

RESEARCH ARTICLE

Open Access



Evaluating the impact of Zanzan city's economic drivers on the quality of life in peri-urban villages: a case study of Do Asb and Payin Kouh villages

Ali Shamaei¹ and Kamran Jafarpour Ghalehtimouri^{1,2,3*} 

Abstract

The interplay between urban centers and peri-urban villages plays a pivotal role in rural development, particularly in the economic dimension. Analyzing these relationships and their influence on the progress and prosperity of peri-urban villages, coupled with capacity building, empowerment, and the integration of urban-rural management, is essential to reduce disparities and promote spatial justice, aligning with the sustainable development of rural areas. This study aims to assess the effects of Zanzan city's economic drivers on the livability quality of Do Asb and Payin Kouh, two peri-urban villages situated in Zanzan city. Employing a descriptive-analytical and practical approach, the study's statistical population comprises the aforementioned villages in Zanzan city. A sample of 219 households was selected from among the sample population based on Cochran's formula. Data collection involved both library research and fieldwork, including the use of questionnaires. Descriptive and inferential statistics (multivariate regression) were employed for data analysis, along with descriptive statistics (averages) and geographic information systems to analyze land use changes. The research findings unveiled a robust correlation (0.87) between the quality of life in peri-urban villages and the economic drivers of Zanzan city. This indicates a significant and positive relationship between Zanzan city's economic drivers (independent variable) and the quality of life in peri-urban villages (dependent variable). Among the examined variables, communication flow for purchases, with a coefficient of 0.28, contributed most to the variance analysis of the quality of life in peri-urban villages. In contrast, the investment flow of urban residents in village economic activities and the flow of money exchange had relatively lower coefficients of 0.13 and 0.14, respectively. Thus, the research underscores the considerable impact of Zanzan's economic drivers on enhancing the quality of life in peri-urban villages and highlights the pivotal role of rural-urban links in fostering sustainable rural development.

Keywords Economic drivers, Rural livability, Rural-urban links, Peri-urban villages, Zanzan City

*Correspondence:

Kamran Jafarpour Ghalehtimouri
space.kamran@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

1 Introduction

In the field of regional, urban, and rural planning, there is a critical focus on the complex interplay between urban and rural environments. This paper aims to explore the intricate dynamics of city-rural interactions, which is a pressing area of research (Keshavarzi et al. 2006; Wang et al., 2024). These interactions are influenced by several transformative forces, including the shift towards a tertiary-based economy, the resulting decline in agrarian populations, and the extensive expansion of transportation and communication infrastructures. Within this context, significant disparities are clear, characterized by unequal development and discrimination between urban and rural areas. However, there is a noticeable gap in our understanding of these interactions, particularly in distinguishing them across various typologies based on scale and function. The dominance of urban functions over rural counterparts is clear through disparities in resource allocation and opportunities, as seen in regional accounts (Delgado-Viñas and Gómez-Moreno, 2022). These city-rural relationships have the potential to harmonize the growth and development of urban and rural regions, as well as sow the seeds of disparity among their communities. Although cities and villages are essential components of any region, there is a need for greater emphasis on nurturing their harmonious coexistence, particularly in the context of regional development initiatives (Friedmann, 1966). The trend of urbanization, capital concentration, technological advancements, and disparities within cities and villages contribute to spatial disparities and dualities across economic, social, and cultural spheres (Rodríguez-Pose, 2010; Medeiros de Freitas et al., 2024). The consequences of these disparities are evident in marginalization, poverty, migrations, spatial injustice, and a range of social issues. One of the most pressing environmental challenges facing developing nations today is rapid urbanization and the resulting overcrowding of city spaces, leading to the transformation of peri-urban communities and the emergence of informal settlements (Ghalehtemouri & Ros 2020; Amini et al., 2022).

The changing dynamics of rural-urban relationships in modern Asia go beyond the traditional linear model to examine a complex web of interactions. Through case studies from India (Louw & Mondal, 2012), Indonesia (Miller & Bunnell, 2012), Malaysia (Stivens, 2012; Ghalehtemouri et al., 2024), and Thailand (Johnson, 2012), the interconnectedness and transformations between urban and rural regions are highlighted, challenging the rural-urban dichotomy. The political implications of these relationships are explored, including governance issues, infrastructure management, and real estate speculation. It is important to move beyond simplistic rural-urban

distinctions and recognize the intricate dynamics of urban sprawl, rural development, and the flow of resources in Asia. Understanding the evolving social, economic, and political aspects of urban and rural areas in contemporary Asian societies is essential (Rigg, 1998; Thompson et al., 2013). In developed countries, there is a growing movement of people moving from urban areas to rural areas near cities to avoid pollution, which is leading to economic growth and improved infrastructure (Pucher et al., 2007). The focus is on implementing circular economy principles and sustainable resource management to create new business opportunities in rural areas, in line with the global Sustainable Development Goals for 2030 (Chen et al., 2020; Širá, E., 2022). In Southeast Asia, rural areas are grappling with challenges such as inadequate infrastructure, low agricultural productivity, and environmental risks (Ghalehtemouri, 2024). International initiatives like the Paris Agreement and Agenda 2030 are working to narrow the gap between rural and urban areas by promoting sustainable farming practices, digital innovations, and renewable energy sources. Emphasizing circular economy practices and building rural resilience are essential for sustainable development in Southeast Asia, addressing issues like poverty, food insecurity, and environmental harm. Enhancing access to essential services and boosting rural economies are key steps towards achieving the Sustainable Development Goals in the region by 2030 (Mihai & Iatu, 2020).

The adaptability, growth, and development of rural communities, along with their internal and external relationships, are intricately influenced by the nature and extent of their interactions with the urban sphere (Savari and Shokati Amghani, 2021; Tuffour et al., 2024). Over time, in tandem with changes in livelihoods, population dynamics, and technological advancements, the nature of rural-urban interactions—the key driving force shaping regional spaces—has undergone significant evolution. This evolution is further shaped by government socioeconomic policies that allocate varying levels of attention to specific population centers, resulting in substantial changes within regions (Hughes, 2020; Nüsseret al., 2024). However, urban-rural disparities have grown over the past few decades due to rapid urbanization, global economic connectivity, and trade liberalization (Pike et al., 2017). While some social scientists and geographers have delved into urban-rural relationships for in-depth research, there is a noteworthy gap concerning the reciprocal relationships between rural and urban areas and their potential to mitigate poverty, especially in emerging countries undergoing rapid urbanization (Ghazaie and Rafeian, 2022).

The interactions between cities and their peri-urban surroundings represent a complex, organic process

influenced by various factors. These interactions hold significant sway over the development of both urban and rural areas (Azizi et al., 2020). In recent times, the rigid boundaries between cities and villages have blurred due to increased interactions, with rural residents adapting to urban lifestyles and commuting between both environments (Shan, 2014). This intertwining of economies is driven by various factors, including the relocation of businesses to rural areas in some countries and the growth of urban areas' agricultural sectors (Sheng, 2002; Ghalehtemouri & Khaliji 2023). Additionally, the phenomenon of immigrants maintaining connections with their home villages, particularly for economic and social safety nets, has been insufficiently explored (Steinberg, 2014). Moreover, the quantity and nature of interactions between urban and rural populations influence various aspects of life in these areas, from the movement of agricultural products and industrial goods to financial remittances (Tian & Wang, 2019).

