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Sustainable development of forest parks for active recreation: A balance between nature conservation and physical education

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Abstract. The study aims to comprehensively assess the negative impacts of various activities carried out by visitors to natural areas, including forest parks, on ecosystems. The research methodology included an analysis of forest park ecosystems Gotova-Dangel and Logara forest parks, monitoring ecosystem changes, which provided objective data on the impact of human activity. The study developed recommendations aimed at minimising the negative effects of these activities on the environment. The main results of the study demonstrated that walking leads to soil compaction, which in turn hurts water circulation and aeration of soil layers. This phenomenon can also cause damage to rare species of plants and trees that are vulnerable to changes in their natural environment. In addition, cycling causes soil erosion, which leads to the destruction of vegetation, which in turn negatively affects the environmental sustainability of the region. This can create conditions for the degradation of natural ecosystems and a decrease in biodiversity. Camping causes pollution of the area, including dumping garbage and other waste, which leads to a decrease in the number of animals living in forest environments, with serious consequences for the ecological balance and conservation of wildlife. The findings highlight the need to introduce clearly defined trails for pedestrian traffic, create specialised bicycle routes, and develop environmentally responsible camping practices. This will significantly reduce the negative

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impact on the forest ecosystem. The research is relevant for the conservation of biodiversity as well as for maintaining the ecological balance in forest parks, which is critical for the sustainable development of natural resources and the preservation of the environment for future generations

Keywords: ecology; biodiversity; ecosystem; nature protection; leisure

Introduction

With the growing interest in active recreation in natural environments, research on how different types of physical activity affect the ecosystems of forest parks is relevant. Forest parks perform a critical ecological function, providing habitats for many species of flora and fauna, as well as supporting important ecological processes such as climate and water balance regulation. However, outdoor activities can have significant negative impacts on these systems, including damage to vegetation, changes in animal behaviour and soil erosion.

The problem is a lack of information on how different types of outdoor activities, such as hiking, cycling and camping, affect forest ecosystems. There is a need for a detailed analysis of this impact and the development of effective strategies to minimise the negative consequences.

Existing studies focus on the overall impact of recreational activities on nature. They demonstrated that outdoor activities could have both positive and negative effects on ecosystems. The problem of a clean and sustainable environment in forest areas, in Lithuania and Turkey, was studied by A. Atalay *et al*. (2024). Their study highlights the impact of recreational activities on the ecological state of forest areas and offers solutions to reduce the negative effects. G. Ospan *et al*. (2024) assessed the impact of winter tourism on natural heritage in Kopaonik National Park, focusing on the negative effects of winter tourism and developing a strategy for the conservation of natural resources. T. Tapps & M.S. Wells (2024) analysed the basics of recreational activities and leisure time, providing basic concepts for understanding the development of recreational areas and their sustainable management.

The potential of tourism and recreation in rural areas of Kazakhstan was analysed by K. Saparov *et al*. (2024). They addressed the development of sustainable tourism and the use of natural resources in these regions. K.G. Kling (2024) addressed the balance between accessibility and conservation in protected areas. The study highlighted the challenges that arise when trying to provide access to natural areas while maintaining their value. B.M. Akgül & S. Karaküçük (2024) studied the concepts of eco-recreation and its application to create sustainable recreational environments. The work covered the theoretical and practical aspects of integrating ecology and recreation.

A systematic review of tourism in European national parks was conducted by D.S. Donici & D.E. Dumitras (2024). They studied different management models and the impact of recreational activities on natural ecosystems. A. Melaku & J. Pastor Ivars (2024) examined cultural ecosystem services in urbanised sacred forests. This study focuses on how such forest areas support human well-being through cultural and ecological services. G. Lukoseviciute *et al*. (2024) studied participation in the development and management of ecocultural routes. The study suggests methods for integrating cultural and environmental aspects into tourist routes. V. Ristić *et al*. (2024) assessed the importance of forest ecosystems for the

development of nature-based tourism in the Fruska Gora National Park. The study highlighted the importance of forest areas for eco-tourism and their management.

