Interdependence of the rural housing stock and the rural population: a scientific perspective

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Abstract. This scientific article addresses the pressing issue of providing decent housing for the rural population of the Kyrgyz Republic, which has arisen due to uneven development of demographic and housing trends in rural areas. The research aims to solve this regional problem by managing interdependent demographic and housing trends. The study employs a general scientific methodology to analyze the relationship between the rural population and the volume of rural housing stock. A methodological approach to solving the regional problem of housing provision is presented, including a statistical analysis of demographic and housing aspects in time and space. The main results of the study include data on the mutual influence of demographic and housing dynamics in rural areas and a comparative forecast of demographic and housing parameters of rural development until 2030. Recommendations are provided within the framework of the Republican housing program "My Home" for 2021-2026. This study is highly significant in terms of its practical applicability and relevance for the development of regional policy.
Key words: rural housing stock, rural population, village, housing supply, relationship, correlation.

1 Introduction

The Kyrgyz Republic is currently experiencing a period of demographic growth, which is expected to last until 2030. The rural population, comprising two-thirds of the total population, is a significant factor in this trend. However, the quality of living conditions for rural citizens is a cause for concern, as housing construction companies tend to focus on building in urban areas where profits are higher due to the greater solvency of urban residents. This leaves the responsibility for providing decent housing for rural citizens on their own shoulders, resulting in a lower quality of buildings and a slower development of the rural housing stock. As the rural population continues to grow, there are questions regarding the adequacy of the existing rural housing stock to meet the needs of the permanent rural population, as well as general issues of housing provision for rural citizens and the interdependence of demographic and housing trends. Therefore, this study aims to address the issue of the relationship between rural housing

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construction and demographic dynamics, in order to identify reasons for the disproportionate development of these processes.

The practical relevance of this study lies in the importance of the rural population to the economy of the Kyrgyz Republic, including the housing industry.

The main objective of the study is to determine whether the current volumes of rural housing construction are sufficient to meet the demands of the growing rural population.

2 Materials and Methods

2.1 Review of foreign and domestic sources.

Issues related to the interdependence of housing and demographic trends have been widely discussed in foreign scientific publications. Works by various authors such as C.H. Mulder [1; 2; 3; 4], G.V. Evans [5], M. Braubach [6] and Yu Zhang et al. [7] present interesting perspectives and solutions regarding the relationship between the housing sector and demographic behavior, including topics such as health care, migration and family household development. In Russia and Kyrgyzstan, scientific opinions indicate that the development of the housing sector is influenced by demographic trends [8; 9; 10; eleven; 12], studies were carried out on the development of housing construction according to demographic indicators [13; 14; 15].

2.2 Research methods.

The methodology used in this scientific article is based on standard scientific research methods, including statistical review, comparative correlation analysis, synthesis of theoretical and practical material. An array of statistical data from 1990 to 2021 on the dynamics of the population and urban housing stock was processed using the Correl program. To forecast indicators up to 2030, a long-term forecasting program “trend and growth” was used. Systematization, classification and grouping of information were also used to analyze the data array. In addition, the study took into account the experience of studying the convergence of disproportionate data [16].

3 Results

3.1 The demographic situation in the countryside.

According to the most recent census conducted in the Kyrgyz Republic in 2022, the total population amounted to 6,936,156 individuals. Within this population, the rural population was found to be 4,527,973 individuals, while the urban population was 2,408,183 individuals. It is noteworthy that the population increased by 29.3% compared to the 2009 census, resulting in an incremental numerical growth of 1573.4 thousand people. However, a more nuanced analysis indicates that the growth rate of the rural population decelerates in comparison to the growth rate of the urban population. In particular, the urban population demonstrated a growth rate of 31.8% relative to the 2009 census, whereas the rural population displayed a growth rate of 28.1%, as highlighted in Table 1.

