

Article

Exploring the Significance of Heritage Preservation in Enhancing the Settlement System Resilience

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Abstract: The sustainable development of urban and rural settlements is considered one of the primary objectives of economic, social, and urban planning. Recent studies focused significant attention on the issue of the resilience of rural settlements due to the challenges and threats they face. One of the essential drivers affecting the resilience of rural settlements is cultural heritage preservation. The research methods were based on the complex systems approach. The study employed a multidimensional analysis method to evaluate the resilience of rural settlements based on five sub-systems: social, economic, environmental, physical, and managerial. The proposed method for evaluation of the settlement sustainability involves the application of a settlement development index and considers the preservation of cultural heritage objects. The data sources used contain open-access information and statistical data provided by municipal organizations, including GIS maps, statistical, and archival records. The study aim was to establish methodological frameworks for evaluating the influence of cultural heritage on the resilience of rural settlements as well as to obtain a quantitative assessment of the resilience of rural settlements within the Zavałočy local council, located at Hlusk district, Mahiloŭ region, Belarus.

Keywords: Belarus; cultural heritage; heritage preservation; heritage significance; settlement resilience; resilience factors; sustainability; sustainable development; settlement system; rural settlement



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1. Introduction

The resilience of the settlement system plays a critical role in sustainable development [1,2]. Sustainable development is often pursued through a multidimensional and integrated approach, taking into account economic, social, and environmental aspects. The sustainability of the built environment is a crucial aspect of overall sustainable development. It focuses on creating and maintaining buildings, infrastructure, and urban spaces that minimize their environmental impact, promote social well-being, and ensure economic viability throughout their life cycle [3,4]. Energy efficiency in design and construction includes using sustainable building materials, incorporating renewable energy sources, and optimizing energy performance through efficient insulation and lighting [5,6]. Resource conservation involves designing buildings and infrastructures that minimize resource consumption and promote circular economy principles. Emphasizing the responsible use of resources by implementing strategies such as water conservation, waste reduction and recycling, and sustainable land use planning [7,8]. The healthy indoor environment includes considering factors like ventilation, thermal comfort, acoustics, and the use of sustainable and low-emission building materials [9]. Resilience and adaptability consider the designing of buildings and infrastructure that can withstand and adapt to changing environmental conditions, including climate change impacts [10]. Social equity and accessibility includes

designing neighborhoods that encourage walkability, green spaces, and community engagement [11–14]. Life cycle assessment involves evaluating the environmental, economic, and social impacts at each stage and making informed decisions to minimize the negative effects [15,16].

In the context of rural areas, resilience refers to the ability of a settlement system to withstand and recover from natural disasters, conflicts, social and political crises, etc. In recent years, there has been an increasing interest in the resilience of rural settlements with a focus on the various affecting forces. The existing research recognizes the critical threats associated with rural settlements, including urbanization, environmental challenges, abandonment, and unsustainable development practices [17,18]. The factors found to be influencing rural settlements have been explored in several studies and comprise social challenges, such as demographic changes and social isolation; economic threats, including limited economic opportunities and lack of investment [19,20]; environmental risks, such as climate change and degradation of natural resources [21–23]; physical challenges, including deteriorating infrastructure and inadequate housing [24]; and managerial factors, such as a lack of support from government officials, inadequate management, and corruption [25].

The systematic review in [26] shows the significance of social drivers/indicators and intangible cultural heritage for the resilience of marginalized communities. The authors suggest a conceptual framework through strategies of conflict resolution, preservation of community capitals, and community-led tourism. Similarly, the impact of the intangible heritage has been discussed in [27]. The urgency of creating digital copies was highlighted in [28]. The research in [29] provides a case study revealing the interaction between the cultural heritage and resilience of rural settlements in seismic areas of Indonesia. The multidimensional approach of the study considers the sets of social, economic, and infrastructural variables.

However, much of the research has failed to address the impact of cultural heritage losses on the resilience of the settlement system. Besides, cultural heritage provides a sense of continuity and identity for local communities, and its loss can lead to social disintegration and a loss of community cohesion [30–32]. Cultural heritage is not only the cultural, spiritual, social, and economic resource of communities [33]. Cultural heritage is intimately involved with culture, education, science and, equally with natural resources, it forms an essential basis for national well-being, the sustainable development of local communities, and urban and rural settlements [34,35]. The value of historical and cultural heritage is recognized both in international and national legislations regarding cultural heritage preservation [36].

Cultural heritage represents the historical memories of the nation. Currently, there are a lot of sites of Belarusian history and culture threatened with destruction; the majority are losing their values through industrial activities, climate impacts, and age. Following the paper by [37], currently there is irresponsible behavior of both the population and public authorities regarding the problem of heritage preservation, which encouraged the authors to conduct the present research. All the above highlights the importance of recognizing the diverse conceptions about rural sustainability in the context of cultural heritage preservation among the actual interdisciplinary approaches for assessment [38]. The research focuses on developing the methodological approaches for assessing the impact of cultural heritage on the rural settlement resilience; obtaining a quantitative assessment of the resilience of the rural settlements of the Zavałočy Local Council located in Belarus.

2. Cultural Heritage in Belarus—General State of Knowledge

Belarus has a rich heritage that reflects its diverse history and culture through its traditions, languages, and architecture (Figure 1a). Our research focuses on tangible (architectural) heritage, as it has a crucial function in enhancing rural resilience and maintaining the cultural texture of an area. Tangible objects of cultural heritage are comprised of monuments, buildings and structures, religious sites (monasteries, churches), as well as natural areas of landscape architecture. Among the essential samples of historical and cultural

heritage are manor residencies, which were highly valuable in the development of rural settlements [39]. The total number of manors, folvarks, and estates in Belarus in the late XIX–early XX centuries was over 8000. Nowadays, there are about 1200 historical manors and their fragments remain, and over 300 of them are still promising for recovery and actual use. Although, according to the ‘List of Historical and Cultural Heritage Sites of the Republic of Belarus’, there are just 175 historical estates under state protection. Historically, there were a lot of risks for heritage in Belarus mostly because of war conflicts and foreign influence. Regarding the Belarusian reality, the density line of heritage objects corresponds with the division of the Belarusian territory within the interwar years (between 1920 and 1939) as shown in Figure 1b. This fact indirectly indicates that the differences in the policies of Poland and Russia affected cultural heritage and the Belarusian settlement system as well. This statement has been confirmed by our recent research on the historical and genetic features of formation of the Belarusian settlement system [40].