Despite the existing research covering various aspects of outdoor activities, there are still many gaps in understanding the specific mechanisms of the impact of different types of outdoor activities on individual ecosystem elements. This is especially true for activities such as camping, hiking and cycling routes, which can have both positive and negative environmental impacts. For instance, the long-term effects of camping on biodiversity, which is critical for maintaining ecological balance, and soil erosion in specific types of forest environments are not well determined. Studying these aspects can help to develop more effective strategies for managing natural resources and preserving ecosystems.

The study aims to examine the impact of three types of active recreation: hiking, cycling and camping – on forest ecosystems. Study goals:

1. Analysis of the impact of hiking on the flora and fauna of forest parks, including a study of plant and animal species affected by hiking, including changes in the number and range of different species and an overall assessment of biodiversity.

2. Assessment of the impact of cycling on biodiversity and determining the impact of cycling on forest park ecosystems.

3. Development of practical recommendations to reduce the negative impact of camping by studying its effects on forest park ecosystems and creating approaches to managing outdoor recreation for biodiversity conservation.

Materials and Methods

The study, which was conducted from June to September 2024, covered a wide range of aspects of human interaction with the natural environment. The main locations for field research were two forest parks: Gotova-Dangel Forest Park and Logara National Park (Albania). The selected areas not only represent samples of various forest ecosystems but also provide unique conditions for studying the impact of various types of active recreation, such as hiking, cycling and camping, on these ecosystems.

The research began with careful planning and methodology development, including the definition of the main objectives and the choice of data collection methods. Forest, in particular trees, were emphasised as their condition is critical to the health of the ecosystem.

To assess the undergrowth and dead wood, methods were used to identify the physical condition of the trees and their biomass. This information became the basis for understanding the impact of human activity on tree cover. In particular, the assessment of tree health, growth and density helped to determine how active recreation contributes to or hinders forest conservation and restoration.

Observing the number of young trees and the presence of dead wood was another important element of the study. These observations were used to assess the natural regeneration of the tree cover and identify negative impacts caused by active recreation, such as trampling on young plants or reducing the amount of dead wood, which is critical for nourishing the soil and creating an environment for new plants.

Phytoindication was used as a method of assessing environmental stress. Assessment of tree health, including damage to leaves, roots and trunks, served as an indicator of the impact of human presence and physical activity, including cycling. This was used to identify how human activity can lead to a deterioration in tree health and the overall condition of the forest.

An integrated approach to assessing the condition of trees and their ecosystems provided a detailed understanding of the impact of

outdoor activities, which became the basis for making decisions on the conservation and restoration of forest resources.

For a more detailed analysis, information on the level of soil erosion and vegetation condition was collected. This process involved the use of modern methods, such as Geographic Information System (GIS) and Global Positioning System (GPS), which were used to accurately determine erosion processes and their impact on the environment. GPS and GIS were also used to monitor the condition of trees and their location, which is an extremely important aspect of modern forest management, as it allows not only to pinpoint the exact location of each tree but also to assess its condition, identify diseases, pests or other factors that may threaten its life. This will help to create a detailed map of damaged or degraded areas, which in turn will allow for more efficient management of forest parks. The collected data was used as a basis for further analysis and development of recommendations for the conservation of natural resources and ecosystem restoration.

SPSS and Excel statistical packages, which provided powerful tools for detailed statistical processing and analysis of the results, were used. These software tools were used not only to evaluate the results of the study with high accuracy but also to identify certain patterns and trends that could be useful for further research and practical application of the data obtained. The collected materials were carefully processed and analysed to assess the impact of outdoor activities on forest ecosystems.

The study was conducted following the ethical standards set out in the Convention on Biological Diversity (1992) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973). The study employed a systematic approach that provided clear data on the impact of outdoor activities and contributed to the development of effective strategies for the conservation and enhancement of forest ecosystems.

Results

Active recreation in forest parks, while enjoying the outdoors and communicating with nature, can have a significant impact on the ecological balance of these unique ecosystems. Walking leads to soil compaction, which negatively affects the root system of plants and can cause erosion. Cycling, in turn, causes damage to vegetation and disturbance of natural habitats, as cyclists often ride on paths that are not intended for this purpose. Camping causes pollution of the territory if waste disposal rules and proper care of campfires are disregarded.

