The contribution of rural natural capital to quality of life of urban-to-rural migrants: combined empirical evidence from national- and municipality-scale studies in Japan using social surveys and geospatial analyses

（地域の自然資本による、地方移住者の生活の質向上効果：日本全国および市町村規模の社会調査と地理空間情報解析を用いた統合的実証研究）

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By

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Abstract

The recent unprecedented urban population concentration across the world has several social and ecological consequences. It is therefore pertinent to explore an alternative deurbanization pathway, in which rural quality of life is key, to achieve a better urban-rural population equilibrium. Literature on environmental contributors to quality of life is accumulating but yet fragmented to support forward-looking policies to realize a deurbanization pathway. This thesis compiled three studies aimed to address this knowledge gap.

The first study applied the value-expectancy research model to analyze a dataset of 742 valid responses to an all-out survey of new residents in Hokuto City within a period from April 2017 to January 2019. The analysis identified common values that underlie their migration decision, i.e., nature, housing and food. It also revealed heterogeneity in priority values among migrants in different age groups, such as employment for singles in ages between 16 and 29, natural child raising environment for married couples in their 30s and 40s, and staying with or near family for retirees in or over 60s. The centrality of nature in the common values of migration implied the need of further investigations into the rural natural capital elements that are salient to these migration values.

To respond to this need, the second study introduced the 'four-capital framework' as a theoretical ground to analyze the causal relationships between rural capital and quality of life. An extended application of the four-capital framework to an analysis of 414 responses to a resident survey with quasi-random sampling from the entire Hokuto City territory and geospatial datasets revealed the contributions of specific rural capital elements to human needs satisfaction. These were natural capital including farmland, symbolic natural sites, mountain peak view, lower temperature and tranquillity; built capital, e.g., highways, railway stations, shops and restaurants; and financial capital such as employments. The results, however, had methodological limitations in the comprehensiveness of and comparability between the indicators representing the six types of rural capital.

The third study validated rural capital contributors to quality of life and their contribution pathways using a structural equation model that was built upon the extended four-capital framework. The modelling used standardized datasets generated by a nation-wide online survey, which obtained 1,315 valid responses by regional quota sampling from rural municipalities across the nation, and geospatial computation to ensure comprehensiveness and comparability. The results identified five rural capital factors and five human need factors, as well as the pathways and relative strength in which these factors contribute to migrants' quality of life. Among the five human need factors, rural amenity, which principally derives from rural natural capital, contributes the strongest to increased quality of life, followed by urban and socio-cultural utilities of a mix of various rural capital. The contribution of household income to quality of life was confirmed but marginal as compared with the above three factors. Furthermore, the results imply the role of rural touristic capital, which is comprised of unique natural and cultural assets of rural areas, to complement limited urban and human capital assets. The robustness of the model was validated modest and still has space for further improvements.

As a total, the three studies have important mutual complementarities. Importantly, a comparison of the rural capital contributors to migrants' quality of life between the second study in Hokuto City and the third study at a national scale reveals local uniqueness of rural capital contributors to quality of life. Findings from the three studies are consistent in that nature is the primary, but not the sole, contributor to rural quality of life, demonstrating the robustness of this finding.

Academic significance of these findings rests on filling critical knowledge gap in our understanding of urban-to-rural migration, quality of life and their causal relationships, particularly the contribution of natural and other various types of capital to quality of life in a rural context, as well as a missing link between migration and quality of life literature. Filling these gaps provides important implications to future studies, particularly to better understand the feedback from nature to human behavior in social ecological systems.

These findings have important practical implications to rural vitalization and population interventions, which are: (i) exemplary elements of core rural capital that contribute to migration motivation and migrants' QoL; (ii) the need of an overarching area design that ensure coherent interventions to enhance core rural capital; and (iii) the importance of intentional efforts to ensure sustainability outcomes of urban-to-rural population shift. These are mutually supportive components of deurbanization pathway, and therefore can create positive feedback loop to put a deurbanization pathway into practice.

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I first would deeply thank my research collaborators who inspired me to work on this theme and provided intellectual and technical support to carry out the work, i.e., Dr Takahiro Yoshida, lecturer at the University of Tokyo Center for Spatial Information Science Division of Spatial Information Analysis; Dr Sawako Shigeto, professor at the Graduate School of Project Design; Dr Brian Alan Johnson, Deputy Director of the Adaptation and Water Area of the Institute for Global Environmental Strategies; and Dr Yoshiki Yamagata, professor at Keio University Graduate School of System Design and Management.

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Table of contents

List of tables

List of figures

1. Introduction

1.1. Urban population concentration and its sustainability consequences

The recent unprecedented urban population concentration across the world (The World Bank, 2019) has several social and ecological consequences. These include land and sea conversion to make space for urban development, increasing biodiversity footprints of high-consumption urban lifestyles, decreasing affinity with nature among urban residents due to the loss of contact with nature, as well as reduced quality of life (QoL) of the residents of densely populated urban areas (Colléony et al., 2020; Cramer et al., 2004; Elmqvist et al., 2013; IPBES, 2019; Li & Kanazawa, 2016; Moran & Kanemoto, 2017; Oliveira et al., 2020; Scholes et al., 2018). Massive urban population shift causes serious rural depopulation, leading to widespread abandonment of agricultural and forest lands managed historically for centuries (MAFF, 2024). As many traditional production landscapes have provided cradle for distinct biodiversity in human mediated ecosystems (Kremen & Merenlender, 2018), their widespread abandonment directly leads to biodiversity and ecosystem services loss (Sasaki et al., 2021). Furthermore, agricultural and forest land abandonment within a territory, which is going widespread particularly in high-income countries like Japan, shifts the footprint away in many cases to low-income countries where the production cost is the lowest (Verones et al., 2017).

In Japan, urban population concentration and contrasting rural depopulation have been continuing over the past half century and are reaching their extremes, with the urban population rate exceeding 90% in 2010 and still in gradual increase (The World Bank, 2019). Strikingly, 744 municipalities, which are approximately 40% of all municipalities across Japan, were reported as “potentially collapsing municipalities” in terms of population loss (Population Strategy Council of Japan, 2024), and nearly 30% of agricultural land was abandoned since its peak in 1960 (MAFF, 2024). This poses pressing and multi-faceted challenge to the society, with projected exacerbating population decline due to low fertility rate in urban areas and economic loss caused by shrinking domestic market and reducing tax revenue (Hiroi, 2019) in one hand, and aggravating food and land security in the other (Inoue et al., 2007). Various efforts have been made to maintain production lands and restore habitats on such lands across the nation, but their continuation relies on producers living in rural lands (Takahashi et al., 2023). Whereas it would not be realistic to drastically reverse the urban-rural population balance considering persistent underlying social and economic drivers, a forward-looking strategy to achieve a more desirable equilibrium is critically needed.

1.2. The reversal trend: urban-to-rural migration

Nevertheless, there has been a relatively small but steady number of people who move from urban to rural areas in search of higher quality of life, particularly in countries with post-industrial economies. The recent COVID-19 pandemic has unveiled the vulnerability of urban life in densely populated cities (Rocklöv & Sjödin, 2020; C. H. Zhang & Schwartz, 2020). This and a widespread acceptance of teleworking is likely to significantly influence migration patterns in the future.

The trend of urban-to-rural migration was initially reported in the 1960s in developed European and North American countries (Fielding, 1982; Fuguitt & Beale, 1978; Gordon, 1979). Geographers and demographers express this trend using different terms with slightly different connotations, such as counterurbanization, exurbanization, rural rebound, lifestyle migration, amenity migration and back-to-the-landers, referring to the traits and objectives of such migrants (Benson & O'Reilly, 2016; Gosnell & Abrams, 2011). Counterurbanization explains spatial changes in settlements and associated migration patterns, particularly from urban centers towards their peripheries or more distant rural areas. Amenity migration specifies that a high quality living environment in rural areas 'pulls' migrants from urban areas, while lifestyle migrants, through migration, aim to enrich their lifestyle and redefine their identities (Mclntyre, 2009). Deurbanization is also a highly relevant term, although it does not directly explain urban-to-rural migration per-se. Some use the term to explain urban decay, such as population and economic decline and associated hollowing out of urban centers (Eskew & Olival, 2018; Gogola & Hocova, 2016). Others make distinction of it from urban decline, stressing the structural rebalancing between urban and rural populations in a wider geographical scale, e.g., at the provincial scale, caused by increased economic gain in rural areas (de Vries, 2012; Hossain, 2021).

In Japan, an urban-to-rural migration trend emerged in the 1960s, too. In this period, rapid economic growth caused a rapid shift of population from rural to urban areas. As a result, depopulation of rural areas became a priority political issue (Morikawa, 1988). In response, the government promoted industrial development and job opportunity creation in rural areas to mitigate the increasing urban-rural gap, but did not make focused policy efforts to promote urban-to-rural migration. Instead, urban-to-rural migration in this period is often depicted as stemming from 'hippie', organic agriculture, producer-consumer partnership and cooperative movements, which emerged along with increasing resistance to the established socio-economic regime and consumerism (Morikawa, 1988). As such, lifestyle migration has existed in Japan since this period.

From the late 1980s to early 1990s, the Japanese bubble economy fueled increasing investments in real estate and holiday homes in rural resort destinations and thereby promoted urban-to-rural migration. A lifestyle of spending holidays and life after retirement in such areas has become popular among urban residents, in which ownership of a rural holiday home is seen as a status symbol. Many even retired earlier to start up rural hotel businesses. With migrant values orientated toward natural amenities, urban-to-rural migration in this period can be interpreted as amenity migration (Gosnell & Abrams, 2011).

After the bursting of the bubble economy in the mid-1990s, the national and local governments began focused policy efforts to promote urban-to-rural migration. These included providing assistance to migrants to take up rural farming jobs, and from the 2000s, a series of exchange programs to expose urban youth to rural life and a rural revitalization staffing program to create an impetus for urban youth to move to rural areas. The Abe administration (2012–2020) placed rural revitalization as a priority policy objective, which further strengthened policies to promote urban-to-rural migration. This includes the promulgation of the Act on Overcoming Population Decline and Vitalizing Local Economy in Japan (2014), which provides the

basis for rural revitalization strategies focusing on creating job opportunities, increasing relational population, supporting child-raising and providing high-quality living environments. With this political and socio-economic backdrop, urban-to-rural migration, mainly of younger generations, has kept increasing since the late 1990s.

In the meantime, the Great East Japan Earthquake and Fukushima Daiichi nuclear disaster in March 2011 disrupted infrastructure and power supply even in Tokyo for several months, unveiling the risks pertinent to urban life. This incident led many urban residents to redefine their lifestyles and seek life in rural areas where they could be more firmly rooted in local communities (MIC, 2017a). In the aftermath, many severely depopulated rural municipalities were receiving increasing number of migrants from urban municipalities (MIC, 2018). A quarter of the population in their 20's living in the Three Major Metropolitan Areas of Japan reported an interest in migration to rural areas (MLIT, 2018). Many of them were attracted to rural areas primarily by more comfortable climatic conditions, enabling conditions for ecological lifestyles and the availability of fresh and lower-price food.

Unfolding throughout 2020, the COVID-19 pandemic, along with its increased risk of infection in densely populated cities as well as rapid and widespread acceptance of teleworking across society, triggered a mindset change among urban workers. Many expressed a preference for living and working in rural settings where they could continue their normal work while avoiding risks of infection and enjoy a higher quality of life (Cabinet Office, 2020). In general, jobs, housing and local community relations in the destinations are the three major barriers that prospective migrants need to overcome to realize their migration plans (Odagiri & Tsutsui, 2016). Currently, changing lifestyle values and mobile jobs are likely to further motivate urban dwellers to move to rural areas.

The history of urban-to-rural migration in Japan over the past half century, as described above, reveals nation-wide social and economic conditions underlying the past migration trends, as well as the impacts of acute and wide-ranging disasters such as the Great East Japan Earthquake and COVID-19. With these, and facilitated by technological advancements, such as online meeting and business administration tools, as well as a society-wide acceptance of teleworking, the migration trend has gradually been picking up. The latest report on the population sustainability of all municipalities across Japan (Population Strategy Council of Japan, 2024) showed that the number of municipalities in serious population decline has reduced in a decade, but is still overall in a concerning rate. Efforts by the national and local governments under the Act on Overcoming Population Decline and Vitalizing Local Economy in Japan (2014), focusing on direct support to urban-to-rural migrants, might have played its role in this slight improvement. These, however, have yet fully utilized the opportunities ahead to amplify the trend, due the limited understanding of the reasons that aspire urban residents to move to rural areas, or in other words the advantages of rural areas over urban areas for urban-to-rural migrants that factors in their migration decision making.

1.3. Quality of life as key to understand the reversal trend

In lifestyle migration, amenity migration and other similar conception of urban-to-rural migration that characterize urban-to-rural migration trend in Japan in the past few decades, increased quality of life (QoL)

in rural destinations is central to the migrants' motivation for migration, including the realization of their life purposes. This reflection helps update the broader conception of deurbanization by de Vries (2012), which originally explained structural urban-to-rural shift in population and economy driven by commercial agriculture in the Netherlands in the 18th to 19th Century, to the modern context. That is structural population shift to rural areas for increased QoL.

In this proposition, deurbanization share key properties with the degrowth concept, which prioritizes ecological sustainability, justice and human well-being over economic growth (Asara et al., 2015). This is exemplified by various proposed degrowth practices which represent rural lifestyles, such as eating locally- or self-produced food, and reconnecting with nature through outdoor recreations (Brossmann & Islar, 2020; Fitzpatrick et al., 2022). Hence, the present study defines deurbanization as structural urban-to-rural population shift that increases ecological sustainability, justice and well-being, as a partial expression of the broader degrowth concept.

Forward-looking policy making to achieve a more sustainable urban-to-rural equilibrium can be benefitted from future scenarios that incorporate a deurbanization pathway. Future scenarios are increasingly used in sustainability studies to help forward-looking policy making for the uncertain future, such as the Nature Futures Framework (NFF) at the global level (Durán et al., 2023) and the PANCES scenarios for Japan (Saito et al., 2019). Narratives of specific scenarios under these frameworks explicitly mention decentralized population, i.e., the 'Nature as Culture' domain of NFF and the 'natural capital-based dispersed society' quadrant of the PANCES scenarios. Hence, substantiating the deurbanization pathway would help apply these scenarios to scientific investigations and policy making. To explore a deurbanization pathway, knowledge on QoL outcomes of urban-to-rural migration, as well as QoL contributors within the rural migration destinations would be extremely useful. Furthermore, better understanding of the unique characteristics of rural municipalities that contribute to migrants' QoL would provide direct practical implications, e.g., to reinforce known or exploring new strengths of each municipality and ultimately to attract migrants.

1.4. Literature on migration and quality of life

There is accumulating literature on urban-to-rural migration, and on environmental contributors to QoL respectively, but barely none on their interactions.

Descriptive literature on urban-to-rural migration is plentiful, including counterurbanization, exurbanization, rural rebound, lifestyle migration, amenity migration and back-to-the-landers (Benson & O'Reilly, 2016; Gosnell & Abrams, 2011), as mentioned above. In Japan, urban-to-rural migration has been a human geography and social study subject, and this research typically provides narratives on macro trends drawing on national demographic data (MIC, 2018) or individual cases focusing on policy efforts and their outcomes (Kasami, 2022; Odagiri & Tsutsui, 2016; Sakuno, 2016). Tanigaki (2018) is an exception, which used a quantitative analysis to identify the characteristics of the potentially collapsing rural municipalities across Japan that had contributed to the arrival of new residents. Its scope, however, was limited to anthropogenic factors such as local economy, government subsidies and welfare services and

convenience, and did not include natural factors. In sum, these studies have barely specified the concrete generalizable elements of rural landscapes that provide amenity or enable ideal lifestyles which are, as explained above, the major motivation for urban-to-rural migration in Japan.

Among theoretical migration literature, the value-expectancy model (De-Jong & Fawcett, 1981) is a theoretical microeconomic model that explains the process in which individuals or households decide to migrate and the factors influencing their decisions, drawing on an extensive review of migration literature across the world including developed and developing countries. The model identified four large domains in the migration decision making process (Figure 1.1). The first is personal or household attributes, including demographic characteristics, societal and cultural norms and personal propensity (e.g., adaptability to changes, take or avoid risks). These constitute the background of the second domain, which is values, or goals of migration. De-Jong & Fawcett (1981) proposed seven broad value/goal categories from both theoretical and empirical bases, i.e., wealth, status, comfort, stimulation, autonomy, affiliation and morality. The third domain, opportunity structure, explains the differences in opportunities among the place of origin and alternative migration destinations, including economic opportunity, marriage opportunity, education, and amenities. Individual perceptions of these opportunities affect the fourth domain: expectancy to attain the values. Access to information on alternative migration destinations affect one's expectation to attain the values. The model postulates that the migration decision is the result of the strength of the aggregate value-expectancy (second and fourth) domains, which are influenced by personal or household attributes (first domain) and the opportunity structure (third domain).

The value-expectancy model, however, has little been substantiated since the 1980s when the model was proposed, even though it would be applicable to explain migration in the modern context including amenity and lifestyle migration. On the other hand, literature on urban to-rural migration is mostly descriptive, as mentioned above, and lacks consistent theoretical underpinning. In my view, the value-expectancy model would provide robust theoretical basis for investigations into urban-to-rural migration, particularly the specific elements of rural landscapes that provide opportunities to migrants to realize their amenity or lifestyle aspirations. The model further would be useful to reveal the values held by migrants that influence migration motivation, which may change alongside major life events such as recruitment, marriage, child-raising and retirement, as described in the first domain of the value-expectancy model (Figure 1.1).

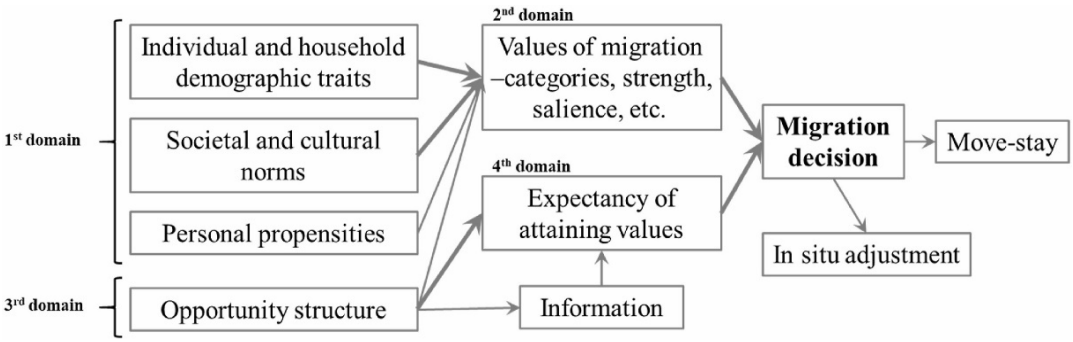


Figure 1.1. Schematic diagram of the value-expectancy research model of migration decision making.
Note: Produced by the author based on De-Jong and Fawcett (1981)

Knowledge of the environmental contributors to QoL is accumulating but yet fragmented to provide their thorough understanding in a deurbanization context. Costanza et al. (2007) provide a comprehensive theoretical foundation, which postulates that the fulfillment of various human needs and resulting overall well-being perceived by an individual constitute one's QoL, and that four types of capital, i.e., natural, built, human and social capital, provide opportunities to meet various human needs. This, so-called 'four-capital framework', is substantiated by several empirical studies and economic theories, but its implementation has diverged: a subjective or perception-based approach using questionnaire surveys (Mulder et al., 2006; Panas, 2013; S. Zhang et al., 2018); and a biophysical data-driven approach such as the Inclusive Wealth Index (Fujii & Managi, 2016; Ikeda & Managi, 2019). This methodological dichotomy created missing links in the investigation of the contribution of four types of capital to QoL, which Costanza et al. (2007) initially advocated in their theoretical model. From a different line of literature, several urban QoL studies use structural equation modelling (SEM) to show the causal relationships, often in cascades or through multiple pathways, between urban environment and residents' QoL (Kweon et al., 2010; Kyttä et al., 2016; Mouratidis & Yiannakou, 2022; von Wirth et al., 2015). The scope of these studies is mostly limited to built infrastructure and its functions, such as access to city centers, railway stations, shops, schools, open spaces and road traffic, or in a few cases include access to public green or blue spaces. Yet, some urban QoL studies look deeper into the quality of public and private urban green spaces, including species biodiversity, and people's interactions with them (Allard-Poesi et al., 2022; Cardinali et al., 2024; Hong et al., 2019; Nghiem et al., 2021). These investigations, however, mostly took place in human-dominated urban landscapes and barely none in rural landscapes covered largely by natural and production lands.

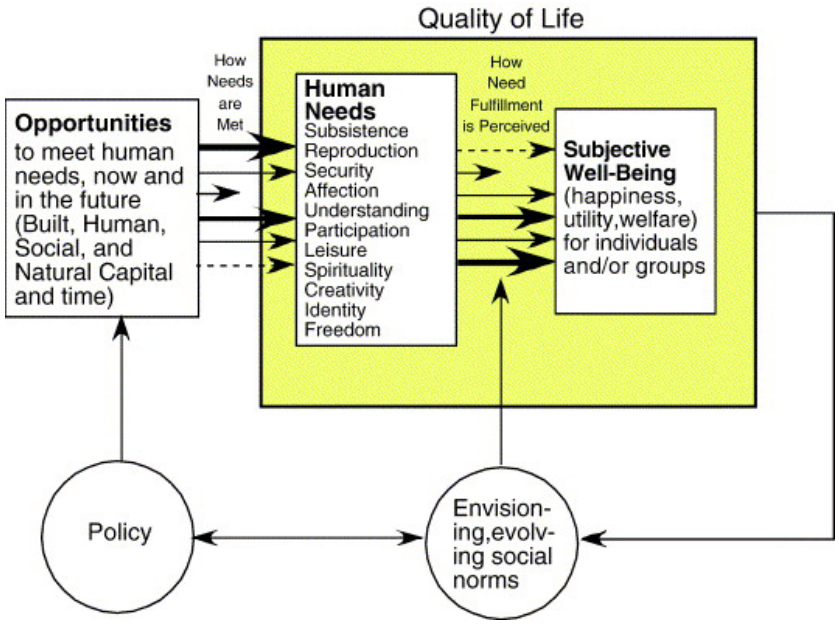


Figure 1.2 An integrated definition of quality of life (QoL) and its environmental contributors captured by four types of capital:
Note: Reproduced with permission from Costanza et al. (2007)

It would be critically important to converge the two threads of literature on migration and QoL, considering the centrality of QoL in the values of urban-to-rural migration, but has never been attempted. More specifically, this convergence provides a hypothesis that natural and other capital assets that characterize rural areas contribute to QoL, and hence to raising urban-to-rural migration motivation. Empirical studies of amenity or lifestyle migration using this hypothesis would help identify specific rural capital elements that contribute to urban-to-rural migration decision. Such findings would provide important policy implications, such as the scope and approaches for exploring new or reinforcing known rural capital assets that effectively attract migrants from urban areas.

Furthermore, the convergence would make important academic contributions, particularly better understanding of nature-human feedbacks in social ecological systems, as well as the basis for more nuanced future population projections that incorporate the feedbacks. Knowledge is accumulating on the impacts of human activities on nature, particularly human population distribution as one of the primary indirect drivers of biodiversity loss, while the effect of the state of nature on human behavior is recognized as an important knowledge gap (IPBES, 2019). Most available population projections rely on the extension of the past to present demographic trend to the future (NIPSSR, 2018a), and hence can deviate from the reality when other factors interplay (Takahashi et al., 2021). Therefore, findings on specific rural capital elements that affect migration decision making would provide the basis for more nuanced modelling of future population projections.

To wrap up and to lay the basis for an integrated analysis of migration and QoL, the conceptual relationships between key terms used in the above literature are illustrated in Figure 1.3. Here the horizontal axis explains the continuum from underlying factors of urban-to-rural migration (left) to its outcomes (right), while the vertical axis contrasts endogenous (bottom) and exogenous (top) domains of individual migrants in which each concept is located.

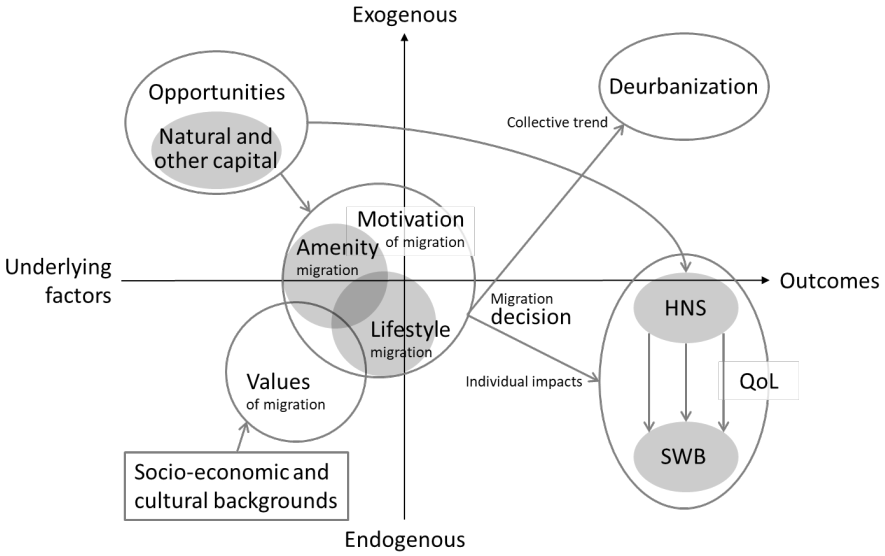


Figure 1.3 Conceptual relationship between key terms in the migration and QoL literature

Evidently quality of life (QoL) of urban-to-rural migrants is located on the fourth quadrant, in which subjective well-being (SWB) and human needs satisfaction (HNS) are nested, in accordance with the Costanza et al.'s (2007) definition. QoL and well-being (WB) are often used interchangeably but World Health Organization (WHO) clarifies their practical difference. The WHO Well-Being Index (WHO-5) is one of the most commonly used questionnaire to assess subjective well-being, asking respondents the level of their agreement with the five statements using a five-point Likert scale, i.e., 1) "I have felt cheerful and in good spirits"; 2) "I have felt calm and relaxed"; 3) "I have felt active and vigorous"; 4) "I woke up feeling fresh and rested"; and 5) "my daily life has been filled with things that interest me" (Topp et al., 2015). In this conception, well-being is inherently narrowly endogenous to individuals and hence located in the right-bottom corner of the fourth quadrant in Figure 1.3. Likewise, WHO provides WHOQOL-100, a questionnaire for assessing individuals' QoL with a set of 100 questions that cut across broad aspects of life including physical capacity, psychological status, level of independence, social relationships, environment and spirituality (WHO, 2012), which partially extends to the exogenous domain. Hence, in these WHO's conceptions, QoL is a higher-level and broader concept that incorporate SWB. These almost agree with the Costanza et al.'s (2007) definitions of QoL and SWB, except that WHOQOL-100 is primarily based on individuals' perception while Costanza et al. (2007) proposes the use of objective measurements of some HNS elements in the exogenous domain. Therefore, in Figure 1.3, SWB, and QoL embracing SWB, partially extends to the exogenous domain.

Motivation of migration is placed at the center of the plain (Figure 1.3), which is formed through the interactions between endogenous and exogenous domains and underlies migration decision. The outcomes of migration decision at the individual level is captured by QoL, while a demographic trend formed by a collection of multiple migration decisions to increase QoL is defined as deurbanization. Amenity migration and lifestyle migration represent different types of migration motivation. These types are not mutually exclusive, as natural amenity enables certain lifestyle options like self-sustaining rural life. Amenity migration is placed higher than lifestyle migration along the vertical axis, because natural amenity derives from the exogenous domain, particularly natural capital. Values of migration is located on the third quadrant, which further underlies migration motivation and affect its amenity, lifestyle and other orientations. These values are formed or constrained by individuals' socio-economic and cultural backgrounds.

1.5. Research aim

This study looks into QoL in the deurbanization context, which requires a deeper understanding of both the endogenous domain of individual migrants, e.g., values and motivations, and their exogenous domain, particularly the opportunities to realize their values and motivations in the rural destinations. More specifically, the research aims are threefold. The first aim is to reveal the motivation for urban-to-rural migration, as well as the variety in the values held by migrants that may influence their motivation, in a popular urban-to-rural migration destination site in Japan. The second aim is to explore natural and other various types of capital assets in the same site that support migrants to realize their values, and ultimately to increase their QoL, within mind variety in their values. The third aim is, building on the outcomes of the

studies on the former two aims, to assess the magnitude and pathways in which natural and other types of rural capital across the nation increase migrants' QoL. The three aims are not only incremental steps to address the final aim, but also designed to provide unique and mutually complementing findings enabled by their respective scope and resolution of analyses. Importantly, the contrast between the municipality-scale studies for the first and second aims and the national-scale study for the third aim would highlight local uniqueness, or endemism, in the contribution of various types of capital to QoL and to migration motivation.

1.6. Chapter outline

The rest of the thesis is organized as follows. The following Chapter 2 provides an overview of the local case study site, i.e., Hokuto City of Yamanashi prefecture, Japan, as well as the general conceptual frameworks and methodologies that were applied throughout the study. Chapters 3, 4 and 5 correspond to the respective three research aims, which include detailed methodologies, results and discussions for the respective aims. Chapter 6 compiles overarching discussion, including key policy implications and academic contributions, as well as the methodological limitations and remaining knowledge gaps that need to be addressed by future studies. The thesis ends with conclusions in Chapter 7.

2. Study area and methods

2.1. Study area

The two case studies presented in the following Chapters 3 and 4 were carried out in Hokuto City of Yamanashi Prefecture, Japan. Hokuto City is located around 158 km west of Japan's capital, Tokyo, a journey of approximately 2 hours by highway or direct express train (Figure 2.1). The area of Hokuto City is approximately 602 square kilometers, encompassing mostly forest land (76%), some agricultural land (9%), as well as urban and other areas (15%) (MAFF, 2015). The City is surrounded by three major scenic mountain chains, i.e., the Yatsugatake Mountains (peak elevation: 2899 m) to the north, Chichibu Mountains (2601 m) to the north-east and the Japanese Southern Alps (3192 m) to the southwest, which are designated as national and regional parks. The City had a population of 46,748 (21,405 households) as of January 2020 (Hokuto City, 2020). The primary production sector is the smallest after service and manufacturing sectors, as is the case in many Japanese municipalities, but provides by far the highest proportion of employment (15.9%) compared to the national average (3.8%).

Hokuto City is the ideal site to address my research aims for the following three reasons. First and foremost, Hokuto City is one of the most popular urban-to-rural migration destinations across Japan, which enabled sampling of sufficient number of urban-to-rural migrants required for quantitative analysis. In 2018 the City was ranked first as the best rural areas to live in, from among rural municipalities across Japan that have a population of less than 100,000 (TAKARAJIMASHA, Inc., 2018), and has been maintaining a high place in the ranking in the past few years. In 2021 the City received 1,615 new residents, among which 485 persons (30%) moved from Tokyo (Statistics Bureau of Japan, 2022). This was not an instant trend only in the past few years but derived initially from tourism development in the Kiyosato area since the 1940s, which currently still is a tourism center of Hokuto City. Kiyosato is first recognized by the location of a landmark Christian monastery Seisen-ryo, established in 1938 by a Christian missionary Dr Paul Rusch. Kiyosato underwent tourism development since the late 1940s, and thereafter became a popular holiday home location for urban residents under the bubble economy in the 1970s (Tsuchiya, 1988), whereas the holiday home boom shrunk after the bursting of the bubble economy since 1990.

