Climate change and migration intentions in Southeast Europe European Temperate Zones: The moderating role of place attachment

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1 Introduction

Southeast European (SEE) countries have long been characterized by high rural out-migration, demographic decline, and strong migration networks toward Western Europe (Fassmann et al., 2014; Horvat, 2004). Migration from this region has been shaped by a complex interplay of economic, political, and social factors. Historically, economic hardship, political instability, and conflict drove large-scale emigration (Daoust & Selby, 2024). Between 2015 and 2020, emigration rose by nearly half a million people, with about one-fifth of the population living abroad by 2020, mostly in OECD countries (OECD, 2025). While remittances provide important support for households, persistent out-migration has reinforced regional inequalities: peripheral and rural areas face depopulation, aging, and technological marginalization, undermining long-term sustainability (de Brauw, 2019; Mendola, 2011; Mitrică et al., 2022; Mitrică et al., 2019; Stockdale, 2004). While individual households may benefit through higher incomes and improved living standards, the broader social and economic sustainability of rural communities is undermined by the continuous loss of working-age populations (Stockdale, 2004).

In the migration literature, climate change has emerged as an additional driver of mobility (Parsons & Nielsen, 2020). Rising temperatures, changing precipitation patterns, and more frequent extreme events increasingly affect livelihoods and well-being, particularly in rural areas (Mertz et al., 2009; Patz et al., 2005; Thornton et al., 2009). Yet, migration responses are highly context-specific: sudden-onset events such as floods often push migration more strongly than slow-onset processes like drought (Daoust & Selby, 2024; Goldbach, 2017; Kaczan & Orgill-Meyer, 2020; Letta et al., 2024). Moreover, decisions are shaped not only by objective risks but also by perceptions, adaptive capacities, and existing vulnerabilities (Cundill et al., 2021; Ekoh et al., 2022; Hunter & Simon, 2023; Oakes, 2019).

Beyond risks and vulnerabilities, migration is also influenced by place attachment, which is defined as the emotional, functional, and symbolic bonds individuals form with their communities and environments (Altman & Low, 1992; Lewicka, 2011; Scannell & Gifford, 2010). Place attachment fosters belonging and rootedness, affects mobility outcomes (Beckley, 2003; Cooke, 2011; Haartsen & Thissen, 2013), and shapes how individuals perceive climate risks (De Dominicis et al., 2015; Tenbrink & Willcock, 2023). The more strongly people identify with their place, the less threatening they perceive environmental stressors to be (Bonaiuto et al., 2016).

Most research on climate and migration, however, has focused on low-income countries in arid or semi-arid regions (Azumah et al., 2022; De Longueville et al., 2019; Hirvonen, 2016; Nawrotzki & DeWaard, 2016; Nawrotzki et al., 2017). By contrast, temperate regions in Europe, where agriculture plays a smaller role in GDP and EU membership lowers barriers to labor mobility, remain understudied (Cattaneo & Peri, 2016; Coniglio & Pesce, 2015). Existing studies are either historical (D'Andrea et al., 2011; Jennings & Gray, 2015) or focus on high-income contexts such as the Netherlands (Duijndam et al., 2023), where economic push factors are negligible. In Southeast Europe, however, environmental stress compounds existing vulnerabilities: rural settlements face climate-induced depopulation (Valjarević, 2025), forest ecosystems are exposed to increasing drought risks (Lindner et al., 2010), and land use changes reflect the interaction of demographic and climatic pressures (Stellmes et al., 2013).

This study contributes to filling this gap by analyzing how both objective climate stressors and place attachment shape migration intentions in Southeast Europe. We hypothesize that the effect of objectively measured climate change on migration intentions decreases with higher levels of place attachment. In other words, place attachment moderates the climate–migration nexus, dampening the extent to which climate stress translates into intentions to migrate. By combining individual-level survey data with high-resolution climate indicators, this paper advances a more nuanced understanding of how climate change and social rootedness jointly shape migration decisions in Europe's temperate rural regions.

2 Data

2.1 Survey data

We use primary household data collected between June and September 2024 in Albania, Kosovo, the Republic of Moldova, and Romania. These countries reflect substantial regional and demographic diversity and different political affiliations, while sharing traits of middle-income contexts in temperate zones.

