks specific to Central Asia and Uzbekistan, including glacier melting, water scarcity, and drought. The article also emphasizes the importance of mitigation and adaptation measures, as well as international cooperation, in combating global warming.

Keywords: global warming, climate change, greenhouse gases, carbon dioxide, methane, extreme weather events, glacier melting, water scarcity, Central Asia, climate adaptation, mitigation and adaptation, renewable energy, Paris Agreement.

Global warming is one of the most pressing and complex environmental problems of the 21st century. It refers to the long-term warming of the Earth's climate system and the resulting large-scale changes. This phenomenon is directly linked to human activities, particularly the massive emissions of greenhouse gases into the atmosphere following the Industrial Revolution. According to the Intergovernmental Panel on Climate Change (IPCC), the Earth's average temperature has increased significantly over the past century, and this trend is accelerating [IPCC, 2023]. The consequences of

global warming pose serious threats not only to the environment but also to the global economy, social stability, and human health.

The fundamental cause of global warming is the rising concentration of greenhouse gases in the atmosphere. These gases do not block incoming solar radiation but trap infrared radiation (heat) emitted from the Earth's surface, intensifying the "greenhouse effect." The main greenhouse gases and their sources are:

Carbon dioxide (CO_2): The largest contributor to global warming, primarily emitted from the combustion of fossil fuels (coal, oil, natural gas) in energy production, transportation, and industry. According to the United Nations Environment Programme (UNEP), atmospheric CO_2 levels have increased by over 50% since industrialization [UNEP, 2022]. Deforestation also plays a critical role, as trees absorb CO_2 during photosynthesis, and their removal disrupts this natural mechanism.

Methane (CH_4): A gas with a much higher heat-trapping potential than CO_2. Its main sources include agriculture (livestock, rice cultivation), decomposition of organic waste in landfills, and extraction and transportation of fossil fuels.

Nitrous oxide (N_2O): Produced mainly from the use of mineral fertilizers in agriculture, industrial processes, and biomass burning. Its heat-trapping potential is hundreds of times stronger than CO_2.

The accumulation of these gases in the atmosphere disrupts the Earth's energy balance and raises the planet's average temperature, which in turn triggers cascading effects on other components of the climate system, including oceans, glaciers, and the biosphere [Karimov, 2021].

The consequences of global warming are widespread and affect all regions differently. Key impacts include:

Increase in extreme weather events: Heatwaves, heavy rainfall, floods, droughts, and severe storms are becoming more frequent and intense. These events cause significant agricultural losses, damage infrastructure, and threaten human lives.

Sea-level rise: Melting polar and mountain glaciers, combined with thermal expansion of ocean water, is causing global sea levels to rise. This poses serious threats to coastal areas and island nations, potentially submerging land [IPCC, 2023].

Water scarcity: Global warming alters the hydrological cycle. Some regions experience decreased precipitation and prolonged droughts, while others may see increased rainfall. For landlocked regions like Central Asia, which depend on transboundary rivers, this problem is particularly acute.

The **Central Asian region** is among the most vulnerable to climate change. According to the Uzbekistan Hydrometeorology Center (UzGidromet), the rate of temperature increase in the region exceeds the global average [UzGidromet, 2024]. The main regional risks include:

Glacier melting: Glaciers in the Pamir and Tien Shan mountains feed major rivers such as the Amu Darya and Syr Darya. Rapid melting initially increases river flows but ultimately leads to a severe long-term reduction in water resources. This poses a critical threat to Uzbekistan's irrigation-based agriculture [Karimov, 2021].

Drought and desertification: Rising temperatures and changing precipitation patterns extend drought periods and accelerate desertification, degrading pastures, reducing crop yields, and threatening food security. The Aral Sea disaster exemplifies the combined effects of climate change and poor water management.

Economic losses: Water scarcity and extreme weather events cause significant economic damage to energy production (reduced hydroelectric output), agriculture, and

industry. The World Bank estimates that without climate adaptation measures, Central Asian countries could lose a substantial portion of their GDP [World Bank, 2023].

Addressing global warming requires a **comprehensive approach** at international, national, and individual levels, focusing on **mitigation** and **adaptation**.

Mitigation measures aim to reduce greenhouse gas emissions and include:

- Transition to renewable energy sources: Expanding the use of solar, wind, geothermal, and hydroelectric energy to reduce dependence on fossil fuels. Uzbekistan has recently launched large-scale solar and wind power projects.
- Increasing energy efficiency: Implementing energy-saving technologies in industry, buildings, and transportation.
- Reforestation and greening initiatives: National projects like "Green Space" help absorb atmospheric CO_2.

Adaptation measures prepare for the inevitable impacts of climate change and reduce their negative effects. For Central Asia, this includes:

- Efficient water resource management: Expanding water-saving irrigation technologies (drip irrigation) and strengthening transboundary water cooperation.
- Agricultural diversification: Developing and planting drought- and salinity-resistant crops.
- Early warning systems: Informing populations and farmers about extreme weather events (droughts, heatwaves) in a timely manner.

At the international level, the **2015 Paris Agreement** was a crucial step in combating global warming. Under this agreement, countries pledged to limit global average temperature rise to well below 2°C above pre-industrial levels, aiming for 1.5°C

where possible [UNEP, 2022]. Achieving this goal requires a substantial reduction in global greenhouse gas emissions.

In conclusion, global warming is not merely an environmental problem but a **global threat to the sustainable development of human civilization**. Its causes are closely linked to human activity, and its consequences leave deep impacts worldwide, particularly in vulnerable regions like Central Asia. Glacier melting, water scarcity, droughts, and economic losses pose serious concerns for the region's future.

Effective solutions require **global solidarity, political will, and technological innovation**. Mitigation measures such as the transition to renewable energy and energy efficiency, together with strict adaptation actions like water conservation and climate-resilient agriculture, are essential. The active participation of every country, community, and individual is the only way to preserve a healthy and sustainable environment for future generations. Research shows that the cost of inaction far exceeds the cost of taking action.

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