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ECOLOGICAL MONITORING: THE ROLE OF NEW TECHNOLOGIES IN THE CONSERVATION OF NATURAL RESOURCES

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Introduction

Ecological monitoring is a critical tool for the conservation of natural resources and sustainable environmental management. In recent years, factors such as environmental changes, climate change, population growth, and industrialization have made the conservation of ecosystems increasingly difficult. Issues such as radiation, air quality, water, and soil pollution require the application of modern technologies to monitor environmental conditions and identify risks in this field. The importance of ecological monitoring becomes evident here.

Traditional monitoring methods, especially in detecting ecological changes, have limitations. Large-scale environmental monitoring, as well as conducting analyses in polluted and difficult areas, often presents technical challenges. However, modern technologies, particularly drones, gamma-ray spectroscopy, and other sensors, have begun to bring about revolutionary changes in this area. These new approaches increase the speed of ecological monitoring, expand the accuracy and scope of results, and enable more effective outcomes in environmental protection.

This article explores the significance of ecological monitoring, the application of modern technologies, and developments in this field, particularly focusing on the role of gamma-ray spectroscopy and dosimetry in measuring and analyzing radiation levels in the environment. It also discusses how the use of drone technology and other sensors has transformed ecological monitoring and examines the prospects in this field.

Main factors threatening ecosystems

Ecosystems play a vital role in ensuring the sustainable use of natural resources and protecting biodiversity. However, many ecological factors pose a threat to these ecosystems. One of the most significant dangers is radiation. While natural radiation levels exist in the natural environment such as soil, water, and air, human activities, particularly nuclear technologies and other industrial processes, have increased these radiation levels, posing serious threats to ecosystems and human health.

In addition to radiation, air pollution, water pollution, and soil contamination also cause significant damage to ecosystems. Industrialization, urbanization, and climate change have all contributed to the increase of these pollutants. The quality of air, the composition of water, and the condition of soil directly affect the vital activities of living organisms within ecosystems. For example, the increase in harmful substances in the air alters the composition of the atmosphere, leading to global warming and climate change.

A comparison of the threats to ecosystems is shown in Figure 1. This graph clearly illustrates how radiation, air pollution, and water contamination impact ecosystems in comparison to soil pollution.

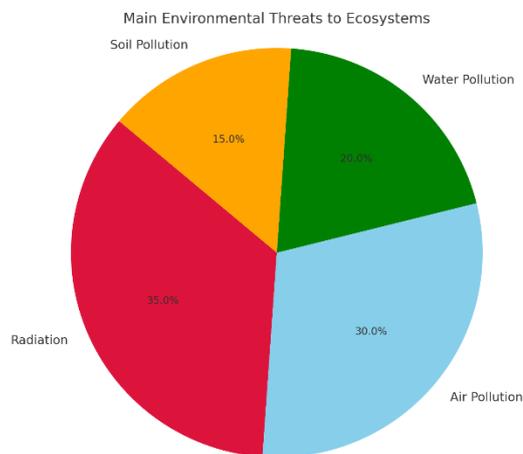


Fig. 1. Main factors threatening ecosystems

Monitoring these primary factors threatening ecosystems and taking appropriate measures will be a crucial step in the conservation of ecosystems.

The importance of ecological monitoring

Ecological monitoring is a crucial tool for ensuring the sustainable use of natural resources, protecting ecosystems, and tracking the impacts of climate change. This field is important not only for assessing the current state of ecosystems but also for predicting future changes and taking appropriate actions.

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In recent years, the increasing human impact on the environment has made this type of monitoring even more essential.

The purpose of ecological monitoring is not only to track radiation but also other environmental factors, such as air, water, and soil pollution. Climate change, urbanization, and industrialization have caused significant changes in the environment. These changes can disrupt the balance of ecosystems, reduce biodiversity, and threaten human health.

One of the primary goals of ecological monitoring is the continuous tracking of radiation levels. Radiation, a significant ecological factor that can spread throughout the environment due to both natural and human activities, is essential to monitor. Tracking these changes is crucial for preserving the health of ecosystems and analyzing radiation sources.

Radiation levels can change over time, especially due to natural events and human activities. For instance, the activities of the nuclear industry can increase natural radiation levels. At the same time, natural radiation may also show specific changes over time, which in turn affects ecosystems.