The second reason is the potential contribution of the natural environment of the City to abating population decline by attracting migrants from urban areas. Hokuto City is designated as an ‘Underpopulated-related municipality’ under the Act on Special Measures for Promotion for Independence for Underpopulated Areas (MIC, 2017b), as the City partially includes underpopulated areas. NIPSSR (2018) predicted a rapid population decline to 30,010 by 2045 under a business-as-usual trajectory. However, the population has actually trended up over the past few years, deviating upward from the projection. MLIT (2015c) mentions that some characteristics of the Hokuto City land, such as scenic mountains ranges, a comfortable climate and rich local food and other resources, as well as relatively good access to urban centers such as Tokyo, have resulted in a continuous population inflow to Hokuto City. This implies the potential effect of natural and other capital elements that characterize rural landscapes on demographic trends, which is central to my research subject. Whereas the rural environmental contributors to in-migration may vary among

municipalities across Japan that have a unique set of landscapes and seascapes, a case study in Hokuto City would enable an in-depth analysis of the contribution of mountains and relevant natural elements that characterize Hokuto City's landscape.

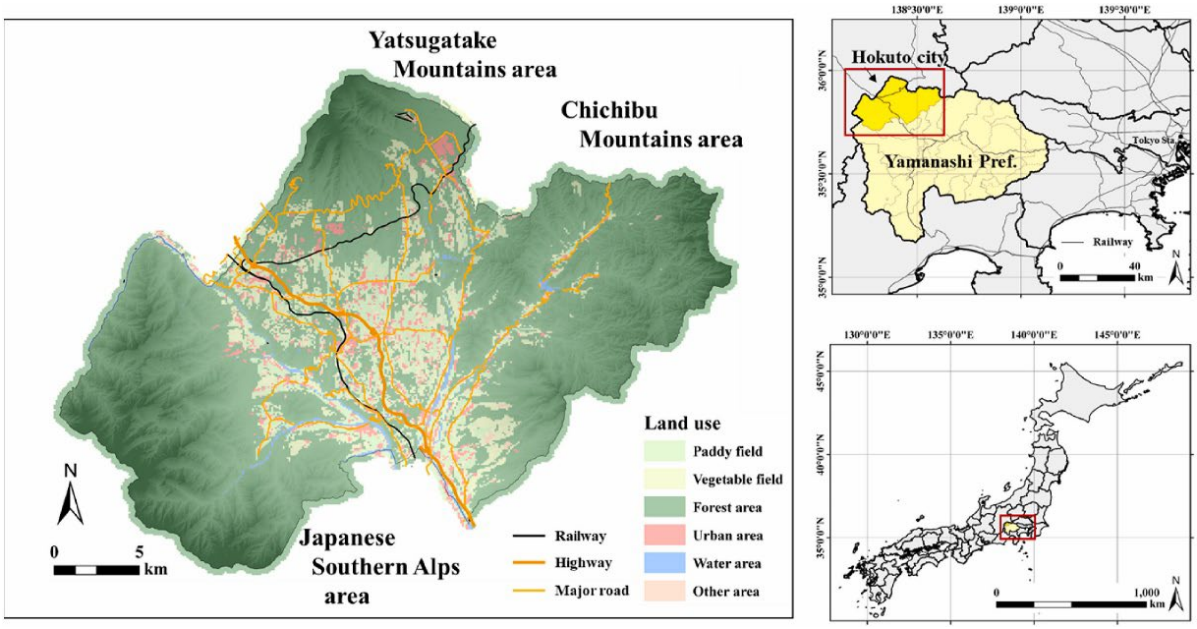


Figure 2.1 Study site: Hokuto City, Yamanashi prefecture, Japan.

The third reason is the focused persistent efforts by the Hokuto City government to assist migrants from urban areas, in tandem with the Yamanashi Prefectural Government. The Hokuto City Population Vision and General Strategy was first promulgated in 2015 under the national Act on Overcoming Population Decline and Vitalizing Local Economy. Its latest revision in 2018 prescribes five objectives, i.e., i) enhance support to child-raising households, ii) provide houses that meet the needs of migrants, iii) create employments rooted in the local economy, iv) promote population exchange and tourism, and v) create comfortable living environment (Hokuto City, 2018). The Yamanashi Prefectural Government opened the Yamanashi Life Support Centre in 2013, with its consultation office in Tokyo and portal website to provide hands-on information to the prospective migrants. As part of such efforts, Hokuto City has conducted surveys of migrants at its resident registration desk since 2017 to inform its population policies. Support from the Hokuto City government enabled the current study, including the provision of the survey dataset which was used for the analysis presented in the following Chapter 3. The study was also motivated to inform the Hokuto City government to further develop and implement effective population and rural revitalization policies.

2.2. Conceptual models

This research applied two main theoretical models to construct conceptual models that fit for its aims. The value-expectancy research model (De-Jong & Fawcett, 1981) was applied in Chapter 3 for the analysis of motivation for urban-to-rural migration and underlying values held by migrants. For the analysis, the model was modified to fit for the context of urban-to-rural migration in Japan, as well as the structure and types of

data used for the analysis (see Section 3.2.2 for details).

The four-capital framework (Costanza et al., 2007) was applied in Chapters 4 and 5 to investigate rural environmental contributors to QoL. In its application, the four-capital framework was extended referring to the community capitals framework (Flora et al., 2018). Flora et al. (2018) propose the use of seven types of capital for a holistic analysis and action in rural communities, which include financial, cultural and political capital, in addition to natural, built, human and social capital. Whereas the three additional capital types are embedded in the Costanza et al.'s (2007) conception of capital and its contributions to QoL, financial and cultural capital was added as explicit categories in my conceptual model to clarify their QoL effect for urban-to-rural migrants. A comprehensive global review of migration literature (De-Jong & Fawcett, 1981) stresses the importance of economic motivation for migration. In addition, we were interested to investigate the contribution of cultural elements to migrants' QoL. Political capital was out of our scope. Therefore, six capital types in were finally included in my conceptual model, i.e., natural, built, human, social, financial and cultural capital, which were referred to collectively as rural capital.

2.3. Data collection and analyses

The overview of data collection and statistical analysis methods used in this study are presented in Table 2.1. To collect migrants' perception-based data, I used different survey methods that were best suited for the subject of the study under Chapters 3, 4 and 5 respectively. Chapter 3, to investigate the values of migrants that underly their migration motivation, used a dataset of an all-out survey of incoming residents at the resident registration desk of the municipality office from April 2017 to January 2019, which was provided by the Hokuto City government (see 3.2.1 for details). Chapter 4 used a paper-based questionnaire survey with quasi-random sampling from houses along all streets across the Hokuto City territory (see 4.2.2). Online survey was not an option here due to a small number of residents registered to the online survey panel. On the contrary, Chapter 5 used a nation-wide online survey of urban-to-rural migrants. The survey implemented a stringent screening process to identify the respondents who met the operational definition of urban-to-rural migrants used in the study (see 5.2.2).

Biophysical data for the metrics of natural and other rural capital, used for the investigation of environmental contributors to QoL in Hokuto City (Chapter 4) and across the nation (Chapter 5), were acquired from commercial and government and other open sources. The details of sources and geospatial computation methods are presented in the respective chapters (see 4.2.3 and 5.2.3).

Various statistical models were used to substantiate each conceptual model, which represent the aim of each chapter, with the collected datasets. Basic multivariate analysis methods were used in Chapters 3 and 4 to describe the data trend and to produce composite variables, such as Principal Component Analysis (PCA), Cluster Analysis, multiple correspondence analysis (MCA) and canonical discriminant analysis (see 3.2.3 and 4.2.4 for details). In addition, Chapter 4 used Analysis of Covariance (ANCOVA) and Analysis of Variance (ANOVA) for hypothesis testing (see 4.2.4). Chapter 5 used Structural Equation Modelling (SEM) with Exploratory Factor Analysis (EFA) and Path Analysis for an integrated analysis of rural capital contributors to migrants' QoL (see 5.2.4).

The scopes and the resolution of analyses of the three studies presented in Chapters 3, 4 and 5 were designed not only to take incremental steps to achieve the final aim, but also achieve unique and mutually complementing findings. The first study looked into the endogenous part of urban-to-rural migrants to understand variety in migrants using a dataset from an all-out survey of newly arrived residents to Hokuto City within a specific period. Considering the variety, the second study investigated how the exogenous factors, i.e., the access to rural capital in Hokuto City, affect migrants' endogenous aspects, particularly their human needs satisfaction. The third study applied the same conceptual model to the national scale, which inevitably reduced the spatial resolution of analyses but expanded the scope to explore a wider variety of rural capital. For example, the second study used high-resolution spatial metrics, such as the access from the respondents' home ward to various rural capital within different distance ranges. These included the measurement of mountain peak views using the viewshed analysis and the level of traffic noise using road traffic data and noise attenuation modelling, which I deemed important to characterize the Hokuto City's mountainous landscape. On the contrary, the third study used municipality as the unit of analysis, which was far coarser than the unit used for the second study but enabled exploring datasets that represent a far wider variety of rural capital. The comparison of the findings from the second and third study would help understand the variety in how rural capital elements, which would differ widely between municipalities across Japan, contribute to migrants' QoL.

Table 2.1. Data collection and analysis methods used in Chapter 3, 4 and 5

Chapter	Aim	Data collection	Statistical analysis
Chapter 3. Diverse values of urban-to-rural migration: A case study of Hokuto City, Japan	Reveal the commonality and varieties in values that underly migration motivations in Hokuto City	All-out survey at the resident registration desk of the Hokuto City municipality office	Multivariate analysis methods, e.g., multiple correspondence analysis, cluster analysis and canonical discriminant analysis
Chapter 4. Spatial exploration of rural capital contributing to QoL and urban-to-rural migration decisions: A case study of Hokuto City, Japan	Identify natural and other types of rural capital in Hokuto City that contribute to residents' QoL and to migration decisions	A resident survey with quasi-random sampling, and geospatial data acquisition from open and commercial sources	ANOVA, ANCOVA and multivariate analysis methods such as PCA and Cluster Analysis
Chapter 5. The contribution of rural natural capital to quality of life of urban-to-rural migrants in Japan: Structural equation modelling using a nation-wide survey and public geospatial data	Assess the magnitude and pathways in which natural and other types of rural capital all across the nation increase migrants' QoL	A nation-wide online survey with quota sampling; and statistics and geospatial data acquisition from government and other open sources	Structural equation modelling, using exploratory factor analysis and path analysis with multiple group models

3. Diverse values of urban-to-rural migration: A case study of Hokuto City, Japan

3.1. Introduction

There is subtle but steady trend of urban-to-rural migration in Japan since the 1960s, which largely can be explained as lifestyle or amenity migration (see Section 1.2). In-depth investigation into this trend from lifestyle migration perspectives would therefore be meaningful to inform forward-looking policies to amplify the urban-to-rural population shift, but little research has examined this trend from that perspectives in Japan in and after the 1990s (Nagatomo, 2013). Furthermore, given common lifestyle changes alongside major life events such as recruitment, marriage and retirement, more comprehensive understanding is needed on the variety in individual lifestyle values that underly migration motivation.

Regarding theoretical models to describe the reversal migration trend, the potential utility of the value-expectancy research model (De-Jong & Fawcett, 1981) was pointed out (see Section 1.4). The model, however has little been substantiated in the deurbanization context.

With this backdrop, the present study applies the value-expectancy research model to reveal the values that underlie motivations for migration and how the migrants' demographic characteristics influence values of migration in Hokuto City, Yamanashi prefecture.

This was enabled by support from Hokuto City municipal government, which provided a dataset from its all-out survey of migrants at its resident registration desk since 2017. The dataset partially included the data items corresponding to the value-expectancy framework, particularly household demographic traits (the first domain: see Figure 1.1) and the values of migration (the second domain). Drawing on this large quantitative dataset, I believe my study offers high academic value in substantiating the value-expectancy framework.

3.2. Materials and methods

3.2.1. The survey

The Hokuto City government has been conducting a short questionnaire survey at the resident registration desk since April 2017, meaning that all households that have relocated to Hokuto City since April 2017 have answered the survey, except for some who refused. The survey has 12 questions (see Appendix 1). Its first question asks respondents whether they relocated for voluntary or involuntary reasons. Examples of involuntary reasons included workplace transfer under the same employer, marriage to a spouse living in the city and schooling in the city. The subsequent questions were answered only by those relocating for voluntary reasons. I obtained survey data from Hokuto City covering the period from April 2017 and January 2019, which included a total of 1574 responses including 868 responses from voluntary inbound migrants. Prior to the analyses, I coded answers to open questions, including the explanation of the ‘other’ option, and integrated the codes with predetermined response options.

3.2.2. Analytical framework

I modified the value-expectancy framework (Figure 1.1) for application to Hokuto City's survey context and data (Figure 3.1). This was necessary to address contextual differences, i.e., the survey data provided the respondents' immediate reasons for their decision to migrate, whereas the original value-expectancy framework traces the entire migration decision-making process. It was also necessary to match the survey questions and response options (see Appendix 1) to the elements of the framework.

More specifically, I integrated the value (second) and the expectancy (fourth) domains of the framework (Figure 3.1) because the questionnaire form did not allow distinction between the two. Hence, in my analyses, I termed this combination as the 'values' that influenced migration decisions, noting that the expectancy component is embedded in the values component. Then, I identified the response options in the questionnaire that represented either of the seven broad categories of 'values of migration' as proposed by De-Jong and Fawcett (1981). This procedure identified 19 value categories (see Table 3.1) from the response options for questions 3, "relevant life events", 8, "reasons for choosing Hokuto City", and 10, "reasons for choosing the current property in Hokuto" provided in the survey form (see Appendix 1).

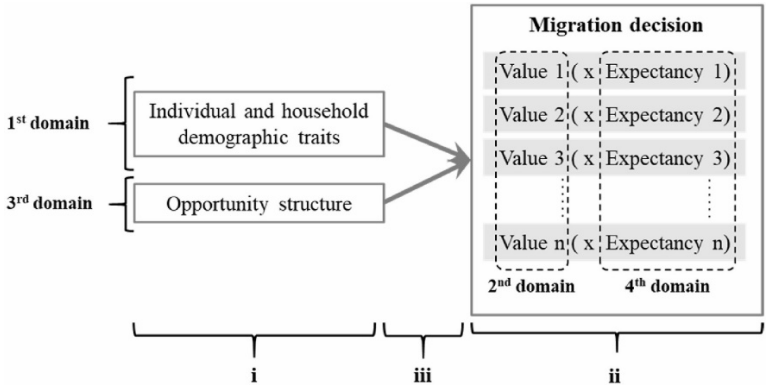


Figure 3.1 Analytical framework.
Note: i, ii and iii indicate the major components of the modified analytical framework, i.e., i) migrants' demographic characteristics and opportunity structure; ii) values that drove their decisions to migrate; and iii) the influence of demographic traits and opportunity structure on the values of migration.

With respect to household attributes (first domain), the survey provided the data on individual and household demographic traits, including the respondents' age and household structure (question 7), occupation (question 11), and influential life event (question 3).

Opportunity structure (third domain) is attributed to place – both the migrants' place of origin and destination. As my study subject was migrants to Hokuto City, I used the respondents' previous address as the surrogate for opportunity structure. In so doing, I classified their previous address into four, i.e., the major urban regions in Japan (the greater Tokyo, Osaka or Nagoya metropolitan regions), Yamanashi prefecture, other prefectures in Japan and other countries.

The study aimed to reveal the elements and their relationship presented in Figure 3.1. These are: i) migrants' demographic characteristics and opportunity structure; ii) values that drove their decisions to migrate; and iii) the influence of demographic traits and opportunity structure on values of migration.

Table 3.1 Respondents' selection of different migration value types and results of stepwise MCA application.

Cluster	Category	Screening steps and category score (for steps 2–5)								
		Step 1[a]	Step 2[d]		Step 3 [d]		Step 4 [d]		Step 5 [d]	
		Total	Axis 1	Axis 2	Axis 1	Axis 2	Axis 1	Axis 2	Axis 1	Axis 2
na	Religion	0 rm	rm	rm	rm	rm	rm	rm	rm	rm
na	Water/sewer	2 rm	rm	rm	rm	rm	rm	rm	rm	rm
na	Eldercare	3 rm	rm	rm	rm	rm	rm	rm	rm	rm
1	Birthplace	86	−4.62*	−1.06	rm	rm	rm	rm	rm	rm
2	Near family	23	2.29	−9.03*	rm	rm	rm	rm	rm	rm
3	Recruit	135	0.23	0.03	−3.34*	−1.22	rm	rm	rm	rm
4	Lifestyle	17	0.04	0.21	3.92*	−9.65*	rm	rm	rm	rm
5	House (antique)	17[b]	0.11	0.22	1.41	−0.2	9.26*	−1.45	rm	rm
6	Transport	100	0.26	0.24	0.28	0.24	−0.46	0.3	0.18	−0.88
	Leisure	59	0.19	0.15	0.38	−0.22	−0.64	0.37	0.14	−1.55
	Nature	452	0.12	0.17	0.22	0.16	−0.07	−0.23	−0.26	−0.37
	Food	216	0.21	0.22	0.18	0.17	0	−0.12	−0.13	−0.34
	Social capital	74	0.23	0.23	−0.22	0.15	0.21	−0.66	−0.62	0.52
	House (other)	239[b]	0.12	0.11	0.21	0.37	−0.66	−1.86	−1.94	0.11
7	Convenience	84	0.19	0.06	−0.06	−0.3	−0.89	2.46	2.01	−2.25
8	Childcare	91	0.18	0.21	0.53	0.69	0.17	0.35	0.54	2.95
	Security	32	0.26	0.23	0.11	0.25	−0.07	0.9	0.89	0.82
	House (space)	151[b]	0.21	0.1	0.36	0.31	0.65	1.05	1.25	0.92
	House (price)	248[b]	0.23	0.17	0.15	0.08	0.27	0.68	0.78	0.44

Note: a: The number of respondents who chose respective value types. *b*: A total of these four numbers does not agree with the number of the respondents who identified housing-related reasons for migration as indicated in text (432), as the question allowed multiple choices. *c*: 'rm' indicates the outlier variables that were removed from analyses in the following steps. *d*: The values under the columns indicating steps 2 to 5 are the category scores for the first and second axes generated by MCA. The values with '*' symbol are outliers at the 5% level by the Smirnov-Grubbs test.

3.2.3. Data analysis

To reveal the factors underlying the variation in demographic traits of migrants, I conducted multiple correspondence analysis (MCA) using five categorical variables: household structure, age of the eldest person in the household, occupation, place of origin and influential life event. MCA is commonly used to profile household demographic characteristics (Ahmed et al., 2020; D'Ambra et al., 2020; Di Talia et al., 2019). I then identified the major groups in migrants who share similar demographic traits by cluster analysis using the MCA outputs, i.e., the category scores for the first and second axes. Likewise, I classified migration values using MCA and cluster analysis.

Finally, I quantified the effect of the migrants' demographic characteristics and opportunity structure on the values of migration using canonical discriminant analysis. This analysis converted the five categorical variables, i.e., household structure, age group, occupation, life event and previous address, to dummy variables for extrapolation as the independent variables. Discriminant analysis is often used in marketing and behavioral research to evaluate the effect of sample attributes on their behavioral consequences (Feinberg, 2010; Kim et al., 2000; Tregear & Ness, 2005). For these analyses, I used Hayashi's second and third quantification methods equipped in BellCurve for Excel, which are the equivalents of canonical discriminant analysis and MCA respectively (Suzuki, 2018).

3.3. Results

3.3.1. Demographic and spatial traits of migrants to Hokuto City

From among the 868 responses extracted from the Hokuto City survey data, I obtained 742 valid responses that had answered to at least one of five questions on household attributes, i.e., age and household structure, occupation, place of origin and influential life event. The data shows two distinct peaks in the number of migrants in their 30s and 60s (Figure 3.2). Evidently, different types of life event at different ages influenced their migration. Recruitment was the dominant reason for migrants in their teens and 20s, but the proportion reduced gradually with age increase. Marriage and childbirth influenced most notably the migration of the households headed by people in their 30s, followed by households headed by people in their 20s and 40s. Retirement is the dominant reason for migration in the 60s age bracket but less among migrants in their 50s and 70s. A certain proportion of households in their 70s or older migrated due to the need to stay with family.

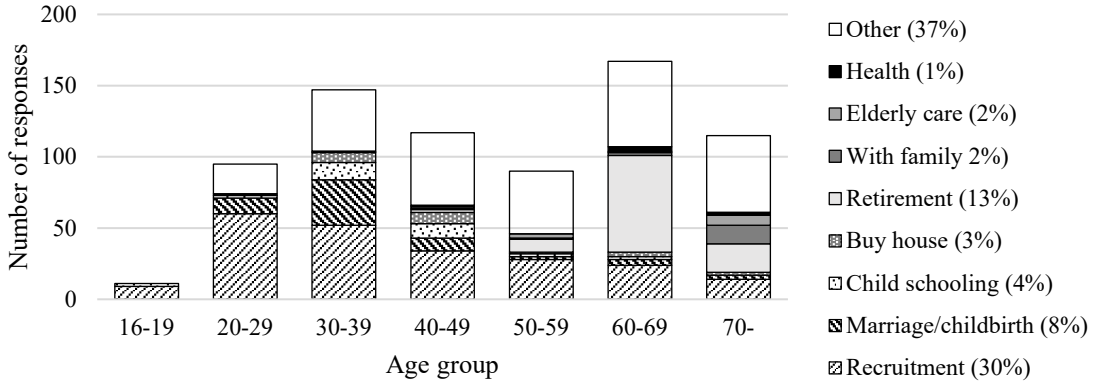


Figure 3.2 Number of respondents in different age groups and their impetus for migration. Percentages shown in brackets after legend items indicate proportion of respondents.

MCA identified two orthogonal axes that explain the sample variance in the four variables representing demographic characteristics and opportunity structure, with the first (horizontal) and the second (vertical) factor inertia being 8.43% and 6.59% respectively (Figure 3.3). Whereas the low inertia values indicate unstable prediction, the horizontal axis aligned with age (increasing from right to left), and the vertical axis was considered to account for the personal (bottom) to the family-oriented (top) motives for migration. Cluster analysis of the category scores for the first and second axes using Ward's method and Euclidean

distance yielded four distinctive groups of migrants: Group 1: people in their teens to 20s who migrated mainly for employment; Group 2: those in their 30s–40s who migrated for marriage and child-related reasons; Group 3: those in their 50s who migrated for relatively mixed reasons; Group 4: those in their 60s and older who moved after retirement (Figure 3.3). The third group was located around the zero scores against the horizontal and vertical axes, indicating that the variables clustered under this group were relatively neutral compared to others in explaining the variance among samples.

The plots with "from" in the label headings in Figure 3.3 explain the differences in the perception of the opportunity structure inherent to Hokuto City by the migrants from different origins. Generally, migrants from foreign countries – mainly returnees – were in search of employment. Short-distance movers from within Yamanashi prefecture tended to prioritize housing and child rearing environment. Respondents from metropolitan and other place of origin was relatively neutral as regards explaining the variation among migrants, whereas the migrants from the former tended to be slightly older and the latter prioritized personal reasons.

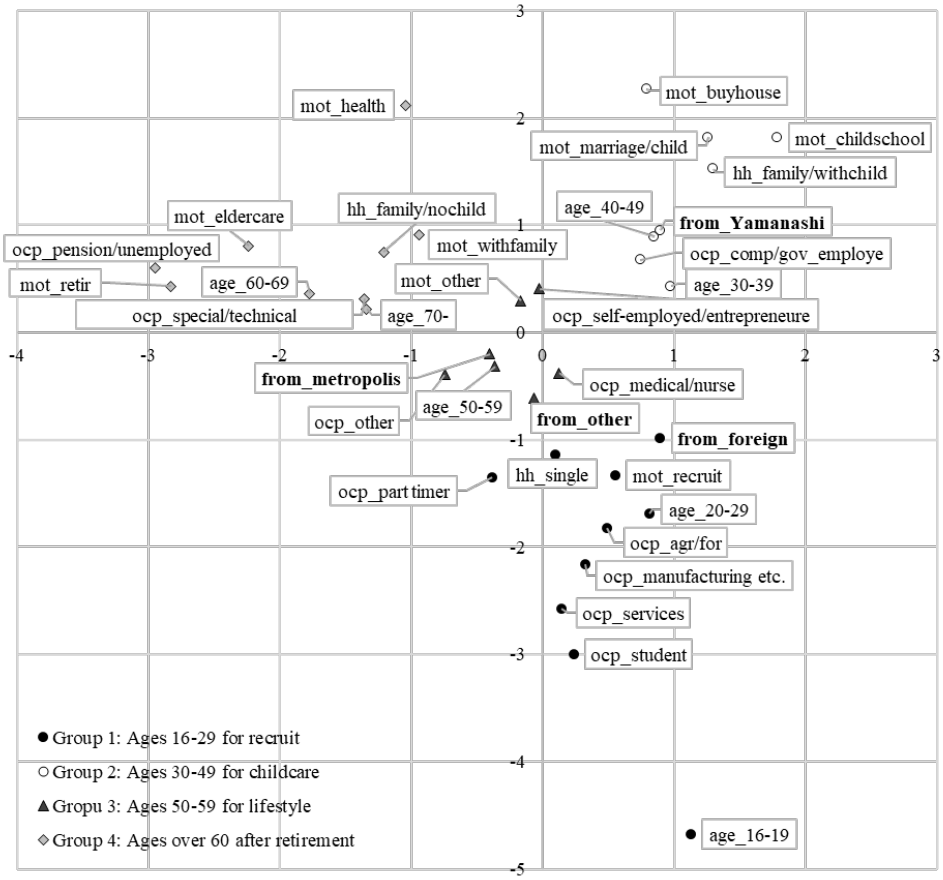


Figure 3.3 Biplot of the household attributes and opportunity structure category scores for the first and second axes generated by MCA.
The category plots were classified into four groups by cluster analysis, which are shown with four different symbols. Abbreviations in the plot label headings indicate variable names: ***from*** –previous address; ***mot*** – motivation for migration; ***hh*** –household structure; ***age*** –age of the eldest person in the household; and ***ocp*** –occupation. Labels on the plots representing previous address were bold-typed to distinguish them (representing opportunity structure) from the variables representing migrants' demographic characteristics.

3.3.2. Values of migration

Respondents numbering 679, of the total 868, specified their reasons for choosing Hokuto City as the migration destination, a variable I interpreted as the value of migration. The first reason was the City's natural environment (Table 3.1) including scenic beauty, climate and clean air. The second was housing-related reasons including house price, space, antiquity and others which were selected by 432 responses in total. These were followed by food, employment and transport.

A total of 19 value types identified in the survey data were grouped into eight clusters after a stepwise screening and clustering process (Table 3.1 and Figure 3.4): Step 1 removed the three value types that few (less than five) respondents selected; Steps 2–4 used MCA and the Smirnoff-Grubbs test to screen outlier value types; and Step 5 classified the remaining value types using their final category scores for the first and second axes generated by MCA. Two, among the eight clusters, encompass multiple co-occurring value types: cluster 6 contained nature, house (other), food, transport, social capital and leisure; and cluster 8 included house (price and space), child rearing and security.

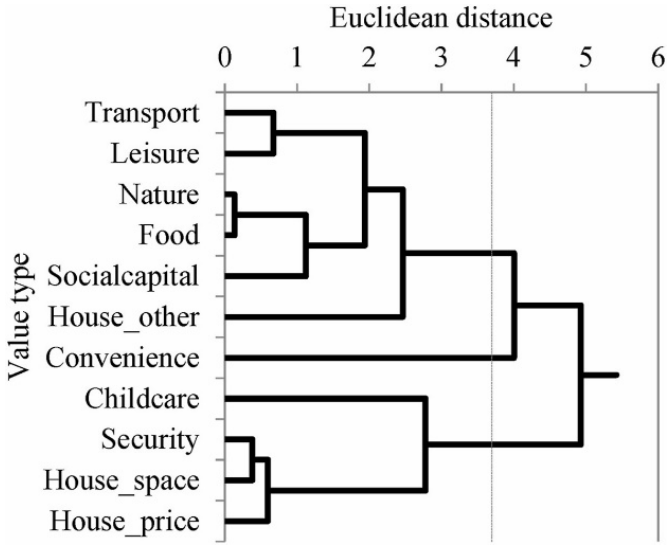


Figure 3.4 Clusters of the migration value types retained in Step 5.
The tree diagram presents the result of cluster analysis using the category values for the first and second axes generated by MCA at the fifth step indicated in Table 3.1.

3.3.3. Effect of migrants' demographic and spatial traits on values of migration

The effect of the variables representing different demographic traits and opportunity structure on the values of migration under the eight clusters was measured by canonical discriminant analysis (Table 3.2). The most important value types for the first household group – representing the youngest age group (16–29 years) with employment-focused motives – were birthplace (cluster 1) and employment (cluster 3). The 'birthplace' value was attributed the strongest to the households moved from foreign countries, indicating that the majority of respondents in this group were raised in Hokuto City, subsequently moved abroad, and finally returned to Hokuto City. The results also show that people in this group tended to find employment in the service sector.

Table 3.2 Effect of migrant group with different household attributes and opportunity structures on migration values.

Cluster[a]	Migration value	Household group[b]				Top 3 household attributes[c]		
		16-29 recruit	30-49 childcare	50-59 lifestyle	60- retire	1	2	3
1	Birthplace	0.49	0	0.11	-0.28	from4_foreign	occup08_part timer	motive11_buyhouse
2	Nearfamily	-0.25	-0.02	0.03	1.1	motive09_eldercare	motive08_withfamily	motive01_retire
3	Employment	0.38	-0.12	-0.17	-0.35	age_16-19	occup05_services	motive02_recruit
4	Lifestyle	-0.26	-0.19	0.42	-0.31	age_60-69	motive15_other	occup11_other
5	House_antique	-0.47	-0.17	-0.1	-0.02	age_70-	from2_Yamanashi	occup01_agr/for
6	Transport	-0.34	-0.15	0.27	-0.04	motive09_eldercare	age_50-59	occup07_sp/te prof.
	Leisure	-0.31	-0.02	0.32	-0.37	motive04_childschool	occup11_other	age_70-
	Nature	-0.53	-0.26	0.28	-0.02	occup07_sp/te prof.	motive01_retire	occup01_agr/for
	Food	-0.24	-0.1	0.18	0.11	motive08_withfamily	occup01_agr/for	occup05_services
	Socialcapital	-0.45	0.05	0.34	-0.79	occup03_medical/nurse	motive11_buyhouse	age_30-39
	House_other	-0.2	0.23	0.3	-0.22	occup03_medical/nurse	motive11_buyhouse	occup06_mf/tr/co/re
7	Convenience	-0.1	0.24	0.12	-0.65	occup08_part timer	motive04_childschool	occup11_other
8	Childcare	-0.16	0.4	-0.08	-0.09	motive04_childschool	hh3_family/withchild	motive03_marriage/child
	Security	0.18	-0.21	0.32	-0.33	from4_foreign	hh3_family/withchild	occup03_medical/nurse
	House_space	-0.18	0.36	0.13	-0.36	occup06_mf/tr/co/re	motive11_buyhouse	motive04_childschool
	House_price	-0.23	0.29	0.09	-0.85	age_40-49	occup01_agr/for	occup07_sp/te prof.

