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The resilience of society to flood risk as a challenge for local government: A case study from Slovakia

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ABSTRACT This paper examines whether local authorities in Slovakia are prepared to manage flood risk in line with resilience principles. The research framework focuses on three dimensions of resilience in local flood risk management: knowledge, policies and actions, and governance. Data were collected through a web-based questionnaire distributed to mayors of Slovak municipalities with previous flood experience. The analysis is based on 499 completed questionnaires. The findings reveal that current local-level flood risk management is inadequate from a resilience perspective. The main shortcomings are the lack of diversified management strategies and highly centralized governance. Three key challenges for enhancing resilience were identified: i) modifying the approach to preliminary flood risk assessments to identify areas of potentially significant flood risk, ii) implementing diversified flood risk management strategies at the river basin scale, and iii) decentralizing flood risk governance. The results highlight the main barriers and challenges that need to be addressed to strengthen resilience in local flood risk management.

KEY WORDS flood risk management – legislative framework – local government competence – social resilience – Slovakia

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1. Introduction

Social resilience to flood risk can only be truly multi-dimensional if it is applied in everyday practice. Local-level flood risk management plays an important role in this respect (Tobin 1999; Norris et al. 2008; Cutter, Ash, Emrich 2014; McDermott et al. 2018). At this level, in addition to the individual responsibility of community members for mitigating the negative consequences of floods, local government authorities play a key role (Gersonius et al. 2016). Local governments should actively support the implementation of diverse measures to mitigate the impact of local factors contributing to flood hazard and vulnerability. From this perspective, flood risk governance is crucial for the implementation of diverse flood risk management strategies (Driessen et al. 2016; Hegger, Driessen, Bakker 2016). Hegger, Driessen, Bakker (2016) note that diversification of flood risk management strategies is indeed necessary to enhance a society's capacity to withstand and cope with negative flood impacts (resilience); however, diversification alone does not guarantee resilience. Therefore, they emphasize that achieving societal resilience to floods through a diversified strategy also requires decentralization of flood risk governance. For instance, in countries like the Netherlands and Poland (Kaufmann 2018, Matczak et al. 2018), where flood risk governance is centralized at the national level, flood risk management is dominated by a uniform, infrastructure-based flood protection strategy. In contrast, clear diversification in flood risk management strategies is evident in countries such as England, Belgium, France, and Sweden (Fournier, Laurrue, Schellenberger 2017; Johnson, Tunstal, Penning-Rowsell 2005; Mees, Crabbé, Suykens 2018), where governance exhibits decentralization characteristics (Hegger, Driessen, Bakker 2016).

An essential component of diversified flood risk management is the adoption of flood risk reduction strategies that regulate economic activities and settlement patterns through spatial planning at the municipal level. Several authors, including Neuvel and Van der Knaap (2010), Dawson et al. (2011), and Begg, Walker, Kuhlicke (2015), consider municipal spatial plans to be one of the key non-structural tools for flood risk management. Burby et al. (2000) argue that local spatial plans integrate technical analysis with community participation, enabling informed decisions among alternative land-use strategies. However, Ran and Nedovic-Budic (2017) point out that there are several obstacles to making it work in practice.

The aim of this paper is to answer the question of whether the local self-government authorities of Slovakia are ready to accept and actively engage in flood risk resilience management; in other words, to adopt a diverse approach to eliminating local flood risk factors and enhancing transformational and adaptive capacity when dealing with the negative effects of flooding. The achievement of this objective is based on data obtained through a web-based questionnaire. We contacted the mayors of 1,867 municipalities with experience of flooding and

cooperation with state authorities responsible for flood protection. A total of 499 mayors responded to the survey.

The paper is structured as follows: Section 2 introduces the concept of societal resilience. Section 3 provides a brief overview of the legislative framework for flood risk governance in Slovakia. Section 4 outlines the research design, including the administration of the questionnaire, processing of responses, and evaluation. Section 5 presents the results. Section 6 discusses these findings and identifies the challenges of resilient flood risk management. Finally, Section 7 provides concluding remarks.

2. The concept of resilience

Several authors, such as Davoudi, Brooks, Mehmood (2013); Alexander (2013); Pizzo (2015) and Abdulkareem, Elkadi (2018), point out that the concept of resilience is not clearly defined and has different meanings in various contexts, each of which is rooted in different scientific traditions. Within the context of resilience, three main approaches are typically identified (Davoudi, Brooks, Mehmood 2013): engineering resilience, ecological resilience, socio-ecological or evolutionary resilience. The term engineering resilience refers to the functional stability of technological systems. It refers to a system's ability to return to a steady state following a disturbance. According to Abdulkareem and Elkadi (2018), the faster a system recovers, the more resilient it is. Ecological resilience is defined as the ability of a system to withstand disturbances while continuing to function (Holling 1973; Zevenbergen, Berry, Mohan 2020). It acknowledges the possibility of multiple stable states (or equilibria), rather than a single fixed one. Socio-ecological or evolutionary resilience is conceived as a broader system characteristic, involving the interaction between natural and human systems (Zevenbergen, Berry, Mohan 2020). The term evolutionary or adaptive refers to the adjustment of a strategy in response to new insights (Bloemen et al. 2017). As noted by Kinzig et al. (2006), evolutionary resilience is based on the recognition that a seemingly stable state can suddenly change and become something radically new, with characteristics profoundly different from those of the original state.

In the context of extreme natural events, the United Nations International Strategy for Disaster Reduction (UNISDR 2009, p. 10) defines resilience as follows: "The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate to, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions."

The key question in this context is how resilience can be measured. Several authors (e.g., Alexander, Priest, Mees 2016; Hegger, Driessen, Bakker 2016) have

stated that resilience can be measured in terms of the capacity for resistance, absorption, recovery, transformation, and adaptation. Hegger, Hegger, Driessen, Bakker (2016) conceptualised these capacities as follows: The capacity to resist refers to a system's ability to withstand external pressures, especially negative ones, without being affected. Examples of resistance-like measures include dikes, dams, embankments, water retention structures, and the implementation of rescue and safety measures. The capacity to absorb and recover refers to situations in which the system is affected but can still respond and return to its original or functional state. It is associated with the implementation of flood preparedness strategies aimed at reducing vulnerability, enhancing recovery capacity, and using more natural ways to reduce flood hazards. The capacity to transform and adapt refers to a system's ability to adjust in order to take advantage of opportunities, moderate potential damages, or cope with consequences. Transformation and adaptation measures are primarily related to flood risk governance, as defined by the legislative framework.

The more extensive methodological elements of resilience assessment are analysed by Gal (2013). He points to the existence of four methodological approaches to the assessment of resilience, which are as follows: (i) outcome-driven approaches, which focus on estimating and/or modelling losses, recovery times and similar; (ii) input-driven approaches, which identify underlying factors that influence resilience, including vulnerability; (iii) scenario-driven approaches, which document past or future system responses to a specific risk; and (iv) complex system approaches, which inventory independent elements of resilience with unknown feedback loops. Other authors, such as Norris et al. (2008), distinguish between two approaches to resilience research. The first approach focuses on community resilience in terms of preventing disaster-related health or mental health problems among community members. The second approach views community resilience as a descriptor of effective organisational behaviour and disaster management. A concept closely related to the first approach is *inherent resilience*, as defined by Cutter, Ash, Emrich (2014). This refers to the qualities of a community that arise from everyday processes, which may either enhance or reduce its ability to prepare for, respond to, recover from, and mitigate environmental hazard events. In this context, social, economic, community, institutional, environmental, and housing/infrastructure capital are usually considered key contributing factors (Cutter, Burton, Emrich 2010; Cutter, Ash, Emrich 2014; Esteban 2018). The second approach to resilience research, as outlined by Norris et al. (2008), is reflected in the work on flood risk governance and diversified management by Hegger, Driessen, Bakker (2016), Driessen et al. (2016), and Bergsma (2016).

3. An analysis of the legislative framework for flood risk management

The activities of local governments in the field of flood risk management in Slovakia are regulated by the Flood Protection Act (Act No. 7/2010) and spatial planning legislation (Act No. 237/2000). Act No. 7/2010 establishes a highly centralized state structure for the organization and management of flood risk, in which the Slovak Water Management Company (SVP, š. p.) serves as the key administrative body. Local government has a lower legal and administrative status, and its activities in the area of flood prevention are contingent upon cooperation with SVP, š. p. The responsibilities of municipalities regarding flood prevention are defined as follows under Section 26 of Act No. 7/2010:

- collaborates with SVP, š. p. on the preparation and updating of preliminary flood risk assessments and flood risk maps, as well as the development of flood risk management plans
- participates in the development of proposals for preventive measures within the cadastral area that slow down runoff from the watershed, reduce peak flow, or protect the area from flooding, and, to the extent possible, also in their implementation
- manages and ensures the implementation of flood protection measures within the cadastral area.

An important aspect of local flood risk management is maintaining watercourses. Only the watercourse administrator is authorized to perform maintenance on watercourses (Act No. 7/2010). Currently, more than 62% of the total length of watercourses is managed by SVP, š. p. The second major manager of small watercourses is Lesy SR ("Forests of the Slovak Republic"; 32%). Municipalities manage watercourses only in isolated cases.

The issue of spatial planning is regulated by Act 237/2000 according to which spatial planning continuously addresses the spatial arrangement and functional use of the territory, determines its principles, proposes the coordination of activities affecting the environment, ecological stability, cultural and historical values of the territory, territorial development, and landscape creation in accordance with the principles of sustainable development. Cities and rural municipalities with more than 2,000 inhabitants are obliged to draw up a spatial plan. Other municipalities are obliged to have a municipal spatial plan when it is necessary to address the concept of their spatial development. The primary task of spatial planning in connection with flood risk management is to ensure territorial claims for the implementation of flood control measures proposed in flood risk management plans and to ensure the regulation of activities on land along the banks and in inundation areas. However, the legislative framework of spatial planning also stipulates that the spatial plan of the municipality includes, in particular:

(i) principles and regulations of spatial arrangement and functional use of the territory of the municipality in relation to the surrounding territory; (ii) permissible, limited and prohibited functional use of areas; (iii) principles and regulations of care for the environment, the territorial system of ecological stability and landscape creation, including green areas; (iv) principles and regulations of protection and use of natural resources, cultural and historical values and important landscape elements; (v) the boundary between the continuously built-up area and the other territory of the municipality; vi) principles and regulations of public transport and technical equipment and civic equipment; and (vii) areas for public works, for remediation and for protected parts of the landscape. The development of the legislative framework is discussed in greater detail in Solín (2020).

4. Research design

To answer whether local authorities are ready to accept and actively manage flood risk in a resilient manner, we conducted a web-based questionnaire among municipalities that experienced at least one flood event from 1996 to 2020. A flood situation was defined as a condition on a watercourse or in a cadastral area that required the declaration of a level III flood activity by the mayor of a municipality. This level is declared when water overflows from the riverbed during extremely heavy or prolonged rainfall or sudden snowmel. Of the 2,890 municipalities in Slovakia, a flood occurred at least once in 1,867 municipalities during the monitored period. The mayors of the municipalities concerned were contacted by email in October 2022 and completed the questionnaire via a Google Form, allowing them the time and flexibility to revisit individual questions if necessary.

The key to designing the questionnaire and formulating its questions lies in establishing a conceptual framework of resilience and an appropriate approach for assessing it. The conceptual framework is based on the UNISDR (2009) definition of resilience.

The assessment of community resilience draws on the concept of effective organisational behaviour and disaster management, as outlined by Norris et al. (2008). The approach to evaluating a municipality's capacity to withstand, absorb, and cope with the negative impacts of floods does not focus on the attributes of individual community members but instead relies on an analysis of resilience indicators affecting the local government's ability to effectively manage and respond to flood risk. Three sets of indicators are considered essential for influencing flood risk management resilience: (i) knowledge indicators, (ii) strategy and measure indicators, and (iii) governance indicators. The questionnaire items were developed in accordance with these indicator groups. The questionnaire was distributed electronically via e-mail to mayors and municipal leaders of

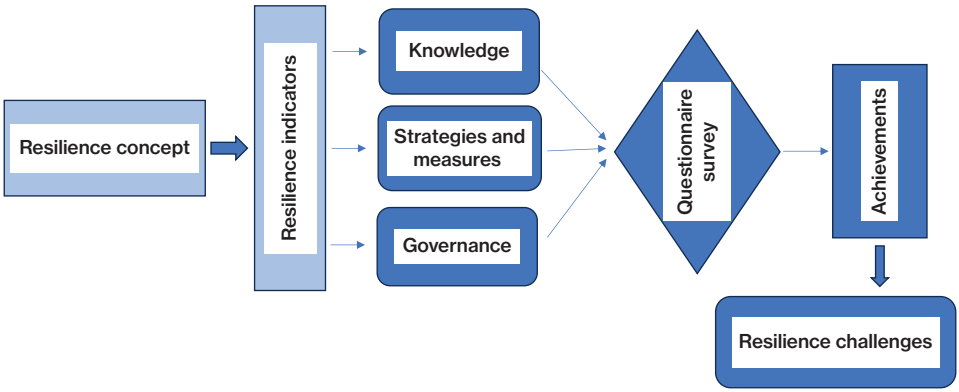


Fig. 1 – Flow chart of the research design. Source: Authors' elaboration.

municipalities that experienced at least one recorded flood event during the study period. The original Slovak-language version of the questionnaire is available online via Google Forms (https://forms.gle/e2cUn2fAQYQsBuWAA). To ensure transparency and accessibility for international readers, an English translation of the survey instrument has been deposited in the Zenodo repository and is openly available under a persistent DOI (Sládeková Madajová, Solín, Výbošťok 2026).

Based on the questionnaire results, the current state of local flood risk management was assessed, and key challenges for achieving resilient management were identified. A flowchart illustrating the research design is presented in Figure 1.

Knowledge Indicator. Knowledge of flood risk provides a rational basis for effective management. The questions primarily concern awareness of the types of flood hazards that occur within the municipality's cadastral area and their causes.

Strategies and Measures Indicator. Diversified flood risk management is a key prerequisite for the concept of resilience-based management. The questions focus on the flood protection measures implemented to date and the assessment of their adequacy, the maintenance of watercourses, the role of spatial planning, and the potential for implementing eco-stabilisation and anti-erosion measures to reduce flood hazards. This section also includes questions related to flood early warning systems and flood preparedness.

Governance Indicator. Effective, diversified flood risk management is closely linked to governance. The questions address the effectiveness of centralised flood risk management and examine the level of cooperation between local authorities and water management bodies in maintaining watercourses and developing preliminary flood risk assessments, flood hazard maps, flood risk maps, and flood risk management plans.

5. Results

The questionnaire data were integrated into an existing GIS database of Slovak municipalities and processed in ArcGIS 10.5.1. Out of a total of 1,867 questionnaires sent the mayors, 499 mayors (i.e., 27%) responded to the questionnaire. The municipalities whose mayors responded to the questionnaire are shown in Figure 2, which presents their spatial distribution by municipality size category. The size categories are determined based on the methodology of the Statistical Office of the Slovak Republic. The number of municipalities in each size category is listed in Table 1. The results are presented in aggregate form within the context of three indicators of resilience-building in flood risk management. Mayors of towns with populations of more than 5,000 account for only 10% of the total respondents. Most respondents come from small and medium-sized municipalities.

5.1. Flood hazard knowledge indicator

The respondents' answers show a wide spectrum of flood hazards across the municipalities (Fig. 3). The occurrence of fluvial flood hazard is considered the most significant (48% of respondents). The incidence of pluvial flood hazards caused by water flowing from slopes and fields is also significant (37%). Third in order of significance is the occurrence of flood hazards due to blockage of bridges and local drainage channels (12%).

The most significant local factor for a flood hazard was considered by 32% of respondents to be overgrown and silted watercourses. Furthermore, 11% of respondents reported high deforestation in the area, and 11% also reported an improper crop mix on arable land. Various obstructions and debris in watercourses, primarily consisting of construction and other solid waste, wood, branches, or

Table 1 – Number of municipalities by size category whose mayors responded to the questionnaire survey

Municipal size categories	Population	Number of municipalities
Very small village	up to 199	39
Small village	200–499	116
Medium-sized municipality	500–999	144
Larger municipality	1 000–1 999	90
Large municipality	2 000–4 999	59
Large municipality / small town	5 000–9 999	20
Smaller town	10 000–19 999	10
Medium-sized city	20 000–49 999	13
Big city	50 000 +	8

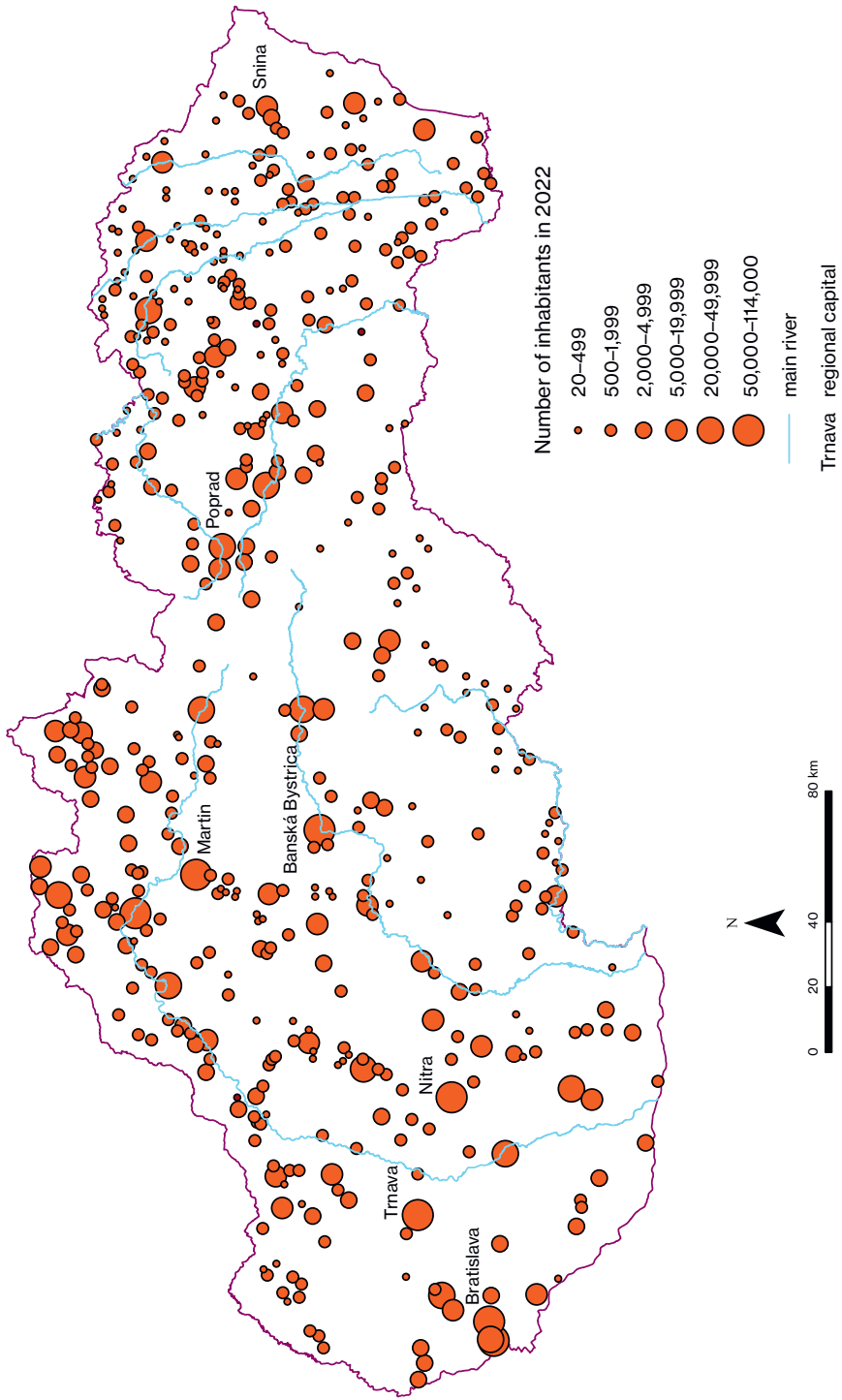


Fig. 2 – Population of the municipalities whose mayors responded to the questionnaire

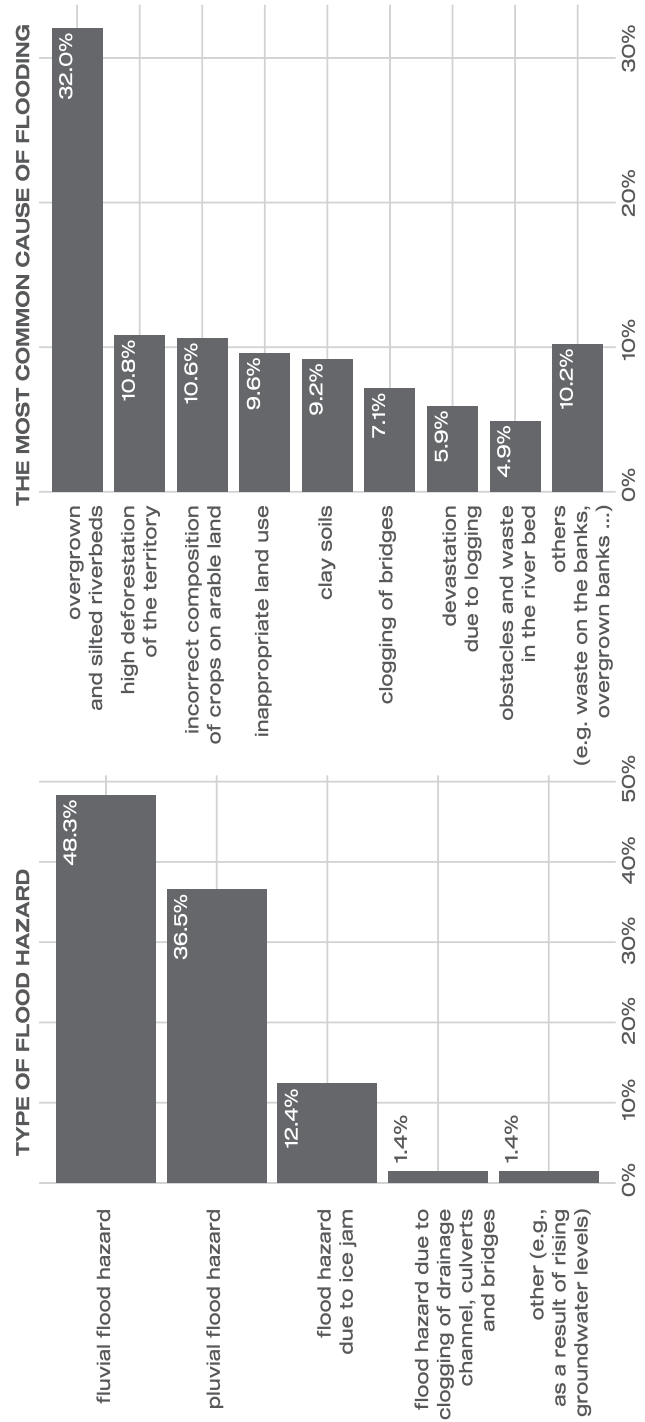


Fig. 3 – Types of flood hazards occurring in municipalities and their causes. Source: Author's calculations.

grass clippings, also contributed to the acceleration of flood hazards, according to the mayors of individual municipalities. More than 41% of respondents reported their presence in the channel.

Inspections of watercourses are an essential activity to assess the condition of watercourses. Up to 72% of respondents reported conducting inspections. The mayors' answers showed that inspections were carried out at varying intervals, most often more than once a year.

The majority of mayors (52%) indicated that they could identify the river sections in the cadastral area where water overflowed from the channel. However, up to 56% could not identify locations in the cadastral area that were susceptible to flooding or subsidence due to blocked bridges, ice barriers or rising groundwater.

Only 8% of respondents indicated that they had developed a flood hazard potential assessment based on a systematic evaluation of the influence of the physical-geographical characteristics of the cadastral area on flood hazard. Effective use of flood hazard knowledge requires that it be processed and presented in a GIS environment. However, regarding GIS software, 79% of respondents reported that the municipality has none.

5.2. Strategy and measures indicator

5.2.1. Management intervention options

The majority of mayors (66%) believed that technical flood-prevention infrastructure was sufficient to reduce flood hazards. However, 34% of respondents did not think so. Furthermore, more than 62% of mayors carried out other activities related to preventive flood protection on their own initiative (Fig. 4). A total of 56% of respondents also had specific proposals to be implemented by watercourse administrators to reduce flood hazards within the municipality's cadastral area. In particular, regular maintenance of watercourses was required, as well as the construction of additional polders, dikes, dams, and channel modifications. To a lesser extent, mayors also called for comprehensive watershed-wide water conservation measures.

The mayors of the municipalities occasionally carried out the maintenance of watercourses and the cleaning of drainage channels and ditches on their own initiative.

However, it should be stressed that the responsibility for the maintenance of watercourses lies with the watercourse administrator. Therefore, if municipalities decide to maintain the watercourse, they must finance it from their own resources. However, most municipalities lack the resources to do so.

An important part of flood risk management is the maintenance by owners of riparian land along the watercourse up to 10m from the bank for major

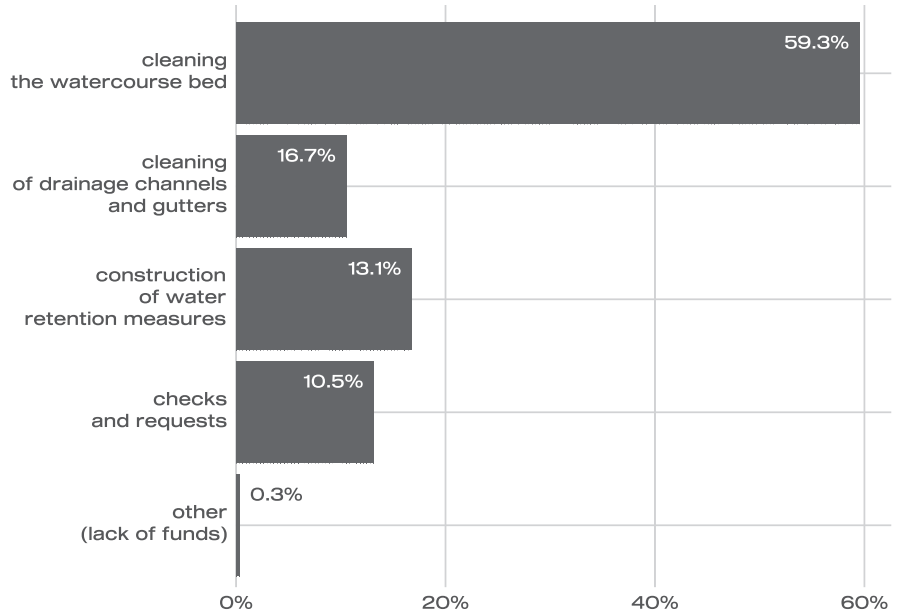


Fig. 4 – Preventive flood protection activities of municipal mayors. Source: Author's calculations.

watercourses and up to 5m for minor watercourses. The responses showed that when there were multiple dumps of material or waste on the riverbanks, the mayors usually dealt with them by contacting the owners. Only 14% of those surveyed mentioned charging a fine for polluting waterways with various solid wastes or organic materials. However, a relatively large group of mayors (more than 20%) did not respond or felt it was the responsibility of the water authority to oversee the maintenance of the riparian areas. The situation is similar to that of waste in watercourses. In this context, local government activities aimed at raising public awareness of flood risk and strengthening individual responsibility for reducing flooding are particularly important. The implementation of such activities (e.g., announcements on the local public address system and the municipality's website, reminding residents to keep stream beds clean, and prohibiting the disposal of biodegradable waste in stream beds, etc.) was reported only by 34% of respondents.

For effective flood risk management, early warning to prepare for a flood are important. 79% of mayors issued flood warnings. However, the warnings did not come in sufficient time. Up to 76% of respondents said they did not have enough time to prepare for a flood event.

5.2.2. Spatial planning

The respondents' answers showed that 62% of municipalities have a municipal spatial plan. The spatial planning framework established by Act 237/2000 requires municipalities to take ecological stability and environmental protection into account in their spatial plans. However, having mapped sites where eco-stabilisation and erosion control measures would be needed was reported by only 36% of respondents. At the same time, if the owners or tenants of the land do not implement eco-stabilisation and anti-erosion measures, only 8% of the respondents said that the local council would complain to the district authority, which has the right to force the land users to implement the required measures. However, action has been taken on complaints only in isolated cases.

From the perspective of effective control of construction in the floodplain, the delineation of the inundation area in the land-use plan is important. However, only 48% of respondents indicated that the floodplain boundaries are shown on the spatial plan. The requirement to build in the inundation area is quite common. This was reported by 42% of respondents. However, only 9% of respondents reported a refusal to build in the inundation area.

5.3. Governance indicator

5.3.1. Competences of municipalities in preventive flood management

A significant proportion of respondents (44%) were unable to comment on the legal framework of local government competence in the field of flood risk assessment and management as defined by Act No. 7/2010. 11% of respondents expressed satisfaction with the current regulatory framework. A further 26% of respondents considered the legal framework adequate but pointed out that its practical implementation was very limited because municipalities lacked sufficient financial, human and material resources to carry out the responsibilities set out in the legislation. 19% of respondents considered the legislative framework insufficient and ineffective.

When mayors were asked to give an overall opinion on their powers to reduce flood risk in the municipality, 68% of respondents did not think they were sufficient (Fig. 5). The main reasons that limited the active participation of the municipality in preventive flood protection were: (i) lack of financial resources, (ii) lack of real/legal powers, and (iii) lack of scientific information on the flood hazard in the municipality's cadastral area (Fig. 5).

Following the implementation of the EU Directive on the assessment and management of flood risks (European Union 2007) into Slovakia legislative system, the

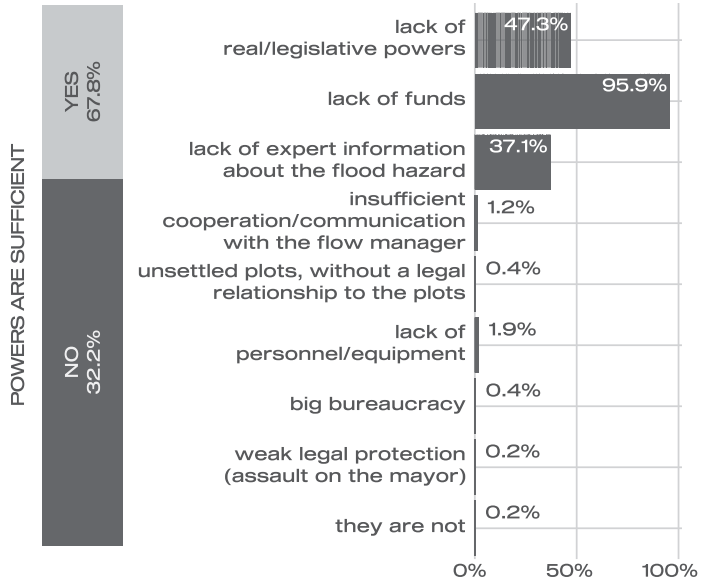


Fig. 5 – Mayors' views on the powers provided by the legislation. Source: Author's calculations.

Flood Risk Management Plans (MOE SR 2015) have become the basic tool for flood risk management. These have been developed for areas with potentially significant flood risk under the responsibility of SVP, š. p. In relation to the identification of significant flood risk areas (MOE SR 2011), the majority of mayors (62%) stated that they had not been approached by SVP, š. p. for cooperation. Almost 70% of respondents reported that their municipality was not included in the list of potentially significant flood risk areas. However, a comparison of these responses with the official list of municipalities classified as areas with potentially significant flood risk revealed several discrepancies. Of the 331 mayors who stated that their municipality had not been classified as an area with a significant flood risk, 52 mayors (16%) provided an incorrect answer. Similarly, of the 146 mayors who stated that their municipality had been classified as an area with a significant flood risk, 79 mayors (54%) provided an incorrect answer. These discrepancies suggest that a substantial proportion of mayors and municipal leaders may not be fully familiar with the official classification of municipalities as areas with potentially significant flood risk.

A significant percentage of respondents (58%) indicated that they had not even been asked to participate in the preparation of the Flood Risk Management Plans. In cases where the SVP, š,p. cooperated with the municipality, only 23% of respondents assessed the cooperation with the SVP positively, while 19% assessed it negatively and 58% gave a neutral assessment.

5.3.2. Watercourse administration

An important aspect of flood risk management at the local level is the maintenance of watercourses. Under ACT 7/2010, the watercourse administrator is responsible for maintaining watercourses. The dominant administrator of watercourses is the Slovak Water Management Enterprise (SVP, š. p.), which manages 62% of the total length of watercourses in Slovakia (61,147 km). In addition to SVP, š. p., another important administrator is the State Forestry Organisation, which manages 32% of the total length of the watercourses. Municipalities are scarce administrators of watercourses and manage only 1% of the total length.

The watercourse manager is authorised to carry out management activities (sediment, vegetation, and debris interventions). The mayors expressed strong dissatisfaction with the authorities' maintenance of watercourses. Up to 79% of the respondents reported dissatisfaction with vegetation management (cutting of riparian vegetation, selective removal of riparian vegetation, maintaining the possibility of riparian areas, etc.). Similarly, a high percentage of respondents (74%) are dissatisfied with the way administrators carry out sediment and debris management (management of in-channel deposition and erosion, removal of fallen branches and trees, removal of organic and other debris from the channel bed or banks). Furthermore, 65% of respondents indicated that administrators undertake maintenance only upon explicit request, and that significant delays (sometimes lasting several years) often occur between the submission of a maintenance request and its implementation.

Given these circumstances, it is not surprising that almost 76% of respondents consider centralized watercourse management by state organizations – established by Act No. 7/2010 – to be ineffective. The main negative aspects of centralised state management of watercourses were seen by the respondents as: insufficient material, technical, financial, and human resources, excessive bureaucracy, and inflexibility. Only flood emergencies are dealt with, and there is no preventive maintenance. On the other hand, the possession of suitable equipment for the maintenance of watercourses, the professionalism of the SVP staff and the fact that the municipality does not have to take care of the watercourses were seen as positive aspects of centralised watercourse management.

Despite the high level of dissatisfaction with the way in which watercourses are managed, only 32% of respondents were in favour of municipalities becoming watercourse administrators. For respondents, the management of watercourses was primarily dependent on the state providing adequate funding for municipalities to maintain watercourses.

6. Discussion

An analysis of the questionnaire responses using the three resilience indicators shows that current flood risk management at the local level is unsatisfactory from a resilience perspective, particularly with regard to the strategy and measures indicator and the governance indicator. These indicators point primarily to a lack of diversified management approaches and highly centralized flood risk governance. The findings from the questionnaire are consistent with the conclusions of the study by Hegger, Driessen, Bakker (2016) regarding the necessity of decentralizing flood risk governance to achieve societal resilience to floods through diversified strategies. Consequently, the existing legislative framework in Slovakia – characterized by centralized state governance emphasizing technical flood protection infrastructure – constitutes a primary limiting factor for resilient flood risk management at the local level.

One of the key tools for flood risk management at the local level should be spatial plans of municipality Despite the fact that as many as 62% of respondents stated that they have an approved municipal spatial plan, however as showed Solín, Sládekova Madajová (2023), spatial plans currently play only a formal role in flood risk management and representing another limiting factor for achieving resilient flood risk management. Local authorities lack sufficient powers to actively pursue local flood risk policies such as enhancing retention capacities through eco-stabilization measures, maintaining watercourse capacities, and reducing flood impacts through functional spatial arrangements and integrated flood risk management at the catchment level is largely overlooked.

The results presented above suggest that flood risk management at the local level is currently unsatisfactory in terms of resilience-oriented management. Several key challenges hinder its effective implementation:

1. In the context of the Flood Hazards Knowledge indicator, a key challenge is to revise the current approach to preliminary flood risk assessment so that areas of potentially significant flood risk are identified. Instead of the previously used preliminary assessment of flood risk based on the identification of critical river sections in terms of overtopping, it is desirable to proceed to an assessment based on a systematic evaluation of the physical-geographical characteristics of cadastral areas and watercourses in terms of their impact on flood hazard (Solín, Rusnák 2020; Solín, Sládekova Madajová, Michaleje 2024). Such an approach would replace the existing binary risk assessment with a more detailed, multi-scale evaluation, providing a rational basis for applying flood risk management across all municipalities, differentiated by flood risk level. Additionally, it is essential to address the inadequate availability of GIS software, which currently limits municipalities' ability to effectively process and spatially visualize flood risk knowledge.

2. In the context of the Strategy and Actions indicator, *increasing resilience* requires adopting diversified flood risk management at the river basin scale rather than focusing exclusively on technical flood protection measures for isolated river sections. It is neither feasible nor environmentally desirable to install technical flood protection infrastructure on every watercourse that floods. The dominant strategy of relying solely on constructing technical infrastructure also faces significant financial constraints, as the state budget has long struggled to provide adequate resources to maintain existing flood protection measures, let alone build new ones. Consequently, creating a legislative framework that enhances the role of municipal spatial plans as effective local flood risk management tools is crucial. However, achieving diversified flood risk management is closely interconnected with improvements in flood risk governance.
3. A critical step toward greater resilience involves transitioning to decentralized flood risk management characterized by a clearly defined hierarchical structure. This requires legally specifying flood risk management actors at national, regional, and local levels, clearly delineating their responsibilities, securing adequate financial resources, and establishing effective communication channels to ensure alignment of management objectives across different hierarchical levels. Decentralization would strengthen the capacities and powers of local governments, enabling them to proactively undertake systematic watercourse maintenance and implement eco-stabilization and erosion-control measures on forest and agricultural lands, as outlined in spatial plans. Such measures would significantly contribute to flood risk reduction at the local level.

