Comparing Distance and Its Frictional Effect on Internal Migration in Countries Around the World

Presentation in the Alan Wilson Plenary Session - Spatial Interaction Modelling - at the European Colloquium on Theoretical and Quantitative Geography at the Park Inn, York, 7 September 2017

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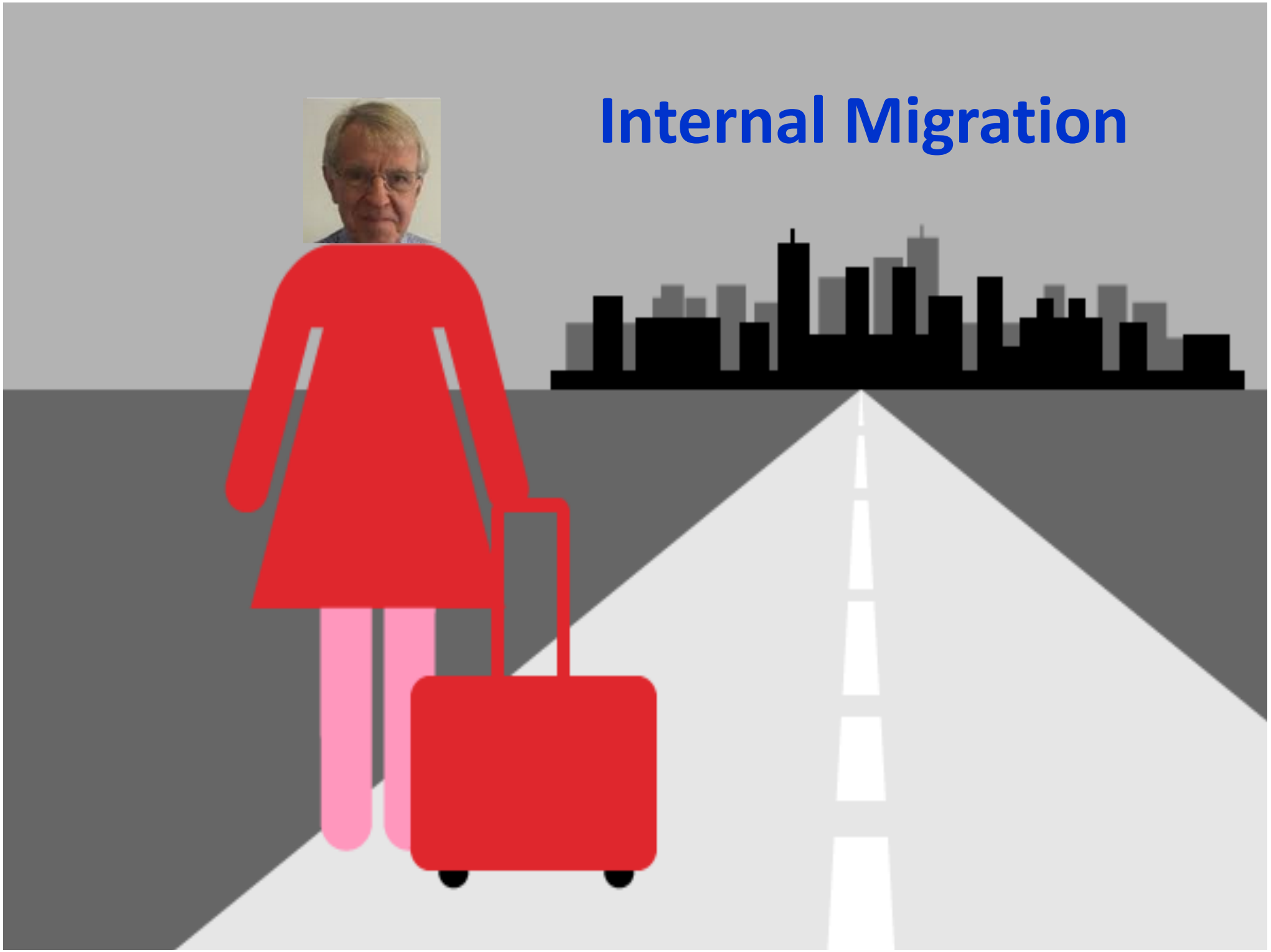
Internal Migration



Measures for Cross-National Comparison of Internal Migration

Measures of migration intensity	
1	Crude Migration Intensity
2	Standardized Migration Intensity
3	Gross Migraproduction Rate
4	Migration Expectancy
5	Peak Migration Intensity
6	Age at Peak Intensity
Measures of migration distance	
7	Mean Distance Moved
8	Distance Decay Parameter
9	Courgeau's *'K'*
Measures of migration connectivity	
10	Index of Migration Connectivity
11	Index of Migration Inequality
12	Migration Weighted Gini
13	Coefficient of Variation
Measures of migration impact	
14	Migration Effectiveness Index
15	Aggregate Net Migration Rate

Source: **Bell, M., Blake, M., Boyle, P., Duke-Williams, O., Rees, P., Stillwell, J. and Hugo, G. (2002)** Cross-national comparison of internal migration: issues and measures, *Journal of the Royal Statistical Society A*, 165(3): 435-464

Research questions

- How far do migrants move in different countries around the world?
- What is the frictional effect of distance in different countries?

- Can we produce league tables of these indicators?

Impediments to cross-national comparison

- Lack of data and access to data
- Differences in concept of migration, e.g. migrants versus moves
- Disparities in the way internal migration data are captured, processed and published
- Differences in temporal and spatial frameworks used for measurement

For a detailed discussion, see Bell, M., Charles-Edwards, E., Kupiszewska, D., Kupiszewski, M., Stillwell, J., & Zhu, Y. (2014). Internal Migration Data Around the World: Assessing Contemporary Practice. *Population, Space and Place,* 21(1), 1-17

Modifiable Areal Unit Problem (MAUP)

- The MAUP has two components (Openshaw, 1984):

- **Scale effect:** How does a migration indicator vary according to the number of regions (lets call them **Aggregated Spatial Regions (ASRs)**?

- **Zonation effect:** How does a migration indicator vary according to the configuration ASRs at any spatial scale (same number of ASRs)?

