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THE ECONOMIC EVALUATION OF WATER ECOSYSTEM SERVICES IN URBAN PLANNING IN NUR SULTAN, KAZAKHSTAN

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Abstract. *With the positive and negative consequences of rapid global urbanization, the main task of the state is to ensure the long-term quality of life of its citizens. Currently, reforms undertaken by post-Soviet states aimed at environment-related projects are facing increasing resistance and protest from local populations.*

In 2020, the authors of this paper carried out a study on the Maly Taldykol lake group, located in the south-western planning region of Nur-Sultan. The purpose of this work was to conduct an assessment of ecosystem services to inform effective management decisions in urban planning. A strategy of combined research methods was applied. Because of the lack of data, the challenge was to explain, summarize, and verify the data obtained by one method through the application of another method. Analysis of the data showed that the annual costs associated with the creation of artificial “islands of nature” through the expansion of green areas is 20 times less than the losses associated with the development of the territory of Maloe Taldykol and the consequential loss of natural landscape.

The results revealed that keeping these ecosystem services in their natural setting reduces the cost of providing these services in an alternative way, and avoids the negative impact of an ill-conceived decision. The uniqueness of this interdisciplinary study lies in the cost-benefit analysis of the findings of the assessment of ecosystem services, which result in the most effective management decisions in urban planning.

Keywords: *public management, ecosystem approach, urban planning, ESVD*

Reikšminiai žodžiai: *viešasis valdymas, požiūris į ekosistemas, miestų planavimas, ESVD*

Introduction

Changing lifestyles and increasing urbanization around the world have been placing increasing demands on natural resources for production and consumption. There is increasing demand for drinking water, clean air, a healthy environment, and the recycling of waste and waste-water. Meeting the high living standards and needs of urban dwellers depends directly on the ability to provide the natural benefits of the environment (Andersson et al. 2015).

The provision of a relatively high standard of living for urban dwellers has steadily decreased, according to TEEB (2010). This research highlights correlations between different dimensions of quality of life and analyses relevant causal relationships. These range from overt correlations such as the health benefits of the natural landscape to less obvious ones such as the cultural and aesthetic values of ecosystems for human spiritual enrichment.

The relevance of this study is dictated by the opposition posed by the residents of Nur-Sultan. The decision of the city authorities to drain and develop the territory of Lake Maly Taldykol was met with resistance expressed through various social networks (Facebook, Instagram, Telegram, and WhatsApp). The demands of the Initiative Group @ sos.taldykol to preserve the lake found support in the expert community and in public organizations in the city. A petition for the conservation of Lake Maly Taldykol bearing 3,140 signatures was addressed to Mr. Tokayev, Kazakhstan’s president, and it has been determined that this issue is one of the five most important problems facing Kazakhstani society (Otinish 2020).

Since the 1990s, the extent of research on the impact of urbanization on the environment has been expanded by scientific work on ecosystem assessment in many countries

(Likens et al. 2012). Urban quality of life has been found to depend, among other things, on the ecosystem services provided by natural landscapes (González-Oreja, Bonache-Regidor, and De La Fuente-Díaz-Ordaz 2010). To date, four categories of ecosystem services affecting people's livelihoods and quality of life have been widely used: provisioning; regulating; supporting; and cultural services (World Resources Institute 2005; Cowling et al. 2008; TEEB 2011).

However, Kazakhstan is barely represented in global research publications. The reasons for this include the lack of a legal framework in Kazakhstan on the use of ecosystem service accounting and the lack of its evaluation in the management decision-making process. The second phase of the BIOFIN, United Nations Development Program in Kazakhstan, ends in 2021. Its plan is to enshrine "forest ecosystem services" in the national legislation and develop methodological documents on the economic evaluation of ecosystem services (UNDP Kazakhstan 2021).

In studies published regarding Kazakhstan, the problem of reducing the area of existing natural landscapes in the territory of the Astana agglomeration is considered through the prism of the effective use of tourist and recreational potential (Chernysh and Kulenova 2019).

The purpose of this research is to reveal the possibility of the assessment of ecosystem services to justify effective management decisions in urban planning, with Lake Maly Taldykol as a case study.

In other words, the object of this study is the effectiveness of management decisions on urban planning in the city of Nur-Sultan, taking into account the ecosystem factor. Additionally, the socio-economic and public relations factors that affect changes in the state of the environment when making management decisions will also be explored.