This paper aims to address significant gaps in understanding the consequences of recent changes in land use, environmental shifts, and uneven transformations resulting from overpopulation, industry polarization, and the abandonment of surrounding areas, particularly in developing countries like Iran. These changes have had profound implications for urban-rural interactions, especially in peri-urban contexts. However, a comprehensive investigation into the livability aspects of peri-urban villages and the primary drivers of agricultural land use changes in the peri-urban areas of Zanzan City remains largely unexplored. This research seeks to fill this gap by focusing on the integration of the spatial system of the city and its surroundings and assessing the implications of these changes on peri-urban communities in Zanzan. Furthermore, it endeavors to explore critical questions regarding the quality of life, development factors, and land use alterations in these areas. This paper embarks on an exploration of these intricate urban-rural interactions, aiming to dissect their implications for regional development in a comprehensive manner. It underscores the pressing need for a nuanced understanding and effective management of these interactions, shedding light on their pivotal role in fostering balanced development and addressing the persistent disparities affecting urban and rural communities alike.

1.1 Theoretical foundations

In the realm of geographical studies and urban planning, peri-urban areas hold a distinctive place as regions that are not only habitable but also contribute to agricultural production, encompass industrial activities, and support tourism, among others (Sieverts, 2003; Javdan et al., 2023). Urban and rural linkages are of paramount

importance from multiple standpoints encompassing economics, social dynamics, environmental considerations, and sociocultural relationships. These linkages arise from the exchange of goods and financial transactions, bearing direct and indirect implications for the quality of life and livelihoods of both urban and rural populations (Adugna & Hailemariam, 2011). One fundamental backdrop in urban and rural planning revolves around the concept of urban livability, a prominent discourse that casts its influence on both urban and rural sustainable development. The interplay of forward and backward linkages in consumption and production is a testament to the interconnectedness of urban and rural areas (Noorollahi et al., 2017; Ghalehtemouri et al., 2021). It is contended that the development of one unit is intrinsically tied to the development of the other, rather than isolating urban and rural areas. Strong urban-rural interconnections can foster the growth of both areas through a chain of interlinked activities, encompassing both backward and forward linkages, which can occur unilaterally or reciprocally (Mihret, 2019).

The economic implications of these connections are tightly linked to diversifying income sources. In this context, agricultural raw materials are transported from rural to urban areas, while industrial goods and services flow from urban to rural areas, contributing to livelihood diversification. Additionally, these interactions facilitate the circulation of capital, benefiting both urban and rural regions. The provision of access to markets and means of subsistence by urban centers to rural populations underscores the existence of robust economic linkages between towns and their surrounding rural areas (Tostensen, 2004). The consequences of these interactions extend to bring about significant changes in both rural and urban areas (Davoudi, 2002). Uncontrolled and disorganized interactions between cities and their suburban environments result in urban sprawl. Effective spatial planning is crucial for addressing the patterns and processes of urban development and the outcomes of urban expansion (Ewing et al., 2002; Kamran et al., 2020).

The expansion of cities into peri-urban environments, driven by economic and social factors, has accelerated uneven suburban growth. The unplanned and disproportionate extension of urban structures is often a result of population migration, changing activities, and their proliferation in suburban areas, particularly along major road arteries leading to cities. Consequently, urban and suburban sprawl has given rise to distinct settlements that substantially alter the landscape, often encroaching on agricultural land for the development of non-sustainable structures (Talkhabi et al., 2022; Noorollahi et al., 2021; Frankenberg and Siegel-Hawley, 2024). "Urban sprawl" is a term that has been used in scholarly literature

for several decades to describe the uneven expansion of cities (Bertino et al., 2019). This phenomenon, closely associated with the growth of personal vehicle usage and the expansion of highways, has provided individuals with opportunities to migrate to suburbs with more favorable climatic conditions, largely due to the lack of building restrictions. However, the European Environment Agency has indicated that suburban urban growth poses a significant threat to nature and rural areas (Foran, 2009).

The consequences of urban sprawl extend to the environment, economy, social fabric, and the physical-spatial aspects. These include alterations in land use, changes in agricultural and forested lands, as well as changes in the steepness of mountain and hill slopes (Langgut and Gadot, 2024). Notably, the once clear division between urban and rural areas has been blurred due to the growing connection between these spaces. Villagers have adapted to urban lifestyles, leading to frequent commuting between the village and the city (Sgroi, 2022). Economic activities in urban and rural areas have become increasingly intertwined, leading to transformations in both regions (Davoudi, 2002). Cities play a pivotal role in providing a wide range of commercial, medical, and educational services to their surrounding areas. The central areas of cities often exhibit an unequal distribution

of power in terms of the economy, society, and politics, as per the center model proposed by Friedman (Friedman, 1966). Remote villages that depend on larger cities have the potential for growth and development due to their improved access to urban services. The relationship between urban and rural producers and agents, as well as the impact of the city on the countryside, are of central importance in exploring this dynamic. Drawing from the new economic geography, the relationship between infrastructure and industry, market access, and high production efficiency is emphasized. These attributes are often the result of cumulative production processes and are influenced by the center-periphery economic relationship (Fujita et al., 1999; Krugman, 1991; Headey et al., 2024). Medium-sized and small cities have assumed a more significant role in recent years, strengthening their ties with rural environments and contributing to a broader network of interactions (Baker & Clilaeson, 1990) (Fig. 1).

The global issue of escalating socioeconomic disparities among different geographical regions is a persistent problem that has garnered significant attention (Jones, 2007). This phenomenon is often conceptualized within the framework of the center-periphery paradigm, which offers a broad lens through which to understand the interconnected gaps in demographic and economic conditions. In this paradigm, the "center" typically denotes

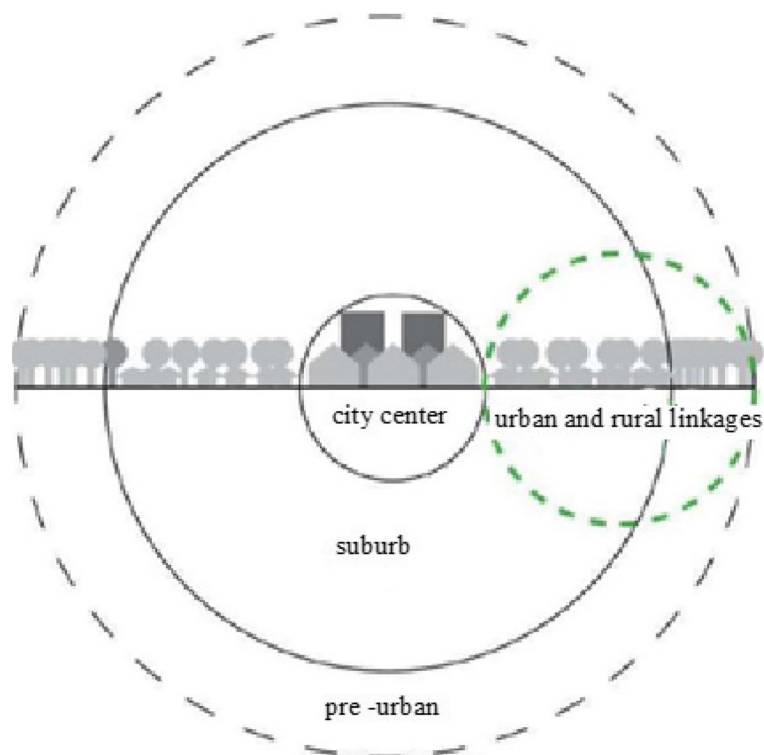


Fig. 1 Urban and rural relationship Source: Verissimo, 2014

a fully urbanized area characterized by concentrated population and economic activity, while the "periphery" is marked by slower economic growth and a smaller population. Consequently, a country's population and economic development tend to concentrate in its central areas, resulting in economic inequality, insufficient quality of services, and infrastructure that are more concentrated in peripheral regions than in the central areas. This pattern is observed in both developed and less developed countries (Portnov & Pearlmutter, 1999).

