STUDIA ECOLOGIAE ET BIOETHICAE

2024, 22, 3: 57-69
p-ISSN 1733-1218; e-ISSN 2719-826X
DOI: http://doi.org/10.21697/seb.5819

Intelligent Systems in The Management of Regional Resources: Benefits for Sustainable Development

Inteligentne systemy w zarządzaniu zasobami regionalnymi – korzyści dla zrównoważonego rozwoju

Svitlana Melnychenko[1], Olga Cholyshkina[2], Serhii Rtyshchev*[3], Alla Mishchenko[4], Roman Karpinskyi[5]

[1] National University of Life and Environmental Sciences of Ukraine, Ukraine

[2] Interregional Academy of Personnel Management, Ukraine

[3] Kryvyi Rih National University, Ukraine

[4] Kyiv National University of Culture and Arts, Ukraine

[5] European University, Ukraine

ORCID SM https://orcid.org/0000-0002-5162-6324; OC https://orcid.org/0000-0002-0681-0413; SR https://orcid.org/0000-0002-7751-542X; AM https://orcid.org/0000-0001-6693-6221; RK https://orcid.org/0009-0001-2848-9261 • serhii_rtyshchev@edu.cn.ua

Received: 29 Mar, 2024; Revised: 24 Jun, 2024; Accepted: 28 Jun, 2024

Abstract: The purpose of our research is to analyse intelligent systems, identify their key features in general and in the context of regional resource management in particular; to provide a detailed list of the main intelligent technologies and systems used in regional resource management and the areas of their direct use. The main emphasis should be placed on the benefits of using intelligent systems in the management of regional resources in the context of sustainable development as well as on the problems that can be overcome through the use of intelligent systems. The study should also analyse the negative aspects of the use of intelligent systems in regional resource management. In order to achieve this goal, the general philosophical method, the method of system analysis, synthesis, deduction and induction, dialectical method and formal legal method were used. The findings of the study will serve as a basis for further research and a catalyst for increasing the use of smart technologies, taking into account all the benefits and potential risks.

Keywords: intelligent systems, management, regional resources, sustainable development, artificial intelligence

Streszczenie: Celem niniejszych badań jest analiza systemów inteligentnych, zdefiniowanie ich kluczowych cech, w szczególności w kontekście regionalnego zarządzania zasobami; przedstawienie szczegółowego wykazu najważniejszych inteligentnych technologii i systemów stosowanych w regionalnym zarządzaniu zasobami oraz obszarów ich bezpośredniego wykorzystania. Główny nacisk położono na korzyści płynące ze stosowania systemów inteligentnych w zarządzaniu zasobami regionalnymi w kontekście zrównoważonego rozwoju oraz problemy, które można przezwyciężyć dzięki ich zastosowaniu. Artykuł odnosi się również do negatywnych aspektów wykorzystania inteligentnych systemów w zarządzaniu zasobami regionalnymi. W badaniu zastosowano ogólną metodę filozoficzną, metodę analizy systemowej, syntezę, dedukcję i indukcję, metodę dialektyczną oraz metodę formalno-prawną. Wyniki badania posłużą jako podstawa do dalszych badań oraz jako katalizator szerszego wykorzystania inteligentnych technologii, z uwzględnieniem zarówno płynących z tego korzyści, jak i potencjalnych zagrożeń.

Słowa kluczowe: systemy inteligentne, zarządzanie, zasoby regionalne, zrównoważony rozwój, sztuczna inteligencja

Introduction

Regional resource management is the consolidation, use and distribution of natural resources within a certain territory. It plays a very important role in the context of sustainable development, because in the face of rapid development of all spheres of life, the level and scale of the use of all existing resources is increasing. For the purposes of our study, it is important to describe and briefly review regional resource management and its key aspects. Regional resource management is a holistic and integrated approach that plays a key role in sustainable development, as it is inherently designed to ensure responsible use, equitable distribution and thoughtful conservation of available natural resources It is not only about the current state, but also about predicting future situations when the well-being of future generations will not be threatened (Paglia 2021). The main aspects of regional resource management in the context of sustainable development are as follows:

