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THE IMPACT OF ARTIFICIAL INTELLIGENCE DATA CENTERS ON FRESHWATER RESOURCES AND THE ENVIRONMENTAL SIGNIFICANCE OF THEIR SITING

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Abstract
This article examines the growing consumption of freshwater resources for cooling the servers of data centers that support artificial intelligence (AI) systems. It analyzes the potential environmental risks associated with increasing water demand and its possible impact on ecological sustainability in the future. Furthermore, the paper discusses practical approaches to mitigating these challenges, including the efficient use of water resources, the implementation of energy-efficient cooling technologies, and the adoption of alternative cooling methods to reduce environmental impacts.

Keywords: Artificial Intelligence (AI), Data Center, Immersion Cooling, Ecology, Servers, Freshwater Resources, Water Consumption, Energy Efficiency, Sustainable Development.

Introduction

The 21st century is recognized as a period in human history when digital technologies and artificial intelligence (AI) are developing rapidly. Artificial intelligence is increasing efficiency in many fields such as healthcare, education, transport, industry, agriculture, and public administration, and is becoming an important factor of economic development. At the same time, the large data centers (Data Centers) that form the basis of AI infrastructure are significantly increasing the demand for energy and water resources.

Today, worldwide, freshwater reserves are steadily decreasing as a result of population growth, climate change, the increasing number of droughts, and the growing volume of water use. For this reason, assessing the impact of artificial intelligence infrastructure on water resources and managing it on a scientific basis is considered one of the pressing environmental issues.

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Freshwater resources on Earth: The total volume of water on Earth is approximately 1.386 billion km³. Of this water, 97.5 percent is saltwater in oceans and seas, and only 2.5 percent is freshwater. The existing freshwater reserves are distributed as follows:

- **68.7 %** — glaciers and permanent snow cover;
- **30.1 %** — groundwater;
- **1.2 %** — surface water and other sources (rivers, lakes, swamps, atmospheric moisture, and others).

Thus, the water resources that humanity can use directly make up a very small part of the total volume of water on Earth.

According to calculations, the total volume of freshwater on Earth is approximately 34.65 million km³.

Since 1 km³ = 10^{12} litres:

34.65 million km³ = 3.465 × 10^{19} litres, that is, **34,650,000,000,000,000,000 litres** of freshwater exist. Although at first glance this seems like a very large amount, since the main part of it is located in glaciers and deep underground layers, the water reserves actually available for human use are several times smaller than this.

Artificial intelligence and water consumption: The operation of artificial intelligence depends on large computing centers. In these centers, thousands of graphics processing units (GPUs) and servers operate continuously. They release a very large amount of heat. Modern cooling technologies are used to keep the operating temperature of the servers within a safe range. Today, many Data Centers use:

- Water cooling systems;
- Evaporative cooling systems;
- Immersion cooling (cooling servers by immersing them in a special dielectric liquid) technologies;
- Closed-loop liquid cooling systems.

It should be especially noted that servers are usually not immersed in ordinary freshwater. In immersion cooling technology, special dielectric liquids that do not conduct electric current are used. However, in many data centers, freshwater or industrial water is still used to release heat into the external environment. Especially in evaporative cooling systems, a certain part of the water evaporates and is released into the atmosphere.