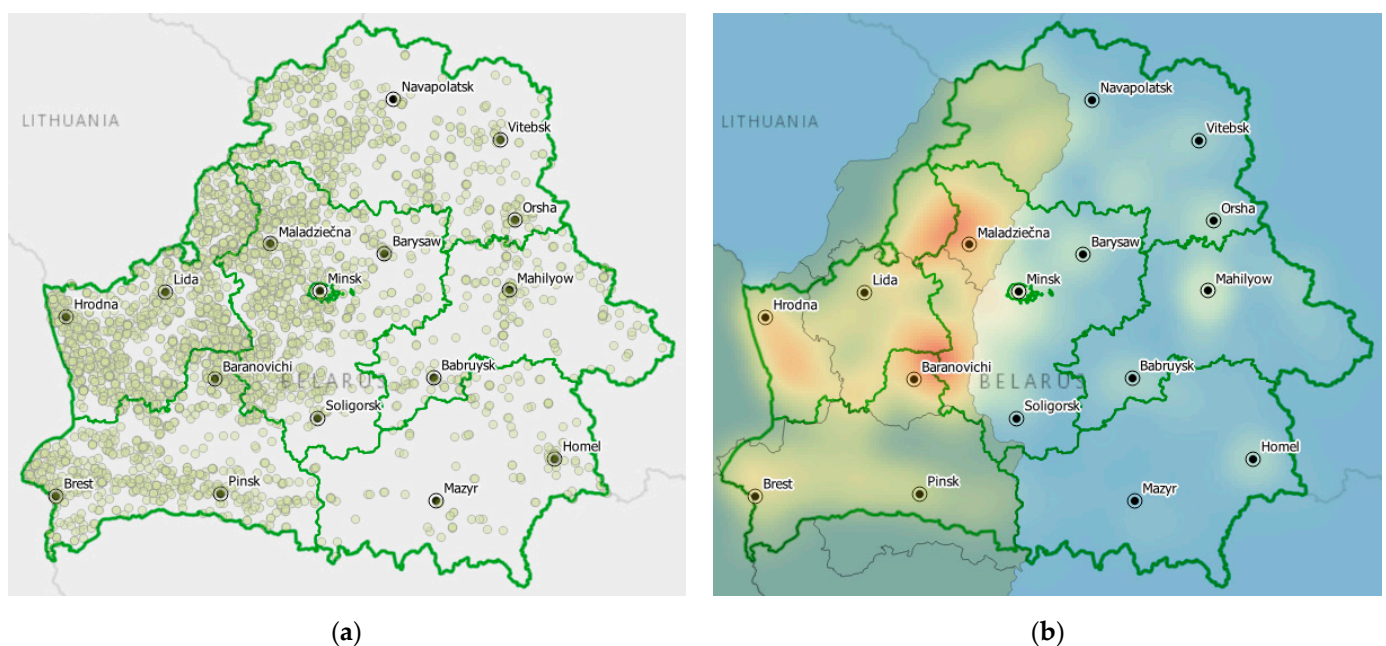


Figure 1. Heritage objects in Belarus: (a) actual map of heritage objects in Belarus; (b) heatmap of heritage objects in Belarus (combined with Polish–USSR border between 1921 and 1939). Names of the settlements using the Belarusian Latin alphabet sourced originally from [41]. Source: Own Study.

In Belarus, the preservation of architectural heritage has been a significant concern, as there have been instances of heritage losses resulting from inadequate management and oversight by local authorities. These losses have had a detrimental impact on the resilience of rural areas and have been a cause for concern among heritage conservationists and local communities.

Figure 2 showcases several examples of heritage losses in Belarusian rural areas since 2002. These losses highlight the need for better management and preservation strategies to protect and conserve the architectural heritage that contributes to the identity and character of rural settlements. By understanding and acknowledging these heritage losses, it becomes increasingly evident that a proactive approach is necessary to safeguard the rich historical and cultural legacy that rural areas possess.

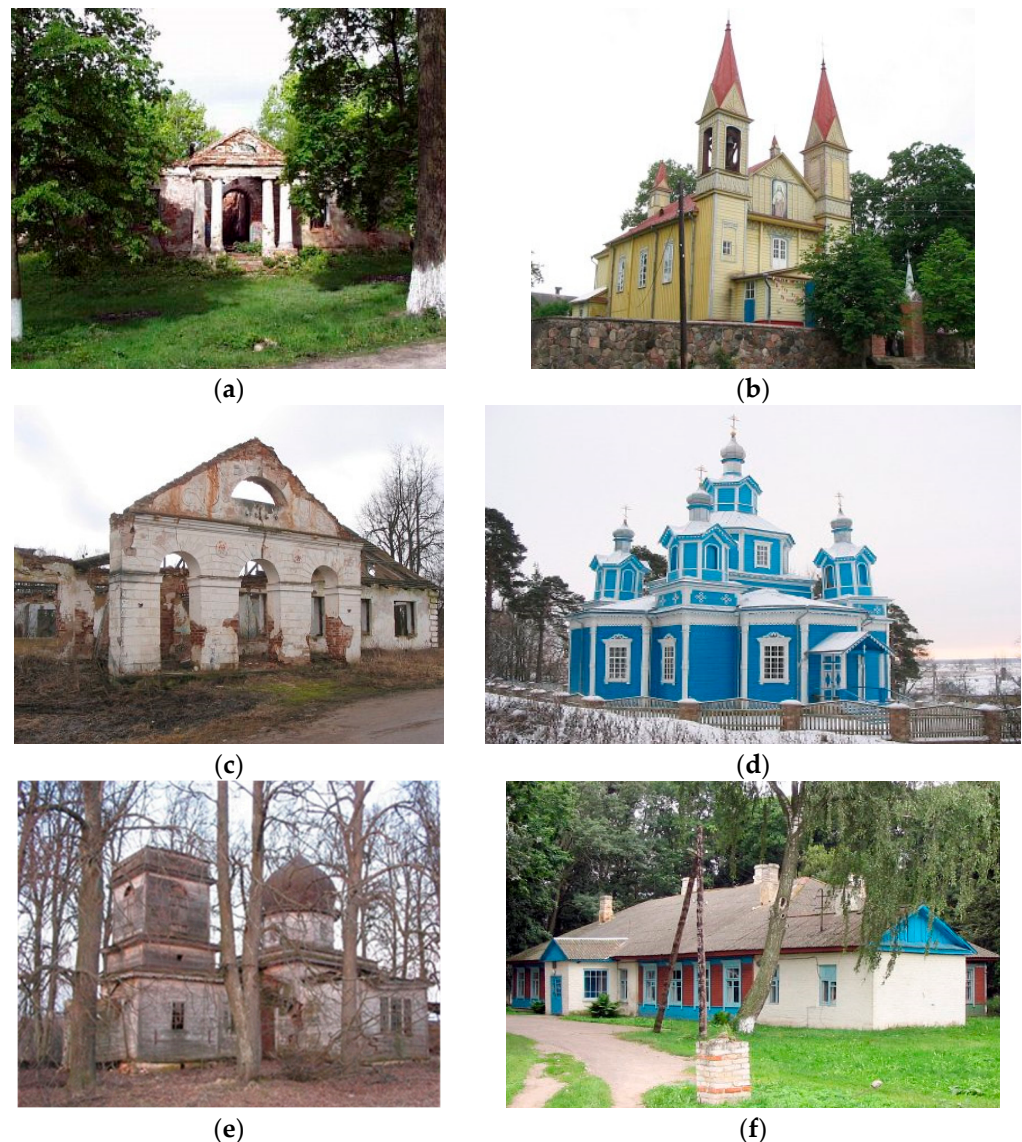


Figure 2. Certain samples and forces of heritage losses in Belarusian rural areas (since 2002): (a) manor house, Homel region, XIX–2008 (demolition) CC BY by I. Romanovskiy; (b) Catholic church, Hrodno region 1726–2017 (fire) CC BY by A. Dybovskiy; (c) manor house, Vitebsk region 1880–2016 (weather erosion) CC BY by A. Dybovskiy; (d) Orthodox church, Minsk region 1897–2013 (fire) CC BY by A. Dybovskiy; (e) Orthodox church, Mahiloŭ region XIX–2009 (weather erosion) CC BY by A. Dybovskiy; (f) manor house, Brest region XVII–2010 (demolition) CC BY by A. Dybovskiy. Source: photo materials obtained from [42].

