

Article

Comprehensive Evaluation of the Design of a New National Park Using the Quintuple Helix Model

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Abstract: Protected areas serve as stepping stones for the preservation of biodiversity, and can provide economic and social benefits to communities. National parks aim to limit human intervention to safeguard natural communities and processes. This study analyzes the impacts of transforming the Křivoklátsko Protected Landscape Area into the proposed Křivoklátsko National Park in the Czech Republic, which is a program promoted by political parties. Using the quintuple helix model, it assesses the change from a sustainable development perspective. The analysis considers economic, social, and environmental aspects, including the impact on the local inhabitants, the economy, forestry, business activities, and regional development. The existing management in the Křivoklátsko region exemplifies sustainable multifunctional forest management. Based on the evaluation, the study finds insufficient arguments for declaring the Křivoklátsko National Park. The study emphasizes the need to balance the social demand for nature protection with the awareness of existing measures and specific area conditions. Nature protection should integrate itself into all human activities within the culturally and historically created landscape, rather than solely pursuing political goals. Participatory forestry management plays a crucial role in landscape transformation. The study highlights the importance of sustainable landscape development and the interactions between the university, government, industry, and civil sector actors with the environment.

Keywords: participatory management; quintuple helix; national park; landscape sustainable development; circulation of knowledge



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1. Introduction

The Sierra Club popularized the in situ nature conservation concept in which John Muir advocated for the preservation of wilderness [1]. The establishment of the International Union for the Conservation of Nature in 1948 institutionalized the idea internationally [2]. The Convention on Biological Diversity defined a protected area as a geographically bounded area managed to accomplish specific conservation objectives [3,4]; it put the nexus between biodiversity protection and nature conservation on the agenda at an international level. In parallel, protected areas became the most important strategy for representing species diversity [5] and protecting landscapes [6]. The high relevance of protected areas in scholar and practitioner discourses led people to broaden the original two functions of protected areas. First, the governance of protected areas might lead to the sustaining of healthy functioning ecosystems [7], strengthening the ecological integrity of ecosystems [8], and promoting cultural heritage sites [9] and religious sanctuaries [10]. Second, using protected areas in order to compare the effects of human activity on the environment [11,12].

In forestry, the diverse functions of forested protected areas have stimulated debate about conflicts arising over the proper management of wooded landscapes [13,14]. Therefore, management of protected areas should include natural and cultural aspects in management decision-making procedures [15]. Therefore, different assumptions regarding

the biocentric and anthropocentric paradigms about preferred values of forests [16,17] have sparked conflicts over forest use. While proponents of the biocentric paradigm avoid the functions of timber production and emphasize preserving the integrity of forested areas derived from aesthetic, spiritual and ecological values [18–20], proponents of the anthropocentric paradigm include representatives of the timber industry, who perceive conservation and biodiversity strategies implemented in protected areas as limiting their economic activities [21–23].

Various variables influence biocentric and anthropocentric forest management advocacy [24], including urban and extra-urban origin [25], soil erosion and environmental pollution in a geographic region [20], land ownership structure [26], mining characteristics [27], and public knowledge about forests and practices used in forests [19]. Conflicts stemming from different human values have led to various interactions and strategies of forest management [28]. The human values themselves are more complex and transcendental than material resources allocated to forestry [29] and often form a matrix structure [19]. While intrinsic values are nature-oriented values [30], which assume that the forest should exist on its own [31], utilitarian values are person-centered beliefs that the forest should be managed to meet human needs and achieve a predetermined goal. Utilitarian values are predominantly egoistic and have led to the provision of ecosystem services [32]. The latest scientific discourse also includes the relational value capturing civil society's relationship to the natural world [33]. These kind of values show that the general population may have more complex attitudes towards forest management than professionals in the forestry and timber sectors [28,34]. The relational values approach takes the complexity of interactions between non-professional forest users that could affect the forestry and timber sectors into account, including social and altruistic values [35] and cultural values [36] that could provide new ideas for conservation management [37].

Participatory management effectively delivers social and economic benefits for local communities. This concept includes the active involvement of local communities in the decision-making process of natural resource management and has relevance for using in land use and in the protection and sustainable use of landscapes, national parks (NPs), and forest park areas [38–41]. Implementation of participatory management policies has been shown to have numerous other benefits, such as improved resource conservation outcomes, increased local support for protected areas, and support for the empowerment of local communities [39,42,43].

The emphasis on nature conservation and the very establishment of a national park (NP) provides economic benefits to the local community through the development of tourism-related businesses and the creation of jobs [44,45]. National parks are a category of protected areas administered by the state and reserved for the conservation of natural, cultural, and recreational resources. The category is an element for biodiversity conservation and also provides economic and social benefits to communities. However, the establishment of a national park also might have negative impacts on the local community, which includes the displacement and loss of access to the natural resources, increased traffic in the local area, and noise pollution [46–49].

The concept of a national park is often described in terms of three pillars of sustainability: ecological, economic, and social. The ecological pillar refers to the importance of national parks for biodiversity conservation and the protection of natural resources. The economic pillar refers to the economic benefits that national parks can provide, such as tourism and recreation. The social pillar refers to the social and cultural value of national parks, including the role they play in education and promoting community well-being. Assessing the performance of national parks in relation to these three pillars is important to ensure that they meet their conservation and sustainability objectives. Many different methods have been developed to assess the ecological, economic, and social impacts of national parks, including both quantitative and qualitative approaches [50].

With reference to the three pillars of sustainability, the aim of this text is to analyze the impacts of the transformation of a part of the current Křivoklátsko Protected Landscape Area (PLA) into the Křivoklátsko National Park [51]. It uses a conceptual framework created on the basis of the quintuple helix model. In particular, this paper quantifies interactions between the national political actors and the efficiency of participatory management to influence the declaration of a national park. It aims to answer the following questions. (1) What are the main reasons for declaring a national park in the geographical area? (2) In what manner does the declaration of the Křivoklátsko National Park align with the goals of sustainable landscape management? The analysis also assumes a role as an evaluation of the current state and expected development in the affected area from socioeconomic aspects, including ecological and broader environmental aspects, based on the analysis of the collected data and an evaluation of the use of participatory management in the declaration of the Křivoklátsko NP; more specifically, to carry out an analysis of the impact of the change in the degree of protection of the territory on the local population and other users of the territory, as well as the infrastructure, and the overall development of the region and the individual systems, as presented in the quintuple helix model.