Sampling followed a proportional random sampling design. Each country (except Kosovo) was divided into macro-regions. Municipalities (rayons in Moldova; counties in Romania) were randomly selected proportional to population size. In Kosovo, all seven municipalities were included. Villages were sampled within municipalities proportional to population size. Households were then systematically sampled, and one eligible adult respondent was randomly chosen within each household (birthday method in Albania and Kosovo; KISH grid in Moldova and Romania).

The gross sample consists of 2,404 valid interviews of rural inhabitants aged 18+. After excluding observations for analytical reasons, the final sample includes 2,315 observations.

Across the full sample, the average respondent age is 49.6 years (Albania: 55.7; Romania: 44.1). Gender distribution is balanced (51.2% men; 48.8% women). 71.8% report family migration experience (highest in Kosovo: 97.6%; lowest in Romania: 41.5%). 14.5% report major financial problems (driven by Moldova: 37.7%; Romania: <1%). 21.6% live in farm households, ranging from 51.3% in Albania to 2.8% in Moldova. Overall, 21.1% report migration intentions (highest in Moldova: 28%; lowest in Albania: 15%).

The survey also covers subjective exposure to climate events: 65.1% report drought experience and 68.3% heatwave experience within the past five years, with strong cross-country variation (e.g., drought: 19.3% Albania vs. 89.1% Moldova).

2.2 Climate data and regional controls

For this study, we used gridded climate data from ERA-5-Land reanalysis dataset of the European Centre for Medium-Range Weather Forecasts (ECMWF), which provides high-resolutions (~12 km) hourly climate variables.

We extracted annual series of temperature (2 m air temperature, converted from Kelvin to C) and precipitation (total precipitation, mm) for the period 1994-2023 for each of the study locations. The data were aggregated to annual values in order to capture long-term climate variability and trends.

Trend estimation: For both long-term annual precipitation and temperature, the Sen's slope (s-slope) was calculated to estimate the magnitude and direction of monotonic trends over the study period. A positive value represents an increasing, trend while a negative value indicates a decreasing trend. The values are expressed in C/year for temperature and mm/year for precipitation, indicating the average change of each parameter per year.

Variability estimation: For both long-term annual precipitation and temperature, the coefficient of variation (CV) was calculated across all locations over the study period and expressed in percentage form.

The climate zones of the study location were identified based on the Köppen–Geiger climate classification (1980-2016). The elevation and slope of the study locations were extracted from the NASA Digital Elevation Mode (NASADEM), which is reprocessing and enhancement of the original Shuttle Radar Topograpgy Mission (SRTM) data.

Additionally, night-time lights were added to approximate economic development in the respective regions. This data was obtained from the Annual Global VIIRS Nighttime Lights dataset (Elvidge, 2021) offering a spatial resolution of 465 meters per pixel. Values range from zero to 60, with larger numbers indicating higher brightness, which is typically closely and positively correlating with economic activity and GDP. As our study sites are located in rural areas, values are quite low, at a mean of 0.8. Between-country variation was not high, country means ranging from 0.4 for Moldova to 1.5 in Kosovo.

3 Empirical Strategy

Given that the migration intention is a binary outcome, we employ a two-level probit with village random intercepts to estimate the likelihood of migration intention *mi* of individual *i* in village *j* in country *k*. We use the following regression equation:

$$P\left(mi_{ijk} = 1\right) = \Phi(\alpha + \beta'\mathbf{climate}_j + pa_{ij}\,\kappa + \gamma'\mathbf{x}_{\boldsymbol{ij}} + \delta'\mathbf{z}_{\boldsymbol{j}} + \boldsymbol{\lambda}_{\boldsymbol{k}} + \mathbf{u}_{\mathbf{0}\boldsymbol{j}} + \boldsymbol{\varepsilon}_{\boldsymbol{ij}}),$$

where *mi* is a binary variable, which takes the value of 0 for no migration intention and 1 for migration intention. $P(mi_i = 1)$ indicates the probability that individual *i* has migration intention. The vector **climate** contains our variables our climate variables. To allow for asymmetric migration responses to long-run precipitation changes, we decompose the 30-year precipitation slope into two variables: a negative component that captures declining trends and a positive component that captures increasing trends, each set to zero outside its sign range. These are constructed as sign-restricted slopes (others set to zero), which is why both can enter the model jointly without perfect collinearity.

