THE ROLE OF DIGITALIZATION IN MONITORING HAZARDOUS GEOLOGICAL PROCESSES

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Abstract. *Digitalization in the field of geology plays an important role, allowing you to collect and analyze data, as well as make quick decisions based on this data. In particular, in the field of monitoring hazardous geological processes, it serves as a basis for collecting up-to-date information on the risk of occurrence of hazardous geological processes and their analysis, as well as for making quick decisions based on this data. This article discusses the role of digitalization in monitoring dangerous geological processes, as well as the expected results, opportunities and prospects for the introduction of information and communication technologies, as well as artificial intelligence in the analysis processes, and the directions for the development of digital technologies are also studied.*

Keywords: *digitalization, geology, hazardous geological processes, artificial intelligence, networks, geographic information systems, modeling, monitoring, drone, virtual and augmented reality.*

Digitalization is a process that is becoming increasingly relevant in the modern world. It affects many areas of human activity, including the monitoring of dangerous geological processes. Monitoring hazardous geological processes is an important task for ensuring the safety of life and property of people. This includes monitoring earthquakes, volcanic eruptions, landslides and other processes that can lead to catastrophic consequences.

Digital technologies can significantly improve the prediction, monitoring and prevention of dangerous geological processes such as earthquakes, mudflows and landslides. Some of the possible directions for the development of digital technologies in this area include:

- the use of artificial intelligence and machine learning to analyze large amounts of data on geological processes and predict the likelihood of their occurrence;
- development of unmanned aerial vehicles and drones for real-time monitoring of geological processes and rapid response to possible threats. This may include using drones to detect ground changes, taking aerial photographs to analyze topography and create 3D terrain models, and using drones to deliver materials and equipment to incident sites. Such technologies can significantly speed up response to threats and help specialists make more effective decisions;
- creation of geoinformation modeling systems that will accurately describe geological processes and their interaction with the environment;
- development of sensor technologies for continuous monitoring of geological processes, such as changes in groundwater levels, soil movement, etc.;
- the use of virtual and augmented reality for the education and training of specialists in the prevention and management of dangerous geological processes. This will allow them to have a more realistic experience of working in various scenarios and learn how to make the right decisions in extreme conditions. In addition, the use of virtual and augmented reality can help reduce training costs and improve the quality of training.

Digitization plays an important role in this area, allowing you to collect and analyze data, as well as make quick decisions based on this data. For example, with the help of digital technologies, it is possible to monitor earthquakes and determine their magnitude and epicenter, which allows you to quickly respond to possible consequences.

Various digital technologies are used to monitor earthquakes and determine their magnitude and epicenter, such as:

Seismic networks – These are networks of measuring stations that are used to record earthquakes. Each station measures ground vibrations and transmits the data to a central server where it is processed and analyzed. These data can be used to determine the magnitude and epicenter of an earthquake.

Global Positioning System (GPS) – used to determine the exact location of seismic network stations and to determine the deformation of the earth's crust, which can be associated with earthquakes.

Interferometric synthetic aperture radar (InSAR) – used to measure the deformation of the earth's crust with high accuracy. This allows you to determine the places where changes in the earth's crust occur, which can be associated with earthquakes.

Acoustic sensors – are used to measure sound waves that occur during earthquakes. This data can help determine the magnitude and epicenter of an earthquake.

Artificial Intelligence (AI)– is used to process and analyze a large amount of data collected using various digital technologies. Smart algorithms can help determine the magnitude and epicenter of an earthquake more accurately and quickly than manually.

In addition, AI can be used to manage risks in geological projects such as construction and mining. AI algorithms can help determine the safest and most efficient working practices, as well as predict potential problems and prevent them.

Thus, the use of AI in geology can significantly improve our ability to understand and predict natural processes, as well as reduce risks and increase the efficiency of geological projects. However, it is necessary to take into account the ethical and social aspects of the use of AI in this area.

Digitalization also makes it possible to create models of dangerous geological processes that can help in predicting their development. For example, models can be used to determine which areas are most prone to landslides or flooding and take action to prevent potential disasters.

When creating models of hazardous geological processes, the following methods are used:

1. Geographic information systems (GIS) are used to collect, store, analyze and visualize geodata, such as data on relief, geological structure, climate, hydrology and other parameters that can affect the development of dangerous geological processes.

Geographic information systems (GIS) play an important role in the digitalization of the field of geology. They are used to collect, store, analyze, and visualize geodata such as terrain, geological structure, climate, hydrology, and other parameters that may influence the development of dangerous geological processes.

GIS allows you to create digital terrain models that can be used to predict the development of dangerous geological phenomena. They also allow you to analyze risks and develop measures to prevent possible consequences.