The IMAGE Project

- An international collaborative program comparing internal migration between countries
- Funded by Australian Research Council
- Bell, Stillwell, Kupiszewski, Zhu, with Charles-Edwards, Daras, Kupiszewska, Ueffing, Rees, Bernard
- Collaborators from 20 countries

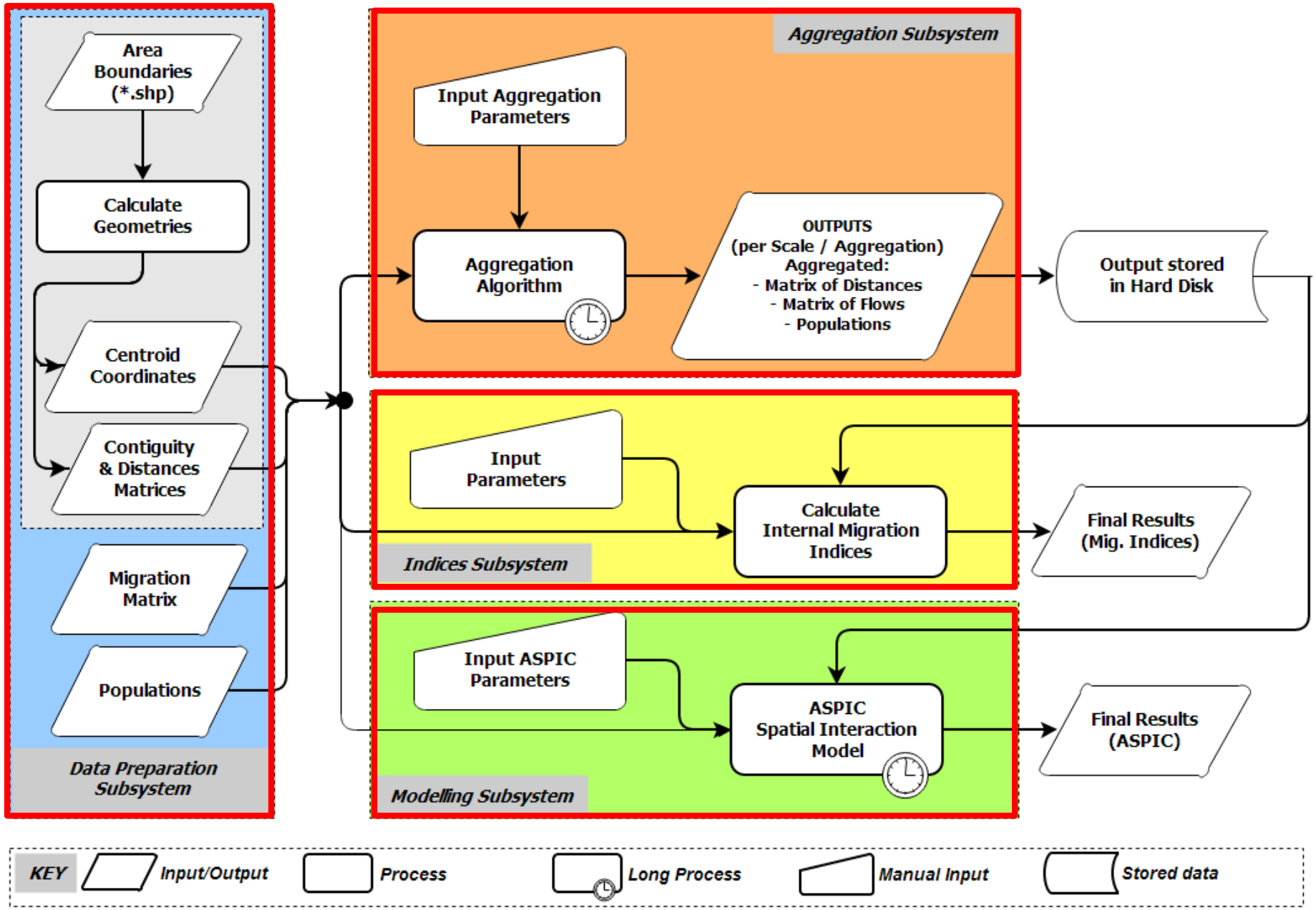
IMAGE Inventory
- Who collects what?
- 193 UN member states

IMAGE Repository
- Data sets for 135 nations

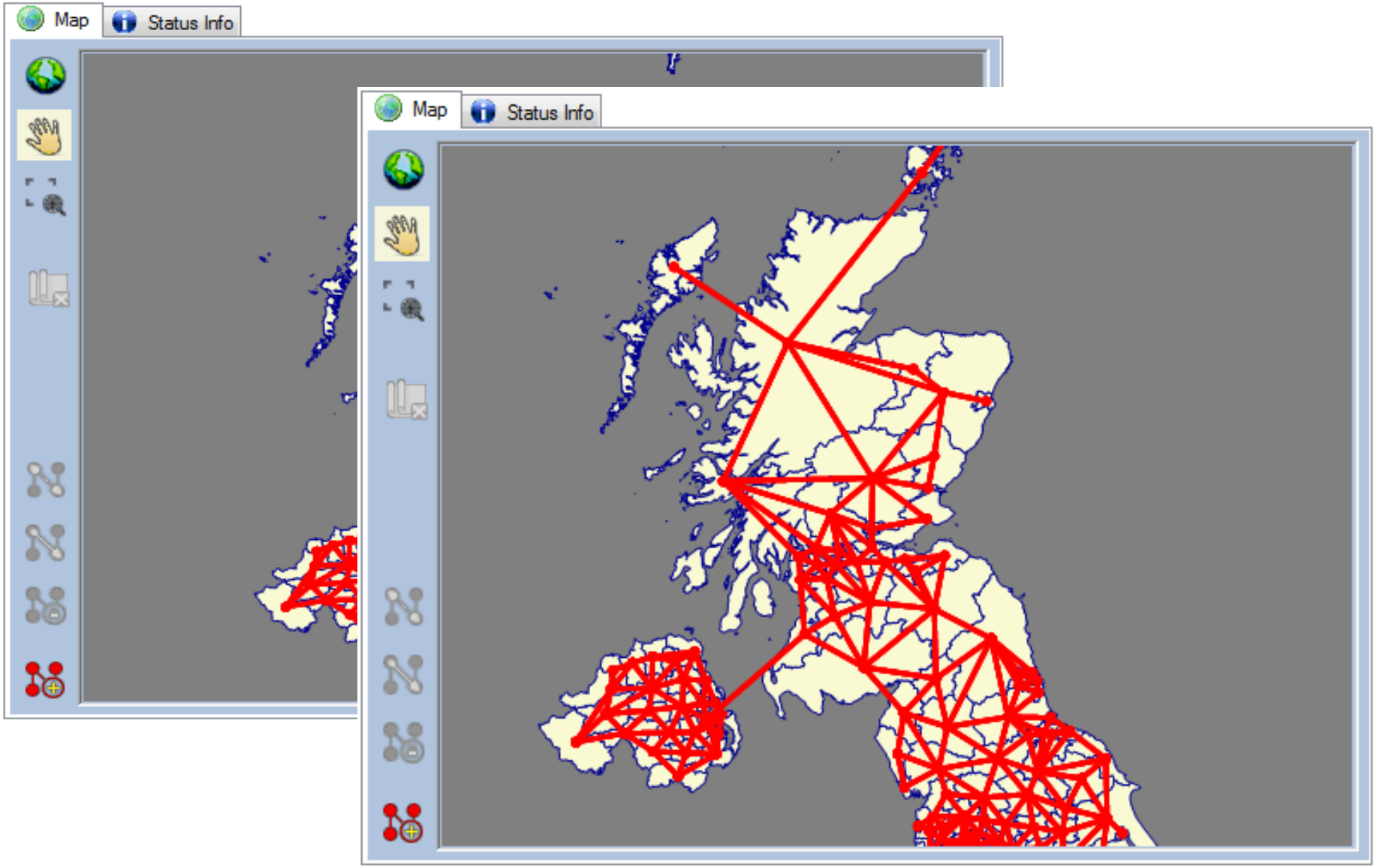
IMAGE Studio
- Computes migration metrics
- Addresses methodological issues – the MAUP