3. Materials and Methods

3.1. Research Area and Data Sources

Before delving into the research area, it is important to provide an overview of the settlement structure in Belarus. Historically, Belarus has had a multi-level administrative system comprising regions, districts, and self-governing local councils as shown in Figure 3. At the highest level, Belarus is divided into regions, also known as ‘oblasts’. Currently, there are six administrative regions in the country: Brest, Homel, Hrodna, Minsk, Mahylew, and Vitebsk. These regions serve as larger administrative units and are responsible for governing multiple districts within their respective territories. Below the regional level, there are districts, also referred to as ‘raions’. The districts are responsible for local governance, providing services, and overseeing the implementation of regional policies at a more localized level. At the lowest level of the settlement structure are self-governing local

councils, which play a crucial role in the governance of rural areas. These local councils, often referred to as village or rural councils, are responsible for managing and making decisions related to local affairs within their specific territories. The self-governing local councils are essential for maintaining community cohesion, promoting local participation, and addressing the specific needs and challenges faced by rural areas. They play a key role in the sustainable development of the settlements within their jurisdiction, including issues related to infrastructure, economic development, social services, and cultural heritage preservation.

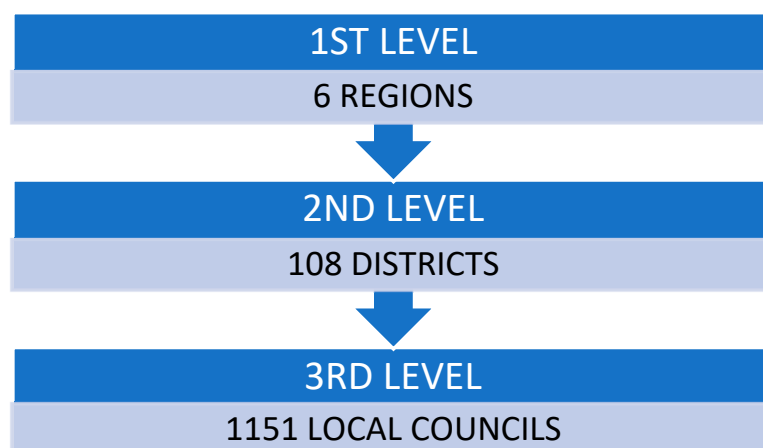


Figure 3. Structure of Settlement System in Belarus. Source: Own Study.

The Zavałočycy local council is a rural unit located in the Hłusk district of the Mahiloŭ region in Belarus. The council is situated in the central part of the country and covers an area of approximately 250 square kilometers (Figure 4). The council population is around 3000 people, and the main economic activities are agriculture, forestry, and small-scale manufacturing. The Zavałočycy agro-town is a traditional Belarusian rural settlement with a rich cultural heritage, including numerous historical objects and archaeological sites. The settlement has a long history dating back to the 13th century and been influenced by various cultures, including the Slavic, Polish, and Russian. The council is home to several cultural heritage sites, including the Holy Trinity Church, the Chapel of St. George, and the ruins of a castle from the 16th century.

The research area of Zavałočycy local council offers a unique and valuable opportunity for studying the multifaceted challenges faced by the rural settlements in Belarus. By examining this specific council, the research can delve into issues pertaining to economic development, infrastructure, environmental sustainability, and the preservation of cultural heritage. Furthermore, the council serves as an insightful case study for understanding the impact of political and social changes on rural communities in the post-Soviet era of Belarus.

In addition, the findings from the research conducted in Zavałočycy local council can contribute to the development of effective strategies and policies that promote sustainable development not only for rural units, but also in cases of other units within the Belarusian settlement system as districts and regions. The council can serve as a model for identifying the best practices and successful approaches in enhancing the resilience of rural settlements, ultimately fostering their long-term growth and prosperity.

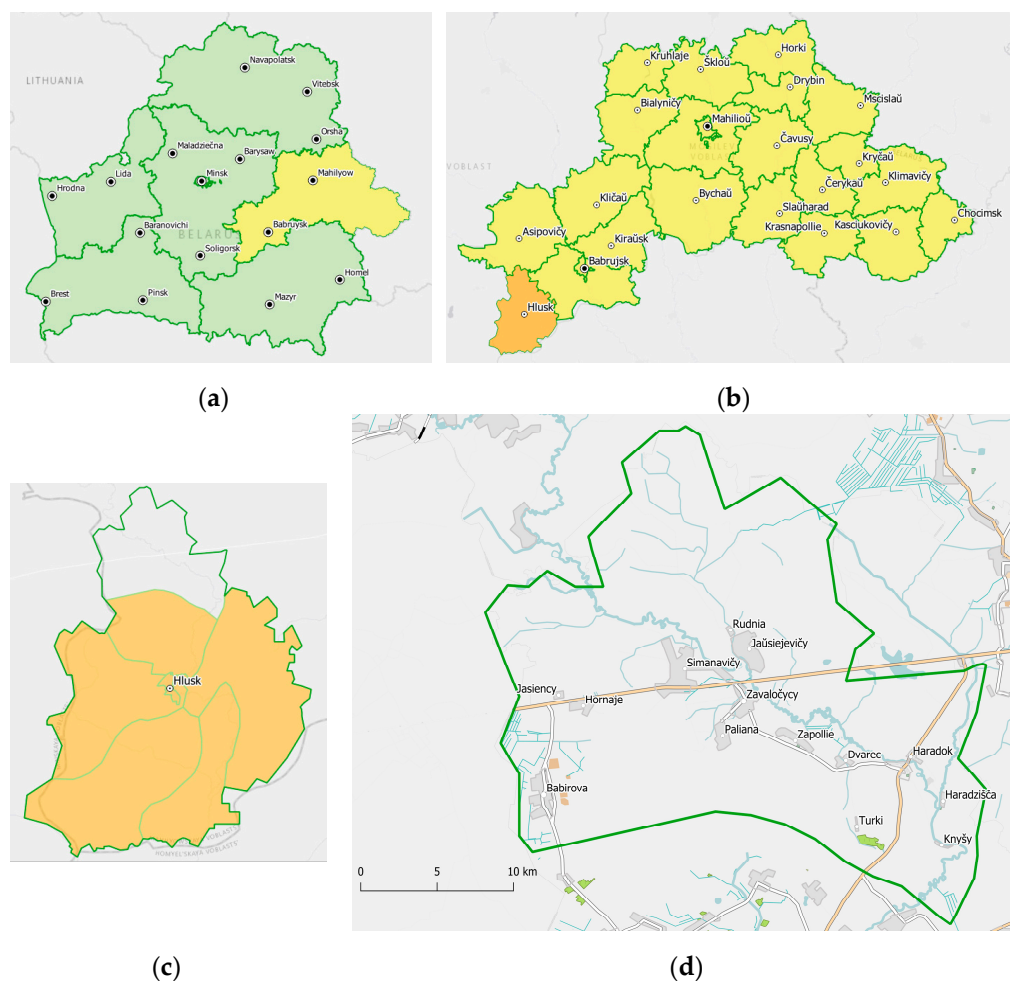


Figure 4. Research area: (a) Belarus; (b) Mahiloŭ region; (c) Hlusk district; (d) Zavalochytsy local council. Names of the settlements using the Belarusian Latin alphabet sourced originally from [41]. Source: Own Study.

To collect comprehensive and reliable data for the research, various sources have been used. We have analyzed the official reports of local self-governing authorities, as well as data from open GIS sources, confirming its adequacy. The administrative and legal documents pertaining to the council, including population statistics and infrastructural data, have been sourced from the Hlusk District Executive Committee [43]. The geographic information data, encompassing aspects such as land use, hydrological features, and transportation networks, have been obtained from ‘NextGIS’ [41]. Additionally, cultural heritage data have been accessed from ‘The Globe of Belarus’ [42]. By integrating data from these diverse sources, the research can ensure a robust and comprehensive analysis of the factors influencing the resilience of rural settlements in the Zavalochytsy local council.