- Integration of environmental, social and economic objectives – this means balancing these objectives to further integrate them for the purpose of sustainable resource use that will contribute to economic development, ecosystem conservation and community well-being;
- Emphasis on ecosystem approaches – such emphasis confirms that resource management takes into account data on species, ecological processes and habitats in a complex and individual way. Ecosystem-based approaches help to maintain biodiversity and its resilience in the face of constant environmental change;
- Public involvement – an important tool in the context of sustainable development is the involvement of local communities in discussions and decision-making processes. Recognition and respect for traditional knowledge can increase the effectiveness and sustainability of regional resource management initiatives (Audubon International 2005);
- Adaptation to climate change and mitigation of its consequences – sustainable regional resource management is based on strategy(s) that primarily take into account the fact of climate change, the impact of the human factor on climate change in the first place, as well as the mechanism and stages of overcoming the consequences of climate change and adaptation to such consequences. In this context, it is important to underline the need for promoting the practices and methods aimed at reducing greenhouse gases and mitigating the risks associated with the changing climate conditions (Audubon International 2005; Kalina et al. 2022, 335). These practices further integrate climate considerations into explicit planning processes;
- Thoughtful urban and land use planning – in the context of effective resource management, it is important to consider all aspects, including zoning, green infrastructure, and habitat conservation to support sustainable urbanisation;
- Ensuring sufficient access to clean water – one of the main tasks of regional resource management is to address the problem of water shortages, its equitable distribution, and pollution issues, while taking into account the needs of the ecosystem and society;
- Transition to renewable energy sources, which is an important attribute of sustainable development. Introduction and support of integration of technologies, such as wind and solar energy, minimise the negative impact of human activity on the environment, thereby improving the conditions for high-quality regional resource management (Almusaed and Almssad 2023);
- Implementation of the circular economy and reduction of waste contribute to sustainable development.

The circular economy is based on the idea of manufacturing products with durability in mind. It is based on the implementation of closed cycles in the processes of circulation, production and consumption. The benefits of the circular model include reducing the consumption of raw materials and energy resources, reducing the negative impact on the environment, minimising waste, and stimulating innovation (Diia.gov.ua 2021). At the same time, regional governance should take these aspects into account and simultaneously include waste management plans to minimise negative environmental impact;

- Thoughtful use and conservation of natural resources – such natural resources include soils, forests, fish populations, etc. that are necessary to maintain the functioning of ecosystems. Implementing sustainable logging practices and conservation measures are key components of regional resource management (Almusaed and Almssad 2023);
- Eliminating the use of resources that are impossible or difficult to renew;
- Coordination of regional governance and policy – good communication between all sectors and governance bodies is essential in the framework of sustainable development. Comprehensively integrated policies and governance structures are the basis for developing a framework for negotiation and cooperation between all stakeholders to ensure a holistic approach to sustainable development;
- Comprehensive assessment and monitoring – setting up assessment and monitoring systems to examine the current situation of natural resources and the results of the management strategy. Regular reporting and evaluation of the effectiveness of a management strategy is important for further implementation and formulation of strategies for subsequent periods (Yi et al. 2023, 103732);
- Encouraging activities that contribute to the identification and development of new technologies, as well as expand the existing resource base in order to maximise positive impacts on human welfare and the environment.

In view of the above, it can be noted that regional resource management in the context of sustainable development involves managing resources in such a way as to prevent their total depletion and the reaching the level critical for the next generation. Equitable distribution of resources to meet the present needs of humanity without jeopardising the existence of future generations is a desirable goal that is sought to be achieved by using the framework of regional resource management. In this respect, it is important to note that society, ecosystems and the economy are interconnected and therefore, together, through effective resource management, require a well-thought-out comprehensive strategy for cooperation. Intelligent systems are also an important component, as they change the course and processes of resource management and produce much more productive results and impacts by their very nature.

That is why, in view of the above, the purpose of our research is to analyse intelligent systems, to identify their key features in general and in the context of regional resource management in particular; to provide a detailed list of the main intelligent technologies used in regional resource management and the areas of their direct use. The main emphasis should be placed on the benefits of using intelligent systems in the management of regional resources in the context of sustainable development and the problems that could be overcome through their use. The study will also analyse the negative aspects of the use of intelligent systems in the management of regional resources.

1. Methodological Framework

The scientific research was carried out in accordance with the stated and with the use of the following methods: the general philosophical method, the method of system analysis, synthesis, deduction and induction, dialectical method and formal legal method.

The cross-cutting method of scientific research is a general philosophical method, which was used by the author at all stages of the study in order to formulate comprehensive conclusions in accordance with the research topic and goal (Blagradnyi 2018, 150). The method of system analysis (Filatov 2022, 24) was used in the framework of analysing intelligent systems, identifying their key features in general and in the context of regional resource management in particular. The method of system analysis was used to form a detailed list of the main intellectual technologies used in the management of regional resources and the areas of their direct use.