Note: a: Eight clusters refer to those identified by the analyses presented in Table 3.1 and Figure 3.4; *b*: Canonical discriminant analysis using the migration value types as dependent variables (binary) and the household traits and opportunity structures as independent variables (binary) generated category scores for the individual independent variables, which express the contribution of the respective independent variables to each dependent variable. The numbers presented in the "Migrant group" columns are, for the respective value types, the group average of the category scores of the independent variables within the four groups of the variables on household traits and opportunity structures identified in Figure 3.3. Larger positive numbers on thicker grey backgrounds indicate stronger positive contribution to, and smaller negative numbers on pale grey or white backgrounds indicate stronger negative contribution to the respective value types. Numbers equal to or close to zero indicate relatively neutral contribution to the type of the respective migration values. *c*: This column lists the variables on household traits and opportunity structures that made the strongest positive contributions to the respective value types, from the first to the third. Abbreviations of the variable names (heading before underscore) are: from –previous address; mot –motivation for migration; hh –household structure; age –age of the eldest person in the household; ocp –occupation. Abbreviations of the variable categories (subheading after underscore) are: agr/for –agriculture and forestry; sp/te prof. –special or technical professionals; mf/tr/co/re –manufacturing, transportation, construction or retailing.

The second-homeowner group in their 30s–40s with marriage and child-related motives rated highly the City's advantages in raising children, education, housing and convenience (clusters 7, 8). It appears that the households with children below 16 years old, as well as those that decided to migrate to Hokuto upon marrying or for raising children appreciated the City's favorable environment for raising children. The availability of spacious houses was rated highly by the households being engaged in manufacturing, transportation, construction and retailing sectors, as well as those that migrated to Hokuto to purchase a new house or to raise children. On the other hand, low housing price was important for the households headed by people in their 40s, especially those engaged in agriculture, forestry or special or technical professions.

The statistical results show a positive correlation between the categories attributed to the third respondent group (represented by people in their 50s) and a wide range of value types, particularly those under clusters 4 (lifestyle) and 6 (social capital, leisure, nature and transport). I discern, however, that the value types under clusters 4 and 6 were held commonly among the four respondent groups because the household attributes of the third respondent group were relatively neutral in explaining sample variance in the variables on household demographic characteristics and opportunity structure (Figure 3.3). Yet, the results

show the household attributes that contributed to the values of these types, such as medical workers valuing local social capital, parents raising children valuing leisure, and special or technical professionals appreciating nature.

The fourth household group represented by retirees over 60s had a focused priority to live with or near their family. This could be attributed to their responsibility to take care of elders, presumably their parents living in Hokuto after retirement.

3.4. Discussion

My results show the breadth of patterns in migrants to Hokuto City which goes beyond a single concept used by scholars to express urban-to-rural migration. The amenity migration concept, among others, would best describe such patterns in migrants, particularly the patterns of those in the 30s–50s age range, considering the centrality of natural amenity in their values of migration. Hokuto City has a number of traits of amenity migration destinations, such as scenic nature, mountains, forest, clean rivers, fresh air, tranquility, recreational fields and local food (Gkartzios et al., 2017; Gurran, 2008; Rainer, 2016; Stein et al., 2007). Lifestyle-related reasons for migration, such as desire for a rural or self-sufficient life, was expressed by a small number of respondents (17) (Table 3.1) who selected the 'other' option for a question on the reasons for moving to Hokuto City. The number was small presumably because 'lifestyle' was not a standalone option for this question. Notwithstanding this, 'lifestyle migration' could apply more widely to the migrants who moved to Hokuto City in search of a high quality natural environment. Migration to rural areas such as Hokuto City for those in the ages from 30s to 50s often necessitates changes in occupations and leisure time activities and thus lifestyle change. Lifestyle migration and amenity migration are conceptualized differently (Mclntyre, 2009), but cannot be distinguished in my results due to the survey design, or possibly because these inherently coincide among the migrants in these ages. Aside from these aspects, I identified two distinctive groups of people who migrated to Hokuto City for other objectives: migrants in the ages from 16 to 20s for recruitment, and those in their 60s and older for elderly caretaking. The breadth in the types of migrants arriving in a single destination as described above calls for an inclusive framework to better understand urban-to-rural migration.

My study demonstrated the utility of the value-expectancy model as an inclusive framework to capture diversity in urban-to-rural migrants. The framework helped me describe the process of migration decision making and the factors influencing the decisions, including the values of migration, in a structured manner. Focus on the values of migration is imperative in the analyses of lifestyle migration which has been increasingly reported but little studied in Japan. Using the value-expectancy framework, I believe this represents an important contribution to fill this knowledge gap.

Among the seven types of values of migration identified by De-Jong & Fawcett (1981), my study mainly covered comfort and affiliation, partially covered wealth, morality and status, and covered autonomy and stimulation only slightly. The limited coverage of the last two value types was primarily due to the limited response options provided in the survey form, which was pre-designed by the Yamanashi Prefectural Government.

De-Jong and Fawcett (1981) summarize the effects of different types of values of migration on migration decisions of people in different contexts, including in developing and developed countries. They postulated that community-based social and economic ties within the places of origin negatively affect people's decisions to move out. This is also revealed in my case but in a different context, that is, community-based ties within Hokuto motivate those who once out-migrated from Hokuto to return, as seen in the centrality of the 'birthplace' value for the group of migrants in ages between 16 and 29 primarily seeking employment. Likewise, my findings show the effect of family and friends affiliation as De-Jong and Fawcett (1981) indicate, but on different groups of people. In my context, this value category is applicable to the retirees who had out-migrated from Hokuto for employment but returned to take care of their family – presumably their aging parents remaining in Hokuto. With these values inherent to returnees, and as Ní Laoire (2007) pointed out, distinction between return migrants and one-way migrants should be made in the analyses of values of migration. Further, my finding on the affinity of housing-related values with the migrants from within Yamanashi prefecture agrees with De-Jong and Fawcett (1981), which explained the importance of residential satisfaction motives for short-distance movers in developed countries.

Among other domains of the value-expectancy framework, my results also show the effect of opportunity structure on the values of migration in terms of it being explained by migrants' previous address. While this presumption may not be wrong, migrants' previous address cannot fully represent such a multifaceted concept as opportunity structure as De-Jong and Fawcett (1981) determine. Further, the expectancy domain was not isolated from the values domain in my analyses due to methodological constraints.

The low quality of description of the variety in migrants by the first two primary factors identified by MCA (15.02% in total), i.e., age and family/individual orientation, might have derived from a much higher complexity in migrants as denoted above. However, the quality of explanation could be improved by a questionnaire design that is better aligned with the value-expectancy framework and that addresses the above issues, particularly distinction between return and one-way migrants, as well as finer breakdown of opportunity structure.

Leaving aside these limitations, my findings demonstrate the utility of the value-expectancy framework to better understand the migration decision making process and the factors influencing the decisions in a structured manner. Knowledge of heterogeneity in migrants and of their values – drawn from such understanding – will enable targeted policies and public services concerning migration. De-Jong and Fawcett (1981) noted a weak, or at best moderate effect of lifestyle preferences on migration decisions but predicted such effect would increase in the future when they proposed the value-expectancy framework 40 years ago. Now that their prediction has come true, the lifestyle preferences component of the value-expectancy framework requires further investigation. The survey I used for this paper was undertaken before the COVID-19 pandemic, which resulted in a rapid spread of teleworking among working ages (Cabinet Office, 2020). Considering the high relevance of employment for people in their 20s or younger, among other values of migration that my study identified, teleworking might offer a wider range of options of places to work and live, or of lifestyles – which could have important implications for urban-rural

population flows post-COVID-19.

The present migration policies of Hokuto City focus on direct civil services to prospective- and post-migrants, as set forth in the Hokuto City Population Vision and General Strategy (Hokuto City, 2018), with little attention to why, for the past few decades, a high number of migrants have been choosing to live in Hokuto City. My finding of the centrality of the proximity to nature in their motivation for migration suggests the efficacy to leverage its scenic nature more in its population policies. Such population policy needs to go beyond the current sectoral silo and to mobilize efforts in other sectors, particularly land use and infrastructure, agriculture, forestry and nature conservation. A more detailed analysis of the natural attributes of motivation for migration can inform such integrated hands-on efforts to promote migration.

3.5. Conclusions

Analysis of the migrant survey data obtained from Hokuto City revealed common values of migration, i.e., nature, housing and food. However, heterogeneity in priority values were found between people in different life stages. Employment was a priority for migrants in ages between 16 and 29. Migrants in their 30s and 40s valued the favorable child-rearing environment. I found no distinctive value tendency of the migrants in their 50s. To stay with or near family was a priority for the retired migrants over 60. Knowledge of heterogeneity in migrants and of their values, as described herein, will enable targeted policies and public services concerning migration. Widespread acceptance of teleworking after experiencing the COVID-19 pandemic might offer people in their working ages, particularly 20s and younger, a wider range of options of places to work and live, or of lifestyles, which might have important implications for urban-rural population flows post-COVID. Also considering the centrality of natural environment in the values of migration to rural areas, such as Hokuto City, a more detailed analysis of the region's natural attributes that attract migrants would be useful to inform regional land use planning that is salient to the values of migrants.

4. Spatial exploration of rural capital contributing to quality of life and urban-to-rural migration decisions: A case study of Hokuto City, Japan

4.1. Introduction

Forward-looking policies to realize a deurbanization pathway would be benefitted from knowledge on environmental contributors to QoL in the rural context. Literature is accumulating in this field, but yet fragmented to provide robust support to such policies (Section 1.4). The fragmentation is notable in a methodological dichotomy into biophysical-data driven approach and perception-based approach. Efforts were made to converge the two approaches but yet limited to urban contexts where land is covered mostly by built-up areas, or at best includes urban green and blue spaces. In addition, the former chapter (Section 3.5) revealed the centrality of natural environment in the values of migration to rural areas, and hence pointed out the need of more detailed understanding of the specific elements of rural natural capital that are salient with such migration values.

Therefore, this study aims to explore the natural and other types of rural capital within Hokuto City, Yamanashi prefecture of Japan, that contribute to QoL of the residents, and thus attract migrants to Hokuto City. The subject of the study is not limited to migrants, but also includes native residents, because the understanding of the differences in the contributors to QoL among the households of different characteristics, e.g., natives and migrants, might provide important policy implications. Geospatial data and tools were used to quantify the access of residents to natural and other types of rural capital, because these capital elements are often spatially distinctive and their contributions to QoL tend to decay with distance (Łaszkiewicz et al., 2022; Olsen et al., 2020). Such a spatially-explicit analysis could provide a useful evidence base for rural landscape design that supports a shift to deurbanization pathway.

4.2. Materials and methods

4.2.1. Analytical framework

The extended four-capital framework (see Section 2.2) was applied to develop a basic analytical framework to explain the contribution of six types of rural capital, i.e., natural, built, human, social, cultural and financial capital, to human needs satisfaction and migration decision making (Figure 4.1). Here the contributions of different types of capital to fulfilling human needs are expressed by the solid-line arrow, from (b) “access to rural capital” to (a) “human needs fulfillment”. In addition, the downward solid-line arrows from these two components towards (c) “migration decision” express my proposition that urban-to-rural migration is driven by people’s desire to meet their human needs by improved accessibility to natural and other type of rural capital. The analytical framework incorporated the effect of (d) “household attributes”, because the level of contribution of each capital item to human needs satisfaction, as well as the values that underly migration motivation, differ among people with different socio-economic and cultural backgrounds (Costanza et al., 2007; Takahashi et al., 2021).

I gathered data on the four components ((a) ~ (d) in Figure 4.1) using a questionnaire survey, open and purchased spatial datasets and government statistics. Using these datasets, I analyzed the contribution of

individual's accessibility to rural capital to the fulfillment of one's human needs, and finally explored the elements of human needs and the rural capital that were decisive for migrants in choosing their present home address. The following Subsections 4.2.2, 4.2.3 and 4.2.4 provide details of the questionnaire survey, the spatial and statistical data gathered and the analytical methods used.

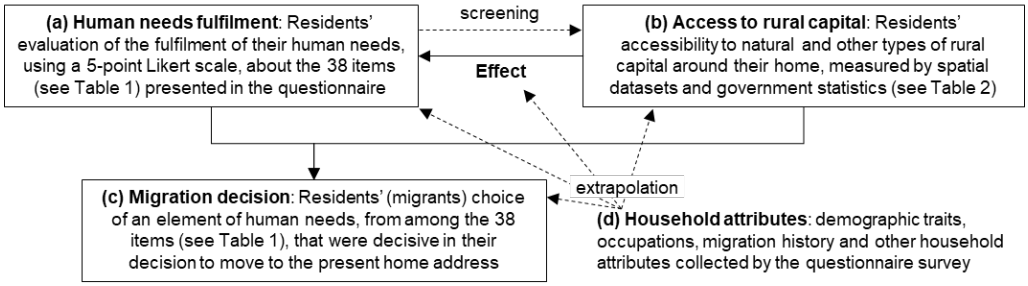


Figure 4.1. Analytical framework

4.2.2. Questionnaire survey

I prepared two questionnaire sheet sets – one for native households and the other for migrant households, respectively containing common and different questions contextualized for the respective type of respondent (See Appendix 1 for an English translation of the questionnaire). In the survey, native households were defined as households in which all adult members were born and raised in the current Hokuto City territory, and had never lived outside the area for a year or longer. The rest were determined as migrant households, which were further divided up into return migrants and one-way migrants for analytical purpose: Return migrant households were those with one or more adult members born and raised in the area; and one-way migrant households were those without such an adult member. The operational definitions of natives, return migrants and one-way migrants as explained above referred to those used by the national authorities but contextualized for my analysis. For example, MIC (2018) and NIPSSR (2018b) define an urban-to-rural migrant household as one which changed its living address from an urban to a rural depopulating municipality between two national census rounds (a five-year interval in Japan). MIC (2018) defines a return migrant as one who migrated back to the area where they were born and raised, after living in an urban municipality for a certain period for education and/or employment. A migrant to the area where one was neither born or raised is defined as a one-way migrant. My operational definitions considered that, in reality, households are usually made up of individuals with different locational backgrounds. I also adopted one year of living outside as the cut-off period for dividing natives and return migrants, which was likely to increase sensitivity in my analysis. The job classification used for the survey derived from the Japanese standard classification system (MIC, 2014).

The question on human needs fulfillment, comprising 38 sub-questions across six different aspects of life (Table 4.1Table 3.1), asked respondents to rate their level of satisfaction with each of the 38 human need elements using a five-point Likert scale. These 38 sub-questions derived from the Costanza et al.'s (2007) list of human needs and adjusted to my survey context referring to the profiling of migrants to Hokuto City by Takahashi et al. (2021) and the Japan's Social Indicators classification system (Statistics Bureau of

Japan, 2020), and considering their relevance to the six types of rural capital within Hokuto City. The questionnaire had an additional question for return and one-way migrant households to identify the top-five human need elements among the 38 that were decisive in choosing the present home address. I finalized the questionnaire after a pilot test with 12 residents, including natives and migrants, at a workshop held in Hokuto City on 12 September, 2019.

I used quasi-random sampling in distributing the survey. I dispatched 2,520 questionnaire packets, covering 11.8% of the households in Hokuto City. This number was based on an assumed response rate of 15% and sufficient sample size for statistical analyses with less than 5% sample error and 95% confidence level, in accordance with the guidance provided by Hill (1998) and Krejcie and Morgan (1970). Each packet enclosed a request letter and two questionnaire sheets – one for natives and the other for migrants respectively – so that respondents could answer the one applicable. The packets were delivered to every seventh house along each street of the entire City area over a period between 20 April and 4 May 2020, based on a commercial housing map provided by Zenrin Co., Ltd. The responses returned no later than 14 May 2020 were used for analyses.

Table 4.1. A list of 38 human need elements relating to six aspects of life

Aspects of life	Human needs element
Work and employment	1. Availability of places, materials and the environment for work
	2. Enabling conditions for a new challenge
	3. Contribute to local community through work
	4. Unique business chance and/or network of collaborators
	5. Urban access
	6. Comfortable workplace
	7. Work-life balance
	8. Prestigious or influential job
	9. Income
	10. Low business cost
Housing and lifestyles	11. Comfortable climate or clean air
	12. Clean water
	13. Local food
	14. Low housing cost
	15. Ideal house
	16. Renewable energy
	17. Scenic beauty
	18. Tranquility and natural soundscape
	19. Ideal lifestyle
	20. Mobility
	21. Shopping and eating out
	22. Low living expenses
	23. Government subsidy or tax exemption
	24. Security
Child raising and education	25. Time with family
	26. Community support to child raising
	27. Outdoor activities for children
	28. Public support/facility for child raising and/or education
	29. Good schooling
Medical and health care	30. Medical services (public facility/support for health and elderly care)
	31. Natural environment to support medical treatment and rehabilitation
Culture, leisure and learning	32. Unique local culture
	33. Public facility/support for learning and sports
	34. Space for sports and outdoor recreations
Family and community relations	35. Nearness of family and friends
	36. Participation in and contributions to the local community
	37. Stimulating people
	38. Sense and identity of place

4.2.3. Spatial data and government statistics

I gathered spatial data and government statistics from digital national land information (https://nlftp.mlit.go.jp/ksj/), basic map information (https://fgd.gsi.go.jp/download/menu.php), Zenrin Building Point Data (ZENRIN, 2020) and the Portal Site of Official Statistics of Japan (e-Stat: https://www.e-stat.go.jp/en). From these sources, I extracted spatial data and statistics that were semantically relevant to the 38 human need elements as well as to the six types of rural capital – referring to the definitions of natural, built, social and human capital by Costanza et al. (2007) and cultural and financial capital by Flora et al. (2018). Among the six capital types, however, social capital was removed from the spatial analyses because the spatial data that explicitly represent social capital was not identified from the above sources.

An initial processing of these datasets generated 27 spatial data items (Table 4.2). These mostly derived from simple extraction of relevant elements from the original sources, except for three numeric data items, i.e. mountain peak view surface data, employment point data and noise level surface data, which required additional calculations. The mountain peak view surface data, proposed as a proxy for scenic beauty, was measured by the visibility of four prominent peaks around Hokuto City (Mt. Akadake of the Yatsugatake range, Mt. Kai-Komagatake of the Japanese Southern Alps range, Mt. Mizugaki and Mt. Fuji) at each spatial location. This was calculated through viewshed analysis using the digital elevation model, following the method used in (Vukomanovic et al., 2014). The employment capacity point data gives the estimated number of employees at individual business locations. Specifically, the total number of employees in each district from the 2014 Economy Census data was distributed to the individual office locations within the district in proportion to the office floor area provided by the Zenrin Building Point Data. The noise level surface data was generated from the national road traffic census data (MLIT, 2015b) and guided by (Watanabe et al., 2009) which provides a simple method to simulate a road traffic volume to meet the Japanese environmental quality standard on noise annoyance. It may be counter-intuitive to use noise level, among others, as a parameter of natural capital: My proposition was to use it as an inverse natural capital parameter considering the increasing natural soundscape pleasantness with reduced human-made noise (Levenhagen et al., 2021).

Table 4.2. Spatial data and government statistics used for geospatial analyses

Feature name	Capital type	Source	Data title (code, where assigned)	Data element used for analysis (code, where assigned)	Year	Processed data type	Unit
Farmlands	natural	Digital National Land Information	Land use 100m mesh (L03-b-16)	Rice paddies (100)	2016	Surface, cat.[a]	m^2
				Other agricultural land (200)	2016	Surface, cat.	m^2
Forest	natural			Forest (500)	2016	Surface, cat.	m^2
Natural parks	natural		Natural parks (A10)	All	2015	Surface, cat.	m^2
Temperature	natural		Climate 1km mesh (G02)	Annual mean temperature (53)	2012	Surface, num.[b]	°C
Streams	natural		Streams (W05)	All	2008	Line, cat.	m
Symbolic natural sites	natural		Symbolic natural/ geological sites (P19)	All	2012	Point, cat.	Number of points
Water	natural			Canyon, waterfall or spring (6-601, 610, 903)	2012	Point, cat.	Number of points
Farmers' markets	natural		Local business facility (P24)	All, incl., on-farm markets/ restaurants and experience farm/facility	2012	Point, cat.	Number of points
	natural		Tourism resource (P12a)	Shops, restaurants and other facility (7-5~6)	2014	Point, cat.	Number of points
Outdoor recreations	natural			Sports and recreation sites (7-4)	2014	Point, cat.	Number of points
Local events	cultural			Natural, cultural or historical events (7-1~2)	2014	Point, cat.	Number of points
Hot springs	natural			Hot spring and healthcare facility (7-3)	2014	Point, cat.	Number of points
Cultural heritages	cultural		Cultural heritage (P32)	All, incl., tangible/intangible/ folkloristic heritages, monuments, cultural landscapes/buildings	2014	Point, cat.	Number of points
Schools	human		Schools (P29)	All, incl., primary, junior high and high schools and colleges	2006	Point, cat.	Number of points
Medical facility	built		Hospitals and clinics (P04)	All, incl., hospitals, general clinics and dentists	2020	Point, cat.	Number of points
Cultural facility	built		Cultural facility (P27)	Museums, archives, libraries, aquariums, zoos and botanical gardens (4-03001 to 03005)	2006	Point, cat.	Number of points
Sports facility	built			Sports field/facility (4-03101 to 03110)	2006	Point, cat.	Number of points
Bus stops	built		Bus stops (P11)	All	2010	Point, cat.	Number of points
Railway stations	built		Railway stations (S12)	All	2020	Point, cat.	Number of points
Highway gates	built		Highway data (N06)	Entrance gates (N06_019/1, 2)	2020	Point, cat.	Number of points
Mountain peak view	natural	Basic Map Information	Digital elevation model 10m mesh	All	2021	Surface, num.	Number of peaks
Shops and restaurants	built	Zenrin Building Point Data	Zenrin Building Point Data	Restaurants, shops and discount stores	2020	Point, cat.	Number of points
Shop/restaurant floor area	built			Floor area of restaurants, shops and discount stores	2020	Point, num.	Number of points
Enterprises	financial			Office	2020	Point, cat.	Number of points
Office floor area	built			Office floor area	2020	Point, num.	m^2
House floor area	built			Resident house floor area	2020	Point, num.	m^2
Employment capacity	financial	e-Stat[c]	2014 Economy Census Basic Survey district statistics	Number of employees	2014	Point, num.	person
Noise level	natural	National Road Traffic Census	Road traffic table - Yamanashi Prefecture	24 hours traffic total, vehicle velocity average and the proportion of cargo vehicles	2015	Surface, num.	dB

a cat. categorical data; *b* num. numeric data; *c* Portal Site of the Government Statistics of Japan

4.2.4. Analyses on human needs fulfillment, accessibility to rural capital and migration decisions and on their interactions

My analyses took the following five steps to unpack each of the four components and their interactions illustrated in the analytical framework (Figure 4.1).

First, I measured the level of the fulfilment of the respondents' human needs (Figure 4.1(a)) by their evaluation of the 38 items (Table 4.1) in the questionnaire. To understand the overall tendency among the residents, I used Principal Component Analysis (PCA) and Cluster Analysis to reduce the dimensions of the variables, and thereafter tested the effects of the respondents' household attributes on the reduced variables using ANOVA and the Bonferroni-type multiple comparison (shown by the dotted-line arrow from component (d) to (a) in Figure 4.1). This procedure followed Hinkin (1998) and Carifio and Perla (2008).

Second, I quantified the respondents' accessibility to different types of rural capital (Figure 4.1(b)) through geospatial analysis. On a digital map, the home address of a respondent was represented by an aggregation of the 100 m square grids that correspond to the settled area of the ward of the respondent's home address (acquired from the questionnaire). This involved generating 100m grid cells from the e-Stat ward-level administrative boundary polygons, extracting the grid cells that contained one or more resident house point(s) provided by the Zenrin Building Point Data (ZENRIN, 2020), merging the settled cells in each ward, and finally matching the ward-wise merged settled cells with the respondent's home address. It was necessary to extract only settled area in each ward to obtain sufficient spatial resolution of resident home locations, considering a high coverage of unsettled lands, particularly mountains and forests, in many wards in Hokuto City.

The measurement of accessibility was taken in seven different distance ranges, i.e., within settled grids of each ward, as well as within the buffer polygons of 250m, 500m, 1 km, 2 km, 4 km and 8 km radii from the external edge of the settled grids. Accessibility to the elements of rural capital represented by categorical surface, line or point data, among the 27 elements (Table 4.2), was measured by their density within the seven distance ranges, producing area coverage rate (%), total length per area (m/m2) and number of points per area (/ha) parameters respectively. Accessibility to the elements represented by numeric surface data, except for temperature and noise level, was measured by the average of the grid cell values within the seven measurement ranges. Likewise, accessibility to the elements represented by numeric point data, except for house floor area, was measured by totaling the point values within the seven measurement ranges respectively, which then was divided by the area of the respective measurement ranges for standardization. The temperature, noise level and house floor area values were averaged only within the settled grids of each ward because these values matter for a resident only at one's home. The measurement of the residents' accessibility to the 24 rural capital elements, excluding these three from among the 27, in different distance ranges from each ward aimed to enable an analysis sensitive to the rural capital elements outside the settled area of each ward that potentially contribute to human needs fulfillment and that have varied spatial patterns. The need for applying different distance ranges was also because varied decay distances of welfares deriving from natural and built capital in different contexts as shown by earlier studies (Cho et al., 2011; Eom et al., 2018; Tammi et al., 2017). This procedure produced 171 variables, in total, of the accessibility to the 27 rural capital elements by residents in each ward.

Third, I generated a longlist of the combinations of rural capital and potentially relevant human need elements, which then was screened to produce a shortlist of combinations of stronger relevance (shown by

the dotted-line arrow from the component (a) to (b) in Figure 4.1). To generate the longlist, each of the 27 rural capital elements was matched with all semantically relevant human need elements from among the 38 items listed in Table 4.1. From the longlist, the combinations with the Spearman's correlation coefficient of no less than 0.2, indicating weak correlation (Akoglu, 2018), in at least one distance range was selected. Regarding each of the selected combinations between the 24 rural capital elements (with the accessibility measurement in seven distance ranges) and human need elements, one distance range that produced the strongest correlation was chosen. The remaining combinations after the above screening process formed the shortlist. I applied this screening process to identify nuanced biophysical indicators, which Roman and Thiry (2016) pointed out as a challenge in the precedent studies.

Fourth, in the shortlisted combinations, I assessed the contribution of the accessibility to rural capital in a specific distance to human needs fulfilment using ANCOVA (expressed by the solid-line arrow from the component (b) to (a) in Figure 4.1). The ANCOVA controlled the household attributes that were tested as significant in the first step to explain variance in the level of the fulfillment of different human needs among the respondents. In addition, an ANOVA of rural capital accessibility among respondents was conducted to help interpret the ANCOVA results.

Fifth, I identified the human need and rural capital elements that were decisive in the migrants' decision to move to the present home address in Hokuto City (shown by the downward solid-line arrows from component (a) and (b) to (c) in Figure 4.1). This analysis matched the respondents' choice of a human need element, from among the 38 elements presented in the questionnaire, that were decisive in making migration decision, with the results of the former step on the links between rural capital and human needs fulfillment.

I used QGIS version 3.10 (QGIS.org, 2020) for geocomputing and R version 4.0.3 (R Core Team, 2021) with the tidyverse package (Wickham et al., 2019) for statistical analyses and graph drawing.

4.3. Results

4.3.1. Summary of survey respondents

The number of questionnaires returned was 414, which is 16% of the questionnaires distributed and 2% of the households registered to the Hokuto City municipal office as of January 2021. Summary statistics on the respondent household attributes are presented in Table A.2.2. This includes basic data with important implications, e.g., distance from one's home to work location where 63 respondents (15 % of all valid responses) identified their work location at home. The data also shows migrants' housing type, where 129 (45% out of all migrant households) built new houses on purchased or rent properties. Further, results using Pearson's Chi-squared test showed a statistically significant association between the respondents' home ward and their migration history (X-squared = 173.88, df = 112, p = 1.63e^{-4}) and occupation sector (X-squared = 357.03, df = 280, p = 1.25e^{-3}), among other household attributes, indicating a spatial difference in home areas between households of these two attributes (Figure 4.2).

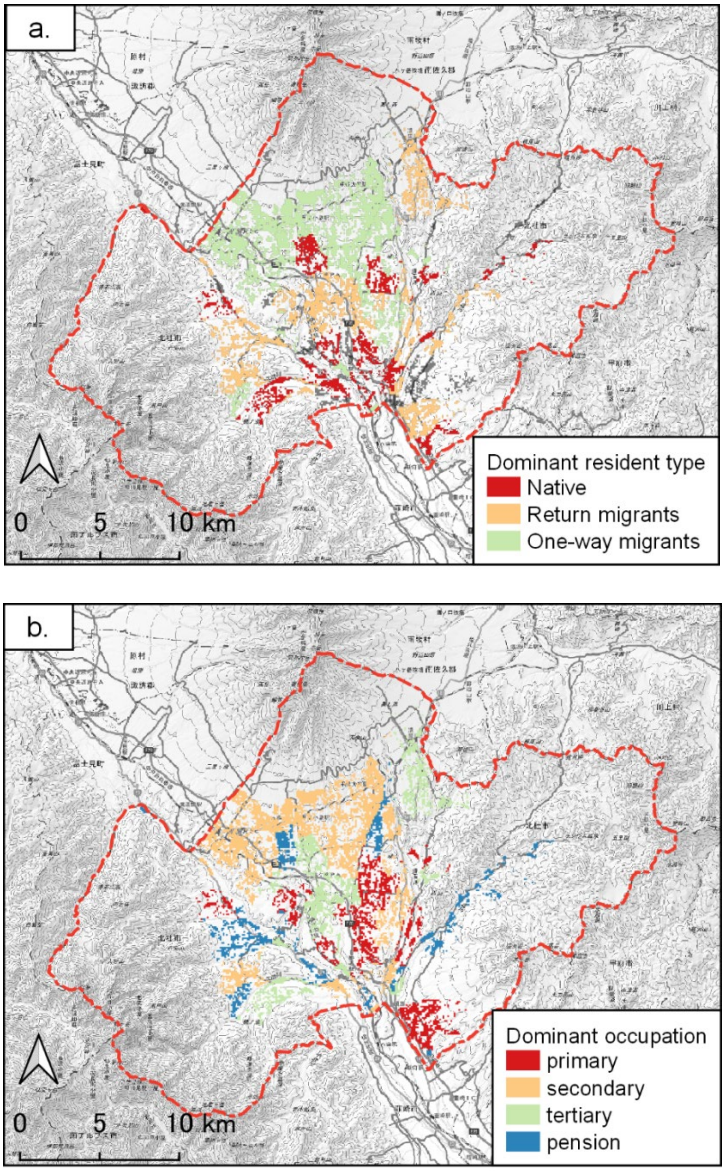


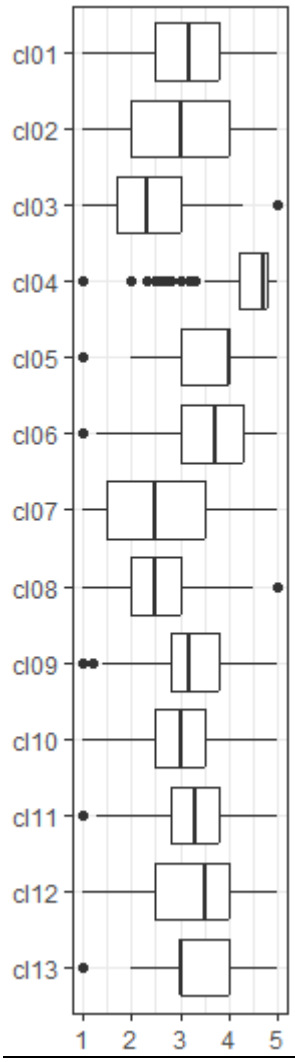
Figure 4.2. Dominant household groups in each ward regarding (a) migration history and (b) occupation of primary income earner
The color of the settlement area represents the relative dominance of household groups of (a) different migration history and (b) different forms of occupation of the primary income earner within each ward. The relative dominance was identified by three steps to account for the difference in sample size between wards and between groups: (1) calculating the proportions of the households falling under respective groups within each ward, (2) transforming these proportions into ranks between wards for each group, and (3) isolating the group that ranked the highest within each ward.

