

Title: Age-Friendly City Typologies and Trajectories based on Older Adults' Migration Types

Extended Abstract (1200 – 2000 words)

As population ageing intensifies, the age-friendly cities discourse has become established as a core agenda in regional policy and urban planning. In particular, Ageing-in-Place (AIP) is presented in many policy documents as an objective to help older adults continue to reside in familiar areas while maintaining health and quality of life. However, if AIP is treated as a simplistic prescription that improving environments is sufficient to prevent migration, it becomes easy to overlook the meanings of migration in older adults' lives, including needs, choices, and constraints, as well as differences in social connectedness, service accessibility, and exposure to climate risks produced by regional systems. Residential change among older adults is not merely a question of whether a move occurred; rather, it reflects entangled relationships to birthplace, prior residential experience, and local changes in economic, environmental, and social-service conditions, including family caregiving and access to medical care. Therefore, from the perspective of regional planning, it is as important to consider through what types of migration or non-migration older adults come to exist in a given place as it is to consider where they remain.

Previous studies explaining older adults' in-migration have largely estimated linear associations between regional characteristics and inflow size. Yet such approaches treat migration as a single inflow event and do not sufficiently capture why older adults come to choose particular regions. Moreover, older adults' migration and settlement are produced by the simultaneous operation of heterogeneous factors, including economic conditions, everyday living environments, social services, and climate exposure. As more variables are incorporated, linear model-centered approaches often become difficult to interpret and can miss non-linear interrelationships. Accordingly, this study redefines older adults' migration as the composition of migration types (non-migration, initial migration, return to birthplace, return to a non-birthplace previously lived in, and onward migration) and employs a Self-Organizing Map (SOM) to integrate this composition with multi-dimensional regional contexts, including economic, environmental and built, and social and service conditions. SOM projects high-dimensional information onto a two-dimensional grid while preserving similarity structures across regions, enabling classification based on complex profiles without relying on linear assumptions and facilitating the identification of trajectories over time.

The objective of this study is to classify 229 si-gun-gu in South Korea using the share of the older population by migration type as the core variable and to identify regional trajectories over time. Using the 20 percent sample of the Population and Housing Census, the study calculates, for each si-gun-gu, the proportion of older adults who come to exist in the current region through particular migration pathways. Migration types are distinguished into five categories based on residential change records

across four time points in the same individual's past residential history: (1) non-migration (residence in the same region at all four time points), (2) initial migration (one instance of migration followed by continued residence in the same region), (3) return to birthplace (returning to the birthplace after residing elsewhere), (4) return to a non-birthplace previously lived in (returning to a prior region that is not the birthplace), and (5) onward migration (residence in different regions at all four time points). This proportional indicator is interpreted as a structural indicator that goes beyond population size by revealing whether a region functions primarily as a place of settlement, inflow retention, return, or circulation, and how those functions change over time.

Along with the migration-type shares, regional context variables are structured into three dimensions to enable policy and planning interpretation. First, the Economic dimension reflects the foundation that supports or pushes settlement, including local economic opportunities, employment structure, fiscal capacity, and cost-of-living burdens. Second, the Environmental and Built dimension includes housing and living environments, transport and accessibility, neighborhood infrastructure, and climatic exposure. To reflect the risk environment of older adults' everyday activity spaces, the study includes heatwave days and tropical-night days as essential variables. Third, the Social and Service dimension reflects population structure, social vulnerability, healthcare, care provision, and the accessibility or supply capacity of public service infrastructure. In addition, to summarize the relative dominance of the three dimensions in a single map for 2020, the study constructs an RGB-based indicator by standardizing variables, computing a dimension-level summary value, and normalizing it to the 0–1 range, mapping Economic to R, Environmental and Built to G, and Social and Service to B. This RGB indicator is interpreted as a cross-sectional profile of contextual combinations in 2020 rather than as a direct measure of temporal change. Methodologically, after standardization, the study trains a SOM to place the multi-dimensional profiles of si-gun-gu onto a two-dimensional grid, applies clustering to derive regional types, and identifies trajectory types by linking positions and type changes across multiple time points.