The identification and evaluation of forestry characteristics of the area of interest and their long-term development, cost–benefit analysis, economic efficiency, subjects within forestry, and analysis of social impacts are also important aspects of this paper. These aspects are derived from analysis of the financial inputs, i.e., the costs of the possible implementation of the proposed change in the protection of the territory by establishing a national park compared with the current state of protection, related to the changes in management, the use of the wood production function of the forest, demands on the government budget, and other induced costs. In practice, the results should thus serve as a basis for decision-making needs in the given territory according to the specific conditions of the proposals. In further research, it is also possible to find differences in the perception of the benefits of the NP declaration over time from the perspective of both the local governments and residents in the area.

The proposal to establish a national park (NP) is not new in the area in the region. In the past, several variants of the NP of different sizes were designed in the Křivoklát region. The relevant territory is specific in that it is located near the capital of the Czech Republic (Prague) in the center of Europe [52,53]. The proposed area is relatively densely populated, with an above-average density of settlements in the vicinity, with a current significant recreational load already and an above-average number of recreational facilities on the edges of and inside the forest parts. The forests in the given area are, to a large extent, valuable in many aspects from the point of view of nature conservation, but created within the framework of sustainable multifunctional forest management by existing sensitive and near-natural forestry approaches. At the same time, they are very strongly influenced by human activities, but they also fulfill a number of essential ecological production and environmental functions, not only due to the natural protection function. As can be seen from Figure 1, the proposed park has very rugged boundaries, as private landowners in the vicinity do not agree with the designation of a NP and do not want their land to be incorporated into the national park. More than 90% of the area is forest land owned by the state, where two state-owned enterprises have the right to manage it.

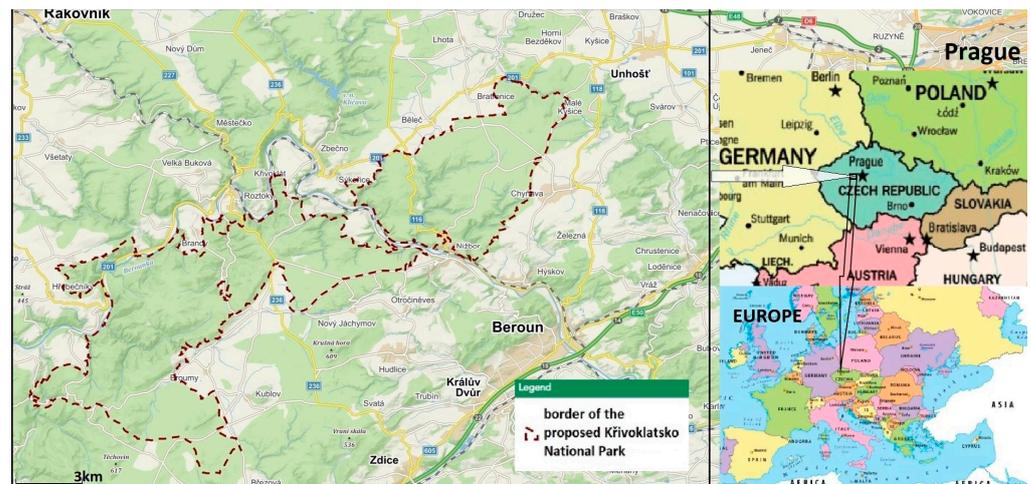


Figure 1. Borders of the proposed Křivoklátsko National Park (custom processing with use [54]).

From a historical point of view, it was a popular hunting place for Czech princes and kings from the 12th century, and all interest in the area was mainly focused on its hunting use. This has changed significantly since the 17th century, when the forests already started to be intensively exploited. Hundreds of years of exploitation of the Křivoklát forests have left almost no original natural forest ecosystems in place [55]. The historical data show that, since the end of the 17th century, there are mostly no original stands left except stands that have been significantly influenced by man, including the changed and established stands. This has been confirmed by the assessment of the territory according to the Decree of the Ministry of the Environment No. 64/2011 Coll., from which it follows that there is no natural forest in the area and only 13% of the territory is near-natural forest. Human economic activity is, thus, evident in 87% of the area of the proposed Křivoklátsko NP, but the remaining 13% of the area is also influenced by man. The Křivoklát forests, cultivated by man for centuries, have a high aesthetic value and are undoubtedly part of the cultural heritage of this landscape unit. Leaving them to natural development on a large scale would probably mean the gradual disintegration of the forest stands and cause a change in the appearance of the Křivoklát forests, including the risk of biotic pest development.

2. Materials and Methods

The rationale for the evaluation was to look at the benefits and potential losses associated with the establishment of the NP by carrying out an analysis. The analysis includes a comparison with the current situation, especially concerning the use of the landscape, taking changes in the management, organization, and management of the given territory, and the use of the social functions of the forest into account using the framework of the quintuple helix model.

2.1. Input Data

This analysis is based on the national databases of input data and information from the field of nature conservation, public administration, forestry, demographic status, socio-economic parameters, and other data, which were publicly available or obtained on the basis of requests from various entities. These included forest management plans, stand maps, economic data and other data from the current forest managers (Czech State Forest, Military Forests, and Estates of the Czech Republic), economic data from existing national parks in the Czech Republic, maps and other data from the Ministry of the Environment [51], the Nature Conservation Agency of the Czech Republic and the Regional Authority of the Central Bohemian Region, data from the statistics of the Czech Statistical Office, legal regulations (laws and decrees) concerning the issue in question, and reports on the state of forests and forestry [56].

Field research was another source of information. It was carried out in the form of quantitative research in municipalities, namely a sociological survey of the inhabitants in the area in the form of a controlled interview, where 356 interviews were conducted, focusing primarily on the interviewees' opinions on the expected change in the protection of the territory from the current state to a national park. Furthermore, qualitative research was carried out with key stakeholders in the affected area in the form of in-depth interviews with representatives of the majority (16) of the municipalities whose cadastral territory is in part of the NP, forest managers from the company Lesy České republiky, s. p. (Czech State Forest, SOE), Vojenské lesy a statky ČR, s. p. (Military Forests and Estates of the Czech Republic, SOE), employees of the Regional Authority of the Central Bohemian Region, and employees of the existing National Park Administrations. Moreover, further meetings with employees of the Nature Conservation Agency, the Ministry of the Environment, sociologists, and representatives of the Křivoklátsko Forestry Park the Czech Statistical Office, and the Institute for Forest Management were also included.

In addition to the analysis of the natural stand and ecological conditions in the given territory, a study of the socioeconomic and ownership conditions was also an important part of the methodology.

In its current form, the proposed Křivoklátsko National Park has an area of 116.4 km², making it the third largest national park in the Czech Republic. The previous variant of the NP proposal from 2010 was with an area of 102.24 km² and included the urban area of a single village—Karlova Ves [57]—which did not agree with the declaration of a National Park and, therefore, the urban area was excluded. This is also evident from Figure 1 as a dedicated site in the central part of the NP. At the same time, the new proposal was extended by the northeastern part.