As a result, the term "peri-urban area" emerges as a distinctive concept, referring to the region where the processes of urban and rural development intersect, merge, and interact (Talkhabi et al., 2022). The peri-urban area serves as a transitional zone situated between predominantly agricultural and fully urbanized regions. This territory is often divided into various administrative regions, marked by mixed land uses, internal and external boundaries. Settlements outside the metropolis in these transitional zones frequently contend with issues of exploitation, conflict, and competition. In contrast to metropolitan areas, these transitional zones are often underfunded, lack comprehensive land use planning, and pay insufficient attention to environmental management. The criteria identified in this study, based on the reviewed literature, provide a foundation for understanding and characterizing peri-urban areas. This understanding is essential for addressing the complex challenges arising from the dynamic interactions and intersections between urban and rural processes within these regions (Fig. 2).

Although, many development theories typically emphasize the relationships between cities and rural areas, often viewed as interconnected feedback loops, Iranian geographers have historically overlooked the role

of the city in their urban planning studies. Instead, they have predominantly focused on the city itself, often analyzing it in isolation from the village and its surrounding areas. However, in order to grasp the complexities of urbanism and find appropriate solutions for fostering magnificent urban and rural development, the study and investigation of city-rural relations are imperative. This approach serves as a solution to address the issues related to rural-to-urban migration and the environmental challenges confronting both urban and rural regions. From the perspective of urban geography, a city is not confined within its geographic borders; rather, its ability to thrive is contingent upon its harmonious coexistence with its neighboring regions. The vitality and stability of a city may draw from sources beyond its immediate boundaries and sphere of influence, transcending its center area (Firozjaei et al., 2020).

The examination of the causes and consequences of city-rural interactions has frequently led to the recognition that these relationships predominantly establish a particular type of "dominion relations," characterized by an exploitative nature exerted by the cities upon the nearby rural areas, which often remain less developed. Much of this research has been carried out at the peripheries of cities, aimed at explaining concepts such as "exploitative capitalism," "parasitic relations," and "government and urbanization." These concepts underscore the overarching socioeconomic dominance of Iranian cities in relation to their surrounding villages. In contrast to this exploitative approach, there is a strategy that advocates for the promotion of organic and balanced relationships within city-rural interactions. This strategy emphasizes changes in infrastructure services, economic diversification, the preservation of natural resources and

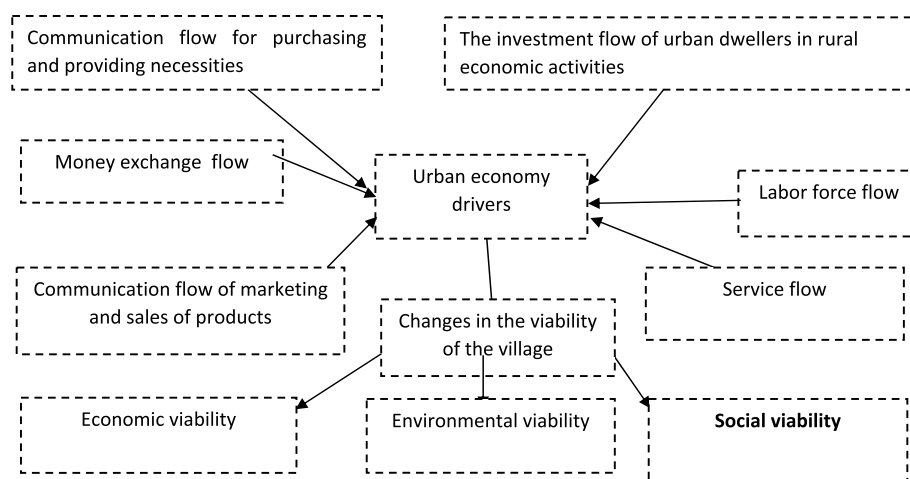


Fig. 2 Research conceptual framework

agriculture, and the maintenance of environmental balance as fundamental aspects to be considered in fostering sustainable and harmonious urban-rural development (Fig. 2).

2 Methods and materials

2.1 Methodology

The methodology for this study is structured to comprehensively investigate the impact of economic drivers on the quality of life in peri-urban villages. It employs a combination of quantitative and qualitative research methods to collect and analyze data. The following sections outline the methodology in more detail:

2.1.1 Research design and data collection

The current research adopts a descriptive-analytical and practical approach to achieve its objectives. To collect the necessary data, a combination of documentary methods and field surveys, which include questionnaires, observations, and interviews, was employed.

2.1.2 Sampling

The research's statistical population consists of two sample villages, namely Do Asb and Payin Kouh villages, located in Zanjan city. The selection of these villages was made based on their structural-functional differences and using a selective approach. To determine the sample size, Cochran's formula was initially used, leading to an initial sample size of 291 households. To refine this figure and ensure adequate representativeness, the modified Cochran's formula was applied, ultimately resulting in a final sample size requirement of 215 households.

In the formula, the variables are defined as follows:

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N} \left[\frac{z^2 pq}{d^2} - 1 \right]}$$

In this formula, N is the population size.

The p-statistic is the percentage distribution of the trait in the society, that is, the proportion of people who have the studied trait.

The q statistic is also the percentage of people who do not have the trait under study.

If the amount of p and q is not known, use their maximum value, i.e. 0.5.

The statistic is $z=t$ and there is no problem if you use t instead of z. At the 5% error level, the value of z is equal to 1.96 and Z2 is equal to 3.8416.

In this formula, the variables are defined as follows:

- N: Population size.

- p: Percentage distribution of the trait in the society.
- q: Percentage of people who do not possess the trait under study.
- z: Statistic used (in this case, $z = 1.96$ at a 5% error level).
- d: Difference between the actual proportion of the trait in the society and the researcher's estimate.

2.1.3 Data analysis

The collected data underwent both descriptive and inferential statistical analyses. Descriptive statistics were used to provide a foundation for summarizing the key characteristics of the data. These simple summaries of the sample and its measurements serve as the basis for quantitative data analysis and provide insights into the tendencies and spatial distribution of the data, which are critical in geographical studies.

For more in-depth analysis, the research employed inferential statistics, specifically the multivariate regression test, using the SPSS software. Multivariate regression is a powerful method for estimating a single regression model with multiple outcome variables, often referred to as multivariate multiple regression analysis when multiple parameters are involved (Sharafi and Ghaleni, 2021).

2.1.4 Household selection

To select households within each village, a simple random method was applied. This approach adheres to the equal opportunity principle and ensures a fair representation of households in the study.

2.1.5 Land use analysis

To analyze land use changes, NASA Landsat products 2001 Landsat 5 and 2021 Landsat 8, and Geographic Information System (GIS) tools were employed. This additional analysis helped provide insights into the dynamic nature of land use in the peri-urban areas under study (Han et al., 2022; Shakeri et al., 2016).

2.1.6 Demographic characteristics

Finally, to provide context for the study, the demographic characteristics of the studied villages in 2015 are presented. This information is derived from the Statistical Yearbook of Zanjan Province and includes details on the number of households, family size, and the total population of the villages, allowing for a clear understanding of the population structure within the study area as it shown in Table 1.