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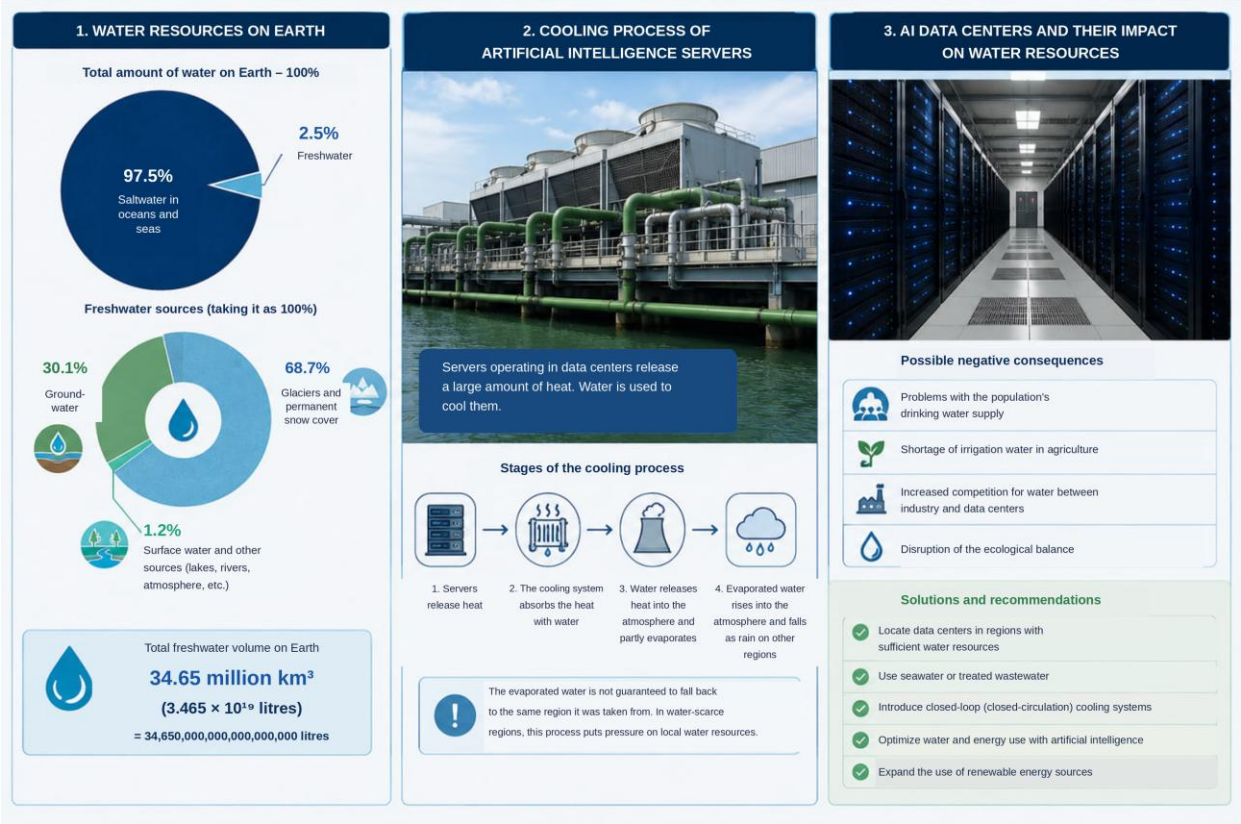

Environmental problems of AI data centers: As the use of artificial intelligence servers expands, water consumption is also increasing. For example, according to international studies:

- Microsoft's water consumption increased by nearly 34 % within one year in 2022.
- Google's data centers consume billions of litres of water per year in some regions.
- During the training of Large Language Models, millions of litres of water may also be consumed directly or indirectly.

Evaporated water returns to the Earth's surface in the form of precipitation through the natural water cycle. However, this water does not fall back into exactly the same region from which it was taken. Air currents in the atmosphere can carry precipitation hundreds, even thousands of kilometres away. As a result, it is not out of the question that data centers located in water-scarce regions may have a negative impact on the local water balance.

Future risks: According to UN forecasts, the world's population is expected to reach 9.7 billion by 2050. At the same time, the demand for freshwater will also increase sharply. If AI data centers are built in regions with limited water resources, negative consequences such as the following may arise:

- Deterioration of the population's drinking water supply;
- Shortage of irrigation water in agriculture;
- Increased competition for water resources between industry and data centers;
- Disruption of the ecological balance.

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Solutions to the problem: In order to develop artificial intelligence infrastructure sustainably in the future, it is advisable to implement the following measures:

- Locate Data Centers in regions with sufficient water resources;
- Expand the use of seawater or recycled treated wastewater;
- Introduce closed-loop cooling systems;
- Optimize water consumption with the help of artificial intelligence;
- Increase the energy efficiency of servers;
- Expand the use of renewable energy sources.

Conclusion

Artificial intelligence technologies are becoming an integral part of human progress. However, the environmental impact of these technologies, in particular their burden on freshwater resources, also needs to be studied in depth. At a time when the number of AI data centers is growing, it is important to take into account water resources, climate conditions, and environmental sustainability factors when siting them. By introducing modern cooling technologies, using water rationally, and managing resources on a scientific basis, the environmental impact of artificial intelligence can be significantly reduced. Therefore, alongside the development of artificial intelligence, the issue of conserving natural resources, especially freshwater reserves, remains one of the priority tasks on a global scale.

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