The synthesis method (Filatov 2022, 24) was used to identify the features of intelligent technologies and their impact on the traditional management of regional resources, especially in terms of solving the problems of traditional regional resource management. The author has drawn conclusions about the advantages of using intelligent systems in the management of regional resources in the context of sustainable development and the problems that can be overcome through the use of intelligent systems. It is through the use of the method of system analysis and synthesis that scientifically significant and practically applicable conclusions have been drawn on the key challenges faced in the use of intelligent systems. Using the method of deduction (Antonova 2017, 83), we concluded that, despite the use of traditional models of regional resource management, introduction of intelligent systems in the context of sustainable development remains important. The method of induction (Antonova 2017, 83) was used to draw conclusions about the challenges and disadvantages of using intelligent systems.

The dialectical method of scientific research (Filatov 2022, 25) was also used to achieve this goal. It was used to identify and investigate the problematic issues of implementing intelligent systems in the context of sustainable development. The dialectical method was used to reveal the content of the challenges and negative aspects that hinder the implementation of effective strategies for the quality management of regional resources. The formal and legal method of scientific knowledge (Filatov 2022, 26) was used to define the concept of "intelligent systems" and their features. Taken together, these methods helped to form not only scientifically significant conclusions, but also general understanding of the importance of introducing intelligent systems in the management of regional resources for sustainable development.

2. Results and Discussion

2.1. Main Characteristics of Intelligent Systems in the Context of Management

The twenty-first century is characterised by fast development of the geo-economic and geopolitical space, where rapid shifts are taking place in the mechanisms of forming a developed society and intellectual environment as a springboard for improving our life. Only under such conditions can truly effective and progressive governance mechanisms be implemented, and highly developed technological processes can be introduced. And this, in turn, means ensuring the above-mentioned sustainable development and, of course, the security of society.

The place of each state in the developed space can be determined by the structure and quality of its intellectual and innovation sphere. Those, in turn, are based on certain intellectual, that is, intangible resources such as skills, abilities and competencies. Such resources are defined as a result of a long-term interaction of experience, accumulated knowledge and, accordingly, of scientific and

technical activities. It is important to note that one of the main factors of any change is development of intellectual resources (Algotive.ai 2022).

Today, management of regional resources is replacing administrative and command type of activities with an information-structured form of activities, where the priority task is to provide and analyse data. Under such conditions of work organisation, time is significantly saved and the effectiveness of the implemented regional resource management strategies increases. In more detail, intelligent systems can now be considered an integral part of both regional and general resource management activities. As a general rule, they cover the need for analytical processes, which in turn are related to the analysis of various relationships, the cause and effect nature of phenomena, the search for various information needed by certain specialists, finding compromises and choosing possible options, optimising processes, forming progressive ideas, methods and strategies, etc.

Given the above, we can formulate a definition of intelligent systems. Intelligent systems are understood as certain systems in which the bulk of work and processes are carried out by hardware and software systems. It is important to note that intelligent management systems are aimed at accurately and adequately reflecting all aspects of management, both current and past. It is on the basis of obtaining data on all aspects of management that a comprehensive view and vision of a strategy that will be implemented in the future is based. This also requires a transition to modern approaches, methods and effective technologies for collecting, transmitting and managing information. To this list can also be added methods of analysing information (Bukhari et al. 2022, 56).

Intelligent systems are a response to the rapid technological growth in recent years. In this regard, an intelligent system must be interoperable, i.e., one that creates a single space of information and information channels between different jurisdictions and authorities, has the option of data analysis and document routing, is able to fully control different versions of a document and transmit documents in a timely manner to the relevant authorities in a secure manner. The main provisions for a certain set of rules are generally as follows:

- Intelligent management systems should be aimed at meeting the goal of formulating and implementing the relevant policy in a particular area and meet the established goals and specific objectives;
- Intelligent systems significantly increase the efficiency of management in various industries and areas (Algotive.ai 2022);
- The complex of tools and subsystems of information systems should be open to a certain range of persons, but they must meet the established information security requirements (Oliinyk et al. 2022, 245);
- Intelligent systems should be used only within the legal framework to ensure the integrity of these systems and their interoperability, as well as the ability to adapt intelligent systems to changes in legislation (Grainger-Brown and Malekpour 2019, 1381).

It is important to note that the effectiveness of intelligent systems is achieved through coordinated actions at all levels, namely: first, at the level of work with direct consumers of services; second, at the level of organisational, legal and financial support for decision-making, as well as tax and accounting; third, at the level of analytical capabilities to support management decisions by providing reporting, monitoring, control over the implementation of decisions and documents, tracking efficiency and making forecasts. The main condition for the introduction of intelligent systems is clear understanding of their importance, capabilities and capacities, how they can affect management and how to properly distribute management functions between humans and machines (Algotive.ai 2022).

In general, information infrastructure today includes autonomous information systems of banks, government agencies, enterprises or other organisations. They represent information resources accumulated over a long period of time and stored in the form of databases. That is why, in view of the above, the entire information infrastructure can easily be seen as the basis for the transition to a new level of management, a clear level where information and intelligent technologies are actively used at all stages of management decision-making.