The authors hypothesize that considering the valuation of ecosystem services in urban planning will improve the effectiveness of management decisions.

The starting point of this study is the assumption that the assessment of urban planning decision-making processes, in accordance with the principles of good governance, allows for the identification of weaknesses in governance and provides an opportunity to discover strategies to improve the management system.

Research questions

1. What is the value of the ecosystem services provided by Lake Maly Taldykol to the residents of Nur-Sultan?
2. What are the gaps in the integrated strategic planning and development of Nur-Sultan while preserving the natural ecosystems?
3. How can management decision-making in urban planning be made more effective?

Materials and Methods

This study was conducted in 2020 on the Maly Taldykol lake group, with an area of 6.02 km², located in the south-western planning area of the city of Nur-Sultan, in

the Republic of Kazakhstan. The authors used a combination of research methods and strategies.

Lake Maly Taldykol is a natural drainless water body of the Ishim river basin, which is located at the confluence of the Ishim and Nura rivers. The volume of water is 4.815 million m³, with an average depth of 0.8m and a maximum depth of 3.41m.

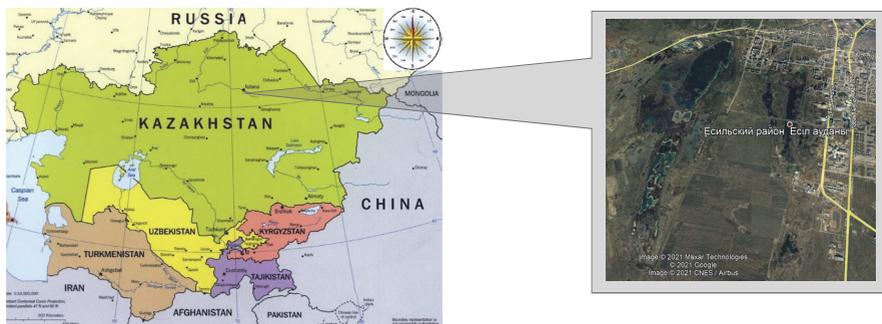


Figure 1. Research site.

Source: <https://www.maps-of-the-world.ru/asia/central-asia>

The identification of gaps in the management of integrated urban infrastructure development in the context of natural ecosystem conservation was performed by comparing the results of an assessment of aquatic ecosystem services with measures taken by city authorities to mitigate the risks associated with the reduction of natural areas.

A quantitative research methodology was applied by analyzing secondary statistics from the Ecosystem Service Value Database (ESVD) survey, which was conducted in 2012 and updated in 2020 (de Groot et al. 2012).

In addition, information on the current state of the biodiversity of the natural ecosystem was gathered through interviewing experts and consulting the results of their research (ACBK 2020)

Qualitative research was conducted via a content analysis of the strategic documents of Nur-Sultan's city administration. These are outlined in the "Concept of Entering the Capital into the Top 10 Cities of the World until 2050", which was approved by the Government of the Republic of Kazakhstan (2014). In addition, the Master Plan of Nur-Sultan city (About the Master Plan 2001), the Interregional Territorial Development Scheme of Astana agglomeration (Government of the Republic of Kazakhstan 2017), and the project of detailed planning of the Territory of Lake Taldykol (Akimat of Nur-Sultan 2020) were also analyzed.

The combined strategy was chosen due to the specificity of the problem and the objectives of the study. Because of the lack of current data, the challenge was to explain, summarize, and verify the data obtained by one method through the application of another.

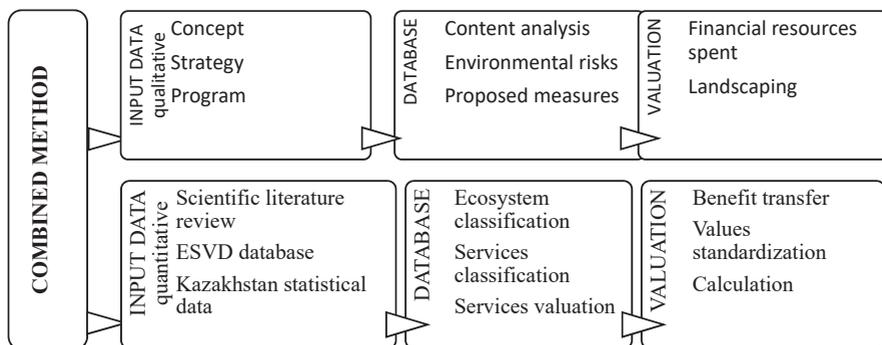


Figure 2. Methodological framework.