The best-known heritage site is the Church of Saints Cosmas and Damian (Figure 5) which was first constructed in 1814 and renovated in 1866. It is located in Haradok village and registered at the State List of Historical and Cultural Heritage of Belarus. The object is a national monument of wooden architecture. It belongs to one of the oldest churches in the Mahiloŭ region. Despite the fact that most churches in Belarus have been destroyed during antireligious campaigns and wars, the church stopped functioning only for half a year during the 200 years of its history. It serves as a typical sample of spiritual heritage.

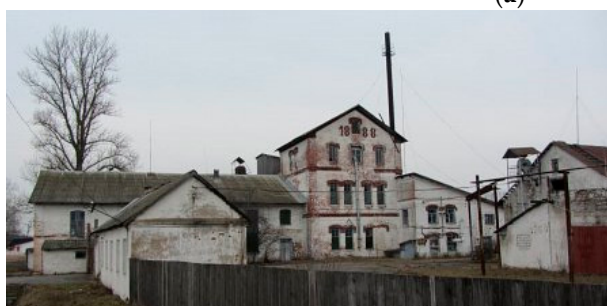


Figure 5. The Church of Saints Cosmas and Damian in Haradok village. CC BY by A. Dybovskiy. Source: photo materials obtained from [42].

Another heritage site is the Żyliński manor complex located in Zawałoczy agro-town. The complex dates from 1886 and entails several elements including the manor house constructed in 1886 and rebuilt in 1914 after fire (Figure 6a), the spirit factory constructed between 1888 and 1889 (Figure 6b,c), the landscape park (Figure 6c) and the irrigation channels (Figure 6e).



(a)



(b)



(c)

Figure 6. *Cont.*



Figure 6. Żyliński manor complex in Zavałočycy agro-town: (a) manor house CC BY by S. Yarokhovich [42]; (b,c) spirit factory CC BY by S. Yarokhovich [42]; (d) landscape park CC BY by R. Brudski [42]; (e) irrigation channel CC BY by S. Rudinski [44]. Source: photo materials obtained from [42,44].

Another Żyliński manor complex, dated at the late 19th century was located in Dvarec village. It is unpreserved at the present time and originally entailed the main sites as follows: the manor wood house (Figure 7a), decorated with carvings (Figure 7b); the ancient landscape park featuring alleys, flowerbeds, and other small architectural items; and the outhouse.



Figure 7. Żyliński manor complex in Dvarec village: (a) manor wood house; (b) carving decorations. Source: CC BY by K. Shastouski [45].

The post station located in Symonavičy village is a mid-19th century building, constructed between 1847 and 1850 (Figure 8). It is located along the historic Moscow–Warsaw highway, one of the oldest in Belarus (current number P-43). The post station was more than just a single building, but a comprehensive complex comprising the main building, the outhouse, the outbuildings, the tavern, as well as the fire tower and the water well.



Figure 8. The post station located in Symonavičy village. Source: CC BY by A. Dybovskiy [42].

3.2. Research Methodology

The complex nature of rural settlements necessitates a comprehensive and structured assessment approach to effectively address their multifaceted challenges. However, due to the unique characteristics and diverse factors involved, there is currently no universally accepted or standardized assessment approach for tackling this intricate issue. Selecting an appropriate model for the assessment of the resilience of rural settlements is a critical task in itself. In our study, we opted to use the multidimensional analysis method, which considers a range of criteria influencing the resilience of rural settlements. Most recent research commonly employs the Analytic Hierarchy Process (AHP) methodology for conducting multicriteria assessments across multiple research areas [46–48]. The AHP method provides a systematic framework for decision-making by establishing a hierarchical structure that captures the various dimensions, criteria, and indicators relevant to the assessment [49–52]. This hierarchical representation allows decision-makers to effectively analyze the complex relationships and interactions among these elements. Furthermore, the AHP method facilitates the aggregation of individual assessments into an overall evaluation index or ranking.

The AHP model seems to be appropriate in the assessment of rural settlements for several reasons. Firstly, rural settlements encompass various interrelated dimensions, including social, economic, environmental, physical, and managerial factors. The AHP model allows decision-makers to systematically evaluate these multiple dimensions and their respective indicators by establishing a hierarchical structure. This enables a comprehensive and structured assessment of the complex nature of rural settlements. Secondly, the AHP model incorporates the input and expertise of decision-makers, stakeholders, and experts which possess valuable knowledge and experience related to the specific context of rural settlements. By utilizing pairwise comparisons, they can provide subjective assessments and judgments considering both quantitative and qualitative aspects. This participatory approach enhances the accuracy and relevance of the assessment. Finally, the model supports the aggregation of individual assessments into an overall resilience index, facilitating a holistic evaluation of rural settlements. This comprehensive analysis aids the decision-making processes by providing a quantitative measure that reflects the overall resilience level of rural areas.

Even though the AHP method offers a valuable approach for assessing rural areas, it is essential to adapt and customize the methodology to comply with specific contexts and objectives from case to case considering the unique characteristics, local conditions, and stakeholder perspectives. To address these needs we suggest the application of the integrated model for the assessment of the resilience of rural settlements, which combines the AHP method with the quadrant analysis chart (QA) method. Using the QC method, the resilience index is then used to position the settlements within the chart. The positioning provides a visual representation of the settlements' resilience levels, allowing for a comparative analysis of their performance. Settlements located in different quadrants of the chart represent varying degrees of resilience and exhibit different strengths and weaknesses across the identified dimensions. Therefore, the integrated AHP-QA model provides a comprehensive framework for evaluating and visualizing the resilience level for rural areas.

The AHP-QA model comprises three main stages: (i) conceptual modelling; (ii) determining the index of rural settlement resilience (RSRI); and (iii) analyzing the results.

3.2.1. Conceptual Modelling

The most recent approaches to the assessment of settlement resilience are based on social, economic, and environmental criteria [53–55]. However, the majority of models concern urban areas [56–58] and do not meet as many criteria that is essential for rural areas as managerial and physical ones. Some of the relevant models for assessment the resilience of rural areas are provided in Table 1.

Table 1. Criteria considered by some of the existing models for assessment the settlements resilience. Source: Own Study.

Model of Balanced Sustainable Rural Development [59]	Model of Sustainable Development of Ethno-Villages [60]	Model of Rural Settlement Consolidation [61]	Model of Riparian Landscape in Rural Areas [62]	Model of Village Effectiveness [63]
Socioeconomic Physical Demographic	Economic Environmental Social	Economic Ecological Social Engineering	Ecological Social Landscape	Production Ecological Living environment

Rural communities face a range of challenges that can impact their sustainability and resilience. Considering heritage as one of the critical aspects of rural resilience [64,65], our study looks at heritage losses' impact on the resilience of rural areas. Achieving the research aim and using our earlier studies on modelling the settlement development [66], identified numerous resilience challenges within five threat categories, including social, environmental, economic, physical, and managerial, which have been further subdivided into specific concerns as shown in Table 2.

Table 2. Challenges facing the resilience of rural settlements in Belarus. Source: Own Study.