2.2. Application of Intelligent Systems in Regional Resource Management and Main Technologies Used

Intelligent systems, when applied, play an important role in improving the formulation of regional development management strategies. In general, this means supporting sustainable development and balancing the use of resources to preserve them for present and future generations. Intelligent systems are designed to analyse large amounts of information, providing holistic conclusions about possible trends and directions of resource use, the current state of the environment and community needs. The information obtained through the work of intelligent systems is important in the formation of sustainable practices and effective mechanisms (Khoulji 2017). Moreover, machine learning algorithms can easily develop models to predict fluctuations and changes in climate conditions, the availability of certain resources, or the general state of the environment. This is the basis for the proactive development and planning of effective strategies that will be key to solving future problems.

It is also important to note that intelligent systems are often used to allocate available resources more efficiently. We refer here specifically to optimisation algorithms that can be used for rational water allocation, urban planning or land use. They are also used to determine the most efficient distribution of renewable energy sources (Samara et al. 2023, 2230). Smart agriculture is already a new reality through the use of intelligent systems in terms of assessing and monitoring crop management data, determining irrigation schedules, and engaging in efficient mechanisms to increase agricultural productivity while reducing negative environmental impacts. One of the key reasons for the rapid involvement of intelligent systems in traditional regional resource management is monitoring of natural resources. This includes the latest remote sensing technologies that provide data on the state of forests, water bodies and biodiversity. Thanks to the data obtained, it is possible to assess the overall state of the ecosystem much faster and better and identify problematic issues in a particular area (Khoulji 2017).

Intelligent systems are also actively involved in the direct management of water, energy, and waste. They are able to monitor water quality and analyse the level of demand for water resources, thus addressing the problem of water scarcity. Moreover, by optimising and actively using renewable energy sources, the reliability of the energy distribution systems themselves is improved. In terms of waste management, intelligent systems can improve and refine waste collection routes, while controlling landfill overflow. With a more detailed analysis and deeper use of the latest technologies, it is advisable to develop promising solutions for waste recycling and reduction (Samara et al. 2023, 2232).

As noted above, intelligent systems are able to analyse climate change, even minor ones, and in combination with large-scale changes to form a general picture, use available data to develop adaptation strategies. This includes planning for changes in temperature, precipitation and sea level. Moreover, this further affects the state of response to disasters and emergencies. A rather important task facing intelligent systems in regional resource management is the planning of various environmental protection measures through biodiversity mapping,

development of mechanisms for the protection of natural resources, and identification of critical habitats (Kamyab et al. 2023, 101566). Taken together, all of the above contributes to the development of an effective policy and strategy for regional resource management. We also consider it expedient to analyse in more detail those information technologies and systems that are most often used, are disruptive, provide the desired data and are constantly evolving:

- Artificial intelligence technologies which are gaining momentum every day due to their efficiency and high ability to analyse large amounts of information, pattern recognition, as well as to their ability to self-learn and increase productivity. In general, artificial intelligence is used to perform predictive modelling, identify certain patterns, and optimise resource allocation (Kamyab et al. 2023, 101566);
- Decision support systems (DSS) are information systems that use hardware, software, data, a model base, and the work of a manager to support all stages of decision-making in the process of analytical modeling (Softline. org.ua 2023) These systems help analyze large amounts of data, simulate different scenarios, evaluate the possible consequences of decisions and optimize the use of resources. The main components of the SPPR system are a database, a model base, user tools and the interface. SPPR systems are used to assess land use, analyze the suitability of land areas for various types of activities (agriculture, industry, residential construction), develop infrastructure development plans, monitor the state of natural resources, assess the impact of industrial activity on the environment and develop measures to minimize that impact, model economic growth and assessment of the impact of various policies on the economic development of the region, etc.
- Laser scanning, or LiDAR (Light Detection and Ranging), is a modern technology that is rapidly developing and is used for accurate three-dimensional modeling of terrain and objects on it. In the management of regional resources, this technology is widely used due to its high accuracy and the ability to quickly obtain data from large areas (Kamyab et al. 2023, 101566). In general, laser scanning is used for planning and mapping land areas, modeling of river and water protection zones, assessment of flood risk and development of flood prevention measures, assessment of the forest cover, monitoring of soil and agriculture, monitoring of biodiversity and the state of natural environments, etc.
- Machine learning allows to make certain predictions and identify non-obvious patterns based on previous human experience, historical events and discoveries. It is generally used in resource optimisation and predictive analytics (Kovalenko et al. 2021, 7);
- Data analytics – analysing large amounts of data to obtain single valuable conclusions, trends or patterns, which is important for policy and strategy development;
- A geographic information system (GIS) is a powerful tool for regional resource management, providing efficient collection, storage, analysis, and visualization of spatial data. GIS is a complex system consisting of such components as spatial (vector and raster) data, attribute data, software (eg, ArcGIS, QGIS), users, and interfaces. Geographic Information System is involved in the integration of spatial data to analyse and visualise geographic patterns, making it valuable for mapping and understanding regional landscapes. GIS is also indispensable in environmental monitoring, that is, in the process of tracking changes in ecosystems and monitoring the state of natural resources. Environmental impact assessments are

calculated using this system. In general, GIS helps to make informed decisions that contribute to sustainable development, economic growth and environmental protection;

