Innovative solutions for providing preservation of natural ecosystems

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Abstract. In the context of increasing anthropogenic pressure and depletion of the Earth's resources, ensuring the preservation of natural ecosystems is becoming a critical task for humanity. The key civilizational challenges at the present stage are climate change, environmental pollution, loss of biodiversity and the rapid reduction of fossil energy reserves. To successfully confront these challenges, an innovative approach to industrial and energy management, waste management and cleanup of polluted natural ecosystems is required. This article discusses such innovative solutions and technologies as ecological restoration of landscapes, the use of biotechnology and genetic engineering to preserve natural diversity, circular economy and modern methods of environmental monitoring.

1 Introduction

Increased energy production and overuse of resources on a global scale are leading to soil and water pollution, forest destruction, drinking water shortages and global climate change. According to the UN, by 2030, energy consumption in the world will increase by 60%, and 2.9 billion people will experience water shortages [1]. Environmental problems are aggravated due to the expansion of production capacity and the use of outdated technologies, leading to irrational use of natural resources. In this regard, the most important task is the development and use of innovative methods to ensure environmental safety in order to preserve natural ecosystems.

Environmental innovations are currently developing in several directions, creating a single complex designed to minimize the impact of human activity on the environment (Fig. 1).

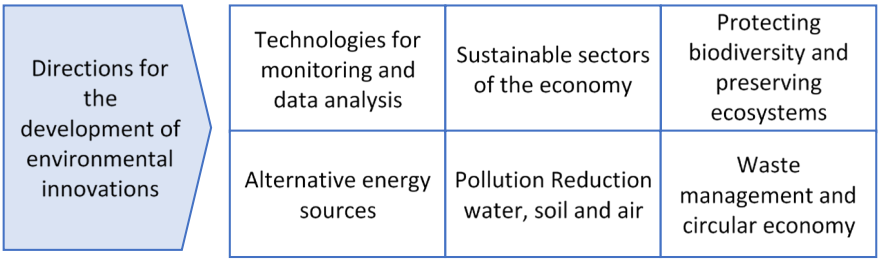

Fig. 1. Directions for implementing innovative solutions to ensure preservation of natural ecosystems

Technologies for monitoring and data analysis help prevent negative impacts on ecosystems and develop a set of measures to protect them based on a database of ongoing natural processes and their dependence on human activities. With the help of environmental monitoring, the consequences of anthropogenic and technogenic factors on the environment are recorded. Monitoring data is processed by ecologists and experts, transferred to federal and regional authorities, helps develop a strategy for the extraction and processing of minerals, and helps managers of industrial enterprises build an environmental safety system.

With the help of environmental monitoring systems in different countries, natural, anthropogenic and technogenic factors affecting the environment are recorded, as well as their consequences - changes in the environmental situation, biodiversity, natural resources and landscape. The data obtained during monitoring is used by environmental engineers, consultants, regional and federal authorities, as well as corporations in the field of extraction and processing of mineral resources, mining, and agriculture.

2 Materials and Methods

Geographic information systems (GIS) are widely used to collect, store and analyze data about natural objects and graphically visualize spatial data. This system, created in the 1980s, was further developed with the advent of such innovative tools as obtaining data on the Earth's surface using unmanned aerial vehicles, the use of raster and vector graphics editors, and the use of automated information systems and artificial intelligence for monitoring.

GIS allows you to solve problems such as collecting and storing data, analyzing data to identify changes in the state of nature, and predicting further changes. High-tech complexes created on the basis of GIS use methods such as a matrix model, graphic-analytical method, and dynamic information model. An example of such a complex is the SKAT air monitoring system, which automatically carries out constant measurements of the concentration of toxic compounds in the atmosphere. This system is designed for use on the territory of production complexes in order to timely prevent harmful emissions into the atmosphere and maintain acceptable emission concentrations during production operations.

Also, based on GIS, in 2021, the state corporation Rosatom created the Logos Hydrogeology software package, capable of modeling groundwater movements. Using the complex, it is possible to assess the negative impact of man-made impacts on groundwater and soil, and to accurately predict the likelihood of rising water levels, dam breaks and other changes that pose a danger to hydraulic structures. Using video cameras operating in automatic mode, the Chinese companies Huawei and Enbo have created an effective forest fire prevention system. The system uses an intelligent circuit that makes it possible to predict the occurrence of a fire and its danger in real time. Thousands of video cameras controlled by one operator,

Another innovative method of environmental monitoring is the use of an image recognition system. The Russian company MTS has developed a program for the Land of the Leopard national park, designed to help preserve the population of an endangered species - the Far Eastern leopard. Video cameras installed in national parks and reserves recognize the animal and track its movement. After analysis from various cameras, changes in population numbers are established and the habitats of leopards are determined.