Table 1. Dynamics of population growth rates by territory

	1979 in % to 1970	**1989 in % to 1979**	**1999 in % to 1989**	**2009 in % to 1999**	**2020 in % to 2009**
Kyrgyz Republic	120,1	120,9	113,3	111,2	129,3
urban population	123,1	120,4	103,3	108,8	131,8
rural population	118,2	121,1	119,4	112,4	128,1

Source: the table was built by the author according to the NSC KR data [17]

The rate of urbanization is consistent with the global signs of demographic transition outlined by Frank W. Notestein, which will undoubtedly have implications for the dynamics of demographic development and housing construction. However, the rural population is twice as large as the urban population, which may lead to the "Malthus trap" in the absence of adequate conditions. As a result, the growth of the rural population and insufficient housing supply could result in rural-urban migration and birth control in rural areas.

Internal migration plays a significant role in the growth of urbanization by providing cities with the necessary labor resources. However, excessive and uncontrolled migration flows can pose a serious challenge to the engineering and social infrastructure of cities. This hypothesis is supported by numerous studies conducted by experts in the field [18; 19; 20; 21; 22; 23]. It is essential to ensure that internal migration is managed properly and balanced with the capacity of urban areas to absorb and provide necessary services and infrastructure to migrants. Failure to do so can result in social and economic issues, such as overcrowding, inadequate housing, and increased pressure on healthcare and educational systems, among others. Therefore, a comprehensive and sustainable approach to internal migration management is crucial for promoting balanced urbanization and achieving inclusive and equitable development.

3.2 Statistical analysis of the relationship between the volume of rural housing stock and the rural population of the republic.

This study aims to establish the degree of relationship between the growth trends of the rural housing stock and the dynamics of the rural population. To achieve this objective, graphical functions were constructed to display the trends in the increase of rural housing stock and the growth in the number of the rural population from 1990 to 2021, using data obtained from the National Statistical Committee of the Kyrgyz Republic (Figure 1).

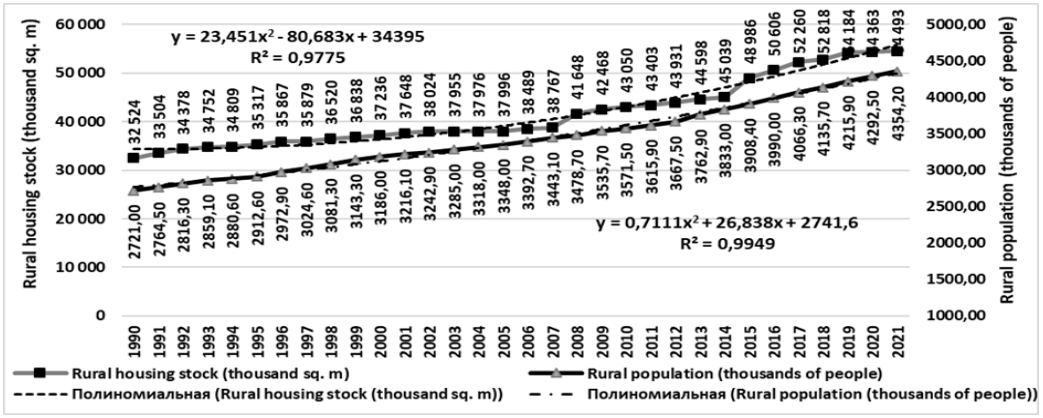

Figure 1. Dynamics of rural housing stock (thousand sq.m.) and rural population (thousand people) for the period from 1990 to 2021 with polynomial functions of rural housing stock and rural population
Полиномиальная – Polynomial
Source: the diagram was built by the author based on the NSC KR data for the period from 1990–2021 [17].

The graphical representations of the rural housing stock and the number of rural populations for the analyzed period indicate a steady upward trend. While a linear function can be used to describe the resulting plots, a quadratic function provides a more reliable approximation. The graph of the dynamics of the rural population displays a stable growth trend. Specifically, the trend line of the rural population is described by the function $y = 0.7111x^2 + 26.838x + 2741.6$, with a high level of reliability coefficient $R^2 = 0.9949$, indicating an accuracy of more than 99%. However, the dynamic picture of the development of the rural housing stock has the form of a more spasmodic development with a period of recession and growth. Therefore, the coefficient of reliability of the trend line of the rural housing stock is slightly lower than that of

the graph of the rural population and is equal to $R^2 = 0.9775$, which is 4% lower than the level of the coefficient of approximation of the dynamics of the rural population. At the same time, the trend line is described by the following quadratic function $y = 23.451x^2 - 80.683x + 34395$.