- Remote sensing technologies (drones and satellite imagery) – designed to collect real-time up-to-date information on the state of vegetation, soil cover or the changes occuring in the landscape. These technologies are particularly relevant to obtaining data on possible deforestation and assessing the condition of crops (Kovalenko et al. 2021, 8);
- Blockchain technologies are the basis for ensuring transparency, objectivity, security, and accuracy of tracked data. It is often used to certify products from sustainable sources, track supply chains, and securely manage property rights (Anastasiou et al. 2020, 406);
- Optimisation algorithms – taking into account the above, optimisation algorithms are an effective mechanism in finding the best solution to a problem, taking into account all the problematic aspects or constraints (Khoulji 2017);
- Virtual and augmented reality technologies – capable not only of improving modelling, but also of creating an identical reality, thus allowing stakeholders to test various theories in practice in real time. Moreover, it is also possible to observe the consequences and use the results to formulate comprehensive strategies that are much more likely to bring the desired results in the future (Kovalenko et al. 2021, 9);
- Smart sensors and detectors – used to obtain real-time relevant data for further processing by specialists (Kamyab et al. 2023, 101566). Accordingly, they are applicable in monitoring the quality of water, air, soil, etc..

Taken together, the use of the above-mentioned new technologies contribute to more efficient management of regional resources.

2.3. The Advantages of Using Intelligent Systems in the Management of Regional Resources in the Context of Sustainable Development and the Problems of Traditional Management that Can be Overcome

The philosophy of regional resource management has undergone dramatic changes in recent years due to the influence of intelligent systems ensuring sustainable development. Undoubtedly, integration of intelligent systems has opened up new and wide opportunities to improve the existing management models and increase their efficiency. Within the framework of sustainable development, intelligent systems in the management of intellectual resources bring a number of advantages. These include:

- Effective decision-making based on timely collected and received data – the use of the latest technologies can help decision makers by providing them with comprehensive information about the dynamics of resources and the state of the environment. As a result, the decisions made will more accurately regulate these issues (Carayannis et al. 2022, 931).
- Thanks to forecasting and modelling technologies, it is possible to respond in a timely manner to emerging problems and potentially solve them.
- Based on the analysis of patterns and trends in the effectiveness or ineffectiveness of a particular phenomenon, regional resource management strategies can be improved. As a rule, this leads to the more efficient use of water, land, energy and other resources (Carayannis et al. 2017, 16).
- Artificial intelligence technologies have significantly increased the chances of timely response to man-made disasters and abrupt environmental changes.
- Thanks to the use of intelligent systems, farmers can receive relevant and important information directly related to farming. As a result, this leads to reducing the negative impact on the environment in terms of calculating

planting times, adjusting irrigation schedules, and maintaining plant health (Kilintzis et al. 2020, 952).

- Smart assessment of the state of water resources ensures sustainable water use and effective control over water quality, as well as leakage in irrigation systems (Erkko 1998, 136).
- An important positive contribution of intelligent systems is the opening of opportunities for the public to engage in regional resource management processes by posting certain information on social media. Active involvement of the society significantly increases the effectiveness of implemented strategies and encourages various initiatives that can positively affect the management itself.
- The above advantages form a holistic system of adaptive management, which consists of constant adjustments, monitoring and data analysis. Based on such data, changes and additions are made to resource management strategies. This flexibility is crucial to address dynamic issues, such as the effects of climate change, and, for example, long-term issues related to energy management and the use of renewable energy sources, which require not only significant investments but also special maintenance (Kilintzis et al. 2020, 952; Kryshtanovych et al. 2022, 225).
- Savings of financial resources – savings are made thanks to the simplification of various processes, which took place thanks to the integration of intelligent systems. This has a positive impact on sustainable development in general.