A popular method of monitoring the natural environment is the processing of remote sensing data, which is carried out by ground, aviation and space means equipped with various types of imaging equipment. Using modern computer programs, specialists obtain high-resolution gravity maps, which make it possible to identify changes in the terrain, the scale of deforestation and soil salinization, oil pollution of water resources, the results of urbanization and the activities of industrial enterprises.

Innovative technologies in the energy sector are aimed at the development of renewable energy sources, the creation of energy-saving technologies and energy storage technologies, and the transition to the use of electric transport. Currently, one of the main trends in the field of renewable energy sources is biofuels produced from plant materials and seaweed. Bioethanol, obtained by processing corn or sugar cane, is actively used in the USA and Brazil, where this fuel is sold at standard gas stations. When burning bioethanol, carbon dioxide emissions into the atmosphere are reduced by 20% and carbon dioxide emissions by five times.

Third-generation biofuels produced from seaweed have become a new direction being developed simultaneously in several countries. In the United States, enough algae is already grown to produce enough biofuel to fuel the annual consumption of 5% of cars. In Russia, scientists from the Joint Institute for High Temperatures (JIHT) of the Russian Academy of Sciences have created a facility that makes it possible to obtain biogasoline from microalgae biomass. The installation eliminates the stage of drying algae, which was energy-consuming and prevented the efficient production of biogasoline from microalgae.

Hydrogen fuel is already used in Honda, Toyota and Hyundai cars. In Germany, the first train running on hydrogen fuel was launched in 2017; in the future, it is planned to launch 4,000 hydrogen trains that previously used diesel fuel. In Japan, in 2020, industrial production of devices that generate energy from ocean currents began. Research into solar energy continues, with Pennsylvania State University developing a photovoltaic system with built-in micro-tracking that produces 50% more energy per day than a standard silicon solar cell.

Energy-saving technologies are new or improved technological methods characterized by a high efficiency of energy resources. The introduction of energy-saving technologies at different levels makes it possible to solve environmental problems such as air pollution and depletion of natural resources.

Energy-saving technologies are actively used in “green construction,” which is characterized by the construction of structures that have minimal impact on the environment. “Green building” uses a number of technologies to reduce the level of consumption of natural resources throughout the entire life cycle of a building, as well as to reduce harmful emissions and waste both during construction and during operation of buildings [2].

Through the use of innovative building materials, the energy efficiency of the building is increased. The construction of boiler houses operating on gas or wood pellets reduces harmful emissions into the atmosphere, reduces energy consumption and reduces building maintenance costs. Recently, the concept of “passive house” has appeared; it is applied to buildings in which a comfortable temperature is maintained in winter without the use of a heating system, and in summer - without the use of an air conditioning system. In the “passive house” concept, an important place is occupied by the supply and exhaust ventilation system, which allows you to use the heat of the exhaust air to heat the air coming from the street. Solar panels installed on the roof or balcony of the house and wind generators are also used to generate energy.

3 Results and Discussion

The smart home lighting system has become very popular, allowing it to optimize the use of light and reduce energy consumption. The system, based on the use of motion sensors, began to be used not only inside the building, but also on city streets. It has shown its high efficiency thanks to intelligent control and the use of energy-saving LED lamps.

The use of sustainable technologies in various sectors of the economy is of fundamental importance to ensure the preservation of natural ecosystems.

For example, sustainable agriculture is an approach to agricultural activities that meets current food and resource needs without compromising the same rights of future generations. One of the current innovative solutions in this area is precision agriculture, which involves the use of sensors, drones and GPS technologies for more accurate and efficient distribution of fertilizers, water and pesticides in order to reduce costs and minimize pollution. Agroforestry, a sustainable agricultural practice that combines the cultivation of crops or livestock with the cultivation of trees and shrubs on the same piece of land, has become widespread in the modern world. Trees prevent soil erosion, effectively resist drought,

Using vertical farming, hydroponics, and aeroponics to grow food in cities reduces transportation costs and reduces the need for packaging. The use of innovative genetic technologies to develop plant varieties resistant to various diseases reduces the need for chemical fertilizers and pesticides. The development of machine learning and analytics algorithms is of great importance for predicting yields, identifying diseases and optimizing production processes [3].