A comprehensive examination of the graphs in Figure 1 reveals a high positive relationship between the volume of rural housing stock and the number of rural populations. To prove the existence of a connection between them for the analyzed period, statistical data on these indicators from 1990 to 2021 were compiled in Table 2.

Table 2. Statistics of rural housing stock and rural population from 1990 to 2021

years	Rural housing stock (thousand sq. m)	Rural population (thousands of people)	Annual increase in rural housing stock (thousand sq. m)	Annual growth of the rural population (thousands of people)	Total living area per person in the village sq.m.
1990	32 524	2721,00			11,9
1991	33 504	2764,50	980	43,50	12,0
1992	34 378	2816,30	874	51,80	12,1
1993	34 752	2859,10	374	42,80	12,1
1994	34 809	2880,60	57	21,50	12,0
1995	35 317	2912,60	508	32,00	11,9
1996	35 867	2972,90	550	60,30	11,9
1997	35 879	3024,60	12	51,70	11,6
1998	36 520	3081,30	641	56,70	11,7
1999	36 838	3143,30	318	62,00	11,6
2000	37 236	3186,00	398	42,70	11,6
2001	37 648	3216,10	412	30,10	11,7
2002	38 024	3242,90	376	26,80	11,7
2003	37 955	3285,00	-69	42,10	11,6
2004	37 976	3318,00	21	33,00	11,5
2005	37 996	3348,00	20	30,00	11,4
2006	38 489	3392,70	493	44,70	11,4
2007	38 767	3443,10	278	50,40	11,4
2008	41 648	3478,70	2 881	35,60	12,1
2009	42 468	3535,70	820	57,00	11,9
2010	43 050	3571,50	582	35,80	11,9
2011	43 403	3615,90	353	44,40	11,8
2012	43 931	3667,50	528	51,60	11,7
2013	44 598	3762,90	667	95,40	11,6
2014	45 039	3833,00	441	70,10	11,5
2015	48 986	3908,40	3 946	75,40	12,3

2016	50 606	3990,00	1 621	81,60	12,4
2017	52 260	4066,30	1 653	76,30	12,6
2018	52 818	4135,70	558	69,40	12,5
2019	54 184	4215,90	1 366	80,20	12,6
2020	54 363	4292,50	179	76,60	12,4
2021	54 493	4354,20	130	61,70	12,5

Source: prepared by the author according to the NSC KR data [17]

Drawing from the data presented in the table, it is discernible that the rural housing stock and rural population figures were at their lowest in 1990. The rural housing stock was recorded at 32,524 thousand square meters, while the rural population was 2721.0 thousand people. In contrast, the highest levels of rural housing stock and rural population were observed in 2021, with the registered volume of housing stock amounting to 54,493 thousand square meters and 4,354.20 thousand people of the rural population. It is noteworthy, however, that the dynamics of annual rural housing stock increase is marked by unevenness, characterized by periods of active growth and sharp decline. For instance, in 2003, relative to 2002, the increase was negative, amounting to -69 thousand square meters, while in 2015, the increase already amounted to +3,946 thousand square meters.

*The result of the correlation analysis for the studied factors of the relationship***.**

We conducted a thorough analysis of the correlation between the increase in rural housing stock and the rural population in the Kyrgyz Republic using the Pearson formula in the Correl program. The resulting correlation coefficient of 0.980033477 indicates a strong positive correlation between the two variables. However, the dependence on increments is less indicative, with a correlation coefficient of 0.34, indicating a small dependence.

In practice, the causality method found a strong positive relationship between the growth of the rural housing stock and population, suggesting a close relationship between these two factors. This is in line with the idea that adequate and decent housing in rural areas can significantly contribute to the development of the rural population, which contrasts with the dynamics of the urban population and housing stock.