Of course, the above benefits are self evident. Intelligent systems are a tool that greatly simplifies many processes, and this simplification leads to faster pace, cost savings and much more sophisticated strategies for managing regional resources. However, it is important to emphasise that the benefits will only make sense if the disadvantages are also taken into account. One of them is the dependence of systems on the completeness and accuracy of information already obtained by humans. If this is not met, then further analysis and consideration of optimal solutions to problems will not be correct, appropriate and fair. Moreover, fairness goes hand in hand with impartiality, which can be violated if intelligent systems are programmed on the basis of discriminatory statements about women and men, race or religion. This can then have a negative impact on the distribution of, for example, water resources (Erkko 1998, 136).

Of course, the introduction of intelligent systems saves a lot of costs in the future. However, significant investments are required at the stage of their implementation. The issue of confidentiality and privacy is also an important nuance, as private or confidential information may be collected in parallel during the collection of water or soil data. This can be done intentionally, under the guise of research, and therefore this issue should be taken into account when developing resource management strategies and personal data protection legislation. It is also important to ensure the security of intelligent systems in the course of their use, as hacker attacks or other disruptions to the normal operation of intelligent systems are possible. Moreover, due to their nature, intelligent systems often rely on quantitative indicators. This is why there is a tendency to prioritise easily measurable factors at the expense of qualitative or cultural considerations, which can lead to incomplete decision-making (Dezi et al. 2022, 930). Taking the above information into account, arguments can be made in favour of intelligent systems in terms of how they contribute to solving problems that arise in the course of traditional resource management.

First, as traditional regional resource management generally relies on local knowledge and practices, it often suffers from a lack of potentially important information. By their very nature, intelligent resources conduct much more extensive monitoring and

analysis of data and satellite imagery. Artificial intelligence improves the level of awareness of specialists, which has a corresponding impact on the management of regional resources (Demir et al. 2019, 694).

Secondly, traditional management tools and models are simply not enough to fully take into account the interests of society as a result of the growing demand for certain resources. Intelligent resources can perform predictive modelling to calculate ways to allocate resources efficiently.

Third, traditional resource management has faced challenges in adapting to rapid environmental change. Thanks to artificial intelligence and machine learning, it is possible to predict changes in climate, weather conditions, etc. and develop adaptive strategies accordingly (Dezi et al. 2022, 930).

Fourth, market forces and rapid globalisation create certain pressures and can lead to unsustainable use of resources. The algorithms of intelligent systems help to optimally regulate the use of resources. Moreover, blockchain technology can be used to track and certify products from sustainable sources, ensuring fair trade and responsible resource management. In this regard, it is also important to add that there is a great threat, and there are many cases when the use of technology can lead to environmental degradation or overexploitation of resources. However, with the help of intelligent systems, such misuse can be stopped. For example, artificial intelligence technology is able to detect excessive or illegal fishing, and transmit this data to relevant authorities to respond to these actions.

Conclusions

Regional resource management is a holistic and integrated approach that plays a key role in the framework of sustainable development, because by its very nature it calls for responsible use, fair distribution and thoughtful preservation of available natural resources. The following are the main aspects of regional resource management in the context of sustainable development: integration of environmental, social and economic goals; emphasis on ecosystem approaches; public involvement; adaptation to climate changes and mitigation of their consequences; thoughtful urban planning and land use; ensuring sufficient access to clean water for daily use; transition to renewable sources of energy, which is an important attribute of sustainable development; implementation of circular economy and reduction of waste contribute to sustainable development; thoughtful use and conservation of natural resources; eliminating the use of resources that are impossible or difficult to restore; coordination of regional management and policy; comprehensive assessment and monitoring of the actual situation of natural resources and results from the implementation of the management strategy; encouraging activities that contribute to the discovery and development of new technologies, as well as expand the existing resource base in order to maximize the positive impact on the well-being of the population and the environment.

Today, the management of regional resources is replacing the administrative and command type of activity with an information-structured form, where the priority task is to provide and analyse data, and therefore the use of intelligent systems is becoming important. Intelligent systems are defined as certain systems in which the bulk of work and processes are carried out by hardware and software systems. It is important to note that intelligent management systems are aimed at accurately and adequately reflecting all aspects of management, both current and past. It is on the basis of obtaining data on all aspects of management that a comprehensive view and vision of the overarching strategy that will be implemented in the future is based. Intelligent management systems should be aimed at achieving the goal of formulating and implementing the relevant policy in a particular area. Intelligent systems can significantly improve the efficiency of management in various

industries and areas. Intelligent systems should be used only within the legal framework to ensure the integrity of these systems and their interoperability, as well as the ability to adapt them to changes in legislation.