IMAGE Outputs
- Thematic papers
- Methodological papers
- Regional papers

Structure of the IMAGE Studio

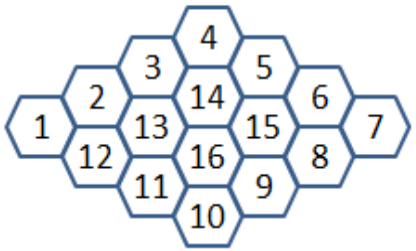


Data Preparation System: Need to ensure contiguities complete

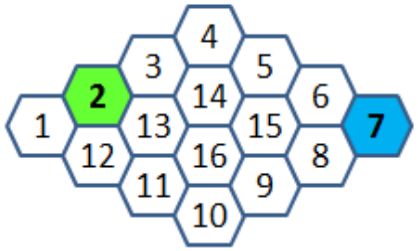


Aggregation Subsystem: IRA wave algorithm

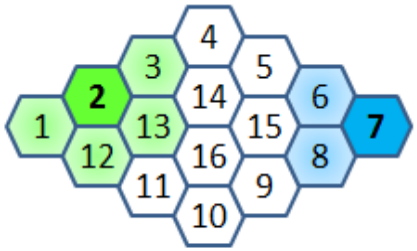
Basic Spatial Units (16 BSUs)



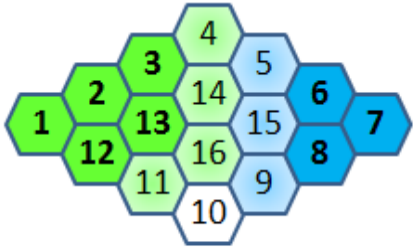
1) Select 2 random seeds



2) Select all neighbouring areas

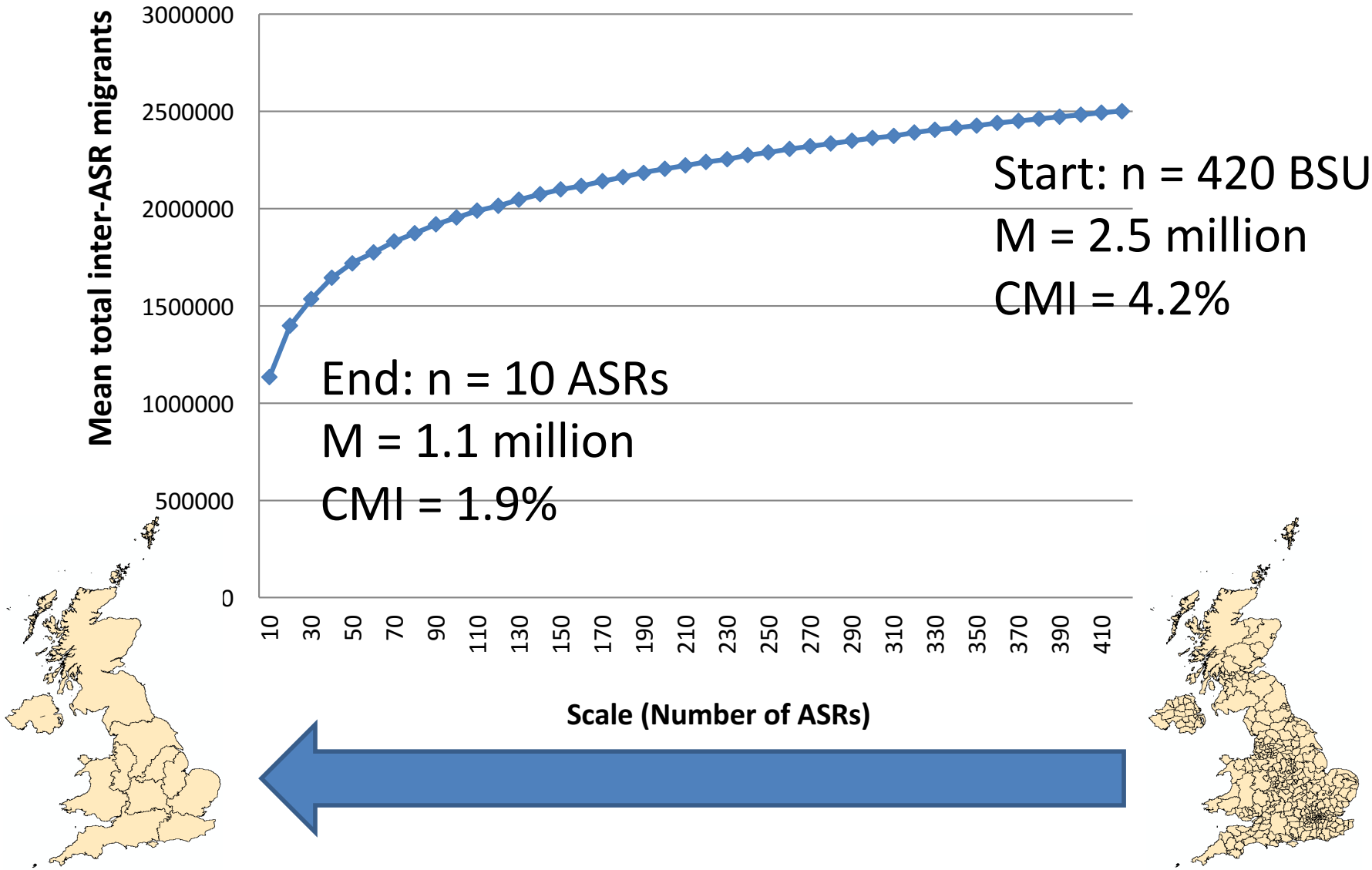


3) Assign the selected areas to region



Final Aggregation to Aggregate Spatial Regions (2 ASRs)

Example: BSU aggregation for the UK



Indicators Subsystem: Global and local indicators

- IMAGE Studio allows choice of whatever scale steps we want plus the number of different configurations of the BSUs at each scale
- It then computes the selected migration indicators at each scale for each configuration and gives summary statistics (e.g. mean, max., min., range)