2.2. Methodology

A methodologically important part of the project was the qualitative analysis of the historical development and causes of the current existence of a unique multifunctional forest ecosystem in the given territory and the comparison with the design of the Křivoklátsko NP. The analysis, thus, includes an evaluation of whether another form of nature protection (the proposed Křivoklátsko NP) in this area is able to bring a possible higher or different effect than the current result achieved by the existing multifunctional and carefully managed cultural landscape. It combines several existing methods of nature protection, such as National nature reserves, nature reserves, UNESCO biosphere reserves, protected landscape areas, bird areas, and site of community importance [58], but also the Křivoklátsko Forestry Park. In several places, there is also a combination of the above with monument protection.

For the evaluation of economic impacts on forest management, the volumes of harvested timber and the prices for the individual ranges of wood in the individual years are crucial. Due to the large bark beetle calamity in the Czech Republic, there have been significant fluctuations in the volume of harvesting and the prices of individual timber assortments, especially since 2017. At the same time, there has been a significant decrease in timber prices, with the lowest value occurring in 2020; but, on the other hand, prices were significantly higher in 2022 than the average over the last 15 years [59,60]. In order to eliminate the fluctuations in prices and quantities of harvested wood, the period 2011–2015 was chosen for the economic evaluation, when the average prices and volumes of harvested wood were achieved and their use thus better reflects the average management of the individual organizations.

For the evaluation of the changes, it is also very important to analyze and evaluate the economic impacts of the proposed change in the protection of the territory in the form of an NP in the given region, which is methodologically solved as follows:

1. Comparison of the alternatives to the land use by conventional sustainable forest management versus the protection of natural processes taking place in the relevant area without the use of biomass or other forest products. This means a comparison of two variants of management:

- (a) An evaluation of current forest management, including:
- Quantification of the monetary value of the management result from classical sustainable forest management, which is based on the harvesting possibilities of the relevant approved forest management plan (FMP), taking the existing nature conservation constraints into account. In this case, the calculations already reflect the current limitation of the amount of mining by nature conservation as stated in the approved FMP. The average prices of the assortments of the respective region at the removal point for the selected average period are used for the calculations, according to the data of the Czech Statistical Office;
 - Definition of any possible other economic side effects from the regime of the territory by classical sustainable forest management, i.e., especially tourism, commercial hunting, and other areas.
- (b) A variant of potential nature protection in the form of management exclusion and its economic impacts based on the definition of commercial areas that will be possible in the “national park” regime in the area, in the following variants:
- An increase in the non-intervention areas to 75% (NP as IUCN category II protected area);
 - An increase in the non-intervention areas of farming (in the case of the establishment of an NP, a reduction in mining by about 50%).

2. An evaluation of the economic demands (contributions of the founder from the government budget) for the operation of the Křivoklátsko NP in the event of its announcement. The methodology of the solution is based on the financing of current NPs in the Czech Republic, taking the economic effects from the point of view of the state into account (the amount of the expected induced costs that will have to be covered from public sources—the government budget) based on an analysis of the costs incurred for the current national parks in the Czech Republic.

For the calculation, and as a possible cost of the government budget, only contributions from the founder (the government budget) are considered as the most meaningful value having a direct impact on the government budget. NPs also have incomes from their own activities, which are dominated by the sale of timber. The proposed Křivoklátsko NP is also expected to carry out mining with similar intentions as in other existing NPs. The estimated costs of the NP were calculated on the basis of the share of the state contribution to the employees in the individual existing national parks.

The expected number of employees of the national park (for the territory of the NP) is determined in two potential variants in the number of employees:

- Minimum number of employees—based on the recalculated area per employee from the average of all the existing NPs, of which the two largest parks differ significantly in size from the proposed NP Křivoklátsko (they are 3–6 times larger);
- Maximum number of employees—based on the average area per employee from the two NPs closest in size to the proposed NP (around 60% of the size of the proposed national park).

The contribution from the founder seems to be optimal for setting the requirements for the government budget. The calculation also takes the reduction of the government budget costs for the existing PLA into account by deducting the costs of employees of the existing Křivoklátsko PLA due to the reduction in the area of the Křivoklátsko PLA by declaring the NP.

3. Environmental problems are very complex and uncertain, relating to different geographical scales and institutions [61]. The use of the quintuple helix conceptual trans-disciplinary model is useful for a comprehensive assessment of the potential NP territory and balancing the creation and sharing of new knowledge in NP reporting in accordance with the socioeconomic sustainability of the environment. The use and combination of these 5 social systems is presented in the following chapter. Within the framework of the quintuple helix model, it is possible to consider a number of questions further regarding the

formulation and implementation of a regional strategy for smart, sustainable, and inclusive growth [62].

2.3. Quintuple Helix

The quintuple helix model emerged as an evolutionary economics model for studying the non-linear dynamics of technology and innovation. It is a conceptual model that can be used, among other ways, for capacity building in socioecological systems [63–66], which contributes to the protection and development of the natural capital of the landscape and the harmonization of sustainable development objectives. It defines five social systems relating to education, economics, politics (self-government), civil society, and the environment. The central element for achieving further progress is knowledge, its content and nature, the process of its formulation, and the dynamics of knowledge exchange based on the type of social interactions. Knowledge and innovation are therefore important, not only for the economic performance of the region, but also for the development of the region as a whole.

“Ecology and environmental protection represent a necessity and challenge for humanity, but they also act as drivers for further knowledge and innovation.” [59]

The innovation process takes place through interactions among diverse actors. In the field of regional science, the outcome of an innovation process is strongly influenced by the geographical (specifically regional) context and institutional arrangements [67].

The model enables analysis and explanation of the creation and circulation of knowledge and how this process leads to the promotion of the sustainable development of society [68,69]. Each of these systems contributes to the creation, dissemination, and application of knowledge in a specific socioeconomic context. The quintuple helix underscores the socioecological perspective of the natural environments of society [70].

When adding new knowledge, there is a change in the input of knowledge for another sub-system.

The application of the quintuple helix model thus helps to solve the fundamental question of how to balance the creation and sharing of new knowledge in the long-term declaration of the NP in accordance with the socioeconomic sustainability of the environment in the comprehensive assessment of the potential NP territory.