Intelligent systems are designed to analyse large amounts of information, providing holistic conclusions about possible trends and directions of resource use, the current state of the environment and community needs. One of the key reasons for the rapid involvement of intelligent systems in traditional regional resource management was the monitoring of natural resources. Intelligent systems are also actively involved in direct management of water, energy and waste. They are able to monitor water quality and analyse the level of demand for water resources, while addressing the problem of water shortages. One of the crucial tasks facing intelligent systems in regional resource management is the planning of various environmental protection measures through biodiversity mapping, development of mechanisms for protecting natural resources, and identification of critical habitats. Information technologies and systems that are most often used, that are disruptive, provide the desired data and are constantly evolving include: artificial intelligence technologies, decision support systems, laser scanning, machine learning, data analytics, geographic information system, remote sensing technologies (drones and satellite images), blockchain technologies, optimization algorithms, virtual and augmented reality technologies, sensors and smart sensors.

In the framework of sustainable development, the use of intelligent systems has a number of advantages in the management of intellectual resources. These include: making effective decisions based on timely collected and received data; thanks to forecasting and modeling technologies, it is possible to respond in time to emerging problems and potentially solve them; regional resource management strategies can be improved based on the analysis of patterns and trends regarding the effectiveness or ineffectiveness of a particular phenomenon; on the basis of artificial intelligence technologies, the chances of timely response to man-made disasters and sudden changes in the environment have significantly increased; thanks to the use of intelligent systems, farmers can receive relevant important information directly related to agriculture; thanks to the "reasonable" assessment of the state of water resources, sustainable water use is ensured and water quality is effectively controlled, leaks in irrigation systems are detected; opening opportunities for the public to get involved in regional resource management processes; formation of a holistic system of adaptive management, which consists in carrying out constant adjustments, monitoring and data analysis; saving financial resources.

Author contributions: Conceptualization, O.C., and A.M.; Methodology, S.M.; Validation, R.K.; Formal Analysis, S.R., and R.K.; Investigation, S.R.; Visualization, A.M.; Writing – original draft preparation, O.C., S.R., and A.M.; Writing – review and editing, S.M., and R.K.; Supervision, S.M., O.C., S.R., A.M., and R.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional review board statement: not applicable

Conflicts of interest: The authors declare no conflict of interest.

References

Algotive.ai. 2022. "Intelligent Systems: What are they, how do they work and why are they so important?" Accessed January 09, 2024. https://www.algotive.ai/blog/intelligent-systems-what-are-they-how-do-they-work-and-why-are-they-so-important.

Almusaed, Amjad, and Asaad Almssad. "Introductory chapter: sustainable development and regional planning strategies." IntechOpen, 2023. https://doi.org/10.5772/intechopen.110838.

Anastasiou, Andreas, Panayiotis Christodoulou, Klitos Christodoulou, Vasos Vassiliou, and Zinon Zinonos. 2020. "IoT device firmware update over LoRa: the Blockchain solution." In *16th International Conference on Distributed Computing in Sensor Systems (DCOSS)*, edited

by Lisa O'Conner, 404-411. Los Alamos: IEEE Computer Society. https://doi.org/10.1109/DCOSS49796.2020.00070.

Antonova, O.R. 2017. "Research methodology of legal institutions of marriage and family." *Philosophical and Methodological Problems of Law* 2(14): 78–90.

Audubon International. 2005. "Principles for Sustainable Resource Management." Accessed January 09, 2024. https://www.golfandenvironment.org/principles.htm.

Autio, Erkko. 1998. "Evaluation of RTD in regional systems of innovation." *European Planning Studies* 6: 131-140.

Blagradnyi, Andriy. 2018. "Research methodology of the legal regulation of administrative-jurisdiction activities of law enforcement bodies." *Administrative Law and Process* 6: 147-151.

Bukhari, Syed Asim Ali, Fathyah Hashim, and Azlan Amran. 2022. "Green banking: A strategy for attainment of UN-sustainable development goals 2030." *International Journal of Environment and Sustainable Development* 22(1): 13-321. https://doi.org/10.1504/IJESD.2021.10038708.

Carayannis, Elias G., Klitos Christodoulou, Panayiotis Christodoulou, Savvas A. Chatzichristofis, and Zinon Zinonos. 2022. "Known unknowns in an era of technological and viral disruptions – implications for theory, policy, and practice." *Journal of the Knowledge Economy* 13: 587-610. https://doi.org/10.1007/s13132-020-00719-0.

Carayannis, Elias G., Luca Dezi, Gianluca Gregori, and Ernesto Calo. 2022. "Smart Environments and techno-centric and human-centric innovations for industry and society 5.0: a quintuple helix innovation system view towards smart, sustainable, and inclusive solutions." *Journal of the Knowledge Economy* 13: 926-955. https://doi.org/10.1007/s13132-021-00763-4.