Therefore, we conclude that the favorable dynamics of the rural housing stock will have a significant impact on the demographic potential of the country in the future. Thus, priority should be given to the development of the rural housing sector to ensure a positive impact on the country's demographic growth. This study provides valuable insights for policymakers and researchers interested in the development of rural areas and the impact of housing on demographic growth.

3.3 Dynamics of provision of rural citizens with housing space and services

The growth trends of the rural housing stock in the Kyrgyz Republic from 1990 to 2021 were analyzed, revealing an increase of almost 22 million sq.m. in housing stock. Despite this growth, the provision of housing per rural citizen increased only by one square meter, from 12 sq.m. in 1990 to 13 sq.m. in 2021. Notably, both rural and urban housing stocks are increasing, but the growth rate of the rural housing stock is twice that of the urban housing stock. This contrasts with other Eurasian Economic Union (EAEU) countries, where the urban housing stock and urban population are actively increasing [14]. However, the growth rate of the rural population in Kyrgyzstan is slower than that of the urban population, even with a high birth rate, due to the significant migration of rural citizens to cities such as Chui and Bishkek.

During the period of independence, the provision of housing and communal services to the rural housing stock consistently lagged behind that of the urban housing stock. As of 2021, the coverage of water supply and sanitation services in rural areas was only one-fifth of that in urban areas, as shown in Figure 2.

These findings suggest that there is a need for greater emphasis on the development of the rural housing sector in order to ensure adequate and decent housing for rural citizens, particularly in terms of water supply and sanitation services. Such efforts would contribute to the growth of the rural population and the overall demographic potential of the country.

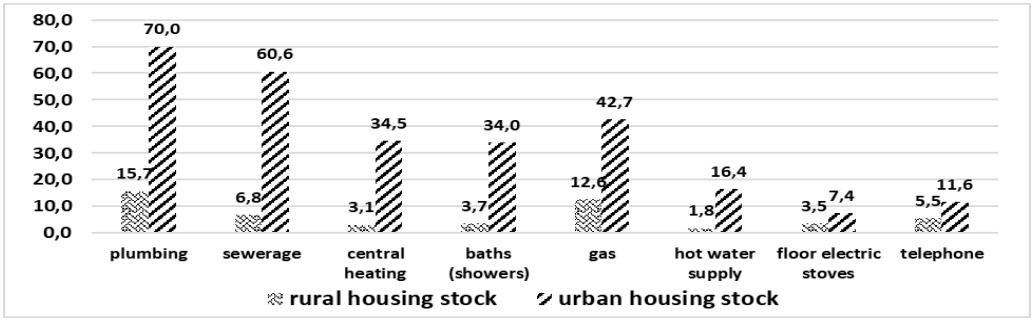

Figure 2. Equipment of the housing stock in the context of village / city in % for 2021
Source: prepared by the author according to the NSC KR data [17]

A thorough analysis of the distribution of total living space per inhabitant in the country from 1990 to 2021 has been conducted. The statistical data presented in Figure 3 have been analyzed to examine the trend in the level of housing per capita in the republic. It has been observed that there has been a noticeable upward trend in this indicator from 2007 onwards, peaking at 15.7 sq. km. in 2010. The dynamics of this trend during this period was mainly due to a significant increase in the total living space per person in the cities of the country. In contrast, this figure remained almost at the same level of 11.9 - 12.6 sq.m. per person in the countryside for 29 years (Figure 3). These findings suggest that the increase in total living space per person in the cities of the country has been the primary driver of the upward trend in the level of housing per capita observed in recent years.