In conclusion, it is important to emphasize that resilient management – which is primarily associated with decentralized management and the implementation of a diversified set of measures (integrated management) to reduce flood risk – is particularly effective in mountainous countries. In these countries, which include Slovakia, management efforts focus primarily on eliminating local factors contributing to both fluvial and pluvial flood hazard in small watersheds. Flood management in small mountainous, foothill, and hilly watersheds is essential for reducing flood risk in the lower reaches of lowland watercourses. Local and regional government bodies play a crucial role in this regard. And the research presented in the article is fully justified. This is somewhat less relevant in the case of lowland countries already crossed by major waterways, or countries at risk of flooding from the sea. In these countries, a centralised governance of flood risk – based exclusively on the development of costly technical infrastructure – has proven to be more effective (Liefferink et al. 2018).

The results of this study should be interpreted in light of several limitations. First, the analysis is based on questionnaire responses from 499 mayors, representing a subset of the 1,867 municipalities that were contacted. Although the number

of responses is sufficient to identify major trends and challenges in local flood risk management, the possibility of non-response bias cannot be entirely excluded. Second, the results rely on the perceptions and self-assessments of mayors and municipal leaders. Consequently, some responses may reflect subjective evaluations rather than the actual state of flood risk management. This is illustrated, for example, by discrepancies between respondents' answers and the official classification of municipalities in areas with potentially significant flood risk.

Another limitation relates to the heterogeneity of the respondent municipalities. The survey included municipalities of different population sizes, and it is possible that local capacities, financial resources, staffing levels, and experience with flood risk management vary according to municipality size. From a methodological perspective, this raises the question of whether the size of the municipality influences the nature of the responses provided. However, Act No. 7/2010 defines the responsibilities of municipalities regarding flood protection irrespective of their size. For this reason, the present analysis focuses on the substantive content of the responses rather than on differences among municipality size categories. While a more detailed analysis based on municipality size could provide valuable insights into the variability of local flood risk management capacities and perceptions, such an analysis falls beyond the scope of the present study and may represent an interesting avenue for future research. Nevertheless, it is unlikely that it would substantially alter the main conclusions regarding the capabilities and limitations of local governments within the current legislative framework for flood risk management.

Third, the study focuses exclusively on the perspective of local governments. Other important stakeholders involved in flood risk management, such as watercourse administrators, regional authorities, landowners, and local residents, were not included in the survey. This limitation is particularly relevant because resilient flood risk management depends not only on the capacities of local authorities but also on the active involvement of the public in flood risk reduction (APFM 2006). Public participation includes engagement in decision-making processes related to the selection of flood risk mitigation measures (e.g., Raška et al. 2020), as well as individual responsibility for protecting property and enhancing the capacity to cope with flood impacts. However, this aspect was not addressed in detail in the present study because it requires a different target group of respondents and a different survey design. Moreover, the issue of household vulnerability and social resilience has already been examined in detail in our previous research (Solín, Sládeková Madajová, Michaleje 2018). In that study, three key dimensions of household social resilience were assessed: (i) the susceptibility of household property to damage, (ii) the propensity of household members to suffer physical and psychological harm, and (iii) the household's ability to cope with the negative impacts of floods.

7. Conclusion

Local-level management plays a crucial role in achieving resilient flood risk management. In this context, the key question is whether local authorities are adequately prepared to implement resilient approaches. The answer to this question is based on empirical insights obtained from mayors via a web-based questionnaire evaluating three basic indicators of resilience-oriented management: (i) knowledge indicators, (ii) policies and measures indicators, and (iii) flood risk governance indicators.

The obtained results indicate that current flood risk management at the local level is not satisfactory in terms of resilience. The primary obstacles include centralized flood risk management dominated by uniform technical flood protection measures, as well as the limited, largely formal role of local spatial plans in this context.

Most mayors considered centralized, state-managed watercourse maintenance ineffective. Despite this dissatisfaction, the majority did not support transferring watercourse management responsibilities directly to municipalities. Mayors also reported rarely being approached by the primary water management authority (SVP, š. p.) to collaborate in developing preliminary flood risk assessments or flood risk management plans. Furthermore, most mayors viewed their current powers to reduce flood risk at the local level as insufficient. The main factors limiting active municipal involvement in preventive flood hazard management include inadequate financial resources, insufficient legal authority, and the lack of systematic flood hazard assessment within municipal cadastral areas.

Although most mayors considered existing technical flood protection infrastructure sufficient, they called for the implementation of comprehensive basin-wide water retention measures. They also expressed significant dissatisfaction with watercourse administrators neglecting the maintenance of smaller watercourses, thereby failing to eliminate local factors accelerating flood occurrences.

Several challenges must be addressed to achieve resilient management. Regarding flood hazard knowledge indicators, it is essential to change the current approach to preliminary flood risk assessments. In terms of strategies and measures, the challenge of enhancing resilience lies in adopting diversified flood risk management strategies that cover the entire cadastral area. Establishing a clear legal framework for municipal spatial plans to serve as effective local flood risk management tools is particularly critical.

Concerning the governance indicator, there is a need to move toward decentralized flood risk management. At its core, decentralized flood risk management requires clearly defined responsibilities, sufficient financial resources, and effective communication channels among national, regional, and local actors to ensure coordinated objectives across hierarchical levels.

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Deconstructing the (geo)political identity of the Gagauz: Why is the quadratic nexus out of tune?

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ABSTRACT This article examines the formation of geopolitical and ethnic identity in the Autonomous Territorial Unit of Gagauzia in Moldova through the lens of constructivist nationalism theories, critical geopolitics, and Smith's concept of the quadratic nexus. Based on 12 semi-structured interviews conducted across the political, media, educational, and business sectors, the study demonstrates the existence of a deep "identity paradox" in which ethnic Turkic identity is decoupled from geopolitical orientation. Despite strong cultural and historical ties to Turkey and significant economic support from the European Union, Gagauz society remains predominantly oriented toward Russia. The article argues that pro-Russian geopolitical identity functions as a defensive mechanism protecting the ethnic boundary against perceived assimilation by the Moldovan state. The findings challenge the deterministic assumptions of the quadratic nexus by showing that external normative and economic incentives are filtered through historical trauma, motivated reasoning, and geopolitical stratigraphy actively reproduced by sub-state political elites and the Russian-speaking media space.

KEY WORDS Gagauzia – Moldova – geopolitical identity – ethnic identity – quadratic nexus – Russkiy mir

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1. Introduction

Since the collapse of the Soviet Union in 1991, the process of formation and transformation of national, ethnic, and geopolitical identities in the post-Soviet space has represented one of the most intense subjects of academic interest within political geography, ethnographic studies, and international relations (for a literature review see Jelen, Kopeček, Lepič 2026). The collapse of the centralized Soviet empire did not only trigger an institutional and economic transition, but also unleashed deeply frozen socio-cultural processes. The original Soviet nationality policy, which for decades systematically aimed to create an anational, secularized, and ideologically unified civic identity in the form of the "Soviet person" (*sovetskyi chelovek*), failed to eliminate ethnic interests (Dostál 1989, Friedgut 1992, Gitelman 1992). As the dramatic developments at the end of the 1980s demonstrated, the institutional architecture of Soviet federalism to some extent preserved ethnic identities and prepared the ground for their explosive political mobilization (Gleason 1990, Kaiser 1994, Tishkov 1996). The moment Gorbachev's reforms of *glasnost* and *perestroika* weakened the repressive apparatus of the center, ethnic nationalism became the primary political program for both the titular nations of the union republics and specific sub-state national minorities (Connor 1992, Beissinger 1992). These groups began to feverishly search for and redefine their geopolitical, cultural, and civilizational anchoring in the newly emerging independent states, which often led to a deep fragmentation of the nascent political communities.

A textbook yet still insufficiently explored example of this complex transformation, internal hybridity, and permanent clash of identity narratives is the Republic of Moldova. Since gaining sovereignty, the political and discursive environment of Moldova has been defined by a deep polarization that paralyzes its state-building project. Society and political elites are structurally split along a line oscillating between a pro-Western, Europeanizing direction of the country (often linked to a pan-Romanian cultural narrative) and a defensive inclination toward the post-Soviet geopolitical space, personified by the concept of the "Russian World" (*Russkij mir*). While at the national level we have witnessed a gradual, albeit fragile, consolidation of pro-European political forces over the past decade – as demonstrated by the results of the presidential and parliamentary elections between 2020 and 2025 – at the regional level Moldova exhibits extreme divergence (Baar, Jakubek 2017; Kosienkowski 2021; O'Loughlin, Toal, Chamberlain-Creangă 2013; Simionov 2023; Roper 2001).

A specific and highly anomalous phenomenon in this regard is the Autonomous Territorial Unit of Gagauzia (ATUG), located in the south of the country. The Gagauz represent a fascinating entity: they are a Turkic people who, however, profess Orthodox Christianity and use Russian as their main language of communication. In the early 1990s, Gagauzia went through a phase of radical ethno-political

mobilization and declared a de facto independent republic, thereby becoming a prelude to the bloodier conflict in Transnistria. Unlike Transnistria, however, the tension in the south was successfully resolved peacefully in 1994 through the granting of broad, constitutionally guaranteed territorial autonomy (King 1997, Zabarah 2012). From the perspective of liberal ethnic reconciliation theory, this step was supposed to lead to the gradual integration of the minority into the structures of the modernizing Moldovan state.

Over the past three decades, the European Union, the Council of Europe, and other Western donors have invested massive financial and normative capital into the infrastructure, civic society, and economic development of Moldova and as well Gagauzia (Morar, Dembińska 2021; Całus, Kosienkowski 2018). The assumption was clear: socio-economic modernization under Western guidance was meant to transform the loyalty of the minority (Kymlicka 2018). However, the reality of 2026 points to the failure of this linear assumption. No identity conversion with the majority society or internalization of pro-European values occurred among the Gagauz population or their political representatives. On the contrary, with Chisinau's growing pressure toward Europeanization and the escalation of the geopolitical conflict in Eastern Europe, Gagauzia has transformed into a rigid, pro-Russian bastion. Today, Gagauz elites openly rely on Turkey's economic aid and EU development funds, yet politically, culturally, and civilizationally they turn their eyes exclusively toward Moscow (Holsapple 2023, Kosienkowski 2021).

This obvious and deepening contradiction between material reality (Western and Turkic financial support) and the ideological, discursive anchoring (pro-Russian geopolitical identity) reveals fundamental theoretical and empirical gaps in existing social science research on ethnopolitical conflicts. Current models fail to satisfactorily explain why a minority rejects rational economic incentives for integration and chooses a strategy of geopolitical resistance.

The primary objective of this article is to deconstruct the (geo)political identity of the Gagauz at both the micro and macro levels and to analyze the structural tensions between their ethnic identity and geopolitical orientation. To integrate the theoretical framework with the empirical findings and conclusions, the study addresses three research questions:

1. How does Gagauz ethnic identity respond to the assimilatory pressures exerted by the central state, and how are historical traumas (the so-called maps of pain) activated in this interaction?
2. What is the relationship between the pragmatic economic dimension (the utilization of Western financial assistance) and the rigid pro-Russian cultural-historical dimension within the minority's geopolitical stratigraphy?
3. Why do the normative and economic influences of international institutions fail to produce the expected outcomes, resulting in a divergence from the theoretical predictions of the quadratic nexus model?

To guide the empirical analysis, the study formulates three analytical propositions:

A. The decoupling proposition: Among the Gagauz, ethnic origin has become anomalously detached from geopolitical identity. Pro-Russian orientation is not an exclusive attribute of ethnic Russians but functions as a distinctively Barthian shield protecting the ethnic boundary against perceived assimilation by Chișinău.
B. The cognitive filters proposition: External normative and material incentives provided by the European Union and Turkey do not foster minority integration. Instead, they are reinterpreted through the cognitive filters of historical memory and motivated reasoning as existential threats, thereby reinforcing a defensive pro-Russian orientation.
C. The sub-state brokerage proposition: This identity paradox, together with the persistent fear of assimilation, is actively maintained and instrumentalized by sub-state political brokers and a heavily saturated pro-Russian media environment in order to preserve their political dominance.

Addressing these objectives not only enables a reassessment of existing structural models by incorporating an overlooked bottom-up perspective but also provides a theoretical foundation for future comparative research on other atypical Russophile minorities across the post-Soviet space.

2. Theoretical framework: Geopolitical identity and the quadratic nexus

2.1. The limits of the quadratic nexus concept in the post-Soviet space

For a theoretical understanding of the dynamics of relations between ethnic minorities, majority societies, and external actors in the post-communist studies, the conceptual model of the so-called *triadic nexus* developed by Rogers Brubaker (1995) was dominant. That viewed ethnopolitics as a dynamic field of constant negotiation, tension, and interaction among three distinct actors: (1) the *nationalizing state*, meaning a newly emerged or restored state whose political elites attempt to assert the cultural, linguistic, and political hegemony of the titular nation; (2) the *national minority*, which perceives this pressure as an existential threat and mobilizes to defend its identity; and (3) the *external national homeland* (or *kin-state*), which shares an ethnic origin with the minority and declares itself its legitimate international protector (Brubaker 1995, 2011).

With the onset of post-communist transformation and the ambitions of Central and Eastern European states to integrate into Euro-Atlantic structures, however, Brubaker's triadic model proved to be too reductionist. It did not account for the massive influence of supranational actors who fundamentally redefined the rules

of the game. David J. Smith (2002) responded to these limitations by transforming the model into a *quadratic nexus*. Smith integrated a fourth field into the scheme – international institutions and Euro-Atlantic structures (represented primarily by the European Union, OSCE, Council of Europe, and NATO). According to Smith's theory, this fourth dimension was meant to function as a key stabilizer and normative arbitrator. Through conditionality policies (economic incentives, the promise of integration, development funds), international institutions were supposed to compel *nationalizing states* to implement liberal standards for protecting minority rights, while simultaneously pacifying the radicalism of the *minority* by offering them legal guarantees and socio-economic development, thereby eliminating the need to resort to the revisionist protection of a *kin-state* (Lepič 2026, Smith 2020).

The case of Gagauzia, however, exposes a theoretical gap in Smith's optimistic linearism. In the spirit of the *quadratic nexus*, the massive presence of the EU and its financial injections into the infrastructure of the autonomy should lead to the gradual "Europeanization" of the minority and to the weakening of the influence of the revisionist *kin-state* (in this case, Russia as a geopolitical surrogate homeland). In the reality of Gagauzia, however, we see the exact opposite: although local actors materially absorb Western normative and financial impulses, at the discursive level they reinterpret them as a threat of their autonomy and identity (O'Loughlin, Toal, Chamberlain-Creangă 2013). The *quadratic nexus* model fails here because it suffers from *structural determinism* – it assumes that external institutional stimuli affect actors directly and rationally. It overlooks, however, the cognitive, psychological, and discursive filters through which local communities interpret international pressure. To understand why this model shows a structural mismatch in Gagauzia, we must shift from describing institutional fields to a deep conceptualization of *geopolitical identity*.

2.2. Conceptualization of geopolitical identity

Within critical geopolitics, identity is viewed not as a static, essential feature written down in demographic tables, but as a dynamic, constantly reconstituted, and performative process (Tuathail, Dalby 1998). Dijkink (2002) argues that the geopolitical identity and the resulting foreign policy preferences of sub-state communities are not the result of a cold, rational calculation of geographical reality, but are deeply saturated with emotions and historical memory. He introduces the term *"maps of pride and pain"*. In the course of its historical genesis, each community constructs a mental map of the world onto which it projects traumas from experienced injustices, oppression, and assimilation (pain), alongside moments when it experienced security, prosperity, and recognition (pride). These maps subsequently function as rigid cognitive filters: external actors who are historically

associated with "pain" are *a priori* perceived with distrust, regardless of their current policies, while actors associated with "pride" are uncritically internalized as protectors (Dijkink 2002).

However, this identity does not maintain itself on its own. As Tuathail (1994) adds, (geo)political identity must be constantly practiced, narratively reproduced, and performed in everyday life. This process takes place through banal geopolitics – via school curricula, rituals, celebrations of historical anniversaries, consumption of specific media, and everyday political discourse. Identities are constantly in the process of becoming, which opens up space for their political instrumentalization.

When applying these concepts to the post-Soviet space, however, it is necessary to avoid the analytical trap of ethnic reductionism, which assumes that ethnolinguistic affiliation automatically determines geopolitical orientation (e.g., the equation: I speak Russian = I want to belong to Russia). Gentile (2015) responds to these limits with the concept of *political stratigraphy*, arguing – using the example of the Ukrainian Donbas – that geopolitical identity in post-Soviet borderlands resembles geographical layers (geopolitical stratigraphy). In the minds of individuals and entire communities, different, often seemingly contradictory identity sediments coexist. An individual may have a deeply rooted cultural and historical pro-Russian layer (nourished by family memory and language), but above it, there may be a pragmatic, economic pro-Western layer that responds to material benefits and the desire for modernization. Which of these layers is activated at any given moment and becomes dominant for political action does not depend on ethnic origin, but on a specific configuration of socio-economic factors, social class, achieved education, and the current political context (Gentile 2015).

This process of selective activation of identity layers is inextricably linked to the role of political elites. Stebelsky (2018), comparing the divergent developments in Kharkiv and the Donbas after 2014, shows that the transformation of latent regional identities into open political conflict or stability is a direct consequence of the clash of narratives that elites actively construct and disseminate. The geopolitical identity of a region is not fixed; it is modeled by which historical myths and geopolitical fears local leaders activate through the media. Local elites in these transit spaces function, within the scope of the concept by Morar and Dembińska (2021), as international brokers. These brokers operate within Putnam's two-level game: they exploit the geopolitical ambivalence and identity fears of the local population (internal level) to secure a political monopoly and legitimacy, while simultaneously using this radicalized local identity as a bargaining chip and tool of blackmail against both the central government and external powers (external level; Putnam 2017).

2.3. Confronting geopolitical and ethnic identity

By connecting these perspectives, we arrive at the core of the theoretical paradox represented by the Gagauz case and at the necessity of confronting the concept of geopolitical identity with classical theories of nationalism and ethnicity. Classical modernist theories of nationalism, represented by Anderson (1983) and Gellner (1983), assumed that the processes of modernization, industrialization, and modern state-building inevitably lead to the cultural and linguistic homogenization of populations within the borders of a given political unit.

Gellner (1983) argued that modern industrial society requires a universal "high culture" and a unified literary language, ensured through the state educational system. The state thus mechanically assimilates or integrates peripheral regions. Anderson (1983) defined the nation as an "imagined political community". This community is constructed through print capitalism – through the mass dissemination of information in a unified language via media, enabling individuals who will never personally meet to imagine themselves as part of one national body sharing the same time and space.

The Gagauz case, however, does not confirm these modernist assumptions. Since 1991, Moldova has attempted Gellnerian homogenization and nationalization through the promotion of the Romanian language and the implementation of a pro-European curriculum (Chinn 1994, King 1997, Putină 2011). According to Gellner, a small national minority should gradually succumb to this pressure and integrate. Yet the Gagauz responded to this pressure through a specific self-preservation reflex that can be explained through Barth's (1998) concept of the ethnic boundary, which a group actively maintains and socially constructs against "the others" (us versus them). Cultural markers may change, language may even be forgotten, but as long as the boundary of distinctiveness is preserved, the ethnic group survives.

In Gagauzia, an interesting phenomenon emerged: in order to preserve their Barthian ethnic boundary against the Gellnerian nationalizing pressure of the Moldovan state, the minority effectively abandoned the development of its own language as the primary marker of identity and instead adopted the Russian language and a pro-Russian geopolitical identity as its defensive shield. Pro-Russian orientation became the key political marker through which the Gagauz fixed their distinctiveness from Chișinău and, by extension, from Romania (Baar, Jakubek 2017). Their Andersonian "imagined community" thus acquired a schizophrenic character: on the basis of ethnic origin, they recognize a sense of kinship with Turkey, yet their everyday informational space (saturated by Russian media) and shared historical myths integrate them into the imagined community of the "Russian World" (Kosienkowski 2021).

Geopolitical identity was therefore fully instrumentalized for the protection of the ethnic boundary. In order to understand how this deep tension emerged,

it is now necessary to analyze in detail the historical trajectories of the region's development.

3. Historical context: The development of Gagauz identity and tensions with Moldovan state-building nationalism

3.1. The interwar period: Bessarabia under Romanian rule and the origins of alienation

The historical genesis of modern Gagauz identity and its deeply rooted distrust of state-building projects associated with Romanian linguistic and cultural centers is a direct consequence of a series of traumatic historical ruptures. The ethnic origins of the Gagauz and their settlement in the Budjak region (present-day southern Moldova and southwestern Ukraine) constitute a complex historical phenomenon. Although competing scholarly hypotheses exist regarding their precise ethnogenesis – the most widely accepted tracing their ancestry to the Turkic Oghuz, Pecheneg, and Cuman tribes that adopted Eastern Orthodox Christianity in the Balkans – the decisive geopolitical turning point in the formation of their modern identity occurred at the turn of the eighteenth and nineteenth centuries.

As a consequence of the Russo-Turkish wars, the then bilingual or Turkic-speaking Orthodox Christian Gagauz left their homes in Ottoman Dobruja and northeastern Bulgaria in large numbers in order to escape religious persecution. The Russian Empire offered them fertile land, exemption from taxation and military service, and the opportunity to settle in the newly annexed territory of southern Bessarabia (Budjak) in exchange for loyalty and the colonization of this strategically important frontier region (King 1997; Sağlam, Adıgüzel 2021). This episode permanently linked Gagauz security and collective existence to the Russian imperial space, transformed Budjak into their new homeland, and laid the foundations for a durable narrative portraying Russia as the historical protector and guarantor of Gagauz survival.

Subsequent developments throughout the twentieth century only reinforced this trajectory (e.g., King 1997, Simionov 2023). The first major formative shock occurred immediately after the First World War and the collapse of the Russian Empire, when Bessarabia was incorporated into Greater Romania (România Mare) in 1918. For the Gagauz population, which had until then enjoyed the privileges granted under Tsarist rule, the arrival of Romanian administration represented a profound rupture and the abrupt dismantling of the existing political and social order (Kosienkowski 2017, Roper 2001).

Bucharest viewed the newly acquired Bessarabian periphery with deep suspicion. Minorities were perceived as a potential fifth column of the revisionist Soviet Union, leading to the implementation of an aggressive and highly centralized policy

of nationalization and assimilation (Sağlam, Adıgüzel 2021). The Romanian state attempted rapid Gellnerian homogenization through the total Romanianization of the educational system, public administration, and the unification of religious life under the Romanian Orthodox Church. For the Gagauz, as a Turkic minority whose identity was Orthodox but linguistically entirely distinct, the prohibition of using languages other than Romanian in the official sphere represented profound marginalization (King 1997, Mayer 2014).

This assimilatory pressure triggered a deep defensive reflex among the Gagauz and fostered the emergence of strong anti-Romanian sentiment. The interwar period became embedded in the community's collective memory as an era of economic exploitation, cultural oppression, and social degradation. In terms of Dijkink's (2002) theory, this historical period laid the foundation for the Gagauz "map of pain". Fear of "Romanianization" and the loss of distinctiveness became a permanent trauma transmitted from generation to generation, one that modern local political actors are able to reactivate with remarkable effectiveness whenever Chișinău attempts rapprochement with Bucharest or the West.

3.2. The Soviet era: Institutionalization of ethnicity, Russification, and the trauma of modernization

The decisive rupture that structurally redefined the internal configuration of Gagauz identity and connected it to the Russian geopolitical space came with the Second World War and the subsequent Soviet annexation of Bessarabia in 1940 (definitively consolidated after 1944), which led to the creation of the Moldavian Soviet Socialist Republic (MSSR). Soviet nationality policy, shaped by Stalinist *korenizatsiya* and its later evolution (Jelen, Kopeček 2026; Shcherbak 2015), applied a highly ambivalent strategy toward the Gagauz. On the one hand, the Soviet regime formally institutionalized and made Gagauz ethnicity visible. For the first time in history, the Gagauz were officially recognized as a distinct nationality rather than merely a linguistic anomaly. In 1957, the Soviet Academy of Sciences created the first official Cyrillic alphabet for the Gagauz language, enabling limited education and publishing in the native language (King 1997; Sağlam, Adıgüzel 2021).

On the other hand, this process of cultural recognition was accompanied by brutal social engineering, Stalinist repression, forced collectivization of the agrarian south, and the catastrophic man-made famine of 1946–1947, which decimated the Gagauz population demographically (many villages lost up to one-third of their inhabitants; Hatłas 2009). Despite these documented atrocities of the totalitarian regime, the Soviet era paradoxically strengthened long-term Gagauz loyalty toward the Soviet-Russian system. The key mechanism behind this process was massive state-directed linguistic Russification.

Russian was projected by the Soviet regime as the universal language of progress, science, industrialization, and social mobility (Dostál, Knippenberg 1979). Because Gagauz was primarily a rural language lacking developed literary and scientific terminology, and because educational experiments in Gagauz were abandoned in the 1960s, the Gagauz massively and voluntarily adopted Russian as their primary "high culture" (Roper 2001). Total assimilation occurred, but not into the Moldovan/Romanian environment; rather, into the Russian-speaking sphere (Crivenco, Jelen 2026; Mayer 2014).

This linguistic shift was accompanied by intensive ideological indoctrination by Soviet historiography, which systematically constructed the concept of artificial Moldovanism (*moldovenism*) in the MSSR. This narrative strictly separated Moldovan identity from Romanian identity and portrayed Tsarist Russia, and later the Soviet Union, as the historical savior of both peoples from Romanian fascism, bourgeois oppression, and Western imperialism (O'Loughlin, Toal, Chamberlain-Creangă 2013). For the Gagauz, Soviet identity became synonymous with modernization, urbanization, and security. Ethnic identity (Turkicness) was reduced to a folkloric and decorative dimension (dance ensembles, wine festivals), while geopolitical and civilizational identity became fully integrated into the Soviet, and subsequently Russian, world (Kosienkowski 2021). Thus emerged a deep Soviet nostalgia that survived the collapse of the regime itself.

3.3. The collapse of the USSR, Moldovan independence, and ethnic mobilization

When the Soviet imperial structure began collapsing in the late 1980s under the weight of internal economic contradictions and Gorbachev's political liberalization, the newly opened institutional space in the MSSR was immediately occupied by radical majority nationalism institutionalized in the Moldovan Popular Front (*Frontul Popular din Moldova*). During this early and turbulent phase, the state-building project of the new Moldova sharply distanced itself from the Soviet narrative of moderate Moldovanism and fully embraced aggressive pan-Romanian nationalism. The dominant political discourse in Chișinău revolved around immediate reunification with Romania, accompanied by openly chauvinistic rhetoric toward non-titular minorities (King 1997, Zabarah 2012).

The turning point that triggered immediate ethno-defensive mobilization in the peripheries was the adoption of the language law in August 1989. This law declared Moldovan (Romanian), written in the Latin alphabet, the sole state language and mandated its compulsory introduction into administration and education, effectively marginalizing the entire Russian-speaking population overnight (Roper 2001). For the Gagauz, who at that time practically did not

speak Romanian, this step represented an immediate threat of losing employment, social status, and cultural survival. The interwar trauma of assimilation was reactivated – Dijkink's "map of pain" became fully activated (Crivenco, Jelen 2026).

This nationalizing pressure provoked a wave of countermobilization. Whereas in industrial Transnistria, dominated by Soviet industrial elites of Russian and Ukrainian nationality, the reaction was primarily ideological and economic in defense of the Soviet status quo, mobilization in Gagauzia was purely ethnodefensive in line with Barthian boundary-making. In August 1990, local elites in Comrat proclaimed the independent Gagauz Republic (*Gagauz Yeri*) in response to Chișinău's declaration of sovereignty. Moldova effectively fragmented into three separate and mutually hostile entities (King 1997, Mayer 2014, Zabarah 2012).

Tensions peaked in October 1990, when Prime Minister Mircea Druc organized the so-called "march on Gagauzia", during which tens of thousands of nationalist Moldovan volunteers advanced toward Comrat with the aim of suppressing Gagauz autonomy by force. A bloody confrontation was prevented only at the last moment through the intervention of Soviet Interior Ministry troops and political pressure from Moscow. Unlike in Transnistria, where tensions escalated into full-scale war in 1992 with the assistance of General Lebed's Russian 14th Army, the conflict in Gagauzia remained within political boundaries. Gagauz elites soberly understood the limits of their geopolitical position: the region was agrarian, economically weak, geographically fragmented, and – unlike Transnistria – lacked territorial continuity with pro-Russian forces or a substantial industrial base, forcing them to seek an institutional compromise with the center (King 1997, Horák 2019, Zabarah 2012).

3.4. The autonomous status of 1994 and the institutionalization of geopolitical schizophrenia

A crucial structural turning point occurred after Moldova's parliamentary elections in 1994. Radical pan-Romanian forces suffered a crushing defeat, and the Agrarian Democratic Party of Moldova, together with the socialists, came to power. These forces revived the Soviet concept of moderate, sovereignty-oriented Moldovanism based on the country's multiethnic character and pragmatic relations with Moscow (O'Loughlin, Toal, Chamberlain-Creangă 2013). This political shift at the center opened a window of opportunity for a historic compromise. In December 1994, the Moldovan parliament adopted the constitutional Law on the Special Legal Status of Gagauzia (*Gagauz Yeri*), thereby formally dissolving the unrecognized republic and replacing it with the Autonomous Territorial Unit of Gagauzia (ATUG; Putină 2011).

In the mid-1990s, this institutional model was internationally celebrated (by the OSCE and the Council of Europe) as a unique, innovative, and peaceful solution to ethnic conflict through territorial autonomy in the post-communist space (Wöber 2013). Gagauzia obtained extensive powers: its own legislative body (*Halk Topluşu*), its own directly elected governor (*bashkan*), who automatically became a member of the Moldovan government, three official languages within its territory (Gagauz, Russian, and Moldovan/Romanian), with Russian remaining the dominant administrative language, and, most importantly, Article 1(4) of the ATUG Constitution, which guaranteed the minority the right to external self-determination (secession) should the Republic of Moldova lose its international legal sovereignty – an explicit constitutional safeguard against Moldova's unification with Romania (Horák 2019, Roper 2001).

However, this specific institutional architecture also produced an unintended long-term structural breakdown within the mechanisms of the quadratic nexus. While autonomy successfully integrated Gagauzia territorially and pacified the acute phase of the conflict, it also de facto institutionalized and froze its distinct identity. As convincingly demonstrated by Kosienkowski (2021), local Gagauz elites began using the newly acquired autonomous institutions as an autonomous platform for permanently building their political legitimacy upon total rejection of integration into Moldovan civic society and upon integration into the concept of the "Russian World" (*Russkiy mir*).

Whereas the modern Moldovan state-building project – especially after the watershed year of 2009 and definitively after 2020 under the presidency of Maia Sandu – became increasingly redefined through the lens of Europeanization, EU structural reforms, and a clear departure from Russia's sphere of influence, Gagauzia remained mentally, discursively, and institutionally anchored in the Soviet-Russian spacetime. This historical development created a unique environment of geopolitical schizophrenia: the region is economically dependent on subsidies from pro-European Chișinău and EU-funded projects, yet its Barthian ethnic boundary is continuously maintained in a defensive and aggressive mode against the center, while rigid and uncritical loyalty toward Moscow has become, in the minds of both elites and the population, the principal existential guarantee of autonomy. The findings from our 12 semi-structured interviews, which form the core of the following analytical section, vividly illustrate this deep contradiction between material reality and cognitive orientation.

4. Analysis of the interviews

4.1. Research methodology

Methodologically, this article is based on empirical research consisting of 12 in-depth semi-structured interviews with key experts and influential actors in local public life. The sample was constructed through purposive expert sampling to represent the four principal structural pillars shaping the regional geopolitical discourse (Toal 2000): the political sphere (P1–P3), the media environment (M1–M3), the educational sector (V1–V3), and the local business sector (B1–B3).

The primary inclusion criterion for participation was Gagauz ethnic origin combined with long-term active involvement within the local community. Given the specific socio-cultural environment and the potential distrust toward external researchers, informants were initially identified and approached through a key gatekeeper, followed by snowball sampling. This strategy enabled effective access to local elite networks and ensured a high degree of openness during the interviews (Hendl 2023).

Data collection was conducted sequentially in two phases. The first phase took place during fieldwork in autumn 2023 in the autonomous region, specifically in Comrat, Ceadîr-Lunga, and Vulcănești, as well as in Tiraspol and Chișinău outside the region. In spring 2024, the dataset was supplemented by additional online interviews reflecting the rapidly evolving geopolitical context. Individual semi-structured interviews lasted between 30 and 60 minutes and were conducted in English or Russian. With the informed and voluntary consent of all participants, the interviews were audio-recorded and subsequently transcribed verbatim. In accordance with ethical standards for qualitative research, all participants remain strictly anonymous and are identified only by their primary field of expertise and regional place of activity, thereby minimizing the risk of political or social repercussions.

The resulting textual corpus was subjected to a rigorous deductive thematic analysis (Braun, Clarke 2006), whose conceptual framework was derived a priori from the theoretical models of geopolitical stratigraphy and the quadratic nexus. Throughout the empirical analysis, respondents' statements are presented as edited quotations (Sandelowski 1994). These excerpts were subject to minor stylistic and grammatical editing, while preserving their substantive meaning and communicative intent, in order to enhance readability and argumentative clarity. Owing to space limitations, the analysis does not explicitly cite all twelve respondents. Instead, those quotations judged to be analytically most representative were purposively selected because they most effectively illustrate the theoretical concepts under investigation. This qualitative research design makes it possible to move beyond official political narratives and to examine the cognitive filters through which both ordinary citizens and local sub-state elites rationalize their paradoxical geopolitical preferences.

4.2. Political sphere: Sub-state brokers and the instrumentalization of fear

Interviews with representatives of the local political elite (P1–P3) clearly demonstrate the validity of Morar and Dembińska's (2021) concept of international brokers. For Gagauz political actors, the permanent maintenance of geopolitical tension between Chișinău and Moscow represents the primary source of their political survival and internal legitimacy. The discourse of political respondents is dominated by the narrative of the "existential threat to autonomy posed by Maia Sandu's pro-European government".

Respondent P1 (former politician, Comrat) explicitly stated:

"Under the guise of European integration, Chișinău is attempting the total liquidation of our autonomous powers. Every reform introduced by the central government is aimed at weakening Comrat. The European Union is a foreign project for us that does not respect our specific identity. Russia is our only real guarantor of sovereignty and rights. If Russia falls, Gagauzia will fall as well, and we will be assimilated by Romania."

This quotation vividly illustrates the activation of Dijkink's (2002) "map of pain" – European integration is not perceived as an opportunity for modernization, but is redefined through a cognitive filter of fear as a threat of assimilation. Political elites deliberately use Article 1 of the constitution concerning the right to secession as a political weapon.

At the same time, respondents in the political sphere display extreme pragmatism, confirming Putnam's two-level game. Respondent P2 (former civil servant, Ceadîr-Lunga) admitted:

"Of course we do not reject the money flowing here from European projects or from Turkey. Infrastructure is being built with Western money. But political loyalty is another matter. Turkey is our ethnic brother, but Russia is our civilizational protector. We have to maneuver. When Chișinău pushes too hard, we must go to Moscow to show that we have a powerful partner behind us."

This opportunistic calculation demonstrates how sub-state elites transform the quadratic nexus into their own business model: they absorb material benefits from one field (EU/Turkey), while drawing political legitimacy from another (Russia).

4.3. Media environment: Constructing the "imagined community" of the Russkiy Mir

Analysis of interviews with respondents from the media sector (M1–M3) reveals how the Andersonian "imagined community" is constructed on a daily basis in Gagauzia. The informational space in the region is completely saturated with

Russian narrative influence, creating a specific cognitive isolation from the rest of Moldova.

Respondent M1 (local media journalist, Comrat) described the situation as follows:

"The Gagauz population lives in a completely different informational spacetime than the rest of Moldova. People here do not watch Moldovan television stations because they do not understand them or deeply distrust them. The main sources of information are Russian satellite channels, Telegram social networks, and Sputnik. Perceptions of the war in Ukraine are radically different here – people do not perceive it as Russian aggression, but as a conflict between NATO and Russia in which Russia is defending traditional values. Media in Comrat must respect this narrative, because if you write in a pro-European way, you lose your audience and will be labeled a traitor."

This informational monopoly, however, is not sustained solely by secular media but is deeply intertwined with the religious sphere, which in the region remains under the jurisdiction of the Moscow Patriarchate. According to Kosienkowski (2021), the Orthodox Church in Gagauzia constitutes a key transmission node through which local elites sacralize the region's pro-Russian geopolitical orientation and transform it into a moral obligation to defend the Orthodox faith.

