Geojournal of Tourism and Geosites
ISSN 2065-0817, E-ISSN 2065-1198

Year XVII, vol. 54, no. 2spl, 2024, p.915-920
DOI 10.30892/gtg.542spl15-1266

THE EVALUATION OF TRANSPORT ACCESSIBILITY OF SHCHUCHINSK-BOROVOYE RESORT AREA USING GEOINFORMATION SYSTEMS

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Citation: Akhmetbekova, G., Plachinta, I., Saipov, A., & Dunets, A. (2024). THE EVALUATION OF TRANSPORT ACCESSIBILITY OF SHCHUCHINSK-BOROVOYE RESORT AREA USING GEOINFORMATION SYSTEMS. *Geojournal of Tourism and Geosites*, 54(2spl), 915–920. https://doi.org/10.30892/gtg.542spl15-1266

Abstract: The aim of the article is to evaluate the transport accessibility of the Shchuchinsk-Borovoye resort area within the territory of Kazakhstan and border areas of the Russian Federation. The aim of the study is to demonstrate the accessibility of the resort area from cities and populated areas, using information provision and to identify areas with varying spatial accessibility. The primary method of evaluation involves a series of operations in the "ArcGIS.10" system (including kriging, the method of direct transport distance, and interpolation of data using the inverse distance weighting method). The results are presented as a series of maps illustrating the accessibility of resort areas from cities and populated areas, using isolines and coloring techniques. The transport accessibility of the resort area is identified and evaluated, highlighting the importance of transport infrastructure in the development of the tourism cluster. The main conclusion of the research focuses on the calculated indicators of accessibility and the density of the transport network in the region.

Keywords: transport accessibility, density of transport network, thickness of transport network, method of isolines, method of kriging, direct transport distance, transport route

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INTRODUCTION

In the modern era of the worldwide tourism market, accessibility plays a crucial role as more and more tourists expand the geography of their journeys, seeking new experiences and discovering the geographic diversity of our planet. Kazakhstan is of vital interest to tourists due to its diverse natural and recreational potential, ranking 129th in the world for the level of contribution of tourism to the country's GDP (Pashkov et al., 2023). Moreover, programs and plans are currently being developed to improve this sector, as tourism is expected to be the primary field of development at both national and regional levels (Zhidkoblinova, 2013; Abubakirova et al., 2016; Tulbayeva et al., 2017). Engaging tourists and satisfying their demands are essential economic goals for the country (Laifa and Benhassine, 2023). As part of potential tourist destination territories, the evaluation of transport accessibility is a key aspect of recreational geography (Sansyzbayeva et al., 2021). There is a clear connection between transport accessibility and economic growth (Jiang et al., 2023).

Moreover, many interrelations are formulated between transport and tourism (Toth et al., 2014). The availability and deficiency of transport routes have a direct impact on the number of tourists and bring mutual benefits (Zhang and Ju, 2021; Ramadan, 2020). Transport accessibility is synonymous with the concept of equality of access to a particular destination (Rahman and Rigar Neema, 2015) and has a considerable influence on the development of tourist destinations (Mikhaylova et al., 2023). Accessibility of transport is a measure of spatial distribution from the point that was adjusted considering the capacity and desire to undergo spatial separation (Gómez et al., 2023). Meanwhile, rather significant importance has time period (Karlinova and Krcal, 2022). Taking into consideration the fact that transport accessibility has different characteristics in different times of day (Hlusko et al., 2024). «Service density and expected travel time are major influencing factors on whether public transport is used» (Truden et al., 2022). The concept of transport accessibility is considered as a function to reach a particular destination using a vehicle and represents the mobility of a person. In the second part of the 20th century, different definitions of the concepts of transport and integral accessibility were formulated in the scientific area (Pirie, 1979).

The given article is devoted to the evaluation of transport accessibility of Shchuchinsk- Borovoye resort area, which is the main tourist attraction of Akmola region in the north of Kazakhstan and detection of regions, which need the

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enhancement of transport network to increase the influx of tourist and building the image of the resort area. To ensure the validity of the results and provide a comprehensive report, the study is conducted within the territory of the site and the Burabay National Park, as Burabay is indeed part of SBRA (Figure 1).