	Global information or Indicator
1	Total population
2	Area
3	Population density
4	Total migrants
5	Mean migration flow
6	Median migration flow
7	Max migration flow
8	Min migration flow
9	Crude migration intensity
10	Aggregate net migration
11	Aggregate net migration rate
12	Migration effectiveness index
13	Mean migration distance (between)
14	Mean migration distance (within)
15	Mean migration distance (All)
16	Median migration distance (between)
17	Median migration distance (within)
18	Median migration distance (All)
19	Coefficient of variation
20	Index of connectivity
21	Index of inequality
22	Theil index

	Local Information or Indicator
1	Population
2	Population density
3	Area
4	Intraregional flow
5	Intraregional rate
6	Mean migration inflow
7	Median migration inflow
8	Max migration inflow
9	Mean migration outflow
10	Median migration outflow
11	Max migration outflow
12	Net migration balance
13	Net migration rate
14	Turnover
15	Turnover rate
16	Churn
17	Churn rate
18	Migration effectiveness index
19	Coefficient of variation
20	Index of migration inequality
21	Index of connectivity
22	Inflows
23	Inflow rates
24	Inflow mean migration distance
25	Inflow median migration distance
26	Outflows
27	Outflow rates
28	Outflow mean migration distance
29	Outflow median migration distance

Modelling Subsystem: Spatial interaction model

We use a SIM to generate two migration indicators:

(i) Mean migration distance

(ii) Frictional effect of distance (distance decay parameter)

The doubly constrained model is:

$$M'ij = Ai\ Oi\ Bj\ Dj\ dij^{-\beta}$$

where:

M'ij is the predicted flow of migrants from area i to area j

Oi is the total outmigration from area i

Dj is the total in-migration to area j

Ai and Bj are balancing factors to ensure the constraints

$Oi = \sum_j M'ij$ and $Dj = \sum_i M'ij$

Dij is the distance between area i and area j

β is the distance decay parameter

Basic Data Required

For any country of interest:

I. an origin-destination matrix of flows between a set of BSUs
II. digital boundaries of the corresponding BSUs
III. populations at risk (PAR) of the respective BSUs

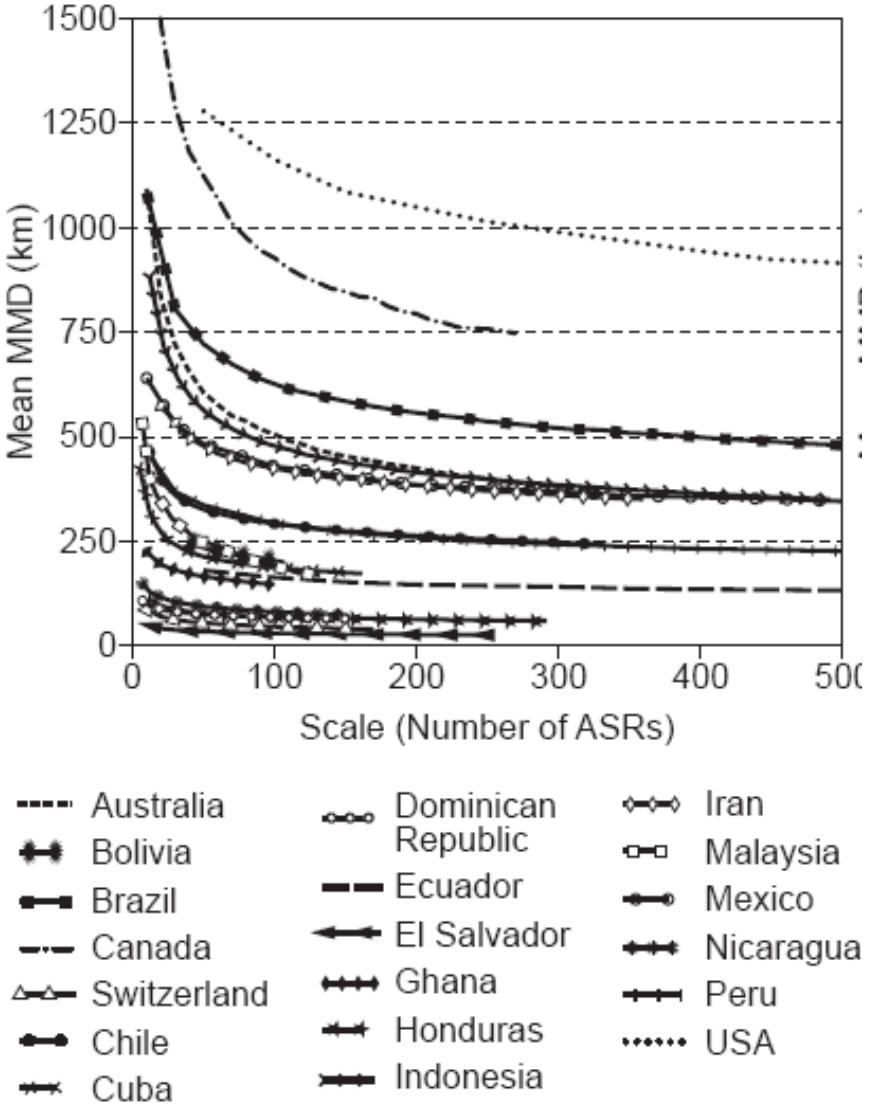
Data sets used: Two samples

- Migration matrices are available for 105 of 193 UN countries BUT we want countries for which there is a sufficiently fine level of spatial detail to enable scale effects to be measured - so we use only countries with 100 or more Basic Spatial Units
- **Sample 1**: 19 countries with 5 year data

