SMART INNOVATIONS FOR UNLOCKING THE SOCIAL POTENTIAL OF BIOSPHERE RESERVES

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ABSTRACT
Biosphere reserves represent important laboratories for testing innovative approaches to sustainable regional development. In recent years, increasing attention has been paid to the role of smart innovations, particularly those that combine digital technologies, open data infrastructures and participatory governance. This paper analyses selected examples of smart innovations implemented in European biosphere reserves, with a particular focus on their contribution to the development of social potential in these territories. The study applies a qualitative research design based on the analysis of 205 European biosphere reserves. Initial case identification was supported by AI-assisted screening, and subsequently validated using secondary sources, including official websites, project documentation and scientific publications. The findings indicate that the most advanced biosphere reserves apply integrated monitoring systems combining remote sensing, sensor networks and participatory data collection. At the same time, open biodiversity databases, socio-environmental observatories and digital communication platforms enable broader access to environmental information, and support collaboration between researchers, public authorities and local communities. Examples from biosphere reserves such as Sierra Nevada, Menorca, Wadden Sea, North Devon, Nordhordland and Kristianstads Vattenrike demonstrate how smart tools can strengthen participatory governance, knowledge exchange, and evidence-based decision-making. The results suggest that biosphere reserves can function not only as sites of technological innovation, but also as platforms for social innovation, where digital tools and participatory approaches contribute to sustainable regional development.
KEY WORDS: *biosphere reserves, smart innovations, social potential, sustainable regional development, open data.*

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Introduction

Biosphere reserves represent internationally recognised model territories for testing and implementing approaches to sustainable development. Established within the framework of the UNESCO Man and the Biosphere (MAB) Programme, they aim to reconcile biodiversity conservation with socio-economic development, and support knowledge exchange between science, policy and local communities (UNESCO, 2017). Over past decades, biosphere reserves have increasingly been understood not only as protected areas, but also as experimental laboratories, where innovative governance models, participatory management approaches and new technological solutions can be tested in practice.

In recent years, the rapid development of digital technologies, environmental monitoring systems and open data infrastructures has significantly influenced the way biosphere reserves manage information about ecosystems and regional development. Advances in remote sensing, geographic information systems, sensor networks and automated monitoring technologies have enabled the collection of large volumes of

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environmental data with increasing spatial and temporal resolution. At the same time, digital platforms and open data initiatives have improved access to environmental information, and strengthened transparency in environmental governance. These technological developments have created new opportunities for biosphere reserves to support evidence-based decision-making, long-term monitoring of ecosystem dynamics, and improved communication with the public.

Alongside technological progress, biosphere reserves have also become important arenas for the emergence of social innovations, particularly those related to participatory governance, citizen science and collaborative knowledge production. Social innovations in environmental management often involve new forms of cooperation between researchers, public authorities, local communities and civil society organisations. In the context of biosphere reserves, such innovations can include participatory monitoring programmes, community-based environmental data collection, open biodiversity databases, or digital platforms that facilitate knowledge sharing between different stakeholder groups. These initiatives contribute to strengthening the social capital of regions, increasing environmental awareness, and supporting inclusive decision-making processes.

Despite the growing importance of digital technologies and participatory approaches in environmental governance, the integration of data-driven tools into strategic planning and management processes remains uneven across biosphere reserves. While some reserves have developed advanced monitoring infrastructures, socio-environmental observatories or open data platforms, others still rely on fragmentary datasets and limited data sharing practices. As a result, the potential of environmental data and digital tools to support strategic planning, adaptive management and regional development is often not fully realised.

This paper aims to analyse selected examples of smart innovations implemented in European biosphere reserves, and examine their contribution to the development of social potential and sustainable regional development. To achieve the aim of the study, the following research questions were formulated:

RQ_1: What types of smart innovation are currently implemented in European biosphere reserves?

RQ_2: How do smart innovations contribute to the development of social potential and participatory governance in biosphere reserves?

By examining examples from several European biosphere reserves, the study seeks to identify key patterns of good practice, and explore how integrated data ecosystems can support more effective governance and participatory decision-making in biosphere reserves. The results show that the most advanced biosphere reserves combine technological innovations with participatory governance approaches, thereby creating integrated systems that link environmental monitoring, open data infrastructures and stakeholder engagement. Such models demonstrate that biosphere reserves can function not only as sites of technological innovation, but also as platforms for social innovation, where digital tools and collaborative governance mechanisms contribute to sustainable regional development. The main contribution of this study is the development of a typology of smart innovations that contribute to the social potential of biosphere reserves, based on an analysis of 205 European biosphere reserves.