Figure 1. Geographical location of SBRA (Source: Author, created in the program ArcGIS.10)

The tourist attraction in the Shchuchinsk-Borovoye resort area extends beyond a single natural location, encompassing the appeal of the entire landscape (Mukayev et al., 2022). The presence of numerous lakes, geomorphological formations such as convex mountain ranges with island hilly regions, and the combination of fresh air and diverse natural environments contribute to the area's attractiveness (Atasoy et al., 2022). The relief of the region is a significant factor in meeting the recreational demands of tourists (Zhanabayev et al., 2023).

SBRA is situated within the boundaries of the Burabay district in the Akmola region, providing the territory with superior transport infrastructure and attracting visitors with approximately 190 tourist attractions (Evloeva and Titova, 2020). The development of tourism in the region plays a vital role in establishing sustainable infrastructure, including the road system, network, and utility sector. SBRA is located 250 km from the city of Astana, 90 km from the center of the Akmola region in the city of Kokshetau, and 22 km from the center of the Burabay district in the city of Schuchinsk (Chirikov et al., 2008). The resort area is traversed by a 6-lane highway of national significance, known as the "Astana-Borovoe" road, as well as railway lines such as "Almaty-Petropavlovsk" and "Kyzylorda-Kokshetau," on which high-speed trains such as "Tulpar-Talgo" operate. The railway station in "Burabay Resort" in Shchuchinsk serves as one of the nearest transport hubs. Aviational means of transport accessibility for SBRA include the international airport in Astana and the national airport in Kokshetau. However, road transportation remains the most popular means of access, making it the focus of transport accessibility evaluation. Currently, the asphalt-concrete transport coverage of the territory, stretching for 9 km, is being renewed, and car roads along Lake Tekekol to the "Northern Diversion of Lake Chebache" road, stretching for 13 km, are being built as part of the development plan for SBRA.

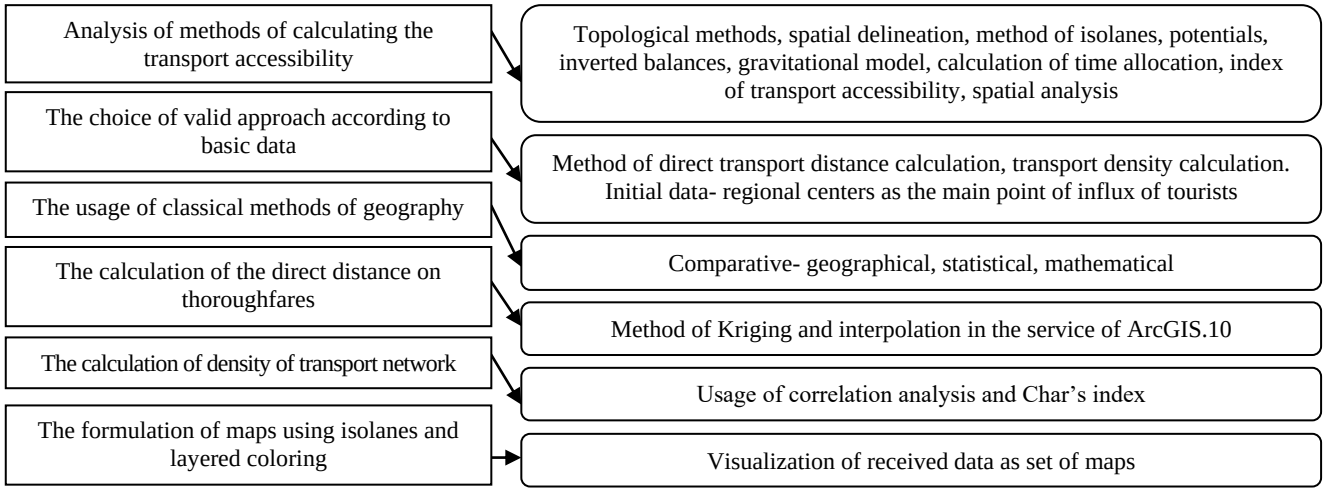

Figure 2. Flow chart of the methodology (Source: created by the autors)