The model presumes five social systems for interactions and knowledge exchange (Figure 2):

- The education system related to human capital in research and education. That is, students, teachers, scientists and researchers, and academics;
 - The economic system contains economic capital in the form of business, products and technologies concentrated within industry, companies, tourism services, finance, etc.;
 - A natural environment system whose capital consists of natural landscape resources such as plants, animals, and other organisms and their interconnections;
 - Media-based and culture-based public—the civil society system combines cultural and social capital, and relationships to media and information. Social capital is primarily made up of cultural traditions and values. Information capital consists of information sources, information systems, intelligence, communication, and social networks;
 - A political system that includes ideas, laws, plans, and policies that make up the political and legal capital together. These systems and their mutual links can also be used to visualize the dynamics of the process of knowledge creation and transfer [71].
- This transdisciplinary framework used for the analysis provides an explanation for the production and circulation of knowledge. This process not only leads to the circulation of knowledge between individual systems, but this exchange of knowledge also contributes to supporting the sustainable development of society, the creation and emergence of innovations, and the implementation of new procedures in practice [72].

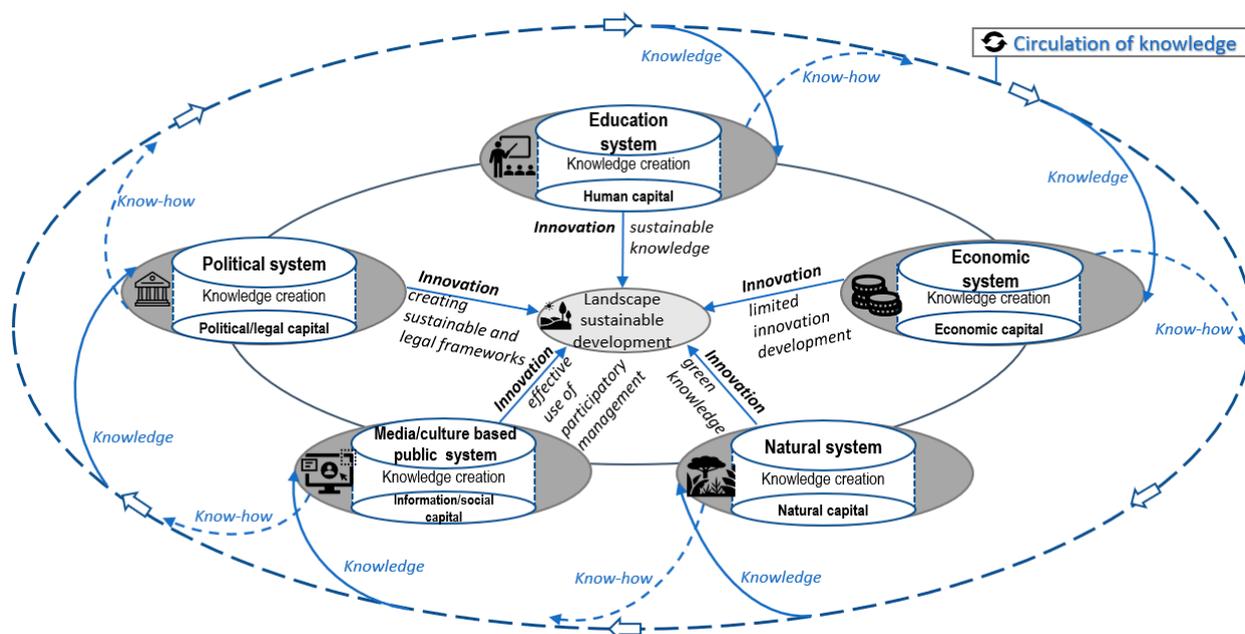


Figure 2. The quintuple helix model and its functions. Modified with using [71], based on [72].

The quintuple helix model offers a valuable framework for understanding knowledge creation, diffusion, and contribution to sustainable development [71,72]. However, some limitations should be considered. First, the model assumes a linear relationship between knowledge creation and sustainable development goals. While knowledge and innovation are key, sustainable development is complex, involving trade-offs and different perspectives. A more nuanced approach considering dynamic feedback loops would increase the model's ability to capture the complexities of sustainable development.

Moreover, the regional focus of the model may overlook the global nature of knowledge creation and exchange. Knowledge often transcends regional boundaries in an interconnected world, and global collaboration can be essential. Neglecting the global dimension limits the model's generalizability and ignores cross-regional knowledge flows and international cooperation. But it is very suitable for regional assessment of the possibility of changing management in the countryside and complements other types of socioeconomic assessment.

The model further assumes a similar share and contribution of all social systems regardless of possible power dynamics, institutional barriers, and resource inequalities [67]. Recognizing asymmetries and imbalances between systems would provide a more realistic representation of knowledge dynamics. Despite these limitations, the quintuple helix model is valuable for analyzing knowledge creation and its impact on sustainable development [68,69]. By acknowledging and addressing limitations, it is thus possible to refine the model's scope and increase its utility for knowledge-driven sustainable development.

3. Results

3.1. Economics of Contemporary Forest Management

In the area of the presumed Křivoklátsko NP, on average (except for the bark beetle calamity), over 35,000 m³ of wood mass is harvested annually, which is further used in the woodworking industry. Two state-owned enterprises hold the decisive influence with regard to the area. These two entities had an average annual profit of EUR 704,000 (i.e., EUR 63.2 per hectare of forest land) over the monitored periods. This value is already burdened by cost items enforced by the state for nature conservation reasons. Only the costs for these activities were quantified in the management of the monitored organizations, but revenues

in the form of governmental subsidies for these activities were not reported. Excluding these items, the gross profit would increase to EUR 801,500.

Revenues from wood matter make up more than 77% of income in forestry; 67% coniferous wood and 33% deciduous timber are harvested in this area. In forest regeneration, this ratio almost reverses, to 32% conifers and 68% deciduous trees, which gradually changes the species composition of the existing forests in favor of deciduous trees. However, due to the longevity of the forest stands, this is reflected in the species composition more slowly, because it is renewed annually only in under 1% of the area of all the stands. In the future (in several decades), this will also have an impact on the management of the fall in economic results by EUR 72,600 per year. An interesting finding is the positive management in hunting, which is around EUR 142,000 per year.

Due to the small area within the proposed NP, the profits of other owners are, on average, around EUR 5000 per year.

3.1.1. Variant after Increasing the Non-Intervention Areas to 75% (NP as IUCN Category II Protected Area)

A variant with an expected 75% reduction in the mining activities, but a related reduction in the direct costs of cultivation activities by 35%, was also calculated. In this case, taking the above-mentioned overhead costs into account, an annual loss of EUR 516,000 would arise in the NP's area, increased by other operating costs of the NP itself.

In fact, already today, mainly for reasons of nature conservation, the potential mining activity has been reduced by 39%. If this amount of wood were harvested, the annual profit would increase by EUR 131,800 compared with the current value, which means that the current owners already respect the views of nature conservation and bear this loss on the management side.