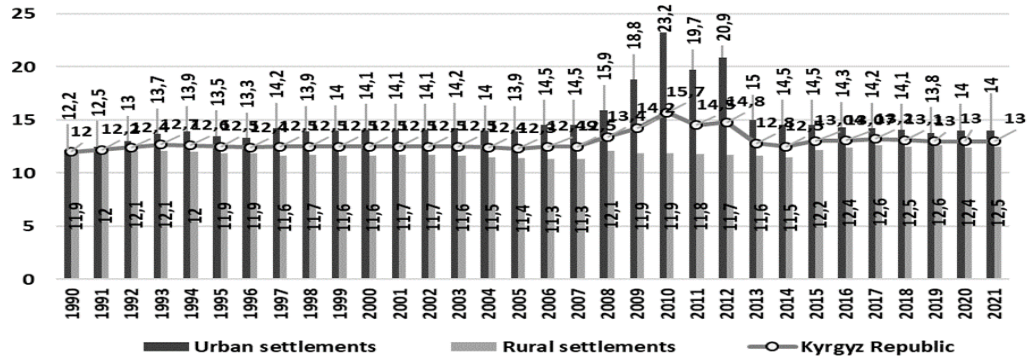

Figure 3. Total living area per person in the whole country and in urban and rural areas from 1990 to 2021 (sq.m.)
Source: prepared by the author according to the NSC KR data [17]

The provision of adequate housing is a fundamental human right that is crucial to the well-being and prosperity of individuals and communities. In accordance with this principle, the Government of the Republic has set a target of increasing the level of housing provision to 18 square meters per person, which will effectively eliminate the current housing shortage in the country. However, despite the efforts made to improve housing construction, the latest trends suggest that achieving this goal will require more than two decades.

Indeed, the annual commissioning of one to one and a half million square meters of living space falls short of the target required to keep up with the positive population growth rate of 1.1. To provide a minimum of one square meter of housing per citizen in the country, at least six

million square meters of new housing must be built each year. While the provision of housing cannot be assessed solely based on this metric, it remains an essential factor in ensuring adequate living conditions for all citizens.

However, the provision of new housing is only part of the picture. The dynamics of the entire housing stock, including the demolition of obsolete and dilapidated housing and the conversion of residential premises into non-residential spaces, also plays a significant role. This situation applies to the rural housing stock and population as well.

Based on our analysis, it will take until 2050 for a villager to reach the target of 18 square meters per person, provided that the rural population remains stable and the rural housing stock continues to grow at the current pace. This projection highlights the need for concerted efforts to improve the quality and quantity of rural housing, in addition to urban areas, to achieve the overall goal of adequate housing provision.

In conclusion, while progress has been made in the construction of new housing, more action is needed to address the dynamics of the entire housing stock and meet the target of providing 18 square meters per person. Concerted efforts by government, industry, and civil society are necessary to ensure that everyone has access to decent and affordable housing, regardless of their socio-economic status or geographic location.

4 Discussion

The significance of the research results can be demonstrated by the ability to predict long-term levels of housing provision for the entire population of the republic, including those residing in rural areas. Our study's findings on the interdependent dynamics of the housing stock and population enable us to make accurate predictions through the "trend and growth" program from 2020 to 2030 (Table 3). These projections are crucial in informing policymakers and stakeholders of the estimated future housing needs of the population, and aid in the development of long-term housing strategies that ensure sufficient provision for all citizens. Such insights into housing stock and population dynamics can be leveraged for effective planning and implementation of housing development programs to support the country's economic and social growth. The findings from our research underscore the importance of long-term planning and policy-making in the housing sector and provide valuable information for future research in this field.

Table 3 Dynamics of population (million people), housing stock of the republic (million sq.m.) and living space per 1 person (sq.m.) for the forecast period from 2020 to 2030.

	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Population (million people).	6.24	6.32	6.40	6.48	6.56	6.64	6.73	6.81	6.90	6.99	7.08
Housing stock, million sq.m.	86.579	88.022	89.489	90.981	92.498	94.040	95.608	97.201	98.822	100.469	102.144
Living area per person (sq.m.)	13,86	13,92	13,98	14,03	14,09	14,15	14,20	14,26	14,32	14,38	14,44

The results of the conducted forecast provide important insights into the future levels of housing provision for the population of the Kyrgyz Republic. The findings indicate a certain growth trend in both the population and housing stock of the republic over the forecast period. However, the rate of increase in the housing stock is insufficient to meet the real needs of the

population. The growth in living space per person is predicted to be only 4% from 2020 to 2030, rising from 13.86 sq.m. to 14.44 sq.m., respectively.