Respondent M2 (independent journalist, Chișinău) highlighted this close relationship between media and religious discourse:

"The media and the Church speak the same language here. Local priests enjoy enormous authority in the villages and essentially function as political commentators. When Russian television talks about the 'decadent West', the priest repeats the same message from the pulpit on Sunday, adding that the pro-European government in Chișinău wants to destroy the Orthodox family. Local media then reinforce these religious narratives. Orthodox Christianity has therefore become the principal argument for why we must remain loyal to Moscow. In popular understanding, being a true Gagauz means being an Orthodox Christian under Moscow's spiritual authority – anything else is regarded as a betrayal of one's identity."

This finding also confirms Stebelsky's (2018) argument regarding the clash of narratives. Russian media have successfully redefined the boundaries of the Andersonian community in the minds of the Gagauz population. Ethnic identity (Turkicness) is pushed into the background because the shared informational space integrates the population into the transnational "Russian World".

Respondent M3 (independent journalist, Comrat) additionally pointed to the phenomenon of motivated reasoning:

"People in Gagauzia actively filter reality. If you show them a new kindergarten built with EU money, they will say: 'That may be nice, but they are only doing it to bribe us and then sell us to Romania.' But when Russia sends symbolic assistance in the form of cheaper gas, people celebrate it as a brotherly rescue. Emotional attachment to Russia completely overwhelms rational facts."

4.4. Educational sector: Gellnerian schism and the reproduction of Russian narratives

Interviews with actors from the educational sector (V1–V3) reveal a deep Gellnerian tension between Chișinău's state educational policy and the local reality in Comrat. Education constitutes the main battlefield over the interpretation of history and linguistic dominance.

Respondent V1 (university lecturer, Tiraspol) explained the linguistic paradox of autonomy:

"Chișinău constantly pressures us to increase the share of instruction in the Romanian language. But we have neither teachers nor interest from parents for that. In our schools, the language of instruction is Russian. Gagauz is taught only as a subject, as folklore. Our children think in Russian, read Russian literature. When they leave for universities, they do not go to Chișinău because they do not know Romanian; instead, they go to Tiraspol, Moscow, or Saint Petersburg."

This quotation constitutes a direct confrontation with Gellner's (1983) theory. The Moldovan state is failing to implement its "high culture" on the periphery. Since the Gagauz language cannot fulfill the role of a universal language of modernization, Russian has fully assumed the role of Gellnerian high culture in Gagauzia. In this way, the status quo fixed during the Soviet era is reproduced.

Respondent V3 (university lecturer, Comrat) pointed to Barth's (1998) mechanism of boundary maintenance:

"The educational system in Gagauzia does not produce Moldovan citizens of Gagauz nationality. It produces Gagauz who define themselves in sharp opposition to the Moldovan state. Russian here serves not only as a communication tool; it is politics. As long as we speak and teach in Russian, Chișinău will not be able to assimilate us. The pro-Russian geopolitical orientation is therefore a direct product of our educational system, which conserves Soviet identity."

4.5. Local business: Geopolitical stratigraphy and the limits of economic pragmatism

Interviews with representatives of the business sphere (B1–B3) provide the clearest evidence of the geopolitical stratigraphy's presence. Entrepreneurs represent the only group in which a deep contradiction emerges between cultural sentiment and economic interest.

Respondent B1 (entrepreneur, Ceadîr-Lunga) described his internal identity tension:

"From a business perspective, we are fully integrated into the European market. Thanks to the free trade agreement (DCFTA), we export our wine to Poland, Czechia, and Germany. The Russian market is de facto closed to us because of Moscow's continual political embargoes. We earn our money in the West. European

funds helped us modernize our technology. If you asked me as a businessman, I would have to say that our future lies in the EU."

At this moment, it appears that the respondent is dominated by a pragmatic, pro-European layer. However, respondent B1 immediately added:

"But when I come home in the evening and switch off business, I am Gagauz. And as a Gagauz, I fear what Chișinău is doing. I fear that they will drag us into a war against Russia; I fear the loss of our traditions that Russia protects. So in a referendum I would still vote against the EU and in favor of the Eurasian Union. I know it is economically irrational, but identity is stronger than the wallet."

This fascinating quotation is the ultimate confirmation of the limits of economic determinism within the quadratic nexus. The entrepreneur explicitly admits that the cognitive layer of cultural sentiment toward Russia (Dijkink's map of pride) is placed higher in the hierarchy of values than material profit.

Respondent B2 (entrepreneur, Vulcănești) further develops this identity split in connection with the current crisis:

"The war in Ukraine complicated everything. We lost logistical routes to Russia, fertilizer prices skyrocketed. Chișinău tells us that Russia is to blame. But our people see it differently. They see it as the fault of Maia Sandu's pro-Western policy, which provoked Moscow. The external shock of war did not lead us to turn away from Russia. On the contrary, it increased our fear and bound us even more tightly to Russia. The crisis only strengthened our defensive pro-Russian identity, because we feel ourselves to be under total siege."

5. Discussion

5.1. The limits of the quadratic nexus

The synthesis of theoretical concepts and empirical findings makes it possible to formulate a revision of the existing political-science understanding of ethnopolitical processes in the post-Soviet space. The first major point of discussion is a radical critique of the structural determinism inherent in Smith's (2002) quadratic nexus model. The original model assumed that international institutions (the EU field) function as a rational, normative force capable of mechanically "rewriting" local nationalist and revisionist discourses through financial incentives and human-rights standards. However, this assumption completely fails when confronted with rigid, historically embedded identity structures. In such a case, ethnic minorities are forced to adopt individual strategies in relation to the majority and the state (Lepič 2026).

The case of Gagauzia clearly demonstrates that international pressure and EU incentives are not perceived objectively by the minority population; rather,

they are filtered through the prism of local power politics and historical traumas. Because Moldova's European integration objectively requires the centralization of standards, transparency, and public-administration reform, local Gagauz elites (acting as international brokers) have successfully redefined and presented it to the population as an "existential threat" to the very survival of Gagauz autonomy.

The discussion here introduces a fundamental theoretical shift: the fourth field of the quadratic nexus (the EU) does not necessarily function as a stabilizer of conflict but may unintentionally act as a catalyst of further polarization when it encounters rigid identity stratigraphy. Material assistance from the West is absorbed within the pragmatic layer (Gentile 2015), while political loyalty remains frozen within a deeper layer of cultural sentiment toward Russia.

5.2. The decoupling of ethnic and geopolitical identity

Classical literature on nationality politics (including Brubaker's early works) implicitly assumed that a minority's ethnic identity and geopolitical orientation exist in natural synergy – the minority logically looks toward the external power that shares its ethno-linguistic origin (the kin-state). The case of the Gagauz, however, represents a profound anomaly in which ethnic and geopolitical identity become completely decoupled.

While at the level of ethnic identity (linguistic origin and Turkic culture) there exists a strong transnational connection to Turkey, manifested through Ankara's massive investments in Comrat's infrastructure, Russia absolutely dominates at the level of geopolitical identity (foreign-policy orientation and civilizational loyalty).

This theoretical paradox can be explained precisely through the psychological mechanism of motivated reasoning described by our respondents from the media sphere. Gagauz geopolitical identity is not shaped by rational evaluation of contemporary benefits (the EU invests the most, Turkey builds hospitals and roads), but by a rigid pro-Russian narrative functioning as an absolute cognitive filter. The crucial integrative element that enables and legitimizes this decoupling is the institutional and discursive influence of the Russian Orthodox Church under the jurisdiction of the Moscow Patriarchate (Kosienkowski 2021). In this context, Orthodox Christianity functions not merely as a religious marker but as a sacralized civilizational bridge to Moscow, effectively redefining pro-Russian orientation as a moral obligation and as a defense against the secular West. Ethnic identity (Turkicness) is marginalized within the hierarchy of values and instrumentalized by local elites only when useful for balancing pressure from Chișinău. Geopolitical identity (the Orthodox "Russian World" and Soviet nostalgia, as discussed by Bakke, Rickard, O'loughlin 2023) becomes the primary cohesive force of the

minority. The Barthian ethnic boundary vis-à-vis Moldova is thus maintained not through the development of an autonomous culture, but through geopolitical attachment to Moscow. Pro-Russian orientation is perceived as the only reliable safeguard against Gellnerian assimilation by the central state.

5.3. Sub-state brokers as architects of "frozen integration"

Whereas Morar and Dembińska (2021) described international brokers as state-level political actors maintaining Moldova within a geopolitical gray zone between the West and Russia, the theoretical contribution of this article lies in transferring this concept to the sub-state, regional level. Interviews with political representatives (P1–P3) suggest that Gagauz regional elites actively exploit and reproduce tensions within the quadratic nexus in order to preserve their own power and economic interests.

For Gagauz sub-state brokers (bashkans, local oligarchs, and deputies), the ideal permanently maintained condition is what may be termed "frozen integration". If Gagauzia were to fully integrate into pro-European Moldova, local elites would immediately lose their exclusive role as "defenders of the nation" against Romanianization, forfeit their political monopoly, and be forced to submit to transparent rules and EU anti-corruption standards, which would destroy their clientelist networks. Conversely, if the region were to declare full separatism (following the model of Transnistria), its agrarian character and geographical isolation would lead to immediate economic collapse.

It can therefore be argued that local elites exploit the population's geopolitical stratigraphy: through total control of the local media environment, they continuously reinforce fears of assimilation by Chișinău and glorify Moscow. In doing so, they ensure that the population grants them a permanent democratic mandate to continue opportunistically maneuvering between Chișinău, Ankara, and Moscow. Sub-state elites have thus transformed the quadratic nexus into a highly profitable business model.

6. Conclusion

This article has conducted a theoretical and empirical deconstruction of the (geo) political identity of the Autonomous Territorial Unit of Gagauzia in Moldova. The research demonstrated that certain explanatory models of post-Soviet identity formation, especially the optimistic linearism of Smith's quadratic nexus concept, fail to adequately explain the ethnopolitical reality of this region. Massive financial and normative support from the European Union and Turkey has not resulted

in the integration of the minority into Moldova's pro-European state-building project; rather, it has generated a specific defensive reflex. Theory must therefore integrate psychological and cognitive filters, as well as the lived geopolitical stratigraphy of minorities (bottom-up), into its core analytical framework. These filters (motivated reasoning, maps of pain) determine whether external normative pressure (the EU) will be accepted by the community or whether it will provoke a radical defensive counterreaction.

Through the analysis of 12 in-depth semi-structured interviews across the political, media, educational, and business sectors, the research demonstrated the presence of profound geopolitical stratigraphy. Within the minds of local actors, a pragmatic economic dimension (the utilization of Western funds) coexists with a rigid, dominant cultural-historical pro-Russian dimension. This condition is actively maintained by sub-state political brokers, a saturated pro-Russian media environment and the institutional influence of the Russian Orthodox Church under the jurisdiction of the Moscow Patriarchate. Together, these actors sacralize geopolitical orientation toward Moscow, deliberately reactivate historical traumas (Dijkink's maps of pain), and reinforce fears of Romanian assimilation.

The case of the Gagauz provides a major theoretical contribution to the study of ethnicity by demonstrating the possibility of a complete decoupling between ethnic origin and geopolitical identity. It shows that a pro-Russian geopolitical identity in the post-Soviet space is not the exclusive domain of ethnic Russians (as is often assumed on the basis of studies of the Baltic states or Donbas), but can be successfully narratively and discursively grafted onto an atypical Turkic ethnic group when religion, historical memory, and linguistic Russification are effectively instrumentalized as tools for protecting ethnic boundaries.

The ethnic identity of the Gagauz has thus paradoxically detached itself from its linguistic and ethnic foundations and become linked to geopolitical loyalty toward Moscow, which functions as a Barthian shield maintaining the ethnic boundary vis-à-vis Chișinău. The case of Gagauzia therefore sends a clear signal to international policymakers and conflict theorists alike: economic conditionality and material incentives are powerless when confronted with deeply rooted identity structures and cognitive filters shaped by historical memory. Future research should focus on comparing Gagauzia with other atypical Russophile minorities in the post-Soviet space in order to verify the broader validity of the identity paradox described here.

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Spatial distribution pattern of rural tourism destinations in China and its influencing factors

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ABSTRACT Based on methods of kernel density estimation, standard deviation ellipse and Geographic Detector, we explored the spatial distribution pattern and influencing factors of China's 2495 rural tourism destinations. Results showed that China's rural tourism destinations increased rapidly from 2014 to 2022, but inter-provincial differences expanded, with South China region and the southern part of North China region gradually becoming areas with relatively abundant rural tourism resources. Central area of Beijing-Tianjin-Hebei district and central area of Yangtze River Delta always had the densest rural tourism destinations, making the spatial pattern showing a circle structure around the core node. Concentration trend of rural tourism destinations along the northeast-southwest axis was gradually obvious, and the gravity center showed a slow westward trend. Double superior rural tourism destinations were also mainly distributed in South China and North China regions, showing a trend of three pillars with more northerly gravity center. Spatial pattern of China's rural tourism destinations was affected by multiple factors, and the driving structure has transitioned from single-factor weak explanatory power to multi-factor strong synergistic effect.

KEY WORDS China's Beautiful Leisure Villages – China's Key Rural Tourism Villages – spatial distribution pattern – influencing factors

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1. Introduction

Research on the spatial patterns of rural tourism destinations is rooted in the tradition of regional spatial structure theory. Core-periphery theory provides a foundational explanatory framework for understanding spatial imbalances in the development of rural tourism destinations. This theory, together with growth pole theory and cumulative causation theory, jointly explains why rural tourism destinations exhibit spatial distribution characteristics such as being around cities or adjacent to scenic areas (Zhou, Deng 2024). Distance decay theory, on the other hand, explains the spatial agglomeration patterns of rural tourism destinations from the perspective of travel costs, and directly gave rise to the formation of the recreational belt around metropolis theory. These theories provide sufficient theoretical support for scholars studying the spatial patterns of rural tourism destinations.

Scholars started to study the spatial pattern and distribution law of rural tourism destinations early, mainly focusing on the spatial structure characteristics and driving factors of rural tourism destinations (Pearce 1999; Nepal 2005; Pulina, Dettori, Paba 2006; Li, Qin 2008; Baležentis et al. 2012), the spatial evolution characteristics (Christaller 1964), and the relationship between rural tourism activities and geospatial structure (Nilsson 2002). They payed attention to the application of theories and models, and commonly addressed the development of rural tourism and its impact on rural areas, with discussions conducted through case studies of typical examples (Iorio, Corsale 2010; Kim, Jamal 2015). For example, Sang-Hyun Lee (Lee et al. 2012) discussed the spatial centrality of 43 villages in South Jeolla Province, South Korea, and its value to integrated tourism management based on centrality theory. Barkauskas (Barkauskas, Barkauskienė, Jasinskas 2015) analyzed the influencing factors of rural tourism in Lithuania from the perspective of macro environment. However, previous studies mainly adopted qualitative methods with relatively simple analysis means and tools.

In the later period, characteristic towns emerged in Spain, France, America and other countries, evaluation systems of rural tourism destinations in China obtained continuous innovation such as China's Beautiful Leisure Villages, China's Key Rural Tourism Villages, China Rural Tourism Maker Demonstration Bases, China Important Agricultural Cultural Heritages and provincial rural tourism characteristic villages, making the spatial distribution of rural tourism destinations become a hot proposition by scholars, especially Chinese scholars. Research methods were increasingly rich and complex and tended to be quantitative, such as geographical concentration index(Xu et al. 2021), Gini coefficient (Lei, Liu 2021), geographical linkage rate (Jiao et al. 2018), spatial variation indicator (Zhang et al. 2019), nearest point index (Ma, Zhang, Huang 2023), global Moran's I index and LISA cluster maps (Sarrión-Gavilán, Benítez-Márquez, Mora-Rangel 2015),

kernel density estimation (Schivo et al. 2019), standard deviation ellipse (Zhu et al. 2023), geographic detector (Qi et al. 2022), Ripley's K function (Yang, Zhu 2023) and so on. Spatial patterns of multi-scale rural tourism destinations have been analyzed, including municipal, provincial, watershed, and national levels. In addition, further studies have been made on potential and accessibility of rural tourism destinations (González-Ramiro et al. 2016), influencing factors of spatial structure characteristics(Mitchell, Shannon 2018) and spatial optimization (Bian, Chen, Zeng 2022; Xie et al. 2022).

However, existing studies primarily take single official list as their research subject and focus solely on China's Beautiful Leisure Villages, China's Key Rural Tourism Villages, or single categories such as traditional villages, star-rated rural tourism sites or forest villages, which suffer from certain sample selection biases. Most studies employ cross-sectional data for analysis, placing villages selected in different years on the same temporal cross-section, thereby neglecting the dynamic evolutionary process of the spatial patterns of rural tourism destinations. In fact, the selection time spans of various batches of lists are considerably long, and differences in selection timing may lead to chronological misalignment in spatial pattern analysis. The study by Zhou et al. (Zhou, Deng 2024) is one of the few representative efforts that attempt to integrate multiple data sources. This research consolidated multiple inventories, including farm stays, homestays, National Demonstration Sites for Leisure Agriculture and Rural Tourism, China's Beautiful Leisure Villages, and China's Key Rural Tourism Villages, revealing the regional distribution patterns of rural tourism destinations as characterized by low mountains, proximity to water, adjacency to roads, surrounding cities, attachment to scenic spots, and multi-variability, marking a breakthrough in data coverage. Nevertheless, its spatial analysis remains primarily focused on static pattern descriptions, failing to fully incorporate the temporal dimension into spatial econometric models, and the considerable heterogeneity of data sources may lead to uneven data quality.

China initiated the selection of China's Beautiful Leisure Villages in 2014 and China's Key Rural Tourism Villages in 2019. By the end of 2022, a total of 1,659 villages had been designated as China's Beautiful Leisure Villages, while 1,366 villages had been listed as China's Key Rural Tourism Villages, reflecting China's abundant rural tourism resources. In 2019, rural tourism received 3.09 billion visits, playing a significant role in promoting rural revitalization and common prosperity. In-depth exploration of the spatio-temporal evolution characteristics and formation mechanisms of China's rural tourism destinations, along with efforts to promote the rational utilization and scientific layout of resources, can provide theoretical support and practical application for improving the quality of rural tourism supply, upgrading consumption, aiding in poverty alleviation, and boosting rural revitalization (Yang et al. 2021). This study integrates two

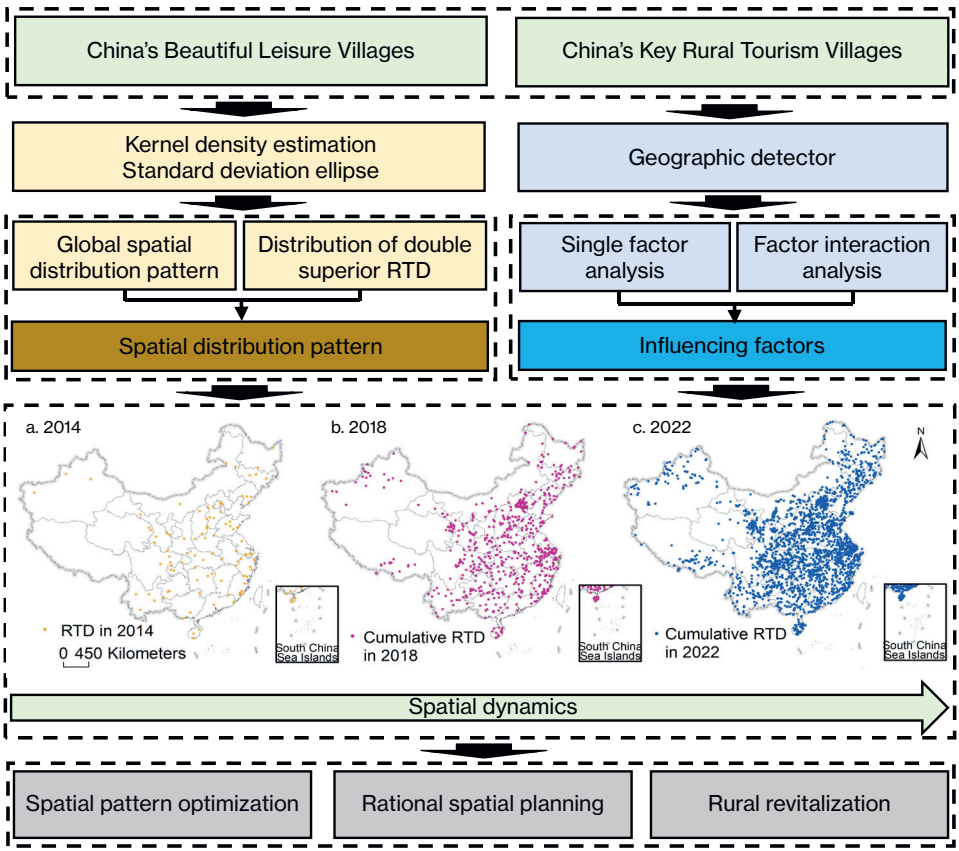


Fig. 1 – Contribution roadmap of this study. RTD – rural tourism destinations.

evaluation systems, namely China's Beautiful Leisure Villages and China's Key Rural Tourism Villages, to more comprehensively depict the spatial pattern of rural tourism destinations in China and further analyzes the influencing factors, aiming to support rational spatial planning, enhance the demonstrative role of key villages and towns, provide scientific basis for local government planning and spatial decision-making (Molinaro, Corrado, Scorza 2025), and promote high-quality development of rural tourism. The contribution roadmap of our study is shown as Figure 1.

The design of this study incorporates three aspects of innovations. Firstly, It integrates two official selection systems, namely China's Beautiful Leisure Villages and China's Key Rural Tourism Villages, and constructs a more complete rural tourism destinations sample through deduplication, which compensates for the coverage limitations of a single selection system and ensures consistency in data sources. Secondly, it covers the time span from 2014 to 2022 and incorporates

multiple batches of selection villages, laying the foundation for subsequently introducing a temporal dimension to analyze the spatial evolution characteristics of China's rural tourism destinations. Thirdly, our research integrates spatial data analysis with spatial econometric models to systematically examine the spatial dependence characteristics and driving factors of the spatial pattern of China's rural tourism destinations, thereby providing a scientific basis for rational spatial planning of rural tourism destinations.

2. Materials and methods

2.1. Data sources and processing

Nine batches of China's Beautiful Leisure Villages and four batches of China's Key Rural Tourism Villages during 2014 to 2022 were obtained from official website of the Ministry of Agriculture and Rural Affairs of the People's Republic of China as basic data, among which rural tourism destinations in Xinjiang Production and Construction Corps were not included in Xinjiang Uygur Autonomous Region. A total of 2,495 rural tourism destinations were sorted out by excluding the repeated rural tourism destinations in the list of China's Beautiful Leisure Villages and the list of China's Key Rural Tourism Villages, and the statistical years of repeated rural tourism destinations were the years of their first inclusion in either of the two lists. Then we obtained the latitude and longitude coordinates of 2495 rural tourism destinations from the website of Baidu Map Coordinate Pickup System as the initial data for the following studies.

Other data required in our study were mainly from the regional statistical bulletins on national economic and social development, statistical yearbooks, and official websites of the cultural and tourism departments. rural tourism destinations of Taiwan, Hong Kong and Macao were not included in the evaluation systems, so our research areas were other 31 regions in China, excluding Taiwan, Hong Kong and Macao.

2.2. Methods

2.2.1. Kernel density estimation

Kernel density estimation is used to analyze the distribution density of rural tourism destinations. Density field surface is constructed by calculating the densities around the elements of rural tourism destinations, and transformation of the elements from discrete to continuous fields is realized through smooth gradient

surfaces (Gao et al. 2023). The higher the kernel density value, the denser the distribution of rural tourism destinations, and vice versa. The formula for calculating kernel density (Zheng, Tian, Yang 2021) is:

$$f(x) = \frac{1}{nh} \sum_{i=1}^{n} k\left(\frac{x - x_i}{h}\right)$$

Where: $f(x)$ represents the estimated kernel density of rural tourism destinations, n is the number of sample points of rural tourism destinations, h is bandwidth, k is kernel function, $(x-x_i)$ is the distance from rural tourism destination valuation point x to sample point x_i.

2.2.2. Standard deviation ellipse

Standard deviation ellipse was first put forward by Lefever in 1926 (Lefever 1926), used to analyze the distribution direction, dispersion and center of geographical elements through ellipse's main parameters such as center coordinates, macro axis, branchy axis, oblateness and azimuth angle. Center coordinates of the standard deviation ellipse represent gravity center of rural tourism destinations, and macro axis and branchy axis indicate the degree of dispersion in X and Y axes. The longer the macro axis and the shorter the branchy axis, the larger the oblateness and more obvious the clustering trend. Azimuth angle represents its main trend direction.

2.2.3. Geographic detector

Geographic detector is used to reveal the interpretation ability of various influencing factors on the spatial differentiation of geographical elements, and is a new statistical method to study spatial differentiation (Wang, Xu 2017). Interpretation ability of each factor is reflected by q value, whose value ranges from 0 to 1. The closer q value is to 1, the stronger the influence of the factor on the spatial differentiation of rural tourism destinations. The closer q value is to 0, the weaker the influence of the factor. Its calculation formula is:

$$q = 1 - \frac{1}{n\sigma^2} \sum_{i=1}^{k} n_i \sigma_i^2$$

Where: k is layer number of influencing factor X_i, n is the number of samples, i is from 1 to k, σ_i^2 and σ^2 are rural tourism destinations number variances of layer i and the whole study area respectively.

3. Results

3.1. Spatial distribution pattern

As obvious from Figure 2, the number of China's Beautiful Leisure Villages was relatively stable over the years. 98 villages were first selected in 2014, about 148 villages were selected each year from 2015 to 2018, and about 250 villages were included each year from 2019 to 2022. The number of China's Key Rural Tourism Villages fluctuated greatly over the years. 314 villages were first evaluated in 2019, and 663 villages were selected in 2020, far exceeding the number of selected China's Beautiful Leisure Villages the same year. However, the number of selected China's Key Rural Tourism Villages dropped rapidly since 2021, with only 194 and 195 villages included each year.

The primary reason for the above-mentioned characteristics of the interannual changes in China's rural tourism destinations lies in the restrictions on selection quotas and adjustments to selection criteria imposed by the Chinese government for the two sets of rural tourism destination systems, as shown in Table 1. From 2014 to 2022, both the selection processes for China's Beautiful Leisure Villages and China's Key Rural Tourism Villages exhibited a shift from provincial quotas to national-level coordination, indicating a transition from local self-nomination to nationwide merit-based selection. The quota for China's Beautiful Leisure Villages generally showed an upward trend, increasing from 165 villages to 201 villages, and eventually stabilizing at around 250 villages. This is broadly consistent with

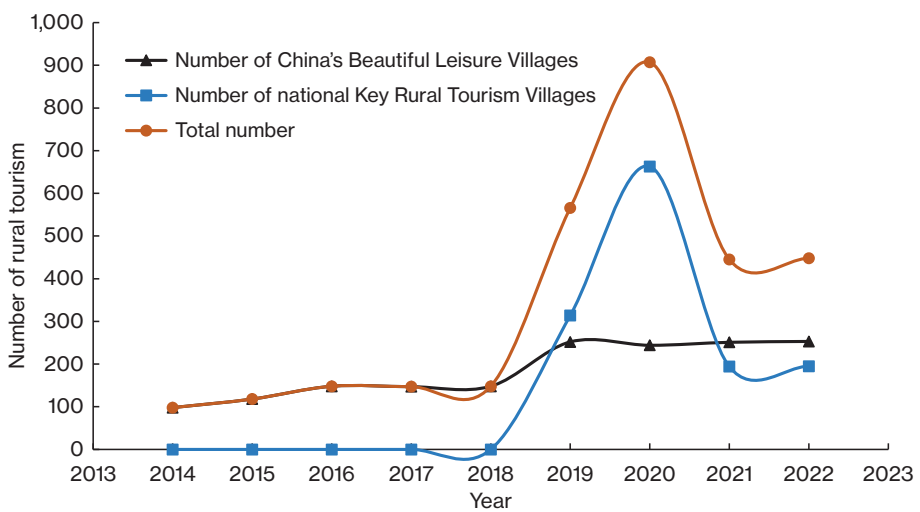


Fig. 2 – Time series change diagram of the number of rural tourism destinations in China

Table 1 – Selection criteria and quota adjustments for China's Beautiful Leisure Villages and China's Key Rural Tourism Villages

Selection system	Selection year	Selection criteria	Selection quatos	Available quotas / count	Actual applications / count
China's Beautiful Leisure Villages	2014	Diverse industrial functions, unique village scenery, positive cultural ethos	Each province: maximum 5 villages Municipalities with independent planning status: maximum 2 villages	165	98
	2015	Same as 2014	same as 2014	165	118
	2016	Beautiful ecological environment, diverse industrial functions, unique village scenery, positive cultural ethos	Each province: maximum 6 villages Municipalities with independent planning status: maximum 3 villages	201	148
	2017	Same as 2016	Same as 2016	201	147
	2018	Strong organizational leadership, notable industrial advantages, solid economic foundation, beautiful ecological environment, diverse industrial formats, well-developed service facilities, sound folk customs, prominent brand effects	Same as 2016	201	148
	2019	Notable distinctive advantages, well-developed service facilities, sound folk customs, prominent brand effects	Each province: maximum 8 villages Municipalities with independent planning status: maximum 3 villages	263	252
	2020	Same as 2019	According to the quota allocation table	245	244
	2021	Same as 2019	According to the quota allocation table	254	251
	2022	Distinct industrial advantages, well-developed service facilities, sound folk customs, prominent brand effects	According to the quota allocation table	256	253

Selection system	Selection year	Selection criteria	Selection quatos	Available quotas / count	Actual applications / count
China's Key Rural Tourism Villages	2019	Rich cultural and tourism resources; sound protection of natural ecology and traditional culture; well-developed rural homestays; mature tourism product systems with high quality; well-established infrastructure and public services; and notable employment-driven income generation effects	Each province: maximum 15 villages	465	314
	2020	Rich and rationally developed cultural and tourism resources; sound inheritance, protection, transformation, and development of rural culture; mature tourism product systems with high quality; well-regulated homestay development with distinctive themes; beautiful and livable ecological environment; well-established infrastructure and public services; sound and rational institutional mechanisms with efficient operations; and notable benefits in driving entrepreneurship, employment, and socio-economic development	Each province: maximum 25 villages Each of the first 71 National All-for-One Tourism Demonstration Areas: up to 2 additional recommended villages	917	663
	2021	Same as 2020	According to the quota allocation table	200	194
	2022	Same as 2020	According to the quota allocation table	200	195

the interannual variation trend of China's Beautiful Leisure Villages. From 2019 to 2020, the quota for China's Key Rural Tourism Villages surged sharply from 465 villages to 917 villages, and then plummeted to 200 villages per year in 2021 and 2022, which consequently led to an extreme peak in the interannual variation of China's Key Rural Tourism Villages and rural tourism destinations in 2020.

From 2014 to 2022, the selection criteria for China's Beautiful Leisure Villages evolved from three dimensions to eight dimensions, and eventually stabilized at four dimensions. The functional positioning of China's Beautiful Leisure Villages shifted from traditional sightseeing to leisure living and industrial integration, the governance requirements transitioned from soft advocacy to institutional constraints and negative lists, and the policy orientation shifted from scale expansion to quality improvement and standardized management. From 2019 to 2022, the selection criteria for China's Key Rural Tourism Villages increased from six dimensions to eight dimensions and remained stable. The evaluation standards deliberately aligned rural tourism with the Five Revitalizations of rural revitalization, and the functional expectations for China's Key Rural Tourism Villages were comprehensively upgraded from a singular tourism demonstration model to a comprehensive rural revitalization benchmark. Although the selection criteria for both systems of rural tourism destinations are mostly qualitative, with only a very few quantitative indicators appearing in the 2018 selection criteria for China's Beautiful Leisure Villages, the connotation of the evaluation standards has shown a trend of continuous deepening, with progressively higher requirements imposed on villages applying for designation. This has constrained the interannual expansion trend of China's rural tourism destinations to a certain extent.

3.1.1. Spatial distribution of global rural tourism destinations

3.1.1.1. Inter-provincial spatial differentiation

According to the data processing method mentioned above, repeated villages were eliminated to obtain the cumulative number of rural tourism destinations in 31 regions in 2014, 2018 and 2022, and the natural break point classification method of ArcGIS10.8 was used to symbolize them. As can be seen in Figure 3, in 2014, the number of rural tourism destinations in different regions ranged from 0 to 6 with a small gap, most regions (67.7%) had 3 or 4 rural tourism destinations. Fujian topped the list with 6 rural tourism destinations, Shandong and Zhejiang come second, both with 5 rural tourism destinations. Heilongjiang, Anhui, Jiangxi, Qinghai, Ningxia and Tianjin had only 1 or 2 rural tourism destinations respectively, and no villages in Tibet had been selected. In 2018, the number of rural tourism destinations in Zhejiang, Fujian and Shandong remained in the top three, rising to 34, 33 and 30 respectively. 13 regions such as Jiangsu, Henan, Guangxi,

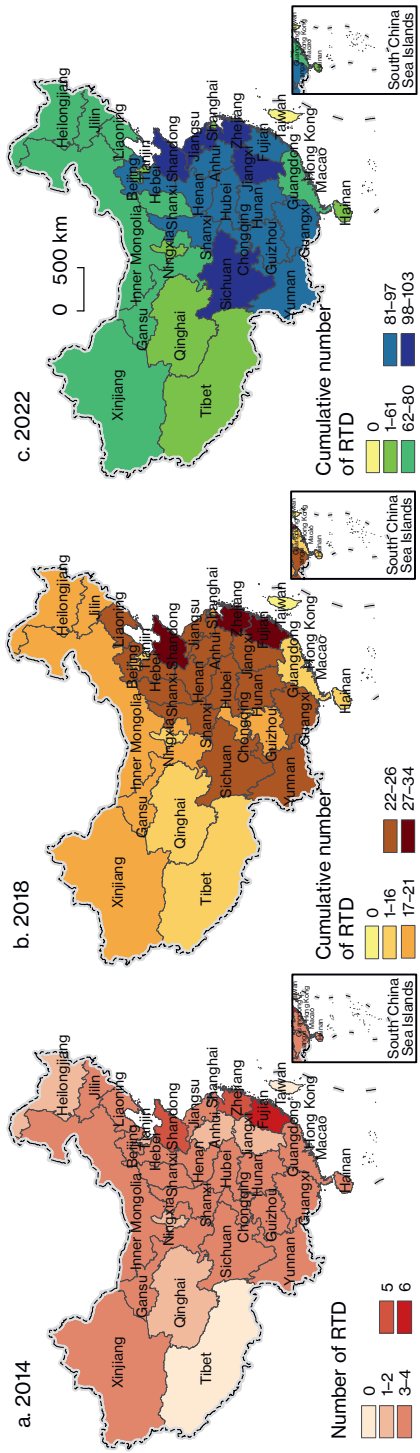


Fig. 3 – Inter-provincial spatial differentiation of rural tourism destinations in China. RTD – rural tourism destination.

Sichuan and Yunnan followed, with 22 to 26 rural tourism destinations. Tibet had the fewest rural tourism destinations, with only 13. In 2022, the number of rural tourism destinations in Zhejiang, Shandong, Sichuan, Jiangsu and Jiangxi had exceeded 98, making them the five regions with the largest number of rural tourism destinations in China. Sichuan replaced Fujian and ranked one of the top three. Tianjin, Ningxia, Hainan, Shanghai, Tibet and Qinghai had fewer rural tourism destinations, and the least of which was Tianjin, who had only 45 rural tourism destinations.

On the whole, the number of rural tourism destinations in all regions continued to increase, providing residents with more rural leisure tourism options, but regional gap in the number of rural tourism destinations widened, with the maximum range increasing from 6 in 2014 to 58 in 2022. According to the four major geographical divisions in China, South China region and North China region gradually become regions with relatively rich rural tourism resources, while Northwest China region and Qinghai-Tibet region were in a relatively inferior position.

3.1.1.2. Kernel density analysis

Spatial kernel density analysis was carried out on point feature set of rural tourism destinations in 2014, 2018 and 2022 respectively by using kernel density estimation tool in ArcGIS10.8 and taking 200 kilometers as search radius. When the travel time exceeds 152 minutes, there is a 100% chance that happiness becomes worse (Erinne 2022), and the average speed of long-distance self-driving travel ranges from 70 to 90 km/h, thus a distance of 200 km can be considered a reasonable spatial interaction range when examining the spatial distribution of rural tourism destinations at the national scale. This range will smooth out local details at the municipal or county level, thereby revealing large-scale spatial hotspot areas.

As can be seen from Figure 4, In 2014, the distribution of rural tourism destinations was scattered and most parts of China had low density of rural tourism destinations, with kernel density value less than 0.355 rural tourism destinations / 10,000 km². Only in the scattered small lamellar areas such as Beijing-Tianjin-western Hebei-eastern Shanxi-northern Henan, southern Jiangsu-southeastern Anhui-eastern Zhejiang-eastern Fujian, eastern Sichuan-western Chongqing, eastern Qinghai, southwest Gansu, southern Ningxia, southwest Guizhou, northeast Hunan, southwest Hainan, and central Shandong, rural tourism destinations were slightly dense, but there were still less than 1.2 rural tourism destinations / 10,000 km².