3.1.2. Variant after Increasing the Non-Intervention Areas of Farming (in the Case of NP Mining Reduction by about 50%)

If the extraction were limited to 50% of the current level, the volume of the cultivation activities in the direct costs would also be reduced by 25%. At the same time, the NP would show an annual loss of EUR 242,000 from the forest management.

3.2. Calculation of the Costs for the New Křivoklátsko National Park

The calculations are based on the quintuple helix model as a conversion of area per employee from the existing four NPs in the Czech Republic. The average values for the selected period of five years eliminate any fluctuations in the economy in the individual years.

It can be stated that, in the Křivoklátsko area, the operating costs of the Křivoklátsko PLA will remain at a similar level and only the wage costs will change, while, according to the assumption, the reduction in the current area of the PLA from 628 km² to 511.6 km² will cause a reduction of two PLA employees.

If we proceed from the average costs of the Křivoklátsko PLA, then the expenditure from the government budget for the PLA would probably decrease by EUR 30,300 (taxes of two employees). The remaining approximately 10 employees would remain employed in the administration of the PLA, which would now belong to the Nature Conservation Agency of the Czech Republic and which would perform the state administration on the territory of protected landscape areas and professional support for the performance of the state administration in the field of nature and landscape protection. IBOs are entitled to carry out state administration only in their territory and the funds in their budget are designated for this.

However, it is likely (e.g., according to the draft law on the declaration of the Křivoklátsko National Park from 2013) that the Křivoklátsko NP Administration will carry out the state administration in nature and landscape protection in the rest of the Křivoklátsko PLA. In this case, the costs of the Křivoklátsko NP administration would be even higher than the current costs of the Křivoklátsko PLA (excluding the above-mentioned costs for

two employees), and they are not calculated as a new expenditure of the government budget, because they are already being spent on the Křivoklátsko PLA. The average area per employee calculated from all the NPs is in the amount of 179.54 ha/employee. If we calculate from two national parks of similar size, the average area per employee would be 154.36 ha/employee, the so-called “maximum variant of the number of employees”. From these values, after conversion to the area of the proposed NP, the expected number of employees ranges from 65 to 75 employees. The recalculation of the expected number of employees and the calculation of the contribution from the founder was carried out, as stated in the methodology, in two variants (Table 1).

Table 1. Expected demands on the government budget (contribution from the founder) annually for the proposed Křivoklátsko NP.

	Number of Employees	Average Contribution (EUR/Employee per Year)	Average Contribution from the State (EUR /Year)
Prerequisite according to other NPs	65	31,874	2,071,833
Premise according to similar parks	75	31,874	2,390,576

At a minimum, there would be claims on the government budget (contribution from the founder) of the amount of EUR 2071 million per year per NP with an expected number of 65 employees. When calculated according to the two existing NPs of similar size, the contribution from the founder (state) would be EUR 2391 million per year with an expected number of 75 employees. Overall (after taking the delimitation of the existing two employees of the PLA into account, who will come under the administration of the national park), the demands on the government budget (contribution from the founder) will increase to at least another EUR 2041 million per year in the case of the variant of the lower number of employees and, in the case of the number of employees based on similar NPs, by EUR 2360 million per year.

The investment costs for the purchase and reconstruction of the building next to the existing building of the administration of the PLA are expected to exceed EUR 1116 million [73], but, due to the increased prices of real estate and construction work, they will be at least 50% higher.

3.3. Forecast of the Demographic Change and Employment in the Downstream Sectors

Due to the non-inclusion of urban areas in the NP, it is not expected that the proclamation of the NP will have a significant impact on business entities in the region. About 30% of the visitors use chalets and cottages, of which there are more than 4500 in the region, which significantly reduces the need for accommodation capacities. It is the users of these chalets and cottages that make up a significant part of the so-called “person visits” to the forests, who also prefer the current state where they can move freely in the forest stands and collect forest fruits. At the same time, some municipalities have problems with the supply of sufficient drinking water, which is also a limiting factor for the construction of other accommodation in the region. Due to the current almost triple and substantiated attendance of castles in the region, better promotion would contribute to an increase in tourism and the associated potential revenues of entrepreneurs, which would bring a significantly higher economic effect than the declaration of the NP. In the last three years, during the COVID-19 pandemic and the inability to travel abroad, the Křivoklát area was frequently visited due to its proximity to Prague, and the infrastructure and residents were overwhelmed with visitors.

3.4. Forecast of the Demographic Change and Employment in the Downstream Sectors

The use of the quintuple helix model, thanks to the division into individual systems, allows for the assessment of the impact of the eventual creation of the national park on the dynamics and interconnection of knowledge and the creation of innovations, as described in

the previous chapters. The figure below shows a visualization of the identified mutual relationships and results related to the sustainable development and innovation potential of the given area in the case of the declaration of the Křivoklátsko NP. From this, understanding the basic interconnections between the individual systems is possible (Figure 3).