1. Biosphere reserves as objects of development

Biosphere reserves represent territories where ecological and social systems interact and mutually influence each other. Their purpose is not only the protection of the natural heritage, but also the promotion of sustainable development and balanced relationships between humans and nature (Ishwaran, Persic, Tri, 2008; Axelsson et al., 2011). Within the UNESCO Man and Biosphere (MAB) Programme, biosphere reserves are understood as model regions where sustainable coexistence between people and nature is tested and demonstrated in practice, while contributing to the objectives of Agenda 2030 (Bridgewater, 2002; Van Cuong, Dart, Hockings, 2017). Biosphere reserves are internationally recognised areas, nominated by national governments and designated within the MAB Programme. Each biosphere reserve forms part of the World Network of Biosphere Reserves, which provides a global platform for cooperation, exchange of knowledge, and sharing of best practices related to sustainable development and biodiversity conservation (UNESCO, 2022). In this context, biosphere reserves represent unique socio-ecological landscapes, where

natural systems, the cultural heritage, human activity and social processes coexist and interact. According to the MAB framework, biosphere reserves fulfil three core functions. The conservation function focuses on protecting biodiversity, ecosystems and landscapes. The development function supports the sustainable socio-economic development of local communities. The logistic function promotes research, monitoring, education and partnerships supporting sustainable development (ŠOP SR, 2022). Recent updates of the MAB strategy also highlight the role of biosphere reserves in climate change mitigation and adaptation (Špulerová et al., 2023). Given their multifunctional nature, biosphere reserves represent complex territories, where environmental protection and socio-economic development have to be addressed simultaneously. Their development therefore requires systematic and coordinated planning.

The existence of a biosphere reserve does not automatically lead to the sustainable development of the territory. As areas where multiple interests intersect, biosphere reserves require coordinated management and long-term development planning. Territorial development can be understood as an economic and social process, aimed at creating a viable and productive territory, while respecting the needs of present and future generations (Vaňová, 2006; Maier, 2012). Biosphere reserves generate numerous societal benefits and positive externalities, including biodiversity protection, ecosystem resilience, environmental regulation, cultural identity preservation, and opportunities for education and research (Kettunen, ten Brink, 2013). Because many of these benefits have the characteristics of public or collective goods, their development requires coordinated governance and strategic decision-making (Merlo, Briales, 2000; Mayer, Job, 2014; Link, 2022). Strategic planning therefore becomes a key tool for guiding biosphere reserve development. It represents a systematic process aimed at defining long-term objectives, identifying opportunities and risks, and coordinating actions that lead to the desired future state of a territory (Vitálišová, 2017; Vaňová, 2006). Several studies highlight the need for strategic approaches in biosphere reserve planning, as development processes often remain fragmented or insufficiently coordinated (Kuhn, 2000; Van Cuong, Dart, Hockings, 2017; Yazdandoost, 2019; Job, Becken, Lane, 2020). Nowadays, development strategies often focus primarily on nature conservation, while other dimensions of development receive less systematic attention.

The development of biosphere reserves should be planned with respect to the three core dimensions of sustainable development: environmental, economic and social. These dimensions correspond to the multifunctional character of biosphere reserves, and reflect the principles of sustainable development (Wheeler, 2009; Hák, Janoušková, Moldan, 2016). The environmental dimension focuses on biodiversity conservation and ecosystem protection. The economic dimension relates to the sustainable use of resources, the development of local economies, and the creation of economic opportunities within the territory. The social dimension concerns the well-being of local communities, participation, social capital, cooperation, and the relationship between communities and their environment. However, several studies point out that development planning in biosphere reserves has focused primarily on environmental protection, while socio-economic aspects have received less systematic attention (Brandon, Wells, 1992; Brown, 2002; Raszka, Hełdak, 2023). This imbalance may limit the ability of biosphere reserves to fully realise their development potential and to fulfil their integrative role within sustainable development frameworks.