In 2018, the kernel density values of rural tourism destinations in large contiguous areas of North China and South China region were mostly higher than 0.355 rural tourism destinations / 10,000 km², among which Beijing-Tianjin district and Taihu Lake Basin were the densest areas of rural tourism destinations,

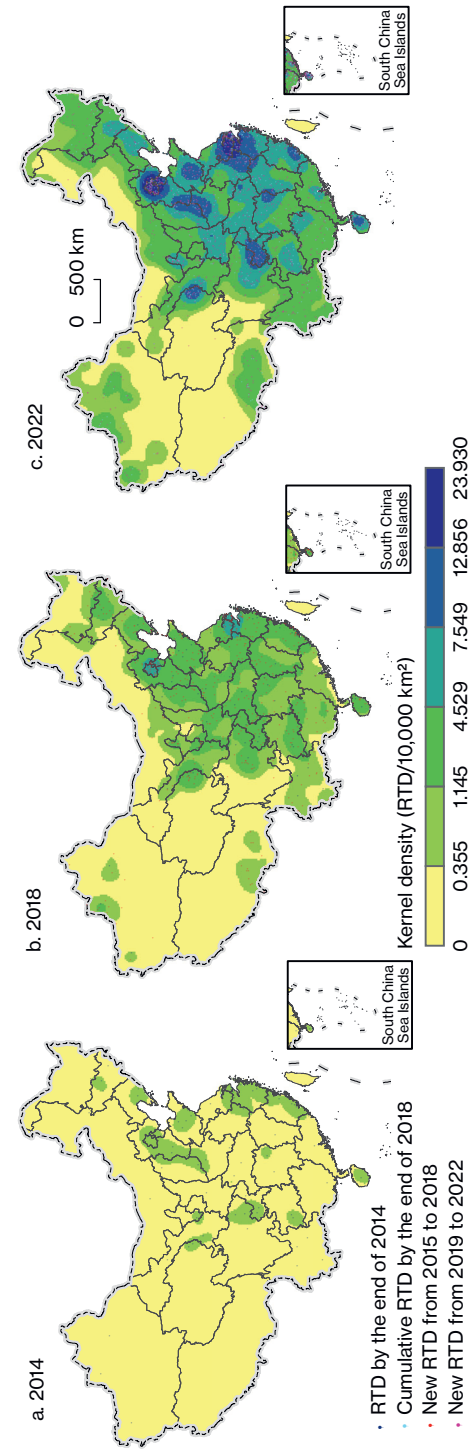


Fig. 4 – Kernel density evolution of rural tourism destinations in China under a 200 km bandwidth

with kernel density values ranging from 4.529 rural tourism destinations / 10,000 km² to 7.549 rural tourism destinations / 10,000 km², forming two core nodes. Five radial continuous areas around the low-density area formed by southwest Henan and central-northern Hubei, and several scattered areas including Hainan, Guangxi-Guizhou-Yunnan border, central-southern Liaoning, central-northern Jilin, northern Ningxia, central-southern Guangxi were the sub-dense areas, with 1.145 to 4.529 rural tourism destinations / 10,000 km². rural tourism destinations were scattered in most of Northwest China region and Qinghai-Tibet region, and the kernel density values were still lower than 0.355 rural tourism destinations / 10,000 km², only in the border between Inner Mongolia and its neighboring provinces, the northwestern and western Xinjiang, the eastern border between Qinghai and Gansu, and the southern part of Tibet, there existed small areas with denser rural tourism destinations.

In 2022, areas with kernel density values higher than 0.355 rural tourism destinations / 10,000 km² further expanded, and the kernel density values of rural tourism destinations in the vast contiguous areas of North China and South China region were generally higher than 1.145 rural tourism destinations / 10,000 km². Large continuous areas along the triangular boundary line formed by the core nodes of Beijing, Chongqing and Shanghai city, and scattered small areas such as southern Jilin-northern Liaoning, northern Ningxia, central-western Guizhou, northeastern Guangxi, central Guangdong and central-eastern Hainan possessed concentrated distribution of rural tourism destinations, with kernel density higher than 4.529 rural tourism destinations / 10,000 km². Among them, Beijing-Tianjin district and Taihu Lake Basin were still areas with the highest density of rural tourism destinations in China, who had more than 12 rural tourism destinations / 10,000 km² on average, and the maximum kernel density value up to 23.929 rural tourism destinations / 10,000 km² as shown in Figure 4. Center of Beijing-Tianjin-Hebei district, center of Yangtze River Delta, central Shandong, Shanxi-Hebei-Henan border, Gansu-eastern Qinghai border, Sichuan-Chongqing border, Jiangxi-eastern Hunan border, southeast Fujian and central Hainan were sub-dense areas of rural tourism destinations, with an average of 7.549 to 12.856 rural tourism destinations / 10,000 km². The kernel density of rural tourism destinations in the Northwest China region and Qinghai-Tibet region such as the border between Inner Mongolia and its neighboring provinces, western and northern Xinjiang, and central-southern Tibet were also higher than 1.145 rural tourism destinations / 10,000 km², and some areas can even reach 4.529 rural tourism destinations / 10,000 km².

To examine the stability of hot spots of rural tourism destinations in China, and travel time tolerance varies across individuals, this study also conducted kernel density estimation using bandwidths of 100 km, 150 km, and 250 km respectively. Due to space limitations, only the kernel density map with a bandwidth of 100 km

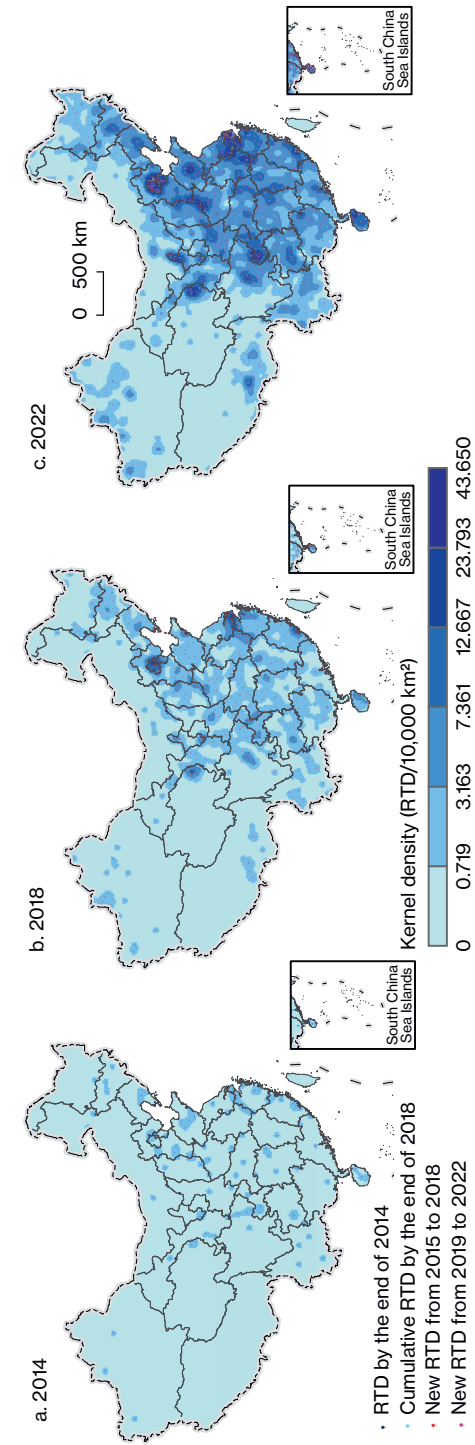


Fig. 5 – Kernel density evolution of rural tourism destinations in China under 100 km bandwidth

is presented in this article, see Figure 5. As shown in the figure, the kernel density distribution at a bandwidth of 100 km is more refined, capable of revealing local hot spots and presenting scattered points and small clusters. However, the hot spot areas of China's rural tourism destinations across different years remain consistent with those under the 200 km bandwidth. The kernel density distributions of China's rural tourism destinations at the unshown bandwidths of 150 km and 250 km exhibit similar characteristics. Specifically, the larger the bandwidth, the more the small-scale details are smoothed out, while the contiguous distribution pattern at the macro scale becomes more prominently highlighted, thus better revealing the overall macroscopic pattern. Conversely, the smaller the bandwidth, the more clearly the relatively dense local areas can be distinguished, though the overall pattern appears more fragmented and richer in detail. Nevertheless, the hot spot areas of China's rural tourism destinations remain stable across all four different bandwidths.

On the whole, the density of rural tourism destinations in China remained increasing from 2014 to 2022, forming a circle structure around the core node. Higher density areas expanded rapidly from the eastern coast and northwest to Inner Mongolia boundary and Sichuan-Tibet-Qinghai-Xinjiang border. Beijing-Tianjin-Hebei district and Yangtze River Delta always had the greatest concentration of rural tourism destinations in China. This aligns with the core–periphery theory and distance decay theory in explaining the imbalanced spatial distribution of rural tourism destinations in China. Hot spot areas with high density, such as the Yangtze River Delta and Beijing-Tianjin-Hebei district, are core regions that benefit from large and affluent tourist markets and convenient transport, resulting in dense distributions of rural tourism destinations. As high-speed rail and private car ownership expand, tourism demand spreads along transport corridors, generating new rural tourism destinations clusters in previously low-density areas, this diffusion effect gradually brings peripheral areas into the core's sphere of influence.

3.1.1.3. Standard deviation ellipse analysis

Dispersion and directionality of rural tourism destinations in 2014, 2018 and 2022 were analyzed respectively by using Directional Distribution (SDE) Tool in ArcGIS10.8, and results can be seen in Figure 6 and Table 2. The first level standard deviation was selected for the size of the ellipse, covering about 68% of China's rural tourism destinations.

Spatial distribution pattern of rural tourism destinations in China was relatively stable during 2014 to 2022, but there existed important changes. Branchy axis of the standard deviation ellipse shortened gradually from 1,025.253 km in 2014 to 1,016.535 km in 2022, indicating that the centripetal force of the spatial

Table 2 – Related eigenvalues of standard deviation ellipses

Year	Longitude of gravity center (°)	Latitude of gravity center (°)	Macro axis (km)	Branchy axis (km)	Azimuth (°)	Oblateness (%)
2014	112.992	33.134	1,127.036	1,025.253	31.287	9.031
2018	112.683	33.438	1,144.298	1,021.854	51.465	10.700
2022	112.085	33.233	1,150.841	1,016.535	51.007	11.670

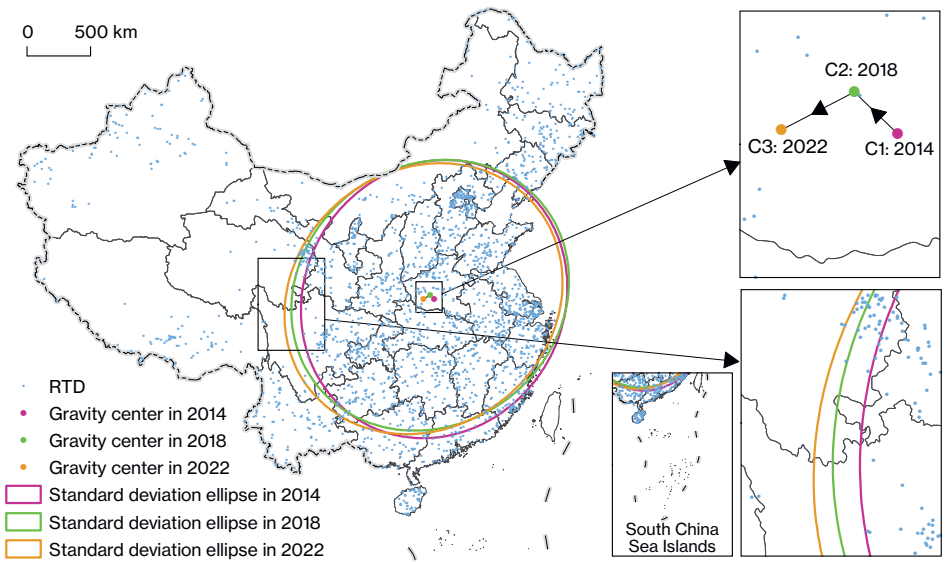


Fig. 6 – Standard deviation ellipse and gravity center migration of rural tourism destinations in China

distribution of rural tourism destinations enhanced. Macro axis of the ellipse lengthened and oblateness of the ellipse enlarged gradually, indicating that the spatial distribution of rural tourism destinations tended to be directional and show a clustering trend along the macro axis. However, the absolute oblateness value and the degree of ellipse flatness were small, which indicated that the spatial agglomeration range of China's rural tourism destinations was not large. In 2014, ellipse azimuth was north by east 31.287°, and it remained about north by east 51° in 2018 and 2022, indicating that the spatial agglomeration direction of rural tourism destinations in China was always southwest to northeast. Gravity center of the standard deviation ellipse was located in Sheqi County of Nanyang City in 2014, moved northwest to Nanzhao County of Nanyang City in 2018, and moved southwest to Zhenping County of Nanyang City in 2022, indicating that the gravity center of China's rural tourism destinations in presented a slow westward migration trend.

3.1.2. Spatial distribution of double superior rural tourism destinations

Honorary title of tourism destinations can significantly improve their popularity and reputation, and tourism destinations with multiple honorary titles can form a siphon effect on surrounding areas. In our study, villages on the list of both China's Beautiful Leisure Villages and China's Key Rural Tourism Villages were collectively referred to as double superior rural tourism destinations, showing their quality superiority compared with other rural tourism destinations selected on one list only. By the end of 2022, China has 530 double superior rural tourism destinations, accounting for 21.24% of the total number of rural tourism destinations. Same methods were used to visualize the spatial distribution, density and direction of double superior rural tourism destinations, see Figure 7.

Double superior rural tourism destinations were mainly concentrated in South China region and North China region, among which Beijing-Tianjin-Hebei district and Yangtze River Delta had 42 and 91 double superior rural tourism destinations respectively, accounting for 25.09% of the total number of double superior

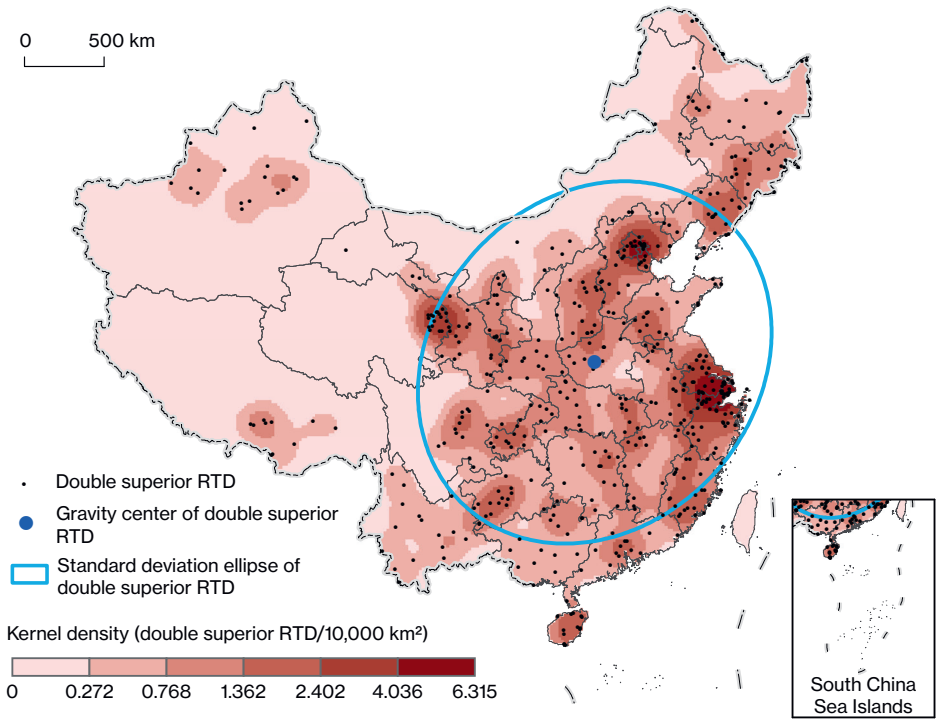


Fig. 7 – Kernel density distribution, standard deviation ellipse and gravity center of double superior rural tourism destinations

rural tourism destinations together. There were very few double superior rural tourism destinations in most areas of Northwest China region and Qinghai-Tibet region, with fairly scattered distribution. Beijing-Tianjin district and Taihu Lake Basin were the densest areas of double superior rural tourism destinations in China, with kernel density values higher than 4.036 rural tourism destinations / 10,000 km². There existed 2.402 to 4.036 double superior rural tourism destinations per 10,000 km² in the central area of Beijing-Tianjin-Hebei district, the central area of Yangtze River Delta, and Gansu-eastern Qinghai border, they were the sub-dense areas and presented a trend of tripartite confrontation. The number of double superior rural tourism destinations in Inner Mongolia, western Gansu, northern Xinjiang and the large areas of Sichuan-Tibet-Qinghai-Xinjiang border was very small, with an average of less than 0.272 double superior rural tourism destinations per 10,000 km².

Standard deviation ellipse of double superior rural tourism destinations was 1,215.918 km on the macro axis and 1,024.277 km on the branchy axis, and the oblateness value was 15.761%, which was greater than any of the oblateness values of global ellipses from 2014 to 2022, indicating that spatial distribution of double superior rural tourism destinations showed more obvious directionality. The gravity center's coordinates were 112.864°E and 33.780°N, located in Lushan County of Pingdingshan City, which was more northerly than the gravity center of all rural tourism destinations. On the whole, double superior rural tourism destinations presented more obvious trend of aggregation distribution in the direction of north by east 40.892°.

3.2. Influencing factors of spatial distribution pattern

Based on the relevant studies (Xie, Zhou, Liu 2022; Li et al. 2023), we took the number of rural tourism destinations in 31 regions of China as the dependent variable (Y), and preliminarily selected 14 subfactors from four aspects as the independent variables (X) to construct the geographic detector model. The natural endowment aspect includes five specific indicators such as regional area and average elevation, the development foundation aspect includes four specific indicators such as the number of township-level administrative units and average income of rural residents, the source market aspect includes four specific indicators such as urban population and total tourism revenue, and the transportation accessibility aspect includes one specific indicator, namely highway density.

To identify which factors truly and independently influence the spatial distribution of rural tourism destinations in China, this study took 2022 data as an example and employed an exploratory regression model to eliminate redundant factors with severe multicollinearity, thereby making the model more reliable.

The exploratory regression model in ArcGIS 10.8 was run to obtain the variance inflation factor for each influencing factor. Factors with the variance inflation factor values higher than 7.5 would be eliminated. The average income of rural residents indicator and the average consumption expenditure of urban residents indicator exhibited multicollinearity, with the variance inflation factor values of 11.90 and 11.24 respectively, therefore, the average income of rural residents, which had the higher variance inflation factor value, was eliminated. The tourist arrivals indicator and tourism revenue indicator also showed multicollinearity, with the variance inflation factor values of 11.16 and 16.17 respectively, thus, the tourism revenue indicator, which had the larger variance inflation factor value, was eliminated. The exploratory regression model was run again after removing these two redundant indicators, and the variance inflation factor values of the remaining 12 influencing factors were all below 7.5, constituting the influencing factor system for rural tourism destinations in China, see Table 3.

In order to examine whether each influencing factor exhibits spatial agglomeration on its own, move from spatial structure verification toward spatial attribution interpretation, and systematically reveal the mechanisms of these influencing factors and enhance the credibility of causal inference, this study conducted global spatial autocorrelation analysis (Moran's I) for each influencing factor. The results were shown in Table 4.

In 2014, 2018 and 2022, global Moran's I values of X_1, X_2, X_3, X_4, X_5 and X_{12} were greater than 0, with $p < 0.01$, passing the significance test at the 1% level. This indicates that these six indicators exhibit significant positive spatial autocorrelation within the study area, meaning that regions with higher values tend to be adjacent to each other, and regions with lower values also tend to cluster together, displaying an overall pronounced spatial agglomeration pattern rather than a random distribution. Among them, X_2, X_3, and X_4 had the highest global Moran's I values and z-scores, indicating the strongest degree of spatial clustering.

Global Moran's I values of X_8, X_9, X_{10} and X_{11} were greater than 0, with $0.05 < p < 0.1$, reaching a marginally significant status. These four indicators exhibit a certain degree of positive spatial autocorrelation, showing an overall trend of spatial clustering.

The p-values of X_6 and X_7 were mostly above 0.2, indicating that the 31 provinces do not exhibit spatial clustering characteristics for these two indicators, but instead display a random distribution pattern.

Quantile method and natural breaks (Jenks) method were applied to convert the continuous data of 12 independent variables of 2014, 2018 and 2022 into category data successively, and the values of each independent variable were divided into 4–7 categories according to their optimal classification. For example, the indicator values of X_1 and X_2 in 2022 were classified into 6 and 4 categories respectively under the quantile method. The cut-points for X_1 were 71,728, 145,369, 176,167,

Table 3 – Influencing factor system

Influencing factors	Specific indicators	Unit	Indicator description	Data source
Natural endowment	Regional area (X_1)	km^2	Reflects the spatial base for regional development	China Statistical Yearbook
	Average elevation (X_2)	–	Characterizes topographic and geomorphic features	China 1 km Topographic Relief Dataset
	Average annual temperature (X_3)	°C	Measures regional climate comfort, represented by the annual average temperature of the provincial capital city	China Statistical Yearbook
	Water resource abundance (X_4)	m^3/km^2	Reflects regional water resource endowment, derived by dividing total regional water resources by regional area	China Statistical Yearbook
	Forest coverage rate (X_5)	%	Characterizes regional ecological environment quality and the proportion of green space	China Statistical Yearbook
Development foundation	Number of township-level administrative units (X_6)	count	Characterizes the spatial distribution density of grassroots administrative organizations, obtained by summing the number of towns and townships in each region	China Statistical Yearbook
	Average output value of agriculture, forestry, animal husbandry, and fishery (X_7)	CNY	Measures agricultural production efficiency and the agricultural economic base, derived by dividing the total output value of agriculture, forestry, animal husbandry, and fishery in each region by the rural population	China Statistical Yearbook
	Abundance of tourism resources (X_8)	count	Reflects the suction effect of well-known scenic spots on surrounding scenic spots, represented by AAAAA tourist attractions in each region	Official announcements from the Ministry of Culture and Tourism of the People's Republic of China
Source market	Urban population (X_9)	10,000 persons	Measures the scale of the potential tourist source market	China Statistical Yearbook
	Average consumption expenditure of urban residents (X_{10})	CNY	Reflects the consumption demand and consumption activity level of urban residents	China Statistical Yearbook
	Tourist arrivals (X_{11})	10,000 arrivals	Characterizes the overall tourism market heat and attractiveness of the region	Statistical bulletins on national economic and social development
Transportation accessibility	Highway density (X_{12})	km/km^2	Measures the accessibility of rural tourism destinations, derived by dividing regional highway mileage by regional area	China Statistical Yearbook

Table 4 – Global spatial autocorrelation results of each influencing factor

Indicators	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
p-value (2014)	0.005	0.001	0.001	0.001	0.001	0.359	0.052	0.023	0.046	0.052	0.009	0.002
z-value (2014)	3.446	7.291	6.194	7.835	5.316	-0.422	1.771	2.378	1.915	1.841	2.991	4.310
Moran's I (2014)	0.234	0.544	0.495	0.690	0.409	-0.061	0.107	0.161	0.125	0.113	0.224	0.357
p-value (2018)	0.005	0.001	0.001	0.001	0.001	0.259	0.356	0.016	0.049	0.092	0.006	0.002
z-value (2018)	3.446	7.291	6.274	7.140	5.348	-0.663	-0.450	2.573	1.834	1.447	3.577	4.213
Moran's I (2018)	0.234	0.544	0.505	0.600	0.415	-0.076	-0.071	0.183	0.119	0.082	0.264	0.346
p-value (2022)	0.005	0.001	0.001	0.001	0.001	0.337	0.410	0.030	0.060	0.028	0.088	0.002
z-value (2022)	3.446	7.291	6.349	7.466	5.348	-0.515	-0.314	2.162	1.759	2.226	1.350	4.232
Moran's I (2022)	0.234	0.544	0.510	0.620	0.415	-0.072	-0.061	0.153	0.111	0.154	0.067	0.342

207,667, and 481,671 km², and those for X_2 were 0.2273, 0.3920, 0.6519, 1.2979 and 2.3682. The indicator values of X_1 and X_2 in 2022 were classified into 5 and 6 categories respectively under the natural breaks (Jenks) method. The cut-points for X_1 were 66,400, 148,000, 236,700 and 721,000 km², and those for X_2 were 0.0982, 0.4523, 1.0217, 1.6173 and 3.5292. Then single factor detection and factor interaction detection results were obtained respectively by running the software of GeoDetector.

3.2.1. Single factor analysis

Single factor detection is used to evaluate the interpretation degree of independent variable to the spatial differentiation of dependent variable. The closer the *q* value of each independent variable is to 1, the greater the influence of the independent variable on the spatial differentiation of rural tourism destinations. The *p* value represents the significance index, and the closer the *p* value is to 0, the more significant the relationship between independent variable and dependent variable. Single factor detection results in 2014, 2018 and 2022 by natural breaks (Jenks) method were shown in Table 5.

From the perspective of temporal evolution, the explanatory power of influencing factors on the spatial differentiation of rural tourism destinations in China exhibited a pronounced increasing trend over the study period. In 2014, only X_{11} passed the significance test at the 5% level, while X_2 and X_5 demonstrated marginally significant effects, with p-values falling between 0.05 and 0.1. The remaining

factors did not reach statistical significance, suggesting that the independent explanatory capacity of individual driving factors during this period remained generally weak, and that the spatial differentiation pattern of rural tourism destinations in China may have been primarily governed by the synergistic interactions among multiple factors or by latent variables not incorporated into the analytical framework.

In 2018, X_1, X_3, X_4, X_5, X_9 and X_{11} successively manifested explanatory power. Among these, X_1 and X_9 passed the significance test at the 5% level, whereas X_3, X_4, X_5 and X_{11} exhibited marginal significance ($0.05 < p < 0.1$), indicating that the influence of certain factors on the spatial pattern had begun to transition from a latent state to a manifest one.

By 2022, a total of five factors, namely X_1, X_6, X_8, X_9, and X_{11}, all passed the significance test at the 1% level, with q-values exceeding 0.57. This indicates that the core set of driving factors had become increasingly well-defined and stable over time.

This sustained upward trajectory suggests that the spatial differentiation pattern of rural tourism destinations in China intensified markedly between the year of 2014 and 2022, with the effects of various driving factors being progressively unleashed and accumulated. Such a pattern reflects a typical evolutionary process in socio-economic systems, wherein influencing factors gradually shift from a state of ambiguity toward one of clarity and specificity.

It is noteworthy that the q-value of X_8 experienced a substantial surge from 0.504 in 2018 to 0.809 in 2022, representing a relative increase of 60.5% and being the most pronounced enhancement among all examined factors. X_8 emerged as the predominant factor exerting the strongest explanatory power and was capable of independently accounting for over 80% of the spatial variation of rural tourism destinations in China. The q-value of X_1 likewise exhibited a considerable upward

Table 5 – Single factor detection results under natural breaks (Jenks) method

Indicators	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
q-value (2014)	0.242	0.385	0.182	0.077	0.294	0.294	0.341	0.361	0.323	0.152	0.400	0.232
p-value (2014)	0.200	0.080	0.421	0.579	0.060	0.672	0.134	0.235	0.137	0.632	0.036	0.156
q-value (2018)	0.508	0.253	0.236	0.260	0.540	0.363	0.293	0.504	0.614	0.186	0.467	0.243
p-value (2018)	0.012	0.348	0.098	0.092	0.059	0.739	0.212	0.196	0.015	0.688	0.052	0.158
q-value (2022)	0.641	0.190	0.310	0.140	0.434	0.614	0.284	0.809	0.710	0.084	0.578	0.439
p-value (2022)	0.000	0.570	0.069	0.403	0.212	0.007	0.219	0.000	0.002	0.931	0.000	0.287

Table 6 – Single factor detection results under Quantile method

Indicators	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
q-value (2014)	0.323	0.188	0.192	0.118	0.275	0.246	0.085	0.211	0.306	0.244	0.332	0.285
p-value (2014)	0.094	0.287	0.297	0.417	0.085	0.108	0.547	0.336	0.064	0.212	0.046	0.069
q-value (2018)	0.628	0.284	0.252	0.138	0.389	0.357	0.523	0.398	0.500	0.379	0.497	0.289
p-value (2018)	0.000	0.103	0.167	0.330	0.039	0.030	0.019	0.068	0.004	0.117	0.008	0.076
q-value (2022)	0.614	0.095	0.390	0.228	0.363	0.643	0.370	0.808	0.747	0.119	0.561	0.299
p-value (2022)	0.002	0.455	0.055	0.152	0.030	0.000	0.154	0.000	0.000	0.380	0.000	0.071

trend, ascending from 0.242 to 0.641 over the nine-year period, with an absolute increment of 39.9%. Similarly, the q-value of X_9 increased from 0.323 to 0.710, maintaining a sustained and steady strengthening trajectory throughout the study period.

Overall, X_{11} consistently maintained a high level of explanatory power, whereas X_1, X_3, X_6, X_8, and X_9 all displayed an increasing trajectory in their respective explanatory capacity in the research period. X_2, X_4, and X_5 demonstrated a declining trajectory in their explanatory power, while X_7, X_{10}, and X_{12} had only a marginal impact on the spatial distribution of rural tourism destinations in China.

In order to test the sensitivity of each influencing factor's classification scheme to the geographic detector analysis results, and to enhance the robustness of the importance ranking of these factors, this study supplemented the natural breaks (Jenks) method with the quantile method for a second discretization of each influencing factor, and then repeated the geographic detector computations. The results are presented in the following Table 6.

As can be seen from Table 6, under the quantile method, the explanatory power of factors on the spatial differentiation of rural tourism destinations in China also exhibited a pronounced increasing trend overall, with X_1, X_3, X_6, X_8, X_9 and X_{11} remaining the core driving factors, consistent with the results obtained from the natural breaks (Jenks) method. However, under the quantile method, X_5 demonstrated an increasing trajectory in its explanatory power, passing the significance test at the 5% level in both 2018 and 2022, thereby emerging as one of the core explanatory variables for the spatial differentiation of rural tourism destinations in China. X_{12}, although consistently remaining at a marginally significant level, nonetheless maintained a certain degree of explanatory power for the spatial differentiation of rural tourism destinations in China. X_7 passed the significance test at the 5% level in 2018, but its influence tended to weaken by 2022. X_2, X_4, and

X_{10} exerted only a negligible influence on the spatial distribution of rural tourism destinations in China. X_8 remained the factor with the strongest explanatory power, with q-value of 0.808 in 2022, which further corroborates the applicability of distance decay theory to explaining the spatial agglomeration of rural tourism destinations, namely, the suction effect of well-known scenic spots can drive the development of surrounding scenic areas through tourist flow spillover.

Regional area (X_1) determined the number of administrative villages to a certain extent, which in turn affected the number of rural tourism destinations. Climate suitability was an important factor to be considered in the construction of scenic spots, and average annual temperature (X_3) was directly related to tourists' willingness to visit. Number of township-level administrative units (X_6) represented the cardinal number of rural tourism destinations in each region. The more administrative units, the higher the probability of creating rural tourism destinations. The more the number of AAAAA tourist attractions, the higher the abundance of tourism resources (X_8). Strong radiation effect of well-known scenic spots would attract a large number of tourists, and the total number of tourist arrivals(X_{11}) increased, bringing more tourist flow and tourism income to the surrounding rural tourism destinations, thus forming a virtuous cycle to promote the construction and sustainable development of rural tourism destinations. As a way of interaction between urban and rural areas, most tourists of rural tourism come from cities and towns, and urban population (X_9) directly affected the size of tourist source market. Forests, as tourism landscape resources with ecological and aesthetic value, provided core attractions for rural tourism. Areas with high forest coverage rate (X_5) tended to possess a sound ecological environment, rich biodiversity, and distinctive landscape features, which can satisfy urban residents' demand for a return to nature experience, thereby constituting the resource base for rural tourism development. Most of the participants in rural tourism were self-driving tourists, and highway become the most important transportation infrastructure. Highway density (X_{12}) would directly affect the accessibility of rural tourism destinations and the time cost of tourists.

Elevation and water resources constituted the natural environmental foundation, which commonly exerted their influence in concert with other factors through mediating their respective conditions. In addition, with socioeconomic development and the progressive maturation of the tourism market, anthropogenic factors such as source market size and transportation accessibility have gradually become the dominant forces shaping spatial differentiation, thus leading to the declining trend of explanatory power of average elevation (X_2) and water resource abundance (X_4).

In summary, the core driving factors of the spatial differentiation in China's rural tourism destinations remained highly consistent across the two classification schemes, which indirectly corroborated the reliability of the research

findings. Combined with the foregoing analysis of spatial autocorrelation among the 12 influencing factors, the spatial clustering of X_1, X_3,X_5, X_8, X_9, X_{11} and X_{12} has contributed to the spatial clustering of rural tourism destinations in China. In contrast, the spatial clustering of X_2, X_4 and X_{10} did not reinforce the spatial clustering pattern. X_6, though randomly distributed, exhibited a positively skewed normal distribution, which helped explain the spatial clustering of rural tourism destinations. X_7, however, was randomly distributed and bore no meaningful association with the spatial differentiation of rural tourism destinations in China.

3.2.2. Factor interaction analysis

Factor interaction detection is used to assess whether the combined effect of two independent variables increased the explanatory power on the dependent variable. Factor interaction detection was conducted using the GeoDetector for the influencing factors under both the natural breaks (Jenks) method and the quantile method for the year of 2014, 2018, and 2022, generating a total of six factor interaction detection result tables. For the sake of brevity, only the factor interaction detection results for 2022 under both classification schemes are presented as Table 7 and Table 8. As can be seen from Table 7, the combined effect of any two independent variables could significantly enhance the interpretation power on the spatial differentiation of rural tourism destinations in China, among which 90% belonged to two-factor enhancement type and 10% belonged to nonlinear enhancement type. X_3 had the strongest interaction with X_7, with *q* value reaching 0.966. Interaction between X_2 and X_4 was the weakest, with *q* value only 0.421, but it was still stronger than the interpretation force by the two alone.

As can be seen from Table 8, the combined effect of any two independent variables could significantly enhance the interpretation power on the spatial

Table 7 – Factor interaction detection results under natural breaks (Jenks) method

Indicators	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	0.641											
X_2	0.844	0.190										
X_3	0.909	0.580	0.310									
X_4	0.827	0.421	0.495	0.140								
X_5	0.819	0.694	0.762	0.585	0.434							
X_6	0.827	0.938	0.925	0.829	0.905	0.614						
X_7	0.848	0.881	0.966	0.766	0.875	0.820	0.284					
X_8	0.932	0.864	0.962	0.949	0.965	0.908	0.915	0.809				
X_9	0.905	0.943	0.958	0.809	0.834	0.914	0.885	0.958	0.710			
X_{10}	0.897	0.509	0.788	0.449	0.824	0.858	0.788	0.931	0.904	0.084		
X_{11}	0.930	0.779	0.890	0.720	0.883	0.880	0.722	0.979	0.861	0.775	0.578	
X_{12}	0.882	0.807	0.786	0.619	0.842	0.900	0.732	0.934	0.849	0.739	0.844	0.439

Table 8 – Factor interaction detection results under Quantile method

Indicators	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}
X_1	0.614											
X_2	0.784	0.095										
X_3	0.921	0.670	0.390									
X_4	0.942	0.549	0.489	0.228								
X_5	0.798	0.482	0.631	0.603	0.363							
X_6	0.876	0.900	0.923	0.857	0.824	0.643						
X_7	0.923	0.950	0.961	0.880	0.925	0.899	0.370					
X_8	0.942	0.870	0.973	0.958	0.893	0.926	0.950	0.808				
X_9	0.937	0.938	0.973	0.838	0.940	0.947	0.919	0.935	0.747			
X_{10}	0.736	0.386	0.562	0.594	0.523	0.848	0.716	0.889	0.950	0.119		
X_{11}	0.912	0.759	0.802	0.756	0.787	0.836	0.672	0.927	0.934	0.730	0.561	
X_{12}	0.915	0.513	0.606	0.555	0.565	0.910	0.734	0.931	0.862	0.465	0.746	0.299

differentiation of rural tourism destinations in China samely under Quantile method. X_3 had the strongest interaction with X_8 and X_9 alike, with q value reaching 0.973. Interaction between X_{10} and X_{12} was the weakest, with q value only 0.465.

The results of factor interaction detection under the natural breaks (Jenks) and quantile methods for 2014 and 2018 (not shown here) also exhibit characteristics similar to those of 2022. The spatial pattern of China's rural tourism destinations was affected by multiple factors, and the driving structure has experienced a fundamental transition from single-factor weak explanatory power to multi-factor strong synergistic effect. Factors with low influence could significantly enhance their interpretation force when combined with other factors. The interaction of natural factors and social and economic factors formed the imbalance of the spatial distribution of China's rural tourism destinations.