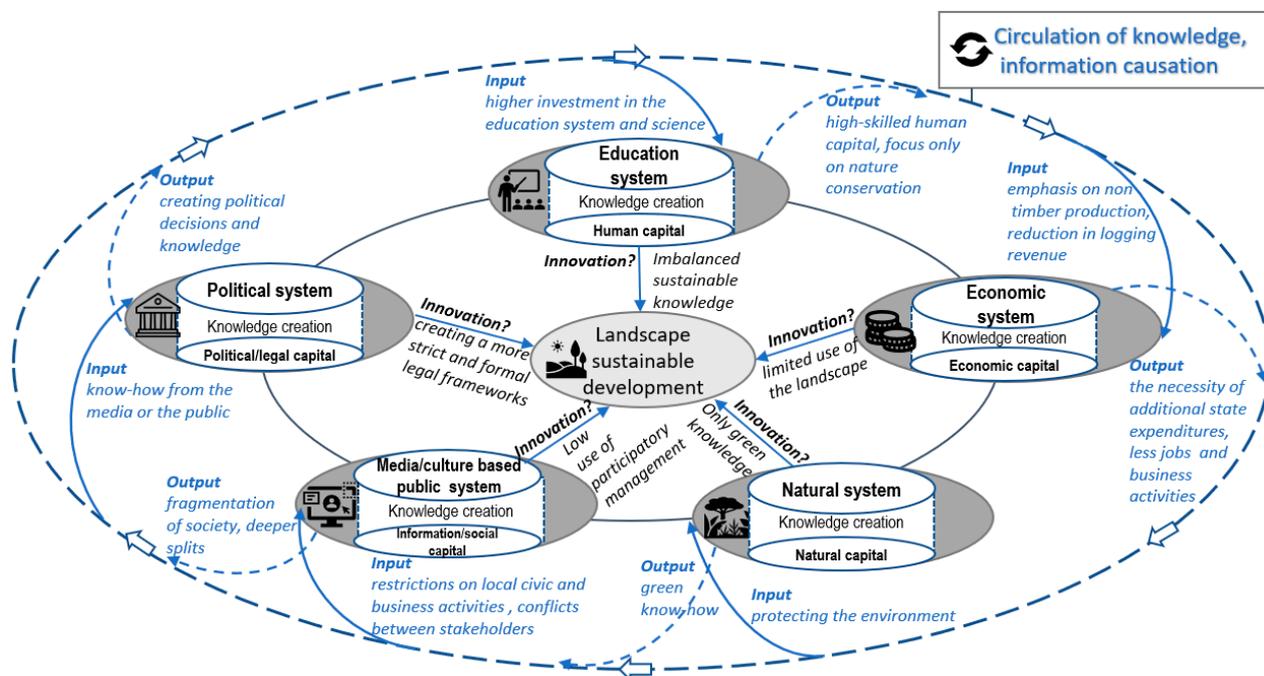


Figure 3. Quintuple helix linked to the innovation potential of the Křivoklátsko National Park. Own creation with use [71].

A more detailed description of the different systems and changes in their relationships, and individual inputs or outputs, with an impact on the possible innovations is given below.

3.4.1. Education System

When more investments flow into the helix of the education system to support environmental research and sustainable development with a view to the creation of a possible Křivoklátsko NP, the five-fold helix model shows creation of new impulses and proposals for new knowledge in education and research, especially in the field of nature conservation, for example, as targeted investments creating new equipment, new places for conservationists, scientists and teachers, and increased opportunities for research in the field.

This will increase the possibility of studying ecosystems in a near-natural state, especially for natural scientists. Another option is the development of environmental education and awareness-raising activities, but this is currently ensured due to the occurrence of other options for protecting the territory (such as national nature reserves, PLAs) and a forestry park. The advantage could be a shorter transport distance for naturalists from Prague, and thus better transport accessibility for scientists.

The results achieved on the basis of research concerning the territory of the NP under consideration can subsequently be mainly published in foreign scientific journals and possibly used in environmental protection. On the other hand, the knowledge and experience of forest management in this cultural and human-influenced landscape will be forgotten.

Probably due to the fact that this is only one pillar of use in the landscape—ecological—for the territory declared a NP, these investments in teaching and research will probably not increase the efficiency of the land use for the whole society, but only for a selected part of it, especially ecologists and conservationists who will thus receive more money for

their research. In particular, investment in education should have a positive impact on the human capital as a manifestation of the output of the education system, which would be usable for the development of society and its efficiency. Investing an increased amount of financial resources in education and environmental research should ideally subsequently increase the efficiency, and enable the human capital to realize opportunities and target their subsequent use, and not only limit itself to nature protection, but also to the sensitive use of the landscape of society in this area, which is already happening. The output that arises from human capital for greener development or sustainable landscape development is, in turn, also an entry into the helix of the economic system.

3.4.2. Economic System

It can be expected that the establishment of the NP will strengthen the natural protection function, including biodiversity, at the expense of the social and economic functions of the forest.

At present, however, an average of EUR 708,700 of annual profit is achieved in forest management (i.e., EUR 63.26 per hectare of forest land), taking the requirements of nature conservation into account, which increase the costs but not the revenues, which makes the potential annual profit of EUR 97,500 per year lower than would be achieved without the restrictions on the management by nature conservation.

In the case of the national park variant with an increase in the area of non-intervention areas, it is expected to reduce logging by about 50% in the future, which would result in a loss of EUR 242,000 per year in the given area. This means that we would lose EUR 829,000 compared with the current situation due to the announcement of the NP.

If Krivoklátsko NP is declared as a protected area of IUCN category II and the increase of the non-intervention areas of farming to 75% occurs in the future, the amount of mining would be at the level of 25% of the current annual level, resulting in an annual loss of EUR 516,000 per year, increased by other operating costs of the NP itself, which would cost EUR 1227 million per year in land use.

In fact, already today, mainly for reasons of nature conservation, the potential mining activity is reduced by 39%. If this amount of wood were harvested, it would increase the annual profit compared with the current value by EUR 131,900, which means that the owners or farmers already respect the opinions of nature conservation and, thus, bear the above-mentioned loss on farming.

When the NP is declared, a new state organization (the administration of the Krivoklátsko National Park), dependent on the government budget, ceases to exist. In addition to the above-mentioned losses from the sustainable landscape management, the new organization will be economically dependent on the government budget, where, based on the analysis, the cost from the government budget is expected to range from EUR 2071 million to EUR 2391 million per year. A total of 65–75 people will be employed in the administration of the NP. Additional investment costs associated with the establishment of an IBO of at least EUR one million are also expected.

At the same time, the announcement of the NP would cause the economic results to be lower by EUR 142,000 per year from hunting, as the hunting associations have over 300 members.

From the above economic point of view, it follows that the economic capital (potential) resulting from the current sustainable management would be significantly reduced. The increase in revenues by declaring the NP for business activities in the region seems to be insignificant, which is confirmed by representatives from various fields, including entrepreneurs in the hospitality industry. A significant impact of the NP declaration on business entities in the region is not expected, with the exception of entities in forestry.

As new knowledge enters the helix economic system through human capital in the quintuple helix model, the value of the knowledge economy should consequently increase, and the use of production facilities and opportunities enabling sustainable development and a future-oriented knowledge-based bioeconomy should be stimulated through the

dissemination of knowledge. The knowledge grid will bring new types of jobs to the economic system—in the NP management—but the use of renewable wood raw material will be significantly reduced. There will also be no such emergence of new services and impulses that also mean the development and economic growth, or increased sustainability in landscape management or better harmony between humans and the landscape. The designation of a national park is unlikely to increase the know-how, which would be unique or stimulate the emergence of new innovations that would increase the sustainability in the territory of the new park.

3.4.3. Natural Environment System

As stated, it is unlikely that the designation of a national park will increase the know-how from an economic point of view and the emergence of innovations that would increase the sustainability, which is supposed to be the main output from the economic system and an investment in the natural environment system. On the other hand, from a scientific point of view, the area where it is possible to study natural processes taking place without humans would be expanded in close proximity to the capital city of Prague.