Among the three development dimensions, the social dimension plays a particularly important role in ensuring the long-term success of biosphere reserves. It includes aspects such as stakeholder participation, cooperation among actors, social capital, local knowledge, community engagement, and the relationship between people and the territory. The importance of these elements is emphasised by theories of participatory governance and stakeholder engagement. Participation enables stakeholders to influence decision-making processes, contribute their knowledge, and cooperate in the planning and management of policies, programmes and development strategies (Quick, Bryson, 2016). Stakeholders include individuals, groups, or organisations that influence or are influenced by decisions related to territorial development (Freeman, 2010; Bryson, 2004). In the context of biosphere reserves, numerous studies highlight the importance of involving local communities, civil society organisations, researchers and public institutions in planning and governance processes (Reed, 2008; Schultz, Duit, Folke, 2011; Wali et al., 2017; Van Cuong, Dart, Hockings, 2017). Participation enables the integration of diverse sources of knowledge, supports cooperation between actors,

and increases the legitimacy and acceptance of management decisions. Participatory approaches contribute to strengthening social capital, improving decision-making processes, and increasing acceptance of management measures. They also facilitate the integration of diverse knowledge sources, and enhance cooperation between actors involved in biosphere reserve governance (Berkes, 2004; Pretty, Ward, 2001). These processes are particularly important in biosphere reserves, because successful conservation and sustainable development depend on cooperation between multiple actors with diverse interests. Despite its importance, the social dimension is often insufficiently addressed in development planning. Social processes such as participation, cooperation, knowledge exchange and community engagement are not always systematically analysed or integrated into planning frameworks. As a result, the social potential of biosphere reserves remains underutilised. For this reason, it is necessary to explicitly consider the development of the social dimension in biosphere reserve planning processes. Strengthening participation, collaboration and social capital can significantly enhance the effectiveness of biosphere reserve governance, and support the integration of conservation and development objectives.

1.1. Smart innovations and data-driven approaches to developing social potential in biosphere reserves

Innovation is recognised as an important driver of territorial development and competitiveness. It contributes to development through the introduction of new products and services, improvements in existing solutions, and increased efficiency of processes and organisational practices. In this sense, innovation represents not only technological progress, but also the practical application of knowledge that creates measurable economic or social value (OECD, 2005). Consequently, innovation capacity has become an essential component of regional development strategies and sustainable territorial competitiveness (Vitálišová, 2018). In recent decades, the development of information and communication technologies has introduced a new dimension to innovation often referred to as smart innovation. Smart innovations combine digital technologies, connectivity and data analytics to create adaptive solutions capable of responding to complex societal challenges. Unlike traditional innovations that focus primarily on improving functionality, smart innovations introduce an additional layer of intelligence, by collecting, analysing and applying data to optimise processes and support decision-making. In territorial governance, these developments are reflected in the concept of smart governance, which promotes the more efficient, transparent and participatory management of public policies and territories. Smart governance is based on open communication, cooperation, and the involvement of multiple actors, including public administration, research institutions, the private sector and citizens. Digital technologies and data infrastructures enable more effective strategic planning, policy evaluation and participatory decision-making processes (Khadar, 2012; Mellouli, Luna-Reyes, Zhang, 2014; Bolívar, Gil-Garcia, Meijer, 2016).

The growing importance of data-driven governance in biosphere reserves is closely related to global challenges, such as climate change, biodiversity loss and the implementation of the Sustainable Development Goals of the 2030 Agenda. Addressing these challenges requires adaptive governance systems based on the systematic collection, analysis and sharing of relevant information. In this context, open data represent an important tool for improving transparency, access to information and evidence-based decision-making. By enabling the reuse of publicly available datasets, open data also create opportunities for new analytical tools, digital applications and innovative forms of public participation (Chlapek et al., 2015). Biosphere reserves represent particularly relevant territories for the application of smart innovations and data-driven governance. As model regions integrating biodiversity conservation, sustainable socio-economic development and participatory governance, biosphere reserves function as learning sites where innovative approaches to managing relationships between humans and nature can be tested and implemented in practice (Schultz, 2011). However, the governance of these territories is complex, as it requires balancing environmental protection with socio-economic development and the interests of multiple stakeholders. The effective planning of biosphere reserve development therefore presupposes the availability of high-quality and systematically collected data on environmental conditions, socio-economic processes and governance practices in

the territory. Data-driven approaches allow for the better monitoring of territorial dynamics, more informed decision-making and the design of evidence-based policies (Khadar, 2012; Mellouli, Luna-Reyes, Zhang, 2014; Bolívar, Gil-Garcia, Meijer, 2016). At the same time, digital tools and open data infrastructures can strengthen transparency, participation and collaboration among stakeholders.