MATERIALS AND METHODS

In the science of geography, numerous types of calculations for transport accessibility are integrated into groups such as topological, spatial delineation, isolines, potentials, and inversion balance. Modern research is based on methods such as spatial and temporal analysis of transport accessibility (Truden et al., 2022). «The Space-Time Accessibility (STA) model is broadly used to measure person-based accessibility based on the space, time, and transport constraints experienced at the individual level in connection to the actual modal choices of observed individuals» (Dianin et al., 2024). Additionally, there are less common methods such as the gravitational model, calculation of time for movement, index of transport accessibility, and spatial analysis. The flow chart of the methodology can be seen in Figure 2.

On the basis of analysis of methods of measuring the transport accessibility, optimal approaches were selected to conduct the research. The analysis was carried out using a comparative-geographical method, analyzing the spatial layout of transport routes, and defining correlation dependencies by studying the relationship between variables. Classical geographical methods such as statistical data processing and mathematical analysis were employed (Wendt and Bogdał-Brzezinska, 2018). As for measurement of transport accessibility, cities such as Pavlodar, Petropavlovsk, Kostanay, Kokshetau and Astana were chosen as examples of regional centers with major influx of visitors , particularly they were shown as starting points of transportation distance calculation (Battakova and Saipov, 2022). On the basis of analysis of methods of measuring the transport accessibility, optimal approaches were selected to conduct the research. «GIS-based methods are useful tools to assess accessibility to public transport» (Zochowska et al., 2022). The method of kriging was used to measure the distance of transportation. The method of kriging involves an interactive investigation of spatial phenomena, wherein selected variables are scattered in the area of interpolating points. The main formula of kriging involves the sum of weighted data:

$$\check{Z}(s_0) = \sum_{i=1}^{N} \lambda_i Z(s_i), \quad \text{(Zhang and Ju, 2021)}$$

where: $Z(s_i)$ – the measured value at the *i*th location, λ_i – an unknown weight for the measured value at the *i*th location; s_0 the location of the prediction, N - the number of measured values. An advantage of the kriging is that it gives the chance to process a large array of data, which is unevenly distributed across timelines and space. In forming the evaluation of transport accessibility for the Burabay district and SBRA, a wide range of initial data were utilized, including the highway network obtained from satellite imagery from Google Earth, space images from the USGS website, electronic maps such as Google Maps, Yandex Maps, OpenStreetMap, and atlases of highways. The measurement of transport accessibility in the ArcGIS 10 system was conducted using the "New Service Area" function from the tools of Network Analyst.

While making the evaluation of transport accessibility of Burabay district and SBRA, following initial data was obtained: the network of highways from space images provided by Google Earth, space images of USGS, electronic maps of Google maps, Yandex maps, Open Street Map, atlases of highways. The calculation of transport accessibility in the system ArcGIS.10 was done by using the function "New Service Area" from the tools of Network Analyst. The cities that are considered as regional centers were chosen as main points of reference , because a major influx of tourists are formulated there.

The direct distance of transportation routes (railways and highways) was estimated, and the area of accessibility from each center of the district was identified. Maps representing transport accessibility were created using isolines with layered paint, which offers a more vivid representation compared to other approaches. The result of this method is the spatial differential accessibility of populated areas. The Char coefficient was chosen as an indicator to characterize the density of the traffic network and was implemented for measuring the traffic network density and selecting figures for correlational analysis.