Therefore, the combination of data collection methods, robust statistical analysis, and a focus on key

Table 1 Demographic characteristics of the studied villages in 2015

Indicator	Do Asb	Payin Kouh
Number of population	2726	1466
Number of households	774	420
Family size	3.52	3.49

Source: Statistical yearbook of Zanjan province, 2015

demographic characteristics ensures a comprehensive and multifaceted investigation into the impact of economic drivers on the quality of life in peri-urban villages.

2.2 Research variables and indicators

To investigate the impact of economic drivers on the livability status of the studied area, the research utilizes a set of variables and indicators. These variables encompass economic drivers and livability, with each dimension having its specific set of indicators.

Economic Drivers:

- *Labor Flow:*

- The flow of people traveling from the city to the village for work.
- The flow of people commuting from the village to the city for work.

- *Communication Flow for Purchasing and Providing Necessities:*

- The frequency of visits by villagers to the city's local and weekly markets.
- The amount of food purchased from the city per month.
- The amount of clothing and apparel purchased from the city per year.
- The amount of household appliances purchased from the city per year.
- The amount of facilities and construction materials purchased from the city per year.
- The amount of agricultural inputs purchased from the city per year.
- The purchase of vehicles and their spare parts.

- *Service Flow:*

- The amount of time spent using various banking services.
- The amount of time spent using insurance services.
- The amount of time spent using medical services.

- The amount of time spent using welfare services.
- The amount of time spent using sports services.
- The amount of time spent using technical and specialized services available in the city.
- The amount of time spent using administrative-economic services.
- The amount of time spent going to the city for recreation and sightseeing.
- The rate of citizens using the village's attractions.

- *Communication Flow Related to Marketing and Sales of Products:*

- Selling crops and garden products to the city.
- Selling handicrafts to the city.
- Selling livestock and livestock products to the city.

- *Investment Flow of Urban Dwellers in Village Economic Activities:*

- Investing in rural land and housing.
- Investing in rural agriculture.
- Investing in rural services.
- Investing in rural and handicraft industries.

- *Exchange Money Flow:*

- The amount of money spent in the city per year.
- The amount of money received from the city per year.

2.2.1 Livability:

- *Economic Viability:*

- The number of sufficient rooms in housing.
- The availability of proper and sanitary bathrooms in housing.
- The availability of proper heating and cooling conditions in housing.
- The accessibility of students to schools in the nearby city.
- The quality of educational equipment.
- The quality of school buildings.
- The availability of a clean way to dispose of wastewater in the home.
- Adequate lighting.
- Decent and suitable dwelling conditions.

- *Social Viability:*

- People's concern for the development of the village.
 - People's communication with the members of the Islamic Council and the village headman.
 - People's self-help during the implementation of construction projects in the village.
 - The presence and common thinking of the village women in village affairs like men.
 - The level of trust villagers have in each other.
 - The spirit of teamwork among the village people.
 - The reliability of the village headman.
 - The willingness of the village headman and the village Islamic council to involve the people.
 - The level of respect the village people have for each other.
 - The reliability of the members of the village Islamic council.
 - Desire to live in the village.
 - The feeling of homesickness when away from the village.
 - Good relationships with relatives and neighbors in the village.
 - Hope for improved living conditions in the village.
 - Desire to work in the village.
 - Desire to invest in the village.
 - Belief in the village as the most suitable place to live in the region.
- *Environmental Viability:*
- The location of the children's playground or the village green space.
 - The size of the children's play space or the village green space.
 - The quality of the children's play space in terms of safety and cleanliness.
 - The impact of pollution due to proximity to the construction waste disposal site.
 - The quality of garbage collection from the village.
 - The quality of surface water collection.
 - The quality of sewage collection.
 - Peace and lack of noise pollution.
 - Pollution due to vehicle traffic.
 - Pollution due to industrial workshops.
 - The amount of land use change in the village.
 - The success rate of land use change.
 - The degree of suitability of land use change with village activities.
 - The growth rate of economic activities in the village due to land use change.
 - The tendency of villagers to change land use.
 - The effect of land use change on migration from the village to the city.

- The effect of land use change on migration from the city to the village.
- The effect of land use change on increased investment by urban capitalists in the village.
- The effect of land use change on reducing the cost of activities and work in the village.
- The effect of land use change on the marketing and sale of products.
- The effect of land use change on strengthening the link with the city.

The independent variable in this research is economic drivers, while the dependent variable is livability. The research aims to understand the relationships and dynamics between these variables within the studied area.

2.3 Study area

The scope of this study is the city of Zanjan and its surrounding villages. The geographical location of this area is between 48 degrees 22 minutes to 48 degrees 36 minutes east longitude and 36 degrees 38 minutes to 36 degrees 43 minutes north latitude. The geographic location of the sample villages is in the Benab villages (the villages of Do Asb and the lands below the mountain) located in the central part of Zanjan city). One of the villages around the city of Zanjan is the village of Baman Kouh, which has a population of 1466 people, which is about 7 kilometers away from the city, and the village of Do Asb D is a village 4 kilometers north of the city of Zanjan. Therefore, according to the report of Iran Statistics Center, according to the 2015 census, there are 2726 people (Fig. 3).

3 Data analysis

Evaluating the statistical population based on its demographic characteristics and examining the diverse viewpoints within different groups is an essential approach for interpreting test results and making comparisons. This multifaceted perspective enhances the examination and assessment of the research subject across various dimensions. The inclusion of various demographic groups in the distribution of questionnaires and interviews leads to a wide spectrum of opinions on the research topic, providing diverse insights. It's important to note that these differences among demographic groups may result in non-uniform analysis outcomes, as the perspectives of individuals, such as men and women, or married and unmarried participants, can significantly vary on different aspects of the research. Consequently, this section investigates a range of demographic characteristics, including gender, age, length of residence, family