Developing the social potential of biosphere reserves through smart innovations and data-driven approaches is therefore particularly important. Digital platforms, citizen science tools and participatory data collection systems can support knowledge sharing, community engagement and cooperation between actors in the territory (Phills et al., 2008; Reed, 2008; Wali et al., 2017). By strengthening participation, transparency and access to information, smart innovations contribute to more inclusive governance, and enhance the capacity of biosphere reserves to function as model territories for sustainable development.

2. Methodology

This study applies a qualitative research design, combining theoretical analysis with the empirical exploration of selected examples of smart innovations implemented in biosphere reserves. The aim of the study is to analyse selected examples of smart innovations implemented in European biosphere reserves, and examine their contribution to the development of social potential and sustainable regional development.

The empirical part of the study focuses on identifying examples of smart innovation implemented in biosphere reserves across the European continent. The research sample consisted of 205 biosphere reserves in Europe, identified through the UNESCO World Network of Biosphere Reserves, which were analysed in order to identify cases where digital technologies, data infrastructures or participatory tools contribute to social development. The data collection was conducted between September 2025 and February 2026. As part of the initial mapping of potential cases, an AI-assisted exploratory analysis was used as a supporting tool to identify relevant examples of good practice, using the ChatGPT OpenAI tool. The analysis was conducted using a standardised prompt applied to individual countries: “Analyse (selected country) biosphere reserves in three steps. I need to know if there are specific good examples of practice that use biosphere reserves (1) in data collection, (2) in the publication of data by a biosphere reserve or other entity, (3) the use of this data for maps, visualisations, applications and subsequently public policy.” The results obtained through the AI-assisted search were subsequently verified through secondary data sources, including official biosphere reserve websites, policy documents, project reports, scientific publications, and publicly available digital platforms. Only cases with verifiable evidence of implemented solutions were included in the analysis. We then compiled a list of the most significant examples of best practice in relation to the stated objective and research questions for the purposes of this study. Based on the identified examples of smart innovation and their comparison with the theoretical framework, the study identifies key characteristics of smart innovations in biosphere reserves, and identifies their potential contribution to strengthening social potential, participatory governance, and data-driven territorial management. The results were subsequently used to develop a typology of smart innovations that contribute to the social potential of biosphere reserves.

3. Results and discussion

Smart innovations implemented in biosphere reserves increasingly contribute not only to technological advancement in environmental monitoring, but also to the development of social potential, particularly through participatory approaches, knowledge sharing and collaborative governance. These innovations create new forms of interaction between local communities, researchers, public authorities and visitors, thereby strengthening the role of biosphere reserves as experimental territories for sustainable regional development. By integrating digital tools, open data infrastructures and participatory monitoring systems, biosphere reserves can enhance transparency, support informed decision-making, and encourage active engagement of local stakeholders in environmental governance.

One of the most prominent examples of innovation supporting social potential is citizen science and participatory environmental monitoring, which allows local communities and volunteers to contribute directly to data collection and biodiversity observation. In the North Devon Biosphere Reserve, the Smart Biosphere initiative combines environmental sensor networks with community-based data collection and digital platforms that allow local stakeholders to access and interpret monitoring data (North Devon Biosphere, 2026_a; North Devon Biosphere, 2026_b). Similarly, the Kristianstads Vattenrike Biosphere Reserve actively engages volunteers in biodiversity monitoring programmes and environmental education activities. Citizen observations are integrated into spatial tools and digital communication platforms that make environmental information accessible to residents and visitors (Vattenriket, 2026; Naturkartan, 2026). In the Dyfi Biosphere Reserve, the COBWEB citizen observatory project demonstrated how mobile technologies can enable residents to collect environmental data and contribute to ecosystem monitoring (CORDIS, 2024). These participatory approaches increase environmental awareness, strengthen local ownership of conservation initiatives, and improve the availability of monitoring data.

A further dimension of social innovation is represented by participatory biodiversity databases and open environmental data infrastructures, which enable collaboration between researchers, public institutions and citizens. For instance, the Nordhordland Biosphere Reserve is associated with the Artsoservasjoner within the Artsdatabanken platform, which integrates large volumes of species occurrence records collected in the field using GPS devices and citizen observations (Artsdatabanken, 2026_a; Artsdatabanken, 2026_b). By enabling open access to environmental information, such systems support transparency and promote evidence-based decision-making in regional governance.