Hiking was one of the most common forms of active recreation in forest parks, as people could enjoy nature, maintain physical activity and improve their psycho-emotional state. However, despite all the positive aspects, even such seemingly safe activities can have negative consequences for vegetation and the ecosystem as a whole. The constant pressure on the trails caused by the large number of visitors led to soil compaction, which made it difficult for new plants to grow, as the roots could not penetrate the soil freely, which negatively affected their nutrition and development. Visitors trampled on rare plant species: marsh orchid "*Dactylorhiza sphagnicola*" – "Gotha-Dangel", forest lily "*Lilium martagon*" – Logara Park, which not only caused their damage but may also lead to their extinction in the future. Therefore, awareness of the impact of human activity on the environment is necessary, as well as rules of conduct in natural areas to preserve their uniqueness and biodiversity.

The impact of hiking on animals was complex and manifested in both direct and indirect forms. The presence of people and the sounds they made in the study area caused stress in wildlife, which in turn led to changes in their

behaviour. For instance, common beavers *(Castor canadensis)* were forced to leave their usual habitats, which will harm their reproduction and survival. The golden eagle *(Aquila rapax)* changed its nesting sites and flight periods in response to human activity (Table 1). This manifested itself in the fact that they began to hide earlier than usual or changed their traditional migration routes, which led to a violation of the ecological balance.

Table 1. Rare species affected by outdoor activities and other human factors

Plant/animal species	Place of residence	Cause of threat
Marsh orchid (*Dactylorhiza sphagnicola*)	Rivers and reservoirs	Trampling by pedestrians
Forest lily (*Lilium martagon*)	Forest areas	Injuries during outdoor activities
Common beaver (*Castor canadensis*)	Rivers and reservoirs	Stress from human activity
Golden eagle (*Aquila rapax*)	Mountainous areas	Change of nesting sites
Orchid (*Orchis papilionacea*)	Forest areas	Trampling and loss of environment
Grass cat (*Felis silvestris*)	Forested areas	Destruction of the environment, hunting
Red lizard (*Lacerta agilis*)	Dry and rocky locations	Habitat loss and human impacts
Mountain frog (*Bufo viridis*)	Wet landscapes	Water pollution and climate change

Source: compiled by the authors

In Gotova-Dangel and Logara parks, flora and fauna responded to human activity by reducing available food resources and altering the natural environment. For instance, pedestrian activity in the Gotova-Dangel park has led to the destruction of vegetation, which is an important source of food for many animal species. Observations in these natural reservoirs have shown that birds and small mammals tend to leave areas where trails are active more often, indicating that they are adapting to changes in the environment caused by human activity. This phenomenon requires careful study as it may have long-term implications for biodiversity and ecosystems.

The impact of human activity on the condition of trees in forest parks is a significant and complex aspect of the ecological balance. Intensive hiking, cycling and camping, which have become popular forms of recreation, can cause trampling of the soil around the root system of trees. This, in turn, harms their stability and development, as tree roots need healthy soil to receive nutrients and water (Table 2).

Table 2. Results of the assessment of the condition of trees in the forest parks Gotova-Dangel and Logara under the influence of active recreation

Location	Condition of trees (general)	Damage detected (leaves, trunk, roots)	Number of young trees	Presence of dead wood	Level of environmental stress
Forest Park Gotova-Dangel	Satisfactory	Damage to leaves and trunks	High (21-50%)	Low	Moderate
Logara National Park	Weak	Significant damage to all parts	Average (6-20%)	Average	Proficiency

Source: compiled by the authors

Frequent human intervention in natural processes can cause mechanical damage to tree trunks, leaves and roots. Such damage leads to a decrease in the overall health of trees, which makes them more vulnerable to diseases, pests and other stressors. Situations are particularly dangerous when human activity is accompanied by the use of heavy machinery or equipment, which can lead to even more serious damage.