According to the expected classification of the proposed NP into the second (II) level according to the IUCN, the non-intervention regime will be extended to 75% of the NP area, where the natural processes can subsequently take place and scientists can obtain new knowledge (i.e., create knowledge). However, this change may, for example, increase the risk of spreading biotic agents, which could spread from non-intervention areas to the surrounding forests and threaten their stability, as was the case with other NPs.

In addition, as mentioned in the landscape description of the potential park, the area is already part of the UNESCO biosphere reserve and is further protected by several different categories of protected areas: in particular, the categories of national nature reserves, nature reserves, protected landscape areas, sites of community importance, and bird areas, which also helps to generate and develop knowledge related to sustainable development. In addition, the “Křivoklátsko Forestry Park” has existed here for many years, which significantly combines both the interests of its own nature protection and the interests of the inhabitants, as well as the interests of multifunctional forest management, ensuring a comprehensive range of forest functions with the slogan “territory for nature and for people”.

In summary, the main objectives of the system concerning the natural environment, which is the use of the landscape in balance with nature and the use of available natural resources in a sustainable and sensitive way, are already being fulfilled in the current state by applying knowledge, especially natural sciences, which create new green know-how for people. This new know-how, as an output of the natural environment system, can provide people with greater environmental protection, but probably not a higher quality of life. Paradoxically, the declaration of the NP will contribute to an increase in CO₂ in the air compared with the current situation, because the wood mass will not be bound in products for a long time. The output of the system when the NP is declared would generate new knowledge that would be narrowly usable only by a small group of companies—scientists who would have a new study object in a cultural landscape that has been used for more than 800 years and with a very small proportion of natural forests.

3.4.4. Media-Based and Culture-Based Public

The output of the natural environment system is the insertion of new knowledge about nature and processes taking place in it without or with limited human intervention for the systems of the media- and culture-based public. That is why it is very important in the quintuple helix model to communicate with the actors in the landscape.

Today’s media-based public is given a new and essential function (i.e., information capital), which begins to spread information about the plan to establish the Křivoklátsko NP by the Ministry of the Environment, the Křivoklátsko Protected Landscape Area, and en-

vironmental associations or organizations that support the declaration of the Křivoklátsko NP, who are very proficient in using the media, including social networks.

Other actors directly affected by the establishment of the NP are also self-governments and citizens living in the area concerned, who will be directly affected by the declaration of the NP. In relation to the municipalities and their inhabitants affected by the possible declaration of the park, there is a lack of better communication and sufficient and demonstrable argumentation for the establishment of an NP.

This was also the reason for discussing the establishment of the Union of Municipalities of the Křivoklát Region on 1 November 2022, which was attended by 30 municipalities that have their cadastral territory in the NP. The union of municipalities of the Křivoklát region should express their common interest—disagreement with the declaration of the NP. “Although municipal representatives are trying to cooperate mainly with the Ministry of the Environment, they do not yet have sufficient information about the planned national park. At the same time, the declaration of the Křivoklátsko National Park would affect 30,000 local residents and thousands of related business activities that are important for the region”. “But it is not that we do not support environmental protection and that we would prevent the natural and cultural identity of the Křivoklát region”, said Lukáš Kocman, mayor of Běleč. “On the contrary, we are very interested in what the environment, where we live, will look like. After all, it is our homes that will fundamentally affect the eventual creation of the national park. But we want to know how and what will affect it, to what extent. So far, we have only a vague and ambiguous idea, because no one has given us specific information” [74,75].

The union of municipalities is, thus, a more suitable partner for unified communication with individual media than individual municipalities and their representatives. However, the form of their media appearance during the announcement is also important, as they do not have much experience when compared with other actors.

At the same time, sociological surveys were carried out (even by individual) municipalities about the possible establishment of the Křivoklátsko National Park, when the vast majority of their citizens expressed their opinion against its creation.

The view is that capital should provide a view of the landscape and create incentives on how to use the landscape ideally for the benefit of a selected group of actors or society as a whole in a conscious way (i.e., knowledge creation). This knowledge then supports the necessary social capital of the culturally based public, on which the society subsequently builds its sustainable landscape development. This social capital should transmit information about the citizens’ wishes, needs, problems, or attitudes as an output to politics or the political system. The output of media and public know-how should, thus, serve as a new input for the helix of the political system.

3.4.5. Political System

The entry of knowledge into the political system is primarily the know-how from the media or the public and, thus, represents collective knowledge from three other systems of society. Discussion of these new findings in politics appears to be important and is an essential impetus for policy-making and knowledge. Politicians should not only defend the interests of their political party or political program, but also think in a broader context, especially when they want to push through a change in landscape use, such as the declaration of a NP, which will exceed their time mandate several times and influence their decisions on landscape management for the next decade, even if the announcement of the Křivoklátsko NP is listed as one of the points in the government’s policy statement.

It is necessary for politicians not to succumb to lobby groups that defend only their own interests without being interested in sustainable management of the landscape as a whole. Politicians from self-government to the top level may have very different opinions and should listen to all the actors concerned by the NP declaration in this case, i.e., natural scientists, local authorities, citizens of the affected area, foresters, conservationists, entrepreneurs, and associations, and form a balanced opinion on the possible impacts of

the Křivoklátsko NP declaration and assess whether this will create a new, more suitable element (method) of landscape management, which will have greater benefits and potential for sustainable landscape management.

Within the political system, the resulting “political and legal capital” should be directed towards more efficient and sustainable landscape management. The output of newly acquired knowledge and know-how from the political system leads the circulation of knowledge back to the education system, the economic system, the natural environment and the media- and culture-based public.

4. Discussion

According to [76], there is no fundamental difference in the approach to subsidies between the administration of the PLA and the administration of the NP. NPs have a higher number of employees who deal with the preparation and submission of project applications. This finding corresponds to socioeconomic aspects of the geographical area for the proposed Křivoklátsko NP. Our findings indicate that the amount of subsidies for the Křivoklátsko NP will double compared with the current situation, but this often does not have a direct impact on the increase or decrease of costs from the government budget. This is confirmed by our methodology for calculating the state contribution to the IBOs.

(1) What are the main reasons for declaring a national park in the geographical area?

The results of other assessments indicate that participatory management has a positive impact on the socioeconomic well-being of the local communities around the national parks. The development of tourism-related businesses and job creation have contributed to an increase in income and a decrease in unemployment in these areas [44]. In addition, the involvement of members of the local communities in the decision-making process increased their sense of ownership and responsibility for the national parks, leading to a higher level of conservation efforts and less conflict over natural resources [38,40,77]. These results do not apply in our case, because almost all the municipalities are against the declaration of a national park, but, so far, the national political representation has not paid much attention to them.