4.3.2. Human needs fulfillment

The 38 sub-questions on human needs fulfillment obtained 314 valid answers. A PCA of the Likert scale scores of these sub-questions identified seven principal components with eigenvalues not less than 1, and the cumulative contributions of the seven eigenvalues to variance in the 38 raw variables was 66.79%. Then, cluster analysis performed on the eigenvectors obtained from the 38 raw variables against the seven principal components identified 13 clusters at a Euclidean distance of 0.464, which was an appropriate resolution to represent different rural capital types (Figure 4.3). Among the 13 human need clusters, natural amenity (cluster 4, natural capital) had by far the highest mean score. In contrast, income or

prestigious/influential job (cluster 3, financial capital) had the lowest score, followed by convenience of life (cluster 7, built capital).

ANOVA and the Bonferroni pairwise t-test of the difference in the mean scores of the 13 human need clusters between households with different traits identified a significant difference between native, return and one-way migrant households in five clusters (Figure 4.3). One-way migrants were more satisfied than return migrants with natural amenity (cluster 4) but less with housing costs (5). Native and return migrant households were more satisfied with their engagement with family, friends and local community (clusters 12 and 13) than one-way migrants. The level of fulfillment of health-related needs (cluster 10) was higher among natives than one-way migrants. Likewise, the households with children were more satisfied with income (cluster 3), lower living expenses (8), outdoor space, schools and community support for children (9) as well as leisure opportunities (11) than those without children.

Score mean	Cluster	Narrative (relevant capital type)	Household (hh) attributes that affected score negatively < positively
	**1**	Unique business opportunity, e.g., material, space, networking (natural, built, social)	pensioner < tertiary*
	2	Convenience of work, e.g., urban access (built)	
	3	Income/prestigious job (financial)	multiple hh without < with children**
	4	Natural amenity, e.g., climate, water, scenic beauty and local food (natural)	return < one-way*
	5	Low housing costs (financial)	one-way < return**
	6	Ideal home, e.g., fireplace, natural lifestyle (natural, built)	
	7	Convenience of life, e.g., mobility and shopping (built)	
	8	Low living expenses (financial)	multiple hh without < with children*
	9	Reproduction, e.g., outdoor space, schools and community support for children (natural, human, social)	single hh < multiple hh with children*
	10	Health, e.g., clean environment and medical services (natural, built)	one-way < native**
	11	Leisure, e.g., outdoor space, facility, groups and programs (natural, built, social, human)	60s < 50s*; multiple hh without < with children*
	12	Affection, e.g., family and friends (social)	60s < over 70*; one-way < native and return***
	13	Participation, e.g., contribution to local community (social)	one-way < native and return***

*p < .05; **p < .01; ***p < .001

Figure 4.3. Distribution of mean score of the 13 human need clusters and influential household attributes

4.3.3. The contribution of rural capital accessibility to human needs fulfillment

The initial longlist contained 1,309 combinations of human need and rural capital elements in different distance ranges. From the longlist, a shortlist of 71 combinations was obtained after screening out the combinations with weak correlation ($R^2 < 0.2$ in all the measurement ranges) and extracting the measurement range with the strongest correlation from each of the remaining combinations. Finally, ANCOVA identified 17 combinations concerning 13 rural capital elements in which better accessibility to each rural capital element in a specific distance range from the respondents' home significantly contributed to fulfilling their human needs (Table 4.3). Maps of the spatial pattern of each rural capital element produced in this process were presented in the supplementary material (Figure A4.1).

Table 4.3. ANCOVA results on the contribution of rural capital accessibility to human needs fulfillment with household attribute covariants

Rural capital	Human needs	Range	Slope		Covariant		Residual SE	Multiple R^2	F-value	Fig.4.4[a]
Farmlands	Local food	4km	Mig: native	3.315 ***	Mig: one-way	-3.009 *	0.974	0.034	2.633 *	N1
	Business resource	100m	Job: primary	1.211	Job: Un-employed	-14.22 *	0.974	0.034	2.91 **	-
Forest	Business resource	100m	Job: primary	2.322	Job: pension	-5.154 *	1.279	0.104	2.805 **	-
Natural parks	Sports/ outdoor recreation	2km	Mig: native	-4.68 *	-		0.993	0.058	4.57 ***	-
Symbolic natural sites	Sports/ outdoor recreation	8km	Mig: native	-0.06	Mig: one-way	0.106 **	0.988	0.066	5.253 ***	N2
	Comfortable work space	8km	Job: primary	-0.07	Job: tertiary	0.19 *	1.215	0.109	2.881 **	-
Mountain peak view	Scenic beauty	500m	Mig: native	0.236 *	-		0.695	0.04	3.209 **	N3
Mean temperature	Ideal lifestyle	100m	Mig: native	-0.01	Mig: one-way	-0.308 *	0.993	0.077	6.092 ***	N4
Noise level	Tranquility	100m	Mig: native	-0.044 *	-		0.721	0.067	5.505 ***	N5
Highway gates	Urban access	1km	Mig: native	0.588 *	-		1.338	0.037	2.355 *	B1
	Mobility	250m	Mig: native	2.864 *	-		1.325	0.038	3.055 *	B2
Railway stations	Urban access	4km	Mig: native	0.274 *	-		1.331	0.048	3.047 *	B3
Shops and restaurants	Shopping/ eating-out	2km	Mig: native	0.015 **	-		1.199	0.066	5.467 ***	B4
Medical facility	Medical services	100m	Mig: native	0.157	Mig: return	-0.370 *	1.029	0.073	6.086 ***	B5
Sports facility	Sports/ outdoor recreation	100m	Mig: native	-0.26	Mig: return	1.006 *	0.975	0.091	7.366 ***	-
Employment capacity	Prestigious/ influential job	2km	Mig: native	0.002 *	-		1.098	0.048	2.675 *	F1
	Income	2km	Mig: native	0.002 *	-		1.002	0.041	2.387 *	F2

*$p < .05$; **$p < .01$; ***$p < .001$

a Column "Fig.4.4" present the label of the respective data plots (sub-diagrams) in Figure 4.4

The analysis revealed the difference in these contributions between native, return and one-way migrant households and between households with different occupation types of the primary income earner. The needs of one-way migrant households, as compared to native households, for leisure opportunities and for the realization of their ideal lifestyles were better met in the areas with the higher accessibility to symbolic natural sites and with lower temperatures, respectively (Figure 4.4 N2, N4). Native households were more satisfied with rich local food and scenery in areas with higher farmland coverage and better mountain views, respectively (Figure 4.4 N1, N3). Lower traffic noise, proximity to highway gates and railway stations and a better accessibility to stores and employment capacity unanimously contributed to meeting the human needs of native, return and one-way migrant households (Figure 4.4 N5, B1-4, F1-2).

The complementary ANOVA tested the variation of rural capital accessibility between the respondents in different groups concerning the two household attributes that were shown as significant, in section 3.1, to explain their settlement patterns, i.e., migration history and occupation groups. The analysis revealed a significant difference in the accessibility to six, among the thirteen, rural capital elements between native households and return and one-way migrant households (Figure 4.5). One-way migrant households tended to live in the wards nearer natural amenities than native and return households, e.g., with higher forest cover, near natural parks and symbolic natural sites, or on higher-up mountain slopes where temperatures are lower. Their home locations were also in the areas with a better accessibility to key built and financial capital elements, i.e., railway station and employments. The analysis also showed difference in the accessibility to three capital elements between the households in different occupation groups. Home location of tertiary sector workers and pension households, among others, tended to have higher forest cover, be nearer natural parks and on higher-up mountain slopes with lower temperatures.

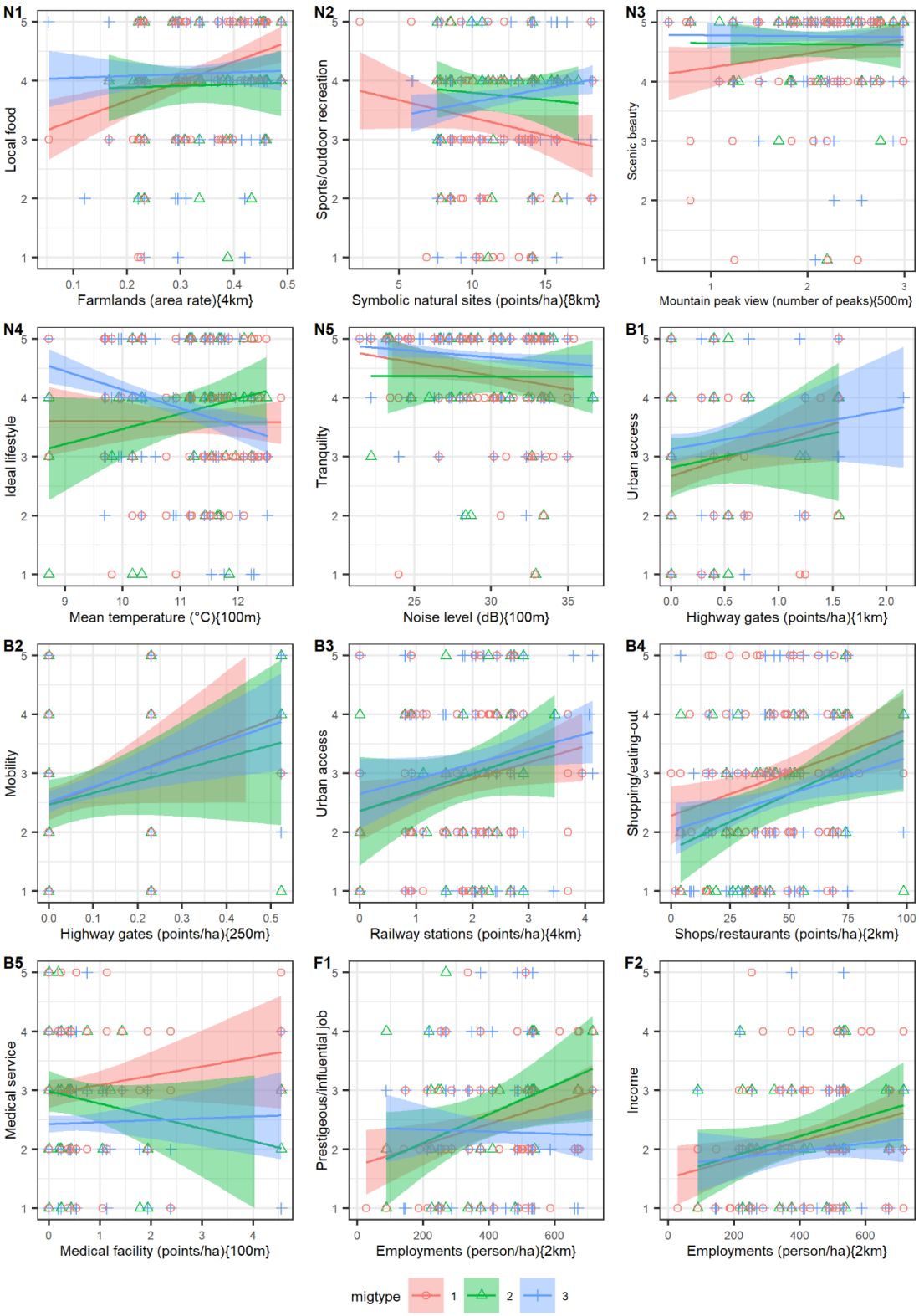


Figure 4.4. Contribution of rural capital accessibility to human needs fulfillment
Legend: migtype (migration type) 1: native residents; 2: return migrants; and 3: one-way migrants. Sub-diagram labels (N1-5, B1-5, F1-2) correspond to the results of ANCOVA presented in Table 4.3, with "N", "B" and "F" representing natural, built and financial capital respectively. Horizontal axis of each sub-diagram shows the accessibility to each rural capital element, with the unit of measurement in round brackets "()" and the measurement range in curly brackets "{}". Vertical axis shows the level of the fulfilment of each human need element which was evaluated by the respondents using a five-piont Likert scale in the questionnaire.

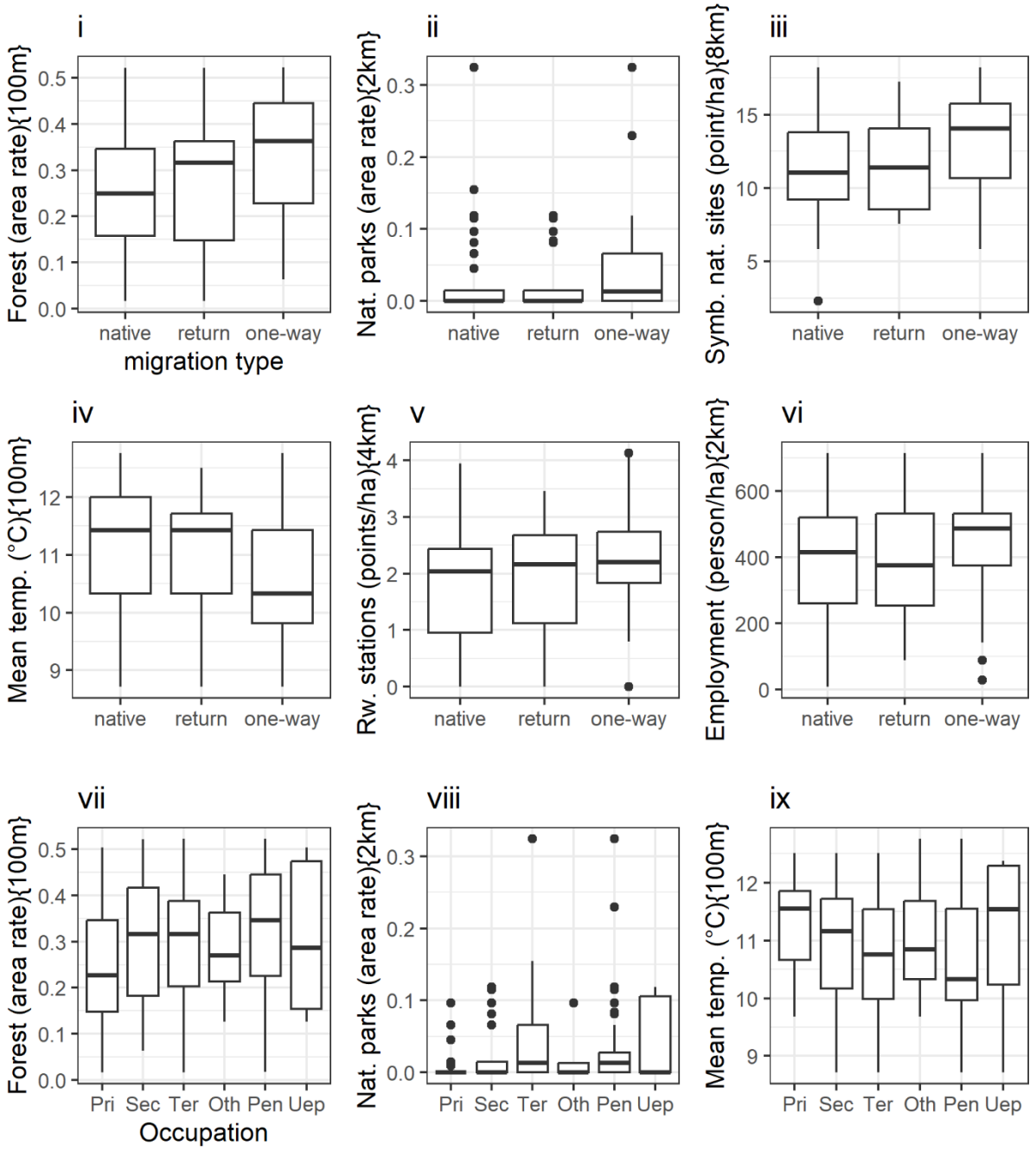


Figure 4.5. Variation in accessibility to rural capital between households with different migration history (i-vi) and occupation of primary income earner (vii-ix)
Vertical axis of each sub-diagram shows the accessibility to each rural capital element, with the unit of measurement in round brackets "()" and the measurement range in curly brackets "{}". In diagrams vii-ix, the horizontal axis label “Pri” indicates the primary sector; “Sec” the secondary sector; “Ter” the tertiary sector; “Oth” other unclassified sector; “Pen” pension; and “Uep” unemployed. F-statistics for the nine sub-diagrams were: i) 14.899***; ii) 4.278*; iii) 12.989***; iv) 19.134***; v) 8.246***; vi) 6.511***; vii) 2.491*; viii) 2.544* and ix) 3.023* (*$p < .05$, **$p < .01$, ***$p < .001$)

4.3.4. Migration decision

The questionnaire identified key human need elements that were decisive for return and one-way migrant households in choosing their new home location (Figure 4.6). More than a quarter of them identified scenic beauty, climate, tranquility and water as the key qualities for choosing their present home address. Linking

these elements to the rural capital elements, referring to Figure 4.4, suggests key elements of rural capital that have attracted migrants to Hokuto City. These were lower temperatures on higher-up mountain slopes providing a comfortable climate and enabling ideal lifestyles; distance from high-traffic roads providing tranquility; proximity to farmlands for local food supply; symbolic natural sites providing sports and outdoor experiences; as well as highway gates and railway stations enabling better urban access.

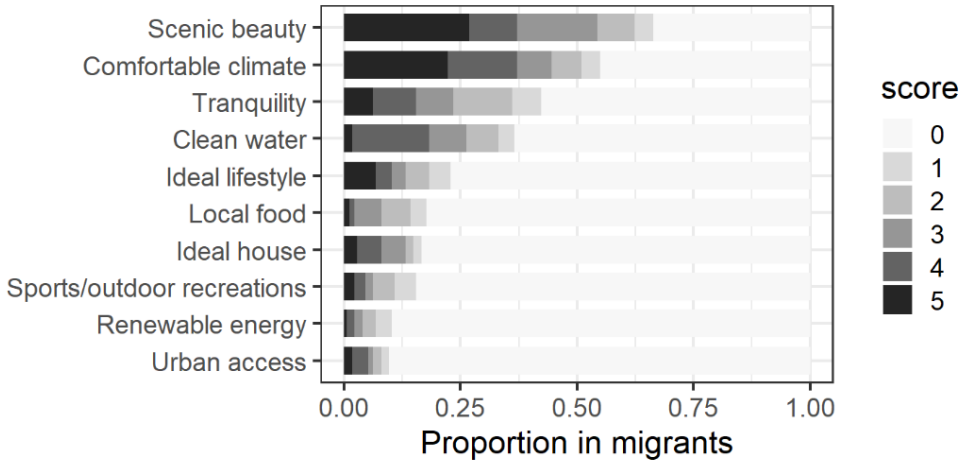


Figure 4.6. Top-10 elements of human needs identified by migrants as the primary reason for choosing their present home address when migrated

4.4. Discussion

To address my primary research aim, I first discuss the pathway in which rural capital contributes to QoL and thereby to migration decisions (Section 4.4.1). This draws on a synthesis of the results of the five-step analyses presented in the former section, and characterizes rural capital in accordance with my capital typologies, i.e., natural, built, financial, social, human and cultural capital. The discussion also highlights my findings in measuring accessibility to various rural capital elements that have different spatial patterns and ways to influence people. I then clarify methodological constraints in the present study and the potential ways to overcome these constraints (Section 4.4.2). The section ends with the social-ecological system implications of deurbanization from my results (section 4.3).

4.4.1. Contribution of rural capital to QoL and migration decisions

Overall, the rural capital elements I tested as effective in increasing QoL agreed with the reasons for the migrants' choice of living in Hokuto City, confirming their aim to increase QoL by migration. Further, my results confirmed the contribution of a set of indicative, but not exhaustive, geospatial metrics of natural, built and financial capital to higher QoL.

Natural capital:

The natural capital metrics found to be contributing to migrants' QoL were accessibility to symbolic natural sites providing leisure opportunities, lower temperatures supporting ideal lifestyles, and lower noise levels

allowing tranquility in life. These three natural capital elements agree with the top three reasons migrants chose Hokuto City, i.e., scenery, climate and tranquility. This well explains that one-way migrants are found living in areas higher up on mountain slopes that have a higher forest cover, better accessibility to symbolic natural sites and lower temperature (Figure 4.5).

Further, two natural capital metrics that contributed solely to the natives' QoL were found, i.e., farmlands providing food, and better views of mountain peaks constituting scenic beauty. The former could be explained by the engagement of a relatively high proportion of native households in farming. Non-market food sharing with neighbors, which is widely practiced in Japanese rural communities (Kamiyama et al., 2016) could be another reason, implying potential interaction between social and natural capital. The latter might have derived from better visibility of mountain peaks from natives' homes, which tend to be located in the areas with high farmland coverage. They also might have a sense of place (Díaz et al., 2018) since their childhood, due to the unique views of mountains in their locality. In contrast, one-way migrants might only have constricted views of mountains from their home surroundings, which largely comprise forests. Considering the known contribution of the view of complex terrain and forests to migrants' home location (Vukomanovic et al., 2014), the presence of views encompassing greenery in migrants' home surroundings, rather than mountain views, could better explain the consistently high satisfaction with scenic beauty expressed by the migrants in my results (Figure 4.4).

Built capital:

The built capital metrics that were found to contribute to QoL, non-selectively among natives and migrants, were the accessibility to highway gates, railway stations and shops and restaurants. Among these, the importance of access to railway stations for migrants is more evident from the relative proximity of their homes to railway stations than natives (Figure 4.5). My analysis did not detect the contribution of the proximity to bus stops to better mobility. Presumably this is due to infrequent bus services and thus less reliance of the residents on buses, particularly in areas distant from railway stations.

Financial capital:

Employment capacity, as a metric of accessibility to financial capital, contributes to QoL of both native and migrant households. The effective distance range of 2 km (Table 4.3) is relatively short as compared to the mean commuting distance in Japanese rural municipalities, which is approximately 30 minutes (MLIT, 2015a) or 20 km assuming a 40 km/h car trip. A certain proportion of respondents indicated zero commuting time (see section 4.3.1 and Table A.2.2), presumably indicating their engagement in home business, which might explain the overall short commuting distance. As home businesses usually don't require large built structure such as office buildings or manufacturing plants, this shows the appropriateness of my attempt to single out financial capital from built capital, unlike Vemuri and Costanza (2006) and S. Zhang et al. (2018), and to represent it by employment capacity.

The effect of the COVID-19 outbreak since 2020 onward, which brought about rapid and widespread uptake of teleworking, on this result was presumably limited, because the analysis relied on the enterprise

location registration data as of 3 August 2020. It is unlikely that the data reflected the telework shift, because moving enterprise registration location would not always be necessary for teleworking, and even when moved, would require a longer time lag to be captured in the enterprise registration data. The results, however, imply that the proximity between home and work locations, as a result of the uptake of teleworking, contributes positively to QoL in rural areas. Many companies in Japan continue teleworking arrangements for employees even after the COVID-19 risk downgrading (Pasona Inc., 2023), which is likely to encourage rural life of employees and to help increase their QoL.

Other rural capital:

No geospatial surrogate for social, human and cultural capital was identified from the scope of my data gathering. Nevertheless, relating to social capital, I detected a higher fulfillment of affection (cluster 12, Figure 4.3) among native and return households, which is linked to the proximity of family members and friends. Strong social capital and its contributions to well-being are found in many Japanese rural communities (Research group on the mechanisms and revitalization of local community activities, 2016). Social capital is known to play an indispensable role for migrants in their migration process and establishment (Odagiri & Tsutsui, 2016). Therefore, identification of a spatially-explicit surrogate for social capital remains an important subject for future studies, which might include natural or other capital elements that provide foundations for building social capital, such as green spaces that facilitate social interactions (Dasgupta et al., 2022; Jennings & Bamkole, 2019).

Metrics of rural capital accessibility:

The results also show different distance ranges within which rural capital contribute to QoL depending on the type of capital and the ways people interact with these. This agrees with Olsen et al. (2020) which clarified unique distance decay parameters for different ecosystem services. My results show roughly three groups of rural capital that have different distance ranges in the decay of their contribution to QoL. The first group, with the shortest decay distance in a 500 m radius or less, includes farmland for livelihood, temperature and low noise level for comfortable living, and mountain views for scenic beauty. These types of capital contribute to individual QoL through one's daily exposure to these elements at home, and presumably in a short walk from home considering the use of a 500m range as a short walking distance range in an urban planning literature (Eom et al., 2018). The second group, with a medium decay distance of 1 to 4 km, includes employments supporting income and status, shops and restaurants for convenience in life, farmland for food and highway gate for easy urban access. Contribution to subsistence within a short trip distance characterizes these types of rural capital. The third group, with the longest decay distance of around 8 km, includes symbolic natural sites that contribute to leisure satisfaction, presumably through occasional recreation visits.

4.4.2. Methodological constraints

The interpretation of these results, however, requires noting the following three major methodological constraints. The first is the bias in the available open and commercial geospatial data, which tended to

represent tangible capital assets such as natural, built and financial capital, but not intangible capital assets, e.g., social, human and cultural capital. Each data item differs in terms of type and resolution of data between one another, which might have limited the veracity of comparing the contribution of different rural capital elements to QoL.

Second, a limited number of and bias in the questionnaire respondents, as well as the processing of the responses might have affected the results. Whereas the number of responses to the survey was sufficient for the analyses on the whole sample, reduced statistical reliability of the results was unavoidable particularly from the analysis with a higher number of group breakdowns, e.g., age groups and occupation groups. Biases might also have derived from different responses rates among groups, e.g., fewer responses from the younger, working generations than from the senior generations. The resolution used to locate the respondents' home, i.e., by the union of 100 m square grids of settled areas in each ward, might also suffer in terms of accuracy. I could not attain a higher resolution with the available geospatial data to project the respondents' home address to a GIS map while also protecting personal information.

Third, the two-step screening process to short-list geospatial surrogates for rural capital might also have affected the reliability of measuring the influence of each capital in terms of distance. The use of Spearman's correlation coefficient, applied collectively to all sample households, to identify the most effective distance from among the seven distance ranges might have neglected a distance range that more strongly effected the satisfaction of human needs of specific household groups.

Whereas the above three constraints suggest the need to further improve the balance and reliability of my model, my finding of the contribution of the 13 geospatial surrogates of natural, built and financial capital to QoL remains valid. A set of standardized geospatial indicators that equally represent different capital types might enable a more balanced and reliable evaluation of the contribution of rural capital to QoL. Future studies might also benefit from a more rigorous and systemic process to optimize the indicator sets.

4.4.3. Social-ecological system implications of deurbanization

My finding regarding the specific elements of natural capital that contribute to urban-to-rural migration decision-making demonstrates an important feedback pathway from nature to human behavior, which was known to be an important knowledge gap in the social-ecological system literature (IPBES, 2019). However, I did not investigate the reverse pathway that motivated the present study, i.e., the potential contribution of urban-to-rural migration to the sustainability of social-ecological systems.

In general, an increasing number of migrants can hamper nature when it comes with new land and infrastructure development. This may or may not be true within the geographical and temporal scope of my study. Nearly half of migrants in my sample had built new houses when they migrated (Table A2. 2). These houses, however, were likely to have been constructed on the pre-existing city infrastructure (e.g., the existing houses were demolished and new houses constructed), as land and infrastructure development had peaked out in Hokuto City in the 1990s towards the end of the Japanese bubble economy which drove a second-house boom, and considering declining total City population since 2004 onward (Hokuto City,

2018). Change in the lifestyles of migrants and its ecological consequences could be another potentially important aspect to be assessed. Filling these knowledge gaps is necessary for a more comprehensive understanding of the feedback loop between nature and human behavior in social-ecological systems under in the deurbanization context.

4.5. Conclusion

Globally, urbanization has significant direct and indirect impacts on social-ecological systems. Deurbanization plans and policies can help to these impacts, but it is important to better understand urban residents' desires for rural migration (e.g., in terms of improving their QoL) to support these policies. The present study shows the contribution of the accessibility of residents to specific elements of natural and other rural capital to their QoL in Hokuto City. Such natural capital includes farmland, symbolic natural sites, mountain peak view, lower temperature and tranquillity. Other rural capital are built capital (highways, railway stations and shops and restaurants) and financial capital (employments). Many of these are related to the reasons that migrants chose their present home location in Hokuto City, indicating their increased QoL by migration. Particularly, one-way migrants are selective in choosing their home locations, which were predominantly on higher-up mountain slopes with lower temperatures, higher forest cover, near natural parks and symbolic natural sites, and yet with easier access to railway stations and employments. These results provide a valuable knowledge base for rural spatial planning for increased QoL and number of migrants that considers ecological-social feedbacks, and hence supports shift to a deurbanization pathway which is attracting even more attention in the post-COVID-19 world. In future research, a more comprehensive and optimised set of geospatial indicators could also be sought for a more balanced representation of key natural, built, social, human, financial and cultural capital. Further, studies on the ecological consequences of urban-to-rural migration are needed for a more comprehensive understanding of the feedback loop between nature and human behaviour in the deurbanization context.

5. The contribution of rural natural capital to quality of life of urban-to-rural migrants in Japan: Structural equation modelling using a nation-wide survey and public geospatial data

5.1. Introduction

Literature is accumulating on the environmental contributors to QoL, but is yet fragmented to fully support a deurbanization pathway to avoid negative consequences of the ongoing extreme urban population concentration across the world (Section 1.4). One of the notable gaps is a methodological dichotomy into biophysical-data driven approach and perception-based approach. Efforts were made to converge the two approaches but yet limited to urban contexts, except for Takahashi et al. (2024) (see Chapter 4). They validated the contributions of natural, built and financial capital to human needs satisfaction in Hokuto City, a Japanese rural municipality popular for migrants from urban areas. They, however, did not validate the contribution pathways, nor even assess the comparative strengths of the pathways, due to methodological limitations. Moreover, these municipality-scale case studies are constrained by a relatively narrow range of contributors to QoL available within its territory. A large scale, desirably nation-wide analysis would allow a far wider scope to explore QoL contributors from among a large variety of unique local setting across the nation, and therefore would substantially improve the reliability and generalizability of the model outcomes.

Therefore, this study aims to explore natural, built and other types of capital within rural municipalities across the nation that contribute to increased QoL of urban-to-rural migrants. It then endeavors to identify the pathways in which different capital factors contribute to QoL and to quantify the relative importance of each pathway. To do so, the study considers differences in demographic, social and economic attributes of migrants that Takahashi et al., (2021, 2024) imply might influence these contributions and pathways.

5.2. Materials and methods

5.2.1. Conceptual model

A basic conceptual model for this study (Figure 5.1) was constructed based on an integrated definition of QoL by Costanza et al. (2007) (see Section 1.4), which then was extended referring to the community capitals framework (Flora et al., 2018) to incorporate six types of capital, i.e., natural, built, human, social, cultural and financial capital, which I defined collectively as rural capital (see Section 2.2). The model was intended to evaluate the effect of change in one's access to rural capital, caused by migration from urban to rural areas, on the change in one's satisfaction of various human needs, and ultimately on the change in one's subjective well-being (SWB).