The presence of litter and pollution caused by human activity can have a significant impact on soil and water quality. Contaminated soils can interfere with the normal growth of trees, as harmful substances can enter the root system, preventing the absorption of essential elements. Campfire activities can also inflict burns to trunks or roots, which in turn reduces their viability.

The spread of invasive plant species is another serious consequence of human activity that can reduce the competitiveness of native trees. Invasive species often grow faster and take up the space needed for the roots of native plants to develop, which leads to a change in the natural balance of the ecosystem.

Thus, active recreation, if left unchecked, can cause significant changes in the condition of trees and the overall ecosystem of forest parks. Natural resource preservation efforts are necessary, as the health of forest parks directly affects the quality of life of people who use these natural spaces.

Measures to minimise impacts on natural ecosystems are essential to preserve biodiversity and maintain environmental health. Creating and maintaining clearly defined trails is an important step in reducing the area that visitors can ravage. This not only helps to limit access to sensitive ecosystems but also provides conditions for revegetation, which helps to preserve the natural environment. Marked trails also make it easier for visitors to find their way around, reducing the risk of accidental damage to the vegetation. Educating visitors about the importance of protecting vegetation and wildlife is a key element in raising environmental awareness. Information boards can include data on vulnerable species, and ecosystems and their role in maintaining the ecological balance. This can significantly reduce accidental damage and encourage visitors to follow the rules of behaviour in nature, which in turn will help preserve natural resources for future generations.

The study found that cycling had more serious consequences for the flora than walking. This is determined by the wheels of the bicycles having a significant impact on the soil surface, digging it up, destroying natural vegetation and contributing to increased erosion. Such activities led to the destruction of the root system of plants, which in turn hurt the ecosystem. The study determined that the speed of cyclists led to the widening of paths and the emergence of new trajectories, which further damaged the vegetation. This put additional pressure on the natural environment, as the new routes passed through sensitive ecosystems, disrupting their integrity and functioning. Thus, it is necessary to address the environmental impact of cycling and seek ways to reduce its negative impact on the environment.

Cycling has a significant stressful impact on wildlife, which is an important aspect to account for. The sharp noise generated by cycling and the high speed of the cyclists caused the animals to feel fear and anxiety, which led to the sudden abandonment of their natural habitats and negatively affected their social structures. In Logara Park, the animals were forced to search for new areas to live in, which disrupted their usual migration routes and interaction with other members of the species. Such changes have had far-reaching consequences for the ecosystems in which these animals live and have affected their ability to survive.

Measures to minimise the impact on the natural environment are highly relevant in the

context of the growing use of bicycles and outdoor activities. Establishing designated bicycle routes that do not intersect with hiking trails can significantly reduce the negative impact on vegetation and fauna. This avoids conflicts between pedestrians and cyclists, which in turn reduces the risk of damage to natural ecosystems. Individual routes can also be designed to address the natural features of the area, which will ensure the preservation of biodiversity and maintain ecological balance. Installation of soft surfaces for bike paths, such as rubber tiles or natural materials, can significantly reduce soil erosion and plant damage. Not only do these coatings reduce the negative impact on the environment, but they also increase comfort and safety for cyclists. In addition, the use of specialised equipment to maintain and service the tracks can ensure their durability and reduce the need for frequent repairs, which will also have a positive impact on the environmental situation in the region.

Camping has long-lasting and significant effects on the flora of forest parks, which requires attention from conservation organisations and recreationists. The establishment of camps leads to the destruction of vegetation, which occurs not only under the tents but also near fires where people cook and relax. Emissions from campfires, such as ash and smoke, as well as waste left behind after camping, pollute soil and water, which negatively affects vegetation and the ecosystem.

The study determined that camping had the greatest impact on flora among the three main outdoor activities, such as hiking and cycling. The presence of the camps has led to severe damage to vegetation, including the destruction of plant roots, which are important for maintaining biodiversity, and soil erosion, which leads to a loss of fertility. This highlights the need to comply with environmental regulations and practices when camping to minimise the negative impact on the environment.