The danger, if left to natural processes, may also be an increased possibility of spreading fires and the increased difficulty in extinguishing these fires due to the unmaintained forest transport network, as was the case last year during the large fire in the Czech Switzerland National Park. The poor landscape management by the National Park Administration was one of the main reasons for the damages..

However, the implementation of participatory management in protected areas is not without its problems. Some of the challenges identified in the literature include the need for effective communication and conflict resolution strategies, the development of appropriate territorial governance structures, and the recognition and integration of traditional knowledge and practices [13,41].

Other assessments have also identified some problems in implementing participatory management in the national park. One problem is the potential for displacement and loss of access to natural resources for some members of the local community [39,47,68]. It is important to assess and address these trade-offs carefully to ensure that the benefits of participatory governance are shared fairly among all community members [47,78,79]. Even these results cannot be confirmed in our case, because it deliberately delimits an area with very complicated borders, which avoids urban areas of municipalities, and so there will be no need for displacement. However, access to natural resources would certainly be reduced. Also, a problem will be the 4500 recreational facilities in the national park and clashes with their owners.

(2) In what manner does the declaration of the Křivoklátsko National Park align with the goals of sustainable landscape management?

Overall, evaluations suggest that participatory management can be an effective approach to the conservation and sustainable use of landscapes, protected areas, national

parks, and forest parks, but political representatives at the regional or state level must listen to and accept the local governments directly affected by the NP declaration. However, it is important to consider carefully the potential benefits and costs of participatory governance, as well as the challenges and best practices identified in the literature [16,18,35].

The danger may be, if left to spontaneous natural processes and ignoring warnings from local governments and foresters, an increased possibility of spreading fires and the increased difficulty in extinguishing these fires due to the unmaintained forest transport network in non-intervention areas, as was the case in 2022, when the largest fire in the Czech Switzerland National Park destroyed a significant part of this national park. The National Park Administration, in the poor management of the landscape, underestimated the prevention and ignored repeated warnings by local governments about the risk of fire due to the long-term drought and extensive dry vegetation near settlements and access roads, endangering the properties and lives of local residents and blocking access roads for firefighters, which subsequently happened. The fire spread uncontrollably, and it had to be extinguished very expensively by air with the help of international aid. The causes of the fire and the possibilities of its prevention are the subject of extensive discussions in the domestic press [80].

From the point of view of local entrepreneurs and economic impacts, it can be stated that the declaration of the NP will not increase their income, because more than 60% of the visitors are so-called “several hours” to “one-day” visitors. Only one-third of them are more than “two-day” visitors, and they still partially use chalets and cottages [81], of which there are more than 4500 in the region, which accounts for 30% of the visitors, and this subsequently significantly reduces the need for accommodation capacities. Users of these chalets and cottages make up a significant part of the so-called “personal visits” to the forests, and they also prefer the current state. These are some of the reasons why it cannot be assumed that the utilization and expansion of accommodation capacities would increase significantly. There is also a problem with the limits of the engineering infrastructure (especially drinking water sources), which is also a limiting factor for the construction of other accommodation in the region. Logically, in the case of the declaration of an NP, it should not be desirable to increase the number of visitors, but rather to protect nature. The nature protection constitutes a significant and prevailing contribution of the proposed Křivoklátsko NP for the fulfillment of sustainable landscape management in the CR. Last but not least, our analysis confirmed that the quintuple helix model is a relevant framework for assessments of socioeconomic aspects of landscape management for nature protection.

5. Conclusions

The interplay of all five systems in the quintuple helix should contribute to innovation and better, more sustainable landscape management.

It follows from the above findings that the announcement of an NP in terms of the individual systems of the quintuple helix model and their interconnection does not contribute to their interconnection.

The current Křivoklát forests are an example of sustainable multifunctional forest management, which preserves their production potential and, at the same time, increases the ecological value of the landscape. By declaring an NP, the knowledge of foresters who participated in the creation and preservation of these values would be lost, and this loss is also important from the point of view of the possible transfer of this knowledge to forestry in other regions. It is not possible to change the fact that the Křivoklát region is traditionally strongly influenced by human activities and that it is not possible to change the inappropriate shape of the national park under consideration due to the disagreement of private forest owners and municipalities that do not want to have an urban area in the NP. Municipalities and residents are satisfied with the current way of landscape protection in the region and do not want to change anything.

It can, therefore, be stated that, at the level of rational arguments, it is not possible to find a sufficiently strong reason for declaring the Křivoklátsko NP. A different situation

occurs on the emotional level, when the generally felt social need to protect nature is associated with insufficient awareness of the existing protection and the situation in a particular territory. For some politicians, it is more attractive to meet this perceived social demand relatively simply in the form of a relatively simple, quick and irreversible directive measure, such as declaring a national park, than to deal with all the impacts and evaluate their decisions.

It is clear from the above that the protection of nature and monuments cannot be an independent goal “per se”, but must become an essential part of all human activities in a given historically created cultural landscape. The result must necessarily be a landscape system consisting of natural and cultural values, but only in close connection with human landscape activities (see, e.g., [15]). This article presents a possible approach—a procedure to quantify comprehensively the impacts of plans related to a significant change in land use, such as the designation of an NP, and to help increase sustainable landscape management, which can also be applied to other proposed land-use changes. Such a fundamental decision as a change in land use should be evaluated using different methods.

Given the fundamental importance regarding the decision to declare the NP, it would be appropriate to carry out a possible comparison of land use in the form of a forestry park and a national park using other methods, such as a threats, opportunities, weaknesses, and strengths (TOWS) analysis using a confrontational matrix, and to carry out further sociological investigations of the attitudes to the declaration of NPs as self-governments after the explanatory campaign, as well as according to the population.

In summary, the quintuple helix model provides a valuable framework for understanding knowledge creation and dissemination, and its role in sustainable development. However, it is important to acknowledge the limitations of the model to refine and enhance its applicability. However, the delivered results have their limitations. The quintuple helix model does not capture the dynamics of innovation interactions between levels of governmental levels in the studied country [82]. The limitations include a possible linear assumption of knowledge creation and sustainable development, its regional focus overlooking global knowledge exchange, limited consideration of ecological factors, and the lack of explicit recognition of power dynamics and inequalities among social systems. Park and Stek proposed a revision of the conceptualization for social networks in the model [83]. The reconceptualization includes a precise operationalization of a number of new institutional actors captured in the model across countries and regions. Clarifying the role of the theoretical and methodological advancements developed in universities in the model is also needed [84]. The criticism of the quintuple helix model points out unresolved metatheoretical assumptions, including the essence of bounded rationality [85].

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Abbreviations

FMP	Forest management plan
NP	National park
NPs	National parks
PLA	Protected Landscape Area

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