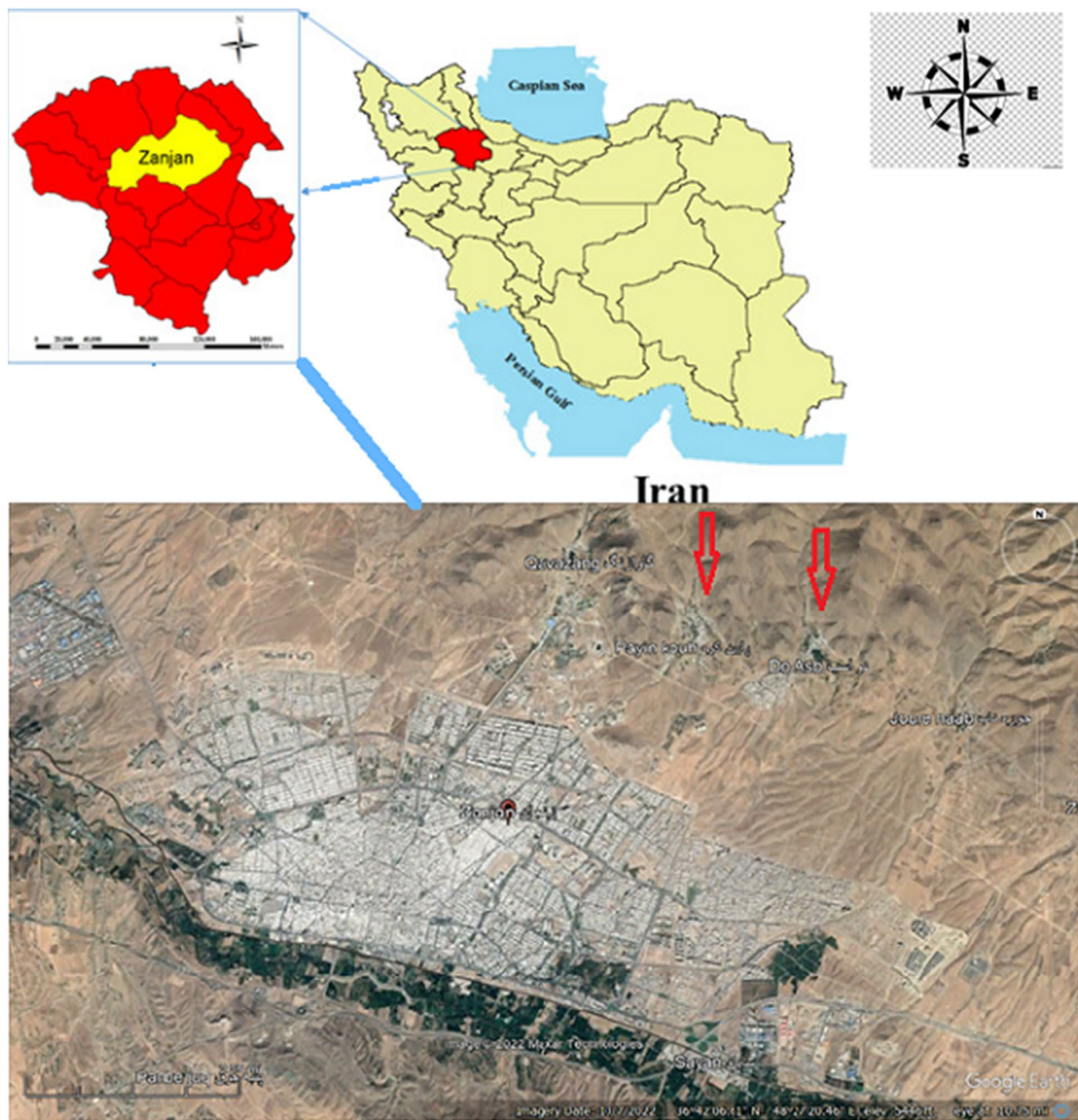


Fig. 3 Study area

size, marital status, educational attainment, and home ownership.

The analysis of questionnaire responses revealed that 90.3% of the respondents were male, while 9.7% were female, indicating a significant male majority among the participants in this study. Regarding age distribution, 7.5% of the respondents were in the 21-30 age group, 35.8% in the 31-40 age group, 32.3% in the 41-50 age group, 15.4% in the 51-60 age group, and 19% were 61

years and older. Notably, the age group of 31-40 years had the highest participation rate. Furthermore, the length of residence varied among the respondents, with 11 participants residing for less than a year, 62 for one to five years, 44 for five to ten years, and 162 for more than ten years. The majority of respondents had families with between 3 and 4 children. In terms of educational background, the analysis revealed that 51 respondents were illiterate, 97 had only completed elementary school, 58 had finished

middle school, 49 had graduated from high school, and 24 held a university degree. An examination of marital status showed that 16 respondents were single, while 263 were married. Lastly, the analysis of home ownership demonstrated that the vast majority of respondents lived in homes they owned, with only a few residing in mortgaged, rented, or other types of housing units. For a detailed breakdown of these demographics, please refer to Table 2.

To address the first research question, a multivariate regression analysis was conducted. The research

findings from the multivariate regression model, utilizing the Enter method, reveal a robust correlation of 0.874 between the quality of life in peri-urban villages and the economic drivers of Zanjan city. This correlation coefficient indicates a strong and positive relationship between the economic drivers of Zanjan city, serving as the independent variable, and the quality of life in peri-urban villages, which is the dependent variable. To assess the independence of the residuals, the Durbin-Watson statistic was employed, yielding a value of 2.082. In the context of the desired hypothesis, this statistic confirms

Table 2 Gender distribution of respondents

Percentage	Variable		Percentage	Variable	
7.5	Between 21-30	Age	9/7	Female	sex
35.8	31-40		90/3	Man	
32.3	41-50		100	Total	
15.4	51-60	education	3/9	Less than a year	residence
19.0	61 And higher		22/2	years 1-5	
100	Total		15/8	years 5-10	
18/3	illiterate	ownership	58/1	More than 10 years	Number of family members
34/8	elementary		100	Total	
20/8	guidance		13/6	2-1	
17/6	High school	Marital status	59/6	4-3	Marital status
8/6	university		25/6	and more 5	
100	Total		100	Total	
79/6	property	ownership	5/7	Single	Marital status
17/6	rental		94/3	married	
8/2	a mortgage		100	Total	
100	Total				

Table 3 . the quality of life of suburban villages through the economic drivers (regression fitting model)

Result	Durbin-Watson	Change Statistics			Std. Error of the estimate	Adjusted R Square	R Square	R
		Sig. F Change	F Change	R Square Change				
Strong correlation	2.082	0.000	146.579	0.764	0.29720	0.759	0.764	0.874

Table 4 The effect of economic drivers of Zanjan city on the quality of life in peri-urban villages

Independent variables	Variable coefficient	standardized coefficient (beta)	T statistic	Significance level	Result
Constant value ^a	0.284	-	0.284	-	2.113
Labor flow	0.176	0.242	0.176	0.242	6.770
Communication flow for purchasing and providing necessities	0.234	0.282	0.234	0.282	6.167
Service flow	0.185	0.223	0.185	0.223	5.063
Communication flow related to marketing and sales of products	0.133	0.160	0.133	0.160	4.446
The investment flow of urban dwellers in rural economic activities	0.126	0.137	0.126	0.137	3.804
Money exchange flow	0.124	0.144	0.124	0.144	4.084

^a Dependent variable

the independence of the residuals from each other (see Table 4). Furthermore, the F-statistic test demonstrated a significance level of 0.000, indicating that the multivariate regression model, featuring six independent variables and one dependent variable, is highly suitable and effective in explaining how this set of independent variables influences the dependent variable, as depicted in Table 3.

Table 4 highlights the varying correlation coefficients based on the standardized coefficients (Beta). Notably, the variables of communication flow for purchasing and providing necessities, labor flow, and service flow have the most substantial contributions to the variance analysis of the dependent variable, which is the quality of life in peri-urban villages. These variables exhibit significant effects at a significance level of 0.01, with standardized coefficients (Beta) of 0.282, 0.242, and 0.223, respectively. This illustrates the high degree of reliance of villagers on urban areas for essential services, underlining the pivotal role of cities in disseminating information to the surrounding regions. Conversely, the investment flow of urban dwellers in village economic activities and the flow of money exchange have relatively lower standardized coefficients (Beta) of 0.137 and 0.144, indicating a comparatively smaller influence. Importantly, all independent variables in the study exert a significant effect on the dependent variable. Consequently, the results underscore the substantial impact of Zanjan's economic drivers on the quality of life in peri-urban villages.

Pearson's correlation coefficient was employed to assess the relationship between Zanjan's economic drivers and the quality of life in peri-urban villages. The results reveal a positive correlation of 0.358, which is statistically significant ($p = 0.000$). This indicates that as the economic drivers of Zanjan city increase, the quality of life in peri-urban villages also tends to increase. It's important to note that the coefficient signifies a weak correlation between these two variables. Therefore, while there is a positive and significant relationship between economic drivers and the quality of life in peri-urban villages, the strength of this relationship is relatively low (See Table 5).