Source: Compiled by the authors.

A review of the applied quantitative methodology for evaluating ecosystem services revealed the currently widespread method of the integrated evaluation of ecosystem services based on the concept of value or benefit transfer (Frélichová et al. 2014). Value or benefit transfer methods facilitate the estimation of the benefits of ecosystem services for the well-being of humans (Liu et al. 2010; Wilson and Hoehn 2006). This method derives the values of the ecosystem from data that have previously been used to evaluate similar goods and services in a similar context (Liu et al. 2010).

The advantage of this methodology is that it is possible to carry out an initial assessment of ecosystem services under time pressures and financial constraints (Shrestha and Loomis 2001). The authors used the Ecosystem Service Value Database (ESVD) survey conducted in 2012 to assess the ecosystem services of Malaya Taldykol (de Groot et al. 2012). In our view, this data is representative because it is based on a review of more than 320 publications covering more than 300 case studies.

The values have been standardized into KZT per hectare per year using the inflation-indexed 2007–2020 USD exchange rate from the base year of 2012. Official current exchange rates (Stat Bureau, n.d.) and key economic indicators are used for these calculations.

Microsoft Excel was used for the economic calculations of the ecosystem services of the Taldykol lake system. The study area was divided into two categories. Category 1 includes the WBU of the Maly Taldykol lake system (its water surface and coastal area), and this area has the highest risk of ecosystem loss. Category 2 includes the WBUs of the Bolshoy Taldykol and Ulmes lakes (their water surface and coastal area).

In the course of this assessment, experts that were consulted concluded that both categories are interconnected as the loss of one area of the territory would lead to the gradual degradation and death of the other. For this reason, this assessment provides calculations for each category separately, as well as their cumulative value.

An important point to note is that this assessment is more ‘expert and averaged’ than it is based on hard quantitative data. On the one hand, it does not seem feasible to carry out this assessment in an area that has not been studied well. On the other hand, there are

not many unique places in Kazakhstan where there are natural areas within a city. In this case, this area is a habitat for more than 190 species of bird, eight of which are classified in the *Red Data Book* (2004). These conditions influenced the selection of the area for the assessment of ecosystem services and for the demonstration of the monetary value of the Taldykol lake system. The processing of monitoring-based data from experts on the conditions of the bird fauna in Lake Maly Taldykol provided the basis for determining the value of habitat services for birds. This calculation was made by accounting for the presumed damage caused by the loss of the natural ecosystem for birds and waterfowl.

Lake fish supply services were calculated using direct market pricing methods.

The results of the assessment of ecosystem services were also correlated with Meta-Regression Analysis (MRA) data from an assessment carried out in developing countries (Chaikumbung et al. 2016)

Analysis/Results

Within the framework of this study, the part of the natural ecosystem adjacent to and included in the Maly Taldykol group of lakes had an area of 1 460 ha (Category 1). The area including the natural landscape around the Greater Taldykol lake and Lake Olmes (Category 2) was 3 219 ha (see Figure 3). This approach is based on the possibility of considering various scenarios of use and development of the designated area in urban planning.

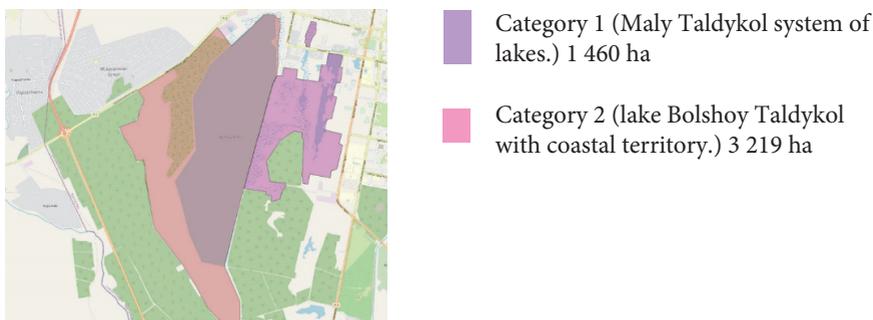


Figure 3. Schematic of the Taldykol Lake area.

Source: Google Earth Pro (March 22, 2021).

According to the *Detailed Construction Plan* approved by the Akimat of Nur-Sultan City, the entire area of the city where the Small Taldykol lake group is located is to be developed as a residential area, as shown in Figure 3 (Akimat of Nur-Sultan 2020).