Figure 2 presents a graph illustrating how radiation levels in a particular area have changed over time. This graph demonstrates how radiation levels have increased or decreased at different periods, while also showing how these changes can affect ecosystems and human health.

Information on changes in radiation levels over time can be monitored more accurately with modern technologies. Continuous environmental monitoring allows for the timely identification of these changes and the implementation of appropriate responses. For example, radiation monitoring helps prevent radiation levels from exceeding normal levels due to the activities of the nuclear industry.

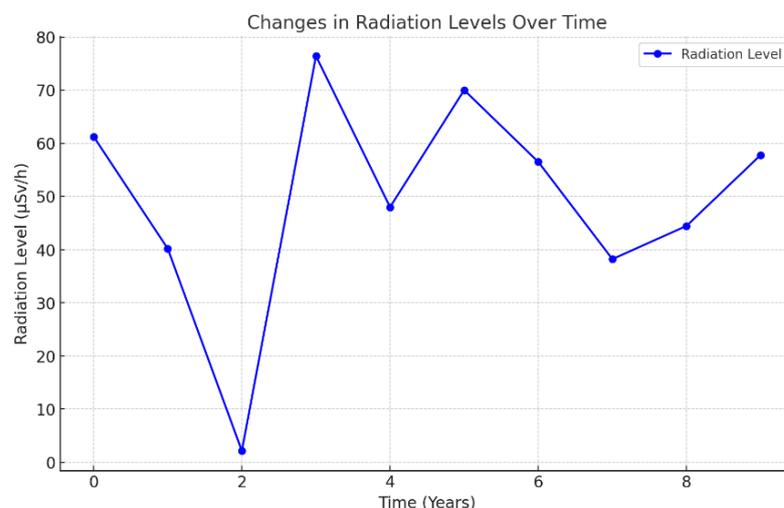


Fig. 2. **Changes in radiation levels over time**

Gamma-ray spectroscopy and dosimetry

Gamma-ray spectroscopy is a technology used to measure the composition and intensity of radiation. Gamma rays are highly energetic photons that can penetrate different materials depending on the substance. This property makes them extremely useful for measuring radiation levels in the environment.

Gamma-ray spectroscopy is used to accurately measure the type and amount of radiation in a specific area. This technology can help identify radiation sources and analyze how radiation affects ecosystems and humans. Gamma-ray spectroscopy is widely applied in monitoring natural radiation levels and detecting illegal radiation sources.

Another advantage of gamma rays is their ability to easily pass through materials. Therefore, gamma-ray spectroscopy offers high precision in measuring and analyzing radiation in the environment. This allows for rapid and reliable measurements of radiation levels over large areas.

Dosimetry is the science of measuring and evaluating radiation doses. Human exposure to radiation can pose health risks, so measuring radiation doses is crucial. Dosimetric devices measure radiation levels to assess the radiation burden on both people and the environment.

In ecological monitoring, gamma-ray spectroscopy and dosimetry are used together. Gamma-ray spectroscopy determines the type and source of radiation, while dosimetry measures the degree of radiation exposure for humans and the environment. Together, these two technologies ensure more accurate assessments of radiation levels and potential hazards.

Different radiation sources have varying impacts on gamma-ray radiation. For example, natural radiation sources such as uranium, thorium, and potassium cause gamma rays to spread through the environment with varying intensities. This is essential for protecting ecosystem health and identifying potential risks.