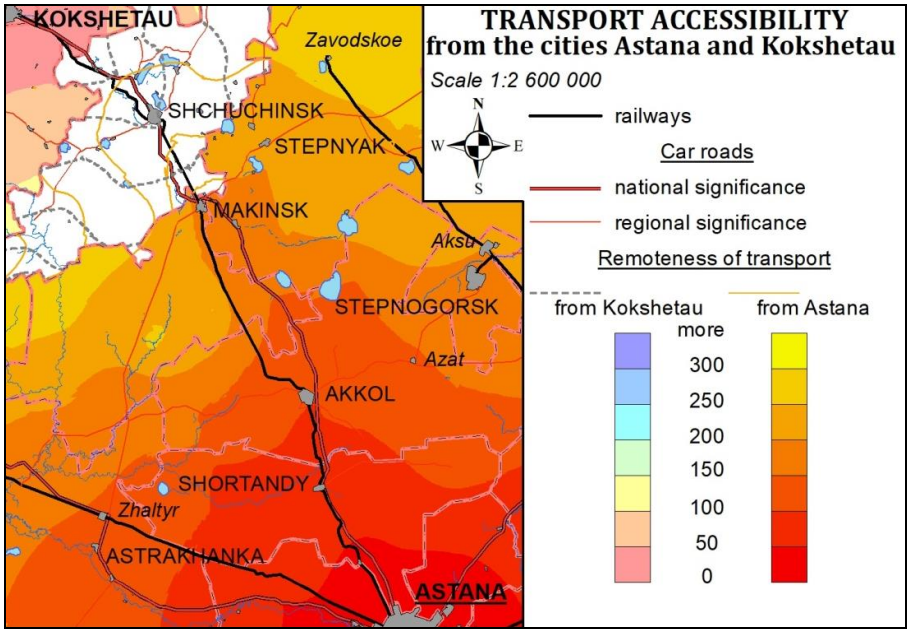

Figure 3. Transport accessibility of SBRA (Source: Author, created in the program ArcGIS.10)

RESULTS AND DISCUSSIONS

During the analysis of the transport network, which encompasses highways and railways in SBRA, it was revealed that the main modes of transportation are road and rail. The assessment of transport accessibility was conducted on both national and regional highways and railways. Additionally, in the investigated area, there are three major road hubs: Astana, Kokshetau, and Shchuchinsk.

Major regional centers were selected to ensure the accurate calculation of transport accessibility, as the development of transport infrastructure plays a crucial role in attracting tourists to these locations. In the case of Kokshetau city in the Akmola region, transport accessibility is extensive, particularly in the northwest part (Figure 3). High-quality transport accessibility can be observed through the presence of the national significance highway A-2, which stretches over 452 km.

The distance between Kostanay and SBRA is 511 km, typically taking around 9 hours by car. Regarding railway service, trains such as Atyrau-Astana, Uralsk-Astana, and Kostanay-Karaganda are available, with travel times ranging from 9 to 11 hours Regarding Pavlodar, the distance is approximately 578 km on highway A-17, with an estimated travel time of around 10 hours and 40 minutes. Alternatively, the railway line passes through Pavlodar-Presnogorkovskaya, with the station in Shchuchinsk «Borovoe Resort» reachable in 11 hours (Figure 4).

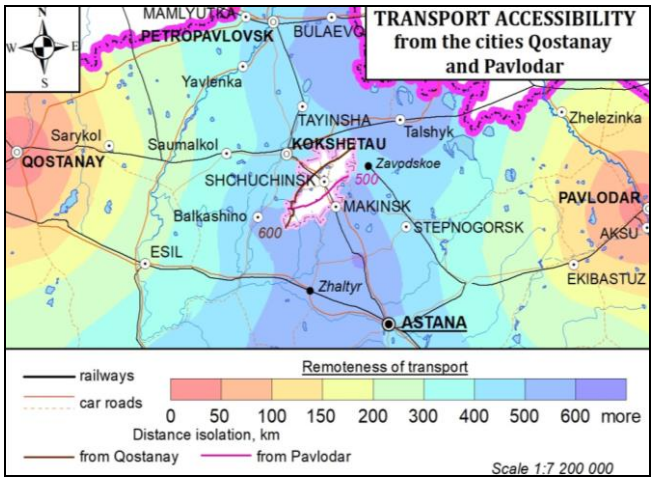

Figure 4. Transport accessibility of SBRA
and Burabay district from Kostanay and Pavlodar
(Source: Author, created in the program ArcGIS.10)