Development Criteria	Challenge	Description
Social	Demographic changes	Depopulation due to outmigration to urban areas, which reduces the local workforce, hinders economic growth, and threatens the viability of rural settlements
	Aging population	As young people move to urban areas, the remaining rural population tends to be older, leading to a decline in social capital and community cohesion
	Social isolation	Geographical isolation of rural settlements makes it difficult for residents to access social services, healthcare, and educational opportunities, which may exacerbate poverty and social exclusion
Economic	Limited economic opportunities	A lack of economic diversity, with agriculture being the dominant sector, leading to a lack of job opportunities and economic growth
	Lack of investments	A lack of investment, both from the government and private sector, which hinders economic growth and development
	Dependence on external markets	Relying on external markets, making them vulnerable to economic fluctuations and global market trends
Environmental	Degradation of natural resources	Environmental degradation due to unsustainable land use practices, such as overuse of pesticides, deforestation, and soil erosion
	Climate changes	Vulnerability to climate change impacts such as flooding, drought, and extreme weather events, which can damage infrastructure, harm crops and livestock, and threaten residents' livelihoods
	Losses of cultural resources	Losses of traditional buildings, customs, and practices due to modernization and globalization

Table 2. Cont.

Development Criteria	Challenge	Description
Social	Deteriorating infrastructure	Aged and inadequate infrastructure, including roads, bridges, water and sewage systems, which hinders economic development and quality of life for residents
	Inadequate housing	Substandard or inadequate housing, which can negatively impact health and well-being, and deter potential new residents from settling in the area
	Limited access to services	Limited access to essential services such as healthcare, education, and public transportation, which can hinder economic development and life quality
Managerial	Lack of support from government	A lack of support from government officials, which can lead to inadequate funding for essential services, lack of investment, and limited opportunities for economic growth and development
	Corruption	Corruption can hinder economic development, deter investment, and limit opportunities for rural settlements in Belarus
	Limited decision-making power	Limited decision-making power due to centralized decision-making structures, which can hinder their ability to respond to local needs and priorities

3.2.2. Assessment of the Resilience of Rural Settlements

Considering the details from Table 2, as well as data sources for rural settlements within the research area, we have formulated a system of criteria for the assessment of rural settlement resilience. The system includes four levels of indicators of rural settlement resilience as shown in Figure 9.

The first level contains two groups, including the core and regulation criteria. The core system involves three sub-criteria. The social index is essential to the development of rural settlements, as strong social networks and community cohesion are important for sustaining rural settlements. The index defines social capital as the level of trust, cooperation, and shared values within the community, which can contribute to community resilience and problem-solving capacity; and social services as the availability and accessibility of social services such as healthcare, education, and public safety, which can impact the well-being and quality of life of residents. The economic index provides residents with livelihood opportunities and ensures that the local economy is strong enough to support the community. The index defines the business environment as the ease of doing business, access to financing and resources, and the level of support and regulations for businesses operating in the area; and the labor balance is defined as the balance between the supply and demand of labor in the area, which can affect employment opportunities, economic growth, and sustainability. The environmental index impacts the development of rural settlements indirectly. Environmental policies and regulations can either support or impede the growth of rural settlements depending on their impact on the local ecosystem. The environmental index defines natural resources as the condition and sustainability of natural resources such as water, air, soil, and biodiversity, which are essential for the well-being and economic activities of the community; and cultural resources including the preservation and promotion of cultural heritage, traditional knowledge, and local customs and practices, which can contribute to community identity and social cohesion.

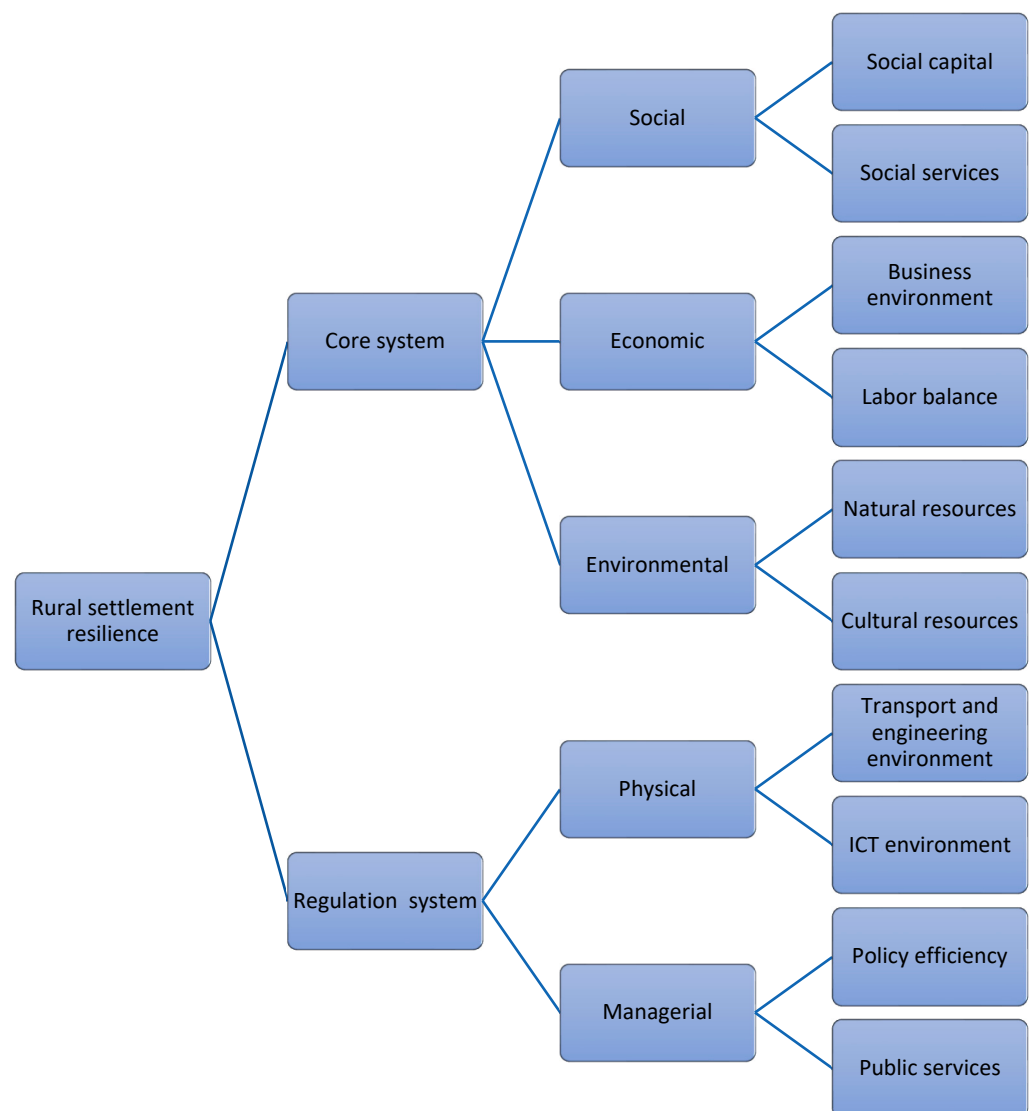


Figure 9. AHP model of rural settlement resilience. Source: Own Study.

The regulation system includes two sub-criteria. The physical index represents a physical infrastructure of the rural settlement and provides the basic amenities necessary for the daily lives of residents. The index defines the transport and engineering environment as the condition and accessibility of infrastructure such as roads, bridges, water and sewage systems, and energy supply, which are essential for economic development and quality of life; and ICT environment as the availability and accessibility of information and communication technologies (ICT) such as internet, mobile phone coverage, and digital services, which can improve access to services, education, and job opportunities. The managerial index refers to the policies and regulations that govern the development of rural settlements. Effective governance and policies are necessary for ensuring the long-term resilience of rural settlements. The index defines policy efficiency as the effectiveness and responsiveness of government policies and regulations in addressing the local needs and priorities, and supporting economic and social development; and public services as the availability and accessibility of essential public services such as healthcare, education, and public transportation, which can impact the well-being and quality of life of residents.