The analysis shows that si-gun-gu are stably classified into five regional types according to the combination of migration-type shares and the three-dimensional context, and that four representative trajectory types moving across these types are identified. First, the Stable AIP Lock-in trajectory maintains a high share of non-migration from the initial to the final period, while shares of other migration types, particularly onward and return migration, remain low. Contextually, the Social and Service foundation is relatively weak or improves slowly, and neighborhood-scale adaptation infrastructure, such as shade, access to cooling, and walkable environments, does not expand sufficiently to offset increases in heatwave and tropical-night exposure. This suggests that AIP may reflect stable settlement grounded in preference, but it can also solidify into settlement under constraints on migration capacity and available options. In the 2020 RGB map, this type tends to exhibit a

combination with relatively low Social and Service (B) and relatively high Environmental and Built (G), indicating that service-base vulnerability and the relative dominance of heat exposure can coexist in the current state.

Second, the Urban Absorber with Initial Migration trajectory shows an increasing share of initial migration over time and a relatively lower share of non-migration. This pattern is prominent in regions with strong Economic and Social and Service foundations and dense everyday living infrastructure. Although heat exposure is relatively high in the Environmental and Built dimension, accessibility to healthcare and care services, everyday convenience, and transport accessibility offset this exposure, strengthening a structure in which older adults continue to reside once they migrate in. The 2020 RGB summary values show a clear combination in which Economic (R) and Social and Service (B) are simultaneously high, and, in some regions, Environmental and Built (G) is also high, suggesting that heat exposure can coexist with strong absorptive capacity.

Third, the Return Migration Reinforcement trajectory is formed as the shares of return to birthplace and return to a non-birthplace previously lived in increase in tandem. Rising return to a non-birthplace previously lived in indicates increased re-settlement to places with prior residential experience, interpreted as an outcome of the combination of familiar networks and service accessibility, including hospitals, proximity to family, and familiarity with everyday activity spaces. Even when the Economic dimension is not strong, the Social and Service dimension tends to be maintained or improve. Where heatwave and tropical-night exposure worsens sharply, return tends to slow rather than be reinforced, suggesting sensitivity of return choices to deteriorating thermal environments. In 2020, this type tends to show relatively prominent Social and Service (B) even when Economic (R) is not excessively high, consistent with the interpretation that service accessibility and local absorptive capacity support re-settlement.

Fourth, the Circular or Transient Gateway trajectory has a relatively high share of onward migration and exhibits a mixed-mobility pattern in which onward migration and return to a non-birthplace previously lived in increase together. This pattern suggests that such regions may function less as final settlement destinations than as gateways where older adults stay temporarily in response to changes in family composition, housing adjustments, and caregiving-related migration. Economic and Service foundations are intermediate or uneven, and increasing heat exposure tends to coincide with increasing mobility. In the 2020 RGB distribution, combinations of R, G, and B vary substantially across regions, indicating cross-sectional heterogeneity in the contextual structures underlying similar increases in mobility. Overall, these trajectories show that regional functions related to older adults' migration differ across settlement, absorption, return, and gateway roles and that these functions can be reinforced, weakened, or transformed amid changes in thermal environments and inequalities in service foundations. SOM-based trajectories account for functional change over time, while the 2020 RGB

indicator complements this by summarizing, in cross-section, the contextual combinations characterizing the current state reached by each trajectory.

These findings also specify policy priorities by trajectory type. For the Stable AIP Lock-in type, residential environment improvements alone are insufficient; neighborhood-based integrated interventions are required that strengthen neighborhood mobility, social connectedness, access to cooling and shade, and nighttime heat responses, given weak service foundations and relatively high heat exposure. For the Urban Absorber with Initial Migration type, demand management is needed alongside proactive expansion of heat-adaptation infrastructure and care and healthcare capacity, because heat exposure can coexist with economic and service advantages. For the Return Migration Reinforcement type, strengthening re-settlement absorptive capacity through community-based care, accessible healthcare and care services, and nighttime heat-response systems is central. For the Circular or Transient Gateway type, continuity-oriented service design should be prioritized, including continuous medical care, portable care arrangements, temporary housing support, and strengthened transport accessibility, premised on short-term stays and repeated migration.

In sum, this study provides an empirically grounded typology-and-trajectory map of how si-gun-gu function through older adults' migration and how those functions change over time. By supplementing SOM-based trajectories with an RGB summary of contextual combinations in 2020, it supports the need to move beyond a single AIP objective and to combine policy instruments according to regional type and trajectory. This contribution is particularly relevant in an era in which heatwave and tropical-night conditions reconfigure everyday life and migration, underscoring the spatial precision required for age-friendly policy.

Keywords: *Age-Friendly Cities, Migration Types, Self-Organizing Map, Trajectory typology*