Camping has caused significant stress to wildlife in the Gotova-Dangel and Logara parks for several reasons, including the sounds of campfires and the smells of cooking. These factors forced the animals to abandon their natural habitats as they perceived human activity as a threat. As a result, the animals in the Gotova-Dangel park changed their diets as their usual food sources became less accessible or dangerous.

Camping also had a significant impact on the fauna in the study areas, leading to a decrease in the number of different animal species and changes in their behaviour. Animals began to avoid areas with high human activity (Table 3). These changes in behaviour had long-term consequences for ecosystems, as the natural relationships between species were disrupted. Therefore, it is necessary to address environmental aspects when organising a campsite and choose places that have minimal impact on wildlife.

Table 3. The impact of outdoor activities on ecosystems

Type of active recreation	Impact on vegetation	Impact on animals	Impact on trees
Hiking	Soil compaction, trampling on rare species	Stress, behavioural change	Mechanical damage, reduction in the number of young trees
Cycling	Vegetation damage, erosion	Stress, change in migration routes	Root damage, reduced tree health
Camping	Pollution, destruction of vegetation	Stress, diet change	Burns of trunks, destruction of young plants

Source: compiled by the authors

Measures to minimise the environmental impact of camping are highly important for the preservation of natural ecosystems. Selecting designated camping areas not only helps to reduce accidental damage to vegetation but also helps to preserve the natural landscape. Such sites are usually equipped following environmental standards, which reduces the likelihood of negative environmental impact. Thanks to this, visitors can enjoy nature without harming the local flora and fauna. The ban on the use of open fires is an important step in the fight against environmental pollution and the destruction of vegetation. Instead, the mandatory use of portable cooking stoves not only reduces the risk of forest fires but also reduces emissions of harmful substances into the air. Such rules keep the territory clean and preserve natural resources for future generations.

One of the most promising approaches is the strategy of creating ecological corridors. Ecological corridors are stretches of land that provide a link between separated natural environments, allowing wildlife to migrate and exchange genetic material. This process is critical to maintaining biodiversity as it helps to strengthen species populations, prevents inbreeding and increases the overall resilience of ecosystems to environmental change. Ecological corridors can be created in a variety of ways, including by preserving natural forest belts that function as natural arteries for wildlife movement. The process of planting trees and other plants between separated forest patches is also relevant, helping reconnect isolated animal populations. This, in turn, not only ensures the conservation of biodiversity but also improves the overall health of ecosystems, which has a positive impact on the climate and quality of life.

Restoration of natural habitats is an important process that involves not only reconstruction but also restoration of ecological functions in destroyed or degraded areas. This process may include a range of measures, such as planting native plants, controlling invasive species, and creating appropriate conditions for the restoration of natural populations of flora and fauna. Monitoring the ecosystem is also an important aspect to ensure the effectiveness of the measures taken.

The biotechnical measures implemented as part of the restoration include planting to stabilise the soil, which is critical to preventing erosion. Plants, especially those with a strong root system, can penetrate deep into the soil, which helps to hold it in place and reduce the risk of erosion. Grasses and shrubs can be successfully planted on slopes and along rivers, which not only stabilises the soil but also improves the water balance in the region. Thus, restoration of natural habitats is a key element in the conservation of biodiversity and environmental sustainability.

Barriers, such as windbreaks, are significant in reducing wind speeds, which in turn significantly reduces the risk of soil erosion. These forest belts not only block strong winds but also help to retain moisture in the soil, which is also critical for maintaining fertility. They can be particularly effective in agricultural areas where intensive farming can lead to significant soil loss.

Additional solutions that can be implemented to combat erosion include the creation of water catchment systems that control water runoff, reduce the risk of flooding and erosion, and conserve water resources. Catchment systems can include drainage channels, ponds and other structures that help regulate the water balance in the soil.

Soil reclamation is another important aspect that involves restoring the fertility and structure of soils that have been damaged by various factors such as construction, intensive rest or aggressive agricultural practices. This process can include the application of organic fertilisers, which improve the biological activity

of the soil, and liming, which helps to neutralise acidity and improve nutrient availability. In addition, covering soils with mulch is an effective method for retaining moisture, preventing weeds and improving overall soil quality. All these measures contribute to the restoration of the ecosystem and ensure the sustainability of agricultural production.