The issue of land use change, particularly in peri-urban areas, is a significant challenge that affects various aspects of the village environment, economy, and culture. It is particularly prevalent in villages near cities and those with favorable climates, often driven by urban capitalists and speculators seeking to convert agricultural land into residential, recreational, and commercial use. The phenomenon of land use change is multifaceted, impacting not only the legal and ownership aspects but also the national economy. The conversion of agricultural land has led to a range of consequences, both positive and negative, in the studied villages. One of the most notable findings is that the index measuring the impact of

Table 5 The relationship between the economic drivers of Zanjan city and the quality of life of peri-urban villages

		Economic drivers	Quality of life in peri-urban villages
Economic drivers of Zanjan city	Pearson	Zanjan city	^a 0.358
	Meaningful	1	0.000
	Number		279
Quality of life in peri-urban villages	Pearson	279	1
	Meaningful	^a 0.358	
	Number	0.000	279

^a It is significant at 99%

land use change on migration from the city to the village received the highest score, with an average of 3.52. This suggests that the transformation of agricultural land into various other uses has led to an influx of urban capitalists and immigrants to the villages on the outskirts of the city, resulting in increased migration. While this phenomenon has negative implications, it has also brought significant changes to the village's economic, social, and cultural fabric.

The index measuring the villagers' propensity to change land use ranks second with an average of 3.26. This shift in behavior is influenced by the demand from urban immigrants and capitalists who are eager to invest in the village. Many farmers have been enticed to convert agricultural land into gardens, which has spurred significant progress in this area. Additionally, the index for the effect of land use change on migration from the village to the city has an average of 3.24. Due to changes in land use, some village residents have chosen to sell their land to urban migrants, and this has contributed to migration from the village as land values rise. The loss of agricultural land has also affected the village's workforce and played a role in rural-urban migration in the studied area. The index measuring the impact of land use change on the increase of urban capitalists' investment in the village has an average of 3.16. Converting agricultural lands into gardens and residential areas has fueled the demand for urban capitalists to invest in and purchase properties in the village. Moreover, the index indicating the effect of land use change on strengthening the link with Zanjan city has an average of 3.02. The arrival of urban capitalists in the village has transformed and strengthened economic ties between the city and the village.

However, it's important to note that not all aspects of land use change are viewed positively. The index measuring the effect of land use change on product marketing and sales ranks second with an average of 2.99. While this index is close to average, the statistical community

believes that land use change has facilitated the development of product marketing and sales. Other metrics related to land use change show scores below the average. For instance, the index for the success rate of land use change has an average score of 2.32. The index of the growth rate of the village's economic activities with land change follows. The rate of change of agricultural land use in the village is ranked second, followed by the rate of change of economic activities in the village, with an average score of 2.18. Finally, the index measuring the suitability of land use change with village activities ranks last with an average of 1.02. This indicates that, from the statistical community's perspective, there is little correlation between land use change and village economic activities.

In addition to these quantitative findings, qualitative responses in the questionnaire revealed that the majority of the statistical community attributes the change in land use to economic inefficiency and low agricultural income. Additionally, enticing offers from urban brokers and the lack of job security were cited as key factors driving land use change in the villages (as shown in Table 6 and Fig. 4).

4 Conclusion

This research highlights the critical importance of rural-urban connections in fostering rural development, particularly in the economic dimension. The interaction between urban and rural areas, including the exchange of

Table 6 People willingness to change land use due to the exchange of information with the city in the studied villages

No.	Indicators	Variance	Average	Total
1	The amount of agricultural land use change in the village	0/25	1/43	510
2	The success rate of land use change	1/72	2/32	1122
3	The appropriateness of the change of use with the activities of the village	1/64	1/02	862
4	The rate of growth of village economic activities with land use change	1/72	2/18	1071
5	Tendency of villagers to change land use	0/2	3/26	969
6	The effect of land use change on migration from the village to the city	1/72	3/24	714
7	The effect of land use change on migration from city to village	3/11	3/52	612
8	The effect of land use change on increasing the investment of urban capitalists in the village	1/72	3/16	459
9	The effect of land use change on reducing the cost of activities and work in the village	0	1/2	714
10	The effect of land use change on product marketing and sales	0/49	2/99	1275
11	The effect of land use change on strengthening the link with the city of Zanjan	0/12	3/02	1023

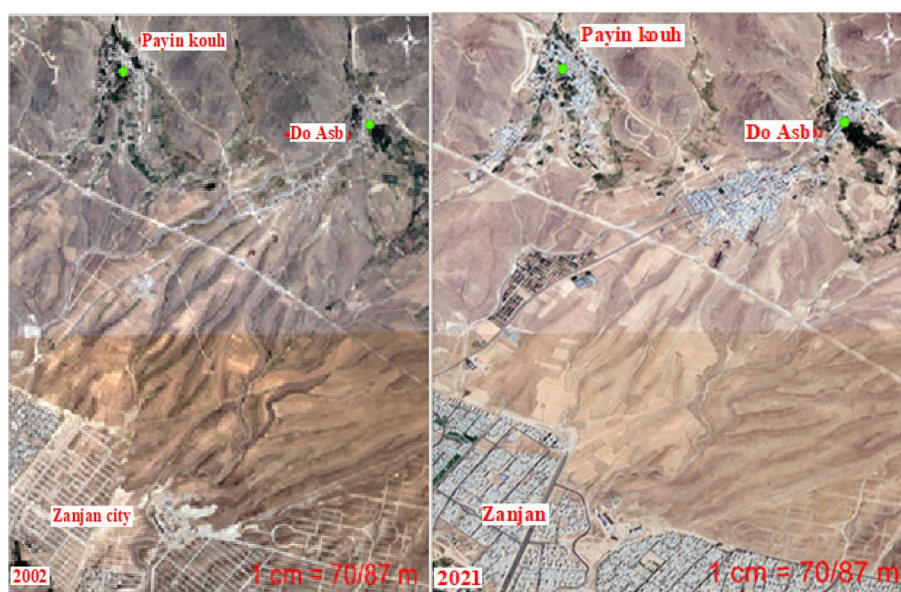


Fig. 4 Pre-urban rural development changes between 2000 and 2021

agricultural products and industrial goods, plays a pivotal role in shaping the economic landscape of regions like Zanjan. Moreover, Zanjan, as a prominent center of capital, industries, services, and facilities, has experienced rapid growth, leading to significant transformations in the nearby villages. Two villages, Do Asb and Payin Kouh, located in close proximity to Zanjan, have witnessed substantial changes in their housing patterns, land use, population characteristics, and economic activities, primarily driven by their proximity to the city.

The relationships and connections between the city and these villages have been instrumental in shaping these changes. However, this has also led to challenges, including population growth, a lack of service infrastructure, and land use changes. This study aimed to investigate the current urban-rural connections and efforts to mitigate disparities and problems resulting from these dynamics. The findings revealed that communication flow for purchasing and providing necessities, labor flow, and service flow were the primary contributors to variations in the quality of life in peri-urban villages. This underscores the heavy dependence of villagers on the city, particularly for essential services and information dissemination. Notably, the use of banking services in Zanjan city received the highest score among the indicators of communication flow, signifying the reliance of villages on the city for banking services.

Furthermore, the study highlighted the significance of urban investment in village economic activities and the flow of money exchange, although these factors contributed less to the quality of life in peri-urban villages. Nevertheless, all the independent variables examined in the study had a significant impact on the dependent variable, indicating the substantial influence of Zanjan's economic drivers on the quality of life in these villages.