Examples of sustainable innovative technologies in industry are the use of sensors, monitoring systems and analytics to optimize resource management, the introduction of energy-efficient industrial systems, the creation of biodegradable plastics, the use of reverse osmosis systems for water purification, etc. The construction industry uses such sustainable technologies as frame construction, building a house from SIP panels and thermogran panels (foam glass), the use of light steel thin-walled structures (LSTC), the technology of permanent formwork made of polystyrene foam and adjustable modular formwork (TISE).

Solving the global environmental problems of our time seems impossible without the development of effective methods for cleaning natural environments from pollution. One of the innovative methods of water and soil purification is bioaugmentation - an organic purification process by adding a mixture of microorganisms to water or soil, which destroys and removes contaminants. The microorganisms used are enzymes and harmless bacteria that react with local bacteria that can metabolize pollutants. The introduction of a large number of additional bacteria of the same species greatly accelerates the decomposition of pollutants. This technology has been successfully used to clean up water bodies and contaminated soils.

The technology for purifying water and soil using nanoparticles is being developed, including nanosorbents, metal nanoparticles, carbon nanotubes, and bioactive nanoparticles. This technology makes it possible to clean water bodies of heavy metals and remove pesticides and toxic substances from the soil. Scientists at the Massachusetts Institute of Technology have created polymer nanoparticles synthesized from polyethylene glycol and polyactic acid. They are capable of neutralizing the most complex types of contaminants, including polycyclic hydrocarbons, which are strong carcinogens. In this case, the substance of nanoparticles is synthesized at room temperature, which ensures the availability of this technology, which is combined with high efficiency.

Innovative air purification technologies play an important role in reducing air pollution and improving air quality. For example, silver nanoparticles can remove bacteria and viruses, and carbon nanoparticles can absorb chemical pollutants. Photocatalytic materials such as titanium dioxide are activated by exposure to ultraviolet light and can break down pollutants in the air into harmless substances. Electrostatic precipitators are used to effectively clean the air of particles such as dust, smoke and aerosols: they attract particles using electrostatic forces and trap them on special electrode surfaces. Genetically modified microorganisms and plants with high phytoremediation activity can also be used to purify atmospheric air from pollutants.

Innovative technologies in the field of biodiversity protection play an important role in the conservation of ecosystems, species and genetic resources of the planet. Thus, drones can be used to monitor wildlife, identify forest fires, search for poachers and control the territories of national parks. Artificial intelligence and big data analytics technologies make it possible

to process large amounts of information obtained from sensors and cameras to detect changes in the biological diversity of an area and effectively respond to the threat of species extinction. A variety of computer models can be used to predict changes in biodiversity based on different scenarios of climate change and human activity.

Ensuring the safety of natural ecosystems is impossible without effective waste management. The problem of waste disposal in Russia lies in the ineffective activities of society and the state in this area. Currently, outdated and unenvironmentally friendly technologies are used for this purpose, which have not been used for a long time in developed countries of the world. To solve this problem, you need to do the following:

- develop innovative technologies for transporting, sorting and processing waste,
- develop technology for the destruction of non-recyclable waste;
- develop technology for the reclamation of land contaminated by garbage;
- conduct trial tests of these technologies;
- create efficient waste treatment plants;
- introduce separate waste collection;
- introduce these technologies throughout the country.

One of the most important areas of activity is the introduction of a system of separate waste collection and the formation of an appropriate culture among the population. This should be done through various social, economic and legal means (social advertising, penalties, etc.). The next step should be a massive transition to recycling household waste. Metal elements should be sent to production, waste of biological origin - to the production of fertilizers, etc. Non-recyclable waste must be burned on site and not disposed of in landfills.

4 Conclusion

Innovative waste management solutions include the installation of sensor containers that monitor fill levels. Advanced sorting systems using artificial intelligence and robotics help automatically separate waste by type and material, increasing recycling efficiency and improving the quality of secondary raw materials. Composting technologies and biogas plants convert organic waste into compost and biogas, which can be used to produce energy. The development and use of biodegradable materials and packaging helps reduce the negative impact on the environment and facilitates recycling processes. Platforms for exchanging and recycling goods help extend the life of goods and minimize resource consumption.

Of fundamental importance for solving modern environmental problems is the creation of a circular economic system in which resources are used, processed and returned to production as efficiently as possible. As part of the circular economy, products are designed to last longer and be refurbished or repaired, allowing them to last longer, and advanced recycling technologies enable the creation of recycled raw materials from waste. The products have reusable packaging that can be used over and over again. Platforms for sharing and reselling products encourage reuse, reducing the need for new products. Car sharing, kick sharing and goods rental services promote sharing and reducing resource consumption. State organisations.

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