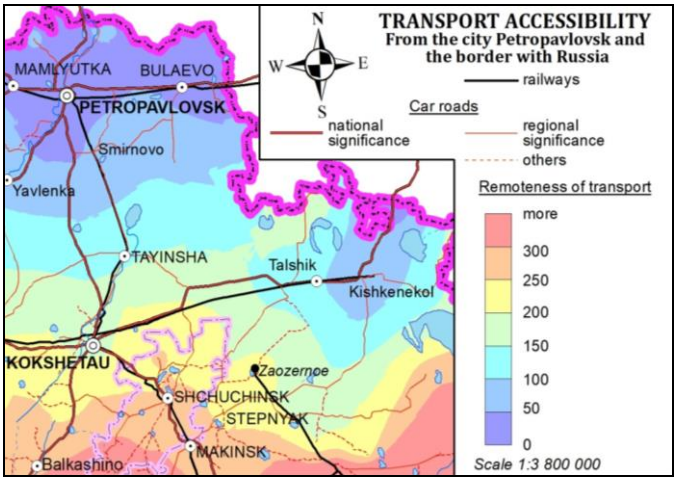

Figure 5. Transport accessibility if SBRA and
Burabay district from Petropavlovsk and borders with Russia
(Source : Author, created in the program ArcGIS.10)

The strategic border location of SBRA provides an opportunity to attract a large number of tourists from frontier areas of Kazakhstan and neighboring regions of the Russian Federation (Dmitriyev et al., 2021). According to data from the Tourism Management of Akmola Province, approximately 30% of tourists in SBRA are Russian citizens.

During the Universal Exhibition "EXPO-2017," the number of foreign tourists increased, with visitors from 80 out of 115 countries involved in the exhibition visiting the resort. Research on the accessibility of the resort from Petropavlovsk and the borders with Russia indicates popularity among locals from regions such as Omsk, Tomsk, Tyumen, Novosibirsk, and cities in the Urals (Figure 5). For example, SBRA can be reached via highway transport in just 5 hours from Omsk, making it easily accessible for Russian tourists. Moreover, many Russian tourists visit the Borovoe resort by car for eco-friendly trips such as tent tours and hiking.

Additionally, the stunning combination of mountains and green fields, diverse range of activities, mountain sports, and thriving infrastructure of the resort make it attractive for visitors from the Russian Federation.

The overall length of the national road in the Burabay region is 72.1 km. Foreign researchers have analyzed the significance of roadways as a transportation factor (Talebi et al., 2019). Roads of regional importance comprise 136 km. On average, the density of the road network is 4.0 km/100 km2 in Kazakhstan, while in the Burabay region, it fluctuates between 0.005 km/100 km2 and a maximum of 0.3 km/100 km2 around the SBRA (Figure 6). Furthermore, the density of the road network in the SBRA was calculated using correlation analysis and the Char index. The Char index is calculated by the formula:

$$D = L / \sqrt{S}\Pi, \text{ (Banister, 2012)}$$

where L – total length of highways, S – area of the territory, Π – number of populated centers. The provided coefficient is adapted from Engel's coefficient, as it addresses a drawback such as the distortion of the level of development of transport roads.

The density and thickness of the transport network with Char's index were calculated using raster interpolation, employing the inverse distance weighting method. This method implies that the influence of the mapped variable (Char's index) decreases as one moves away from the object's location (SBRA).

The result of the research has shown that the territory of northern and southern parts of Burabay region have low levels of transport network density (less than 0,01 km/100 km ^{2}, which in turn influences the transport accessibility of SBRA. Main influx of tourists came from regional centers, where the roadways are qualitative and save time for travelers. The

improvement of road network in northern and southern parts of the region, the enhancement of roadways will give opportunity to enlarge the number of visitors, to boost the economic efficiency and competitiveness of tourism in SBRA.