4. Discussion

From the perspective of place-based policy, the designation of various types of rural tourism destination lists constitutes a spatial selection mechanism. The final inclusion in these lists is not a random sample but an outcome of policy-induced preferential selection. Consequently, governmental policy interventions exert a significant influence on the spatial configuration of rural tourism destinations. Given the substantial volume and limited accessibility of data pertaining to non-designated villages, this study does not undertake a comparative analysis of the spatial distribution patterns and determinant factors between designated and non-designated villages. To a certain extent, this may impede the ability to disentangle the natural spatial distribution of rural tourism destinations from the spatial biases inherent in policy evaluation. Nevertheless, it is important to

recognize that the spatial distribution of both designated and non-designated villages is not solely dictated by policy intervention, rather, it is the result of a complex interplay of multiple factors, including the physical geographical environment, the abundance of tourism resources, and the scale of urban population. Therefore, focusing exclusively on the designated villages as the research subject remains methodologically justifiable and offers a certain degree of feasibility.

According to current population distribution pattern and distribution of cities of different sizes in China, main source market of rural tourism will remain in the central and eastern regions of China for a long time, and the spatial pattern of rural tourism destinations will not change suddenly. Therefore, government should formulate relevant policies to publicize and promote the specific requirements of China's Beautiful Leisure Villages, China's Key Rural Tourism Villages and other standards, using evaluation as a tool to promote rural construction. Encourage all regions to actively recommend villages that meet the standards, and moderately increase the number of rural tourism destinations in densely populated areas while taking regional balance into account, so as to provide more rural tourism options for tourists. At the same time, establish a periodic acceptance system for China's Beautiful Leisure Villages and China's Key Rural Tourism Villages, strengthen landscape quality management, folk heritage protection and tourism service quality monitoring of selected villages, thus maintaining the sustainability of rural tourism development.

Well-known tourist destinations have a strong siphon effect, and the surrounding rural tourism destinations can realize the secondary distribution of tourism economy to well-known tourism destinations through differentiated product attraction and convenient transportation conditions. Therefore, all regions should pay attention to the construction of AAA level and above tourist attractions, strive to create more high-quality AAAAA and AAAA level scenic spots, and use the radiation driving role of high-level tourist attractions to increase tourist arrivals and income in rural tourism destinations. High-level tourist attractions can also cooperate with the surrounding rural tourism destinations to promote integration construction, create boutique tourism routes, and strive for the integrated development of urban and rural areas.

The key to the development of rural tourism lies in the excellent attractiveness of rural tourism destinations. rural tourism destinations should seriously consider their local characteristics of history, geography, culture and technology to scientifically formulate rural tourism development plans, guide misplaced competition, encourage qualified rural tourism destinations to build rural tourism resorts, and gradually improve the quality of rural landscape. Improve infrastructures such as roads, communications, water and electricity, as well as tourism facilities such as farm houses and homestays. Reasonably add leisure and entertainment facilities with special features to make tours more convenient and interesting,

so as to obtain tourist loyalty (Campón-Cerro, Hernández-Mogollón, Alves 2017). Encourage young people to return to their hometowns to start businesses, carry out training on tourism services, strengthen supervision over service quality, and improve the quality and level of rural tourism reception. Attach importance to ecological construction and protect rural natural environment (Li, Ismail, Aminuddin 2024). Strengthen new media marketing and self-media operation and management, steadily improve the visibility and reputation of rural tourism destinations, and pay more attention to "retention" than "flow".

5. Conclusions

By methods of kernel density estimation, standard deviation ellipse and geographic detector, this study revealed spatial differentiation evolution characteristics and influencing factors of rural tourism destinations in China from 2014 to 2022. The conclusions are as follows: (1) The number of rural tourism destinations in all regions increased rapidly, and the difference between 31 regions gradually expanded. South China region and the southern continuous area of North China region gradually become areas with relatively rich rural tourism resources. (2) Inner Mongolia boundary and Sichuan-Tibet-Qinghai-Xinjiang border had always been low-density areas of rural tourism destinations, and other areas possessed increasingly dense distribution, forming a circle structure around the core node. Central areas of Beijing-Tianjin-Hebei district and Yangtze River Delta were always the densest areas of rural tourism destinations. (3) Concentration trend and directionality of China's rural tourism destinations along the southwest to northeast axis was gradually obvious, and their gravity center showed a slow westward trend, but spatial distribution pattern was relatively stable. (4) 530 double superior rural tourism destinations showed similar distribution pattern, but emerged three core code with the densest distribution, including central area of Beijing-Tianjin-Hebei district, central area of Yangtze River Delta, and border area between eastern Qinghai and Gansu, showing a trend of three pillars. The gravity center of double superior rural tourism destinations was more northerly, and showed more obvious trend of aggregation distribution along the direction of north by east 40.892°. (5) Regional area, number of township-level administrative units, abundance of tourism resources, urban population and tourist arrivals were the key factors affecting the spatial differentiation of rural tourism destinations. Average annual temperature, forest coverage rate and highway density were main factors. Combined effect of any two factors could significantly increase the interpretation force, and imbalance of the spatial distribution of rural tourism destinations in China was caused by multiple factors.

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Destination image across Chinese- and English-language reviews of Macao's Historic Centre: A cognitive-affective-behavioral analysis

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ABSTRACT This study investigates cross-cultural differences in the perceived destination image of the Historic Centre of Macao across Chinese- and English-language reviews of the Historic Centre of Macao. Grounded in the cognitive-affective-behavioral framework, it analyzes user-generated content from Ctrip, MaFengWo, and Tripadvisor. Latent Dirichlet Allocation was used to identify cognitive themes, a Support Vector Machine classifier to estimate sentiment polarity, and semantic co-occurrence networks to examine action-related language. The two language-platform corpora exhibited distinct but overlapping patterns across the three analytical dimensions. Cognitively, Chinese-language reviews emphasize iconic landmarks and symbolic heritage attractions, whereas English-language reviews focus more on the atmosphere of East-West cultural integration and immersive experiences. Affectively, both groups show predominantly positive attitudes, but Chinese-language reviews more frequently foreground crowding, whereas English-language reviews more frequently emphasize cultural interpretation and experiential value. In action-related language, the Chinese-language reviews is more landmark- and photography-oriented, whereas the English-language reviews is more strongly associated with walking, exploration, and learning.

KEY WORDS heritage tourism – destination image – cross-cultural research – cognitive-affective-behavioral theory – user-generated content – historic centre of Macao

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1. Introduction

In the context of rapid urbanization and the continued expansion of tourism economies, the protection and revitalization of built heritage have become central concerns in both urban governance and tourism development. Historical districts and traditional residential environments are not only material repositories of urban memory but also important spaces through which local culture is interpreted, experienced, and circulated (Wang, Li, Liu 2025). This is especially true of the Historic Centre of Macao, which was inscribed on the UNESCO World Heritage List in 2005 and comprises 22 historic buildings and 8 public squares. Since the mid-sixteenth century, Macao has served as a key point of contact between Chinese and Portuguese civilizations. Its architecture, street texture, food culture, and religious landscape collectively reflect a long process of East-West interaction, giving the city a distinctive cultural character that continues to attract global visitors (Suntikul, Jachna 2015).

At the same time, reviews written in different languages may represent heritage destinations in systematically different ways. Variations in language use, values, prior knowledge, and cognitive habits shape how visitors perceive, evaluate, and experience the same place (Vinyals-Mirabent 2019). Although destination image has long been a core topic in tourism studies, cross-cultural comparisons remain comparatively underdeveloped, particularly in the context of cultural heritage destinations (Chen et al. 2024). Language is especially important in this regard because it functions as a stable cultural marker that influences information processing, emotional expression, and behavior in decision-making contexts (Turner, Reisinger, McQuilken 2002; Schuckert, Liu, Law 2015). For this reason, the present study compares Chinese- and English-language review corpora rather than relying solely on nationality or place of residence as a proxy for cultural difference.

In recent years, the proliferation of Web 2.0 applications and social media platforms has made user-generated content an increasingly valuable source of tourism information. Reviews, photographs, and travel narratives posted on online travel platforms allow tourists to move from being passive recipients of destination images to active producers and disseminators of them, thereby exerting a strong influence on the decisions of other potential visitors (Stepchenkova, Kim, Kirilenko 2014; Chen et al. 2024). Because such content is generated spontaneously and at scale, it provides researchers with an opportunity to observe destination image formation in a more naturalistic way than is typically possible through surveys alone (Chen et al. 2021). When combined with computational methods, user-generated content can be used to detect underlying thematic structures, emotional evaluations, and behavior-oriented expressions within large text corpora (Jia et al. 2024).

To organize this analysis, the study adopts the cognitive-affective-behavioral framework. Within this framework, the cognitive dimension refers to what

tourists know, notice, and describe about a destination; the affective dimension concerns emotional evaluations and feelings; and the behavioral dimension concerns action tendencies and experience-related expressions. The framework therefore provides a clear theoretical basis for aligning three analytical methods with three dimensions of destination image: Latent Dirichlet Allocation topic modeling for cognition, Support Vector Machine based sentiment analysis for affect, and semantic network co-occurrence analysis for behavior.

The objective is to explain how the two language corpora differ in the objects, evaluations, and practices through which Macao's heritage destination image is constructed. Three research questions guide the analysis:

1. Which cognitive themes organize Chinese- and English-language representations of the Historic Centre of Macao?
2. How do the salient positive and negative affective attributes differ between the two language corpora?
3. How do behavior-related lexical associations concerning heritage engagement, consumption, and sightseeing differ between the two corpora?

2. Literature review

2.1. Description of Macao destination

Macao is internationally promoted through a combination of gaming, food, festivals, and a compact multicultural urban heritage. Within this broader destination, the Historic Centre is presented as an interconnected group of monuments and urban squares woven into the functioning city rather than as an isolated heritage precinct (Macao Government Tourism Office 2021; UNESCO World Heritage Centre 2005). Following the broader discussion of destination image and heritage experience, this section situates the Historic Centre of Macao within its destination context.

Macao's heritage landscape reflects long-term interaction among Chinese, Portuguese, and other trading communities. Churches, temples, civic buildings, plazas, and narrow streets are close enough to be experienced on foot, while their architectural languages and continuing uses produce a visible narrative of exchange (Dewar, du Cros, Li 2012; Suntikul, Jachna 2015). This spatial juxtaposition supports both landmark-focused visits and more relational readings of the ensemble. It also creates a branding challenge: awareness may be concentrated on the Ruins of St. Paul's even though World Heritage value resides in the wider network of sites (Dewar, du Cros, Li 2012).

Research on Macao has examined the changing image of the city through text mining (Liu et al. 2020), User-generated content based visitor perceptions

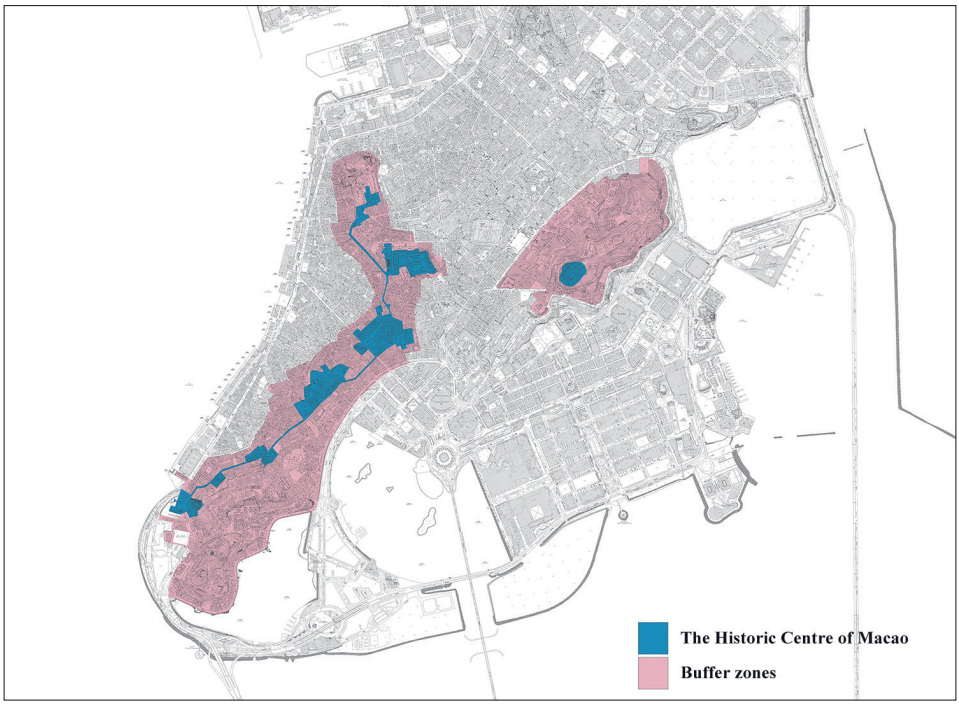


Fig. 1 – The Historic Centre of Macao and its buffer zones. Blue indicates the World Heritage property and pink indicates the buffer zones.

(Yin et al. 2023, Jia et al. 2024), historic squares and urban revitalization (Wang, Yamaguchi, Kawasaki 2016), streetscape structure (Teng, Yang, Huang 2021), heritage planning (Li et al. 2024), and visual conservation (Zhang et al. 2024). This literature establishes the importance of the historic environment but leaves two connected gaps. First, language-group comparisons remain limited for this compact heritage ensemble. Second, cognition, affect, and action-related language are often analyzed separately, making it difficult to see whether landmark recognition, evaluation, and narrated practice reinforce one another.

The Historic Centre of Macao is located in the southern-central part of the Macao Peninsula and is recognized as China's thirty-first UNESCO World Heritage inscription. Its 22 principal monuments and public spaces include A-Ma Temple, Mandarin's House, Senado Square and the Leal Senado Building, the Ruins of St. Paul's, Na Tcha Temple, the surviving Old City Walls, and Mount Fortress. Their distribution makes the property a serial urban ensemble rather than a single bounded attraction. Figure 1 shows the overall spatial relationship between the inscribed property, marked in blue, and its surrounding buffer zones, marked in pink, across the Macao Peninsula.

Its urban landscape combines traditional Chinese architectural elements with Portuguese urban design principles, reflecting the prosperity of the Maritime Silk Road and several centuries of cultural exchange between East and West (Wang, Yamaguchi, Kawasaki 2016; Jia et al. 2024). By the nineteenth century, Macao had evolved into a multicultural port city inhabited by Portuguese, Chinese, Japanese, Malay, Indian, and African communities, contributing to the formation of a distinctive Macanese culture (Dewar, du Cros, Li 2012). This cultural coexistence remains visible in the city's churches, temples, plazas, and winding streets, which together form an urban heritage landscape unlike that of most Chinese cities.

Existing research on the Historic Centre of Macao has primarily focused on architectural form and spatial configuration (Zhou, Wang 2023), heritage conservation and reuse (Li et al. 2024), urban color systems and visual landscape management (Teng, Yang, Huang 2021; Zhang et al. 2024), and tourist experience and satisfaction (Jia et al. 2024; Wang, Li, Liu 2025). For example, Zhang et al. (2024) showed that inconsistencies in façade maintenance and color control may undermine the authenticity of the heritage environment, while Jia et al. (2024) used online reviews to identify broad patterns in visitor experience. Nevertheless, there remains limited research that explicitly compares how visitors from different cultural or linguistic backgrounds perceive the destination image of the Historic Centre of Macao. A cross-cultural, language-based comparison is therefore necessary to extend current knowledge beyond general experience evaluation.

2.2. Place perception, destination image, and heritage experience

Since Hunt (1975) introduced the concept of image into tourism research, destination image has become central to market positioning and destination competitiveness (Zheng et al. 2024). In general, tourism destination image refers to the overall set of impressions, beliefs, evaluations, and feelings that tourists hold toward a place. Following Gartner (1993), destination image can be understood as comprising cognitive, affective, and conative components. Together, these perspectives show why an image cannot be reduced to a list of monuments: it also includes atmosphere, perceived value, comfort, identity, and anticipated or narrated conduct.

In heritage tourism contexts, this multidimensional structure is especially relevant because tourists do not merely consume attractions; they interpret symbolic meanings, negotiate authenticity, and evaluate the relationship between history, culture, and experience. The attractiveness of a World Heritage city partly rests on claims of historical continuity and cultural distinctiveness, yet tourism presentation can stage, simplify, or commercialize those qualities. MacCannell (1973) described the tension between staged display and the tourist

search for an authentic "back region", while Wang (1999) distinguished object-related authenticity from existential experiences of feeling true to oneself. For Macao, authenticity can therefore refer to the material conservation of a church or temple, the credibility of interpretation, the coexistence of living religious practice with tourism, or an embodied sense of discovery in streets beyond the most photographed façade.

The heritage encounter is also shaped by crowding. Crowding is not simply a visitor count; it is an evaluation of density relative to expectations, activity, control, and place type. In Florence, for example, tourists could interpret urban density positively as liveliness or negatively as obstruction and loss of enjoyment (Popp 2012). Research on heritage cities further shows how concentration at a small number of iconic sites can produce a "vicious circle": rising visitation and tourism-oriented commerce weaken residential functions and the qualities that initially supported attraction (Russo 2002). Overtourism should thus be analyzed as a context-specific relationship among visitors, residents, governance, and urban systems rather than as a universal numerical threshold (Koens, Postma, Papp 2018). These concepts are directly relevant to Macao, where famous monuments, food streets, retail activity, and everyday urban circulation overlap within a compact area.

2.3. Cross-cultural and language-mediated destination images

Cross-cultural research has demonstrated that tourists from different societies do not respond to the same destination in uniform ways. Culture shapes values, behavioral norms, emotional display rules, and preferred communication styles, all of which influence what visitors notice and how they evaluate it (Kang, Moscardo 2006; Özdemir, Yolal 2016). Heritage destinations are particularly sensitive to such variation because they contain symbolic and historical content that may be interpreted differently depending on visitors' cultural background. As a result, not all heritage destinations possess universal appeal, nor do all source markets respond equally to the same destination attributes (Dewar, du Cros, Li 2012).

Language plays a critical role in this process because it is both a carrier of culture and a medium through which cognition, affect, and behavior are expressed. Compared with indicators such as nationality or religion, review language provides an observable basis for corpus construction, although it should not be treated as a direct or exclusive measure of culture in cross-cultural studies (Schuckert, Liu, Law 2015). Recent research supports this approach. Chen et al. (2024), for instance, showed that Chinese- and English-language reviews exhibited significant differences in theme perception and emotional orientation toward Xiamen. Lee

and Park (2023) found that tourists from different source markets varied considerably in their evaluations of Hong Kong's culture, infrastructure, atmosphere, and social environment. Wang et al. (2024), in a study of panda tourism, reported that English-language reviews emphasized animal welfare, whereas Chinese-language reviews paid more attention to parent-child experiences. These findings suggest that a language-based comparison of the Historic Centre of Macao is both theoretically meaningful and practically useful.

2.4. Cognitive-affective-behavioral theory

The tripartite view of attitude distinguishes cognitive, affective, and behavioral components (Rosenberg et al. 1960). Cognition refers to beliefs, perceptions, knowledge, and judgments concerning an object; affect refers to the feelings or emotional responses elicited by that object; and behavior refers to intentions or actions associated with it. In tourism, this framework has been widely used to explain how tourists perceive destinations, form emotional evaluations, and develop subsequent behavioral tendencies (He, Zhan, Fang 2025).

Within destination studies, the cognitive dimension concerns what tourists know about a destination and the attributes they associate with it; the affective dimension concerns how they feel about that destination; and the behavioral dimension concerns experience-related actions, intentions, or action-related expressions associated with cognitive themes and evaluative language. Numerous studies have applied the cognitive-affective-behavioral model using questionnaires, interviews, or structured scales. Yang et al. (2022), for example, linked aesthetics and involvement to cultural identity formation in heritage tourism, while Chen and Xu (2021) used the model to explain the formation of tourist loyalty in rural homestays. These studies confirm the usefulness of the model, but most are based on conventional survey data.

The present study extends this line of research by applying the cognitive-affective-behavioral framework to large-scale user-generated content. More specifically, the framework directly guides methodological selection. Topic modeling is used to capture the cognitive dimension because topics represent what tourists repeatedly notice and describe. Sentiment analysis is used to capture the affective dimension because emotional polarity and sentiment-laden words reflect tourists' positive and negative evaluations. Semantic network co-occurrence analysis is used to capture the behavioral dimension because action-related expressions in reviews reveal how tourists connect attractions, consumption, and cultural participation in practice. In this way, the cognitive-affective-behavioral model is not treated merely as a conceptual backdrop; it functions as the organizing logic of the entire research design.

3. Methodology

3.1. Research design and analytical framework

The study follows the cognitive-affective-behavioral framework in a three-step analytical sequence, as shown in Figure 2. First, the cognitive dimension is examined through Latent Dirichlet Allocation topic modeling in order to identify the major themes that Chinese- and English-language reviews use to describe the Historic Centre of Macao. Second, the affective dimension is analyzed through an Support Vector Machine-based sentiment classifier to determine the polarity of reviews and the most salient positive and negative sentiment words. Third, the behavioral dimension is explored through semantic network co-occurrence analysis centered on culture/history, buying/eating, and visiting/photo-taking expressions. This design allows the three dimensions of destination image to be examined in a coordinated and theoretically coherent manner.

3.2. Data collection and preprocessing

A Python-based web crawler was developed to collect visitor reviews from three travel platforms: the Chinese online travel agencies Ctrip and MaFengWo, and the international platform Tripadvisor. According to QuestMobile (2024), Ctrip recorded 83.94 million active users in March 2023, making it the most widely

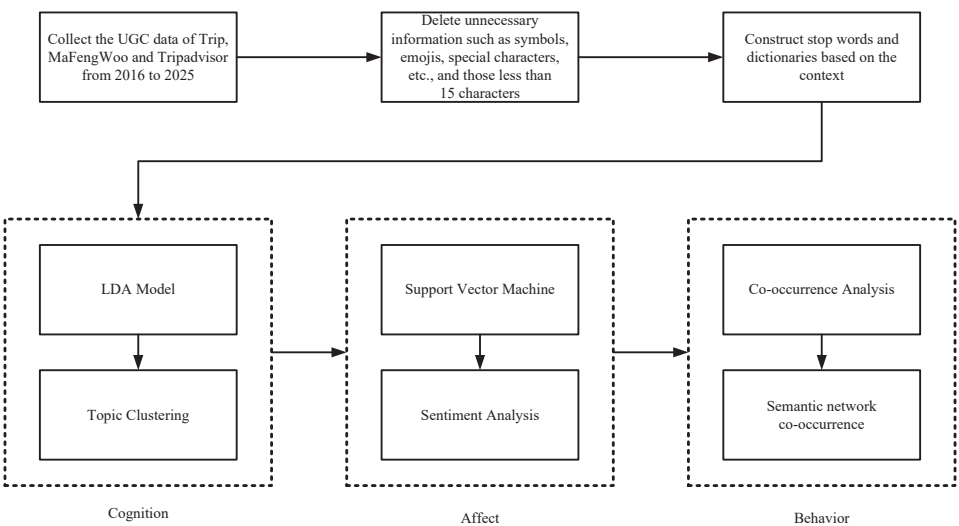


Fig. 2 – Research process

used online travel platform in China. Founded in 1999, Ctrip offers over 1.7 million travel-related services globally. Mafengwo, a comparatively younger yet highly influential platform, hosts extensive user-generated travelogues, reviews, and destination guides. TripAdvisor is a global travel information platform where users from diverse countries share their travel experiences through reviews (Wong, Qi 2017). Employing both domestic and international platforms enhances source diversity and mitigates platform-specific biases, thereby enabling the study to capture a broader spectrum of review styles, linguistic features, and travel motivations. The collection period covered January 2016 to September 2025 and focused on the 22 buildings and 8 squares that constitute the Historic Centre of Macao. Data collection started on September 1, 2025. After cleaning, the final corpus contained 11,520 reviews, including 5,806 Chinese-language reviews and 5,714 English-language reviews.

The raw texts were preprocessed to remove symbols, emojis, special characters, and other irrelevant content. Reviews containing fewer than 15 words or lacking substantive meaning were excluded. To preserve linguistic specificity, the Chinese and English corpora were processed separately. For Chinese reviews, Jieba segmentation was used together with a custom stopword list developed for the context of the Historic Centre of Macao, following Zhang et al. (2023). Onomatopoeic expressions and extremely high-frequency but analytically uninformative words such as "Historic Centre of Macao" and "Macao" were removed. At the same time, attraction names such as "Ruins of St. Paul's", "A-Ma Temple", and "Senado Square" were added to the segmentation dictionary to preserve semantic integrity.

For English reviews, all texts were converted to lowercase and attraction names were standardized before tokenization. Expressions such as "mazhu temple", "ma temple", and "ama temple" were unified as "A-Ma Temple". Common but contextually weak function words were removed, and tokenization and lemmatization were performed with NLTK-based tools. This normalization procedure ensured that key place names were retained as stable analytical units across subsequent modeling steps. In addition, the corpus was divided into two periods, 2016–2020 and 2021–2025, in order to preserve the possibility of examining temporal change in future analyses.

3.3. Latent Dirichlet Allocation topic modeling

Latent Dirichlet Allocation is an unsupervised probabilistic topic model that represents each document as a mixture of latent topics and each topic as a probability distribution over words (Blei, Lafferty 2006). In tourism research, Latent Dirichlet Allocation has been widely used to identify recurring semantic structures in large bodies of reviews, posts, or travel narratives. In the present study, separate Latent

Dirichlet Allocation models were estimated for the Chinese-language and English-language corpora in order to compare the cognitive structures reflected in the two groups' descriptions of the Historic Centre of Macao.

To determine the optimal number of topics, the study jointly considered perplexity and topic coherence. Perplexity evaluates model fit by measuring how well a model predicts unseen textual data; lower values generally indicate a better statistical fit (Cao et al. 2009). Topic coherence, by contrast, evaluates the semantic consistency of the top words within a topic; higher values indicate better interpretability (Mimno et al. 2011). Because statistical fit and substantive interpretability do not always point to the same solution, the final number of topics was selected by considering both indicators together rather than relying on a single criterion.

3.4. Support Vector Machine-based sentiment analysis

Support Vector Machine is a supervised classifier that identifies a separating boundary between labeled classes while maximizing the margin between them. Support Vector Machine was selected because linear Support Vector Machines perform reliably with sparse, high-dimensional text features and have been widely tested in tourism sentiment research (Kirilenko et al. 2017), the preprocessed user-generated content texts were converted into term frequency-inverse document frequency vectors and used to train a linear-kernel Support Vector Machine model. Term frequency-inverse document frequency increases the weight of terms that are frequent in a review but comparatively uncommon across the corpus, reducing the dominance of ubiquitous words. For each language corpus, the data were split into training and testing sets at a ratio of 7:3. After model training, the complete datasets were classified to obtain positive and negative sentiment probabilities for each review.

Define the positive-class probability explicitly. If 0.60 is retained, introduce an uncertainty/neutral band or justify why every value below 0.60 is negative; report sensitivity to 0.50 versus 0.60. Based on the classified texts, the study further summarized the ten most salient positive and negative sentiment words in each language group, thereby identifying the lexical triggers associated with favorable and unfavorable visitor evaluations.

3.5. Semantic network co-occurrence analysis

The behavioral dimension was examined through semantic network co-occurrence analysis. Co-occurrence networks depict how frequently words appear together,

with thicker links indicating stronger associations between terms. In this study, three behavior-related analytical foci were constructed: cultural identity behavior, consumption behavior, and tourism behavior. These dimensions were operationalized through core terms related respectively to "culture/history", "buying/eating", and "visit/take photos".

By calculating co-occurrence frequencies between the core terms and surrounding words, the study generated node attributes and edge weights that reveal how tourists connect specific attractions, evaluations, and actions in their review narratives (Xiang et al. 2025). Compared with topic modeling and sentiment classification, this approach is especially useful for uncovering relational patterns embedded in action-oriented language, thus complementing the other two components of the cognitive-affective-behavioral framework.

4. Results

4.1. Cognitive topic clustering

4.1.1. Topic number selection

Figures 3 and 4 present the perplexity and coherence results for the Chinese-language and English-language corpora. In the Chinese corpus, topic coherence reaches its highest value at K = 4, while perplexity remains within an acceptable range before rising sharply as the number of topics continues to increase. This pattern suggests that a four-topic solution provides the best balance between model fit and semantic interpretability.

For the English corpus, the coherence curve displays several local peaks, and the highest coherence value appears at a relatively small number of topics. However, a two-topic solution is too coarse to capture the thematic diversity evident in the English-language reviews. After jointly considering coherence, perplexity, and substantive interpretability, the study retained five topics for the English corpus. This decision yields a more analytically meaningful representation of the cognitive structure reflected in English-language user-generated content.

4.1.2. Topics in Chinese-language user-generated content

The first Chinese-language topic centers on traditional Chinese architecture in the historic district, especially the Zheng Family Mansion, Nezha Temple, and Lu Family Mansion. Associated words such as "visit" and "worth seeing" indicate that this topic combines architectural recognition with evaluative appreciation. A representative review notes that the restored Lingnan-style mansion reveals

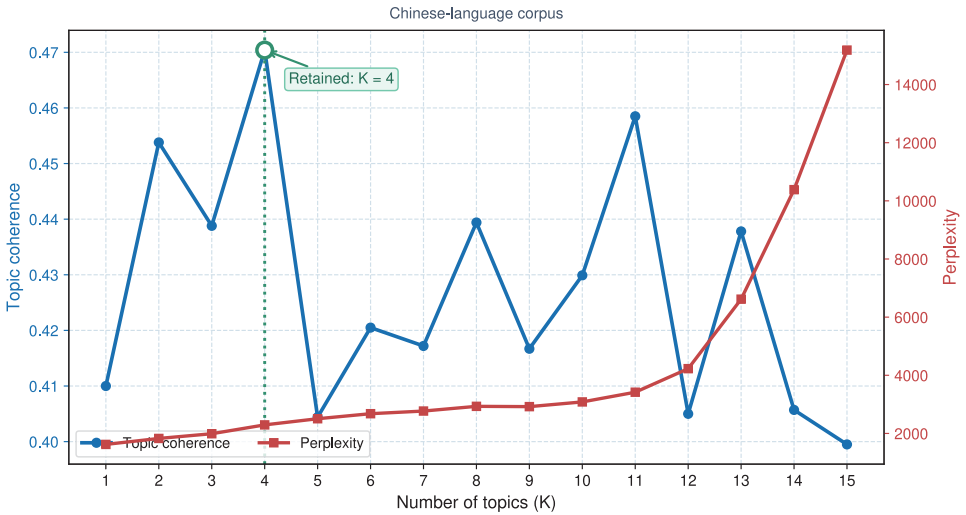


Fig. 3 – Perplexity and coherence of Chinese user-generated content. The annotation identifies the maximum-coherence solution; K = 4 was retained. Source: authors' analysis.

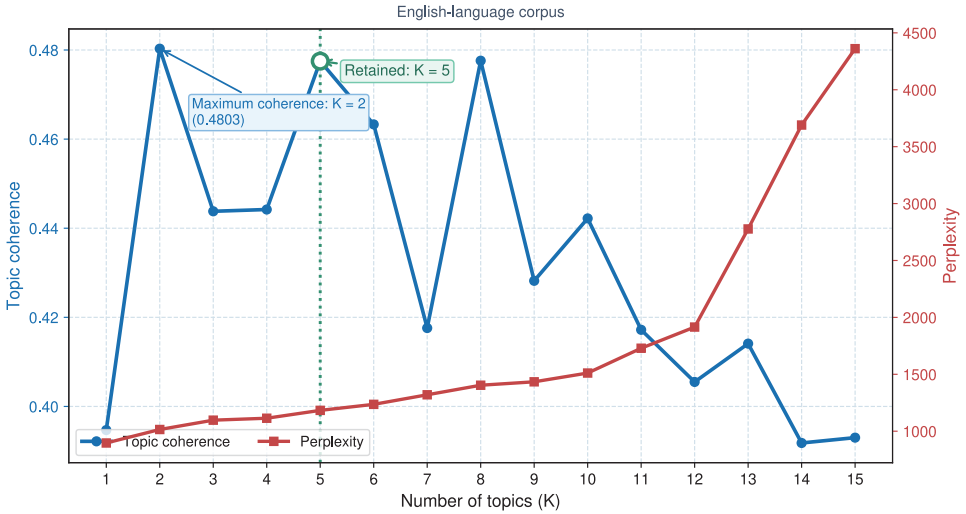


Fig. 4 – Perplexity and coherence of English user-generated content. The maximum-coherence solution is K = 2; K = 5 was retained after considering thematic interpretability and diagnostic performance together. Source: authors' analysis.

a carefully organized courtyard layout and a blend of Chinese and Western architectural forms. Overall, this topic reflects a cognitively concrete understanding of specific heritage buildings and their historical value.

The second topic is organized around Senado Square and its surrounding Portuguese-style civic buildings, including the Holy House of Mercy and the Municipal Affairs facilities. High-frequency words such as "square", "fountain", and "pavilion" indicate that this topic highlights the square as a visually attractive urban landmark and a popular setting for photography. Reviews repeatedly emphasize the vibrant colors of the surrounding façades and the square's strong Southern European atmosphere.

The third topic focuses on the Ruins of St. Paul's and is strongly associated with landmark recognition, photography, and check-in behavior. Keywords such as "Ruins", "attraction", "photograph", and "check-in" show that this site functions as the most iconic image node in the Chinese-language corpus. The Ruins of St. Paul's are not only described as historically significant but also as a compulsory photo location for first-time visitors to Macao.

The fourth topic centers on Mount Fortress and the adjacent museum area. Terms such as "museum", "fortress", "history", and "ancient" indicate that this topic combines historical understanding with on-site exploration. Compared with the more crowded Ruins of St. Paul's area, comments in this topic often highlight Mount Fortress as a quieter and more contemplative heritage space.

4.1.3. Topics in English-language user-generated content

The first English-language topic concerns temple visits and worship practices, especially those associated with A-Ma Temple. Core words such as "temple", "incense", "pray", "worship", and "goddess" indicate a strong interest in traditional Chinese religion and ritual observation. Reviews in this topic often describe the temple not only as a historic site but also as a living sacred space in which local religious practices remain visible.

The second topic centers on the Ruins of St. Paul's and nearby fortifications. Keywords such as "St. Paul", "facade", "view", "fortress", and "fort" show that English-language reviews also recognize this site as an iconic landmark. However, the emphasis is somewhat less on obligatory check-in behavior and more on visual appreciation, panoramic views, and the spatial relationship between the ruins and nearby defensive heritage.

The third topic highlights architectural features across the World Heritage landscape as a whole. Terms such as "building", "architecture", "cathedral", "UNESCO", and "world heritage" suggest that English-language reviews are comparatively more attentive to the broader heritage assemblage and to the formal qualities of East-West architectural integration.

The fourth topic captures general visitor behavior and subjective on-site experience. Words such as "visit", "walk", "climb", "photo", and "enjoy" indicate an experiential orientation toward movement, observation, and exploration. Reviews in this cluster often frame the Historic Centre of Macao as a place worth wandering through in order to learn about local culture.

The fifth topic concerns shopping and culinary experience. Core terms including "buy", "shop", "souvenir", "food", and "egg tart" show that consumption is closely integrated into the English-language reviews' experience of the destination. Nevertheless, consumption in this context is not described purely as commercial activity; it is linked to local flavor, place-specific products, and the experiential appeal of everyday street life.

4.2. Affective analysis

The sentiment classification results are summarized in Table 1. Across both language groups, the overall emotional tendency is predominantly positive, but the lexical composition of positive and negative evaluation differs in meaningful ways. In the Chinese-language corpus, the most salient positive words include "good-looking", "worthwhile", "good", "comfortable", and "beautiful" indicating that visual appeal, immediate satisfaction, and the pleasant atmosphere of the heritage environment are major sources of positive evaluation. Reviews frequently praise the preservation of historic buildings, the city's Portuguese charm, and the lively urban ambiance surrounding central attractions.

The negative side of the Chinese-language corpus is dominated by words such as "crowded", "people", "expensive", "disappointed", and "overcrowded". These expressions suggest that physical congestion, heavy visitor flow, and related inconvenience are the main triggers of negative affect for Chinese-language reviews. In other words, dissatisfaction is driven less by the symbolic meaning of the site than by the embodied experience of crowding, queuing, and reduced comfort in highly concentrated tourist zones.

In the English-language corpus, the most salient positive words include "good", "worth", "like", "unique", "beautiful", "great", and "excellent". These words indicate not only general approval but also recognition of distinctiveness and experiential value. Representative reviews emphasize that the Historic Centre of Macao feels culturally unique, architecturally striking, and worthy of time and attention. This suggests that positive affect among English-language reviews is closely tied to cultural exploration and to the perception of the site as an unusual and meaningful heritage setting.

Negative English-language sentiment is reflected in words such as "poor", "bad", "worse", "expensive", "waste", "dirty", "inconvenient", and "awful".

Table 1 – Top ten positive and negative sentiment words in Chinese and English user-generated content

Language	Sentiment	Top ten words
Chinese	Positive	Good-looking; Worthwhile; Good; Comfortable; Beautiful; Stunning; Recommend; Delicious; Convenient; Likeable
Chinese	Negative	Crowded; People; Expensive; Disappointed; Regretful; Disappointing; Dirty; Boring; Crowd; Overcrowded
English	Positive	Good; Worth; Like; Unique; Beautiful; Great; Nice; Recommend; Comfortable; Excellent
English	Negative	Poor; Bad; Worse; Expensive; Waste; Dirty; Inconvenient; Uncomfortable; Annoying; Awful

Note: Terms are ordered by model-derived salience within each language and polarity. Bold type identifies exact terms shared by the two language corpora within the same polarity; regular type identifies corpus-specific terms.