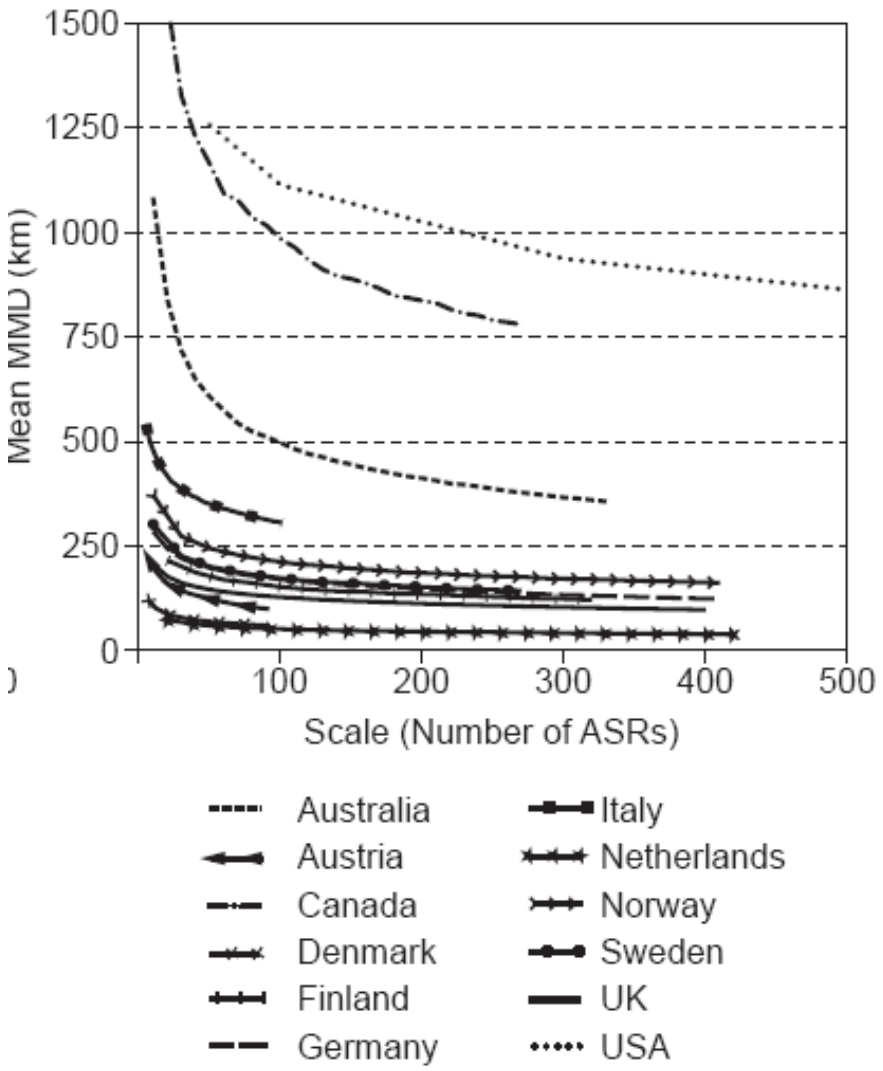
  Sample 2: 13 countries with 1 year data
- No data on intra-zonal moves
- Run Studio using wave aggregation routine in steps of 10 with 200 configurations at each scale
- Present mean MMD and beta for each scale

Mean inter-zonal distances by scale

Five-year migration countries



One-year migration countries



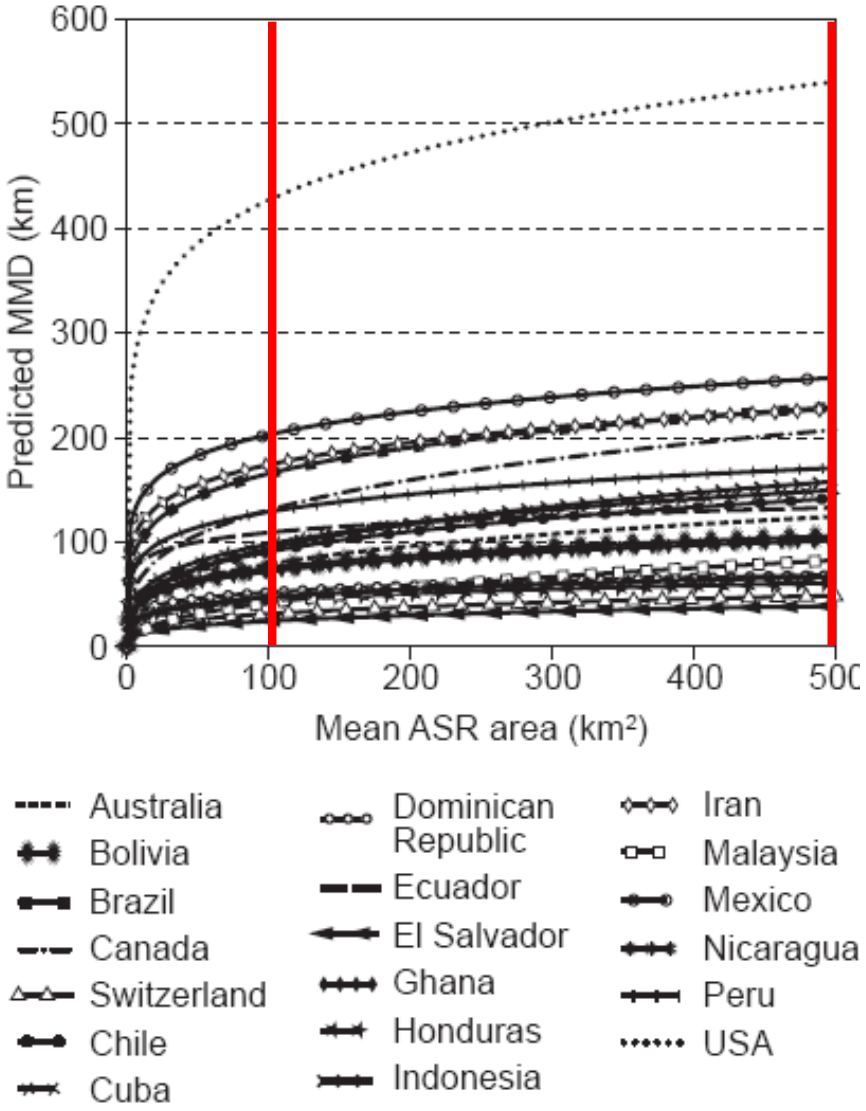
- Graphs reveal the scale effects for each country, **BUT** the number of ASRs is a poor basis for comparison as ASRs differ between countries in terms of area and/or population
- To make more robust comparisons, we use mean area size at each spatial scale to replace the number of ASRs on the horizontal axis
- When curves are fitted to the MMD-area relationship for each country using R, the best-fit is represented by a function which can be written as:

$$MMD = a\,(A/n)^b$$

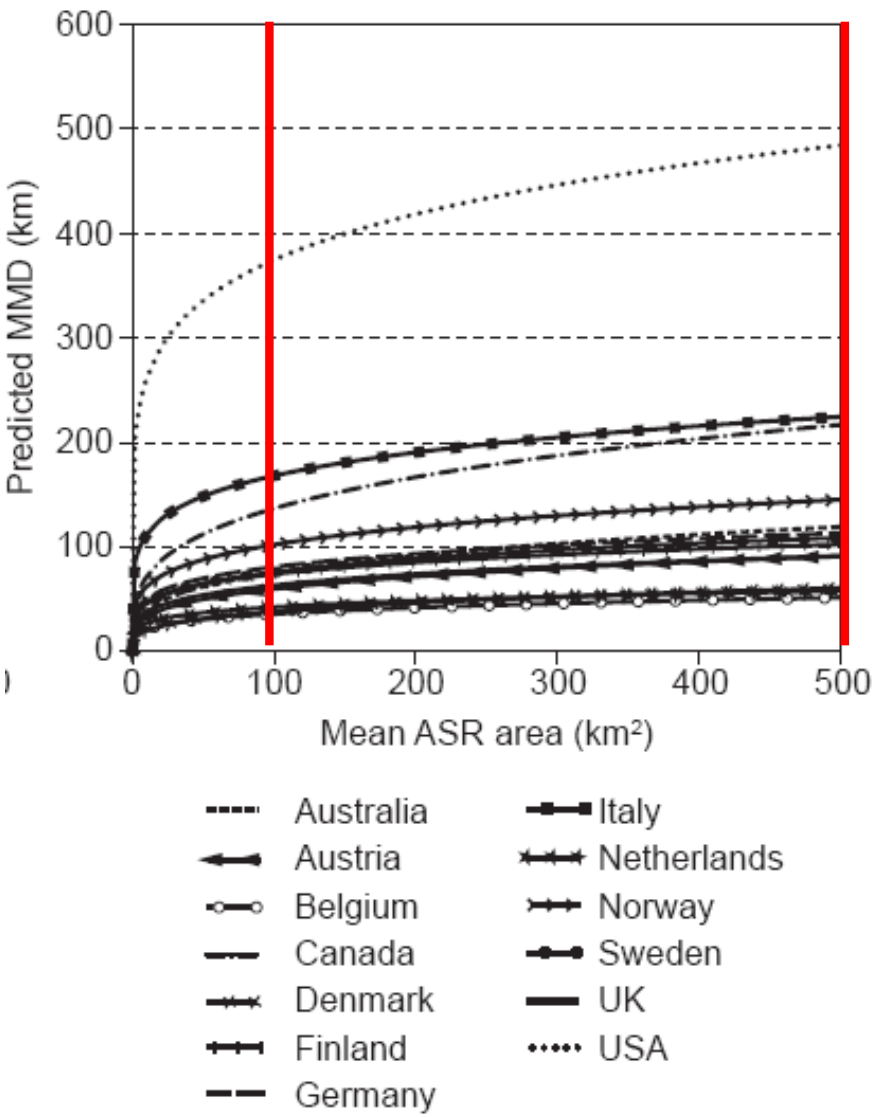
where A/n is the mean ASR area size at scale n and a and b are parameters that define the function