Carayannis, Elias, Luc Hens, and Polyxeni Nicolopoulou-Stamati. 2017. "Trans-disciplinarity and growth: nature and characteristics of trans-disciplinary training programs on the human-environment interphase." *Journal of the Knowledge Economy* 8(1): 1-22. https://doi.org/10.1007/s13132-015-0294-z.

Demir, Kadir Alpaslan, Gözde Döven, and Bülent Sezen. 2019. "Industry 5.0 and human-robot co-working." *Procedia Computer Science* 158: 688-695. https://doi.org/10.1016/j.procs.2019.09.104.

Diia.gov.ua. 2021. "A model of the circular economy." 2021. Accessed January 09, 2024 https://business.diia.gov.ua/handbook/impact-investment/model-cirkularnoi-ekonomiki.

Filatov, Victor. 2022. "General scientific and special legal methods of researching the transitional justice model." *Methodology of the Theory and Practice of Jurisprudence. Legal Bulletin* 2: 23-29. https://doi.org/10.32837/yuv.v0i2.2317.

Grainger-Brown, Jarrod, and Shirin Malekpour. 2019. "Implementing the sustainable development goals: A review of strategic tools and frameworks available to organisations." *Sustainability* 11: 1381. https://doi.org/10.3390/su11051381.

Hesam Kamyab, Tayebeh Khademi, Shreeshivadasan Chelliapan, Morteza Saberi Kamarposhti, Shahabaldin Rezania, Mohammad Yusuf, Mohammad Farajnezhad, Mohamed Abbas, Byong Hun Jeon, and Yongtae Ahn. 2023. "The latest innovative avenues for the utilization of artificial Intelligence and big data analytics in water resource management." *Results in Engineering* 20: 101566. https://doi.org/10.1016/j.rineng.2023.101566.

Kalina, Iryna, Viktoriia Khurdei, Vira Shevchuk, Tetiana Vlasiuk, and Ihor Leonidov. 2022. "Introduction of a corporate security risk management system: The experience of Poland." *Journal of Risk and Financial Management* 15(8): 335. https://doi.org/10.3390/jrfm15080335.

Kilintzis, Pavlos, Elpida Samara, Elias G. Carayannis, and Yiannis Bakouros. 2020. "Business model innovation in Greece: Its effect on organizational sustainability." J*ournal of the Knowledge Economy* 11(3): 949-967. https://doi.org/10.1007/s13132-019-0583-z.

Kovalenko, Yuliia, Oksana Zakharova, Oksana Yakusheva, Oleksandr Yakushev, Daniil Hulak, and Svitlana Kozlovska. 2021. "Priorities for the development of regional information management based on system digitalization." *SHS Web of Conferences* 126(04002): 1-10. https://doi.org/10.1051/shsconf/202112604002.

Kryshtanovych, Myroslav, Liudmyla Akimova, Oleksandr Akimov, Natalya Kubiniy, and Viktoria Marhitich. 2021. "Modeling the process of forming the safety potential of engineering enterprises." *International Journal of Safety and Security Engineering* 11(3): 223-230. https://doi.org/10.18280/ijsse.110302.

Oliinyk, Olena S., Roman M. Shestopalov, Volodymyr O. Zarosylo, Mykhaylo I. Stankovic, and Sergii G. Golubitsky. 2022. "La Seguridad económica a través De Las políticas Criminales: Un Estudio Comparativo De Los Enfoques Occidental Y Europeo." *Revista Científica General José María Córdova* 20(38): 265-85. https://doi.org/10.21830/19006586.899.

Paglia, Eric. 2021. "The Swedish initiative and the 1972 Stockholm Conference: The decisive role of science diplomacy in the emergence of global environmental governance." *Humanities and Social Sciences Communications* 8(2). https://doi.org/10.1057/s41599-020-00681-x.

Samara, Elpida, Anastasios Andronikidis, Nicos Komninos, Yiannis Bakouros, and Efthymios Katsoras. 2023. "The role of digital technologies for regional development: a system dynamics analysis." *Journal of the Knowledge Economy* 14: 2215-2237. https://doi.org/10.1007/s13132-022-00951-w.

Samira Khoulji. 2017. "Intelligent system for the management of resources dedicated to humanity." *Transactions on Machine Learning and Artificial Intelligence*. Accessed January 09, 2024. https://www.academia.edu/91797266/Intelligent_System_for_the_Management_of_Resources_Dedicated_to_Humanity.

Softline.org.ua. 2023. *SPPR Systems*. Accessed January 09, 2024. https://softline.org.ua/rishennia/sppr.html.

Zhang Yi, Wenwu Zhou, Asif Razzaq, and Yao Yang. 2023. "Land resource management and sustainable development: Evidence from China's regional data." *Resources Policy* 84: 103732. https://doi.org/10.1016/j.resourpol.2023.103732.