Based on the research findings, recommendations have been formulated to enhance the urban-rural relations and strengthen the economic ties between Zanjan city and its surrounding villages. These include establishing urban services in rural areas, creating marketing channels for agricultural products with guaranteed purchases, preventing the conversion of agricultural land for non-agricultural uses, encouraging villagers to invest in various sectors within the city, and promoting private sector investment in the agricultural development of the villages around Zanjan city. Therefore, this research underscores the intricate dynamics between urban and rural areas and emphasizes the need for well-planned strategies to ensure the balanced development of peri-urban villages while harnessing the potential for sustainable growth and improvement in the quality of life in these areas.

Acknowledgements

The authors would like to acknowledge the University Kahrazmi providing facilities for this study.

Authors' contributions

Shamaie A. collected data, supervised, prepared maps, and wrote part of the manuscript, the framework of the study wrote part and finalized the manuscript; Jafarpour K. visualized the work and finalized the work, correction, editing, and the manuscript.

Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Availability of data and materials

All the data and materials related to the manuscript are published with the paper, and available from the corresponding author upon request.

Declarations

Ethics approval and consent to participate

Not applicable.

Competing interests

The authors declare that they have no conflict of interest.

Author details

¹Department of Geographical Sciences, Faculty of Geography and Urban planning, Kharazmi University, Human Sciences building 4th floor, Tehran 14911 – 15719, Iran. ²Environmental Resilience and Sustainability, Malaysia-Japan International of Technology, Universiti Teknologi Malaysia Kuala Lumpur, Jalan Sultan Yahya Petra, Kuala Lumpur, Malaysia. ³Disaster Preparedness & Prevention Centre, Malaysia-Japan International of Technology, Universiti Teknologi Malaysia Kuala Lumpur, Jalan Sultan Yahya Petra, Kuala Lumpur, Malaysia.

Received: 20 October 2023 Revised: 18 April 2024 Accepted: 23 April 2024

Published online: 10 May 2024

References

- Adugna, A., & Hailemariam, A. (2011). Rural-urban linkages in Ethiopia: insuring rural livelihoods and development of urban centers. In *The Demographic Transition and Development in Africa* (pp. 167-186). Springer, Dordrecht.
- Al, S., Shan, P. C. H., Juhre, C., Valin, I., & Wang, C. (Eds.). (2014). *Villages in the City: A Guide to South China's Informal Settlements (Vol. 1)*. Hong Kong University Press.
- Amini, A., Jafarinaia, G., Gorgin, B., & Jafarpour Ghalehtemouri, K. (2022). Evaluating social sustainability through social and cultural barriers. *Theoretical and Empirical Researches in Urban Management*, 17(1), 62–78.
- Azizi, M. M., Zebardast, E., & Akbari, R. (2020). *Explaining the process of merging villages to cities in warm and dry climate of Iran*. Hoviatshahr. <https://doi.org/10.30495/hoviatshahr.2020.15715>
- Baker, J. and Claeson, C-F. (1990) "Introduction", in Baker, J. (Ed.), *Small Town Africa: Studies in Rural-Urban Interaction*, The Scandinavian Institute of African Studies, Uppsala, pp. 7-34.
- Bertino, G., Fischer, T., Pühr, G., Langergraber, G., & Österreicher, D. (2019). Framework conditions and strategies for pop-up environments in urban planning. *Sustainability*, 11(24), 7204. <https://doi.org/10.3390/su11247204>
- Chen, T. L., Kim, H., Pan, S. Y., Tseng, P. C., Lin, Y. P., & Chiang, P. C. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. *Science of the Total Environment*, 716, 136998.
- Davoudi, S., (2002), ESPRID. Short summary, Key Phrase: rural-urban Relationship, University of Newcastle upon type.pp.269-277.
- Delgado-Viñas, C., & Gómez-Moreno, M. L. (2022). The interaction between urban and rural areas: an updated paradigmatic methodological and