Modelled relationship between MMD and area size

Five-year migration countries

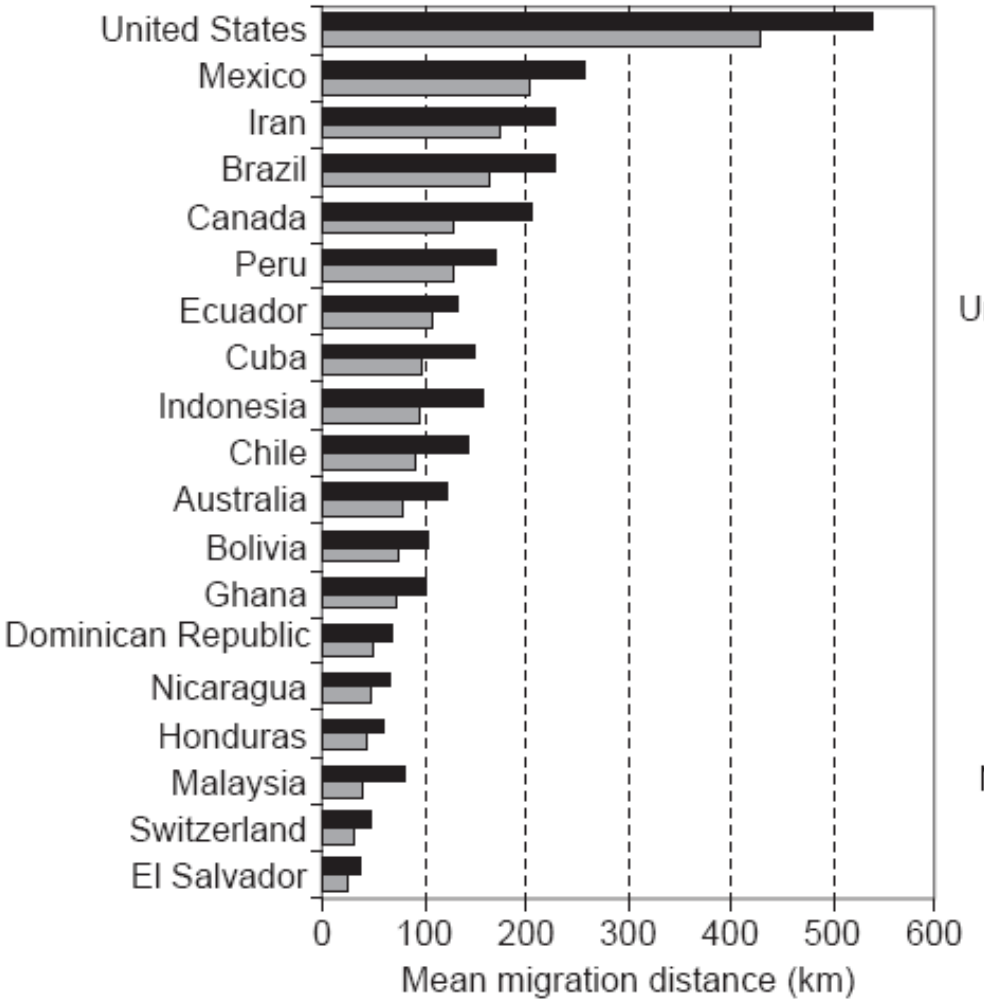


One-year migration countries

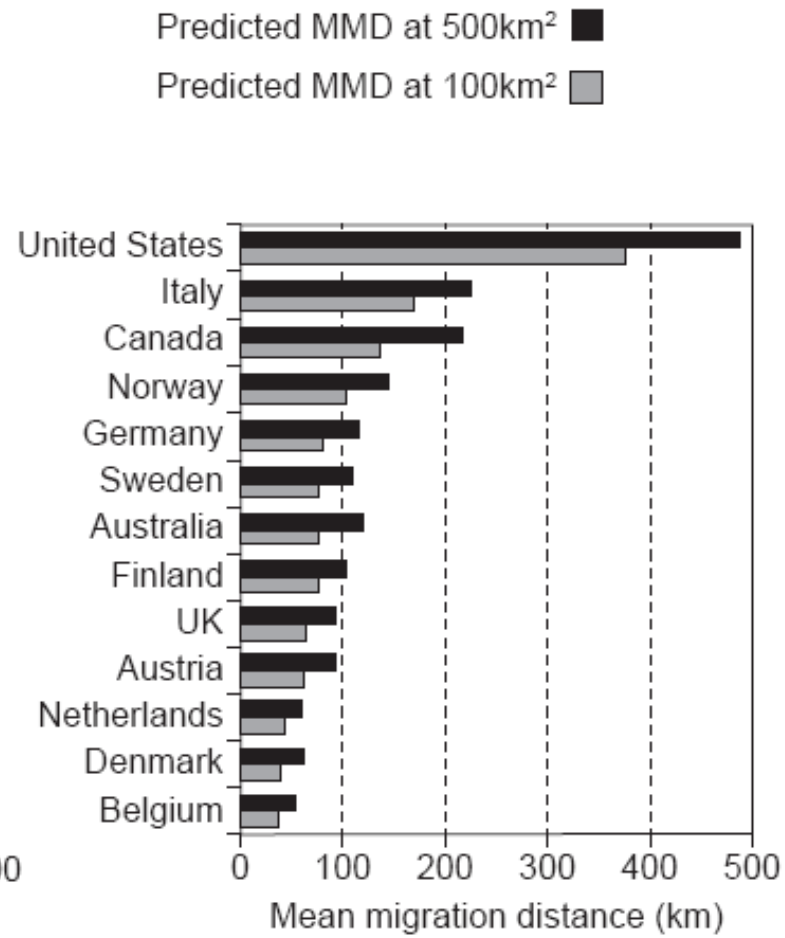


Mean migration distances for areas of 100 and 500 sq kilometres

Five-year migration countries

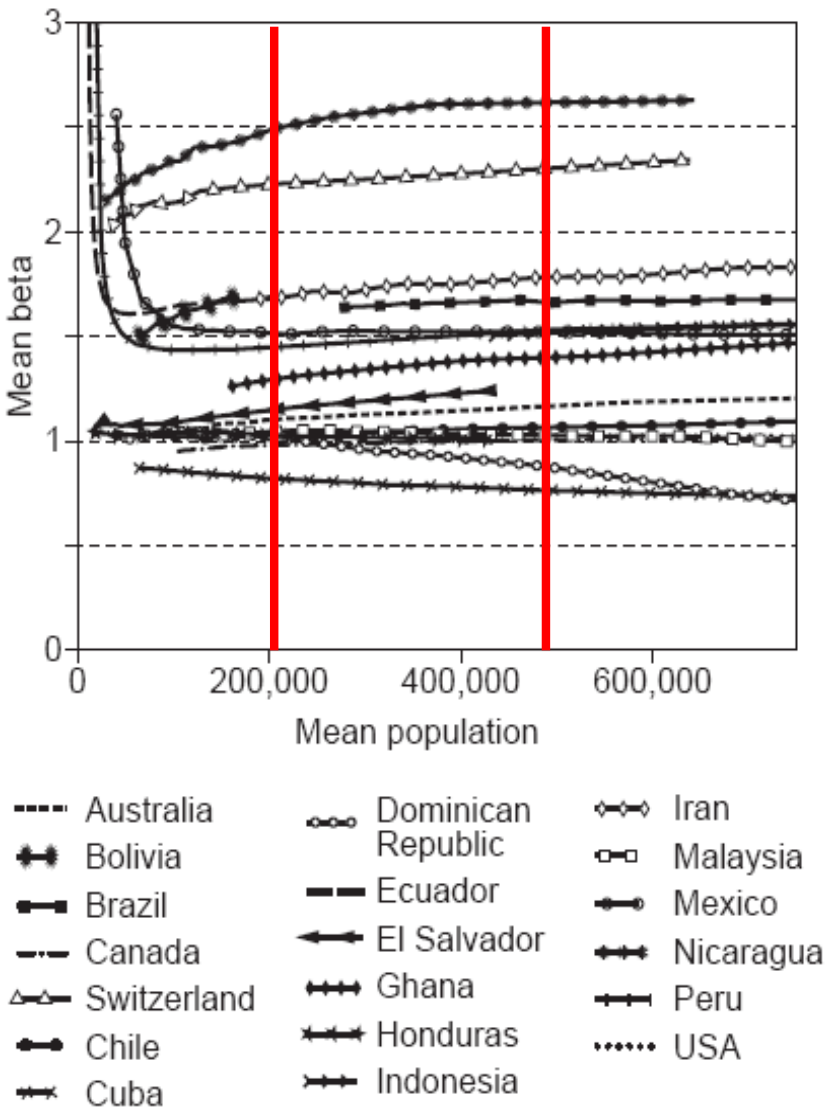


One-year migration countries

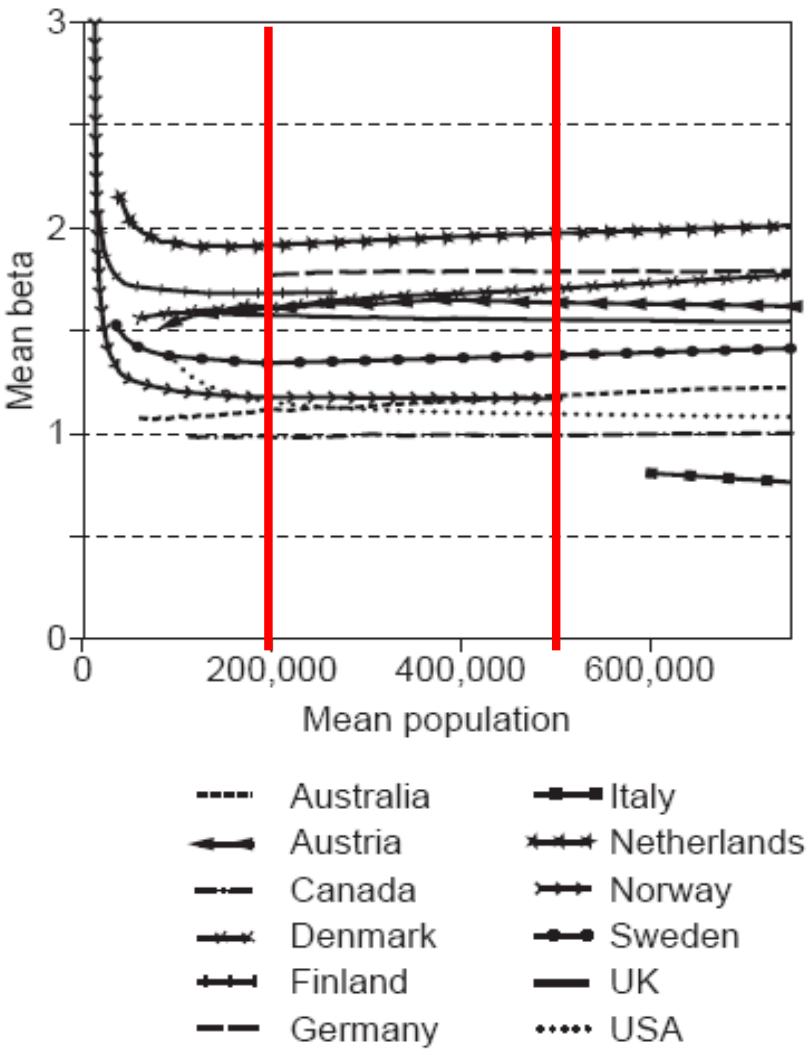


Distance decay parameters

Five-year migration countries

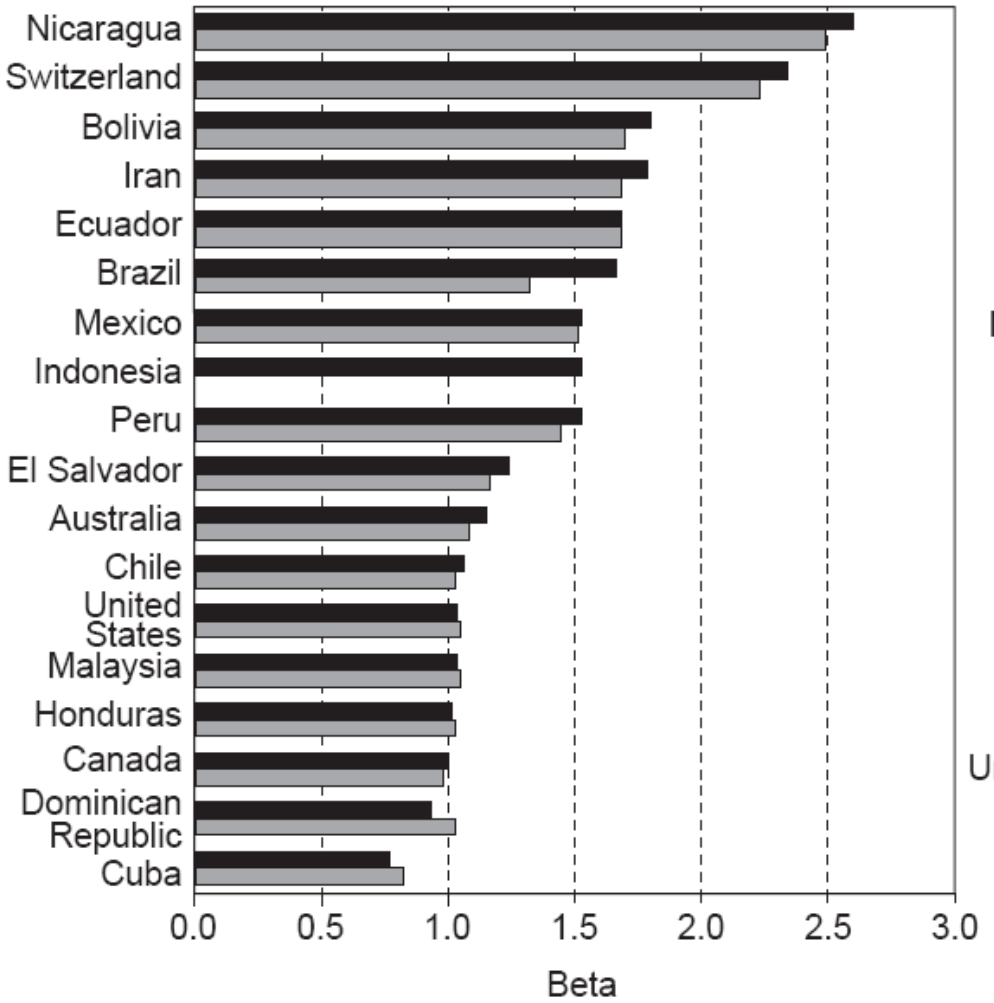


One-year migration countries

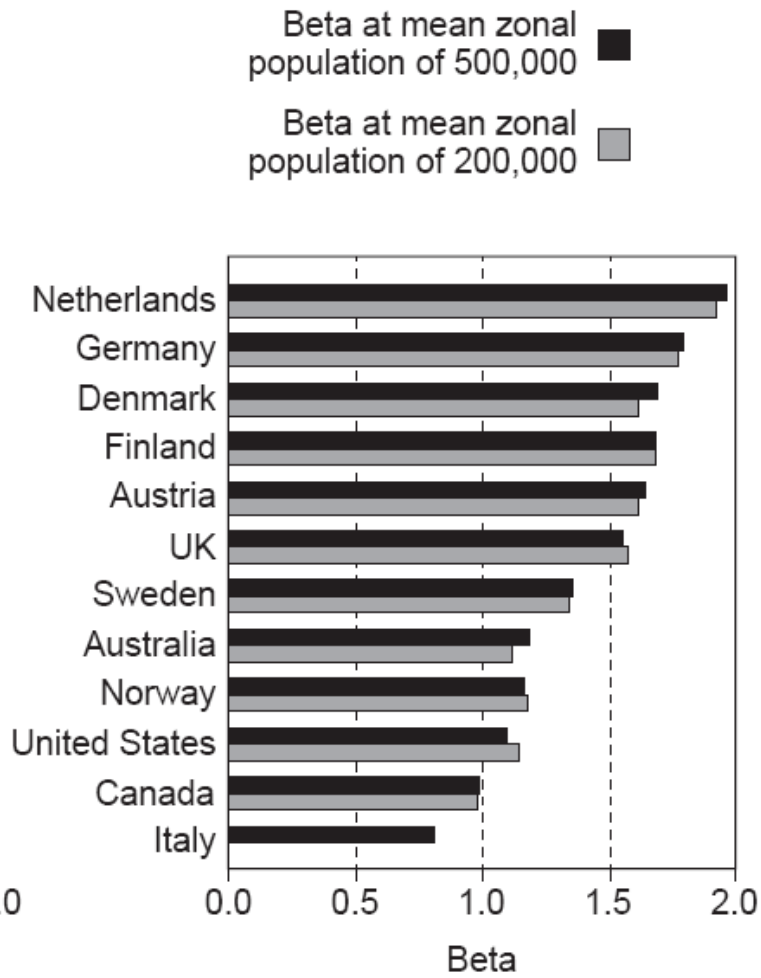


League tables at alternative populations

Five-year migration countries



One-year migration countries



Conclusions

- Cross-national comparisons of internal migration:
  - prove very challenging
  - require spatial harmonisation
- IMAGE Studio is an attempt at handling the MAUP challenge when trying to make cross-national comparisons
- Spatial interaction modelling at different levels of aggregation enables us to observe scale (and zonation) effects on distance moved and decay parameter
- Whereas the mean migration distance varies with scale, the distance decay parameter is scale independent and league tables have been generated for both indicators
- Ongoing work is investigating MAUP effects on inter-district flows in the UK in different age, sex, ethnic and socio-economic groups

Thanks for your attention

Further details of IMAGE Project available at:
www.imageproject.com.au

IMAGE Studio and manual available on 

IMAGE Studio setup file
https://github.com/IMAGE-Project/IMAGE_Studio_bin/releases

IMAGE Studio data
https://github.com/IMAGE-Project/IMAGE_Data

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