Although these expressions occur less frequently than positive ones, they point to dissatisfaction with tourism facilities, service quality, accessibility, and the commercialization of parts of the visitor experience. Compared with the Chinese-language corpus, English-language negative evaluations appear somewhat more closely connected to interpretive and service-related expectations rather than solely to crowd density.

4.3. Semantic network co-occurrence

4.3.1. Cultural identity behavior

Figure 5 presents the semantic network centered on culture and history. In the Chinese-language network, the strongest associations cluster around “History”, which is linked to terms such as “Ruins of St. Paul’s”, “A-Ma Temple”, “Church”, “Architecture”, “Landmark”, “Symbol”, and “Significance”. This pattern indicates that Chinese-language reviews frame cultural identity primarily through concrete heritage symbols and historically meaningful sites. The co-occurrence of words such as “feel”, “witness”, and “location” further suggests an experiential form of cultural recognition in which visitors perceive themselves as encountering and confirming the historical significance of specific landmarks.

By contrast, the English-language network is organized around “History” and “Culture” in relation to terms such as “Visit”, “View”, “Learn”, “Portuguese”, “Museum”, “Temple”, “Walk”, and “Worth”. This configuration indicates a more exploratory and interpretive engagement with the destination. Rather than concentrating exclusively on single iconic attractions, English-language reviews more often relate cultural identity to movement through the historic environment, cross-cultural comparison, and the educational value of the visit. Taken together,

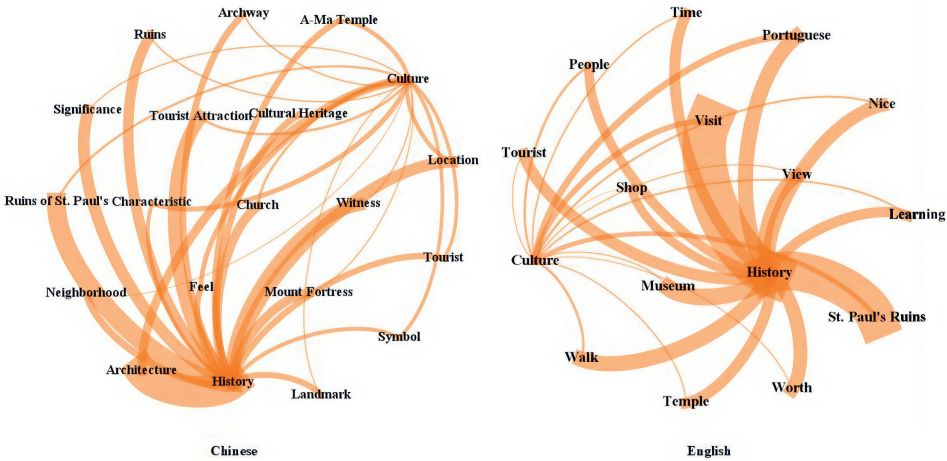


Fig. 5 – Co-occurrence networks for culture- and history-related expressions in (left) Chinese-language and (right) English-language reviews. Labels are co-occurring terms; wider lines indicate stronger relative co-occurrence.

the two networks suggest that Chinese-language reviews emphasize symbolic recognition of landmark heritage, whereas English-language reviews emphasize learning, viewing, and experiencing cultural hybridity.

4.3.2. Consumption behavior

Figure 6 displays the semantic network centered on buying and eating. In the Chinese-language network, "Buying" and "Eating" are associated with words such as "souvenir", "shopping", "snacks", "egg tarts", "take photos", and "Ruins of St. Paul's". This structure indicates that consumption is strongly embedded in landmark-based tourism and photo-taking practices. Food and shopping are not treated as separate activities; rather, they form part of a check-in style consumption experience connected to famous attractions and walkable tourism circuits.

In the English-language network, the strongest links around "Buying" and "Eating" connect to terms such as "snack", "food", "local", "sample", "famous", "St. Paul's Ruins", "visit", and "walk". Compared with the Chinese-language network, the English-language network places greater emphasis on tasting local products and integrating consumption into exploratory walking. This suggests that, for English-language reviews, shopping and food consumption function as extensions of cultural experience and place discovery rather than as purely transactional behavior.

Despite these differences, the two language groups also share important commonalities. In both networks, Portuguese-style snacks, egg tarts, souvenirs, and

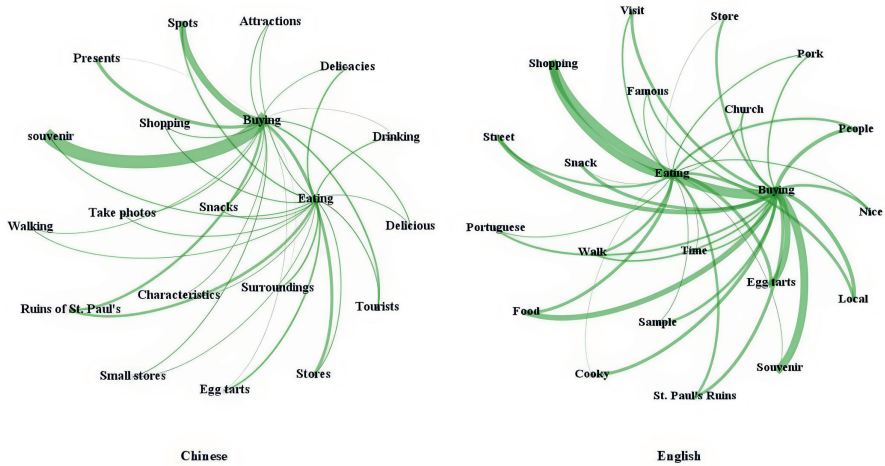


Fig. 6 – Co-occurrence networks for buying- and eating-related expressions in (left) Chinese-language and (right) English-language reviews. Labels are co-occurring terms; wider lines indicate stronger relative co-occurrence.

streets near major attractions occupy a central place. This suggests that Macao's heritage consumption landscape is formed through the close integration of landmark sightseeing, everyday street experience, and food-related memory.

4.3.3. Tourism behavior

Figure 7 presents the semantic network related to visiting and photo-taking. In the Chinese-language network, the core nodes "Visit" and "Take Photos" are strongly associated with "Ruins of St. Paul's", "Mount Fortress", "Photo Spot", "Suitable", "Good-looking", "Souvenir", and "Open". This pattern indicates that tourism behavior among Chinese-language reviews is closely tied to visually recognizable landmarks, route convenience, and the practical conditions that support photography and sightseeing. The prominence of "Take Photos" confirms the importance of image capture and shareable landmark presence within this group's destination experience.

In the English-language network, "Visit" is the dominant node and is linked to "Worth", "View", "Walk", "Tourist", "Time", "Temple", "St. Paul's Ruins", and "Recommend". Although "Take photos" also appears, it is less central than in the Chinese-language network. This suggests that English-language reviews frame tourism behavior more as a process of moving through space, allocating time, and evaluating the site's experiential and interpretive value. Recommendation and perceived worth are integrated into this behavioral structure, indicating a stronger emphasis on discovery and reflective appraisal.

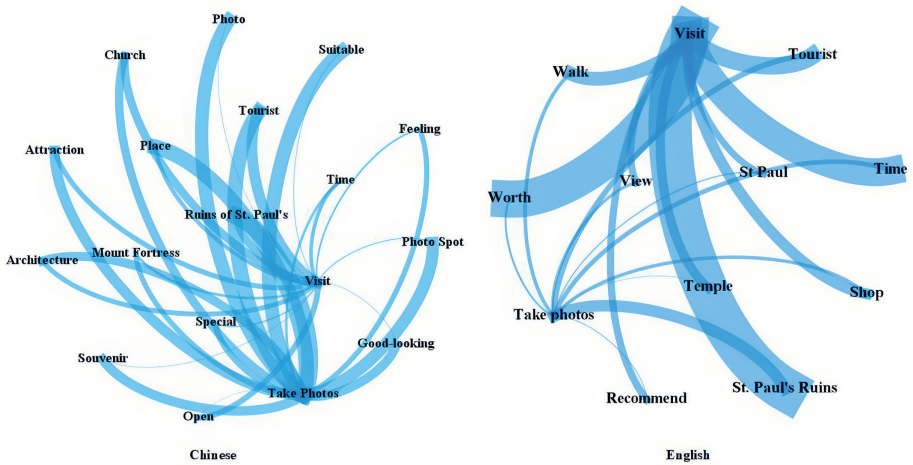


Fig. 7 – Co-occurrence networks for visiting- and photography-related expressions in (left) Chinese-language and (right) English-language reviews. Labels are co-occurring terms; wider lines indicate stronger relative co-occurrence.

Overall, the tourism-behavior networks confirm the distinction already visible in the cognitive and affective analyses. Chinese-language reviews display a more landmark-oriented, photo-centered, and check-in style pattern, whereas English-language reviews display a more exploratory, walking-based, and experience-oriented pattern.

5. Discussion

5.1. From landmark recognition to relational place experience

The three analyses converge on two contrasting, but overlapping, ways of assembling Macao's destination image. Chinese-language reviews more often organize cognition around iconic nodes, evaluate the immediate visual and bodily experience, and connect sightseeing to photography. English-language reviews more often distribute attention across the heritage ensemble, living religion, walking, cultural interpretation, and experiential value. The distinction is not that one group sees monuments and the other does not; the Ruins of St. Paul's is central to both. Rather, it concerns how the landmark is placed in a narrative. In the Chinese corpus it frequently serves as the destination's visual shorthand, while in the English corpus it more often becomes one stop within a walk connecting ruins, fortifications, temples, and streets.

This pattern extends destination image beyond attribute recognition. Tuan's (1977) distinction between space and experienced place helps explain why the

same arrangement can support different images. A landmark-centered itinerary converts the district into a sequence of recognizable nodes and photo opportunities. A walking-and-learning narrative emphasizes relations among sites and makes the route itself part of the heritage experience. Neither is intrinsically superficial or deep. Chinese-language reviews of Mount Fortress also contain reflective experience, while English-language reviews include photographs, shopping, and iconic attractions. The results identify modal emphases within platform corpora, not fixed cultural types.

The findings align with comparative work in Xiamen and Hong Kong, where language or source-market groups differed in thematic attention, atmosphere, and evaluation (Chen et al. 2024; Lee, Park 2023). Macao's specificity lies in the extreme proximity of Chinese and Portuguese heritage forms and in the dominance of one façade within the city's visual brand. Dewar, du Cros and Li (2012) identified the difficulty of extending awareness beyond iconic heritage; the present results show that this challenge is uneven across communicative communities. Multilingual interpretation can therefore do more than translate identical facts. It can connect a familiar landmark to the spatial and historical relationships that constitute the World Heritage ensemble.

5.2. Authenticity, crowding, and the platform-mediated heritage gaze

Reviewer narratives of authenticity take several forms. English-language attention to living worship, architectural interweaving, learning, and local food suggests a search for credible cultural context rather than only intact fabric. This resembles Wang's (1999) distinction between object authenticity and existential experience: value may arise from feeling engaged in a meaningful walk or observing an active temple, even when tourism services are present. It also qualifies a simple MacCannellian contrast between staged and authentic space (MacCannell 1973). In Macao, photographed landmarks, religious practices, retail streets, and residents' routines occupy the same compact urban field; authenticity is negotiated through their coexistence.

Chinese-language negative affect is especially sensitive to crowding. Because landmark-centered practices concentrate visitors at the same photogenic nodes, cognitive salience and behavioral narration may reinforce congestion. This echoes the relational nature of tourist crowding observed in Florence: density becomes negative when it obstructs expected activities and perceived control (Popp 2012). The result also recalls the heritage-city cycle described by Russo (2002), in which iconic cores accumulate visitors and tourism commerce while less famous areas receive limited attention. Macao differs from many European cases because its tourism economy, border regime, casino brand, and high share of short visits

produce a distinctive mobility system. Even so, dispersing attention across the serial property may simultaneously improve visitor experience and reduce pressure on the most visible sites.

Platform architecture also matters. Ctrip and Mafengwo integrate attractions with itineraries, photography, booking, and recommendation practices, while Tripadvisor organizes a globally recognizable review-and-rating environment. These affordances may amplify the observed differences. The analytical outcome should therefore be described as a language–platform pattern rather than evidence that language alone produces behavior. Future work using the same languages across multiple platforms, together with surveys or GPS-supported route data, could separate language, origin, platform, and itinerary effects.

5.3. Shared consumption and transferability

Consumption networks are more similar than the heritage-engagement networks. Egg tarts, souvenirs, famous foods, and shopping streets connect to major attractions in both corpora. This shared repertoire suggests that destination images are neither wholly culturally specific nor fully homogenized. Global travel platforms circulate recognizable products and evaluative conventions, while language communities still assemble them into different stories of place. Macao's food landscape is particularly suited to this hybrid image because Portuguese-associated products are marketed within a Chinese urban context and are readily integrated into pedestrian heritage routes.

Transferability is therefore conditional. In other Chinese or Asian gateway cities, researchers may also find contrasts between iconic-node tourism and relational exploration, but the relevant symbols and platform ecologies will differ. In European or American heritage cities, crowding and authenticity may be equally important, yet resident displacement, transport systems, museumization, and the geography of day trips may produce different networks. The analytical framework can travel more readily than the substantive result: cognitive-affective-behavioral dimensions and coordinated text methods offer a comparative template, whereas Macao's topic labels and language patterns remain case specific.

6. Conclusion

This study compared 11,520 Chinese- and English-language reviews of the Historic Centre of Macao through a cognitive-affective-behavioral framework. Its contribution is a theoretically coordinated reading of established computational methods rather than a claim of algorithmic novelty. Topic modeling identified

what reviewers noticed, sentiment analysis compared evaluative vocabularies, and semantic networks showed how action-related terms connected places, objects, and judgments.

The answers to the research questions are explicit. For research question 1, Chinese-language cognition is structured more strongly by iconic landmarks – especially the Ruins of St. Paul's, Senado Square, and Mount Fortress – whereas English-language cognition gives greater weight to the connected World Heritage ensemble, living religion, architecture, walking, and East–West cultural interweaving.

For research question 2, both corpora are predominantly positive, but Chinese-language dissatisfaction is more concentrated on crowding and congestion; English-language negative terms are more dispersed across service, value, convenience, and environmental quality. Shared positive and negative attributes demonstrate overlap rather than two separate images.

For research question 3, Chinese-language behavior-related expressions more strongly connect sightseeing with landmark photography, while English-language expressions more strongly connect visits with walking, learning, time, and perceived worth. Consumption is comparatively similar across corpora.

Theoretically, the study links destination image to place-making practices and clarifies what can – and cannot – be inferred from user-generated content. Cognitive-affective-behavioral dimensions are not directly observed mental states; they are analytical lenses on recurring themes, evaluations, and narrated actions. The language comparison likewise captures communicative and platform environments, not national essences. These boundaries make the interpretation more geographically precise and reduce the risk of cultural stereotyping.

For management, a single undifferentiated heritage message is unlikely to be optimal. Chinese-language communication can retain the appeal of core landmarks while using real-time crowd information, timed interventions, and route prompts to direct visitors toward secondary sites and quieter periods. English-language interpretation can strengthen connections among temples, churches, fortifications, civic spaces, and food streets through coherent walking routes, multilingual signs, and explanations of living heritage. Across markets, the goal should be to convert the Ruins of St. Paul's from an isolated visual icon into a gateway to the serial property.

The study has limitations. Its contributors are self-selected platform users; language is confounded with platform and cannot establish cultural causality; attraction listings create spatial bias; English may be a second language; user demographics are unavailable; the 2016–2025 period includes COVID-related discontinuity; and NLP preprocessing is not perfectly equivalent across languages. Support Vector Machine outputs are comparative classifier results rather than direct emotion measures, and co-occurrence networks do not record actual

trajectories or causal sequences. Future research should compare the same language across platforms, use manually validated multilingual sentiment samples, analyze periods separately, include underrepresented streets and public spaces, and combine reviews with interviews, surveys, or consent-based mobility traces. Comparative applications to other Asian and Euro-American heritage cities would test which patterns reflect Macao's cultural setting and which generalize to dense urban heritage destinations.

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From theory to application: Planning geography lessons to develop geographical thinking

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ABSTRACT Geographical thinking has become a central aim of geography education internationally. However, student teachers and teachers still have limited conceptual and didactic support for translating this aim into lesson planning and classroom practice. Geography didactics needs a coherent way of developing geographical thinking in teacher education. This article builds on the geographical concepts chessboard, an existing framework that connects key and organising geographical concepts and supports systematic geographical inquiry. Drawing on the distinction between the content dimension of geographical thinking (geographical concepts) and its procedural dimension (geographical questioning), we show how the framework visualises the structure of geographical thinking and supports its didactic transformation. The approach is illustrated through the post-industrial Rosice-Oslavany region and the intersection of the concepts of place and interpretation. The article contributes to geography didactics by linking disciplinary concepts with geographical questioning, offers a practical tool for geography teacher education, and concludes by distinguishing different levels of pupil engagement in geographical thinking.

KEY WORDS geographical thinking – thinking geographically – geography education – geography curriculum

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1. Introduction

Initial teacher education in Czechia is undergoing a major shift. At the centre of this change is the newly adopted Competence Framework for Graduates of Teacher Education (KRAAU, Ministry of Education 2021, 2023), which seeks to bring greater coherence to previously fragmented teacher education programmes and respond to long-standing concerns about their relevance and purpose. While the role of academic disciplines has been reduced, subject didactics has gained a slightly stronger position. For geography teacher educators, this creates both an opportunity and a challenge. If geography didactics is to remain a distinctive and indispensable part of initial teacher education, the field must clearly demonstrate how it contributes to teachers' professional preparedness and how its goals can be meaningfully translated into teaching practice.

This challenge coincides with the ongoing curriculum reform in Czechia, which identifies geographical thinking as the central aim of geography education (FEP BE; NPI 2025). Rather than representing a uniquely Czech development, this shift reflects a broader international trend that positions geographical thinking as the overarching purpose of school geography and a unifying principle for curriculum, teaching, and teacher education (Bendl et al. 2025b). Against this background, we present a conceptual study that develops a didactic framework for fostering geographical thinking in initial teacher education by connecting geographical concepts with geographical questioning.

We understand geographical thinking as the ability to use geographical concepts to ask questions, analyse relationships, and make sense of geographical phenomena (Bendl et al. 2025a; see also Jackson 2006; Lambert, Morgan 2010; Maude 2024; Bendl et al. 2025b). This places geographical concepts at the centre of disciplinary inquiry and makes their purposeful use a key challenge for geography teacher education. However, student teachers often struggle to use geographical concepts in this way. Instead of employing geographical concepts as tools for disciplinary inquiry, they tend to treat them as isolated curriculum content, making it difficult to translate geographical thinking into lesson planning and classroom practice.

At the centre of this article is the geographical concepts chessboard (Spurná, Knecht, Bendl 2025), an existing framework that connects geographical concepts with geographical questioning. We elaborate its didactic foundations by explaining how the interaction between geographical concepts and geographical questioning underpins the structure of geographical thinking, making this structure explicit for its didactic recontextualisation in teacher education and school geography. In doing so, the article provides a coherent approach for moving from talking about geographical thinking to deliberately developing it in teaching and teacher education.

The article proceeds from theory to application. It first establishes the need for a stronger focus on geographical thinking in geography teacher education, then conceptualises geographical thinking, and subsequently develops a framework that connects geographical concepts with geographical questioning. Using the Rosice-Oslavany coal basin region as an example, we show how the concepts of place and interpretation can be used to support the development of geographical thinking. The final section extends the discussion to geography teacher education and classroom practice by distinguishing three approaches to developing geographical thinking: teaching through geographical thinking, teaching with geographical thinking, and teaching geographical thinking.

2. Geography didactics as catalyst of geographical content

Graduates of teacher education programmes are expected to know what to teach and how to teach it (Brooks 2016). The Competence Framework (KRAAU) does not yet provide a specific subject knowledge, and even the geographical extension of this framework will function more as a general recommendation than as a list of well-defined thematic units or topics. Similarly, at the primary and secondary level, the Framework Educational Programmes (FEP) do not prescribe a specific subject knowledge but work exclusively with expected learning outcomes.

Geographers have long struggled to define the core, big ideas, or essence of geography (Knecht, Doboš 2024). This challenge reflects enduring debates within the discipline itself. Geography has been described both as something that is "all around us" (Doel 1999) and as a culturally and historically situated way of making sense of the world, shaped by power relations and epistemological assumptions (Lewis, Wigen 1997). Geographers continuously debate which perspectives should be privileged, which remain marginalised (Castree 2005), and where the boundaries of the discipline actually lie (Castree, Fuller, Lambert 2007). As a result, geography offers no straightforward or universally accepted answer to the question of what knowledge is most important to teach.

This creates a particular challenge for initial teacher education. If the discipline itself remains open, diverse, and contested, geography teacher educators must decide which knowledge, concepts, and themes deserve emphasis in the preparation of future teachers. These decisions are rarely self-evident. They are shaped by disciplinary developments (Walford 2001, Lambert et al. 2025), curricular priorities (Krause et al. 2025), powerful knowledge debates (Beneker, Palings 2017; Muller, Young 2019), contemporary issues such as climate change (Dal et al. 2015) or globalisation (Jurek et al. 2022), perceived difficulty for student teachers and pupils (Clausen 2018), the availability of teaching resources (Otieno, Githinji, Mayanja 2025), and the often uneven geographical backgrounds

and expectations of student teachers themselves (Solem 2023; Healy, Hammond 2025). It is therefore unsurprising that geography didactics courses can appear fragmented and difficult to situate within traditional disciplinary structures. Their focus on the transformation of knowledge for educational purposes often makes them less visible and less readily recognised within academic geography, where disciplinary content tends to take precedence. As a result, the contribution of geography didactics may appear difficult to grasp from the outside, despite its central role in connecting geographical knowledge with educational practice.

The role of geography didactics is not simply to transmit academic knowledge, but to transform it into forms that are educationally meaningful. This process has been described as translation, content transformation or recontextualisation (Puttick 2015; Maude 2021; Scholten, Doll 2024; Bendl, Rubáš 2023). It requires deliberate professional judgement about what knowledge is selected, how it is organised, and how it is made accessible to learners while retaining its disciplinary grounding. In this sense, geography teacher educators act as mediators between the discipline and the classroom.

From this perspective, geographical thinking can serve as a content catalyst. Much like a catalyst in a chemical reaction, it does not replace geographical knowledge but helps determine how it is selected, organised, and transformed for educational purposes. Orienting teacher education towards the development of geographical thinking provides a rationale for deciding which concepts, questions, and forms of reasoning deserve emphasis. In this way, geographical thinking acts as a filter through which the vast and often fragmented body of geographical knowledge can be made more coherent, meaningful, and educationally powerful. Throughout this process, the foundational geographical content retains its disciplinary grounding.

3. Geographical thinking: Between concepts and questions

In university-based geography education, the term geographical thinking appears in two principal senses. The first, theoretical, refers to paradigm shifts and the development of scientific thinking in geography (e.g. Daněk 2013; Matlovič, Matlovičová 2015). The second, didactic, understands geographical thinking as a specific mode of disciplinary reasoning that is central to meaningful geography education (Morgan 2017; Bendl et al. 2025b).

The roots of geographical thinking cannot be precisely dated. However, within geography as a discipline, interest in defining geographical thinking has emerged partly in response to the positivist–determinist era of geography (Daněk 2013). New approaches began to emphasise context, subjectivity, interpretation and qualitative methods, and geographical thinking became a central element of

these approaches. Geographers placed greater emphasis on understanding and interpreting space through subjective human perspectives (Massey 1985, 2005), cultural aspects, power relations, and other social factors (Foucault 1977). New paradigms, e.g. radical, humanistic, and cultural geography came to the forefront (Cresswell 2013), each generating and working with established or newly formulated concepts. These paradigmatic and methodological developments also show that, while some geographical concepts persist, the ways in which they are explained and interpreted have evolved (Daněk 2013, Couper 2015). Despite changes in geographical paradigms, the concepts of place and space have remained among the most frequently discussed geographical concepts (Jackson 2006; Lambert, Morgan 2010; Matlovič, Matlovičová 2020), although their meanings vary across cultural and geographical contexts (Doboš, Šerý, Lichter 2023).

This disciplinary development is important for the second, didactic sense of geographical thinking, because geography education has continuously reflected transformations within geography and translated them into curriculum and teaching (Spurná 2024). Alongside place and space, concepts such as scale, distance and interaction are widely used, although their selection varies across traditions and authors (Bustin 2017, Uhlenwinkel 2013). No universally accepted set of geographical concepts exists (Bendl et al. 2025a). In Czech geography didactics, concept-based approaches have been discussed since the 1990s (Vávra 2010) and a significant contribution can be found in the Czech Conception of Geography Education (Marada et al. 2017; see Table 1). The Conception defines seven key concepts: place, region, development, location, interaction, hierarchy (scale) and distribution. Comparable frameworks are found in the Geographical Association (2009, 2022) and the US National Geography Standards (NGS 2012).

Geographical concepts constitute fundamental building blocks of the discipline. They enable the formulation of research questions, theoretical frameworks and models that describe, explain and interpret the world. As paradigms and perspectives have shifted, new theoretical frameworks have emerged, each with its own assumptions, research methodologies, data collection strategies, forms of analysis and interpretations of key concepts (cf. Cresswell 2013, Couper 2015). In essence, two constants appear to endure in geography. First, the discipline consistently raises questions. Second, it relies on a set of key concepts. It can thus be inferred that geographical thinking, as a core aim of geography education, is also a reflection of a deeper, ongoing disciplinary crisis related to the persistent challenge of defining the subject of geography. Regarding the first constant, geography engages with a broad array of questions – often metaphysical, philosophical, existential or methodological in nature: Can geography depict an objective world? To what extent is geographical knowledge socially constructed? How successfully does geography bridge the natural sciences and the humanities? What constitutes geographical knowledge, and what is its use? (examples

taken from Morgan 2013, 2017). These questions show that questioning is not only a methodological procedure in geography, but is philosophically embedded in the discipline itself. Changing paradigms and interpretations of geographical thinking contribute to perceptions of geography as a field with fluid disciplinary boundaries (Lambert 2017).

Both constants – geographical concepts and geographical questions – are deeply rooted in geographical thinking. Geographical concepts thus "summarise what we might call the core of geography as a discipline" (Geographical Association 2022, p. 8). Although geographical thinking has become a target category in curriculum documents in many countries (Bendl et al. 2025b), diverse and often vague conceptualisations of geographical thinking may weaken its potential and reduce its applicability in practice (Bendl et al. 2025a). For the purposes of this study, geographical thinking is understood as the interaction of a content dimension, grounded in geographical concepts, and a procedural dimension, involving reasoning, analysing, interpreting and evaluating geographical questions (Bendl et al. 2025a). In the context of initial teacher education, it is therefore crucial that student teachers learn not only to understand geographical concepts, but also to use them purposefully in geographical questioning and in teaching.

4. The didactic hierarchy of geographical concepts: The content dimension of geographical thinking

Since the concept-based approach is defined as a fundamental principle of contemporary geography education (Lambert, Morgan 2010; Marada et al. 2017), it is logical to assume that geographical thinking and related key geographical concepts should also frame the disciplinary content of geography initial teacher education. Teaching geographical thinking is not straightforward; there is no established and proven method for teaching student teachers to think geographically (Fouberg, Smith, eds., 2023). We argue that the ability to distinguish and interrelate the content and procedural dimensions of geographical thinking enables student teachers to fulfil the aims of geography education and guide pupils towards an informed understanding of the contemporary world.

It is well established that geographical concepts can be organised into hierarchical structures (Maude 2024). In this study, we draw primarily on the Geographical Association's framework because it provides one of the most developed accounts of geographical thinking in contemporary geography education. Unlike the Czech Conception of Geography Education (Marada et al. 2017), the framework explicitly distinguishes between key and organising concepts (see Table 1). It also provides extensive support for teachers through curriculum guidance, lesson planning resources, and classroom materials available via the Geographical Association

Table 1 – Hierarchical classification of geographical concepts in British and Czech curriculum frameworks (first-order, second-order, third-order)

Orders	Sources	
	British framework for the school geography curriculum (Geographical Association 2022)	Czech conception of geography education (Marada et al. 2017)
Key concepts 1st order	Place Space Earth systems Environment	Place Region Development Location Interaction Hierarchy (scale) Distribution
Organising concepts 2nd order	Time Scale Diversity Interconnection Interpretation	
Teaching (substantive) concepts 3rd order	character, identity, sense of place, home, community, nation, landscape, assemblage, meanings, place narratives, culture, migration, cultural diversity, social, economic and political processes location, distribution, pattern, interaction, interdependence, globalisation, spatial process, distance, flows, spatial dynamics, spatial narratives, spatial possibilities, spatial justice carbon cycle, water cycle, photosynthesis, respiration, decomposition, weathering, erosion, land use change and management, landform processes – fluvial, aeolian, marine, glacial, physical/human interaction, physical and human processes, ecosystems, biodiversity, resources, environmental change, environmental impact, sustainability, environmental stewardship and citizenship	settlements, tertiary and quaternary sectors, geopolitics, integration, population, industry, agriculture, culture and religion, region, planning, administrative division, social conditions, globalisation, global issues, planning, lithosphere, atmosphere, hydrosphere, pedosphere, biosphere, the Earth as a planet, maps and other sources of geographical data, landscape and environment, social-economic conditions, physical conditions

Source: own proposal

website (https://geography.org.uk/). Moreover, it functions as a living framework that continues to evolve through professional dialogue, curriculum development, and scholarly debate within the geography education community (Huckle 2024; Warren-Lee, Biddulph 2025). Building on these foundations, Spurná, Knecht and Bendl (2025) have developed a hierarchy for working with concepts in geography subject didactics:

- First-order (key) concepts – the constants of the field: Place, Space, Environment and Earth systems.
- Second-order (organising) concepts – the variable "lenses" for viewing reality: Time, Scale, Diversity, Interconnection, and Interpretation.

– Third-order (teaching) concepts – instructional themes common in school practice (e.g., settlements, globalisation, erosion, but also regions).

In the context of initial teacher education, working with an unstructured set of geographical concepts proves to be ineffective. This may explain why British curriculum documents distinguish between key and organising concepts. Organising concepts offer alternative viewpoints and interpretive angles on key concepts. Together, the conceptual hierarchy allows student teachers and teachers to formulate a wide variety of geographical questions. First- and second-order concepts constitute the foundation of geographical thinking and are typically linked to third-order teaching concepts (Spurná 2024; Spurná, Knecht, Bendl 2025). The following sections discuss their didactic significance in greater detail.

4.1. Key concepts (first-order concepts)

Space: Space focuses on the distribution, localisation, networks, relationships, and spatial organisation of geographical phenomena. In geography, it has a distinct meaning from mathematics or physics and serves as an overarching concept that includes location, distribution, interaction, and distance. Spatial patterns and networks can be described and explained through social, economic, environmental, and political theories. Space is not a neutral container but a historically evolving concept shaped by societal and globalisation processes (Wardenga 2024). Geographical inquiry therefore examines where phenomena are located, how they are connected, and what their spatial arrangements imply, using tools such as maps and spatial analysis (Tuan 1977, Massey 2005, Harvey 2006). Because space is often abstract, geography education commonly links it to place, where spatial relationships acquire human meaning.

Place: Place refers to the uniqueness, functions, meanings, and lived experience. It can be understood as a meaningful manifestation of space that connects abstract spatial relationships with human experience (Wardenga 2024). As a central geographical concept, place integrates physical, social, and experiential dimensions (Larsen, Harrington 2018a, 2018b). Freeman and Morgan's (2017) "three lamps" model highlights three perspectives: natural science (geomorphology, landscape, environment), humanistic (meanings, emotions, identities, sense of place), and social science (social, economic, cultural, and political processes). These perspectives show that place extends beyond physical location and provides a key framework for geographical thinking.

Earth systems: Earth systems is a relatively recent geographical concept that emphasises regularities, patterns, cycles, and dynamic processes in both physical and human geography. Although not strongly tied to specific places or spaces,

it is often taught through model regions where such processes are visible. Understanding Earth systems involves recognising that landscapes and result from ongoing physical processes, while socio-economic processes such as population distribution, migration, and locational factors also display recurring patterns. This understanding is essential for explaining and responding to change (Castree 2016; Crane, Kasting, Kump 2010).

Environment: Environment addresses ecological and environmental processes, transformations, and human impacts, particularly in the context of the Anthropocene. It emphasises that landscapes, environments, and societies are continuously shaped by natural and social processes. The concept focuses on relationships between people, nature, resources, and sustainability, highlighting both human dependence on and transformation of the environment. Student teachers should understand environmental risks, sustainability principles, and issues of responsibility, pollution, and human impact (IPCC 2021).

4.2. Organising concepts (second-order concepts)

Time: This concept relates to change, variability, development, evolution, stability, and continuity of geographical phenomena over time, all of which are fundamental to understanding processes in both physical and human geography (see overview in Klapka, Ellegård, Frantál 2020). Time is closely intertwined with space, as geographical phenomena unfold through time–space relations, everyday mobilities, and changing patterns of human activity (Ouředníček 2002; Zévl, Ouředníček, 2025). Understanding these temporal dimensions is essential for explaining how geographical processes develop and why places change.

Scale: This concept enables geographical phenomena to be understood at different scalar levels by placing them in broader contexts and linking global, national, regional and local levels, as well as macro- and micro-scales. Scale influences our perception of phenomena; therefore, the choice of scale for analysis is essential. Student teachers should understand that connections exist between different scales; for example, decisions or events at the local level may have global consequences and vice versa. Scale can therefore be understood as a "zooming lens" (Herod 2011).

Diversity: This concept emphasises diversity, heterogeneity, similarities and differences, and variation in geographical phenomena and regions, such as people, environments and cultures, and highlights their contribution to the dynamic functioning of societies and economies. Diversity exists primarily between and within places and cultures and may result in inequalities and conflicts (Valentine, Sadgrove 2014).

Interconnection: This concept refers to relationships, influences, causes and consequences among geographical phenomena. It helps explain how geographical

phenomena "at the same level" affect one another. It is important to recognise that climate, population, economy and culture are shaped by interconnections occuring at local, regional, national or global levels (Massey 1994).

Interpretation: This concept explains geographical phenomena through values, meanings, representations and narratives, including fake news, and reflects postmodern geographical approaches (Massey 2005). It allows us to understand geographical phenomena as an open system of meanings that is fluid, ambiguous and dependent on perspective.

4.3. Teaching concepts (third-order concepts)

Third-order concepts can be understood as geographical teaching topics commonly found in school practise (Table 1). These topics serve as vehicles for demonstrating more abstract first- and second-order concepts, and for conveying the educational content of geography (Spurná, Knecht, Bendl 2025). A similar term, "substantive (geographical) concepts", has been used in this sense (Mentlík, Slavík, Coufalová 2018, p. 13; Geographical Association 2022). To date, lower-order concepts have been more prominently represented in geography curricula than higher-order concepts such as key and organising concepts (Bagoly-Simó 2021, Kácovský et al. 2022). With the revision of the Framework Educational Programme in Czechia (FEP BE; NPI 2025), and in line with the trends in other English-speaking countries (Cambridge International Education, n.d.; Maude 2024; Fouberg, Smith, eds. 2023), it appears that the first- and second-order concepts will increasingly be prioritised in geography teaching.

Spurná, Knecht and Bendl (2025) also demonstrated how regional geography can be taught through geographical concepts. When regions are approached through selected first- and second-order concepts, they no longer function merely as descriptive territorial units, but become meaningful teaching contexts through which powerful geographical knowledge can be developed. For this reason, regions may also be included among third-order teaching concepts. The three-level hierarchy helps teacher educationists and school teachers guide content selection. Concurrently it supports the comparison and, where needed, the alignment of various national frameworks, including the Czech Conception of Geography Education (Marada et al. 2017).

From the point of view of geography teacher educators, a list of key and organising concepts is not enough, because when different scholars use different concepts without coordination, it can confuse student teachers, cause inconsistency, and lead to misunderstandings. A hierarchical classification of geographical concepts helps avoid fragmented teaching and supports the structured development of student teachers' geographical thinking and their ability to ask geographical

questions. Developing geographical thinking requires, above all, understanding first-order and second-order concepts, followed by the ability to distinguish between them (Spurná, Knecht, Bendl 2025).

5. Geographical questioning: The procedural dimension of geographical thinking

The previous section established the didactic hierarchy of geographical concepts and showed how the content dimension of geographical thinking can be anchored in key, organising and teaching concepts. While questioning is deeply embedded in geography as a discipline, it is not exclusive to geography as a cognitive procedure.

While these perspectives enrich geographical education, they also risk blurring the boundaries of geographical thinking. For example, Bendl and Marada (2021) explore whether geographical thinking may be regarded as a form of critical thinking, concluding that "geography as a school subject across all educational levels has tremendous potential for fostering one of the most desired competencies of the 21st century – critical thinking" (p. 386). Similar arguments could be made for other forms of thinking, highlighting the need for greater conceptual clarity regarding the procedural dimension of geographical thinking. If we draw on established psychological definitions, however, a clearer delimitation of thinking becomes possible. In cognitive psychology, thinking encompasses higher-order cognitive processes such as problem solving, judgement and decision making, and reasoning (Braisby, Gellatly, eds. 2012). These cognitive processes are not innate skills; rather, they are cultivated through systematic instruction and require sustained intellectual engagement (Lambert 2017, Řezníčková 2003). Their presence enables geography education to move beyond the transmission of facts and towards a deeper understanding of the world.