Thanks to GIS, one can quickly obtain information about geological processes and take prompt measures to manage them. This helps to reduce the response time to crisis situations and minimize possible damage.

GIS is also used to create digital maps of geological resources that help optimize the search and extraction of minerals. This increases the efficiency of the work of geological companies and contributes to the economic development of the regions.

Thus, GIS is an important tool in the digitalization of the field of geology, which allows you to effectively manage hazardous geological processes and optimize the processes of prospecting and mining.

2. Modeling - used to create mathematical models of processes that can lead to hazardous geological events such as earthquakes, volcanic eruptions, landslides and others. These models can help predict the development of these processes and determine the possible consequences.

Modeling is an important part of GIS and plays a key role in the digitalization of the field of geology. With the help of modeling, you can create digital terrain models that allow you to predict the development of hazardous geological phenomena and conduct risk analysis.

Modeling is also used to create digital maps of geological resources that help optimize the search and extraction of minerals. This allows to increase the efficiency of the work of geological companies and contributes to the economic development of the regions.

In general, modeling is an important tool in the digitalization of the field of geology, which allows you to effectively manage dangerous geological processes and optimize the processes of prospecting and mining.

3. Monitoring - used for continuous monitoring of dangerous geological processes and collecting data on their development. This allows you to quickly respond to changes in processes and take measures to minimize possible consequences.

Monitoring is an integral part of the digitalization of the field of geology. With the help of monitoring, you can track changes in geological processes and analyze data for decision making.

For example, monitoring allows you to track changes in the level of groundwater, which is important in the construction of buildings and structures. Monitoring is also used to track changes in the state of mountain ranges, which helps prevent dangerous situations and take the necessary measures to ensure safety.

Monitoring also plays a key role in mining. With the help of monitoring, you can track changes in the state of deposits and optimize production processes.

In general, monitoring is an important tool in the digitalization of the field of geology, which allows you to effectively manage geological processes and ensure safety during construction and mining.

4. Analysis of historical data - used to study past dangerous geological events and determine the patterns of their development. This can help in predicting future events and developing measures to prevent them.

The analysis of historical data plays an important role in the digitalization of the field of geology. By analyzing historical data, you can obtain information about past geological events, which allows you to better understand current processes and make more informed decisions.

For example, analysis of historical earthquake data can help identify areas of high risk and develop disaster prevention measures. Analysis of historical data on changes in the groundwater

level can help in determining the required depth of the foundation in the construction of buildings and structures.

In addition, analysis of historical data can help identify mining technologies that have been successfully applied in the past. This allows you to optimize production processes and increase work efficiency.

In general, the analysis of historical data is an important tool in the digitalization of the field of geology, which allows you to obtain valuable information about past geological events and use it to make decisions in the present.

5. Artificial intelligence - used to process and analyze a large amount of data collected using various methods. Intelligent algorithms can help predict the development of dangerous geological processes and determine the possible consequences.

Artificial intelligence (AI) plays an important role in the digitalization of the field of geology. It allows you to process large amounts of data and reveal hidden patterns and trends, which helps you make more accurate decisions.

For example, AI can be used to analyze geological data and predict high-risk areas for earthquakes, volcanic eruptions, and other natural disasters. Also, AI can be used to optimize mining processes, which can improve efficiency and reduce costs.

In addition, AI can be used to create 3D models of geological objects and predict their behavior under various conditions. This allows you to make more accurate forecasts and make informed decisions in the design and construction of buildings and structures. They can also be used to create more accurate maps of the geological structure and distribution of minerals. This can help mining companies identify the most promising areas for exploration and production.

Finally, AI can be used to create more accurate models of climate change and its impact on geological processes. This can help scientists and governments take better action to combat climate change and its impacts.

In general, AI has great potential to improve the work of geology and improve the safety of people in the face of natural disasters. However, it is necessary to take into account the ethical and social aspects of the use of AI in order to minimize possible negative consequences. AI is a powerful tool in the digitalization of the field of geology, which allows you to get more accurate and complete information about geological processes and use it to make decisions in the present.

In addition, digitalization makes it possible to create automatic warning systems for possible hazardous geological processes. Such systems can use data from a variety of sources, including sensors, satellites, and weather stations, to warn people of earthquakes, avalanches, landslides, and other natural disasters. These systems can be especially useful in areas where the risk of natural disasters is high.

Such systems can be linked to sensors that collect data about the state of the environment and can automatically alert people to possible dangers.

In general, the development of digital technologies in the field of dangerous geological processes can significantly improve the safety of people and reduce the risks of catastrophic events. Digitalization plays an important role in the monitoring of hazardous geological processes, allowing the collection and analysis of data, the creation of models and automatic warning systems. This helps to ensure the safety of life and property of people and reduce the risk of disasters.

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