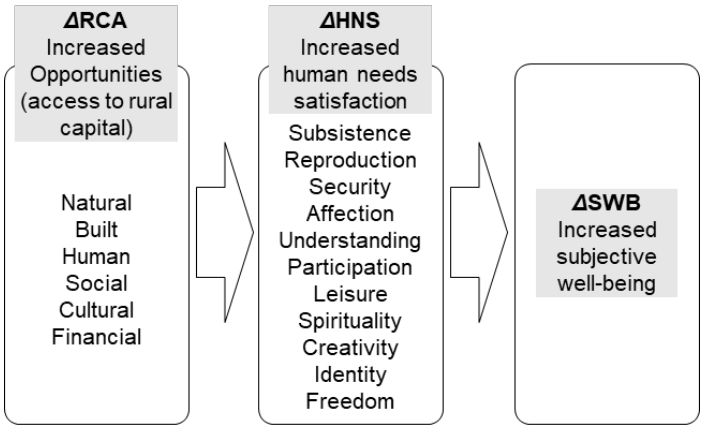


Figure 5.1. A basic conceptual model

5.2.2. Human needs satisfaction and subjective well-being

I conducted a nation-wide online survey to collect data on the satisfaction of various human needs and SWB perceived by urban-to-rural migrants before and after their migration event, motivations and experiences related to migration as well as on socio-economic characteristics of their households.

As the foundation for the survey, I first specified an operational definition of urban-to-rural migrants, which is people moved from the municipalities within the ten Major Metropolitan Areas to the rest of Japan. The Major Metropolitan Areas are used to classify urban municipalities in the national statistics, which are comprised of the central cities that have a population of no less than 0.5 million and the adjacent municipalities that have strong socio-economic connections with the central cities (Statistics Bureau of Japan, 1996). The scope of the survey included partial migrants who had not completely moved out from urban municipalities and therefore have multiple home locations in both urban and rural municipalities, which had become increasingly popular in Japan (MLIT, 2023c). The scope was limited to people moved from urban to rural municipalities no earlier than 2010, so that they would be able to remember their past migration event and associated changes in their life when they answered to the questionnaire.

I prepared a questionnaire comprised of screening and main sections, which finally had nine and fourteen questions respectively (see Appendix 1). The screening section had questions to specify whether a respondent met the above definition of an urban-to-rural migrant based on the postal codes of one's home locations before and after migration, as well as on basic demographics including place of birth, gender, age and household structure. The main section had questions on motivation for migration, housing property type, job and income, as well as on the fulfilment of various human needs and overall SWB before and after migration. The question on human needs presented a list of 37 human need items (Table 5.1) and asked a respondent to rate the level of one's satisfaction with each item before and after migration using a five-point Likert scale. The 37 human need items derived from a local case study of urban-to-rural migration in Hokuto City, Yamanashi Prefecture of Japan (Takahashi et al., 2024). They developed a list of 38 human need items based on a list of 11 broad categories of human needs used by Costanza et al. (2007), and by breaking them down into specific statements referring to the Japan's Social Indicators classification

systems (Statistics Bureau of Japan, 2020) and considering their relevance to six types of capital, i.e., natural, built, human, social, cultural and financial capital, available in Hokuto City. To create a new list of 37 human need items, I made minor adjustments to the previous list considering the results of the previous study and the relevance of each item to the six types of capital available across the nation. Furthermore, to enable an in-depth analysis of the contribution of rural natural capital to fulfilling migrants' human needs, I selected a relatively large number of human need items related to natural capital to cover as many of the 18 categories of nature's contributions to people (NCP) (Díaz et al., 2018) as possible. The subsequent question on SWB asked respondents "overall, taking all aspects into account, are you satisfied with your life", in accordance with the phrasing that Mulder et al. (2006) used to measure SWB of intentional communities and control groups in the US, and requested them to evaluate the level of satisfaction before and after migration using an eleven-point Likert scale. I applied a finer scale measure to this specific question, aiming to increase the likelihood of normal distribution (Leung, 2011) of this single final outcome variable.

The questionnaire was distributed and collected by an online research company over the period from 8 to 13 March 2022. The survey applied quota sampling across 10 regional blocks of the nation, namely Hokkaido, Tohoku, Hokuriku, Kanto, Tokai, Kansai, Chugoku, Shikoku, Kyushu and Okinawa regions, where the number of samples from each block was proportional to the total population of rural municipalities within the region. The research company distributed the questionnaire to 50,000 individuals registered to the panel of the company, and closed the survey at the end of the survey period (13 March 2022) or earlier when the number of responses that fully met the screening criteria reached the predetermined limits: 1,000 samples from full migrants who had completely moved out from previous urban home; and 1,000 samples from partial migrants who had not. By the end of the survey period, the company collected 1,000 full migrant samples and 315 partial migrant samples (see Table A3.1 for the regional breakdown). The proportions of the number of samples from the 10 regional blocks mostly met the intended quota, except for Kanto region, where a high proportion of municipalities are classified as urban municipalities, which were replaced by increased samples from Hokuriku region.

Table 5.1. A list of human need items used for the questionnaire

No	Capital type	NCP category	Human need category	Statement	Code
1	Built		Subsistence	Shopping, dining out or transportation is convenient	B_*convenience*
2			Subsistence	Housing is comfortable	B_*housing*
3			Security	Infrastructure for natural disaster or crime prevention is sufficient	B_*security*
4			Leisure	I enjoy indoor sports/activities or am healed or moved in the city, entertainment facilities or art	B_*leisure*
5	Cultural		Participation	I contribute to passing on or creating local culture	C_*creation*
6			Leisure	I enjoy or am healed or moved by the local culture	C_*leisure*
7			Creativity	I obtain inspiration for artwork, business, living or recreation from the local culture	C_*inspiration*
8			Identity	I feel attached to, or derive my own identity from the local culture	C_*identity*
9	Financial		Subsistence	Government subsidies or tax relief to support housing, subsistence and childcare are sufficient	F_*subsidies&taxrelief*
10			Participation	My job is worthwhile or contribute to the local community or society	F_*worthwhilejob*
11	Human		Security	Medical or care facility is sufficient	H_*medcare*
12			Subsistence	I obtain knowledge useful for my work or life from local people	H_*knowledge*
13			Reproduction	The area has a good school or a desirable education opportunity	H_*school*
14			Creativity	I obtain inspiration for artwork, business, living or recreation from encounters with people	H_*inspiration*
15	Natural	NCP01_Habitat	Participation	I participate in nature conservation, restoration or cleaning activities	N_*conservation*
16		NCP03_AirQual	Subsistence	Air is clean	N_*cleanair*
17		NCP04_Climate	Subsistence	Climate is pleasant	N_*pleasantclimate*
18		NCP07_WaterQual	Subsistence	Water is abundant or clean	N_*cleanwater*
19		NCP09_HazardReg	Security	Nature, such as forests and reefs, protects us from natural disasters such as tidal waves, floods, landslides and storm winds	N_*hazardprotection*
20		NCP10_BioReg	Security	There is no or less human-wildlife conflict causing human casualties or economic loss	N_*wildlifeconflict*
21		NCP11_Energy	Subsistence	I use local renewable energy resources, such as wood biomass, hydro, wind or solar power	N_*natenergy*
22		NCP12_FoodFeed	Subsistence	The area has rich local cousins or food ingredients	N_*localfood*
23		NCP13_MatConLab	Subsistence	I use locally produced wood or other materials of plant or animal origin or grow ornamental plants or pet animals	N_*localmaterials*
24		NCP14_MedGen	Subsistence	I use locally produced medicinal plants	N_*medicinplants*
25		NCP15_LearnInspr	Reproduction	I can raise my children in a nature-rich environment or have access to nature experience education for children	N_*natureeducation*
26		NCP15_LearnInspr	Creativity	I obtain inspiration for artwork, business, living or recreation from nature	N_*inspiration*
27		NCP16_Experiences	Affection	I share fulfilling time and experiences in nature with family, acquaintances, and pet animals	N_*socialising*
28		NCP16_Experiences	Leisure	I enjoy sports/activities in nature, or am healed or moved by nature	N_*leisure*
29		NCP16_Experiences	Leisure	Scenery is beautiful	N_*scenery*
30		NCP17_Identity	Identity	I feel attached to, or derive my own identity from the local nature	N_*identity*
31		NCP18_Options	Freedom	I feel freedom in nature for working, living or playing	N_*freedom*
32	Social		Subsistence	I share or give away food and other necessities of life with neighbors	S_*sharing*
33			Reproduction	Local community/neighbors are supportive to child raising	S_*childraising*
34			Security	Neighborhood is secure, or mutual support and disaster/crime prevention activities in the local community is reliable	S_*security*
35			Affection	I have good relationships with family, friends, and acquaintances	S_*socialising*
36			Participation	I support the local community e.g., by volunteering	S_*volunteering*
37			Freedom	My work or life is free from interference or stereotypes held by others	S_*freedom*

5.2.3. Access to rural capital

I generated indicators to measure the access to six types of rural capital in each municipality using public geospatial data, and subsequently matched the indicators to the survey data to calculate the change in the respondents' access to rural capital caused by migration. This process took an inductive approach to identify a small set of relevant indicators to explain the change in QoL of urban-to-rural migrants from diverse data sources, as presented in the following five steps (see Figure 5.2). Precedent studies on QoL and its biophysical environmental contributors mostly took a deductive approach, where researchers predetermine a small set of indicators, such as access to city centers, public green or blue spaces as well as forest and farmland cover (Cardinali et al., 2024; Kweon et al., 2010; Kyttä et al., 2016; Mouratidis & Yiannakou, 2022; von Wirth et al., 2015). The deductive approach is enabled by accumulated literature, e.g., on urban QoL and ecosystem services, and is beneficial to avoid complexity caused by multiple interacting indicators which easily goes beyond the capacity of statistical modelling. The deductive approach, however, may unreasonably narrow the scope for my subject matter, where knowledge is limited on rural QoL and its diverse contributors that may differ from an urban setting, especially in an urban-to-rural migration context. For these reasons, and benefitting from a relatively data-rich environment in Japan and advancements in multivariate statistical modelling techniques, I adopted an inductive process.

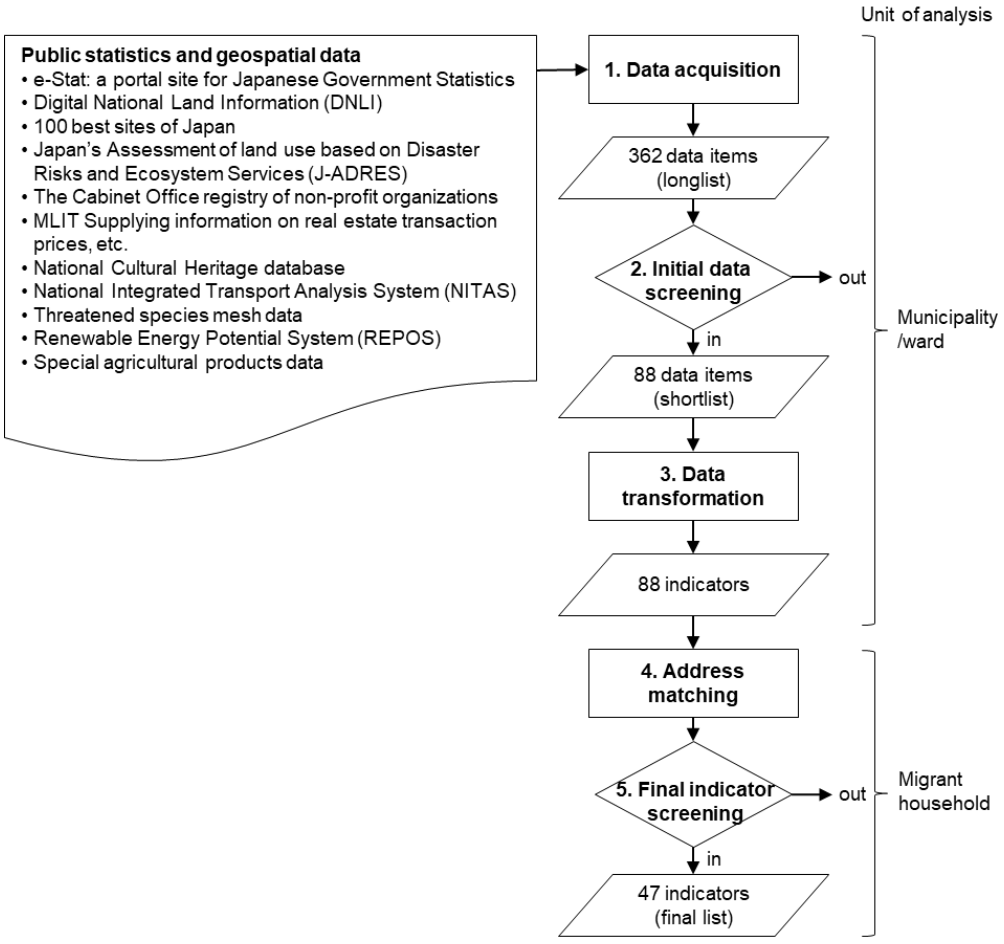


Figure 5.2. Process to develop rural capital access indicators

The indicator generation process started with data acquisition from 11 different sources of public geospatial data (see Figure 5.2). I first looked at e-Stat, or the Portal Site of Official Statistics of Japan (National Statistics Center, 2023) for municipality statistics and the Digital National Land Information (DNLI) (MLIT, 2023a) for geospatial data. From these, I identified data items semantically relevant to the six types of rural capital as well as to the 37 human need items used for the questionnaire. In addition, I looked up relevant data items mainly in the government sources to fill gaps, and finally created a longlist of 362 data items from 11 sources.

Secondly, I manually screened the longlisted data items using five screening criteria: (1) clearer semantic relevance to the 37 human need items; (2) availability for all municipalities across Japan; (3) data validity in terms of data year and spatial resolution; (4) precedent use in the literature; and (5) relative importance among a group of items with a similar connotation. The first criterion was to further scrutinize the relevance of each data item to either of the 37 human need items used in the questionnaire, which was already but loosely considered in the data acquisition process. The third criterion on data year and spatial resolution was applied when I had two or more options of items which had the same or similar meaning but difference in data year or spatial resolution. I generally opted for the data of the latest or with the highest spatial resolution, but did not exclude old data when considered valid. For example, I used the point data of 300 best mountains that include 100 mountains identified in 1964 by three criteria: dignity, history and uniqueness (Fukada, 1964), which wouldn't be lost in a few decades. The fourth criterion on the literature was used for additional consideration when available, particularly for prioritizing among data items with a similar meaning under the firth criterion. As a result, I created a shortlist of 88 data items.

Thirdly, I extracted data of the 88 shortlisted items and transformed them to create a set of standardized indicators of rural capital access. Here I used municipality as the basic unit of analysis, whereas ward-level breakdown for the Ordinance Designated Cities (Local Autonomy Act, 2021), which have population of over 0.5 million, as well as the 23 Tokyo Special Wards. Among the 11 sources, e-Stat, J-ADRES (RIHN Eco-DRR Project, 2023), the Cabinet Office registry of non-profit organizations (Cabinet Office, 2022), the Supplying information on real estate transaction prices (MLIT, 2022) and REPOS (MOE, 2020) provided data of all municipalities, and mostly had the ward-level breakdown for the Ordinance Designated cities and the Tokyo 23 Special Wards. The Specialty Agricultural Product data (Japan Specialty Agricultural Products Association, 2022), which provided data on the production of medicinal plants, only had the prefecture-level data, and was prorated to each municipality by its total land area. For the data items extracted from DNLI, the 100 best sites of Japan (https://100sen.cyber-ninja.jp/), and the National Cultural Heritage Database (ACA, 1997), I used QGIS version 3.10 (QGIS.org, 2020) to generate four different types of geospatial metrics, i.e., point density for point data, total line length per unit area for line data, area cover rate for polygon data and the average of grid cell values for raster data. The spatial range of measurement was the settled areas of each municipality for the data items that were generally restricted to settled areas, particularly those representing built, social, human and financial capital, while the total municipality area for other items, particularly natural and cultural capital. I used the National Integrated Transport Analysis System (NITAS) Ver.2.8 (MLIT, 2023b) to measure the time distance from the center of

each municipality to the capital of the prefecture it belongs to, as well as to the center of Tokyo, in two different ways: by all transportation modes including car, and by only public transports. The measurement used the locations of the head office of the municipal and prefectural government and the National Diet Building to represent the center of each municipality, prefectural capital and Tokyo respectively. After all these measurements, I checked for data gaps, and confirmed their data distribution. In the items that lacked ward-level breakdown data for the Ordinance Designated cities and the Tokyo 23 Special Wards, the municipality-level value was applied to all wards under the municipality. To the metrics that were likely to have negative causality to meet human needs, e.g., real estate price and time distance to city centers, I applied reciprocal transformation. To the data items that had Poisson-like distribution, I applied natural log transformation. Finally, I applied the 'scale' function in R (R Core Team, 2021) to all data items to create a set of 88 standardized indicators of rural capital access.

Fourthly, I matched the rural capital access indicator value of each municipality with the home locations of the survey respondents before and after their migration, referring to their postal codes. I then calculated the difference in the values of each indicator before and after their migration.

Lastly, I did final screening of the rural capital access indicators referring to the Spearman correlation coefficients of the pairs of each rural capital access indicator and the value of relevant human need item. More specifically, I calculated the Spearman correlation coefficients between the change in each rural capital access indicator value before and after migration, and the change in the value of relevant human need item (see examples in Table 5.2) before and after migration. I then screened out the indicators that had apparently weak correlation among each group of indicators of similar meaning. The above five step process created a final list of 47 rural capital access indicators used for the subsequent statistical modelling (Table 5.2).

Table 5.2. The final list of rural capital access indicators

Source	Data title	Indicator code	Data year	Capital type[a]	Relevant human need item code
e-Stat[b]	#H06130_number of restaurants per thousand people	restaurants_pc	2016	B	1.B_*convenience*
	#H06131_number of large retail shops (floor area >= 1,000m2) per 0.1 million people	largeshops_pc	2016	B	1.B_*convenience*
	#H02103_Total floor area per residential house (m2)	house_floor	2018	B	2.B_*housing*
	B1103_Inhabitable land area (ha)	inhabland_ha	2020	N	2.B_*housing*
	D320311_Municipal budget for disaster recovery (thousands JPY)	disasterbudget_perha	2019	B	3.B_*security*
	#G01104_Number of libraries (per million people)	libraries	2018	H	4.B_*leisure*
	#D02206_Taxable income per taxpayer (thousands JPY)	income_pc	2020	F	9.F_*subsidies&taxrelief*
	C2107_Number of business establishments (Economic Census Basic Survey) (establishments)	enterprises_perha	2019	F	10.F_*worthwhilejob*
	Total number of medical doctors, dentists and pharmacists (persons)	medworkers_pc	2018	H	11.H_*medcare*
	#E0110203_Number of high schools (per 100 km2 of inhabitable land area)	hschools_perhab100km2	2020	H	13.H_*school*
	Number of elementary school teachers per student	pschool_teacher_ps	2020	H	13.H_*school*
	Weighted total number of schools	allschools	2020, 2019	H	13.H_*school*
	Total population (persons)	totalpopulation	2020	H	14.H_*inspiration*
	A5103_Number of new residents (persons)	newresidents_pc	2020	H	14.H_*inspiration*
	B1106_Forest area (ha)	forest_perha	2014	N	16.N_*cleanair*
	Agricultural production estimate by municipality (ten million JPY per ha)	agriproduct_perha	2020	N	22.N_*localfood*
	Forestry production estimate (Prefecture-level timber production (million JPY) prorated by municipality forest cover)	timberproduct_perha	2020	N	23.N_*localmaterials*
	#G01101_Number of public halls per 1 million people (points)	pubhalls	2018	S	32.S_*sharing*
DNLI[c]	Gas stations (points)	gasstations	2016	B	1.B_*convenience*
	Highways (area within 4km radius from entrance/exit gates (m2)	highwaygate4km	2021	B	1.B_*convenience*
	Railways (lines / points)	railstation1km	2021	B	1.B_*convenience*
	Evacuation facility (points)	evacuation	2012	B	3.B_*security*
	Cultural facility (points)	culfacility	2013	B	4.B_*leisure*
	Halls, theaters, studiums and other customer attraction facilities (points)	custattracts	2014	B	4.B_*leisure*
	Tourism resource category 2: historical and cultural (points)	cultourism	2014	C	5.C_*creation*
	Temperature mesh data (annual average)	temp_anmean	2022	N	17.N_*pleasantclimate*
	local industry centers (points)	localindustcenter	2012	N	22.N_*localfood*
	Tourism resources class 1: nature (points)	nattourism	2014	N	28.N_*leisure*
	Nature parks, nature conservation areas and wildlife protection zones (ha)	natparks	2015	N	28.N_*leisure*
	Tourism resources (water-related items) (points)	allwaters_dnli	2012	N	18.N_*cleanwater*

[a] Capital type: N -natural capital; B -built capital; H -human capital; S -social capital; C -cultural capital; F -financial capital
[b] The Portal Site of Official Statistics of Japan (National Statistics Center, 2023)
[c] Digital National Land Information portal (MLIT, 2023a)

100 best sites in Japan[d]	100 best hot springs in Japan (points)	100best_hotspring	2000~2002	N	28.N_*leisure*
	100 best forest therapy sites in Japan (points)	100best_foresttherapy	1986	N	28.N_*leisure*
	300 best mountains of Japan (points)	300best_mountain	1964, 1978	N	29.N_*scenery*
	Aggregate of nature-related 100 best sites in Japan	100best_natall	1964~2010	N	29.N_*scenery*
J-ADRES[e]	Groundwater recharge (relative %)	res_groundwater	2023	N	18.N_*cleanwater*
	Landslide prevention (relative %)	res_landslide	2023	N	19.N_*hazardprotection*
	Food production potential (farmland cover (%))	pes_food	2023	N	22.N_*localfood*
	Green space accessibility (relative %)	ces_greenspace	2023	N	25.N_*natureeducation*
	Location probability of autocamping sites (relative %)	ces_camping	2023	N	28.N_*leisure*
NITAS[f]	Access time to Tokyo by public transports (hours)	Tokyoaccess_public	2022	B	1.B_*convenience*
	Access time to prefecture capital by public transport (minutes)	prefcapaccess_public	2022	B	1.B_*convenience*
REPOS[g]	Proportion of renewable energy use against the total electricity demand (%)	natenergy	2020, 2022	N	21.N_*natenergy*
MLIT Supplying information on real estate transaction prices, etc.[h]	Real estate transaction prices (JPY)	realestateprice	2022	F	2.B_*housing*
National Cultural Heritage Database[i]	National important cultural heritage (except for natural monument) (points)	ncheritage	2022	C	5.C_*creation*
Specialty agricultural products data[j]	Medicinal plant production (Prefecture-level production (kg) prorated by municipality total land area)	medplant	2020	N	24.N_*medicinplants*
The Cabinet Office registry of non-profit organizations[k]	NPO Database (organizations)	npos	2022	S	32.S_*sharing*
Threatened species mesh data[l]	Number of observed threatened species mesh data (species)	threatenedsp	2009	N	15.N_*conservation*

[d] From a private website providing the coordinate data of various types of 100 best sites of Japan: https://100sen.cyber-ninja.jp/
[e] Japan's Assessment of land use based on Disaster Risks and Ecosystem Services (RIHN Eco-DRR Project, 2023)
[f] The National Integrated Transport Analysis System Ver 2.8 (MLIT, 2023b)
[g] Renewable Energy Potential System (MOE, 2020)
[h] (MLIT, 2022)
[i] (ACA, 1997)
[j] (Japan Specialty Agricultural Products Association, 2022)
[k] (Cabinet Office, 2022)
[l] (MOE, 2019)

5.2.4. Statistical analyses

To start with, the change in subjective well-being (SWB) before and after migration was tested using paired t-test. Subsequently, the difference in SWB change between respondents with different household attributes was assessed using ANOVA for categorical attributes and t-test for binary attributes.

To verify the effect of access to various rural capital to increase QoL of urban-to-rural migrants and its pathways, I carried out path analysis of the Structural Equation Modelling (SEM), which was comprised of latent constructs pertaining to rural capital and human needs satisfaction, as well as the causal relationship between these latent constructs and SWB. SEM enables validating complex hypotheses, such as those comprised of multiple observed and latent variables and their cascading causal relationships (Rosseel, 2012). Hence it is frequently used to understand complex relationships between people's well-being or behavior and their environmental contributors, such as the effect of urban physical environments, including green spaces and species diversity, on people's physical activities, health and overall well-being (Allard-Poesi et al., 2022; Cardinali et al., 2024; Colléony & Shwartz, 2019; Hong et al., 2019; Krols et al., 2022; Kweon et al., 2010; Kyttä et al., 2016; Mouratidis, 2020; Mouratidis & Yiannakou, 2022; Nghiem et al., 2021). These mostly took a deductive approach to constructing model architecture, where hypothetical latent constructs, measured variables and their relationships were imposed by the authors with literature underpinning. Yet, a few studies took an inductive approach, such as Wakita et al. (2014) which investigated the causal relationship between people's perception of marine ecosystem services and their behavioral intentions. They identified observed variables based on the ecosystem services classification system of the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment Board, 2005), i.e., supporting, provisioning, regulating and cultural services, but used exploratory factor analysis (EFA) to identify an alternative latent construct to better explain their key concept, i.e., "perceived indispensability of marine ecosystem services". I followed Wakita et al. (2014) to take an inductive approach, whereas my observed variables were firmly based on the literature.

Hence, I first carried out EFA to identify latent constructs around two key concepts in my conceptual model, i.e., human needs satisfaction and rural capital access, and subsequently constructed and validated a SEM to explain the causal relationship between these two constructs and SWB. To do so, I noted that the effect of rural capital access to increase migrants' QoL and its pathways vary among households with different demographic and socio-economic characteristics (Takahashi et al., 2021, 2024), and that capturing these elements in the model construction might improve goodness-of-fit of the model. I therefore used these household demographic and socio-economic factors to construct alternative multiple group models. Further, to evaluate the relative importance of household income to explain increased QoL, I constructed and validated an extended model that extrapolated household income as an additional direct predictor of SWB. I used R version 4.0.3 (R Core Team, 2021) for a series of statistical analyses, with 'tidyverse' package (Wickham et al., 2019) for data manipulation, and 'lavaan' package (Rosseel, 2012) for SEM.

5.3. Results

5.3.1. Sample characteristics

The demographic and socio-economic characteristics of the sample were presented in Table 5.3, focusing on the items that Takahashi et al. (2021) showed were influencing the values of urban-to-rural migrants. Sample numbers distributed across categories of each item while slight bias was found in some items, e.g., a lower proportion of women (32%), child-raising households (21%) and return migrants (45%) (see Table A3.2 for more detailed sample breakdown; and Figure A3. 1 for the geographical distribution of samples and their migration pathways).

Table 5.3. Sample distribution across categories of different demographic and socio-economic aspects

Class	Level and answer count				
Age group	10-20s	30s	40s	50s	60 and over
	110	219	279	245	147
Sex	Female	Male			
	425	890			
Child raising	Yes	No			
	281	1034			
Migration type	Full	Partial			
	1000	315			
Migration pathway	One-way	Return			
	728	587			
Employment	Employed	Unemployed			
	963	352			
Housing	Own	Rented			
	818	497			
Motivation	Recruited	Transferred	Entrepreneur	Child raising	Retired
	498	107	96	197	325
	Self-health/elderly caring	NA			
	63	29			
Income group	~1M	1~2M	2~4M	4~6M	6~8M
	130	104	300	256	164
	8~10M	10~12M	12~14M	14~16M	16~18M
	86	35	18	10	7
	18~20M	20M~	NA		
	4	22	179		

Paired t-test of the difference in SWB before and after migration revealed no overall significant difference ($t = -0.149$, $df = 1314$, $p = 0.8812$). Nevertheless, ANOVA and t-test showed significant difference in SWB change between specific respondent groups. From among the household attribute classes listed in Table 5.3, the difference was found between groups with different age range, motivation of migration, sex and house ownership type (Table 5.4). Between age groups, senior people of no younger than 70 and in their 60s had stronger SWB increase than people in their teens and in 30s respectively. Regarding migration motivation,

child-raising households experienced stronger SWB increase than the recruited, entrepreneurs and the retired. Likewise, male than female respondents, and the respondents with own house than those with rented or other types of house ownership, showed stronger SWB increase caused by migration.

Table 5.4. Test of difference of the change in SWB among population groups

Class	Test stats.		Level mean						
Age group	**F**	***p***	**10s** [a]	**20s**	**30s** [b]	**40s**	**50s**	**60s** [b]	**70~** [a]
	4.302	0.001	-1.830	0.242	-0.345	-0.240	0.154	0.583	1.670
Motivation			**Recruited** [a]	**Transferred**	**Entrepreneur** [b]	**Child raising** [a,b c]	**Retired** [c]	**Caring**	
	3.922	0.002	-0.076	0.383	-0.740	0.701	-0.305	0.159	
Sex	**T**	***p***	**Female**	**Male**					
	5.057	0.000	-0.682	0.345					
Housing			**Own**	**Rented**					
	-2.677	0.008	0.194	-0.286					

Note: The pairs of levels with the same upper-case alphabets attached are the pairs in which Bonferroni multiple comparison test identified significant difference in the change in SWB before and after migration.

5.3.2. Latent constructs of human needs satisfaction and rural capital access

Exploratory Factor Analysis (EFA) on human needs satisfaction and rural capital access variables, applying three to six factors respectively, showed improved AIC value with a higher number of factors (Table 5.5). The variables that significantly contributed to either of the given factors with 1% level were retained, and were then grouped by the factor to which each variable had the strongest positive or negative contribution. A set of a factor and a group of multiple variables that contributed the strongest to the factor was defined as a latent construct. The models with five latent constructs, for human needs satisfaction and for rural capital access respectively, best balanced the model efficiency, i.e., smaller AIC value, and support to logical explanation of each latent construct. Each latent variable was named after the observed variables that strongly contributed to it. These were Urban, Rural sociocultural, Rural subsistence, Rural amenity and Child-raising for human needs satisfaction; and Touristic, Rural land, Human capital, Urban and Forest for rural capital access (Table 5.6, Table 5.7).

Table 5.5. Fit measures of EFA models of human needs satisfaction and rural capital access, with three to six factors

Domain	Number of factors	npar	df	*p*-value	AIC	BIC	ntotal	RMSEA
Human needs satisfaction	3	145	558	0	121,344	122,095	1315	0.042
	4	179	524	0	121,080	122,008	1315	0.038
	5	212	491	0	120,941	122,040	1315	0.036
	6	244	459	0	120,816	122,080	1315	0.034
Rural capital access	3	181	900	0	107,735	108,633	1054	0.116
	4	224	857	0	105,229	106,341	1054	0.107
	5	266	815	0	103,397	104,716	1054	0.099
	6	307	774	0	102,100	103,623	1054	0.093

Note npar: number of parameters; AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; RMSEA: Root Mean Square Error of Approximation

Table 5.6. Five latent constructs of human needs satisfaction variables

No.	Observed variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Latent variable
11	H_medcare	0.646					HNf1.Urban
1	B_convenience	0.642					
13	H_school	0.608					
3	B_security	0.575					
20	N_wildlifeconflict	0.494					
4	B_leisure	0.467					
9	F_subsidies&taxrelief	0.379					
17	N_pleasantclimate	0.345					
37	S_freedom	0.341				-0.318	
14	H_inspiration		0.514				HNf2.Rural sociocultural
7	C_inspiration		0.510				
10	F_worthwhilejob		0.472				
12	H_knowledge		0.451				
8	C_identity		0.440				
21	N_natenergy			0.556			HNf3.Rura subsistence
24	N_medicinplants			0.519			
5	C_creation			0.503			
15	N_conservation			0.501			
23	N_localmaterials			0.499			
36	S_volunteering			0.401			
19	N_hazardprotection			0.314			
26	N_inspiration			0.304			
29	N_scenery				0.737		HNf4.Rural amenity
16	N_cleanair				0.722		
22	N_localfood				0.594		
18	N_cleanwater				0.575		
30	N_identity				0.532		
28	N_leisure				0.522		
31	N_freedom				0.493		
2	B_housing	0.302			0.434		
27	N_socialising				0.433		
6	C_leisure		0.365		0.394		
34	S_security				0.360	0.314	
33	S_childraising					0.652	HNf5.Child-raising
32	S_sharing					0.363	
25	N_natureeducation					0.355	

Note: The table only presents the factor loadings that were significant with 1% level.