In Czechia, geography teacher educators have long been interested in geographical questioning and analysing geographical questions (Trahorsch, Knecht 2021). We understand geographical questioning as a key expression of the procedural dimension of geographical thinking. Since geographical questioning is not, and cannot be, part of everyday thinking (Lambert 2017), student teachers need to learn how to formulate geographical questions explicitly. This skill is crucial because they are later expected to foster geographical questioning in their own pupils.

The foundation of geographical questioning lies in general question forms: What? Where? When? Why? Who? How? What could? and What should? Without geographical concepts, these questions remain generic and not specifically geographical. To support purposeful and structured questioning, we use the geographical concepts chessboard (Spurná, Knecht, Bendl 2025). The chessboard

organises geographical concepts into a two-dimensional grid in which each square represents the intersection of one key geographical concept and one organising concept. These intersections provide opportunities for developing geographical thinking through asking questions about teaching topics. Distinguishing between key and organising geographical concepts is essential to the process of geographical enquiry.

We guide student teachers to pose general questions at the level of third-order concepts that is, teaching topics, and to understand:

1. ...that each general question elicits a specific answer. For example, the question How did industry develop in Brno and Ostrava (the second and third largest cities of Czechia)? (place and time) will generate a different answer from How do different groups interpret the industrial heritage of Brno and Ostrava? (place and interpretation).
2. ...that each intersection on the chessboard of concepts focuses the question on a particular area of geography and enables diverse geographical approaches.
3. ...that when working with teaching concepts within the chessboard of geographical concepts, we stay within the boundaries of geography (as opposed to, for example, biology or history).
4. ...that geographical questions that combine concepts of different orders may vary in complexity. Questions focusing on isolated first-order concepts (e.g. What is place? or How does place differ from space?) are often more abstract than questions generated through combinations of concepts from different orders. For example, the question Why do the impacts of migration differ from one place to another? (place, diversity, migration) connects geographical concepts to a specific geographical phenomenon and therefore offers a more concrete basis for inquiry. This skill helps student teachers consider the appropriateness of questioning and evaluate pupils' responses.

In principle, there are no fixed limits to the combination of key and organising concepts. However, student teachers do not need to work with every possible square on the chessboard. Geographical thinking develops when they consider what kinds of questions geographers might ask at the intersection of a selected key concept and a selected organising concept.

6. From the geographical concepts chessboard to lesson planning: An illustrative example from geography ITE

Even in initial teacher education, engagement in everyday routines and fragmented tasks may not explicitly lead to the development of geographical thinking. We therefore use one illustrative application of the geographical concepts chessboard

Table 2 – Adapted geographical concepts chessboard showing all intersections of geographical concepts used in the Rosice-Oslavany region

Organising concepts	Time	Scale	Diversity	Interconnection	Interpretation
Key concepts					
Place	How has the identity of the Rosice-Oslavany region changed from the coal mining period to today?	What role did the Rosice-Oslavany region play in the industrial development of Moravia and the Czech Republic?	What different employment opportunities and economic activities emerged or were available in the Rosice-Oslavany region in connection with coal mining?	How was the development of coal mining related to population growth in the Rosice-Oslavany region?	HOW DO LOCAL PEOPLE INTERPRET THE INDUSTRIAL HERITAGE OF THE ROSICE-OSLAVANY REGION?
Space	How did the spatial distribution of mines, industry and housing change over time in the Rosice-Oslavany region?	How were industrial sites in the Rosice-Oslavany region connected to wider transport networks?	How did the urban structure of settlements differ across the Rosice-Oslavany region?	What spatial connections existed between mines, railways and settlements in the Rosice-Oslavany region?	How do local people perceive the location of different industrial zones within the Rosice-Oslavany region?
Earth Systems	How has the importance of coal as an energy source changed over time?	What role did regional coal mining play in the Czech energy system?	What different economic and energy-related activities were connected to coal mining?	How did the mining industry affect water management in the region?	What advantages and disadvantages did coal mining bring to local communities?
Environment	How has the landscape of the Rosice-Oslavany region changed over time up to the present day?	How has air quality changed in the Rosice-Oslavany region in relation to industrial development?	What types of post-mining landscapes can be found in the Rosice-Oslavany region today?	What environmental impacts did coal mining have on the landscape of the Rosice-Oslavany region?	How do local people perceive the quality of the landscape in the Rosice-Oslavany region today?

Note: The question at the intersection of place and interpretation (highlighted in capital letters) is the primary focus of this study. It can be translated into more specific questions for student teachers and pupils, such as: What memories and meanings do local people associate with former mining sites in the Rosice-Oslavany coal basin? How do industrial heritage sites and mining features shape people's sense of place? How do inhabitants interpret the region's transformation from a mining to a post-industrial landscape? The remaining cells of the chessboard illustrate questions generated by other combinations of geographical concepts. Any of these questions can be further deepened through follow-up prompts such as Why? or Why do you think so? to encourage explanation, argumentation and reflection.
Source: authors' own proposal

based on the selected intersection of two concepts: the key geographical concept of place and the organising concept of interpretation (Table 2). The concepts of place and interpretation were selected for both theoretical and didactic reasons. Place is among the most established concepts in geographical education and has long been associated with experience, identity, and meaning-making (Larsen, Harrington 2018a). Interpretation offers a means of exploring these dimensions, yet remains a long-neglected and underdeveloped concept in geography didactics in Czechia (Vávra 2010). The selection of concepts is not arbitrary; the key concept anchors what is being examined, while the organising concept determines how the phenomenon is approached and understood.

The example is drawn from a geography ITE master's thesis by one of this study's co-authors (Moos 2025). Building on the geographical concepts chessboard, Moos (2025) used the intersection of the concepts place and interpretation to design lessons for the Rosice-Oslavany coal basin region. Drawing on the geographical "three lamps" model of place (Freeman, Morgan 2017) and humanist and post-positivist theories (Tuan 1977, Massey 1985), Moos (2025) examines how the Rosice-Oslavany coal basin region can be interpreted through the concept of place. In this perspective, attention shifts from the region as a bounded spatial unit to the meanings, experiences, memories, identities, and human–environment relationships associated with it (Kulich, Hájková, Hušková 2022; Marada et al. 2017).

In school geography, the concepts of place and interpretation provide a framework for moving beyond description towards deeper understanding, creating opportunities for place-based learning (Larsen, Harrington 2018a; Kulich, Hájková, Hušková 2022). Rather than focusing only on locational facts, this approach helps pupils understand space as a relational and value-laden phenomenon. Combining the concepts of place and interpretation leads to the notion of sense of place, defined as an emotionally and cognitively mediated relationship with a place (Foote, Azaryahu 2009; Krasny 2020). Sense of place is commonly understood through two dimensions: place attachment and place meaning (Kudryavtsev, Stedman, Krasny 2012; Rubáš, Matějček, Řezníčková 2024). Research also suggests that pupils' sense of place may weaken over time without intentional educational support (Rubáš et al. 2025).

7. Integrated geographical understanding through two concepts: Place and interpretation in the Rosice-Oslavany coal basin region

Using the selected chessboard intersection of the key geographical concept of place and the organising concept of interpretation, this section develops an integrated geographical understanding of the Rosice-Oslavany coal basin region, located

southwest of Brno (Kolejka 2006; https://www.mikroregionkahan.cz/). The region has been shaped by a long history of coal mining, which has influenced its landscape, identity, and collective memory. It can be understood as a post-industrial cultural landscape, formed by industrial activity and subsequently transformed by new dominant functions (Kolejka, Klimánek 2012). The combination of place and interpretation provides a lens through which the region can be understood as the product of interactions between material landscape change, mining history, collective memory, changing social functions, and locally constructed meanings. In such landscapes, industrial heritage affects not only landforms and land use but also the social and cultural structures through which places are experienced, interpreted, and remembered. This relationship can be analysed from different perspectives, each highlighting particular meanings that people attach to the region and contributing to their distinctive sense of place.

Given the significant transformation of the region following the end of mining in the second half of the 20th century, it would be possible to include the concepts of time and environment in the analysis. However, we primarily focus on the present state of the place and its perceived significance, without addressing at least two other possible transformations: change over time and change in environmental quality. From the perspective of traditional teaching, the region could be explored as a space with distinct elements such as visible marks of past mining and their spatial distribution. Current approaches in geographical education increasingly recognise sense of place as a foundation for understanding space, as it enables pupils to grasp the complexity of the world through personal and situated experience (Castree, Oakes, Sinclair 2023). Such an understanding allows a shift from place to space, encompassing the spatial distribution not only of geographical phenomena but also of values and meanings, thereby linking the concepts of place, space, and interpretation. The relationship between these concepts is explored in depth in the timeless and still unsurpassed review by Vávra (2010).

In line with this perspective, the concept of interpretation is used to examine the meanings that people assign to place. Meanings are not objectively fixed; rather, they are constructed through personal stories, memories, photographs, and lived experiences. A narrative approach makes it possible to capture these subjective dimensions of place, revealing how individual and collective identities are shaped through spatial engagement. Drawing on this, Moos (2025) collected and analysed narratives from the Rosice-Oslavany coal basin region, illustrating how meanings are continually redefined through experience. As Oliver (1998) argues, stories are not merely records of events, but structures through which people interpret and make sense of reality. To illustrate this complexity, we draw on Freeman and Morgan's (2017) "three lamps" model, introduced earlier in the article.

7.1. Industrial heritage as the basis of the historical identity of place (lamp of natural science approach)

From a historical perspective, sense of place in the Rosice-Oslavany coal basin is shaped primarily by the legacy of coal mining, which influenced both the landscape and the everyday life of local communities for more than two centuries (Plchová 2002; Macholán 2004). The region represents a distinctive post-industrial landscape whose present character remains closely linked to former mining and energy production activities (Svatoňová, Lněnička 2013). Industrial development brought economic growth and urban expansion, but also substantial environmental transformation and the creation of a landscape marked by mining infrastructure. Visible traces of this development include spoil heaps (e.g. Babice, Zbýšov and Oslavany), abandoned mines (e.g. Julius, Ferdinand and Jindřich II), miners' colonies, railway infrastructure, and repurposed industrial buildings such as the Herring, Simson, Františka and Kukla complexes. These features are more than physical remnants of industrial activity. They represent visible traces of the region's industrial development and provide evidence of how coal mining shaped the landscape over time. Spoil heaps, mine shafts, industrial buildings, and transport infrastructure document the spatial extent and intensity of mining activities and reveal their impact on settlement patterns, land use, and environmental conditions. From a natural science perspective, these features can be observed, described, mapped, and compared as material indicators of historical landscape transformation. Their continued presence makes it possible to reconstruct key stages of the region's development and to understand how industrial activity contributed to the distinctive character of the contemporary landscape. These features provide a basis for different interpretations of the region's industrial past. As visible traces of historical landscape transformation, they offer evidence through which the development of the region can be reconstructed and explained from different geographical perspectives.

7.2. Place narratives as expressions of lived history (lamp of the humanistic approach)

The second dimension of place emerges through lived experience, memory, and local narratives. While industrial heritage provides the material foundation of place, narratives connect these physical features with the experiences of individuals and communities. In the Rosice-Oslavany region, stories associated with mining shafts, railway lines, miners' housing, and spoil heaps preserve memories of everyday life in a mining landscape and transmit them across generations. Some of these places are shared with visitors through narratives that portray them as

locations "where the earth whispers of the past" (Moos 2025). From this perspective, former mining sites become more than historical objects. They are interpreted through stories that connect people, experiences, and places. As Oliver (1998) argues, narratives do not simply describe reality; they help people make sense of it. Through storytelling, places acquire meanings that extend beyond their physical characteristics and become part of individual and collective identities. Different narratives may emphasise different aspects of the same place, highlighting that meanings are neither fixed nor universal but depend on perspective and experience (Massey 2005). This understanding resonates with place-based approaches in geography education, which emphasise that learning about place involves not only acquiring knowledge but also developing emotional and experiential connections to it (Israel 2012). Such narratives contribute to place attachment and place meaning (Rubáš, Matějček, Řezníčková 2024), linking contemporary understandings of the region with its industrial past.

7.3. Changing functions of industrial features in place (lamp of the cultural approach)

The third dimension of sense of place concerns the cultural and social relationships through which places are continually transformed and reinterpreted. Following the decline of mining activities in the second half of the twentieth century, the region underwent extensive reclamation and functional transformation, gradually shifting from an industrial landscape towards new cultural, recreational, educational, and tourism-oriented uses (Svatoňová, Lněnička 2013; Jarczewski, Koj 2023). Former industrial sites have acquired new meanings and functions. These meanings are not inherent in the sites themselves but emerge through social, cultural, and political processes. The same industrial feature may be interpreted as a symbol of technological progress, environmental degradation, regional pride, or cultural heritage, depending on the perspective adopted (Massey 2005). Typical examples include the repurposing of the Julius mine, the Zbýšov spoil heap, and the former Oslavany power station, one of the most important industrial monuments in the region (Kyselák 2002). Today, these sites serve as museums, visitor attractions, educational venues, and symbols of regional identity. A living tradition of mining heritage is sustained through regular cultural events (e.g. the Mining Festival, Steam for Miners), thematic exhibitions (e.g. Jewels among the Waste), museum activities, and local toponymy. These transformations demonstrate that places are not static entities but dynamic products of ongoing interactions between people, landscape, memory, and social practice. In the Rosice-Oslavany coal basin, industrial heritage continues to influence how the region is understood and experienced, even though its original economic function has largely disappeared.

8. Further implications for teacher education and classroom practice

The Rosice-Oslavany coal basin region provided the setting for six teaching plans developed through the geographical concepts chessboard. The full lesson plans are available in an open-access master's thesis by one of the study's authors (Moos 2025). Through the selected intersection of place and interpretation, the region is understood not merely as a physical space, but as a place full of meanings, stories, memories and the values of the local community.

This example does not exhaust the full potential of the geographical concepts chessboard. When applied to a region, the chessboard offers a transferable model for interpreting urban, rural or post-industrial regions not only as places, but also as spaces and environments. Other intersections of key and organising concepts can be used, for example, to explain stable processes and patterns, or to examine diversity and transformations in the landscape. Working with the remaining concepts and their intersections can therefore support deeper, more intensive development of geographical thinking and enable student teachers and pupils to understand the world around them in more complex ways. The remaining intersections presented in Table 2 demonstrate how different combinations of key and organising concepts can be used to generate geographical questions and to structure teaching through third-order teaching concepts.

The Rosice-Oslavany coal basin region was used to show how the selected intersection of place and interpretation can guide the transformation of regional content into geographical questions. A further implication for teacher education and classroom practice concerns how the geographical concepts chessboard can be used to incorporate geographical concepts and geographical questioning into classroom activities at different levels of engagement with geographical thinking. Student teachers should therefore consider how intensively pupils are expected to engage with the geographical concepts chessboard within a learning activity. In this respect, we distinguish three levels of pupils' classroom engagement with the chessboard: teaching through geographical thinking, teaching with geographical thinking and teaching geographical thinking.

The first level is *teaching through geographical thinking*. In the Rosice-Oslavany example, the concepts of place and interpretation would guide the teacher in planning and organising questions about the region, while pupils would engage mainly with the prepared questions and tasks. At this level, the geographical concepts chessboard functions as a tool for the teacher: it supports lesson planning, the organisation of learning activities and reflection on the conceptual focus of these activities. The chessboard itself is not introduced to pupils as an explicit classroom tool. During lesson planning, the teacher selects key and organising concepts in advance and uses them to prepare geographical questions. In the lesson, the teacher explicitly introduces these concepts and questions to pupils. However,

pupils do not work with the chessboard, do not generate geographical questions themselves and do not use the concepts to define questions. Their task, and the main aim at this level, is to work with the questions prepared by the teacher, search for answers and formulate responses. The selected concepts help the teacher keep the activity within the intended conceptual line. They also provide feedback for the teacher during and after the activity. If pupils' search for answers or their responses move towards another concept, the teacher can guide their search for answers and responses back to the intended focus. This is not treated as a mistake, but as a shift that the teacher can recognise, frame and reflect on.

The second level is *teaching with geographical thinking*. In the Rosice-Oslavany example, pupils would work explicitly with the intersection of place and interpretation in the geographical concepts chessboard, but the questions about the region would still be prepared and conceptually structured by the teacher. This level includes the teacher's planning, organisation and monitoring of the activity described at the first level, but the geographical concepts chessboard is now also brought into the classroom as an explicit tool for pupils. Key and organising concepts are made visible in the lesson, and pupils work with the chessboard as a structured support for the activity. However, they do not generate geographical questions themselves, do not use the concepts to define new questions, and are not expected to memorise the meanings or definitions of the concepts. Rather, pupils use the chessboard to understand how the prepared questions are conceptually framed. The geographical questions are prepared by the teacher in advance: pupils may either work with questions that have already been placed within the chessboard, or they may assign teacher-prepared questions to the relevant intersections of key and organising concepts. Their task remains to work with these questions, search for answers and formulate responses. As at the first level, the teacher continues to guide and monitor the activity. If pupils' search for answers or their responses move towards another concept, the teacher can guide their work back to the intended focus or reframe the shift conceptually.

The third level is *teaching geographical thinking*. In the Rosice-Oslavany example, pupils would not only learn about a post-industrial region or work with teacher-prepared questions; they would actively use the geographical concepts chessboard to explore how the region can be understood through different intersections of key and organising concepts. At this level, the teacher prepares the activity so that pupils work directly with the chessboard, understand the meanings of the concepts involved and use them to formulate geographical questions themselves. These questions may be created within intersections selected in advance by the teacher, or pupils may choose different intersections and generate their own questions from them. Pupils therefore work not only with answers, but also with the conceptual construction of questions. They search for answers, formulate responses and use these responses to check the precision and adequacy of the

geographical questions they have formulated. They can explore how different combinations of key, organising and teaching concepts lead to different geographical questions, different kinds of answers and different ways of understanding the same region. In this sense, pupils also learn to reflect on their own use of concepts, on the questions they formulate and on the geographical answers they develop. Throughout this process, the teacher continues to supervise the activity and guide pupils' work where needed.

The third level most directly supports the aim of the revised Czech geography curriculum (NPI 2025), because it enables pupils not only to acquire geographical knowledge, but to think geographically. It helps them make sense of places, interpret spatial patterns and meanings, and connect local experience with broader geographical understanding. For geography initial teacher education, this means that the geographical concepts chessboard can function not only as a conceptual framework, but also as a practical tool for preparing student teachers to plan, teach and evaluate geography lessons aimed at the development of geographical thinking.

Regardless of the level at which we work, however, the aim of using the geographical concepts chessboard is not simply to fulfil curriculum requirements. Nor is it merely to ensure that pupils acquire factual knowledge of concepts or learn to generate geographical questions mechanically. The fundamental aim of working with the geographical concepts chessboard is broader: to cultivate a way of noticing, questioning and interpreting the world geographically beyond the classroom. As Roberts (2017) argues, geographical education becomes powerful when it values students' everyday knowledge, enables them to see the world in different ways and has effects on their thinking that endure beyond school. Geographical thinking is developed when pupils begin to use geographical concepts and questions in their own encounters with places, landscapes and everyday environments. A particular success for teachers is when pupils spontaneously notice what is around them and, out of curiosity, begin to ask why it is there, how it has changed, what meanings it carries and how it might be interpreted. In this way, big geographical questions can become pupils' own questions, as Roberts (2010) suggests in relation to geographical enquiry. The geographical concepts chessboard can support this shift by helping student teachers and pupils move from abstract concepts to questions that structure enquiry into real places. Its value lies not only in lesson planning, but in supporting pupils to carry geographical questioning into their everyday lives.

9. Conclusion

The geographical concepts chessboard (Spurná, Knecht, Bendl 2025) offers a coherent way of translating geographical thinking into lesson planning and classroom practice. Using the intersection of the concepts of place and interpretation, we

demonstrated how geographical concepts can be transformed into geographical questions and how the content and procedural dimensions of geographical thinking can be connected in geography education. The Rosice-Oslavany coal basin region served as an illustrative example of this process.

The study forms part of a broader project funded by the Czech Science Foundation that responds to current reforms in both geography education and initial teacher education in Czechia. These reforms raise important questions about coherence, content selection, and the role of subject didactics in teacher preparation. Our findings suggest that a stronger orientation towards geographical thinking can provide a shared conceptual foundation for geography teacher education without prescribing specific content or limiting academic autonomy. Departments and teacher educators may continue to work with different topics, regions, and examples, while sharing a common focus on the development of geographical thinking.

Several questions remain open. While we focused on a single intersection of the geographical concepts chessboard, further work is needed to explore how other combinations of key and organising concepts support the development of geographical thinking. Equally important is research on how student teachers learn to work with geographical concepts and questions over time, and how such learning influences their classroom practice. Given the growing emphasis on geographical thinking in curriculum frameworks internationally (Bendl et al. 2025b), greater attention should be paid to the ways in which this aim is translated into teacher education, lesson planning, and assessment. The geographical concepts chessboard provides one possible framework for such work and a basis for further empirical investigation.

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Úskalí a metodologické limity prognózování populačního vývoje malých územních celků

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ABSTRACT **Pitfalls and methodological limits of population forecasting in small territorial units** – This article examines the methodological limits of population forecasting in small territorial units, particularly at the municipal level. It explains why local population forecasts cannot be treated as simple scaled-down versions of regional or national models and how their specific constraints can be addressed in forecasting practice. The article focuses on low counts of demographic events, migration volatility, spatial heterogeneity, and discrepancies between administratively registered residence and usual residence. The proposed framework combines the cohort-component model with typological differentiation of municipalities and a capacity-constrained approach to migration modelling, linking expected population change to the actual development capacity of the territory, particularly housing construction. The analysis shows that migration is the main source of uncertainty in local forecasts, while low event counts increase random variation in observed demographic structures and trends. Reliable local forecasting therefore requires specific treatment of uncertainty, migration assumptions grounded in actual territorial development capacity, and adaptation of selected forecasting procedures to local conditions.

KEY WORDS population forecasting – small territorial units – migration volatility – small numbers – housing unit method – municipal typology

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1. Úvod

Rozhodování ve veřejné správě i soukromém sektoru by mělo vycházet z racionálních podkladů, mezi něž patří populační prognózy jako vědecky podložené závěry o pravděpodobném budoucím vývoji. Velikost populace a její pohlavně-věková struktura patří k základním charakteristikám obyvatelstva, které ovlivňují fungování sociálních a územních systémů. Zároveň představují klíčový vstup pro plánování kapacit školství, sociálních a zdravotních služeb, bydlení či dopravní infrastruktury (Keyfitz 1984; Lutz, Goldstein, Prinz 1996; Hulík, Šídlo, Tesárková 2008; Průša 2015, 2018, 2019; Šídlo, Křesťanová 2018; Bleha a kol. 2023; Burcin, Kučera 2022). V českém prostředí s vysokým počtem malých obcí má lokální populační prognostika přímé uplatnění v územním plánování i strategickém řízení rozvoje.

Na národní a regionální úrovni bývají demografické trendy opřeny o robustnější časové řady. V malých územních celcích se naopak výrazněji projevují nízké četnosti narození, úmrtí a migračních pohybů, takže i omezený počet demografických událostí může vyvolat výrazné relativní výkyvy. Tyto výkyvy nemusí znamenat trvalou změnu populačního vývoje, ale krátkodobou fluktuaci.

Populační vývoj malých územních celků je zároveň citlivý na lokálně specifické podmínky, zejména na migrační atraktivitu daného území. Tu mohou ovlivňovat například rozsah a načasování bytové výstavby, dostupnost veřejných služeb, dopravní napojení či konkrétní institucionální rozhodnutí, například změny územního plánu, otevření nebo uzavření školy či významného zaměstnavatele. Tyto faktory působí na populační vývoj převážně nepřímo, prostřednictvím změn v migračním chování obyvatel, a jejich význam se může v krátkém období výrazně proměňovat.

Navzdory rozsáhlé literatuře věnované populačnímu prognózování zůstávají metodická specifika malých územních celků relativně méně reflektována, zejména v českém kontextu. Dosavadní výzkum se soustředí především na aplikaci standardních kohortně-komponentních modelů, zatímco omezení vyplývající z malých populačních souborů – malé počty demografických událostí, migrační volatilita, prostorová heterogenita a diskrepance mezi administrativní a faktickou populací – bývají tematizována spíše implicitně.

Cílem článku je systematicky vymezit tyto hlavní zdroje nejistoty a ukázat, jak je lze metodicky zohlednit při tvorbě lokálních populačních výhledů. Propojením teoretických poznatků s demograficko-geografickou aplikací na souboru obcí Kraje Vysočina text prokazuje, že inherentní nejistota těchto prognóz nevyplývá pouze z nízké četnosti událostí v malých populacích, ale je silně podmíněna právě prostorovou heterogenitou obcí a vysokou volatilitou migrační složky. Jako řešení proto článek představuje metodický rámec, který kombinuje klasický kohortně-komponentní model s typologickou diferenciací obcí a kapacitně podmíněným

přístupem k migraci. Ambicí článku přitom není empiricky testovat přesnost konkrétní populační prognózy, ale systematicky vymezit limity lokální populační prognostiky a formulovat metodologický rámec jejich ošetření. Text usiluje o konceptualizaci hlavních zdrojů nejistoty v malých územních celcích a o návrh metodických principů, které umožňují tyto limity transparentně zohlednit v prognostické praxi. Malým územním celkem je zde rozuměna obec vymezená administrativními hranicemi, což odpovídá dostupnosti statistických dat; současně je zdůrazněna nutnost reflektovat jejich vnitřní heterogenitu. Obec je zároveň základní jednotkou územního plánování a samosprávného rozhodování, což zvyšuje relevanci prognostických výstupů právě na této úrovni.

2. Teoreticko-metodologická východiska lokálních populačních prognóz

Tato kapitola shrnuje teoretická a metodická východiska tvorby populačních prognóz malých územních celků, a vymezuje faktory ovlivňující volbu prognostického postupu i interpretaci výsledků. Populační dynamika malých obcí je citlivější na náhodné výkyvy a lokální faktory než na vyšších územních úrovních, kde větší populační soubory zajišťují vyšší statistickou stabilitu pozorovaných demografických ukazatelů.

2.1. Prognóza, projekce a epistemologická povaha demografického poznání

Specifičnost lokálních populačních prognóz nespočívá pouze v omezeném rozsahu dat a vyšší variabilitě ukazatelů, ale i v povaze samotné prognostické výpovědi. V prostředí malých územních celků je odhad budoucí populační velikosti i pohlavně-věkové struktury výrazněji podmíněn formulací vstupních předpokladů a volbou metodického rámce. Nízké absolutní počty demografických událostí způsobují, že i několik narození, úmrtí či migračních přesunů může vyvolat výrazné relativní změny. Tyto změny však nelze automaticky interpretovat jako dlouhodobý trend, přestože představují krátkodobou fluktuaci. Prognostický proces zde proto nepředstavuje pouhou extrapolaci minulého vývoje, ale také posouzení, zda pozorované změny vyjadřují trvalejší tendenci, nebo náhodný výkyv.

V této souvislosti je nezbytné důsledně rozlišovat mezi pojmy prognóza a projekce. V souladu s vymezením Kučery (1998) je prognóza chápána jako nepodmíněná výpověď o nejpravděpodobnějším budoucím populačním vývoji, založená na jeho vědeckém poznání. Prognóza vychází ze syntézy obecných i specifických poznatků o populačních procesech a z analýzy dosavadního vývoje.

Naproti tomu projekce představuje podmíněnou výpověď o budoucím vývoji populace, jejíž platnost je vázána na splnění konkrétně formulovaných

předpokladů. Tyto předpoklady se mohou týkat jak demografických procesů (plodnosti, úmrtnosti a migrace), tak mimodemografických faktorů, zejména institucionálních, ekonomických a prostorových podmínek. Prognóza usiluje o identifikaci nejpravděpodobnějšího budoucího vývoje, zatímco projekce slouží k modelování alternativních scénářů a posouzení důsledků různých vstupních předpokladů.

Prognózování populačního vývoje je zatíženo inherentní nejistotou. Jak uvádějí Keyfitz (1972) či Keilman (1990), nejistota nepředstavuje chybu modelu, ale jeho vnitřní vlastnost vyplývající z nemožnosti deterministicky predikovat lidské chování. Tato skutečnost je tradičně reflektována prostřednictvím konkrétního vymezení předpokladů, za nichž prognóza ztrácí svou platnost (tzv. Hoemovy *„disclaimers"*).

Význam tohoto rozlišení narůstá v kontextu územního plánování. Nový stavební zákon č. 283/2021 Sb. v § 38 odst. 2 stanovuje, že územní plánování „vyhodnocuje potenciál rozvoje území a prognózy jeho dalšího vývoje". Přestože zákon používá pojem prognóza, plánovací rozhodnutí jsou spjata s explicitními předpoklady o budoucím využití území. Výsledná demografická výpověď je proto v praxi projekcí podmíněnou realizací rozvojových záměrů.

2.2. Úskalí prognózování populace v malých územních celcích

Prognózování populačního vývoje v malých územních celcích je spojeno se specifickými metodickými omezeními. Ta vyplývají z charakteru malých populačních souborů, dostupnosti dat i povahy lokální demografické dynamiky. Následující podkapitoly tyto aspekty systematicky vymezují.

2.2.1. Malý počet demografických událostí

Malé počty narození, úmrtí a migračních událostí v málo početných populacích představují klíčový zdroj statistické nestability. Nízká četnost událostí zvyšuje relativní variabilitu ukazatelů a komplikuje odlišení dlouhodobějších tendencí od krátkodobých fluktuací (Burcin, Kučera 2012; Temelová a kol. 2013). Parametry odhadované z krátkých časových řad jsou zatíženy výraznou náhodnou složkou a jejich přímá extrapolace může vést k systematickému zkreslení prognózy.

Citlivost malých populací znamená, že krátkodobé výkyvy mohou být chybně interpretovány jako dlouhodobý trend. Demografické procesy na lokální úrovni jsou proto obecně méně stabilní a méně předvídatelné než na úrovni národní (Wilson, Rowe 2011). Nejvýrazněji se tato nestabilita projevuje u migrace, jejíž objemy, směry i struktura se mohou meziročně výrazně měnit (Burcin, Kučera 2022).

Metodickou reakcí je agregace dat, stabilizace parametrů na úrovni homogennějších skupin obcí a opatrná interpretace krátkodobých výkyvů.

2.2.2. Omezená dostupnost dat

Vedle omezené velikosti statistických souborů představuje u lokálních populačních prognóz problém také dostupnost a využitelnost dat. Přestože má Česko díky tradici centralizovaného sběru demografických dat a systematické kontrole jejich kvality relativně výhodné postavení, analýza malých územních celků zůstává náročná z hlediska datové úplnosti i stability sledovaných ukazatelů (Wilson, Rowe 2011; Burcin, Kučera 2012; Bleha a kol. 2018). Soubor jednotlivých obcí vykazuje vysokou variabilitu a často absenci trendů, které by bylo možné spolehlivě extrapolovat (Rayer 2015).

Zvláštní pozornost je třeba věnovat také změnám v definicích sledovaného obyvatelstva, například zahrnutí cizinců s dlouhodobým pobytem do obyvatelstva Česka od roku 2001, které například Burcin, Kučera (2022) zohlednili při zajištění homogenity časových řad.

2.2.3. Administrativní evidence a koncept reálné populace

Specifickým metodologickým problémem lokálních prognóz je rozdíl mezi administrativně evidovaným a fakticky přítomným obyvatelstvem. Základním zdrojem informací o populaci v Česku je Sčítání lidu, domů a bytů (SLDB), které pracuje s konceptem obvykle bydlícího obyvatelstva, zatímco průběžné demografické bilance vycházejí z evidence registrovaného pobytu. Administrativní registr však nemusí odpovídat skutečnému místu života osob, neboť jde o právní úkon, nikoli nutně o faktickou přítomnost (ČSÚ 2025). Na celostátní úrovni se tyto rozdíly částečně vyrovnávají, avšak na úrovni jednotlivých obcí mohou mít výrazný dopad. Analýzy ČSÚ (2025) ukazují například v Kraji Vysočina rozdíl mezi evidovaným a faktickým počtem obyvatel o téměř 6 tisíc osob.

Odborný diskurz proto pracuje s konceptem reálné populace, který reflektuje skutečné využívání prostoru a každodenní přítomnost obyvatel (Ouředníček a kol. 2008). Empirické studie založené například na geolokačních datech mobilních operátorů potvrzují, že rozdíly mezi administrativní evidencí a faktickým zatížením území mohou být na lokální úrovni významné (Jirásek, Šomplák 2025). Tyto diskrepance nepředstavují pouze statistický problém, ale významně ovlivňují interpretaci demografických dat i dimenzování veřejné infrastruktury.

V podmínkách malých územních celků se tyto rozdíly zesilují problémem velikosti sledovaných populací. I malé absolutní odchylky mohou představovat významný podíl velikosti obce a promítat se do odhadů plodnosti, úmrtnosti

i migrace. Nesoulad mezi evidovaným a faktickým stavem tak nepředstavuje pouze statistický detail, ale významný zdroj nejistoty lokálních prognóz.

2.2.4. Specifika migračního vývoje

Migrace představuje obecně nejobtížněji prognózovatelnou složku populačního vývoje; v malých územních celcích se tyto obtíže dále zesilují a migrace zde často vystupuje jako klíčový faktor určující celkový populační růst či pokles. Jak upozorňuje Isserman (1993), zatímco přirozená měna obyvatelstva je do značné míry podmíněna biologickými a dlouhodobými sociálními faktory, migrační chování reaguje pružněji na změny lokálních podmínek a individuální rozhodnutí domácností. Wilson, Rowe (2011) proto označují migraci za nejslabší článek populačních prognóz.

Malé populace jsou citlivé na lokální vlivy, přičemž migrace na ně reaguje nejrychleji. Jak už bylo zmíněno výše nová bytová výstavba, změna dopravní dostupnosti mohou v krátkém období zásadně změnit migrační bilanci. Významným impulzem může být také rozvoj velkého zaměstnavatele. Příkladem je dynamický růst strategické průmyslové zóny Solnice–Kvasiny–Rychnov nad Kněžnou, kde počet zaměstnanců vzrostl mezi lety 2007 a 2017 z 2 500 na 10 300 (Šindlerová 2022), což vedlo k výraznému zvýšení dojížďky pracovníků, jejich ubytování v okolních obcích a k růstu tlaku na bytovou výstavbu i místní infrastrukturu. I jednotlivé developerské či průmyslové projekty tak mohou vést k výrazným „skokům" populačního vývoje, které nelze interpretovat jako pokračování historického trendu (Burcin, Kučera 2022).

Důležitou roli hrají také diskontinuální impulzy, které lze členit na realizované rozvojové zásahy a záměry deklarované, avšak nerealizované (*„phantom developments"*). Pokud jsou developerské projekty zahrnuty do migračních předpokladů bez posouzení jejich realizovatelnosti, dochází k systematickému nadhodnocení projekcí. Analogické problémy dokumentují i zahraniční studie lokálních prognóz (Tayman 2011, Wilson a kol. 2021). V podmínkách malých obcí nejde pouze o kolísání migračních bilancí, ale o odlišnou povahu migrační složky. Zatímco u přirozené měny lze při splnění určitých předpokladů uvažovat o prognostickém přístupu, u migrace je vhodnější hovořit o projekci podmíněné rozvojovými předpoklady. Migraci nelze „předpovědět", ale modelovat jako funkci očekávaného územního, investičního a infrastrukturního vývoje.

Uvedené omezení se vztahuje především k migraci podmíněné rozvojovými faktory. Specifickou kategorii představují náhlé exogenní migrační šoky vyvolané geopolitickými událostmi (např. migrační vlna po roce 2022). Takové pohyby nejsou odvozeny od lokálních rozvojových kapacit, ale představují systémový zásah z vnějšího prostředí, který může krátkodobě změnit populační realitu území. Tato hranice je tradičně reflektována prostřednictvím explicitního vymezení předpokladů (Hoemovy *„disclaimers"*).

Vedle nízkých absolutních počtů migračních událostí představují významný problém také limity kvality migračních dat. Nesoulad mezi administrativně evidovaným trvalým bydlištěm a faktickým místem pobytu může zkreslovat migrační obraz obce. Typickým příkladem je obec Chorvátsky Grob, kde se odhaduje 1 000 až 2 000 nepřihlášených obyvatel (Šveda, Šuška 2014). Tento příklad ilustruje obecný problém administrativní evidence, který je relevantní i pro české suburbanizační oblasti. Extrapolace minulého migračního vývoje je v malých obcích problematická. Wilson, Grossman, Temple (2022) upozorňují na vysoké datové nároky komplexních multiregionálních modelů a navrhují jednodušší syntetický přístup. Metodickou reakcí na migrační volatilitu je kapacitně orientovaná metoda bytových jednotek (Housing Unit Method – HUM), která odvozuje migrační přírůstky z bytové výstavby a absorpční kapacity území (Swanson, Schlottmann, Schmidt 2009; Smith, Tayman, Swanson 2013; Baker a kol. 2017). Tento přístup umožňuje vymezit náhodnou složku migračního vývoje a propojit demografickou projekci s reálnými rozvojovými podmínkami území.

