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AN EMPIRICAL HIGH-RESOLUTION GEOSPATIAL MODEL OF FUTURE POPULATION DISTRIBUTION FOR ASSESSING HEAT DEMANDS

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Why heat supply planning needs detailed spatial demographics

- Future heat demands, efficiency and supply depend on:
 - The energetic development of the existing building mass
 - The intensity at which buildings are used
 - The replacement of existing building stock
 - The expansion of urban areas with new building stock.
- An assessment of future population distribution may help describing:
 - Where to expect new-build areas, at which density
 - Where to anticipate a further decline in population
 - Where to foresee urban economic development: "booming areas".





Fundamental thoughts on population development

- There are significant differences of population development across Europe and its regions
- In the past 30 years, structural change has driven population development, e.g.:
 - Trending metropolitan areas keep growing
 - Transition economies of the East experience shrinking city centres
 - Rural Europe continues to be de-populated
- A myriad of causalities and heterogeneities, rooted in the great diversity of European countries, drives population development
- The remotely sensed evidence of the past may be key to understand future urban development.





A (bold) attempt to model the future distribution of population on the hectare level

- Basic hypothesis: past population development in places drives future development in their neighbourhood:
 - Places that have experienced significant growth or decline influence locations nearby, which expose a similar trend
 - If areas near existing growth areas are suitable, then the attractiveness of growth areas rubs off on these
 - The past population increment within a defined neighbourhood can be used to calculate future population in each location











- The GHS multitemporal population grid has been resampled to 100m resolution.
- It comprises a synthetic distribution of historical census data to remotely sensed built-up areas and their built-up intensity.
- Therefore, GHS reflects urban tissue as well as demography.







Method

- Raster-based analysis in geographical information systems (ArcGIS 10.7 SA)
- Functional spatial unit: 1 hectare
- Calculate per-cell annual increment from past development: 1990-2015
- Calculate local increment as the x-th percentile of population development in a defined circular neighbourhood around each populated cell
- Adjust local increment to regional and national population forecasts
- If the development is positive, apply increment to suitable neighbour cells
- If the development is negative or zero, apply increment to same cells
- Iterate for the periods of 2015-2030 and 2030-2050



 Population distribution in 2030 and 2050 in seamless 1-hectare grids for the EU 28

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Local urban and rural development (Potsdam)







Trends in populated area development, 1990 - 2050







Tuning

- Two main parameters:
 - Choice of neighbourhood radius:
 - Determines expansion range and density
 - The percentile value
 - Determines density and similarity between exisiting and new-build areas
- In addition:
 - The reclassification of land cover into suitable development areas







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• The model was run to replicate the 2015 population using the 1975-1900 period. Overall fit is acceptable. Rural areas perform better than urban areas.





Limitations

- Needless to say that such models will always be oversimplified, mechanistic, ultra-positivist and deterministic
- There is little room to design urban areas in a desired way
- Linear trends are assumed, which are conservative in the light of rapid transformation scenarios
- A single model for all or Europe (N-S, E-W, rural-urban)
- Weaknesses in the GHS population layer.





Outlook

- A first model of future population distribution yields realistic results
- More needs to be done to understand the dynamics of urban development
- Use kernel weight function for more realistic neighbourhood statistics
- Develop scenarios for dense and energy efficient cities.





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THANK YOU, TIME FOR QUESTIONS

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