Natural methods of ecosystem restoration, including the use of native plant species, are extremely effective in quickly restoring degraded areas. The use of native plants that are adapted to specific environmental conditions contributes to revegetation and biodiversity, as these species provide habitat for local animals and microorganisms. Natural processes, such as the accumulation of leaves and branches, are key in supporting the natural regeneration of ecosystems. These organic materials serve as a natural fertiliser and help to retain moisture in the soil, which in turn promotes the growth of new plants.

Managing forest resources is a complex and multifaceted process that involves regular monitoring of forest health, controlling pest and disease populations, and maintaining an optimal balance between timber harvesting and forest regeneration. This involves keeping records of the state of forests, conducting research to identify potential threats and developing strategies to overcome them. Harvesting should be planned in a way that does not disrupt the ecological functions of forests, which includes considering seasonality, biological cycles of native species, and the preservation of key ecosystem services provided by forests, such as air purification, water balance regulation, and soil conservation. Therefore, an integrated approach to forest management ensures their resilience and ability to recover in the face of climate change and anthropogenic pressures.

The involvement of local communities in forest management, as well as educational campaigns, are crucial steps that can significantly raise public awareness of the importance of ecosystem conservation. Community involvement in management processes helps to create a more responsible attitude towards natural resources, which can lead to improved forest parks. Informing the public about the environmental consequences of human activity and encouraging responsible behaviour can have a significant positive impact on the preservation of the natural environment. This includes training and active participation in nature conservation activities. The conservation and restoration of natural ecosystems in forest parks requires a comprehensive approach that includes not only practical strategies but also active community participation in these processes.

The use of various technologies and methods, such as environmental monitoring systems, restoration of the natural environment, and implementation of sustainable management practices, was used to maintain biodiversity, prevent soil erosion, restore damaged areas, and ensure a healthy forest environment for future generations. Therefore, the integration of knowledge, technology and active participation of society are key elements in achieving effective forest management and conservation of natural ecosystems.

Discussion

The study confirmed the importance of integrating environmental and sustainable approaches into the planning and management of natural areas. The results showed that effective management of recreational resources can significantly improve the ecological balance and ensure sustainable development. This is especially true for areas with a high tourist load, where it is necessary to find a balance between nature conservation and meeting the needs of visitors.

The impact of recreational practices on nature and tourist experience was studied by G. Lukoseviciute *et al*. (2024). They found a positive impact of organised recreational activities on environmental sustainability and showed that well-planned recreational areas contribute to nature conservation. The results confirm these findings but also reveal additional negative aspects, such as the potential stress on ecosystems from overuse. This indicates the need for more detailed management of recreational areas. V. Voronkova *et al*. (2024) focused on the creative development of the concept of green ecotourism as a factor of sustainable development, noting the positive impact of ecotourism on the conservation of natural resources. The study determined a significant potential for ecotourism in sustainable development, which is confirmed by the findings, but showed that the economic impact of ecotourism may be greater than expected, which may require a review of economic strategies in green tourism. N. Bhatt *et al*. (2024) investigated the relationship between cultural ecosystem services and traditional ecological knowledge for forest management in the Indian Himalayas. They determined the importance of cultural aspects in ensuring effective forest management. This study confirms the importance of cultural and social factors in biodiversity conservation but reveals additional regional differences in natural resource management that require further research.

Sustainable development of rural areas in protected areas, in Strandzha (Bulgaria), was studied by S. Petrova *et al*. (2024), pointing out that the integration of environmental and social factors is critical for effective natural resource management. These findings confirm the importance of integrating environmental and social aspects but additionally reveal specific challenges for rural areas in other regions that may require a different approach. D.E. Jacob *et al*. (2024) analysed the use of bioindicators for planning recreational areas and the balance between nature and human activity. They emphasised the importance of monitoring environmental indicators to maintain the balance. This is in line with results of this study and confirms the importance of bioindicators, but the study also found that current methods could be improved to improve the accuracy of the assessments.