Vazba mezi migrací, bytovou výstavbou a rozvojovou kapacitou území je zvláště patrná v zázemí velkých měst, kde se populační růst často koncentruje do obcí s intenzivní rezidenční výstavbou. Jak zdůrazňuje Šindlerová a kol. (2022), vymezování zastavitelných ploch není pouze reakcí na populační růst, ale tento růst aktivně spoluutváří. Praxe nabízí příklady expanzivního rozvoje (Moravany, Vysoký Újezd, Mezouň, Hýskov, Dobrovíz, Kolomuty a mnoho dalších).

Z hlediska populační prognostiky představuje taková dynamika výrazný případ migrační volatility. Překotná bytová výstavba nereflektující časové sladění s rozvojem veřejné infrastruktury může vést k situaci, kdy migrační růst předbíhá institucionální kapacitu území. Pro prognostika to znamená, že migrační vývoj nelze interpretovat jako lineární pokračování minulého trendu, ale jako proces podmíněný rozvojovými zásahy. Pokud tento rozvojový kontext není zohledněn, může dojít k významnému nadhodnocení či podhodnocení budoucího populačního vývoje.

Vedle expanzivního rozvoje se v praxi objevuje také „papírové" naddimenzování zastavitelných ploch v územních plánech. Zastavitelnou plochou je v tomto kontextu myšlena plocha vymezená územním plánem pro budoucí zástavbu, jejíž skutečná realizace však závisí na řadě dalších podmínek, například vlastnických vztazích, dostupnosti technické a dopravní infrastruktury, ekonomické poptávce nebo připravenosti investora. V některých obcích tak mohou být vymezeny rozsáhlé plochy pro bydlení, aniž by existoval reálný předpoklad jejich úplného nebo rychlého využití (Starý Mateřov, Leština u Světlé a jiné) (Jirásek 2025).

Pokud by byly tyto kapacity mechanicky zahrnuty do projekčních předpokladů, implikovaly by výrazný populační nárůst, který není v daném územním kontextu podložen identifikovatelnými migračními procesy ani reálně doložitelnými rozvojovými impulzy. Takové „papírové" kapacity proto představují zdroj

nejistoty – mohou vést k systematickému nadhodnocení migrační složky, pokud není posouzena jejich reálná realizovatelnost.

Důsledkem uvedených specifik je, že migrační složka představuje hlavní zdroj nejistoty lokálních populačních výhledů. Metodicky je proto vhodnější pracovat s variantní projekční logikou podmíněnou rozvojovými scénáři (Burcin, Kučera 2012) než prezentovat výsledky jako jednoznačnou prognózu.

2.2.5. Přesnost prognóz a limity malých populací

Přesnost populačních prognóz je nepřímo úměrná velikosti sledované populace a přímo závislá na délce projekčního horizontu (Rayer 2008; Tayman 2011; Wilson, Rowe 2011). Tento vztah vyplývá z povahy malých populačních souborů, nikoli z nedostatečné metodiky. V malých populacích tvoří náhodná složka významnou část celkové variability. Prognostická chyba tak může vyplývat jak z nesprávně stanovených předpokladů, tak z inherentní náhodnosti procesů a interpretačních omezení modelu, přičemž dominantní roli sehrává migrační složka.

Teoretická reflexe nejistoty v demografickém prognózování je spojena s pracemi Keyfitze (1972, 1981), Alha a Spencera (1985, 2005), Leeho (1993), Keilmana (1990, 2002, 2003, 2005, 2019), Hyndmana a Bootha (2008), Rafteryho a kol. (2012), Ševčíkové a Rafteryho (2021) a dalších. Tyto studie ukazují, že nejistota nepředstavuje metodické selhání, ale imanentní vlastnost demografických výhledů. Přesto zůstávají prognózy pro rozhodovací praxi nezbytné (Keilman 2019).

S prodlužujícím se horizontem prognózy roste nejen velikost chyby, ale i nejistota vstupních parametrů. Vyšší modelová komplexita přitom automaticky nezaručuje vyšší přesnost (Petropoulos a kol. 2022). Navzdory rozvoji automatizovaných a strojových metod naráží jejich aplikace v prostředí malých územních celků na riziko přeučení modelu v důsledku krátkých časových řad a nízkých četností (Petropoulos a kol. 2022). Současná literatura proto zdůrazňuje význam kombinace kvantitativního modelování a expertní interpretace, zejména v podmínkách malých populací (Temple, Grossman, Wilson 2025).

V lokálním prognózování tak zůstává klíčový expertní úsudek. Jak uvádí Kučera (1998), prognostik musí být schopen odlišit náhodné výkyvy od dlouhodobějších tendencí populačního vývoje. Kombinace statistického modelování a expertního posouzení prokazatelně snižuje chybovost a umožňuje zohlednit kontextové faktory, které nejsou obsaženy v historických datech (Armstrong 2001; Webby, O'connor, Edmundson 2005).

2.2.6. Prostorová heterogenita malých obcí

Malé obce nelze chápat jako homogenní kategorii definovanou pouze velikostí populace. Jejich populační dynamika je výrazně podmíněna polohou v sídelním

systému, funkčními vazbami na vyšší centra a mírou zapojení do regionálních pracovních a rezidenčních trhů. Postavení obce v sídelní hierarchii – zda jde o metropolitní zázemí, mikroregionální středisko či periferní venkovskou jednotku – zásadně ovlivňuje její migrační atraktivitu, věkovou strukturu i reprodukční potenciál. Rozvojový potenciál regionů je významně ovlivněn jejich geografickou polohou, strukturou osídlení a kvalitou lidského kapitálu, přičemž tyto faktory společně formují regionální rozdíly v socioekonomickém vývoji (Perlín a kol. 2025). Prostorová heterogenita tak představuje samostatný zdroj metodologické nejistoty lokálních populačních prognóz.

Obce s obdobným počtem obyvatel mohou vykazovat zásadně odlišné populační režimy – od dynamicky rostoucích suburbánních sídel integrovaných do metropolitního pracovního trhu přes stabilizovaná lokální centra s částečnou obslužnou funkcí až po periferní obce s omezenou dostupností služeb a dlouhodobým úbytkem obyvatelstva. Tyto rozdíly se promítají nejen do intenzity migrační složky, ale i do věkové struktury, reprodukční kapacity a dlouhodobé trajektorie populačního vývoje.

Ignorování této diferenciace vede k aplikaci průměrných parametrů na rozdílné jednotky a zvyšuje riziko zkreslení prognózy. Prostorová heterogenita proto nepředstavuje pouze popisný znak sídelní struktury, ale také klíčové metodologické omezení lokální prognostiky. Vyžaduje proto diferenciovaný přístup při konstrukci prognostických předpokladů.

3. Metodologický rámec populačního prognózování malých územních celků

Tato kapitola vymezuje metodický rámec pro tvorbu populačních výhledů v malých územních celcích a ilustruje jeho využití na souboru obcí Kraje Vysočina. Nejde o úplnou validaci prognostické přesnosti modelu, ale o ukázku toho, jak lze při práci s malými populacemi metodicky reagovat na nízké četnosti demografických událostí, vysokou variabilitu migrační složky a prostorovou heterogenitu obcí. Kapitola se proto zaměřuje na dva postupy: typologickou agregaci obcí, která umožňuje stabilizovat vstupní demografické parametry, a kapacitně podmíněné modelování migrace, které váže migrační předpoklady na reálné rozvojové možnosti území.

3.1. Základní principy a metodologie demografických prognóz

Demografické prognózy vývoje obyvatelstva jsou tradičně založeny na deterministickém přístupu, vycházejícím z předpokladu relativní kontinuity demografických procesů v čase. Předpokládá se, že budoucí vývoj plodnosti, úmrtnosti a migrace

bude do určité míry navazovat na minulý trend nebo se bude vyvíjet podle odborně formulovaných předpokladů. Díky relativní stabilitě demografických procesů dokáží deterministické prognózy zachytit hlavní směry vývoje počtu obyvatel i věkové struktury (Wilson 2019). Výjimky představují období zásadních společenských zlomů (např. rok 1989) či mimořádné události typu pandemie COVID-19.

Základní metodologický rámec deterministických prognóz představuje kohortně-komponentní model, sledující vývoj jednotlivých věkových kohort a zohledňující plodnost, úmrtnost a migraci. Je považován za standard populační prognostiky díky své transparentnosti a schopnosti detailně zachytit změny věkové struktury (Kučera 1998, Burcin a kol. 2013). Jeho aplikace na malé územní celky je však limitována vysokými nároky na vstupní data.

V mezinárodní literatuře se ustálily dva hlavní přístupy k zachycení nejistoty. Dominantní zůstává deterministický přístup založený na variantních scénářích (nízká, střední, vysoká varianta), užívaný statistickými úřady již od prací Whelptona (1947; viz Keilman, Cruijsen 1992). Varianta zde nepředstavuje pravděpodobnostní výrok, ale analytický nástroj vymezující rozpětí možných trajektorií (Kučera 1998). Jeho limitem je absence explicitní kvantifikace pravděpodobnosti (Keilman 2003, 2005).

Vedle tohoto přístupu se od konce 20. století rozvíjejí také stochastické metody populačního prognózování, které pracují s pravděpodobnostním rozdělením budoucích hodnot a umožňují vyjádřit nejistotu prostřednictvím intervalů spolehlivosti (Alho, Spencer 1985, 2005; Lee 1993; Keilman 2002; Hyndman, Booth 2008; Raftery a kol. 2012; Ševčíková, Raftery 2021).

Pro účely tohoto článku je podstatné, že dále diskutované přístupy vycházejí z deterministického pojetí prognózy, které je v lokálním plánování nejrozšířenější. Vhodnost stochastických metod pro malé územní celky zatížené vysokou náhodností přesahuje rámec tohoto textu. Cílem článku není komparativní testování širokého spektra metod, ale vymezení specifických omezení prognostického modelování v prostředí malých územních celků a jejich empirická ilustrace prostřednictvím dvou metodických adaptací – typologické agregace územních celků a kapacitně podmíněného modelování migrace – které umožňují stabilizaci parametrů složek populačního vývoje, zejména migrační komponenty.

3.2. Typologická agregace obcí jako nástroj stabilizace prognostických parametrů migrace

Jak již bylo uvedeno výše, v malých územních celcích jsou vstupní parametry populační prognózy zatíženy vyšší náhodnou variabilitou. Omezený počet událostí zvyšuje variabilitu demografických ukazatelů a činí modelové odhady citlivými na náhodné výkyvy v datech (Rayer 2015; Tayman 2011; Wilson a kol. 2021). Možným způsobem, jak tento problém zmírnit, je využití agregace dat za územní

jednotky, které vykazují podobné demografické, sídelní a polohové charakteristiky. Takový postup umožňuje zvýšit počet pozorovaných demografických událostí. Obdobné přístupy jsou v demografii malých území běžně využívány například při konstrukci demografických měr nebo při odhadu vstupních parametrů populačních prognóz, kde sdílení informací mezi podobnými územními jednotkami pomáhá omezit vliv náhodné variability v datech (Bryant, Graham 2013; Dyrting 2020; Wilson, Grossman, Temple 2022).

V tomto článku označuje typologická agregace obcí postup, při němž jsou obce seskupeny do relativně homogenních typologických skupin a vybrané demografické události, zejména migrační pohyby, jsou následně analyzovány na úrovni těchto skupin. Smyslem typologického členění není pouze klasifikace území, ale především vytvoření analytických jednotek, v jejichž rámci lze demografické procesy hodnotit s vyšší statistickou stabilitou.

Odhadnuté parametry jsou následně aplikovány na jednotlivé obce náležející do příslušného typu. Tento postup vychází z obecného principu stabilizace demografických odhadů prostřednictvím práce s agregovanými daty pro skupiny územních celků s podobnými charakteristikami, což umožňuje zvýšit statistickou stabilitu odhadovaných parametrů v prostředí malých populací (Bryant, Zhang 2018; Congdon 2014).

Typologická agregace tak představuje kompromis mezi individuálním modelováním jednotlivých obcí, které je statisticky nestabilní, a plně agregovaným přístupem vyšších územních úrovní, jenž sice stabilizuje parametry, ale potlačuje prostorovou diferenciaci demografických procesů.

Využití typologie v prognostice proto umožňuje stabilizovat vstupní předpoklady při současném zachování prostorové diferenciace prognózy. Typologie obcí zde nepředstavuje pouze analytickou klasifikaci, ale také metodický nástroj stabilizace demografických parametrů. Jak uvádějí Burcin, Kučera (2022), stabilní demografické trendy lze identifikovat především na relativně homogenních statistických subpopulacích. Typologické členění proto plní dvojí funkci: stabilizuje parametry přirozené měny prostřednictvím práce s širšími homogenními skupinami a současně vytváří rámec pro diferencované modelování migrační složky, která je v malých obcích zpravidla nejvíce volatilní.

Česko disponuje řadou typologií a regionalizací obcí reflektujících jejich polohu i populační režimy (Bernard, Šimon 2017; Blažek, Netrdová 2009; Hampl 2005; Ouředníček, Nemeškal 2018, 2022; Perlín, Kučerová, Kučera 2010; Perlín a kol. 2025; Ženka, Slach, Sopkuliak 2017; Ženka, Krtička 2021 aj.). Tyto přístupy potvrzují, že obce obdobné velikosti mohou vykazovat zásadně odlišnou populační dynamiku v závislosti na vazbě k metropolitním centrům, funkční specializaci či migrační atraktivitě.

Jako doplňkový analytický rámec je možné využít také koncept prostorové autokorelace, zejména lokální Moranovo I, které umožňuje identifikovat, zda se

podobné hodnoty syntetického populačního profilu shlukují v prostoru, nebo zda jde spíše o lokální odchylky. V navrženém rámci však prostorová autokorelace nepředstavuje samostatné rozhodovací kritérium typologie, ale podpůrný interpretační nástroj pro posouzení prostorového kontextu populačního vývoje.

3.3. Vymezení typologie obcí

3.3.1. Použité ukazatele a časové vymezení

Konstrukce typologie obcí vychází z předpokladu, že jejich „podobnost" nelze spolehlivě zachytit jediným ukazatelem. Typologie proto musí být založena na kombinaci více demografických indikátorů a vybraných nedemografických charakteristik souvisejících s populační dynamikou. Nejde o detailní popis všech aspektů vývoje, ale o identifikaci dominantních demografických režimů relevantních pro prognostický proces.

Zásadním požadavkem je jednoznačná definice použitých prostorových a vývojových kritérií. V navrženém postupu je typologie opřena o ukazatele dlouhodobé populační změny, recentního populačního trendu, migrační dynamiky, věkové struktury a dostupnosti k okresním centrům. Tyto proměnné zachycují hlavní dimenze populačního a polohového profilu obcí a umožňují rozlišit, zda je populační vývoj obce spíše růstový, stabilizovaný, nebo úbytkový.

Vzhledem k nízkým četnostem sledovaných jevů bylo nutné pracovat s agregací ukazatelů za delší časové období. Volba délky referenčního intervalu představuje metodický kompromis mezi stabilitou a aktuálností: kratší období lépe zachycuje současnou dynamiku, avšak je zatíženo vyšší náhodností, zatímco delší interval poskytuje robustnější obraz dlouhodobého vývoje. V aplikované variantě metodiky je dlouhodobý vývoj zachycen změnou počtu obyvatel v období 2005–2021, recentní trend obdobím 2015–2021 a migrační složka průměrem za roky 2015–2021.

Objektivizace typologie může vycházet z prostorových a funkčních ukazatelů, jako je dopravní dostupnost, dojížďkové vazby či poloha v sídelním systému. V tomto článku je prostorová dimenze zachycena jednak dostupností do okresního centra, jednak doplňkovým posouzením prostorového kontextu pomocí lokálního Moranova I. Ten slouží k rozlišení, zda je demografický vývoj obce součástí širšího prostorového vzorce, například shluku populačně rostoucích či ztrátových obcí, nebo zda jde spíše o izolovanou odchylku od okolního prostředí. V tomto smyslu nejde o samostatnou prognostickou metodu, ale o podpůrný nástroj pro zpřesnění interpretace typologie obcí.

3.3.2. Vymezení typů obcí v Kraji Vysočina

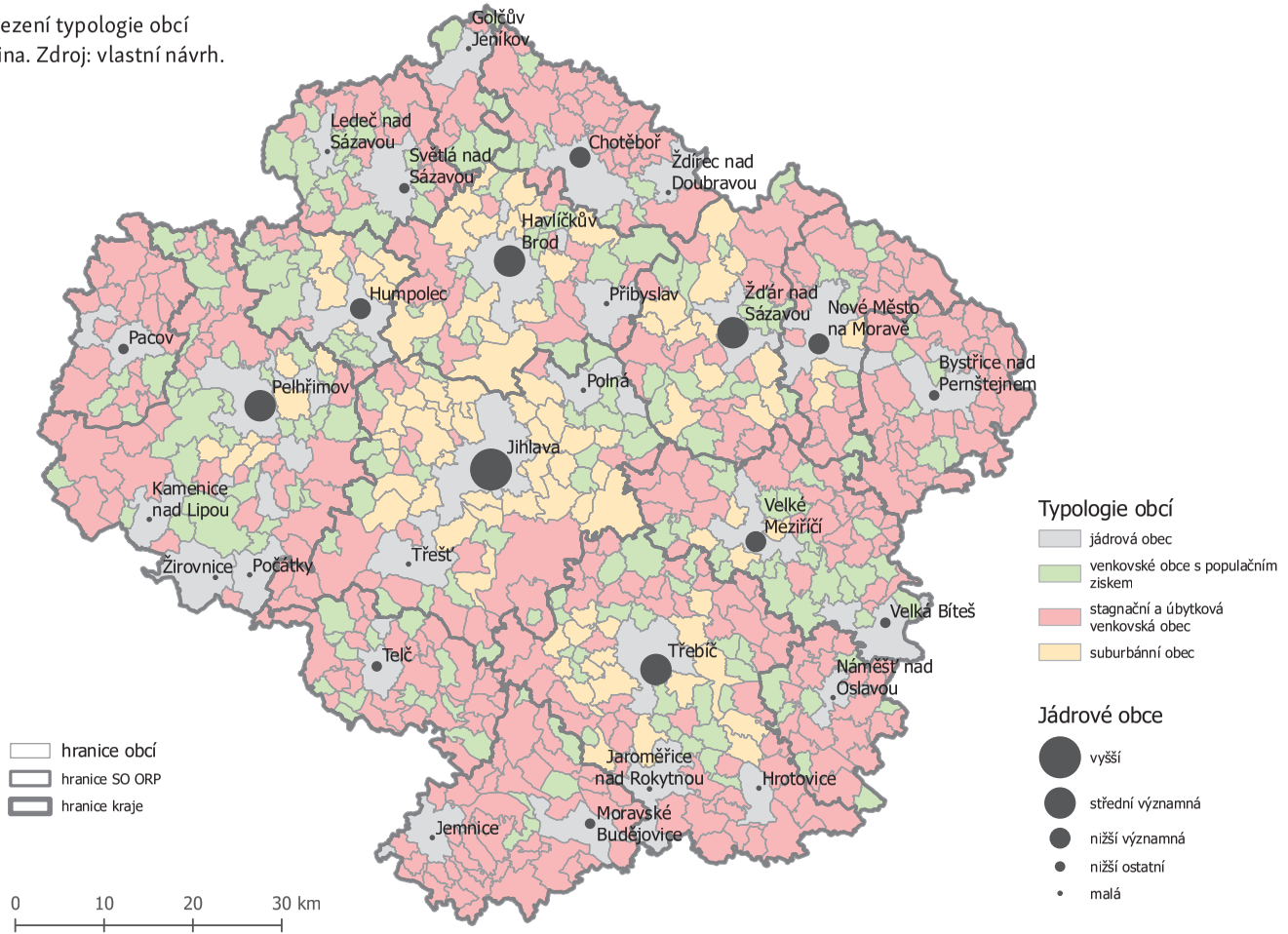
Následující aplikace ilustruje využití typologického přístupu v podmínkách Kraje Vysočina a ukazuje, jak lze typologickou agregaci územních celků využít při formulaci diferencovaných prognostických předpokladů.

Vymezení typů obcí bylo provedeno kombinací demografických ukazatelů a institucionálně ukotvených prostorových kritérií. Pro identifikaci jádrových obcí byla využita centra osídlení definovaná v Zásadách územního rozvoje Kraje Vysočina, která reflektují funkční význam sídel v regionální struktuře. Suburbánní obce byly vymezeny jako samostatná kategorie, protože jejich populační růst je podmíněn specifickým mechanismem rezidenční suburbanizace a nelze jej bez dalšího ztotožňovat s růstem ostatních venkovských obcí.

Pro ilustraci metodického přístupu byly obce Kraje Vysočina rozděleny do čtyř základních, vzájemně nepřekryvných typů: jádrové obce, suburbánní obce, venkovské obce s populačním ziskem a venkovské obce se stagnací nebo populačním úbytkem. Každá obec je zařazena právě do jedné kategorie. Rozdělení vychází z dlouhodobé populační změny, recentního trendu, migrační dynamiky, věkové struktury, dostupnosti k okresním centrům a z doplňkové interpretace prostorového kontextu populačního vývoje (viz obr. 1). Referenční období končí rokem 2021, aby typologie nebyla ovlivněna mimořádnou změnou migrační bilance po roce 2022, spojenou s příchodem osob z Ukrajiny a institutem dočasné ochrany.

1. První typ tvoří jádrové obce, často sídla ORP. Tyto obce se vyznačují vyšší hustotou zalidnění, koncentrací ekonomických aktivit a služeb a relativně komplexními migračními vzorci. Jádrové obce byly vymezeny na základě center osídlení definovaných v Zásadách územního rozvoje Kraje Vysočina, která jsou hierarchicky členěna podle funkčního významu v sídelní struktuře kraje (viz obr. 1).
2. Druhým typem jsou suburbánní obce, jejichž populační vývoj je výrazně ovlivněn procesem rezidenční suburbanizace. Jde o sídla v zázemí jádrových center, do nichž se koncentruje nová bytová výstavba a migrační přírůstky spojené s přesunem obyvatelstva z měst do jejich zázemí. Z hlediska prognózy je účelné tuto skupinu oddělit od ostatních populačně rostoucích obcí, protože její vývoj je podmíněn specifickým mechanismem prostorové redistribuce obyvatelstva.
3. Třetí typ představují venkovské obce s populačním ziskem. Do této kategorie jsou zařazeny obce, které nejsou jádrové ani suburbánní, v období 2005–2021 vykazují celkový populační růst vyšší než 5 % a v období 2015–2021 populačně neklesají. Tento práh byl stanoven jako pragmatické kritérium vycházející z empirické analýzy dat a z obdobných přístupů použitých v literatuře (Ouředníček, Nemeškal 2022). Vyloučení roku 2022 a následujících let souvisí s tím, že od roku 2022 se v populačních bilancích výrazně projevuje migrace z Ukrajiny a přítomnost osob s dočasnou ochranou; tyto vlivy proto nejsou

Obr. 1 – Vymezení typologie obcí v Kraji Vysočina. Zdroj: vlastní návrh.



zahrnuty do referenčního období použitého pro vymezení typologie. Jde tedy o obce, u nichž se kombinuje dlouhodobější růst počtu obyvatel, nepoklesový recentní vývoj a příznivější migrační i polohové charakteristiky.

4. Čtvrtý typ tvoří venkovské obce se stagnací nebo populačním úbytkem. Patří sem všechny obce, které nejsou klasifikovány jako jádrové nebo suburbánní a současně nesplňují podmínky pro zařazení mezi venkovské obce s populačním ziskem. Tato kategorie zahrnuje obce s populační stagnací, úbytkem nebo méně příznivou kombinací sledovaných charakteristik, například slabší migrační atraktivitou, starší věkovou strukturou nebo horší dostupností k hlavním centrům.

Navržená typologie není statisticky optimalizovanou klasifikací obcí. Slouží jako metodicky funkční rámec pro diferenciaci prognostických předpokladů v územně heterogenním souboru obcí. Vzhledem k tomu, že článek má charakter metodologického příspěvku zaměřeného na limity lokální prognostiky, není cílem testovat všechny možné klasifikační algoritmy ani kvantifikovat dopad změny prahových parametrů na výsledné zařazení obcí. Navržená typologie demonstruje princip typologické agregace obcí jako metodického nástroje stabilizace prognostických parametrů.

3.3.3. Vazba typologie na prognostický proces

Navržená typologie obcí nepředstavuje cíl sama o sobě, ale slouží jako metodický nástroj pro zpřesnění populační prognózy. Pro každý typ obce je možné stanovit specifické parametry jednotlivých složek populačního vývoje, tedy věkově specifické míry plodnosti, koeficienty přežití a předpoklady budoucí migrace. Tím se omezuje nutnost aplikovat jednotné průměrné hodnoty na heterogenní soubor obcí a snižuje se riziko systematického zkreslení výsledků.

Typologie je přímo integrována do konstrukce prognostických předpokladů. V rámci kohortně-komponentního rámce jsou parametry plodnosti a přežití stabilizovány na úrovni jednotlivých typů obcí, nikoli jednotlivých obcí, čímž dochází ke snížení náhodné variability vyplývající z malých četností. Migrační předpoklady jsou formulovány diferencovaně podle čtyř typů demografického režimu: jádrových obcí, suburbánních obcí, venkovských obcí s populačním ziskem a venkovských obcí se stagnací nebo populačním úbytkem. U populačně růstových a suburbánních obcí je migrační složka dále korigována kapacitně podmíněným přístupem (HUM/M-HUM), který omezuje čistou extrapolaci trendu a váže potenciální populační růst na absorpční kapacitu území a plánovanou bytovou výstavbu.

Výsledky prostorové autokorelace mají v prognostickém procesu především interpretační funkci. Umožňují posoudit, zda růstový nebo ztrátový profil obce odpovídá širšímu prostorovému vzorci, nebo zda jde spíše o lokálně specifickou

odchylku. Tato informace může podpořit formulaci variantních migračních předpokladů a interpretaci nejistoty, nemění však automaticky základní typologické zařazení obce. Typologie tak slouží nejen jako klasifikační rámec, ale také součást prognostického postupu, která umožňuje stabilizaci vstupních parametrů při současném zachování prostorové diferenciace prognózy.

3.4. Kapacitně podmíněné modelování migrace (ilustrativní aplikace)

Kapacitně podmíněné modelování migrace představuje metodickou reakci na vysokou volatilitu migrační složky v malých územních celcích. Migrace je v malých obcích nejméně stabilní složkou populační bilance a její mechanická extrapolace může vést ke zkreslení prognózy.

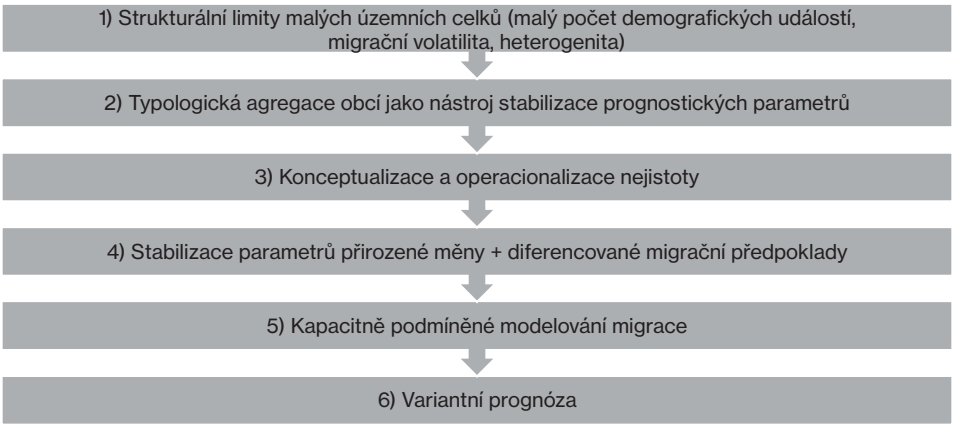
Princip kapacitního přístupu spočívá v tom, že migrační přírůstek není odvozován pouze z historického trendu, ale je omezen rozvojovou kapacitou území, zejména tempem realizace nové výstavby. Cílem tohoto přístupu není předpovídat migrační chování, ale vymezit jeho horní hranici v rámci realistických rozvojových kapacit území. Metodicky vychází z konceptu Housing Unit Method (HUM) a jeho modifikací (Swanson, Schlottmann, Schmidt 2009; Smith, Tayman, Swanson 2013; Baker a kol. 2017), avšak je aplikován v typologicky agregované podobě odpovídající podmínkám malých územních celků.

Klasická *Housing Unit Method* (HUM) je v článku modifikována pro podmínky malých územních celků (dále M-HUM). Modifikace spočívá zejména v:

- typologickém členění obcí
- stanovení parametrů populačního dopadu nové výstavby na úrovni územních typů namísto jednotlivých obcí
- integraci kapacitního omezení migrační složky do kohortně-komponentního rámce.

M-HUM zde není samostatným predikčním modelem, ale korekční složkou migračních předpokladů.

Kapacitně podmíněný přístup současně nepředpokládá, že samotná bytová kapacita automaticky generuje migrační přírůstek. Dostupnost zastavitelných ploch a realizovaná výstavba představují nutnou, nikoli postačující podmínku populačního růstu. Ekonomická atraktivita území, regionální konkurenční vztahy, cenová dostupnost bydlení či saturace místního trhu mohou reálnou migrační odezvu výrazně modifikovat. Model proto neinterpretuje výstavbu jako determinující faktor migrace, ale jako omezení její horní hranice v daném území. V podmínkách Kraje Vysočina byly parametry populačního dopadu nové výstavby stanoveny na úrovni vymezených typů obcí. Vycházely z analýzy historického tempa zástavby referenčních obcí v rámci jednotlivých typů a z expertně formulovaných



Obr. 2 – Integrovaný metodický rámec prognózování populace malých územních celků

předpokladů o podílu technické infrastruktury, struktuře zástavby (RD/BD), hustotě bytových jednotek a průměrné obsazenosti domácností. Výsledkem je typologicky diferencovaný parametr populačního dopadu nové výstavby vyjádřený intenzitou přírůstku obyvatel na hektar zastavěné plochy a rok.

Schéma na obrázku 2 shrnuje propojení typologické agregace obcí, stabilizace parametrů přirozené měny a kapacitní korekce migrace v rámci kohortně-komponentního modelu.

4. Diskuse

Navržený metodologický rámec je konstruován primárně pro podmínky malých územních celků s omezenou populační velikostí, vysokou migrační volatilitou a dostupností administrativních dat na úrovni obcí. Jeho přenositelnost je proto podmíněna charakterem sledovaného území a strukturou jeho populační dynamiky. V regionech s výraznou metropolitní dynamikou, intenzivní meziregionální či mezinárodní migrací a komplexními prostorovými vazbami může být nutné rámec doplnit o multiregionální modelování a explicitní zachycení prostorových toků. Naopak v územích s dlouhodobě stabilní nebo setrvale klesající populací může být jeho aplikace metodicky zjednodušena. Diskuse limitů lokální prognostiky ukazuje, že nejistota není nahodilým problémem jednotlivých případů, ale systematickým rysem malých populačních systémů. Tabulka 1 proto nepředstavuje pouze souhrnný přehled, ale syntézu vazby mezi zdroji nejistoty a jejich metodickým ošetřením. Každý identifikovaný problém (malý počet demografických událostí, migrační volatilita, diskontinuální impulzy, administrativní zkreslení,

Tab. 1 – Hlavní zdroje nejistoty lokálních populačních prognóz a odpovídající metodické reakce

Zdroj nejistoty	Projev v prostředí malých územních celků	Metodický problém	Navržená metodická reakce
Malý počet demografických událostí	Vysoká relativní variabilita ukazatelů; citlivost na jednotlivé případy; obtížné rozlišení trendu od fluktuace	Nestabilita parametrů plodnosti, úmrtnosti i migrace; podíl náhodné složky	Agregace časových řad; typologická agregace obcí; stabilizace parametrů na úrovni homogennějších skupin
Migrační volatilita	Skokové změny populační bilance; silná reakce na lokální impulzy, zejména bytovou výstavbu, zaměstnavatele či změny dopravní dostupnosti	Nízká predikovatelnost migrace; riziko mechanické extrapolace minulého vývoje	Kapacitně podmíněné modelování migrace (HUM/M-HUM); vazba migračních předpokladů na bytovou kapacitu a rozvojový rámec
Diskontinuální rozvojové impulzy	Jednorázové developerské nebo investiční projekty; deklarované, avšak nerealizované záměry; časové zpoždění realizace	Riziko nadhodnocení populačního růstu při nekritickém zahrnutí rozvojových záměrů	Ověření realizovatelnosti; variantní přístup k projekčním předpokladům
Administrativní vs. faktická populace	Nesoulad mezi evidencí trvalého pobytu a reálným zatížením území	Zkreslení populační velikosti, migračních bilancí a věkové struktury	Kritická interpretace dat; doplňková validace pomocí alternativních datových zdrojů, například geolokačních dat; práce s konceptem reálné populace
Prostorová heterogenita obcí	Odlišné populační režimy u obcí s obdobnou populační velikosti obce	Riziko aplikace průměrných parametrů na demograficky a funkčně rozdílné jednotky	Typologická klasifikace obcí; diferenciace prognostických předpokladů pole typu území
Délka prognostického horizontu	Rychlý nárůst nejistoty v čase; rostoucí nestabilita zejména migračních předpokladů	Kumulace prognostické chyby a rostoucí nejistota vstupních předpokladů	Preferování krátko-až střednědobého horizontu (cca 10–15 let); explicitní komunikace nejistoty výsledků

Zdroj: vlastní zpracování na základě syntézy teoretických východisek a metodických přístupů diskutovaných v textu

prostorová heterogenita a délka horizontu) je propojen s konkrétní metodickou reakcí. Smyslem rámce není eliminovat nejistotu, ale převést ji do analyticky kontrolovatelné podoby.

Pro českou prognostickou praxi z toho vyplývá několik důsledků. Lokální populační výhledy je vhodné interpretovat jako podmíněné scénáře ukotvené v konkrétním rozvojovém rámci. Největší riziko spočívá v mechanickém přenosu metod vyšších územních úrovní na úroveň obcí bez zohlednění nízkých četností populačních událostí a migrační volatility. Rámec je nejvhodnější pro malé a středně velké obce s relativně přehlednou rozvojovou strukturou a omezenou mezinárodní mobilitou. Jeho použitelnost je omezená v územích s vysokou

intenzitou globálních migračních toků nebo v rychle transformujících se metropolitních regionech.

Otevřenou otázkou zůstává empirická kvantifikace dopadu jednotlivých metodických kroků na projekční chybu. Systematická komparace trendových a kapacitně podmíněných projekcí, porovnání alternativních typologických prahů či integrace nových datových zdrojů (např. geolokačních dat) představují možné směry dalšího výzkumu. Tyto kroky by však měly být prováděny při zachování interpretační transparentnosti, která je klíčová pro aplikační využitelnost výsledků.

Lokální populační prognostika proto nemůže dosáhnout stejné prediktivní stability jako prognózy na národní úrovni. Její metodická kvalita spočívá v transparentní práci s předpoklady, v ukotvení migrace v rozvojovém kontextu a v jasné komunikaci nejistoty. Takový přístup zvyšuje využitelnost demografických prognóz v územním plánování a strategickém rozhodování. Výše diskutované zdroje nejistoty a odpovídající metodické reakce lze shrnout do systematického rámce, který propojuje identifikované problémy s jejich metodickým ošetřením (viz tab. 1).

5. Závěr

Článek ukazuje, že nejistota v lokální populační prognostice není primárně důsledkem nedostatečné modelové sofistikovanosti, ale vyplývá z povahy malých populačních systémů. Malé počty demografických událostí, migrační volatilita, prostorová heterogenita a diskrepance mezi administrativní a faktickou populací vytvářejí prostředí, v němž je odhad vstupních parametrů zatížen vyšší variabilitou a dlouhodobá extrapolace je problematická.

Hlavním přínosem článku je formulace integrovaného metodického rámce, který systematicky propojuje limity lokální populační prognostiky s konkrétními metodickými reakcemi. Typologická agregace obcí redukuje heterogenitu souboru a stabilizuje vstupní parametry; kapacitně podmíněné modelování migrace ukotvuje nejslabší složku populační bilance v reálném rozvojovém kontextu a variantní přístup převádí nejistotu do analyticky uchopitelné podoby. Z metodologického hlediska článek ukazuje, že lokální populační prognózy vyžadují odlišné zacházení s nejistotou než prognózy na vyšších územních úrovních. V malých obcích nelze spoléhat pouze na extrapolaci minulého vývoje, protože krátké časové řady a nízké počty demografických událostí zvyšují relativní význam náhodných výkyvů. Klíčové je proto kombinovat stabilizaci demografických parametrů s expertním posouzením lokálního kontextu a s explicitním vymezením rozvojových předpokladů, zejména u migrační složky. Takový přístup umožňuje interpretovat výsledky nikoli jako jednoznačnou predikci, ale jako podmíněný výhled závislý na reálných kapacitách, plánovacích rozhodnutích a lokálních rozvojových

impulzech. Článek tak nepředkládá novou univerzální prognostickou metodu, ale systematizuje principy umožňující metodicky stabilizovat lokální populační výhledy a zvýšit jejich využitelnost v plánovací praxi.

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