Table 5.7. Five latent constructs of rural capital access indicators

Observed variable	Capital	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Latent variable
custattracts	B	0.522			0.464		RCf1.Touristic
gasstations	B	0.501	-0.321				
100best_natall	N	0.450					
newresidents_pc	H	0.447		0.321			
cultourism	C	0.423					
ncheritage	C	0.353					
100best_foresttherapy	N	0.352					
threatenedsp	N	0.338					
inhabland_ha	N	-0.353					
realestateprice	F		0.721				RCf2.Rural land
pschool_teacher_ps	H		0.665				
house_floor	B		0.655				
ces_greenspace	N		0.570				
libraries_pc	H		0.536				
natenergy	N		0.403				
pubhalls	S		0.359				
temp_anmean	N		-0.384				
totalpopulation	H		-0.606				
hschools_perhab100km2	H			0.960			RCf3.Human capital
allschools	H			0.933			
railstation1km	B			0.541			
culfacility	B	0.374		0.431			
medworkers_pc	H				0.968		RCf4.Urban
npos	S				0.930		
largeshops_pc	B				0.886		
restaurants_pc	B	0.319			0.760		
income_pc	F			0.312	0.494		
enterprises_perha	F	0.438			0.484		
forest_perha	N		0.317			0.680	RCf5.Forest
res_landslide	N					0.471	
res_groundwater	N					0.436	
ces_camping	N			-0.379		0.387	
natparks	N					0.359	
agriproduct_perha	N					-0.660	
pes_food	N					-0.810	

Note: The table only presents the factor loadings that were significant with 1% level.

5.3.3. Structural equation modelling

A hypothetical structural equation model (SEM) was constructed based on my initial conceptual model (Figure 5.1) and using five latent constructs for human needs satisfaction and rural capital access respectively (Figure 5.3). The hypothetical paths between the rural capital access constructs and the human needs satisfaction constructs in the SEM were limited to those that allow logical explanation of their causal links to enable the model to converge. Subsequently, SEM was calculated in ten variations including a

simple one-group model that did not include household income in the model equation; an extended one-group model that included household income; and eight multiple group models which accounted for demographic and socio-economic differences in the respondents (see Table 5.3) that were likely to influence the modelling outcomes. Among the ten, six models converged (Table 5.8) with modest goodness-of-fit as indicated by the root mean square error of approximation (RMSEA) values around 0.08 (Hooper et al., 2008). AIC values indicate that household income, migration pathway (either one way or return migration), home ownership, employment and sex, in this order, significantly improved the model efficiency.

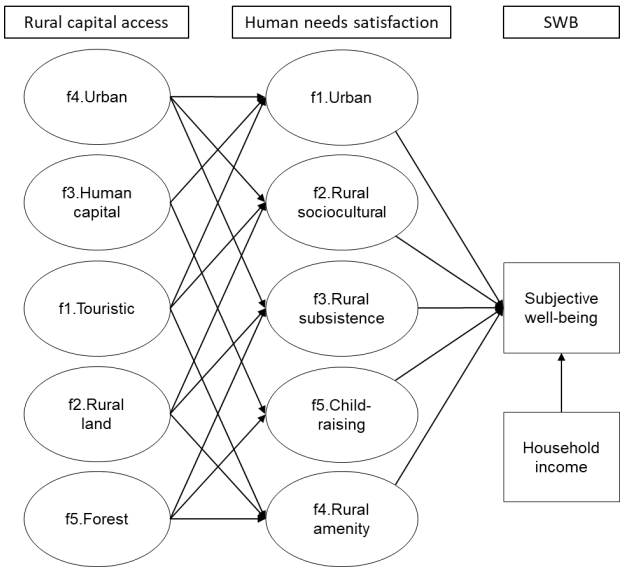


Figure 5.3. Hypothetical SEM

Table 5.8. Fit measures of the six SEM variations

Model	ntotal	df	pvalue	aic	rmsea
One group with income	1,029	2,527	0	175,831	0.079
Two groups by oneway/return migration	1,190	4,912	0	200,592	0.081
Two groups by home ownership	1,190	4,912	0	201,173	0.082
Two groups by employment	1,190	4,912	0	201,478	0.082
Two groups by sex	1,190	4,912	0	201,602	0.082
One group basic	1,190	2,456	0	201,917	0.080

Calculation of the six SEM variations produced regression coefficients between SWB and the latent constructs of human needs satisfaction and rural capital access (Table 5.9), as well as the standard loading of each observed variable on a specific latent variable (Table A3.3) for each model. Figure 5.4 illustrates the causal relationships between rural capital access, human needs satisfaction and subjective well-being produced by the extended one-group model with household income, which was validated as the most efficient model among the six model variations. The figure shows the strongest contribution of increased rural amenity, representing clean air and water, leisure in nature, scenery, etc., to increased SWB. This was followed by urban services which encompass convenience in shopping, dining out and moving, child

schooling, urban leisure, medical services, etc., and thereafter by rural sociocultural elements such as cultural inspiration, local knowledge, worthwhile job and cultural identity. Contribution of household income to increased SWB was found but marginal as compared with these three factors. Furthermore, Figure 5.4 shows strong contribution of increased access to touristic rural capital, including customer attractions such as theaters and stadiums, the 100 best natural sites of Japan, cultural tourism resources and national cultural heritages, caused by urban-to-rural migration, to increased urban services and rural sociocultural satisfaction. Likewise, rural land, which aggregated notable features of rural areas including spacious houses, more green spaces, lower real estate purchase prices as well as lower population density and annual mean temperatures, contributed to increased satisfaction with rural socio-cultural aspects, subsistence and amenities. Furthermore forest, associated with its cultural and regulating services and natural parks, contributed to migrants' satisfaction with rural amenity and child raising.

The multiple group models (Table 5.9) showed some contrasting trends between groups of samples in the causal relationships. For example, the contribution of increased perceived rural amenity to increased SWB of one-way migrants was stronger than that of return migrants, while the contribution of increased satisfaction with urbanness and rural socio-cultural elements to SWB was significant only for return migrants. Increased perceived urbanees contributed stronger to the increased in SWB of the employed, while perceived richer rural socio-cultural elements and rural amenity contributed the stronger to the SWB of the unemployed. Female respondents had stronger increase in SWB caused by increased perceived rural amenity, whereas male respondents increased their SWB with richer rural socio-cultural elements.

Table 5.9. Regression coefficients between SWB and latent variables on human needs satisfaction and rural capital access

		One group		Migration path		Employed		Sex		Housing	
Response variable	**Predictors**	**basic**	**income**	**oneway**	**return**	**true**	**false**	**female**	**male**	**own**	**rented**
SWB	HNf1.Urban	0.366	0.380		0.280	0.407	0.233	0.284	0.297	0.336	0.384
	HNf2.Rural sociocultural	0.206	0.205		0.203	0.185	0.315		0.169	0.193	0.209
	HNf3.Rural subsistence	-0.062	-0.086	-0.132		-0.082		-0.200			-0.09
	HNf4.Rural amenity	0.409	0.424	0.549	0.256	0.396	0.459	0.552	0.355	0.357	0.481
	HNf5.Child-raising	-0.112	-0.110	-0.204		-0.086	-0.174	-0.109	-0.114	-0.091	-0.137
	Income	-	0.053	-	-	-	-	-	-	-	-
HNf1.Urban	RCf1.Touristic	0.343	0.463		0.243	0.409	0.349	11.580			0.533
	RCf3.Humancapital										
	RCf4.Urban	-0.191	-0.298			-0.266		-11.183			
HNf2.Rural sociocultural	RCf1.Touristic	0.371	0.427		0.273	0.338	0.513		0.223	0.273	0.451
	RCf2.Ruralland	0.203	0.207			0.213			0.125	0.216	
	RCf4.Urban	-0.278	-0.343		-0.218	-0.248	-0.405		-0.177	-0.223	-0.319
HNf3.Rural subsistence	RCf2.Ruralland	0.200	0.139	0.239		0.183	0.169	0.275	0.178	0.201	
	RCf4.Vibrant city	-0.095	-0.137	-0.121		-0.120			-0.137	-0.121	
	RCf5.Forest						0.174				
HNf4.Rural amenity	RCf1.Touristic										
	RCf2.Ruralland	0.205	0.120	0.238		0.174	0.258	0.291	0.166	0.220	
	RCf5.Forest	0.095	0.158		0.141		0.162		0.120	0.108	
HNf5.Child-raising	RCf3.Humancapital	-0.127	-0.102	-0.180		-0.142		-0.164	-0.110	-0.126	
	RCf5.Forest	0.083	0.132				0.172		0.109		

Note: Estimated coefficients are colored by direction (red for positive and blue for negative) and strength (the stronger the darker). Only the coefficients that were significant with 1% confidence interval are presented.

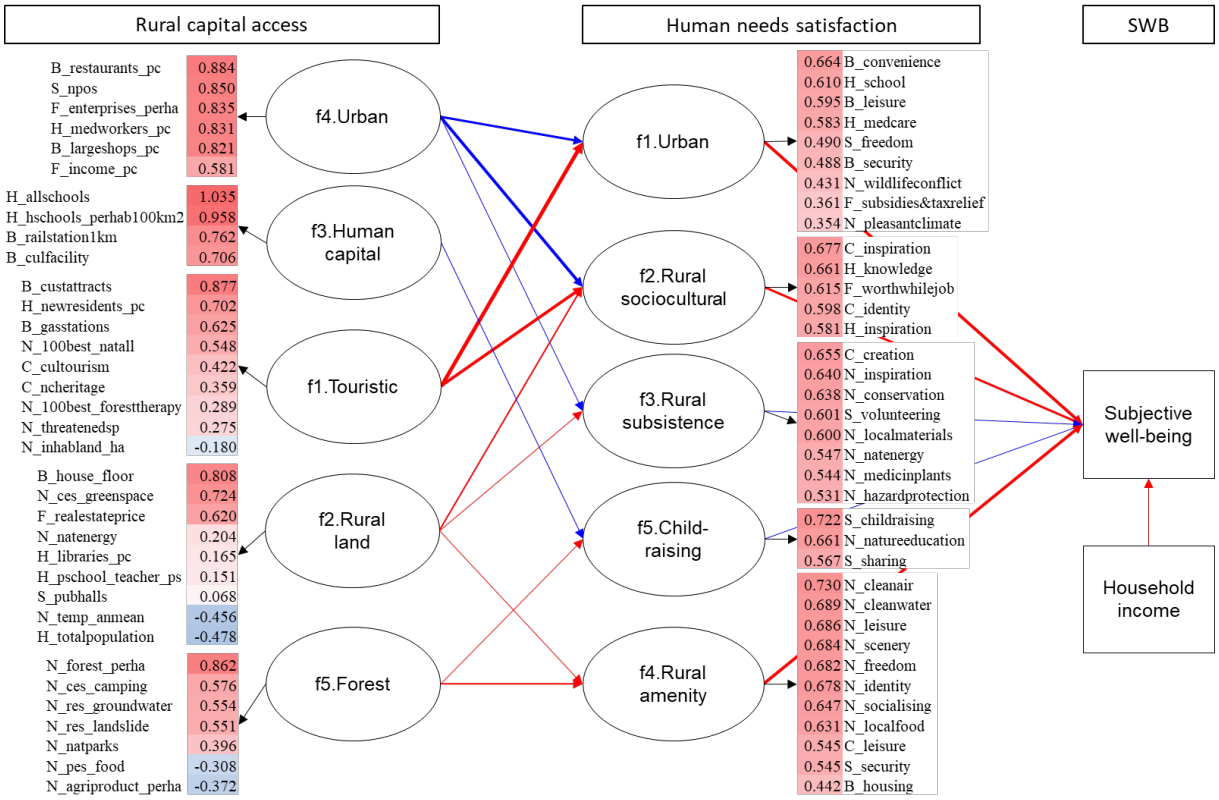


Figure 5.4. Visual presentation of the validated SEM for the one group model with income

Note: Arrows linking rural capital access, human needs satisfaction, SWB and household income domains are colored by the direction of their causal relationship (red for positive and blue for negative). Line width is proportional to the regression coefficient value. Factor loading of each observed variable on a factor is colored by direction (red for positive and blue for negative) and factor loading value (the larger the darker).

5.4. Discussion

One of two key findings from the study is that, across Japan, urban-to-rural migration does not universally increase migrants' QoL. It does, however, increase QoL of migrants with specific demographic and socio-economic traits, particularly senior citizens in the age of 60 and older, households seeking desirable child raising environment, males and people with their own housing properties. The other key finding is the strongest contribution of the utility of rural natural amenity to QoL of urban-to-rural migrants, followed by that of their satisfaction with urban-related and rural sociocultural aspects. Particularly, the study was successful in unpacking the natural and socio-cultural elements that contribute to QoL of migrants, e.g., forests, natural parks, green spaces, the prominent natural features recognized as the 100 best natural sites of Japan, low temperature, cultural tourism resources and national cultural heritage, as well as in identifying their contribution pathways. Importantly, the contribution of household income to QoL was confirmed but marginal as compared with these rural natural and socio-cultural elements.

The findings on the contribution of rural natural capital to migrants' QoL broadly agrees with a local case study (Takahashi et al., 2024) that used a similar conceptual model, in terms of natural, built and financial capital contributors to QoL, but advanced our understanding in the following three aspects: The first and foremost addition is a nation-wide validation of rural capital contributors to the QoL of urban-to-rural migrants, which substantially increased the reliability and generalizability of the estimation results.

Secondly, cultural contributors to QoL stood out in my results, which was not explicit in Takahashi et al., (2024). Presumably my nation-wide scope, including municipalities with a high cultural accumulation, enabled this addition. Thirdly, the use of path analysis in the application of the four-capital framework (Costanza et al., 2007) enabled the identification of pathways in which different types of rural capital contribute to QoL through the satisfaction of various human needs.

Below I discuss my interpretation of the modelling outcomes, particularly the latent constructs of rural capital contributors and human needs satisfaction, their contribution pathways to QoL, as well as differences in these contributions and pathways between migrants with different demographic, social and economic characteristics. I then clarify limitations and knowledge gaps that should be addressed by future studies, and end the discussion with policy implications.

My broad scope enabled an alternative classification of rural capital, which derived from the original six capital classification but optimized to explain their contribution to QoL of urban-to-rural migrants. Among the five rural capital factors identified by EFA (see Table 5.7, Figure 5.4), f5.Forest corresponds solely to forest natural capital, which provides various regulating, cultural and provisioning forest ecosystem services. Likewise, 3.Human capital and 4.Urban factors mainly correspond to built, human and financial capital which are usually concentrated in urban landscapes. In contrast, f2.Rural land encompasses various types of capital that are typically found in rural agricultural landscapes. f1.Touristic captures the uniqueness of cultural landscapes mainly by natural and cultural capital. These include national cultural heritage and nature-related 100 best sites of Japan, which were intrinsically identified by in-depth qualitative queries (see Fukada, 1964, for example) but measured in my study with spatial metrics. This demonstrates the usefulness of qualitative spatial data to quantify rural capital contributors to QoL, particularly cultural elements which often do not contain quantitative information, in a large-scale spatial analysis.

Similarly, my results provide an insightful reclassification of human needs better met by migration from urban to rural areas, which is comprised of three rural factors, an urban factor and a child-raising related factor (see Table 5.6 and Figure 5.4). Among these, f4.Rural amenity explains the utility of regulating and cultural ecosystem services. Whereas this cannot be clearly logically separated from f3.Rural subsistence, the latter has narrower focus on the utility of provisioning ecosystem services such as materials, energy and medicine. 2.Rural socio-cultural factor highlights the utility of human and cultural capital which characterize rural areas, whereas 1.Urban factor represents the utility of urban physical and financial assets.

Results from path analysis (Figure 5.4) shows an interesting discrepancy in the causal relationships between urban and human capital access and their human needs satisfaction counterparts. More specifically, urban and human capital metrics are generally lower in rural areas than urban areas, but my results showed significant contribution of the increased utility of urban assets and rural socio-cultural elements to SWB of migrants. My interpretation is that touristic rural capital, characterized by unique natural and cultural assets of rural areas, complements limited urban and human capital assets and thereby underpins human needs satisfaction associated to urban physical and rural socio-cultural factors. Likewise, limited human capital support to child raising might be complemented by the use of various forest

ecosystem services such as nature experience education in forests.

The outcomes of multiple group models are plausible to explain different realities facing the urban-to-rural migrants in different demographic and socio-economic status. For example, one-way migrants have higher utility of rural amenity than return migrants presumably because this is their primary motivation to choose their present home location, as Takahashi et al. (2024) showed in a case study in Hokuto City. In contrast, for return migrants, rural socio-cultural elements had stronger contribution to SWB, presumably because of their established social capital and cultural affinity since their childhoods. The contrast between the households with and without the employed was notable, where urban-oriented human needs satisfaction contributed stronger to increased SWB of the households with the employed, while the fulfillment of rural amenity and touristic needs contributed stronger to increased SWB of the households without the employed. This may imply more active economic engagement of the households with the employed such as working and spending in urban settings. On the contrary, households without the employed, mostly after retirement at their 60s, might have stronger engagements with society, culture and nature which center on rural touristic and land-based capital. The strong positive contribution of these capital elements, which characterize rural landscapes, to SWB of the unemployed, or the retired, might explain the significant increase in SWB caused by migration at their age of 60 or older, as presented in Table 5.4.

The above discussion validates the robustness of the overall causal relationships between rural capital access, human needs satisfaction and SWB of urban-to-rural migrants. Their details, however, are subject to the following three major methodological constraints. Firstly, details of SEM, including each latent construct and their causal links, are sensitive to the initial model construct and variable manipulation. I made my best efforts to address this issue pertinent to SEM, such as by carrying out an extensive variable screening process and by the selection of optimal models of EFA and SEM from among their several variations. However, additional efforts would be required to reinforce the reliability of the model details, such as by targeted validation of specific model components and by automated iteration of modelling with its wider variations. The root mean square error of approximation (RMSEA) values of the six SEM variations which were deemed acceptable but not optimal (Hooper et al., 2008) would indicate the space for improving these models by these additional efforts. Secondly, sampling bias might have affected the outcomes of multiple group SEMs. For example, Takahashi et al., (2021, 2024) showed in a case study in Hokuto City that the contributions of child-raising and leisure environments to migrants' QoL were different between child-raising and no-child households, as well as between people in different age group of migration. My multiple group models that compared these groups did not converge, presumably because of skewed sample size from different groups. Hence, purposeful sampling might be required to validate such group differences. Lastly, the scope of my data collection might still not be broad enough to get a full picture of rural capital contributors to migrants QoL. To do so would require a more exhaustive data collection, which would be benefited from automated data acquisition using application programing interface (API). The basic causal relationships between rural capital access, human needs satisfaction and subjective well-being established by the current study would help pursue such a direction for future.

In Japan, urban population concentration and contrasting rural depopulation have been continuing over the past half century and are reaching their extremes, with ongoing and projected negative social and ecological consequences. Overcoming this challenge does not only require short-term remedial actions such as financial and administrative support to urban-to-rural migrants, but also long-term strategies and actions to address the root causes. Key for overcoming the root causes lies in the increased QoL in rural areas, which is supported by a unique set of rural capital and potentially attracts migrants from urban areas and encourages their settlement. My study identified five rural capital factors, five human need factors and their contribution to QoL, in which rural municipalities have comparative advantages against urban municipalities. Knowledge of these factors and pathways would help long-term strategies and actions to address the root causes of rural population loss. Furthermore, considering that an extreme rural depopulation is not a unique problem of Japan but also progressing in many, particularly developed, countries across the world, my findings might also have important implications to population policies in these countries.

5.5. Conclusion

Using a nation-wide survey of urban-to-rural migrants, statistical and geospatial data acquisition and structural equation modelling, I identified five rural capital factors, five human need factors and their contribution to migrants' QoL, in which rural municipalities have comparative advantages against urban municipalities. Among the five human need factors, rural amenity, which principally derives from rural natural capital, contributes the strongest to increased QoL, followed by urban and socio-cultural utilities of a mix of various rural capital. The contribution of household income to QoL was confirmed but marginal as compared with the above three factors. Furthermore, my results imply the role of rural touristic capital, which is comprised of unique natural and cultural assets of rural areas, to complement limited urban and human capital assets in rural areas and thereby to augment human needs satisfaction associated to urban physical and rural socio-cultural factors. Whereas these results and underpinning literature validates the robustness of the overall causal relationships between rural capital access, human needs satisfaction and SWB of urban-to-rural migrants, their details are subject to future scrutiny. Knowledge of these factors and pathways would help long-term strategies and actions to address the root causes of rural population loss.

6. General discussion

The recent unprecedented urban population concentration across the world has several social and ecological consequences. It is therefore pertinent to explore an alternative deurbanization pathway, in which rural QoL is key, to achieve a better urban-rural population equilibrium. Literature on environmental contributors to QoL is accumulating but yet fragmented to support forward-looking policies to realize a deurbanization pathway. This motivated me to look into QoL in the urban-to-rural migration context, which required a deeper understanding of both the endogenous domain of individual migrants, i.e., migration motivations and underlying values, and their exogenous domain, particularly the opportunities to realize their motivations and values in their rural destinations. This chapter synthesizes the findings from three studies presented in Chapters 3, 4 and 5, which aimed to address key knowledge gaps in a sought of a deurbanization pathway, and thereby puts forward implications for policies and future studies.

6.1. Synthesis of key findings from the three studies

Chapter 3 applied the value-expectancy research model (De-Jong & Fawcett, 1981) to analyze a dataset of an all-out survey of new residents in Hokuto City within a period from April 2017 to January 2019. The analysis identified common values that underlie their migration decision, i.e., nature, housing and food. It also revealed heterogeneity in priority values among migrants in different age groups, such as employment for singles in ages between 16 and 29, natural child raising environment for married couples in their 30s and 40s, and staying with or near family for retirees in or over 60s. The centrality of nature in the common values of migration implied the need of further investigations into the rural natural capital elements that are salient to these migration values.

To respond to this need, Chapter 4 introduced the 'four-capital framework' (Costanza et al., 2007) as a theoretical ground to analyze the causal relationships between rural capital and QoL. An extended application of the four-capital framework (see Section 2.2) to an analysis of resident survey and geospatial datasets revealed the contributions of specific rural capital elements to human needs satisfaction. These were natural capital including farmland, symbolic natural sites, mountain peak view, lower temperature and tranquillity; built capital, e.g., highways, railway stations, shops and restaurants; and financial capital such as employments. The results, however, had methodological limitations in the comprehensiveness of and comparability between the indicators representing the six types of rural capital.

Chapter 5 revealed increase in SWB, a single overarching variable to explain QoL, of urban-to-rural migrants with specific socio-demographic traits, particularly senior citizens in the age of 60 and older, households seeking desirable child raising environment, males and people with their own housing properties. The Chapter further validated rural capital contributors to their QoL and the pathways in which rural capital contribute to QoL using a structural equation model that was built upon the extended four-capital framework. The modelling used standardized datasets generated by a nation-wide online survey and geospatial computation to ensure comprehensiveness and comparability. The results identified five rural capital factors and five human need factors, as well as the pathways and relative strength in which these

factors contribute to migrants' QoL. Among the five human need factors, rural amenity, which principally derives from rural natural capital, contributes the strongest to increased QoL, followed by urban and socio-cultural utilities of a mix of various rural capital. Also, the study unpacked rural natural and socio-cultural capital contributors to QoL of migrants, specifically forests, natural parks, green spaces, the prominent natural features recognized as the 100 best natural sites of Japan, low temperature, cultural tourism resources and national cultural heritage. Furthermore, the results imply the role of rural touristic capital, which is comprised of unique natural and cultural assets of rural areas, to complement limited urban and human capital assets. Importantly, the contribution of household income to QoL was confirmed but marginal as compared with that of rural natural and socio-cultural capital. The robustness of the model was validated modest and still has space for further improvements, e.g., by iterative fitting of a wider model variations, focused and balanced sampling and automated data collection.

As a total, the three studies have important mutual complementarities (Table 6.1). Particularly, Chapter 3 revealed migrants' endogenous values that underly their migration motivation, whereas Chapter 4 identified their exogenous factors, i.e., natural and other rural capital elements in a rural migration destination, that provide opportunities to put their values and motivations into practice. Chapter 5 revealed weighted causal relationships between the endogenous and exogenous factors using nation-wide data collection and path analysis. The municipality-scale case study presented in Chapter 4 has strength in high-resolution geospatial analyses that consider distance effects and viewsheds, whereas the national scale study in Chapter 5 enabled a far wider scope to explore the QoL contributors from among a large variety of unique local setting across the nation, and therefore substantially improved the reliability and generalizability of the model outcomes. Findings from the three studies are consistent in that nature is the primary, but not the sole, contributor to rural QoL. It works with social, cultural, built and financial capital to increase migrants' QoL. Also, the findings of the differences in these contributions by the migrants' demographic and socio-economic attributes are consistent. The consistency across the three studies demonstrates the robustness of these key findings.

Table 6.1. Key findings from Chapter 3, 4 and 5

Chapter	Aim	Key methods	Key findings
Chapter 3. Diverse values of urban-to-rural migration: A case study of Hokuto City, Japan	Understand the commonality and varieties in values that affected migration decisions in Hokuto City	Statistical analysis of the results from all-out survey at the resident registration desk of the Hokuto City government	Common values are favourable nature, housing and food. Other aspects differ between migrants in different age groups.
Chapter 4. Spatial exploration of rural capital contributing to QoL and urban-to-rural migration decisions: A case study of Hokuto City, Japan	Identify natural and other types of rural capital in Hokuto City that contribute to residents' QoL and to migration decisions	A resident survey with quasi-random sampling, geospatial data acquisition and an integrated statistical analysis	Natural, built and financial capital increases QoL and influence migration decisions, but their properties differ between one-way and return migrants and native residents.
Chapter 5. The contribution of rural natural capital to quality of life of urban-to-rural migrants in Japan: Structural equation modelling using a nation-wide survey and public geospatial data	Assess the magnitude and pathways in which natural and other types of rural capital all across the nation increase migrants' QoL	A nation-wide online survey with quota sampling, statistics and geospatial data acquisition and structural equation modelling	Rural natural amenity contributes the strongest to QoL, followed by urban and socio-cultural utilities. These may complement limited urban and human capital in rural areas.

6.2. Academic significance and areas left for future studies

Here I revisit key knowledge gaps in the literature on urban-to-rural migration and QoL, as presented in Section 1.4, and demonstrate how the studies presented in Chapters 3, 4 and 5 addressed these knowledge gaps. Figure 6.1 illustrates key concepts and their relationships covered by the three studies by yellow, blue and green colored oval shapes respectively. One of the two major knowledge gaps identified in Section 1.4 was the contribution of natural and other various types of capital to QoL in rural context, which is explained in Figure 6.1 by the two grey-line oval shapes labelled "opportunities" and "QoL", and their causal link shown by a grey solid-line arrow between the two oval shapes. Chapter 4 identified specific natural, built and financial capital elements that were found contributing to QoL in Hokuto City, while Chapter 5 revealed the contribution of specific elements of rural natural, built, human, cultural and financial capital to QoL across Japan, as presented in the blue- and green-lined rectangular shapes respectively (Figure 6.1). A comparison of the rural capital contributors to migrants' QoL between the two studies reveals local uniqueness of rural capital contributors to QoL. For example, farmland cover and mountain peak view contributed to QoL in Hokuto City, which were not explicit in the nation-wide study. Conversely, national heritage and other cultural assets contributed to QoL in the nation-wide study, which were not found in Hokuto City. The difference might be caused by prominent mountain peaks and farmlands that characterize the Hokuto City's landscape, as well as relatively low accumulation of cultural heritage as compared with the national average, even considering the potential effect of the difference in the scope and resolution of date used for the analyses.

The other critical gap mentioned in Section 1.4 was a missing link between migration and QoL literature, which is indicated in Figure 6.1 by the grey solid line arrow from the "motivation of migration" to the "QoL" oval shapes. This causal link was validated in Chapter 5 which revealed increase in SWB caused by urban-to-rural migration of those with specific socio-demographic traits, i.e., senior, child-raising, male and house ownership. This SWB consequence of urban-to-rural migration supports my initial hypothesis that better QoL constitute key property of urban-to-rural migration motivation, at least for the migrants falling under these socio-demographic categories. Hence, rural capital contributors to QoL, as specified above, can also be regarded as contributors to migration motivation as explained in Figure 6.1 by the solid grey line arrow from the "opportunities" to the "motivation of migration" oval shapes. It already has been well known that rich natural environment in rural areas is one of the primary motivation for urban-to-rural migration (MIC, 2018), but not exactly what constitute such natural environment. Therefore, with the above interpretation, the current study is highly valuable in that it specified measurable natural and other types of rural capital that factor in motivation of migration. These factors effectively explain the "opportunity structure" component of the value-expectancy research model (Figure 1.1) (De-Jong & Fawcett, 1981) when the model is applied to urban-to-rural migration context, and therefore can be used as key predictors of migration motivation, or ultimately migration decision. Likewise, locally unique rural capital contributors to QoL would also have unique contribution to migration motivation, implying that the areas with significantly different landscapes may have other sets of rural capital contributors to migration motivation beyond those presented in the blue and green boxes in Figure 6.1. For example, beach access

and ocean view can be important contributors to migration motivation in coastal municipalities. It, however, requires deeper investigation to unpack the details of local uniqueness, such as appropriate classification of rural landscapes and comparison of rural capital contributors to QoL between the areas that fall under different landscape classes.