- bibliographic review. *Land*, 11(8), 1298. <https://doi.org/10.3390/land11081298>
- Ewing, R., Pendall, R., & Chen, D.D.T. (2002). *Measuring Sprawl and Impact*. Washington D.C. Smart Growth America.
- Firozjaei, M. K., Weng, Q., Zhao, C., Kiavarz, M., Lu, L., & Alavipanah, S. K. (2020). Surface anthropogenic heat islands in six megacities: an assessment based on a triple-source surface energy balance model. *Remote Sensing of Environment*, 242, 111751. <https://doi.org/10.1016/j.rse.2020.111751>
- Foran, M. (2009). *Expansive Discourses: Urban Sprawl in Calgary, 1945-1978*. Athabasca University Press.
- Frankenberg, E., & Siegel-Hawley, G. (2024). *Understanding Suburban School Segregation: Toward a Renewed Civil Rights Agenda*. Los Angeles: The Civil Rights Project/Proyecto Derechos Civiles, UCLA.
- Friedmann, J. (1966). *Regional development policy: a case study of Venezuela (No. HT395. V4 F7)*.
- Fujita, M., Krugman, P., & Venables, A. (1999). *the Spatial Economy: Cities, Regions, and International Trade* (pp. 20–31). MIT Press.
- Ghalehtemouri, K. J., & Khaliji, M. A. (2023). *A multi-criteria decision-making is the ANP network analysis process for identification relief centers in urban areas: A case of study Tabriz city*.
- Ghalehtemouri, K. J., & Ros, F. B. C. (2020). The spatial turn in the National Physical Plan (NPP) Malaysia in compare to Germany for better criteria identification on climate change and environmental hazards issues. *Climate Change*, 6(21), 141–155.
- Ghalehtemouri, K. J., Shamaei, A., & Ros, F. B. C. (2021). Effectiveness of spatial justice in sustainable development and classification of sustainability in Tehran province. *Regional Statistics*, 11(2), 52–80.
- Ghalehtemouri, K. J., Ros, F. C., Rambat, S., & Nasr, T. (2024). Spatial and Temporal Water Pattern Change Detection through the Normalized Difference Water Index (NDWI) for Initial Flood Assessment: A Case Study of Kuala Lumpur 1990 and 2021. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, 114(1), 178–187.
- Ghalehtemouri, K. J. (2024). *Evaluate the capacity of Japanese spatial planning system for hazards integration realities and (f) acts: a pre-post the great east Japan Earthquake in Fukushima, 2011*. Safety in Extreme Environments, 1–18.
- Ghazaie, M., & Rafeian, M. (2022). Is affordable housing a pro-poor policy? Evidence from a prominent housing policy in Iran. *Poverty & Public Policy*, 14(4), 381–404. <https://doi.org/10.1002/pop4.355>
- Han, J., Pei, J., & Tong, H. (2022). *Data mining: concepts and techniques*. Morgan kaufmann.
- Headey, D. D., Alderman, H., Hoddinott, J., & Narayanan, S. (2024). The glass of milk half-empty? Dairy development and nutrition in low and middle income countries. *Food Policy*, 122, 102585.
- Hughes, S. (2020). Principles, drivers, and policy tools for just climate change adaptation in legacy cities. *Environmental Science & Policy*, 111, 35–41. <https://doi.org/10.1016/j.envsci.2020.05.007>
- Javdan, M., Ghalehtemouri, K. J., Ghasemi, M., & Riazi, A. (2023). A novel framework for social life cycle assessment to achieve sustainable cultural tourism destinations. *Turyzm/Tourism*, 7–18.
- Johnson, A. A. (2012). The city as promise and ruin: The supernatural and urban change in Chiang Mai. *Cleavage, Connection and Conflict in Rural, Urban and Contemporary Asia* (pp. 223–239). Springer, Netherlands.
- Jones, P. W. (2007). *World Bank financing of education: Lending, learning and development*. Routledge.
- Kamran, J. G., Musa, K. K., & Sadeqh, G. F. (2020). An Investigation Into Urban Development Patterns With Sprawl and Other Corresponding Changes: A Case Study of Babol City. *Journal of Urban Culture Research*, 20, 26–43. <https://doi.org/10.14456/jucr.2020.2>
- Keshavarzi, A. R., Sharifzadeh, M., Haghghi, A. K., Amin, S., Keshtkar, S., & Bamdad, A. (2006). Rural domestic water consumption behavior: a case study in Ramjerd area, Fars province IR Iran. *Water Research*, 40(6), 1173–1178. <https://doi.org/10.1016/j.watres.2006.01.021>
- Krugman, P. (1991). Increasing returns and economic geography. *Journal of Political Economy*, 99(3), 483–499.
- Langgut, D., & Gadot, Y. (2024). *Wildscapes, landscapes, and specialized land management: the impact of the Assyrian rule over land exploitation in the Kingdom of Judah*. Crossing Borders between the Domestic and the Wild: Space, Fauna, and Flora.
- Louw, S. J., & Mondal, P. (2012). Livelihoods and Development: Socioeconomic Exclusion in Mumbai's Hinterland. In *Cleavage, connection and conflict in rural, urban and contemporary Asia* (pp. 47–62). Dordrecht: Springer Netherlands.
- Medeiros de Freitas, D., Soares Lima, C. M., Nawratek, K., & Pataro, B. M. (2024). *Epistemic Ambivalence: Pentecostalism and Candomblé in a Brazilian City*.
- Mihai, F. C., & Iatu, C. (2020). *Sustainable rural development under Agenda 2030. Sustainability Assessment at the 21st century*, 9–18.
- Mihret, T. (2019). *Rural Urban Linkages and Local Economic Development in Ankesha Wereda, Awi Zone, Ethiopia (Doctoral dissertation, Addis Ababa University)*.
- Miller, M. A., & Bunnell, T. (2012). Urban-rural connections: Banda Aceh through conflict, tsunami, and decentralization. In *Cleavage, connection and conflict in rural, urban and contemporary Asia* (pp. 83–98). Dordrecht: Springer Netherlands.
- Noorollahi, E., Fadaei, D., Ghodsipour, S. H., & Shirazi, M. A. (2017). Developing a new optimization framework for power generation expansion planning with the inclusion of renewable energy—a case study of Iran. *Journal of Renewable and Sustainable Energy*, 9(1).
- Noorollahi, Y., Pourarshad, M., & Veisi, A. (2021). The synergy of renewable energies for sustainable energy systems development in oil-rich nations; case of Iran. *Renewable Energy*, 173, 561–568.
- Rigg, J. (1998). Rural-urban interactions, agriculture and wealth: a southeast Asian perspective. *Progress in human geography*, 22(4), 497–522.
- Nüsser, M., Haefner, M., Müller, J., Bhattacharya, S., Bhattacharya, S., Mukherjee, J., & Choudry, A. (2024). *Open access edited by. Solutions to Water Crises (Related to Actual Interventions)*, 95.
- Pike, A., Rodríguez-Pose, A., & Tomaney, J. (2017). Shifting horizons in local and regional development. *Regional studies*, 51(1), 46–57.
- Portnov, B. A., & Pearlmutter, D. (1999). Sustainable urban growth in peripheral areas. *Progress in Planning*, 52(4), 239–308.
- Pucher, J., Peng, Z. R., Mittal, N., Zhu, Y., & Korattyswaroopam, N. (2007). Urban transport trends and policies in China and India: impacts of rapid economic growth. *Transport Reviews*, 27(4), 379–410.
- Rodríguez-Pose, A. (2010). Economic geographers and the limelight: institutions and policy in the World Development Report 2009. *Economic Geography*, 86(4), 361–370.
- Savari, M., & Shokati Amghani, M. (2021). Factors influencing farmers' adaptation strategies in confronting the drought in Iran. *Environment, Development and Sustainability*, 23(4), 4949–4972. <https://doi.org/10.1007/s10668-020-00798-8>
- Sgroi, F. (2022). Evaluating of the sustainability of complex rural ecosystems during the transition from agricultural villages to tourist destinations and modern agri-food systems. *Journal of Agriculture and Food Research*, 9, 100330. <https://doi.org/10.1016/j.jafr.2022.100330>
- Shakeri, M. T., Afshari, R., Aghajani, H., Dinmohamadi, E., & Hadianfar, A. (2016). Study geographical distribution of poisoning cases referred to the emergency department of Imam-Reza Hospital Mashhad: 2013. *Medical Journal of Mashhad University of Medical Sciences*, 59(3), 171–178.
- Sharafi, S., & Ghaleni, M. M. (2021). Evaluation of multivariate linear regression for reference evapotranspiration modeling in different climates of Iran. *Theoretical and Applied Climatology*, 143(3), 1409–1423. <https://doi.org/10.1007/s00704-020-03473-0>
- Sheng, Y. K. (2002). *Poverty alleviation through rural-urban Linkages: policy implications*. Economic and Social Commission for Asia and the Pacific.
- Sievert, T. (2003). *Cities without cities: an interpretation of the Zwischenstadt*. Routledge.
- Širá, E., Kravčáková Vozárová, I., Kotulič, R., & Dubravská, M. (2022). EU27 countries' sustainable agricultural development toward the 2030 agenda: the circular economy and waste management. *Agronomy*, 12(10), 2270.
- Steinberg F. (2014). *Rural-Urban Linkages: an urban perspective. Working Paper Series N° 128. Working Group: Development with Territorial Cohesion*. Territorial Cohesion for Development Program. Rimisp, Santiago, Chile.
- Stivens, M. (2012). Gender and the interplay of rural and urban: a Malaysian case. In *Cleavage, Connection and Conflict in Rural, Urban and Contemporary Asia* (pp. 143–160). Dordrecht: Springer Netherlands.
- Talkhabi, H., Ghalehtemouri, K. J., Mehranjani, M. S., Zanganeh, A., & Karami, T. (2022). Spatial and temporal population change in the Tehran Metropolitan Region and its consequences on urban decline and sprawl. *Ecological Informatics*, 70, 101731.
- Thompson, E. C., Bunnell, T., & Parthasarathy, D. (2013). *Introduction: Place, society and politics across urban and rural Asia*. *Cleavage, connection and conflict in rural, urban and contemporary Asia*, 1–11.

- Tian, Y., & Wang, L. (2019). Mutualism of intra-and inter-prefecture level cities and its effects on regional socio-economic development: a case study of Hubei Province, Central China. *Sustainable Cities and Society*, 44, 16–26.
- Tostensen, A. (2004). *Rural-urban linkages in sub-Saharan Africa: Contemporary debates and implications for Kenyan urban workers in the 21st century*. Chr. Michelsen Institute.
- Tuffour, M., Owusu, G., & Sarpong, D. B. (2024). Urbanization effects on urban vegetable farmers adaptation: Evidence from Ghana. *Urban Agriculture & Regional Food Systems*, 9(1), e20052.
- Veríssimo, C. (2014). *The Significance of Outdoor Domestic Space for an Ecodelopment Model of Medium-Size Cities. A Case Study of Dondo, Mozambique. RCCS Annual Review. A selection from the Portuguese journal Revista Crítica de Ciências Sociais*, (6).
- Wang, Y., Yang, X., & Wang, Z. H. (2024). Causal mediation of urban temperature by geopotential height in US cities. *Sustainable Cities and Society*, 100, 105010.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.