An important issue that arises in this process is the weighting of indicators, which poses a significant challenge due to the lack of a universally accepted weighting procedure. Considering this problem, recent studies propose both expert and non-expert approaches

for weighting indicators, as well as assigning equal importance to all indicators. In this study, we suggest applying the expert method to assign the indicators weights as a common approach for addressing the weighting problem in decision-making processes. The experts in the areas of architecture and urban planning were involved in the process of criteria weighting.

The generalized algorithm of assessment of the rural settlement resilience comprises several steps as follows: (i) input data normalization; (ii) indicators weighting; and (iii) calculating the resilience index for rural settlements, as provided in Figure 10. The model comprises the following variables. The normalized value of i -th indicator for j -th object is labeled as k_{ij} . k_{ij} is a function of measured (t_{ij}) and benchmark (t_i^{et}) values of i -th indicator within j -th object. The weighting coefficient coded as (α_i) represents a function of the expert values (q_{ij}) within the group of N experts. The rural settlement resilience index (RSRI) is a function of indicators' weights (α_i) and normalized values of indicators (k_{ij}).

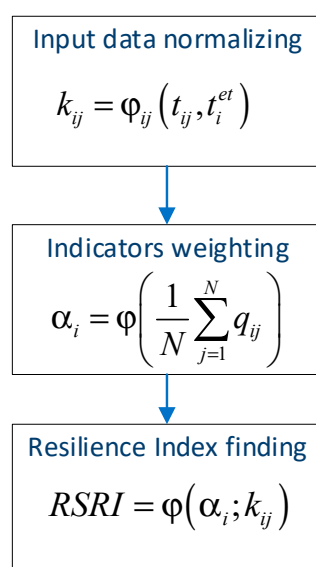


Figure 10. The algorithm of assessment the rural settlement resilience. Source: Own Study.

3.2.3. Rural Resilience Matching Model

To evaluate the outcomes, we suggest the QA method since it is a widespread practice in multiple research areas [67], including urban and regional planning [63,68]. So, we consider it a useful tool for analyzing the resilience of settlements because it provides a visual representation of how different settlements compare in terms of their core and regulation systems. The quadrant analysis chart model helps to promote a more holistic sense of resilience as well as a more nuanced understanding of the factors affecting settlement resilience.

To determine a settlement's resilience, we combine the resilience dimension with the concept of rural settlement resilience discussed in Section 3.2.2. The settlements are categorized as having resilience when both their kernel and regulation criteria align with the evaluation dimension and results. We use a four-quadrant analytical approach to match settlement resilience. The horizontal and vertical axes represent the normalized kernel and regulatory indices, respectively. The midpoint value of the 'kernel' and 'regulatory' values is determined at the intersection of the four quadrants' split points between high and low indices. The coordinate system is divided into four quadrants, as shown in Figure 11, comprising the 'high-kernel high-regulatory zone (HK-HR)', 'low-kernel high-regulatory zone (LK-HR)', 'low-kernel low-regulatory zone' (LK-LR), and 'high-kernel low-regulatory zone' (HK-LR). We consider settlements falling in the first quadrant of the HK-HR zone as resilient areas. This procedure further refines the evaluation units.

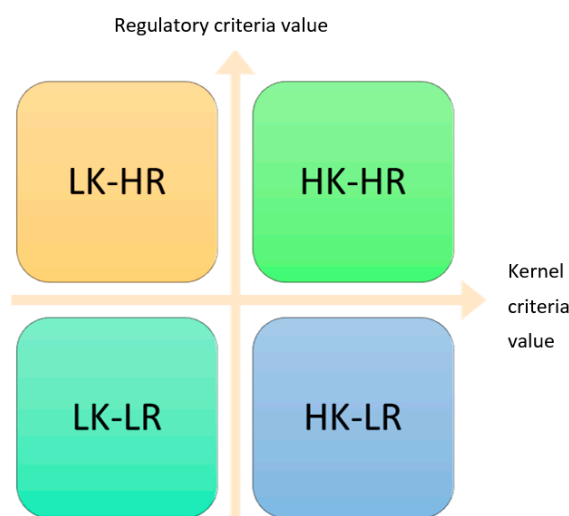


Figure 11. A Quadrant Analysis Chart Model for Evaluation the Rural Settlement Resilience. Source: Own Study.

4. Results

In this study, various criteria have been weighted to determine the factors contributing to the resilience of rural settlements. Social capital, social services, business environment, labor balance, natural resources, cultural resources, transport and engineering environment, ICT environment, policy efficiency, and public services, are the ten criteria that have been considered. The normalized weights represent the significance of each criterion in contributing to the overall resilience of rural settlements (Table 3).

Table 3. Normalized weights and structure of criteria of rural settlement resilience. Source: Own Study.

Criterion	Code	Weight	Rank	Criterion Structure
Social capital	SC	0.10890	4	Population amount Percentage of seniors Young-to-old population ratio
Social services	SS	0.10522	6	Time needed to reach a social facility, min Number of social facilities
Business environment	BE	0.10596	5	Number of farm households Economic diversity
Labor balance	LB	0.10964	3	Active working age percentage Time needed to reach a work location, min
Natural resources	NR	0.09198	9	Recreational areas, percentage Recreational areas, availability
Cultural resources	CR	0.11258	1	Heritage objects Nonmaterial heritage
Transport and engineering environment	TE	0.11111	2	Transport environment accessibility Engineering environment availability
ICT environment	ICT	0.09713	8	Number of households with data networks Total number of households
Policy efficiency	PE	0.09860	7	Availability of local spatial development plan Administrative status
Public services	PS	0.05887	10	E-accessibility of public services Availability of multi-purpose public service center

The social capital (SC) is ranked fourth in terms of weight, with a weight of 0.10890. The key components of social capital in this study are the population amount, the percentage of seniors in the population, and the young-to-old population ratio. This suggests that a larger and balanced population with a mix of age groups contributes significantly to the social resilience of rural settlements. The social services (SS) have a weight of 0.10522, ranking sixth in importance. The evaluation includes factors like the time needed to reach a social facility and the number of social facilities available. This implies that accessible and sufficient social facilities play a role in enhancing the social resilience of rural settlements. The business environment (BE) is ranked fifth with a weight of 0.10596. The number of farm households and the economic diversity of the settlement are considered in this criterion. This suggests that a diverse economic landscape and a thriving agricultural sector contribute to the overall economic resilience of rural settlements. The labor balance (LB) holds a weight of 0.10964, ranking third in importance. The active working age percentage and the time needed to reach a work location are part of this criterion. This indicates that a balanced and accessible job market is crucial for the economic resilience of rural settlements. Natural resources (NR) have a weight of 0.09198 and rank ninth in significance. The evaluation includes the percentage and availability of recreational areas in the settlement. This highlights the role of preserving and utilizing recreational areas for enhancing the natural resilience of rural settlements. The cultural resources (CR) are the most critical criterion with a weight of 0.11258, ranking first. The presence of heritage objects and nonmaterial heritage aspects is considered in this criterion. This emphasizes the significance of cultural preservation and heritage in enhancing the resilience of rural settlements. The transport and engineering environment (TE) ranks second in importance with a weight of 0.11111. This criterion assesses the accessibility of the transport environment and the availability of engineering infrastructure. This indicates that well-developed transportation and engineering facilities contribute significantly to the physical resilience of rural settlements. The ICT environment (ICT) holds a weight of 0.09713, ranking eighth in significance. The evaluation includes the number of households with data networks and the total number of households. This suggests that access to digital infrastructure is a contributing factor to the overall resilience of rural settlements. The policy efficiency (PE) has a weight of 0.09860, ranking seventh. The availability of a local spatial development plan and the administrative status of the settlement are considered in this criterion. This highlights the importance of efficient and supportive governance policies in enhancing the resilience of rural settlements. The public services (PS) rank tenth in importance with a weight of 0.05887. The evaluation includes factors like the e-accessibility of the public services and the availability of multi-purpose public service centers. This indicates that accessible and diverse public services play a role in enhancing the overall resilience of rural settlements.