The current housing program of the Kyrgyz Republic, "My House" for 2021-2026, sets the ambitious goal of achieving a level of housing provision of 18 sq. m per person [24]. However, based on the achieved growth rates of housing commissioning and the volume of its disposal for various reasons, it will be impossible to achieve this goal even by 2030. To meet this target, the commissioning of housing needs to be increased to the level of 127,365.7 thousand square meters per year. This necessitates significant investments and the implementation of drastic measures at the financial-republican and construction-industry levels.

The housing commissioning schedule should be more ascending to combine the productivity of housing commissioning and the formation of the housing stock with the rate of population growth. The measures taken should contribute to the achievement of international standards for housing, which require 30 sq.m. per person. The success of the My Home housing program and its future extensions will depend on the implementation of effective policies and strategies that support the construction of new and the preservation of existing housing stock. The attainment of these goals will undoubtedly have a positive impact on the living conditions and well-being of the citizens of the Kyrgyz Republic.

In accordance with the scientific study, a forecast has been conducted to predict the dynamics of the rural population and the volume of rural housing stock for the period 2020-2030. The relevance of this forecast is confirmed by the interdependent dynamics of the entire population and housing stock of the country, which indicates the need to consider the specific conditions of rural areas. The obtained forecast dynamics of rural parameters corroborated the findings of the development pattern observed in the country as a whole. However, the rate of growth of the housing stock for the growing rural population is inadequate according to the criteria of the Republic's housing program. Specifically, the provision of residents in rural areas is 14.01 sq.m. against the target of 18.0 sq.m. per person. These findings reveal that it is necessary to implement a more aggressive policy approach to meet the growing housing needs of the rural population, which can be achieved through the implementation of the "My House" housing program and its subsequent extensions. The implementation of such measures will contribute to meeting international housing standards and ensuring the provision of adequate housing to all citizens, regardless of their location.

Table 4 Forecast of the dynamics of the rural housing stock (l / f) (million sq.m.), the number of rural population and living space per 1 person (sq.m.) from 2020 to 2030

	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Rural housing stock, million sq.m	55.17	56.62	58.1	59.63	61.19	62.80	64.44	66.14	67.87	69.66	71.48
Rural population million people	4.30	4.37	4.45	4.53	4.60	4.68	4.76	4.85	4.93	5.02	5.1
Living area per person in the village (sq.m.)	12,84	12,95	13,06	13,18	13,29	13,41	13,53	13,65	13,77	13,89	14,01

The proposed methodology for conducting regular forecasts of housing and demographic trends can serve as a valuable tool for monitoring the implementation of housing and demographic policies at various levels, including regional and rural settlements, as well as

within industries and enterprises. By regularly implementing these forecasts, decision-makers can effectively monitor the progress of housing and demographic programs and strategies, as well as the associated processes and outcomes. Such monitoring can inform the development of medium- and long-term measures and policies aimed at addressing issues related to housing provision and population growth. Therefore, the regular implementation of these forecasts can contribute significantly to the successful implementation of housing and demographic policies and strategies in time and space.

5 Conclusion

In conclusion, the research conducted in this study has contributed to the development of a methodological approach to address the regional problem of providing housing for the rural population in the Kyrgyz Republic. The study identified interdependent and disproportionate housing and demographic development trends that affect the rural housing stock and population dynamics. By analyzing these factors and their correlations, the study was able to forecast the future dynamics of rural parameters and formulate recommendations to improve the housing policy at the republic and rural level. The recommendations include regular monitoring of the rural housing stock, constant forecasting, and the development of appropriate measures to fulfill the indicators of the republican housing program. By implementing these recommendations, the Kyrgyz Republic can ensure that the rural population has adequate access to housing, which will ultimately contribute to the country's sustainable development.

Overall, the methodological approach developed in this study and the recommendations provided can contribute to the successful implementation of the republican housing program “My Home” and to the development of an effective housing policy in the Kyrgyz Republic, especially in rural areas.

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