Identification of ecosystem services

According to accepted methodology, all of the ecosystem services of the Maly and Bolshoi Taldykol lake systems are divided into four categories: provisioning (supplying);

regulating; supporting; and cultural services (World Resources Institute 2005, Cowling et al. 2008; TEEB 2011).

Interviews with experts from fisheries revealed an annual fish yield from Lake Maly Taldykol of 50–100 tonnes, which was directed towards feeding farm animals (Abdiev et al. 2013). Calculations of the fish productivity of the nearby Lake Maibalyk, which is hydrologically similar, confirmed the presence of fish stocks of no less than 54 tonnes of fish per year.

The prospects for using groundwater reserves for the city's needs have not yet been investigated by hydrologists. The area adjacent to the lake has been a permanent wintering ground for livestock grazing since the last century. Thus, the supply services of this ecosystem include important biological resources that are directly used by the population for subsistence and economic development.

In terms of spiritual and physical well-being, cultural and educational services (CES) are important for human existence. These include tourism and recreation, as well as spiritual services such as holy sites (burial sites) and revered cultural and architectural monuments. While cultural ecosystem services are difficult to assess, experts argue that their assessment should be at the forefront of research into urban ecosystem services. The evaluation of CES will also contribute to effective urban planning and decision-making (Kremer et al. 2015).

The economic and ecological value of regulating services includes regulating and purifying water and air quality, protecting against erosion, controlling public health and biological control, as well as playing a role in plant pollination and maintaining species and genetic diversity. Flooding due to rainwater and biologically treated wastewater from the Taldykol reservoir and the areas west of Nur-Sultan city was the first important environmental issue recognized in the Interregional Territorial Development Scheme of Astana agglomeration (Government of the Republic of Kazakhstan 2017).

In order to provide all other ecosystem services, supporting services are needed to assist the operation of the ecosystem as a whole. This lake system is a habitat and migration area for over 160 species of bird. The heterogeneous soil and vegetation cover, dominated by herbaceous grasses and saltwort vegetation, provides habitat for the endemic animals living in the preserved local landscape.

The assessment of ecosystem services

Table 1 illustrates that the cultural services of this ecosystem are calculated to be of the highest value, as they primarily represent the educational and scientific value of this natural site. They also support the spiritual and physical development of humans. Second most important are the regulating services of the ecosystem, as they are worth \$102.6 million/year. These services maintain air quality and climate mitigation, prevent soil erosion, and provide a natural barrier against flooding in the city. Not to be underestimated are the habitat and ecosystem supply services that support over 160 species of birds, fish, mammals, and the pristine plant community, which are valued at over \$17.6 million/year.

Table 1. Assessment of the ecosystem services of the Taldykol lake system.

No.	Name of service	Cost per Category 1	Cost per Category 2	Total cost in thousands USD
1.	Supply services –Ecosystem?	3 084.0	6 749.7	9 833.7
2.	Regulatory services	32 030.8	70 599.4	102 630.2
3.	Habitat services	5 678.4	12 150.0	17 828.4
4.	Cultural services	94 664.5	17 089.7	111 754.3
	Total economic value	135 457.8	106 588.8	242 046.6

Content analysis

Content analysis of the strategic documents of the city administration of Nur-Sultan revealed the following documents:

- The “Concept of Entering the Capital into the Ranking of 10 Best Cities in the World by 2050” was approved by the Kazakhstan government in 2014.
- The “Development Strategy of Nur-Sultan until 2050” (Maslikhat of Nur-Sultan 2019) was developed in accordance with the methodology for the development of strategies of cities of national and regional importance of the Ministry of National Economy of the Republic of Kazakhstan. This document defines the goals and objectives of development for the city in the long term. The city authorities have set themselves the ambitious goal of becoming one of the top ten global cities; with a sustainable, harmonious, and environmentally friendly urban environment, they seek to become a point of attraction for the entire Eurasian continent.

In addition, materials on the approval of the General Plan of Nur-Sultan city and the scheme of improvement and detailed planning of the Taldykol lake territory (Akimat of Nur-Sultan 2020) were analyzed. However, there are no targets for the expansion of green areas in the Program for the Development of Nur-Sultan in 2021–2025 (Maslikhat of Nur-Sultan 2021).

Approaches used in a number of other developed cities have been considered as solutions in a fragmented way.