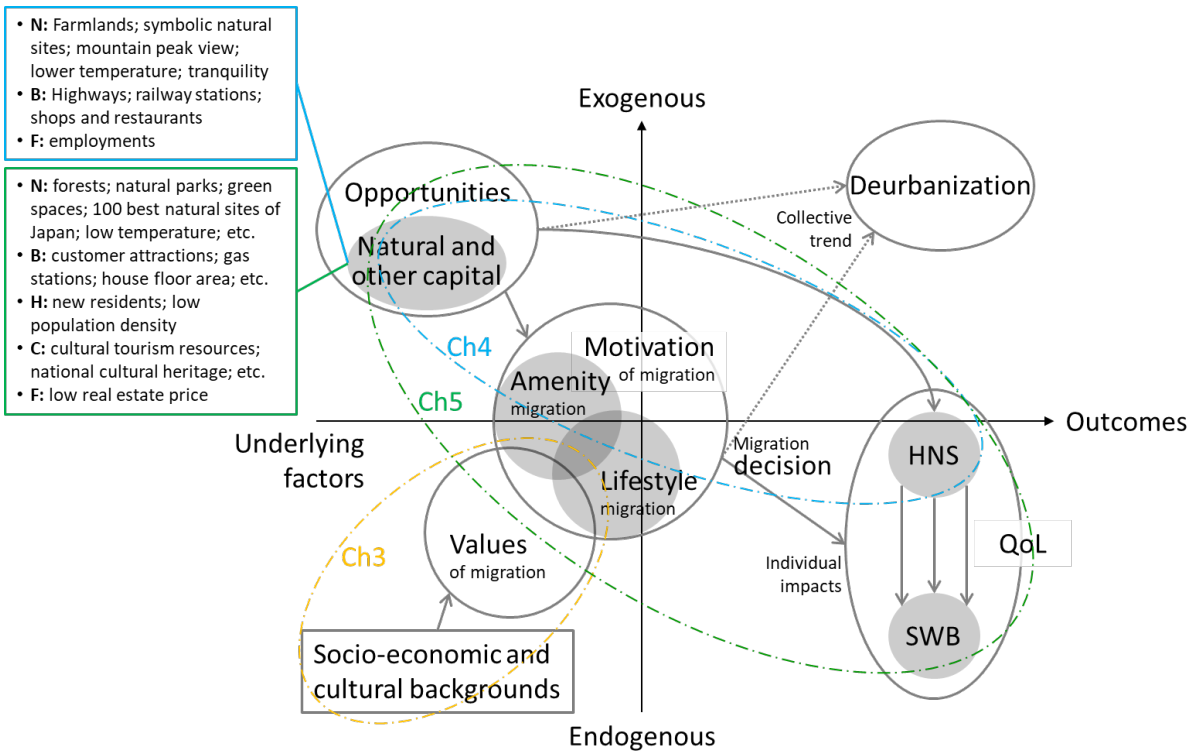


Figure 6.1 Key concepts and their relationships covered by the three studies presented in chapters 3, 4 and 5

Note: The base layer derives from Figure 1.3 which presents key terms and their conceptual relationships used in the literature on migration and QoL. Colored oval shapes indicate the key concepts and their relationships covered by Chapters 3, 4, 5 respectively. The blue rectangle shows the elements of rural capital that a case study in Hokuto City, as presented in Chapter 4, showed contributing significantly to human needs satisfaction. Likewise, the green rectangle contains the elements of rural capital constituting the latent construct that a nation-wide study in Japan, as presented in Chapter 5, found positively contributing to human needs satisfaction, with a cut-off limit of the factor loading of no less than 0.3. The bold capital N, B, H, C and F in the two rectangular shapes represent natural, built, human, cultural and financial capital respectively. The solid grey line arrows show the relationships between key concepts validated by at least one of the three studies, while the dotted grey line arrows show hypothetical relationships that were left validated.

My achievement in addressing the two critical gaps in our understanding of urban-to-rural migration and QoL, as outlined above, provides important implications to future studies, particularly to understand the feedback from nature to human behavior in social ecological systems which Section 1.4 pointed out as key knowledge gap. My results suggest the potential use of specific metrics of natural and other rural capital as the predictors of individual migration decisions, and ultimately QoL from the individual migrants' perspective. A collection of individual migration decisions for better QoL, when it takes scale, forms a trend that I defined earlier as deurbanization (illustrated in Figure 6.1 by dotted-line arrow from "motivation" to "deurbanization" oval shapes). This logic creates a new hypothetical causal link from

“natural and other capital” to “deurbanization”, as expressed by another dotted-line arrow. It is the scope for future studies to validate these hypothetical causal relationships, which can effectively leverage on the findings from the current study. That validation would enable modelling of deurbanization scenarios, including alternative future population projections for depopulating rural areas that do not only extend the ongoing pessimistic demographic trend to the future, but consider the effect of natural and other rural capital and relevant landscape interventions. Future studies in that direction would benefit from the research/sampling design that fit for the purpose, such as longitudinal design to capture both pre- and post-migration phases, as well as targeted sampling from different population groups, such as urban population who have never considered, or considered but ended up not, to migrate to rural areas, and part of rural population who have migrated out to urban areas.

6.3. To put a deurbanization pathway into practice

Halting rapid rural population decline has long been a priority policy agenda for Japanese national and local governments. Act on Overcoming Population Decline and Vitalizing Local Economy in Japan (2014) provides the foundation for strategies and plans for rural revitalization. On this legal basis, the General Strategy for Overcoming Population Decline and Vitalizing Local Economy in Japan (Cabinet Office, Government of Japan, 2022) prescribes a strategy with four objectives, i.e., increasing number and quality of employments, increasing rural migration and related population, enhancing child-raising support and creating safe and high-quality living environment. Municipalities have formulated their own population visions and general strategies aligned to the national-level strategy. For example, Hokuto City has its Population Vision and General Strategy (Hokuto City, 2018) which focuses on child-raising support, housing support, employment creation, increasing migration and related population, as well as creating comfortable and ecological living environment. These commonly bring together relevant policies and practices from across sectoral departments to provide direct life and business support, but are not clear about the real needs and aspirations of residents, particularly urban-to-rural migrants which the very strategy aims to increase.

Direct business and life support from governments are undoubtedly important, but may not be sufficient to meet the ends: to attract migrants from urban areas who intentionally give up a convenient urban life and chose an inconvenient rural life. It rather would be more important to understand what motivate urban residents to migrate to rural areas, and to strengthen the comparative advantages of rural areas over urban areas that accommodate their motivations. Inspired by this question, the current study attempted to capture the comparative advantages of rural areas by natural, built, cultural and other capital assets of rural areas which I termed collectively as rural capital. As the result, I identified specific rural capital elements that contribute to QoL, and thereby factor in migration motivation, in Hokuto City and across Japan. Further, the comparison of such rural capital elements within Hokuto City and across Japan revealed their potential local uniqueness. These findings have significant practical implications, including for the implementation and future revision of municipality-level population vision and general strategies. The findings are particularly relevant when municipalities apply the fourth objective of the national strategy to their own strategy, which is to create safe and high-quality living environment that leverage local authenticity

deriving from unique local resources. More specifically, a list of rural capital contributors to migrants' QoL in Hokuto City and across Japan can be used by local governments and stakeholders when they identify and plan the effective use of various rural capital. Furthermore, potential difference in such rural capital contributors in different landscapes implied from my results suggest the importance of the efforts to explore other rural capital elements within each municipality that characterize the uniqueness, or authenticity, of the area.

Nevertheless, I would highlight two key caveats in rural vitalization and population interventions centered on unique rural capital. One is the need of coherent policy and planning to enhance the value and utility of rural capital, and to avoid conflicting developments. For example, Hokuto City government envisages being an environmental pioneer city, centering on four major capital assets in which the City is ranked first among other Japanese municipalities, i.e., scenic mountain views, a habitat of the largest population of the Japan's national butterfly Great purple emperor (*Sasakia charonda*), clean and abundant water, as well as the longest sunshine duration (Hisai, 2020). Leveraging the longest sunshine duration, the City has developed the Hokuto City Renewable Energy Vision (Hokuto City, 2016) to upscale renewable energy introduction, particularly the photovoltaics (PVs). This, and the renewable energy feed-in tariff (FIT) by the national government resulted in rapid and uncontrolled expansion of large-scale PV facility which, by 2018, mostly occurred on the former forest (71%) and agricultural (24%) lands (Hirota, 2019). The PV expansion substantially transformed rural landscapes, seriously hampering three other rural capital flagships, i.e., scenic beauty, forest biodiversity and water which well correspond to motivation for migration to Hokuto City (Figure 4.6), and invited strong confrontation from the residents (Hirota, 2019). The arguments led to the promulgation of the Hokuto City Ordinance on the Photovoltaic Plant Development and Nature Conservation (2023) which prescribes administrative procedures to regulate PV developments. This case provides an important lesson to rural vitalization and population interventions, particularly the need of an overarching area design that ensure coherent interventions to enhance core rural capital and that provides pre-emptive measures to potentially conflicting developments. My results would help rural municipal governments and stakeholders identify core rural capital on which rural vitalization and population strategies are centered.

The other caveat is that increased urban-to-rural migration does not always result in sustainability outcomes, whereas I stated in the beginning that the ongoing extreme urban population concentration needs to be reversed to achieve social and ecological sustainability (see Section 1.1). Here I reiterate the importance of intentional efforts to ensure sustainability and QoL outcomes of urban-to-rural population shift. For example, increased migrants can hamper ecological sustainability if it comes with new land and infrastructure development. However, in the Japanese rural context where land and housing abandonment is widespread due to rapid population decline, it is possible and environmentally desirable to effectively use existing developed lands and infrastructure by new residents, and where possible centralizing such uses to realize a compact city, in accordance with the General Strategy for Overcoming Population Decline and Vitalizing Local Economy in Japan (Cabinet Office, Government of Japan, 2022). The formerly developed and now abandoned lands could desirably be used for sustainability purposes, such as renewable energy

production and ecosystem restoration. Furthermore, creating local circular economy, e.g., by promoting local food consumption, would help reduce ecological footprint leakage.

Likewise, although I pointed out the need to reverse the ongoing rural population decline to maintain domestic food and material production, only a few migrants from urban areas across Japan take up farming or other primary sector jobs, as shown by the nation-wide survey (see Table A3.2). Nevertheless, Hokuto City presents slightly different facts where commercial food enterprises have been establishing increasing number of large-scale vegetable factories, taking advantage of the availability of abandoned farmland, long sunshine duration, clean and abundant groundwater and labor (Goto, 2023). This demonstrates the possibility to leverage rural population and natural capital to boost domestic food production, and hence reduce ecological footprints of food consumption. Yet, vegetable factories and their operation significantly transform the use of land, water, energy and labor from the former open land cultivation and can hamper other core rural capital elements. This would not be as problematic as uncontrollable PV developments because vegetable factories are usually developed on abandoned farmlands, not by replacing forests, and are more firmly established, but would still require careful consideration of its interactions with other core rural capital elements.

In sum, my study made three major practical implications to rural vitalization and population interventions: (i) exemplary elements of core rural capital that contribute to migration motivation and migrants' QoL; (ii) the need of an overarching area design that ensure coherent interventions to enhance core rural capital; and (iii) the importance of intentional efforts to ensure sustainability outcomes of urban-to-rural population shift. These are mutually supportive components of deurbanization pathway, which I determined earlier as structural urban-to-rural population shift that increases ecological sustainability, justice and well-being, and therefore can create positive feedback loop to put a deurbanization pathway into practice.

7. General conclusions

The recent unprecedented urban population concentration across the world has several social and ecological consequences. It is therefore pertinent to explore an alternative deurbanization pathway, in which rural QoL is key, to achieve a better urban-rural population equilibrium. Literature on environmental contributors to QoL is accumulating but yet fragmented to support forward-looking policies to realize a deurbanization pathway. This thesis compiled three studies aimed to address this knowledge gap.

The first study identified common values that underlie their migration decision by an analysis of a dataset of an all-out survey of new residents in Hokuto City, i.e., nature, housing and food, and also revealed heterogeneity in priority values among migrants in different age groups. The second study in Hokuto City revealed the contributions of specific rural capital elements to human needs satisfaction. These were natural capital including farmland, symbolic natural sites, mountain peak view, lower temperature and tranquillity; built capital, e.g., highways, railway stations, shops and restaurants; and financial capital such as employments. In the third study, structural equation modelling using datasets of a nation-wide online survey of urban-to-rural migrants and geospatial computing identified five rural capital factors and five human need factors, as well as the pathways and relative strength in which these factors contribute to migrants' QoL. Among the five human need factors, rural amenity, which principally derives from rural natural capital, contributes the strongest to increased QoL, followed by urban and socio-cultural utilities of a mix of various rural capital. The contribution of household income to QoL was confirmed but marginal as compared with the above three factors. Furthermore, the results imply the role of rural touristic capital, which is comprised of unique natural and cultural assets of rural areas, to complement limited urban and human capital assets. As a total, the three studies have important mutual complementarities. Importantly, a comparison of the rural capital contributors to migrants' QoL between the second study in Hokuto City and the third study at a national scale reveals local uniqueness of rural capital contributors to QoL. Findings from the three studies are consistent in that nature is the primary, but not the sole, contributor to rural QoL, demonstrating the robustness of this finding.

Academic significance of these findings rests on filling critical knowledge gap in our understanding of urban-to-rural migration, QoL and their causal relationships, particularly the contribution of natural and other various types of capital to QoL in a rural context, as well as a missing link between migration and QoL literature. Filling these gaps provides important implications to future studies, particularly to understand the feedback from nature to human behavior in social ecological systems, such as the validation of a hypothetical causal link from natural capital to deurbanization, an expression of a collection of urban-to-rural migration decision for better QoL at scale. That validation would enable modelling of deurbanization scenarios, including alternative future population projections for depopulating rural areas that consider the effect of natural and other rural capital.

The findings from the current study has important practical implications to rural vitalization and population interventions, particularly those planned and implemented under the Act on Overcoming Population

Decline and Vitalizing Local Economy in Japan, and associated national and municipality strategies. These are: (i) exemplary elements of core rural capital that contribute to migration motivation and migrants' QoL; (ii) the need of an overarching area design that ensure coherent interventions to enhance core rural capital; and (iii) the importance of intentional efforts to ensure sustainability outcomes of urban-to-rural population shift. These are mutually supportive components of deurbanization pathway, and therefore can create positive feedback loop to put a deurbanization pathway into practice.

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Appendices

Appendix 1. Questionnaire (English translation)

Request for cooperation in completing a questionnaire on migration:

- We kindly request all in-migrating households to complete this questionnaire, and wish to thank you in advance for taking the time during your busy schedule. The questionnaire aims to assess the effectiveness of our ongoing efforts to promote migration from other prefectures and to assist in improving our future efforts. Your understanding of our aim and cooperation are very much appreciated.
- The questionnaire is anonymous and information provided in the questionnaire will be kept strictly confidential.
- Your answers will only be used to inform our future migration policies.

Q1. Is your migration voluntary or involuntary?

1. Involuntary migration means it is related to workplace transfer under the same employer, marriage or education of self => There is no need to fill out this questionnaire.
2. Voluntary migration => Please kindly answer the following questions:

Q2. Where did you live before?

1. Within Yamanashi Prefecture (City/Town/Village)
2. Not Yamanashi Prefecture => (Prefecture/City/District/Town/Village)

Q3. Why you decided to migrate?

1. Retirement
2. Employment (including change of job, farming and entrepreneur)
3. Marriage, childbirth or childrearing
4. Child education
5. Travel
6. Recommended by an acquaintance(s)
7. Other (Please specify:)

Q4. Did you consider other migration destinations?

1. Yes (Prefecture) (Prefecture) (Prefecture)
2. No

Q5. Which support did you use when you migrated? (Pleases choose as many as applicable)

1. Migration information desk
2. Migration related events (e.g., consultations, seminars or site visits)
3. Website (Please specify:)
4. Media (e.g., book, TV or magazines)
5. The municipality's vacant house database
6. Housing support for migration experience
7. Recruitment support
8. Other (Please specify:)

Q6 (Please answer if you chose "1. Migration information desk" for Q5)
Please choose which desk you visited.

1. Yamanashi Life Support Center (Tokyo Yurakuchou migration information desk)
2. Municipal office
3. Other (Please specify:)

When did you first visit the desk? (year/month)

Q7 Please specify your migration date and household structure

Date migrated (Year/month)
Household structure (e.g., household head, wife and two children)
Age and number of household members

Age	Male	Female	Age	Male	Female
0~15			40~49		
16~19			50~59		

20~29			60~69		
30~39			70~		

Q8. Why did you choose to migrate to this municipality? (Pleases choose as many as applicable)

1. Climate, natural environment
2. Food (farm) and water
3. Child growing and education environment
4. Leisure
5. Reliable support for employment, farming or firm start-up
6. Access from outside other prefectures
7. Security
8. Relationship with local communities or their acceptance of in-migrants
9. Other (Please specify:)

Q9. How did you identify a house in this municipality?

1. The municipality's vacant house database
2. Through a real estate agent(s)
3. Housing information magazines (including housing information websites)
4. Through a relative(s) or an acquaintance(s)
5. Other (Please specify:)

Q10. Which aspect was important when you chose your present house? (Choose as many as applicable)

1. Price
2. Property size
3. A newly built house(s)
4. An antique house(s)
5. A property(ies) for rent
6. A private property(ies)
7. A property(ies) with garden(s)
8. Near workplace
9. Convenience (e.g., near shopping centers and hospitals)
10. Other (Please specify:)

Q11. What is the occupation of the main income earner in your household?
What is the occupation type?

1. Agriculture/forestry
2. Company employee (including public servant)
3. Medical
4. Self-employed/entrepreneur
5. Other (Please specify:)

Is the present occupation the same as the one["Are the present occupants the same as"] before migration?

1. Same
2. Different

Please provide any opinions or suggestions, if any:

End of the questionnaire. Thank you very much for your cooperation.

Appendix 2

Table A2. 1 English translation of the questionnaire

Question	Answer options	Note
1 Were all members of your household born and raised in Hokuto City, or one or more members migrated from other municipality(ies)? Please select the one that is the most applicable to your household.	a. Native: All members born and raised in Hokuto City and have not lived outside the City for more than a year b. Return migrants: One or more member(s) born in Hokuto City and lived outside the City for more than a year c. One-way migrants: All members were born and raised outside the City	Single choice
2 Please specify your household structure		
2.1 Number of household members	Open question	Integer
2.2 Gender of each member	a. Male / b. Female	Single choice
2.3 Age of each member	a.0-15 / b.15-19 / c.20s / d.30s / e.40s / f.50s / g.60s / h.70s-	Single choice
3 Your current home address	Ward and street (open question)	Short text
4 Housing type	a. The property of or inherited from parents b. Purchased second-hand property c. Purchased new property d. Rent house e. Employee staff house f. Other (specify)	Single choice
5 Do you have one or more home address outside the City? Please select the most applicable one.	a. Yes and stay home outside the City for more than half a year b. Yes and stay home outside the City for less than half a year c. No	Single choice; only to return or one-way migrants
6 Your previous home address	Prefecture and municipality (open question)	Short text; only to return or one-way migrants
7 Year and month of migration	Year and month (open question)	Integer; only to return or one-way migrants
8 What was a life event that drove you to migrate? Please select the most applicable one.	a. Recruitment b. Position transfer under the same employer c. Taking over family business d. Marriage e. Baby birth and child raising f. Education for children g. Independence of children h. Retirement of self i. Caring for parents j. Rehabilitation from sickness or injury of self k. Found a favourite place or house to life, or felt inspired by the specific location l. For ideal lifestyle or worthy life m. Other (specify:)	Single choice; only to return or one-way migrants
9 Which information source or support from the government did you use for migration? Please select all applicable.	a. Migration consultation desk b. Migration promotion event (e.g., seminars and experimental migration) c. Support to recruitment or farm start-up d. Temporal home for experimental migration or subsidized home for child raising	Multiple choice; only to return or one-way migrants

Question	Answer options	Note
	e. Other subsidies or tax exemptions f. Vacant house bank g. Real estate companies h. Book, magazines, TV, internet or SNS i. Information from relatives or acquaintance j. None k. Other (specify:)	
10 What is the employment type of the primary income earner of your household? Please select the most applicable one.	a. Business owner or executive b. Permanent staff c. Part-time or temporary staff d. Family business or self-employed e. Pension f. Other (specify:) g. Unemployed	Single choice
11 What is the occupation of the primary income earner of your household?		
11.1 Please describe in short	(Open question)	Short text
11.2 Please select the most applicable one	a. Agriculture and forestry b. Fisheries c. Mining and quarrying of stone and gravel d. Construction e. Manufacturing f. Electricity, gas, heat supply and water g. Information and communications h. Transport and postal activities i. Wholesale and retail trade j. Finance and insurance k. Real estate and goods rental and leasing l. Scientific research, professional and technical services m. Accommodations, eating and drinking services n. Living-related and personal services and amusement services o. Education, learning support p. Medical, health care and welfare q. Compound services r. Services N.E.C. s. Government, except elsewhere classified t. Industries unable to classify u. Other (specify:) v. None	Single choice
12 Please specify the business address	Prefecture, municipality, ward and street	Short text
13 Did the occupation change from before migration?	a. Yes b. No	Single choice; only to return or one-way migrants
14 What was the employment type of the primary income earner of your household <u>before migration</u>? Please select the most applicable one.	a. Business owner or executive b. Permanent staff c. Part-time or temporary staff d. Family business or self-employed e. Pension f. Other (specify:) g. Unemployed	Single choice; only to return or one-way migrants
15 What was the occupation of the primary income earner of your household <u>before migration</u>?		
15.1 Please describe in short	(Open question)	Short text
15.2 Please select the most	a. Agriculture and forestry	Single choice;

Question		Answer options	Note
	applicable one	b. Fisheries c. Mining and quarrying of stone and gravel d. Construction e. Manufacturing f. Electricity, gas, heat supply and water g. Information and communications a. Transport and postal activities b. Wholesale and retail trade c. Finance and insurance d. Real estate and goods rental and leasing e. Scientific research, professional and technical services f. Accommodations, eating and drinking services g. Living-related and personal services and amusement services h. Education, learning support i. Medical, health care and welfare j. Compound services k. Services N.E.C. l. Government, except elsewhere classified m. Industries unable to classify n. Other (specify:) o. None	only to return or one-way migrants
16	How much is your household satisfied with different aspects of life in Hokuto City? Please evaluate the level of satisfaction with each of the below listed items using a five-point scale. <Work and employment> 16.1 Availability of places, materials and environments necessary for work 16.2 Enabling environment for work of one's own 16.3 Contribute to local community through work 16.4 Unique business chance or network 16.5 Urban access 16.6 Comfortable workplace 16.7 Work-life balance 16.8 Status or influence of work 16.9 High or sufficient income 16.10 Low business cost 16.11 Other (specify:) <Housing and life> 16.12 Comfortable climate and clean air 16.13 Clean water 16.14 Local food 16.15 Low housing cost 16.16 Ideal house 16.17 Renewable energy 16.18 Scenic beauty 16.19 Tranquillity and natural soundscape 16.20 Ideal lifestyle	Scale: 1. Very satisfied 2. Satisfied 3. Neither 4. Not much satisfied 5. Not at all satisfied 6. Not applicable	Single answer for each item

Question	Answer options	Note
16.21 Mobility 16.22 Shopping and eating out 16.23 Low living expenses 16.24 Government subsidy or tax exemption 16.25 Security 16.26 Other (specify:) <Child raising and education> 16.27 Time with family 16.28 Community support to child raising 16.29 Outdoor activities for children 16.30 Sufficient facilities to support child raising and education 16.31 Good schools 16.32 Other (specify:) <Medical and health care> 16.33 Facilities and support for health or elderly care 16.34 Natural environment to support medical treatment and rehabilitation 16.35 Other (specify:) <Culture, leisure and learning> 16.36 Unique local culture 16.37 Facility to support learning and sports 16.38 Places for sports and outdoor recreations 16.39 Other (specify:) <Family and community bond> 16.40 Nearness of family and friends 16.41 Local community participation and contributions 16.42 Stimulating people 16.43 Sense and identity of place 16.44 Other (specify:)		
17 What was the most important factors in deciding to migrate to Hokuto City? Please list the top-5 important factors from among the items listed in Question 16.	A list of top-5 items from the above sub-questions	Ranking; only to return or one-way migrants
18 Where migrants and native residents meet? Please identify the three most important locations of such places, events or gatherings.	(Open question) A list of top-3 name of place, event of gathering and their locations on a map	Ranking and map points
19 For how long you are likely to be living in Hokuto City?		Single choice
19.1 Please select the most applicable one.	a. For the rest of life b. From 6 to 10 years c. From 4 to 5 years d. From 2 to 3 years e. No more than a year f. Other (specify:)	
19.2 If you selected d or e in question 19.1, please describe the reason that you will be leaving Hokuto City	(Open question)	Long text
20 Please describe the unexpected or any	(Open question)	Long text

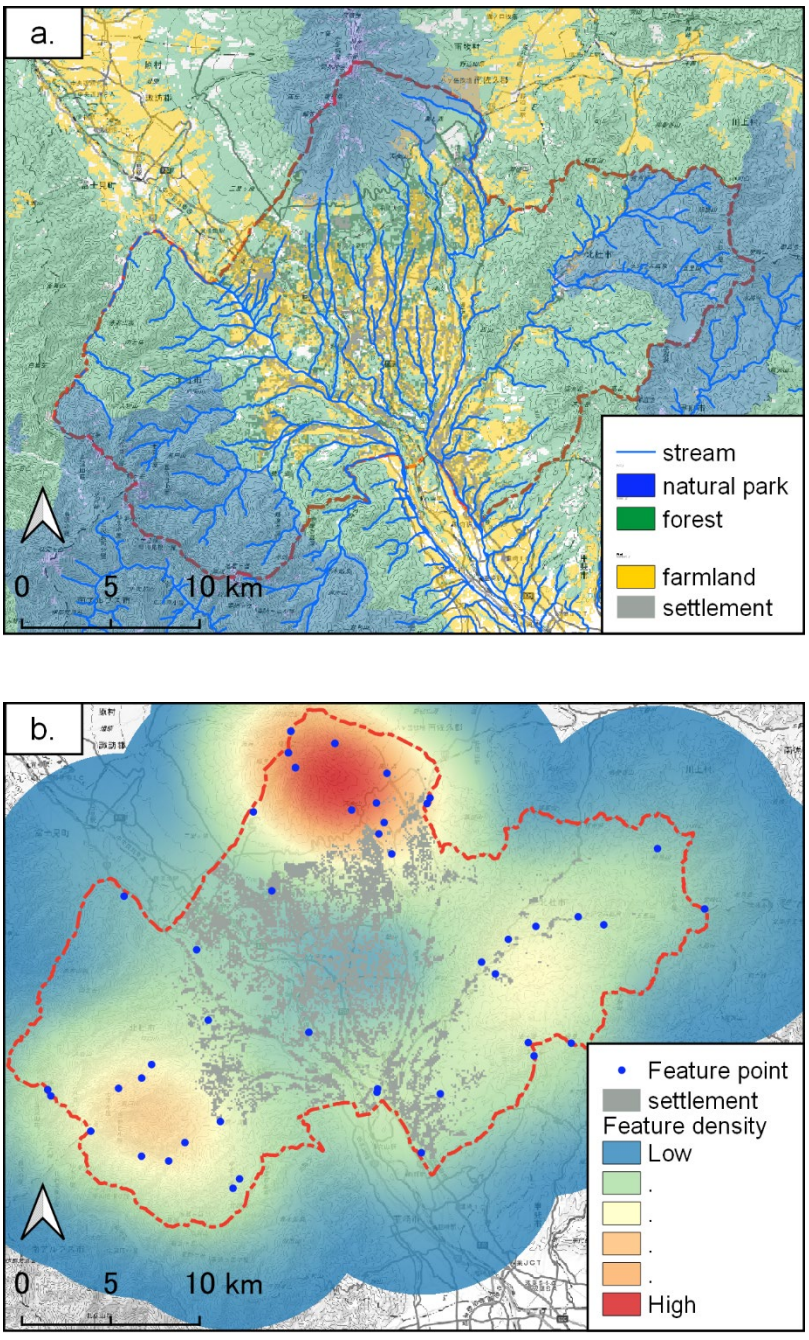
Question	Answer options	Note
other issues related to migration if any.		
21 Please identify the current household income from the below list	a. Less than 2 M JPY b. From 2 M to less than 4 M JPY c. From 4 M to less than 6 M JPY d. From 6 M to less than 8 M JPY e. From 8 M to less than 10 M JPY f. From 10 M to less than 12 M JPY g. From 12 M to less than 15 M JPY h. From 15 M to less than 20 M JPY i. From 20 M JPY or higher j. Don't know	Single choice
22 Please identify the previous household income before migration from the below list	a. Less than 2 M JPY b. From 2 M to less than 4 M JPY c. From 4 M to less than 6 M JPY d. From 6 M to less than 8 M JPY e. From 8 M to less than 10 M JPY f. From 10 M to less than 12 M JPY g. From 12 M to less than 15 M JPY h. From 15 M to less than 20 M JPY i. From 20 M JPY or higher j. Don't know	Single choice; only to return or one-way migrants
23 Please identify the highest education accomplishment of the primary income earner of your household	a. Junior-high (9^{th} grade) b. High (12^{th} grade) c. Junior college or vocational schools (14^{th} grade) d. University undergraduate (16^{th} grade) e. Graduate school (18^{th} grade or higher) f. Other (Specify:)	Single choice

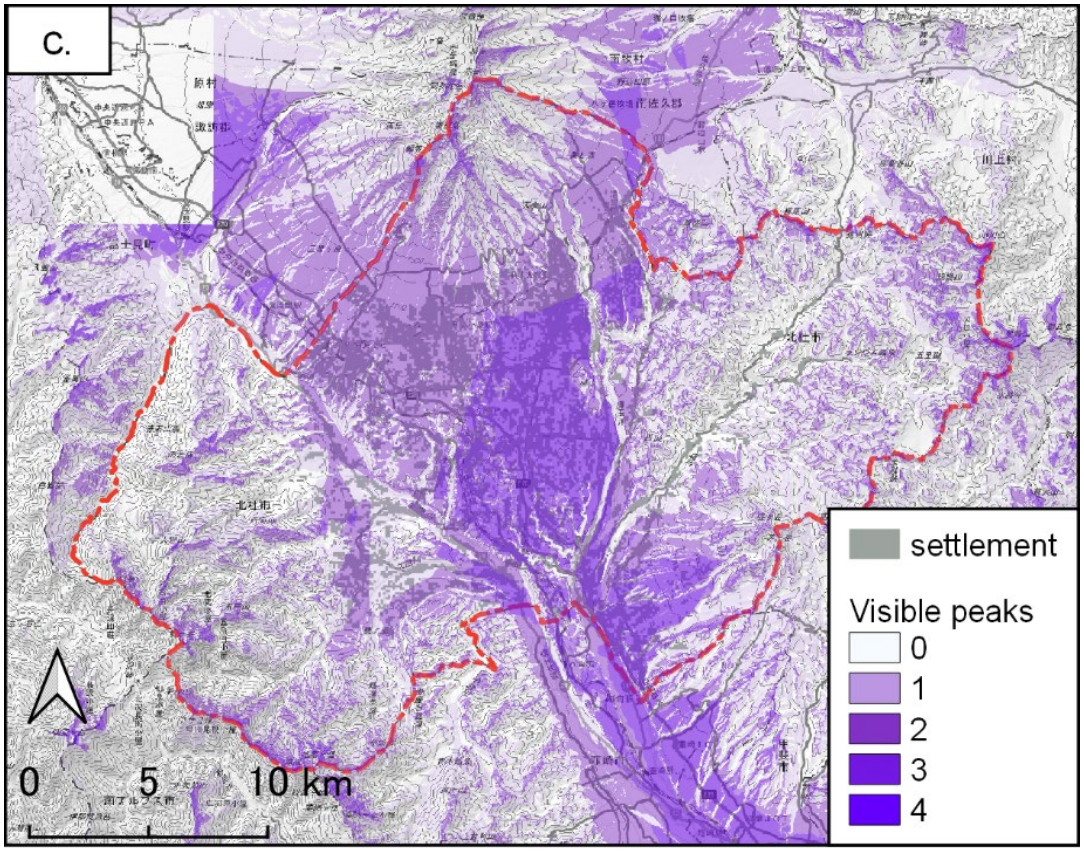
Table A2. 2 Summary statistics of the sample households