Place attachment: We then interact each climate indicator with place attachment (PA) to test whether social rootedness conditions climate–migration pathways.

The vector **x** represents the socio-demographic and socio-economic characteristics of an individual. We control for a set of standard characteristics, such as the respondent's age in years, gender, education, financial status, health status, existence of migration experience within the household, and if the respondent lives in a farm household.

The vector **z** represents the characteristics of the village. We include nighttime lights, climate zone according to Küppen classification, the elevation calculated with a 1 km radius from the village center, the slope calculated from a 5 km radius from the village center, and nighttime lights.

The parameter Φ represents the cumulative distribution function (CDF) of the standard normal distribution, which transforms the linear prediction into a probability between 0 and 1, and β and γ are the parameters to be estimated. Multilevel probit models include random intercepts at the village level and country fixed effects; the intraclass correlation at the village level is about 0.095, supporting the multilevel specification.

4 Results

The estimated ICC of about 0.10 indicates that around ten percent of the variance in migration intentions is attributable to differences between villages, while the remaining 90 percent is due to within-village heterogeneity. This justifies the use of a multilevel model with random intercepts at the village level.

Baseline model (**without interactions)**.

Place attachment is a strong negative predictor of migration intention (coef = −0.728, p<0.001; AME ≈ −0.147): a one-unit increase in PA reduces migration intention by ~15 percentage points, ceteris paribus. Respondents from farm households are also less likely to intend migration (AME ≈ −0.065). Climate indicators are weak in the aggregate: temperature variability is borderline positive (p≈0.052; AME ≈ +0.039), while precipitation variance and precipitation trends are not reliably different from zero. This suggests that social rootedness dominates average climate signals unless heterogeneity is explicitly modeled.

Climate × place attachment.

Once climate effects are allowed to vary by PA, two robust patterns emerge:

- Positive precipitation trend (Sen's slope, positive component). The main effect is positive (+1.080, p<0.001), while the interaction with PA is negative (−0.248, p<0.001). Thus, strengthening positive precipitation trends raise migration intentions particularly among individuals with low place attachment, whereas the effect is attenuated—and can become negligible—at high PA. Predictive margins show steep increases across the observed trend range for PA=1 and much flatter lines for PA=5.
- Precipitation variability (CV). The main effect is negative (−0.376, p=0.030), but the interaction with PA is positive (+0.098, p=0.018), implying a sign flip across attachment levels. At low PA, higher precipitation variability reduces migration intention; at high PA, the slope turns positive. Predictive margins indicate high but flat/declining probabilities at PA=1, versus low but rising probabilities at PA=5.

Negative precipitation trends do not show robust associations (main or interaction). Temperature variability shows a modest positive association (AME ≈ +0.046, p=0.024) but no evidence of moderation by PA. Temperature trends are not significant.

Overall, the results indicate that climate does not uniformly push migration intentions in SEE. Instead, climate–migration linkages are conditional on social rootedness: place attachment dampens some climate pathways (positive precipitation trends) and qualitatively changes others (precipitation variability).

5 Discussion and implications

Our findings nuance the climate–migration nexus in temperate, middle-income rural Europe. The same climatic dynamic can imply different migration responses depending on social rootedness: individuals with low place attachment appear more climate responsive, whereas those with high attachment are buffered—and may even show opposite associations depending on the climate indicator. This aligns with research emphasizing that mobility outcomes are shaped by appraisal, coping, and social embeddedness rather than climate exposure alone (Bonaiuto et al., 2016; Cundill et al., 2021; De Dominicis et al., 2015; Hunter & Simon, 2023).

Policy implications follow directly: responses to climate risks in SEE rural areas should combine climate adaptation with place-based investments that strengthen local opportunities and sustain social ties. Otherwise, climate stress may translate into higher out-migration intentions particularly among populations that are already weakly rooted. At the same time, strong attachment may also imply staying despite rising risks—highlighting the importance of supporting in-situ resilience and well-being in highly attached communities.

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