Thus, the strategic documents of the development of the city until 2050 outline the following main environmental aspects of urban environment development as seen in Table 3.

Table 2. Environmental aspects of urban development as defined in the strategic documents.

Environmental aspects of urban development defined by strategic documents		
Concept		Strategy
Astana 2014	Astana (Nur-Sultan) 2050	Key issues
Growing levels of air pollution from stationary sources and water pollution from the discharge of polluted effluents	The development of alternative energy and the introduction of new cleaning technologies and eco-standards have made it possible to minimize the degree of pollution	High level of air pollution from stationary sources and automobile transport. Soil degradation and pollution of soils. Pollution of surface and underground water.
Reduction of natural ecosystems due to increased building development	Widespread creation of artificial “nature islands” and the expansion of green spaces will be an integral part of the city-planning concept	Since 1997 in Nur-Sultan, large-scale work on the creation of the “Green belt” around the city and landscaping of the city territory have been carried out. Greening of the city with an area of more than 78 000 hectares is planned to continue until 2030.
Growing area of landfill	A full-cycle recycling system will help increase the share of waste recycled to 50%.	Low percentage of recycling and an increase in the volume of MSW taken to landfills. Problems with the disposal of hazardous waste produced by the city.

The threat of reducing the area of natural ecosystems because of the increase in residential zones, as identified in the SWOT analysis, is addressed by the Concept (2014), which proposes to balance this by creating artificial “islands of nature” and expanding the area of green space. Later, in 2018, the “Development Strategy of Nur-Sultan until 2050” (Maslikhat of Nur-Sultan 2019) proposed to continue large-scale work started in 1997 to create a “Green Belt” around the city and to continue the greening of the city’s territory. It should be noted that these goals are budgeted from between KZT 2.3 and 5.34 bn – approximately \$12.7 m annually.

The detailed planning of the territory of the area around Lake Taldykol (Akimat of Nur-Sultan 2020) endeavors to cover the south-eastern part of the coastal area of Greater Lake Taldykol with greenery (Akimat of Nur-Sultan 2019). It is proposed that the territory of the Maly Taldykol lake system be drained and built up with real estate projects, as illustrated in Figure 4.



Figure 4. The strategic visions of aspects of Nur-Sultan’s environment
a) Scheme of landscaping of the coastal part of lake Big Taldykol;
b) Project of detailed construction of lake Maly Taldykol (Akimat of Nur-Sultan 2019).

Source: Department of Architecture 2020.

There are two important aspects to this which should be noted. First, it is vital to consider the ecosystem of the Bolshoi and Maly Taldykol lakes as a whole, in view of their unviable separate existence. Secondly, the value of the services provided by the Maly Taldykol ecosystem exceeds that of the Bolshoi Taldykol ecosystem. Thus, the reasonableness of the decision to construct buildings and infrastructure on Maly Taldykol is questioned.

Discussion of results

The analysis of publicly available strategic documents and reports on urban development shows that the annual cost of solving environmental problems associated with the creation of artificial “islands of nature” by expanding the area of green space is 20 times less than the losses associated with the development of the territory of Maly Taldykol and the consequent loss of natural landscape. Figure 5 compares the costs of the strategies to address the problems associated with the reduction of natural ecosystems due to the increase in the area of construction.

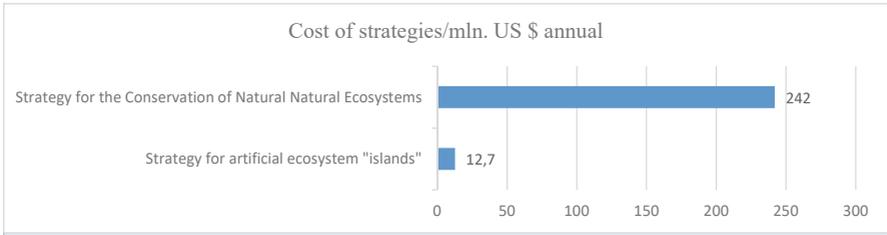


Figure 5: Comparison of strategies

These results justify the conclusion that keeping these ecosystem services in their natural environment will reduce the cost of providing these services in an alternative way, and will prevent damage being caused by an ill-conceived decision.