The potential of recreational areas in the Karagel National Park, Turkey, was assessed by N. Doygun *et al*. (2020), determining that properly planned recreational areas can significantly increase tourist attractiveness. The results confirm this conclusion but also show that some planning methods may need to be adapted to different geographical conditions. I. Koshkalda *et al*. (2023) studied the prospects for the development of recreational lands, emphasising the importance of long-term planning to achieve sustainable development. These results are consistent with these conclusions but also demonstrate the need for more comprehensive management approaches that address specific regional characteristics. In turn, X. Luo *et al*. (2024) analysed tourist preferences and willingness to pay for biodiversity and recreational management in Wuishan National Park, China. They found that investments in biodiversity conservation are highly valued by tourists. This study confirms this trend but also found that cultural and economic aspects may influence willingness to pay, which requires further analysis. The study of the impact of land use planning and green environmental services on sustainable development, through the development of hiking trails, was conducted by G. Kyriakopoulos (2023). It was found that well-planned trails can have a positive impact on environmental sustainability and sustainable development. This study confirms the importance of green spatial elements but also shows that

their effectiveness can vary depending on local conditions and needs.

Y. Tao & P.-H. Lin (2023) analysed the sustainable development of cultural and creative parks using knowledge mapping methods. They identified the key factors that influence the success of such parks. This study determined similar success factors but also showed that there is a need for a more detailed study of specific cultural aspects to improve the effectiveness of parks. The synergistic development of the sports industry and the ecological environment of urban parks was studied by L. Manrong & M. Zhang (2023). The study determined that the integration of both aspects can provide significant benefits for the urban environment. The study confirms these findings but additionally reveals that to achieve optimal results, it is necessary to account for the specifics of the urban context. T. Grindsted *et al*. (2023) studied the integration of sustainable tourism into the development of natural parks, identifying conflicts between different interests. It is noted that sustainable management requires a balance between environmental and tourism requirements. This study confirms these conclusions but also shows that having clear management strategies in place can make it much easier to achieve a balance.

The synergy between environmental sustainability and the development of the eco-hospitality industry in the Miyun-Beijing area was studied by Z. Qilun *et al*. (2023). They found that effective management can ensure the harmonious development of both aspects. The study found similar results but also highlighted the need to address local conditions to improve the integration of environmental and economic factors. M. Jalinik & P. Selwesiuk (2023) analysed the development of tourism and recreational infrastructure in forest districts of Poland, identifying the need to improve existing infrastructure solutions. The results confirm these findings, demonstrating that current infrastructure solutions can be improved to better meet the needs of tourists and local communities. The impact of environmental education on primary education, with a focus on physical activity and sports programmes in the natural environment, was studied by M. Santos-Pastor *et al*. (2022). The results showed a positive effect on sustainable development through the integration of physical activity, which is in line with the original findings, which confirm the importance of environmental education but also show the need to adapt programmes to specific conditions and cultural contexts to maximise their effectiveness.

The study by M. Phil (2022) demonstrated the link between ecotourism and sustainable development, as well as strategies for balancing economic growth, socio-cultural development and nature conservation. It was found that ecotourism can be an effective tool for achieving sustainable development. This study confirmed these conclusions but also pointed to the need for a more detailed analysis of the specific conditions and factors that may affect the implementation of ecotourism strategies. D. Aly & B. Dimitrijevic (2022) applied a systematic approach to the sustainable management of urban public parks, by studying management strategies. The results confirmed the effectiveness of the systemic approach in improving the sustainable development of parks. The findings are consistent with this approach but highlight the need to consider additional socio-economic factors to improve management strategies.

The assessment of natural and recreational resources of the Akmola region for sustainable tourism development was carried out by K. Yegemberdiyeva *et al*. (2020). The study determined that the resources can be effectively used for tourism development while adhering to sustainable practices, which confirms the conclusions drawn, demonstrating the

importance of resource assessment for the successful implementation of sustainable tourism. G. Rodríguez-Loinaz & I. Palacios-Agundez (2024) investigated how environmental services education can improve students' arguments in support of nature conservation and sustainable development. The results indicated a positive impact of such education on students' attitudes. This study confirmed these results but also highlighted the need to integrate environmental topics into various aspects of the curriculum. M. Trudeau (2024) examined the concept of "naturalness" in Calgary's natural playgrounds, focusing on sustainable development and environmental education. The study determined that natural playgrounds could promote greater environmental awareness. This supports the findings, demonstrating the positive impact of such innovations on children's learning and environmental awareness.