Another important group of innovations strengthening social potential is represented by socio-environmental observatories, which integrate environmental monitoring with socio-economic indicators, and make these data accessible for public decision-making. A leading example is the Sierra Nevada Biosphere Reserve, where the Sierra Nevada Global Change Observatory operates a long-term ecological monitoring system, integrating climate data, biodiversity observations and remote sensing datasets. The observatory also publishes curated datasets and data papers, enabling researchers and policymakers to access standardised information on ecosystem dynamics and environmental change. Similarly, the Menorca Biosphere Reserve hosts the OBSAM socio-environmental observatory, which publishes indicators related to environmental quality, tourism pressure and regional development. These observatories act as knowledge hubs that connect research institutions, public authorities and local communities, thereby strengthening participatory governance and evidence-based policy-making (OBSNEV, 2026; OBSAM, 2026).

Smart innovations also contribute to social potential through digital communication tools and visitor-oriented applications, which translate environmental data into accessible formats for the public and promote sustainable visitor behaviour. Digital platforms such as Naturkartan, used in the Kristianstads Vattenrike Biosphere Reserve, allow users to explore protected areas through interactive maps, and learn about ecological values of the landscape (Naturkartan, 2026). Similarly, the Juliana Trail mobile application, developed in the Julian Alps Biosphere Reserve, provides digital navigation tools and interpretive content about local ecosystems and the cultural heritage. In coastal areas, the Wadden Sea Explorer application, used in the Wadden Sea Biosphere Reserve, helps visitors understand tidal dynamics, biodiversity and conservation measures in the intertidal ecosystem. These tools transform complex environmental datasets into user-friendly formats, supporting environmental education and strengthening the relationship between visitors and the landscape.

Another important example of social innovation is represented by transboundary governance and collaborative monitoring frameworks, which strengthen institutional cooperation between countries and regions. The Wadden Sea Biosphere Reserve provides a well-known example through the Trilateral Monitoring and Assessment Programme (TMAP). This system harmonises monitoring methodologies, biodiversity indicators and ecosystem assessments across Denmark, Germany and the Netherlands, allowing comparable datasets to be generated for the entire Wadden Sea ecosystem (Wadden Sea World Heritage, 2026). Such collaborative monitoring frameworks enhance knowledge exchange and contribute to coordinated environmental governance at an international level.

In addition to environmental monitoring, some biosphere reserves have also introduced innovations related to sustainable tourism management and visitor data analysis, which support participatory regional development. For example, the Entlebuch Biosphere Reserve has implemented visitor monitoring systems and spatial analyses of tourism flows in order to balance conservation objectives with regional economic development. These analyses are used to inform spatial planning and tourism management strategies that involve local stakeholders and tourism operators (Weber, Knaus, 2017). Similar approaches can be observed in the Camargue Biosphere Reserve, where remote sensing data and environmental monitoring support the adaptive management of wetlands and coastal landscapes (Davranche et al., 2024). Examples of smart innovations as best practices identified in European biosphere reserves are shown in Table 1.

Table 1. Examples of smart innovations identified in European biosphere reserves

Biosphere reserve	Country	Innovation type	Main contribution
North Devon	UK	Citizen science and sensors	Participatory monitoring
Dyfi	UK	Observatory	Community data collection
Kristianstads Vattenrike	Sweden	Citizen science and biodiversity monitoring	Public participation
Nordhordland	Norway	Data bank	Open biodiversity data
Sierra Nevada	Spain	Observatory	Evidence-based governance
Menorca	Spain	Observatory	Socio-environmental indicators
Julian Alps	Slovenia	App	Visitor engagement
Wadden Sea	Denmark/Germany/ Netherlands	Map and app	Transboundary governance
Entlebuch	Switzerland	Visitor monitoring	Tourism management

Source: The authors.

Overall, these examples show that smart innovations in biosphere reserves play an important role in strengthening social potential, by enabling participation, improving access to environmental information, and fostering collaboration among different stakeholder groups. Through participatory monitoring, open data infrastructures, digital communication tools and collaborative governance models, biosphere reserves increasingly function as laboratories for social innovation that support sustainable regional development and evidence-based environmental management. According to the analysis, we identified five main categories of smart innovation contributing to the development of social potential in European biosphere reserves (Table 2). The identified categories differ in their technological complexity, but share a common objective: strengthening stakeholder participation, knowledge exchange and evidence-based decision-making.