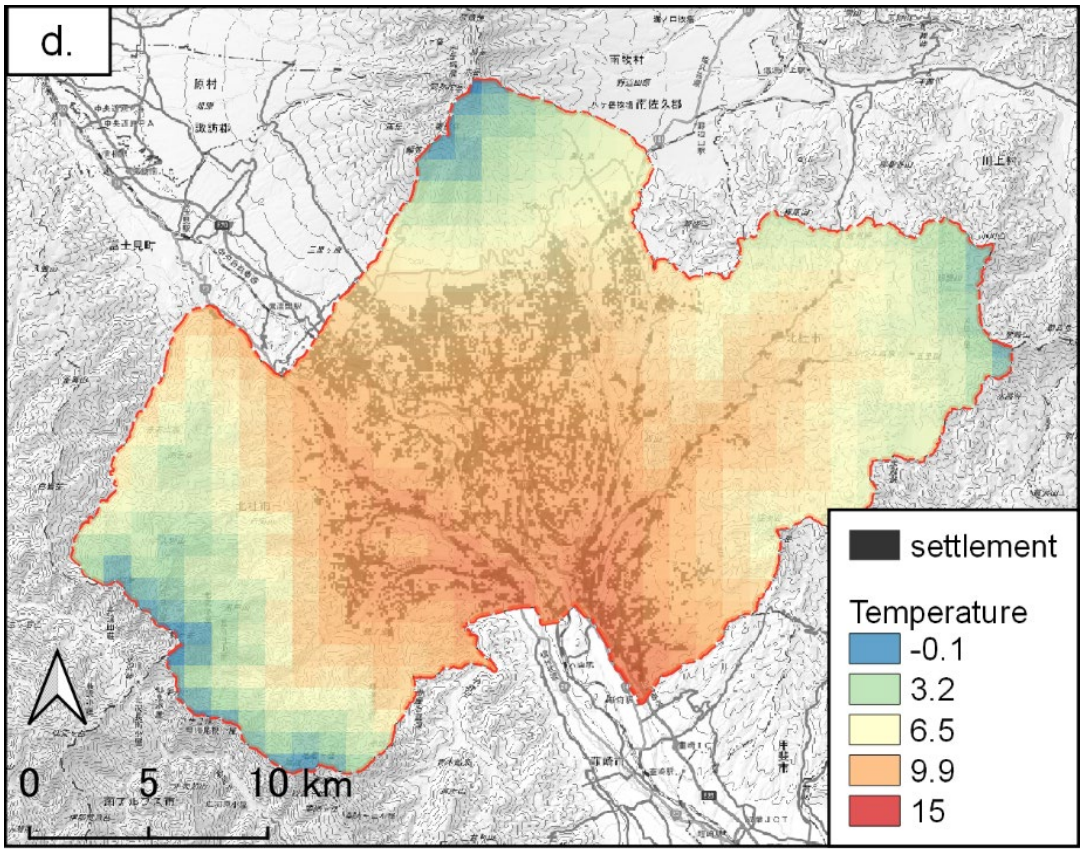
Class	Level	Number	%
Migration history	Native	124	30%
	Return migrants	53	13%
	One-way migrants	237	57%
Household structure	Single	75	18%
	Multiple without children	262	63%
	Multiple with children	68	16%
	No answer	9	2%
Age group (household head)	20s	5	1%
	30s	20	5%
	40s	36	9%
	50s	45	11%
	60s	84	20%
	>= 70s	215	52%
	No answer	9	2%
Housing type of migrant households	A house/property of or inherited from parents	70	24%
	A second-hand own house	38	13%
	A newly-built own house	129	45%
	Rented house	30	10%
	Employee staff house	5	2%
	Other	16	6%
Occupation sector (the primary income earner)	Primary	42	10%
	Secondary	59	14%
	Tertiary	150	36%
	Other sector	12	3%
	Pension	121	29%
	Unemployed	11	3%
	No answer	19	5%
Commuting distance (the primary income earner)	0	63	15%
	0 < and =< 1 km	0	0%
	> 1 km and =< 2 km	18	4%
	> 2 km and =< 4 km	17	4%
	> 4 km and =< 8 km	41	10%
	> 8 km	20	5%
	No answer	255	62%
Sample size total		414	100%

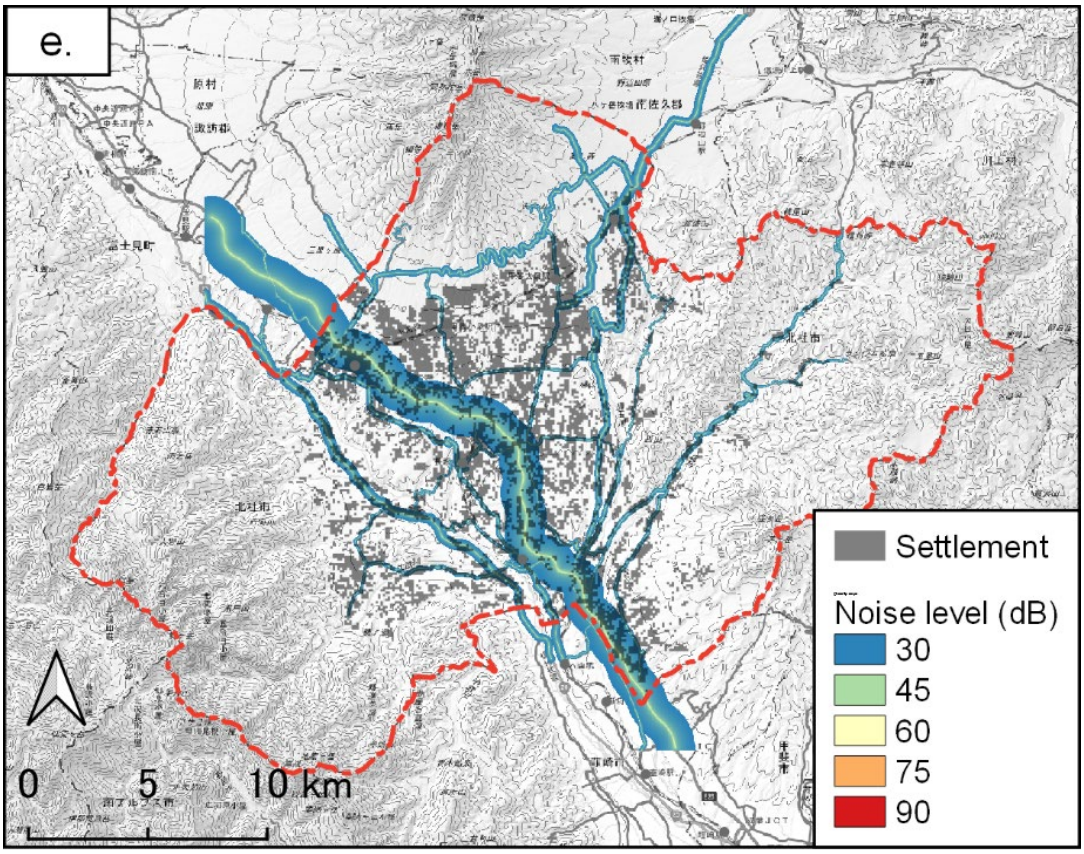
Figure A2. 1. Rural capital hotspot maps

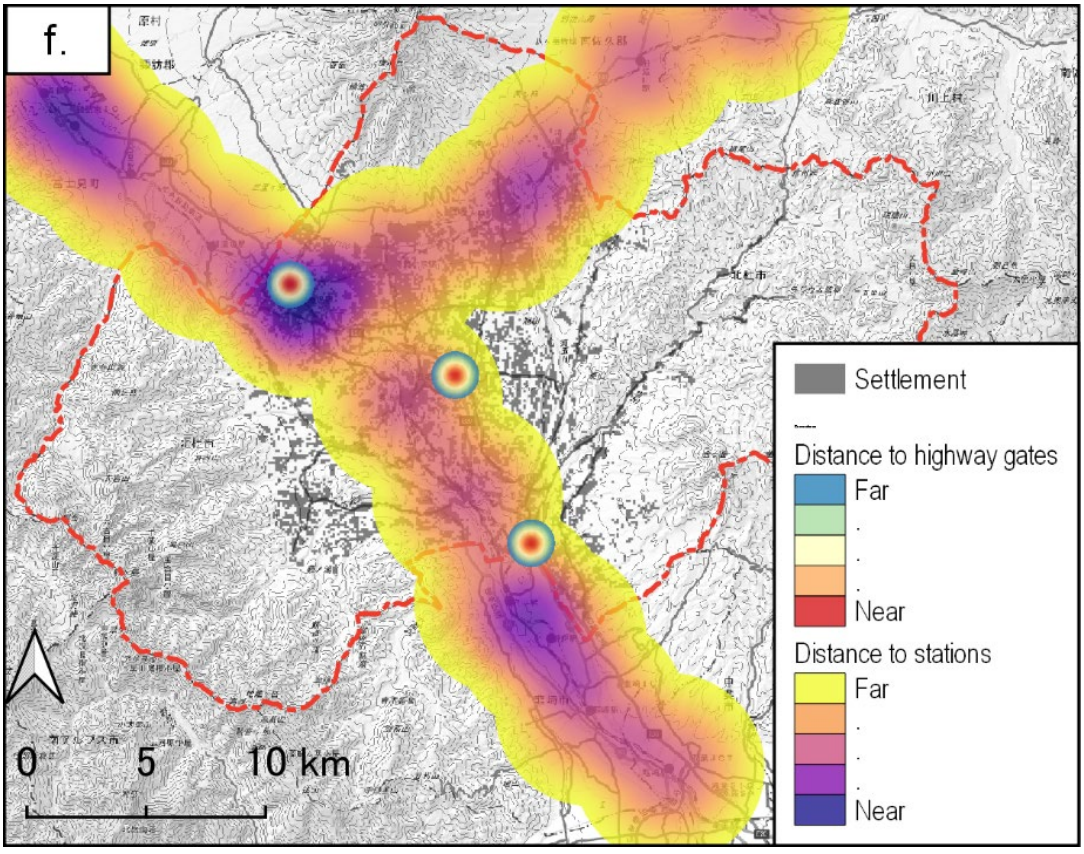
Maps (b), (f), (g) and (h) show the Kernel density of respective rural capital elements using the distance ranges specified in Table 4.3 as the bandwidths. Map (c) shows the visibility of the four prominent mountain peaks visible from Hokuto City, i.e., Mt. Fuji, Mt. Akadake, Mt. Kaikomagatake and Mt. Mizugaki. Map (e) shows estimated road traffic noise level using the equation suggested by (Watanabe et al., 2009).

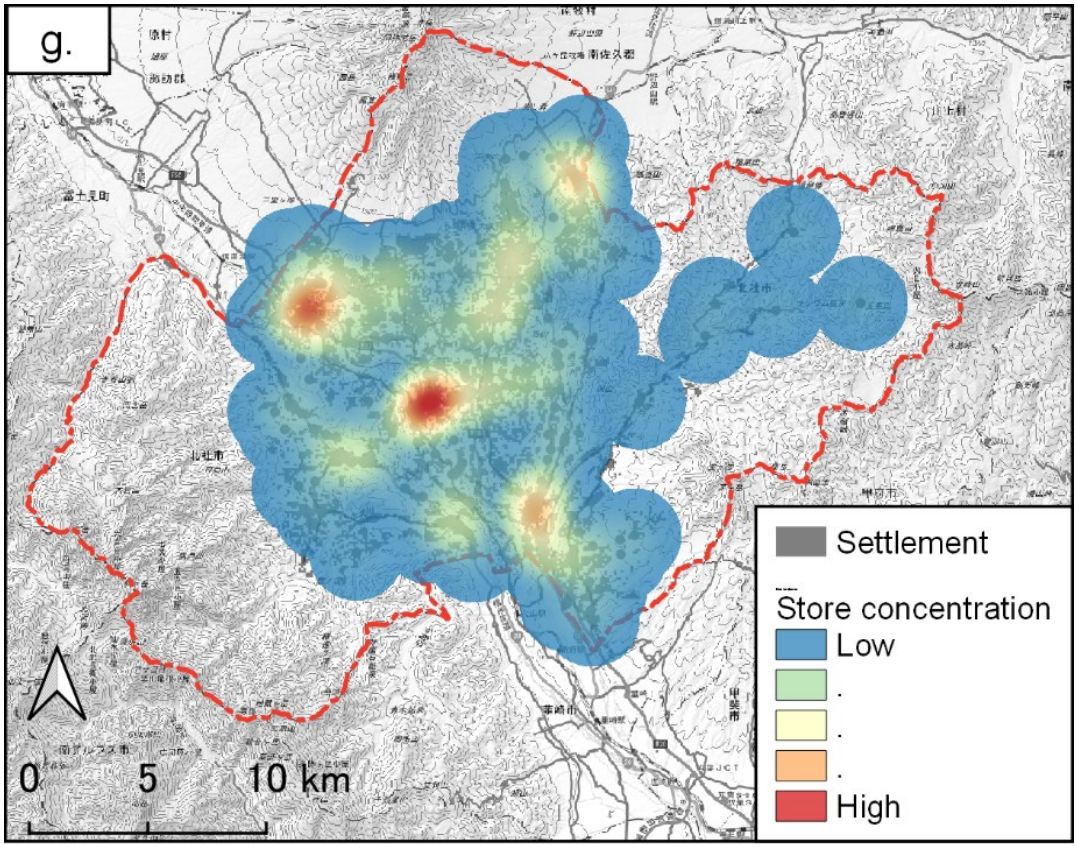


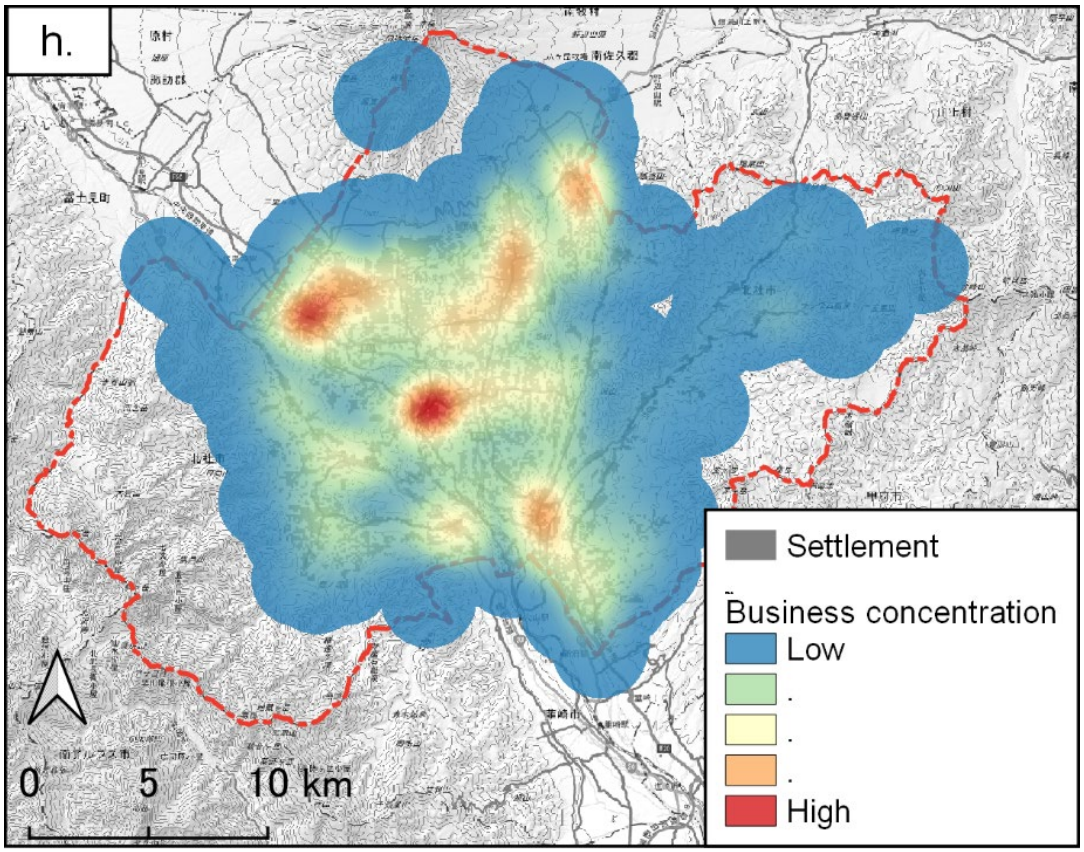

c.
settlement
Visible peaks
0
1
2
3
4
0
5
10 km


d.
settlement
Temperature
-0.1
3.2
6.5
9.9
15
0
5
10 km


e.
Settlement
Noise level (dB)
30
45
60
75
90
0
5
10 km


f.
Settlement
Distance to highway gates
Far
Near
Distance to stations
Far
Near
0
5
10 km


g.
Settlement
Store concentration
Low
.
.
.
High
0
5
10 km


h.
Settlement
Business concentration
Low
.
.
.
High
0
5
10 km

Appendix 3

Table A3.1. Sample breakdown by regional block and by full or partial migration

Regional block	Population of rural municipalities	(%)	Full migrant samples	(%)	Partial migrant samples	(%)	Total sample	(%)
Hokkaido	2,602,552	6%	65	7%	23	7%	88	7%
Tohoku	6,459,233	16%	160	16%	36	11%	196	15%
Hokuriku	3,820,559	9%	212	21%	68	22%	280	21%
Kanto	8,562,922	21%	95	10%	31	10%	126	10%
Tokai	2,665,718	7%	66	7%	31	10%	97	7%
Kinki	1,454,395	4%	36	4%	21	7%	57	4%
Chugoku	3,333,960	8%	83	8%	29	9%	112	9%
Shikoku	3,766,866	9%	94	9%	30	10%	124	9%
Kyushu	6,109,629	15%	152	15%	26	8%	178	14%
Okinawa	1,485,484	4%	37	4%	20	6%	57	4%
Total	40,261,318	100%	1,000	100%	315	100%	1,315	100%

Table A3.2. Sample breakdown by demographic and socio-economic groups

Class	Level	Full migrant	%	Partial migrant	%	Total	%
Movement pattern	One-way	546	55%	182	58%	728	55%
	Birthplace prefecture	177	18%	66	21%	243	18%
	Birthplace municipality	277	28%	67	21%	344	26%
Age of migration	10-20s	110	11%	30	10%	140	11%
	30s	219	22%	62	20%	281	21%
	40s	279	28%	75	24%	354	27%
	50s	245	25%	99	31%	344	26%
	>60	147	15%	49	16%	196	15%
Sex	Male	667	67%	223	71%	890	68%
	Female	333	33%	92	29%	425	32%
Household structure	Single	244	24%	59	19%	303	23%
	Family, no children	555	56%	176	56%	731	56%
	Family, whith children	201	20%	80	25%	281	21%
Employment type	Executive	52	5%	22	7%	74	6%
	Permanent	422	42%	176	56%	598	45%
	Part-time	118	12%	31	10%	149	11%
	Freelance	118	12%	25	8%	143	11%
	Pension	203	20%	46	15%	249	19%
	Other	87	9%	15	5%	102	8%
Sector	Agriculture and forestry	27	3%	4	1%	31	2%
	Fisheries	0	0%	2	1%	2	0%
	Mining and quarrying	2	0%	0	0%	2	0%
	Construction	45	5%	16	5%	61	5%
	Manufacturing	127	13%	47	15%	174	13%
	Electricity, gas, heat and water supply	11	1%	6	2%	17	1%
	Information and communications	33	3%	16	5%	49	4%
	Transportation	32	3%	9	3%	41	3%
	Wholesaling and retailing	58	6%	19	6%	77	6%
	Finance and insurance	16	2%	17	5%	33	3%
	Real estate	20	2%	8	3%	28	2%
	Research, science and technology	27	3%	7	2%	34	3%
	Lodging and restaurants	43	4%	6	2%	49	4%
	Life support and leisure	17	2%	6	2%	23	2%
	Education	36	4%	11	3%	47	4%
	Medical and welfare services	79	8%	17	5%	96	7%
	Complex services	10	1%	3	1%	13	1%

	Other services	68	7%	24	8%	92	7%				
	Public services	42	4%	26	8%	68	5%				
	Other	78	8%	19	6%	97	7%				
	None	229	23%	52	17%	281	21%				
Motivation	Recruitment	204	20%	68	22%	272	21%				
	Telework	15	2%	23	7%	38	3%				
	Job transfer	111	11%	82	26%	193	15%				
	Family enterprise	16	2%	8	3%	24	2%				
	Entrepreneur	35	4%	10	3%	45	3%				
	Marriage	72	7%	13	4%	85	6%				
	Child birth/raising	24	2%	5	2%	29	2%				
	Child education	6	1%	2	1%	8	1%				
	Child independence	2	0%	3	1%	5	0%				
	Retirement	136	14%	34	11%	170	13%				
	Parents care taking	129	13%	28	9%	157	12%				
	Homesick	101	10%	11	3%	112	9%				
	Other	149	15%	28	9%	177	13%				
Housing type	Inherited house	287	29%	63	20%	350	27%				
	Newly constructed house on inherited land	51	5%	20	6%	71	5%				
	Purchased second-hand house	121	12%	38	12%	159	12%				
	Newly constructed house on purchased or rented land	144	14%	58	18%	202	15%				
	Rented house, including subscription	310	31%	93	30%	403	31%				
	Staff housing, dormitories, etc.	48	5%	35	11%	83	6%				
	Other	39	4%	8	3%	47	4%				

Table A3.3. Standardized loading of each observed variable on latent variable in the six SEM variations

		One group		Migration path		Employed		Sex		Housing	
Latent variable	**Observed variable**	basic	income	oneway	return	true	false	female	male	own	rented
RCf1.Touristic	N_inhabland_ha	-0.212	-0.180	-0.105	-0.237	-0.230	-0.200	-0.155	-0.211	-0.173	-0.284
	C_ncheritage	0.396	0.359	0.356	0.443	0.609	0.314	0.255	0.465	0.410	0.372
	B_gasstations	0.643	0.625	0.679	0.573	0.589	0.665	0.554	0.658	0.600	0.703
	N_100best_natall	0.535	0.548	0.452	0.600	0.516	0.539	0.467	0.566	0.579	0.451
	H_newresidents_pc	0.691	0.702	0.585	0.714	0.759	0.658	0.597	0.694	0.722	0.615
	N_100best_foresttherapy	0.246	0.289	0.184	0.324	0.314	0.210	0.383	0.189	0.290	0.159
	B_custattracts	0.856	0.877	0.857	0.900	0.884	0.847	0.884	0.858	0.885	0.812
	N_threatenedsp	0.291	0.275	0.232	0.298	0.249	0.307	0.218	0.284	0.278	0.308
	C_cultourism	0.430	0.422	0.349	0.474	0.518	0.397	0.320	0.481	0.427	0.426
RCf2.Ruralland	N_natenergy	0.201	0.204	0.225	0.174	0.225	0.192	0.244	0.179	0.179	0.241
	N_ces_greenspace	0.723	0.724	0.746	0.683	0.730	0.712	0.726	0.721	0.744	0.581
	B_house_floor	0.813	0.808	0.834	0.759	0.824	0.807	0.801	0.818	0.806	0.693
	H_libraries_pc	0.164	0.165	0.192	0.143	0.148	0.175	0.184	0.152	0.163	0.194
	H_totalpopulation	-0.480	-0.478	-0.533	-0.418	-0.410	-0.494	-0.461	-0.491	-0.475	-0.465
	F_realestateprice	0.638	0.620	0.685	0.587	0.582	0.652	0.673	0.619	0.580	0.750
	S_pubhalls	0.069	0.068	0.084	0.054	0.071	0.068	0.081	0.063	0.072	0.060
	H_pschool_teacher_ps	0.152	0.151	0.157	0.149	0.149	0.154	0.158	0.148	0.147	0.169
	N_temp_anmean	-0.452	-0.456	-0.511	-0.345	-0.401	-0.469	-0.464	-0.443	-0.372	-0.506
RCf3.Humancapital	B_railstation1km	0.770	0.762	0.763	0.771	0.740	0.783	0.767	0.772	0.755	0.773
	B_culfacility	0.699	0.706	0.721	0.667	0.699	0.702	0.657	0.720	0.670	0.724
	H_hschools_perhab100km2	0.936	0.958	0.887	0.987	1.113	0.867	0.909	0.949	0.978	0.846
	H_allschools	1.019	1.035	1.005	1.026	1.074	0.995	0.987	1.034	1.035	0.964
RCf4.Urban	F_enterprises_perha	0.817	0.835	0.927	0.780	0.751	0.853	0.885	0.815	0.829	0.788
	F_income_pc	0.589	0.581	0.619	0.601	0.663	0.557	0.653	0.577	0.647	0.473
	H_medworkers_pc	0.895	0.831	0.506	1.228	1.086	0.816	0.751	0.927	0.958	0.784
	S_npos	0.892	0.850	0.566	1.177	1.101	0.807	0.767	0.926	0.962	0.772
	B_restaurants_pc	0.882	0.884	0.715	0.975	0.891	0.887	0.801	0.911	0.897	0.852

	B_largeshops_pc	0.855	0.821	0.566	1.078	0.992	0.799	0.766	0.877	0.895	0.783
RCf5.Forest	N_natparks	0.401	0.396	0.453	0.353	0.302	0.433	0.396	0.405	0.399	0.384
	N_agriproduct_perha	-0.402	-0.372	-0.365	-0.459	-0.432	-0.390	-0.424	-0.392	-0.457	-0.332
	N_ces_camping	0.584	0.576	0.622	0.561	0.552	0.593	0.613	0.571	0.578	0.556
	N_forest_perha	0.868	0.862	0.905	0.801	0.855	0.871	0.823	0.883	0.829	0.936
	N_pes_food	-0.331	-0.308	-0.312	-0.363	-0.431	-0.297	-0.342	-0.326	-0.403	-0.263
	N_res_groundwater	0.539	0.554	0.533	0.547	0.472	0.564	0.574	0.524	0.526	0.521
	N_res_landslide	0.532	0.551	0.523	0.553	0.576	0.515	0.550	0.526	0.598	0.394
HNf1.Urban	B_convenience	0.677	0.664		0.686	0.607	0.696	0.453	0.610	0.655	0.706
	B_security	0.495	0.488		0.337	0.379	0.530	0.336	0.485	0.458	0.569
	B_leisure	0.595	0.595		0.659	0.494	0.627	0.470	0.472	0.637	0.525
	F_subsidies&taxrelief	0.386	0.361		0.267	0.338	0.401	0.289	0.360	0.332	0.476
	H_medcare	0.599	0.583		0.607	0.543	0.619	0.416	0.547	0.575	0.638
	H_school	0.621	0.610		0.675	0.561	0.635	0.355	0.644	0.616	0.626
	N_pleasantclimate	0.341	0.354		0.296	0.169	0.398	0.256	0.292	0.345	0.341
	N_wildlifeconflict	0.425	0.431		0.343	0.436	0.422	0.255	0.427	0.463	0.367
	S_freedom	0.484	0.490		0.508	0.408	0.506	0.367	0.392	0.517	0.437
HNf2.Rural sociocultural	C_inspiration	0.662	0.677		0.652	0.476	0.710		0.594	0.623	0.720
	C_identity	0.608	0.598		0.609	0.431	0.655		0.549	0.668	0.502
	F_worthwhilejob	0.610	0.615		0.529	0.450	0.664		0.550	0.617	0.590
	H_knowledge	0.632	0.661		0.551	0.435	0.687		0.652	0.663	0.569
	H_inspiration	0.564	0.581		0.525	0.532	0.578		0.505	0.554	0.588
HNf3.Rural subsistence	C_creation	0.634	0.655	0.607	0.674	0.490	0.681	0.629	0.633	0.701	0.504
	N_conservation	0.625	0.638	0.623	0.624	0.575	0.632	0.657	0.604	0.677	0.513
	N_hazardprotection	0.508	0.531	0.514	0.500	0.429	0.532	0.567	0.477	0.569	0.412
	N_natenergy	0.540	0.547	0.585	0.482	0.568	0.535	0.588	0.512	0.602	0.395
	N_localmaterials	0.594	0.600	0.637	0.540	0.523	0.617	0.648	0.560	0.624	0.502
	N_medicinplants	0.542	0.544	0.539	0.546	0.422	0.584	0.533	0.539	0.563	0.513
	N_inspiration	0.621	0.640	0.651	0.571	0.560	0.639	0.743	0.557	0.655	0.547
	S_volunteering	0.587	0.601	0.568	0.602	0.421	0.631	0.626	0.562	0.643	0.465
HNf4.Rural amenity	B_housing	0.454	0.442	0.506	0.382	0.457	0.451	0.518	0.423	0.466	0.406
	C_leisure	0.545	0.545	0.585	0.491	0.377	0.600	0.600	0.517	0.529	0.596
	N_cleanair	0.709	0.730	0.694	0.725	0.581	0.747	0.685	0.720	0.747	0.633
	N_cleanwater	0.662	0.689	0.586	0.751	0.567	0.695	0.665	0.656	0.714	0.544
	N_localfood	0.621	0.631	0.628	0.611	0.519	0.652	0.634	0.610	0.634	0.613
	N_socialising	0.637	0.647	0.681	0.582	0.585	0.651	0.680	0.616	0.685	0.532
	N_leisure	0.688	0.686	0.717	0.659	0.603	0.717	0.707	0.678	0.730	0.627
	N_scenery	0.682	0.684	0.707	0.646	0.644	0.691	0.657	0.693	0.738	0.582
	N_identity	0.683	0.678	0.699	0.652	0.576	0.716	0.744	0.650	0.722	0.602
	N_freedom	0.675	0.682	0.710	0.630	0.597	0.699	0.701	0.659	0.699	0.641
	S_security	0.523	0.545	0.500	0.549	0.427	0.556	0.576	0.497	0.563	0.440
HNf5.Child-raising	N_natureeducation	0.666	0.661	0.704	0.638	0.620	0.685	0.779	0.611	0.711	0.594
	S_sharing	0.561	0.567	0.531	0.581	0.485	0.585	0.587	0.550	0.622	0.432
	S_childraising	0.723	0.722	0.679	0.748	0.564	0.767	0.800	0.672	0.745	0.684

Note: Estimated coefficients are colored by direction (red for positive and blue for negative) and strength (the stronger the darker)

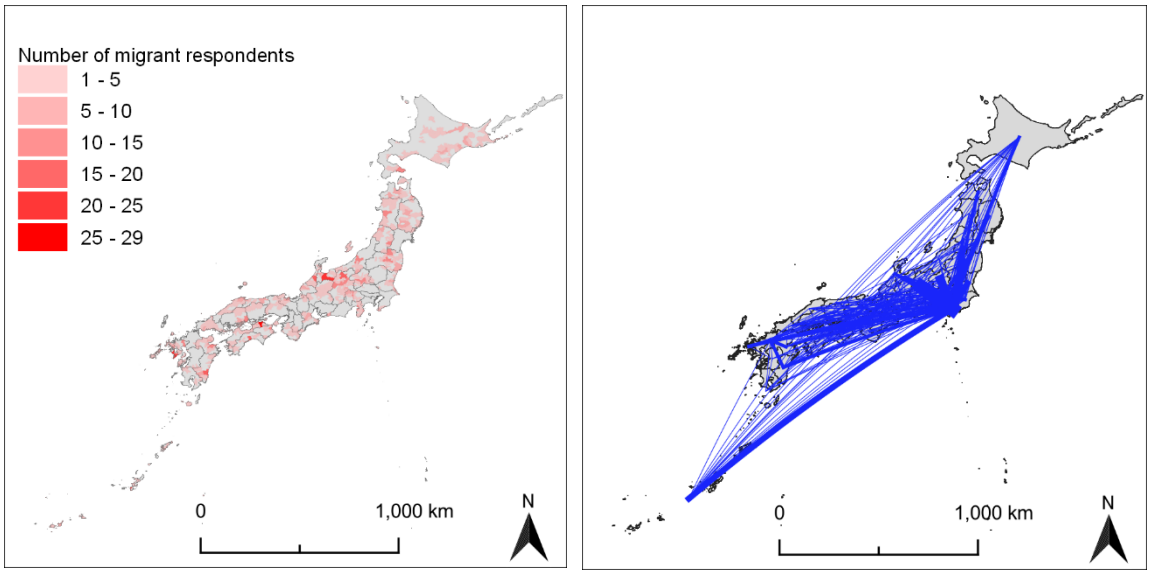


Figure A3. 1. Geographical distribution of samples and their migration pathways