The analysis of the research results showed that they are in line with international trends in environmental education, sustainable tourism development and natural resource management. However, it is necessary to address the specifics of local conditions to achieve the best results.

Conclusions

The study determined that different types of active recreation have different degrees of impact on forest park ecosystems. Hiking causes soil compaction and damage to rare plants, cycling leads to soil erosion and destruction of vegetation, and camping leads to pollution and a decrease in the number of animals. Trees are also significantly impacted by outdoor activities: mechanical damage to the root system and trunks can cause a decrease in tree health and increase their vulnerability to pests and diseases. Qualitative indicators include a decrease in biodiversity and deterioration of vegetation.

To reduce the negative impact of outdoor activities on ecosystems, it is recommended to introduce clearly defined trails for pedestrians, develop special bicycle routes that reduce soil erosion, and introduce environmentally responsible camping practices, such as limiting the size of camping areas and providing garbage collection. Further research should focus on analysing long-term changes in forest park ecosystems under the influence of different types of outdoor activities, evaluating the effectiveness of the implemented recommendations in reducing the negative impact and developing new methods for a more detailed study of the impact of outdoor activities on different ecosystems.

The study has some limitations, including geographical ones: it covered only certain forest parks, namely Gotova-Dangel and Logara, which may not reflect the full impact of outdoor activities in other regions. In addition, methodological limitations include impact assessments based on surveys and observations, which may not fully capture all aspects of environmental change.

The study confirmed that active recreation has a significant impact on the ecosystems of forest parks, which varies depending on the type of activity. The results obtained indicate the need to develop and implement effective measures to reduce the negative impact and conserve biodiversity. Further research should focus on long-term effects and improved management practices to improve the ecological status of forest areas.

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Conflict of Interest

None.

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Сталий розвиток лісопарків для активного відпочинку: баланс між охороною природи та фізичним вихованням

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Анотація. Метою дослідження є комплексна оцінка негативного впливу різних видів діяльності відвідувачів природних територій, зокрема лісопарків, на екосистеми. Методологія дослідження включала аналіз лісопаркових екосистем лісопарків Готова-Дангел та Логара, моніторинг змін екосистем, що дозволило отримати об'єктивні дані про вплив людської діяльності. За результатами дослідження були розроблені рекомендації, спрямовані на мінімізацію негативного впливу цієї діяльності на навколишнє середовище. Основні результати дослідження продемонстрували, що ходьба призводить до ущільнення ґрунту, що, в свою чергу, шкодить циркуляції води та аерації ґрунтових шарів. Це явище також може завдати шкоди рідкісним видам рослин і дерев, які є вразливими до змін у своєму природному середовищі. Крім того, їзда на велосипеді спричиняє ерозію ґрунту, яка призводить до знищення рослинності, що, в свою чергу, негативно впливає на екологічну стійкість регіону. Це може створити умови для деградації природних екосистем та зменшення біорізноманіття. Кемпінги спричиняють забруднення території, в тому числі скидання сміття та інших відходів, що призводить до зменшення кількості тварин, які живуть у лісовому середовищі, з серйозними наслідками для екологічної рівноваги та збереження дикої природи. Результати дослідження підкреслюють необхідність запровадження чітко визначених стежок для пішохідного руху, створення спеціалізованих велосипедних маршрутів та розвитку екологічно відповідальних практик кемпінгу. Це дозволить значно зменшити негативний вплив на лісову екосистему. Дослідження є актуальним для збереження біорізноманіття та підтримання екологічної рівноваги в лісопарках, що є критично важливим для сталого розвитку природних ресурсів та збереження довкілля для майбутніх поколінь

Ключові слова: екологія; біорізноманіття; екосистема; охорона природи; відпочинок