Table 2. Typology of smart innovations contributing social potential

Category	Main function	Contribution to social potential
Participatory monitoring	Data collection	Community engagement
Open databases	Data sharing	Knowledge exchange
Socio-environmental observatories	Integrated monitoring	Evidence-based governance
Digital communication tools	Information access	Environmental awareness
Collaborative governance systems	Cooperation	Institutional collaboration

Source: The authors.

Conclusion

The analysis of smart innovations implemented in European biosphere reserves demonstrates that these territories increasingly function as laboratories where technological tools, open data infrastructures and participatory governance models are combined to support sustainable regional development.

The study identified five major categories of smart innovation implemented in European biosphere reserves. Participatory monitoring, open biodiversity databases, socio-environmental observatories, digital communication tools and collaborative governance systems represent the most common approaches used to strengthen social potential and improve territorial governance, which answers RQ_1. The study shows that these categories of smart innovation contribute to community engagement, knowledge exchange, evidence-based governance, environmental awareness and institutional collaboration, which answers RQ_2. The findings suggest that the most advanced biosphere reserves are not necessarily those with the most sophisticated technologies, but rather those that successfully combine technological solutions with participatory governance and stakeholder engagement. The findings of this study suggest that strengthening data ecosystems in biosphere reserves should be a strategic priority for environmental governance and regional development policies. Public authorities and biosphere reserve management bodies should support the development of integrated monitoring systems that combine remote sensing, sensor networks and participatory data collection with open data infrastructures. Particular attention should be paid to expanding citizen science initiatives and digital platforms that facilitate collaboration between researchers, local communities and public institutions. Furthermore, policy frameworks should promote interoperability between national databases, research infrastructures and biosphere reserve monitoring systems, to ensure that data can be effectively used for decision-making and spatial planning. Finally, investing in digital capacities and knowledge exchange within the UNESCO MAB network may significantly enhance the role of biosphere reserves as laboratories for smart and socially inclusive regional development.

The results also show that the most advanced biosphere reserves are characterised by the integration of multiple data sources, long-term monitoring systems and digital platforms that allow environmental data to be collected, shared and used for decision-making. Such integrated approaches can significantly improve the quality of ecosystem monitoring, and also provide valuable information for territorial management, public policy and planning. The study highlights the growing importance of participatory and socially oriented innovations in biosphere reserve governance. Citizen science initiatives, open biodiversity databases and socio-environmental observatories represent important mechanisms that enable local communities, researchers and public institutions to collaborate in the production and interpretation of environmental knowledge. These innovations not only increase the availability of environmental data, but also contribute to strengthening social capital, environmental awareness and stakeholder engagement in biosphere reserve management. At the same time, the results indicate that the level of data integration and digital innovation differs significantly across European biosphere reserves. While some reserves have developed advanced monitoring infrastructures, open data systems and digital communication tools, others still face challenges related to fragmentary datasets, limited interoperability and insufficient integration of socio-economic information into environmental monitoring frameworks. The findings therefore suggest that the key challenge for future development is not the absence of data, but rather the lack of their systematic integration into coherent data ecosystems that support strategic planning and participatory governance.

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SUMANIOSIOS INOVACIJOS, ATSKLEIDŽIANČIOS BIOSFEROS REZERVATŲ SOCIALINĮ POTENCIALĄ

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Santrauka

Biosferos rezervatai yra tarptautiniu mastu pripažintos teritorijos, kuriose biologinės įvairovės apsauga, tvari socialinė ir ekonominė plėtra bei žinių mainai yra integruojami pagal UNESCO programos „Žmogus ir biosfera“ (MAB) principus. Pastaraisiais dešimtmečiais šios teritorijos vis dažniau suvokiamos ne tik kaip saugomos kraštovaizdžio teritorijos, bet ir kaip eksperimentinės laboratorijos, kuriose išbandomi inovatyvūs valdymo modeliai ir technologiniai sprendimai, skirti tvariai regioninei plėtrai. Spartus skaitmeninių

technologijų, aplinkos stebėsenos sistemų ir atvirų duomenų infrastruktūrų vystymasis reikšmingai išplėtė galimybes šiose teritorijose rinkti, analizuoti ir dalytis informacija.