The results of the evaluation of the resilience of rural settlements show a wide range of resilience levels within the research area. The highest resilience index was recorded in the Zavaľočycy agro-town, while the lowest was in the Hornaje village. Generally, the results suggest that some settlements are more prepared to cope with and recover from adverse events than others (Table 4). The quadrant chart illustrates the core and regulation indices for each of the rural settlements within the research area (Zavaľočycy local council), based on the social, economic, environmental, physical, and managerial indices (Figure 12).

Considering the core as comprising the social, economic, and environmental indicators, and the regulation quadrant as comprising the physical and managerial indicators, we can gain a deeper knowledge of the rural settlements' resilience within the research area. In this context, the settlements in the top-right quadrant of the chart, such as the Zavaľočycy agro-town and Haradok village, have a strong core and regulation system, indicating a high level of resilience. These settlements have a solid foundation in terms of the social, economic, and environmental indicators, as well as a good physical infrastructure and strong managerial support. It should be also added here that the mentioned settlements are the only ones where the heritage objects remained preserved. Additionally, the results correspond to our previous research outcomes in the same area [65].

Table 4. The results of evaluation of the resilience of rural settlements in Zavaļočy local council.
Source: Own Study.

Settlement Name	Rural Settlement Resilience Index RSRI	Core Index CRI	Regulation Index RRI	Social Resilience Index SRI	Economic Resilience Index EcRI	Environmental Resilience Index EnvRI	Physical Resilience Index PhRI	Managerial Resilience Index MRI
Zavaļočy	73.60	36.30	37.31	3.93	11.54	20.82	21.56	15.75
Symonavičy	47.52	28.57	18.95	6.12	13.89	8.55	12.06	6.89
Jaūsiejevičy	48.32	29.66	18.66	7.00	10.23	12.43	11.77	6.89
Rudnia	43.30	28.99	14.31	6.33	10.23	12.43	7.42	6.89
Palana	30.85	16.99	13.86	3.17	6.94	6.87	6.97	6.89
Zapolle	47.96	26.94	21.03	5.69	8.82	12.43	14.13	6.89
Dvarec	43.29	30.31	12.98	5.98	10.23	14.11	6.09	6.89
Turki	45.46	26.83	18.64	8.32	11.64	6.87	11.75	6.89
Haradok	66.31	38.19	28.12	7.88	11.17	19.15	21.23	6.89
Haradzišča	57.28	38.73	18.54	11.39	14.92	12.43	11.65	6.89
Knyšy	59.01	40.55	18.46	12.26	15.86	12.43	11.56	6.89
Babirova	46.20	17.75	28.45	3.93	6.94	6.87	21.56	6.89
Hornaje	42.68	22.29	20.39	6.12	9.29	6.87	13.50	6.89
Jasiency	44.87	25.92	18.95	7.88	11.17	6.87	12.06	6.89

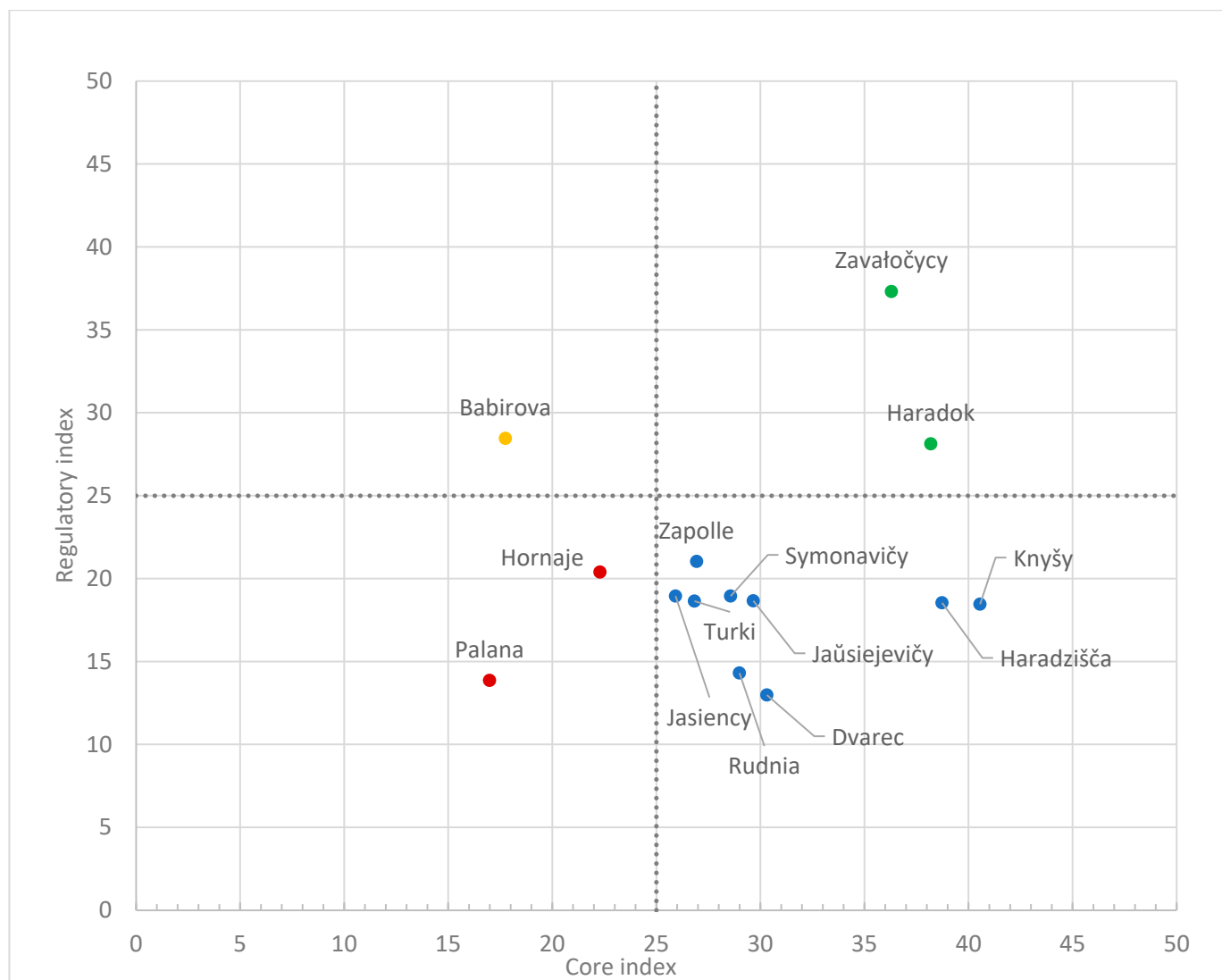


Figure 12. The quadrant chart of the settlements' resilience. Source: Own Study.