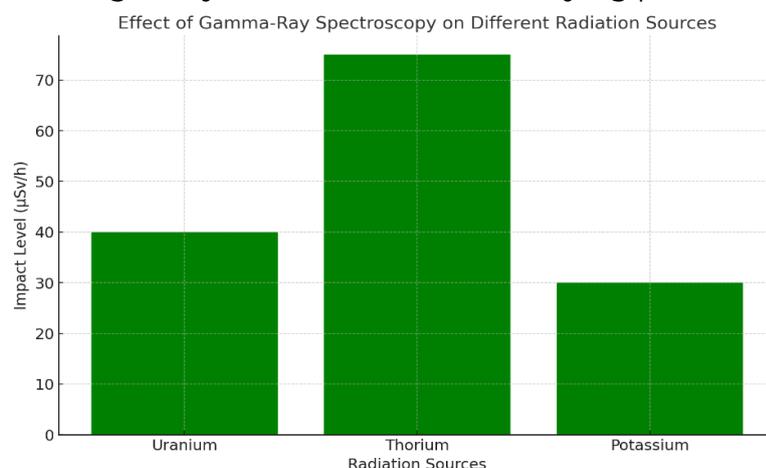


Fig. 3. The effect of gamma-ray spectroscopy on different radiation sources

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Figure 3 presents a bar chart showing the effect of different radiation sources on gamma-ray radiation. This graph visualizes how radiation sources affect the intensity of radiation and their potential impact on the environment.

With the application of gamma-ray spectroscopy, the impact of different radiation sources on the environment can be measured more accurately.

Application of drone technology in ecological monitoring

Drones are revolutionary technologies that have brought significant changes to the field of ecological monitoring. Compared to traditional monitoring methods, drones are faster, more accurate, and cost-effective. The use of drones to monitor and analyze various environmental parameters is widespread. For example, drones can be used to measure radiation levels, analyze air quality, assess water pollution, and evaluate soil conditions.

The advantage of drones is their ability to monitor large areas in a short amount of time and with high precision. This capability makes it easier to collect data in mountainous or polluted areas, where traditional monitoring methods face challenges. Furthermore, drones collect data with minimal impact on the environment, solving a problem often encountered in traditional methods.

Drone technology is particularly useful in monitoring the health of ecosystems and agriculture. This technology is also an ideal tool for monitoring in difficult and risky areas while ensuring human safety.

Figure 4 presents a pie chart showing how drone technology is applied in ecological monitoring. This graph demonstrates how drones' impact various ecological factors, such as air quality, water pollution, soil conditions, and radiation.

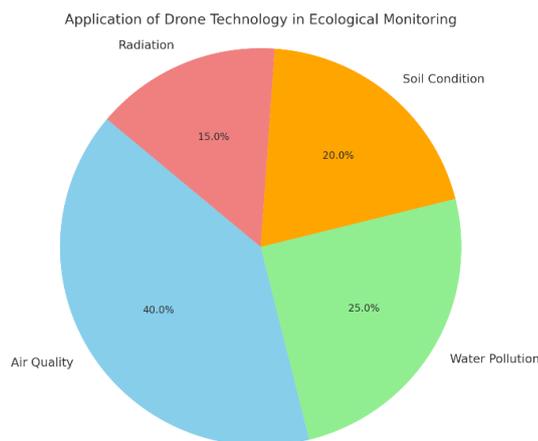


Fig. 4. **Application of drone technology in ecological monitoring**

Drones collect data with minimal environmental impact. This feature addresses a problem often encountered in traditional monitoring methods. For

example, conventional monitoring techniques in radiation or polluted areas can sometimes cause additional harm to the environment and humans. Drones, however, minimize these impacts as they can collect data without making physical contact with the ground.

Furthermore, the use of drones prevents humans from encountering radiation in high-risk and difficult areas, ensuring worker safety and reducing the risk of radiation exposure.

Drones are not limited to radiation monitoring. They are also used to track air quality, water pollution, and soil conditions. Equipped with specialized sensors, drones can measure various environmental parameters. For example, gas sensors can be added to drones to measure air quality, helping to determine the levels of harmful substances in the atmosphere.

In water bodies, drones can measure the composition of water and the quantity of pollutants present. They also collect data on soil conditions and how water interacts with the soil. These insights are crucial for evaluating the health of ecosystems and mitigating future pollution risks.

Conclusion

Ecological monitoring is crucial for conserving natural resources, tracking radiation levels, and ensuring environmental sustainability. Modern technologies like gamma-ray spectroscopy, dosimetry, and drones overcome the limitations of traditional methods, enabling faster, broader, and safer data collection. These technologies play a key role in monitoring radiation and pollution, while also protecting humans and the environment. In the future, drones, enhanced by artificial intelligence and data analytics, will evolve into automated systems that issue alerts and take action in areas with high radiation and pollution levels. This technological advancement will be a vital step in safeguarding ecosystems and human health.

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