Šiame straipsnyje nagrinėjamas sumaniųjų inovacijų vaidmuo atskleidžiant biosferos rezervatų socialinį potencialą. Sumaniųjų inovacijų sprendimai susieja skaitmenines technologijas, ryšio infrastruktūras ir duomenimis grindžiamus metodus, siekiant užtikrinti efektyvesnius, skaidresnius ir labiau dalyvavimu grindžiamus valdymo procesus. Biosferos rezervatuose tokios inovacijos apima aplinkos stebėsenos sistemas, atvirųjų duomenų platformas, skaitmeninės komunikacijos priemones ir dalyvaujamąsias duomenų rinkimo iniciatyvas. Gerindamos prieigą prie aplinkos informacijos ir sudarydamos suinteresuotųjų šalių bendradarbiavimo sąlygas, šios inovacijos prisideda prie įrodymais pagrįsto sprendimų priėmimo ir skatina vietos bendruomenių dalyvavimą aplinkos valdyme.

Tyrime taikomas kokybinis tyrimo metodas, susiejantis teorinę analizę ir empirinį sumaniųjų inovacijų, įgyvendinamų Europos biosferos rezervatuose, nagrinėjimą. Iš viso buvo analizuoti 205 biosferos rezervatai Europoje, siekiant nustatyti atvejus, kai skaitmeninės technologijos ir duomenų infrastruktūros naudojamos aplinkos stebėsenai, atviriesiems duomenims publikuoti arba praktiniam aplinkos duomenų taikymui valdant teritorijas ir stiprinant socialinį potencialą. Pateikti pavyzdžiai paremti dirbtiniu intelektu grįsta žvalgomojo pobūdžio analize, o gauti rezultatai vėliau buvo patikrinti naudojant oficialias interneto svetaines, projektų ataskaitas ir mokslines publikacijas.

Tyrimo rezultatai atskleidžia, kad pažangiausi biosferos rezervatai kuria integruotas stebėsenos sistemas, kurios susieja nuotolinio stebėjimo technologijas, jutiklių tinklus ir dalyvaujamąsias stebėsenos praktikas. Piliečių mokslo iniciatyvos leidžia vietos bendruomenėms ir savanoriams dalyvauti stebint biologinę įvairovę bei renkant aplinkos duomenis, taip stiprinant aplinkosauginį sąmoningumą ir vietos gyventojų įsitraukimą. Tokie pavyzdžiai kaip Šiaurės Devono (*North Devon*), Kristianstado (*Kristianstads Vattenrike*) ir Daifio (*Dyfi*) biosferos rezervatai parodo, kaip skaitmeninės platformos ir mobiliosios technologijos gali palaikyti bendruomenėmis grindžiamą aplinkos stebėseną.

Kita svarbi inovacijų grupė apima atviras biologinės įvairovės duomenų bazes ir socioaplinkos observatorijas, kurios skatina dalijimąsi žiniomis ir mokslininkų, viešųjų institucijų bei piliečių bendradarbiavimą. Tokios platformos kaip Norvegijos „Artsdatabanken“ suteikia atvirą prieigą prie ekologinių duomenų rinkinių ir palaiko bendradarbiavimu grindžiamą aplinkos stebėseną. Socioaplinkos observatorijos, tokios kaip Siera Nevados pasaulinių pokyčių observatorija (angl. *Sierra Nevada Global Change Observatory*) ar Menorkos socioaplinkos observatorija (OBSAM), integruoja aplinkos ir socialinius-ekonominius rodiklius bei teikia vertingą informaciją formuoti įrodymais pagrįstą politiką bei planuoti teritorijas.

Apskritai tyrimo rezultatai atskleidžia, kad biosferos rezervatai gali veikti ne tik kaip technologinių inovacijų erdvės, bet ir kaip socialinių inovacijų platformos. Integruodamos aplinkos stebėsenos sistemas, atvirųjų duomenų infrastruktūras ir dalyvaujamąsias valdymo praktikas, sumaniosios inovacijos stiprina socialinį kapitalą, didina skaidrumą ir skatina įtraukesnius sprendimų priėmimo procesus, taip prisidėdamos prie tvarios regioninės plėtros.

RAKTINIAI ŽODŽIAI: *biosferos rezervatai, išmaniosios inovacijos, socialinis potencialas, tvari regioninė plėtra, atviri duomenys.*

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