On the other hand, settlements in the bottom-left quadrant, such as Palana and Hornaje villages, have weaker core and regulation systems, indicating a lower resilience. The settlements may have limited social and economic opportunities, poor environmental conditions, and weaker physical infrastructure, which are further exacerbated by poor managerial support. The Babirova village is located in the top-left quadrant and has a strong core system but a weaker regulation system, indicating that it has good social, economic, and environmental indicators but faces challenges related to the physical infrastructure and managerial support. Finally, settlements in the bottom-right quadrant, such as the Symonavičy, Jaūsiejevičy, Rudnia, Zapolle, Dvarec, Turki, Haradzišča, Knyšy, and Jasiency villages have a weaker core system but a stronger regulation system, indicating that they have a good physical infrastructure and managerial support, but face challenges related to social, economic, and environmental indicators.

Generally, the research results demonstrate that a balanced approach is needed to improve the resilience of rural settlements, focusing on the improvements in both the core and regulatory systems. With enhanced social, economic, and environmental conditions, as well as improved physical infrastructure and management support, rural settlements have a better capability to face both shocks and pressures and to thrive against challenges.

5. Discussion

5.1. Findings and Implications

The findings of the research provide valuable insights into the resilience of rural settlements in the research area, as assessed using the integrated AHP-QA model. The model categorized settlements into four quadrants based on their core (social, economic, and environmental indicators) and regulation (physical and managerial indicators) systems. The implications of the research are as follows:

1. To enhance the rural settlement resilience, it is crucial to recognize the value of heritage and adopt strategies that preserve and integrate cultural resources into sustainable development plans. Investing in heritage conservation can boost the community resilience, promote sustainable tourism, and strengthen the overall socio-economic and environmental fabric of rural settlements.
2. This research identified settlements that exhibited a high level of resilience, characterized by a strong core and regulation system. The Zavałočycy agro-town and Haradok village were among the most resilient settlements in the top-right quadrant of the chart. This suggests that these settlements possess a solid foundation in terms of social cohesion, economic opportunities, environmental sustainability, physical infrastructure, and effective governance, enabling them to cope with challenges effectively.
3. This research also highlighted the challenges faced by the less resilient settlements, such as the Palana and Hornaje villages in the bottom-left quadrant. These settlements have weaker core and regulation systems, indicating limited social and economic opportunities, poor environmental conditions, inadequate physical infrastructure, and ineffective managerial support. Understanding these challenges can help guide targeted interventions and policies to enhance their resilience.
4. This research underscores the importance of a balanced approach to improving the resilience of rural settlements. Settlements like the Babirova village in the top-left quadrant have a strong core system but face challenges related to the physical infrastructure and managerial support. On the other hand, settlements like Symonavičy, Jaūsiejevičy, and others in the bottom-right quadrant have a strong regulation system but face challenges related to the social, economic, and environmental indicators. This indicates that a comprehensive strategy should address both the core and regulation aspects to enhance overall resilience.
5. Enhancing the social, economic, and environmental conditions, along with improving the physical infrastructure and managerial support, can significantly improve the capacity of rural settlements to withstand shocks and pressures. Resilient settlements

are better equipped to adapt to changes, foster economic growth, and maintain their cultural and natural assets.

6. The research findings have important policy implications for rural development. Policymakers and local authorities should consider a multidimensional approach that addresses various aspects of resilience, including community empowerment, economic diversification, sustainable resource management, infrastructure development, and efficient governance.

While this research provides valuable insights into the resilience of rural settlements using the integrated AHP-QA model, it is essential to acknowledge some limitations that might have impacted the study:

- Sample size and generalizability: The research focused on a specific region (Zavałočycy local council) in Belarus, which might not fully represent the diversity of rural settlements across the entire country. Therefore, the findings may have limited generalizability to other regions with different socio-economic and environmental characteristics.
- Exclusion of stakeholder perspectives: The research focused primarily on expert opinions, potentially overlooking the perspectives of local residents and community stakeholders. Incorporating the views and experiences of the residents could offer a more comprehensive understanding of resilience and potentially highlight additional challenges and opportunities.
- Time sensitivity: The resilience of rural settlements can be influenced by various dynamic factors, such as policy changes, economic fluctuations, and environmental conditions. As the study is based on data from a specific time period, the findings might not fully capture the current or future state of resilience in the area.

Considering the above limitations, it is crucial to interpret the research findings with caution and use them as a starting point for further investigations and targeted policies to enhance the resilience of rural settlements effectively. Future research could explore these limitations and aim to address them for a more comprehensive understanding of rural resilience.

5.2. Future Research Directions

Building upon the insights gained from the current research, the following future research directions are recommended to further advance the understanding of rural settlement resilience:

- Longitudinal studies: Conducting longitudinal studies that span multiple years or decades would provide a more dynamic view of rural settlement resilience. Long-term data collection and analysis can capture changes over time, identifying trends, and understanding how various factors influence resilience trajectories.
- Incorporating stakeholder engagement: Future research should involve meaningful engagement with local residents, community leaders, and other stakeholders. Understanding their perspectives, needs, and aspirations can lead to more context-specific and community-driven strategies for enhancing resilience.
- Comparative studies: Conduct comparative studies across different regions or countries to identify variations in rural settlement resilience patterns. Such research can unveil the best practices and innovative approaches employed by resilient communities in diverse contexts.
- Resilience thresholds: Investigate the existence of resilience thresholds for rural settlements. Identifying critical thresholds can help policy-makers and planners understand when and where interventions are most effective in bolstering resilience.
- Policy implications: Investigate the policy implications of enhancing rural settlement resilience. Analyze the effectiveness of existing policies and propose evidence-based recommendations for strengthening resilience at the local, regional, and national levels.

By addressing the mentioned future research directions, scholars, policymakers, and practitioners as well will have the capacity to contribute more robust and actionable

knowledge for building sustainable and resilient rural settlements. This research can empower communities to proactively respond to challenges and opportunities, ultimately fostering thriving and adaptive rural environments.

6. Conclusions

The findings highlight the need for balanced approaches that take into account both core and regulatory systems to improve rural settlement resilience. To create more resilient communities, it is essential to address social, economic, and environmental aspects while strengthening physical infrastructure and enhancing managerial support. The research emphasizes the significance of cultural heritage, their preservation and restoration following a variety of impacts such as natural and man-made ones. A crucial point is that care and attention should be directed not just to national heritage sites, but also to regional and local sites as well.

Based on the integrated assessment of rural settlements in the Zavałożycy local council, it is evident that the combination of the AHP method and quadrant analysis model provides a comprehensive approach to prioritize indicators and identify areas for improvement.

The resilience index serves as a valuable tool for decision-making, as it provides a quantifiable measure of resilience that can be used to prioritize interventions, allocate resources, and monitor progress over time. By integrating the resilience index within the AHP-QA framework, the model facilitates a more holistic and evidence-based assessment of the resilience of rural settlements. It goes beyond a simplistic evaluation of individual factors and provides a comprehensive understanding of the overall resilience profile of each settlement. The visual representation, holistic perspective, nuanced assessment, identification of improvement areas, and complementary analysis offered by the QA-model enhance the effectiveness and reliability of the assessment process. Ultimately, this combined approach supports informed decision-making and the development of targeted strategies to promote the resilience and sustainable development of rural settlements.

Overall, the results provide a comprehensive understanding of the key factors influencing the resilience of rural settlements, allowing policymakers and stakeholders to prioritize and focus on specific areas for improving resilience. The integrated AHP-QA model proves to be an effective tool in evaluating the multidimensional nature of rural settlement resilience, supporting informed decision-making and sustainable development efforts. It is also essential to recognize that the research findings are specific to the context of the study and may require adaptation when applied to different regions or settings.

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