Conclusions

This study confirms that the government's efforts to improve the quality of life for the inhabitants of the rapidly growing city of Nur-Sultan are challenging. Based on the principles of good governance, signs of the weak institutional capacity of the local government need to be addressed. The first of these is a lack of biodiversity conservation targets, which has led to the neglect of key social and environmental issues. The second is that the public authorities' attempts to comprehensively address urban development issues are limited because of the lack of legislative norms for the practical implementation of the ecosystem approach concept.

The interest of the population of the city in the conservation of Lake Maly Taldykol is confirmed by the cultural value of this ecosystem, which has great potential for aesthetic and spiritual development. The educational and scientific value of this natural site, which is of growing interest to a community of experts, cannot be underestimated. The regulating services of the ecosystem play the most important role in maintaining air quality and mitigating the climate of the city, which is characterized by its sharply continental nature. The role of the Maly Taldykol lake system in providing a natural barrier against flooding in the city has been underestimated. The inability of the city's sewer system to cope with stormwater is causing flooding to emerge more often in connection with the inevitable processes of global warming. This actualizes the issue of preserving the natural ecosystem, which provides a natural water cycle.

In view of the above, six proposals should be considered in order for Nur-Sultan to achieve its goal of becoming one of the 10 best cities in the world by 2050 and receiving international recognition.

1. In Nur-Sultan, a pilot project should be implemented to identify urban ecosystems. This project should account for natural capital and should introduce mechanisms for the evaluation of ecosystem services in the decision-making process.

The examples of the Integrated Development Planning (IDP) and City Development Strategies (CDS) method (TEEB 2010, 92) could be followed.

2. It is necessary that the targets of strategic and program documents on the city's development be revised to reflect biodiversity conservation goals.
3. Widespread public participation in the process of planning, implementation, and monitoring of the strategies and policies related to urban infrastructure development should be encouraged and ensured.
4. The Nur-Sultan Akimat should take measures to include the territory of the Maly and Bolshoi Taldykol lakes into the recreation zone, with the establishment of a regime of limited economic activity. In view of the fragmentation of the lake area, measures must be taken to suspend all construction survey work, and the Adaptive Landscape Management Plan should be approved.
5. The Nur-Sultan Akimat, together with the Department of Education and the Department of Environmental Control of the city, should consider organizing educational tours for school-children and teenagers on the territory of the Maly Taldykol lakes.
6. Opportunities to use the natural landscape of Lake Maly Taldykol to contain and accumulate flood waters should be explored. Additionally, the use of its significant underground reserves for the needs of the population should be considered.

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Ekonominis vandens ekosistemos paslaugų vertinimas miestų planavimui nur sultane, kazachstane

Anotacija

Vykstant sparčiai pasaulio urbanizacijai ir atsižvelgiant į teigiamas bei neigiamas proceso pasekmes, pagrindinis valstybės uždavinys yra užtikrinti ilgalaikę savo piliečių gyvenimo kokybę. Šiuo metu posovietinių valstybių vykdomos reformos, skirtos su aplinka susijusiems projektams, vis dažniau susiduria su vietos gyventojų pasipriešinimu ir atgrasymu.

Šio straipsnio autoriai 2020 m. atliko tyrimą Maly Taldykol ežerų grupėje, esančioje pietvakariniame planavimo regione Nur Sultane. Šio darbo tikslas buvo atlikti ekosistemos paslaugų vertinimą, siekiant informuoti apie efektyvius valdymo sprendimus miesto planavimo srityje. Tyrime taikyta kombinuoto tyrimo metodo strategija. Dėl duomenų trūkumo iššūkis buvo paaiškinti, apibendrinti ir patikrinti duomenis, gautus vienu metodu, taikant kitą metodą. Duomenų analizė parodė, kad metinės išlaidos, susijusios su dirbtinių „gamtos salų“ sukūrimu plečiant žaliuosius plotus, yra 20 kartų mažesnės nei nuostoliai, susiję su Maly Taldykol teritorijos plėtra ir dėl to nykstančiu natūraliu kraštovaizdžiu.

Rezultatai atskleidė, kad, išlaikant šias ekosistemos paslaugas natūralioje aplinkoje, sumažėja šių paslaugų teikimo alternatyviu būdu išlaidų ir išvengiama neigiamo bei netinkamo sprendimo poveikio. Šio tarpdisciplininio tyrimo išskirtinumas susijęs su ekosistemos paslaugų vertinimo išvadomis, kurios lemia efektyviausius valdymo sprendimus analizuojant miesto planavimą, sąnaudas ir naudą.

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