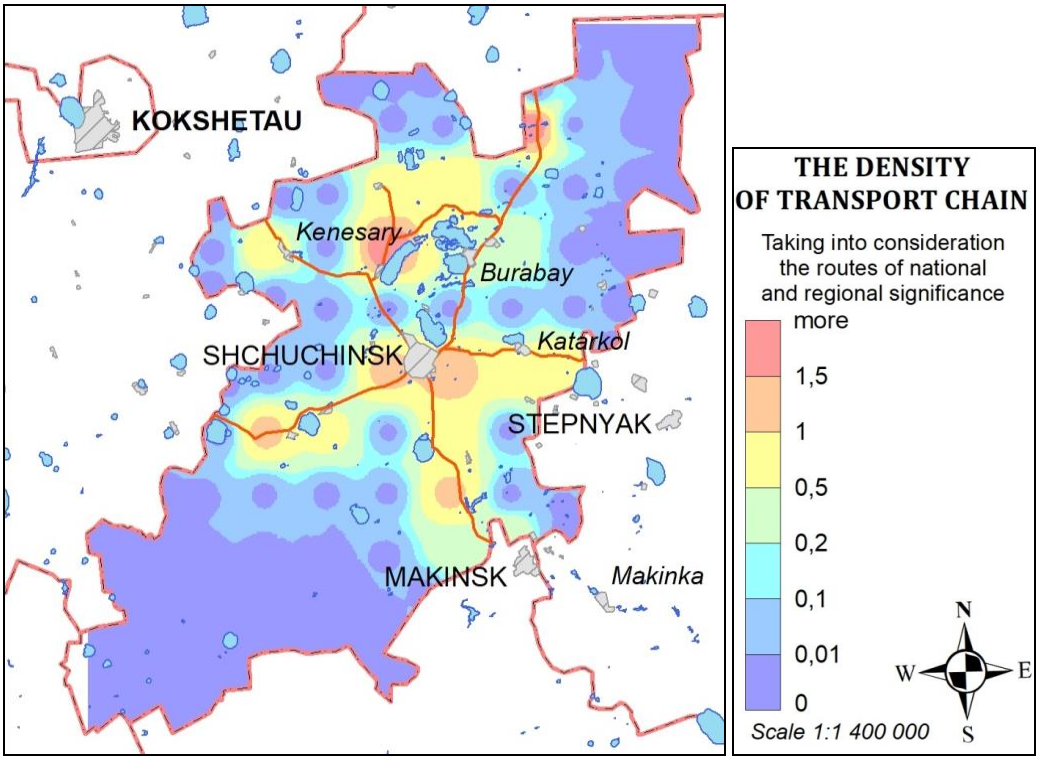

Figure 6. The density of transport network in SBRA and Burabay region using Char's method
(Source: Author, created in the program ArcGIS.10)

CONCLUSION

After studying a wide range of approaches to evaluate transport accessibility, we have opted for optimal methods for measuring the accessibility of the resort area Shchuchinsk-Borovoye and the district of Borovoe. The chosen methods have given us a chance to analyze transport accessibility, taking into consideration the initial data. For the development of touristic resorts, transport is one of the important factors to accelerate the processes of modernization of logistics and infrastructure. Comparative analysis using the method of direct transport distances, interpolation of data gave the chance to define the regions with minimal density of transport network and accessibility. The given areas need the improvement of conditions of transport routes to increase the influx of tourists.

The maps, created by the authors using software, visually represent the transport accessibility of the analyzed area. Transport accessibility of the resort area from regional centers and the Russian Federation was estimated using direct transport distance and kriging methods, as well as the calculation of direct transport distances for road and rail transports. The correlation between length indicators, highway indicators, land area, and the number of localities was shown using the Char index. The results of index calculation are depicted on the map, indicating the density of transport accessibility through interpolation of raster, applying the method of inverse distance calculation.

The collected data, which emphasizes the length and density of the transport network and accessibility of SBRA from regional centers, enables us to conclude that the transport network and accessibility of the resort are distant from the cities of regional significance. This gives the opportunity for relative accessibility of tourist destinations and the possibility to explore the resort using highway and railway transportation.

Author Contributions: Conceptualization, G.A and I.P.; methodology, A.S. and G.A.; software, I.P.; validation, A.S. and A.D.; formal analysis, G.A.; investigation, A.S.; data curation, G.A.; writing - original draft preparation, G.A.; writing - review and editing, A.S., A.D. and G.A.; visualization, I.P.; supervision, G.A. and I.P; project administration, G.A. All authors have read and agreed to the published version of the manuscript.

Funding: Not applicable.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study may be obtained on request from the corresponding author.

Acknowledgments: The research undertaken was made possible by the equal scientific involvement of all the authors concerned.

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

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Article history: Received: 28.03.2024 Revised: 03.06.2024 Accepted: 21.06.2024 Available online: 28.06.2024