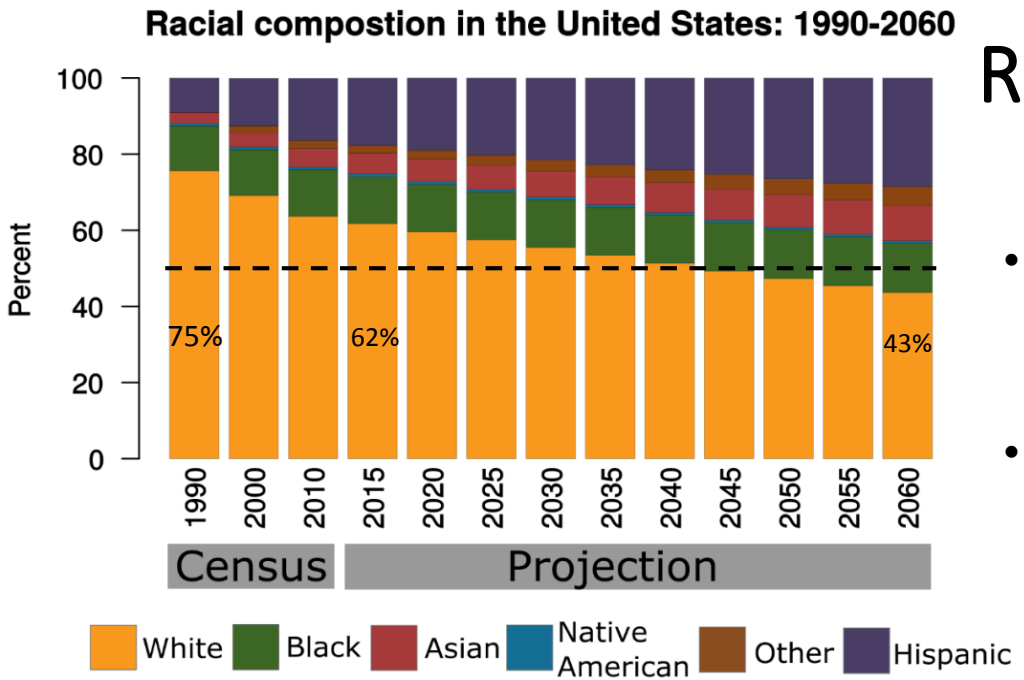
Spatial approach to identyfing trends in racial composition changes for large American cities: 1990-2000-2010

Anna Dmowska[1] (*dmowska@amu.edu.pl*),
Tomasz Stepinski[2] (*stepintz@ucmail.uc.edu*)

[1]Adam Mickiewicz University, Poznan, Poland
[2]Space Informatics Lab, University of Cincinnati, US

GeoComputation 2017, 4.09.2017-7.09.2017, Leeds, UK



Racial composition changes in the United States

- Changes in racial composition over time steer U.S into overall multiethnic society by **2045** (U.S Census population projection).
- This changes are even more rapid in the largest American cities.

Racial composition in the three most populated U.S cities

Race Ethnicity	% of population in 2010 (% changes 1990-2010)			
	New York	Los Angeles	Chicago	U.S
White	33.3 (-14.6)	28.7 (-12.1)	31.7 (-34.4)	63.7 (-11.9)
Black	25.5 (+2.6)	9.6 (-1.0)	32.9 (+13.8)	12.6 (-0.9)
Native Am.	0.7 (+0.5)	0.7 (+0.3)	0.5 (+0.4)	0.9 (+0.2)
Asian	12.8 (+ 6.6)	11.4 (+1.2)	5.5 (-1.2)	5.0 (-2.2)
Other race	4.0 (+3.7)	4.6 (+4.3)	2.7 (+2.6)	2.9 (+2.8)
Hispanic	28.6 (+ 6.5)	48.5 (+10.7)	28.9 (+ 27.5)	16.3 (+7.3)

US_2010

2/3 (Whites)

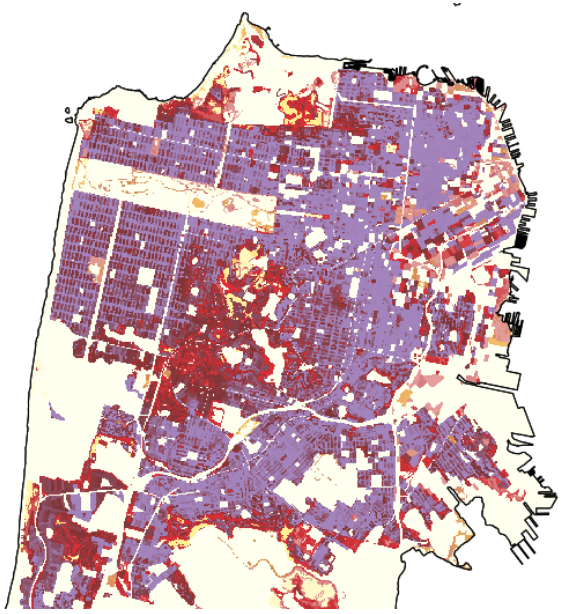
1/3 (minorities)

Cities_2010

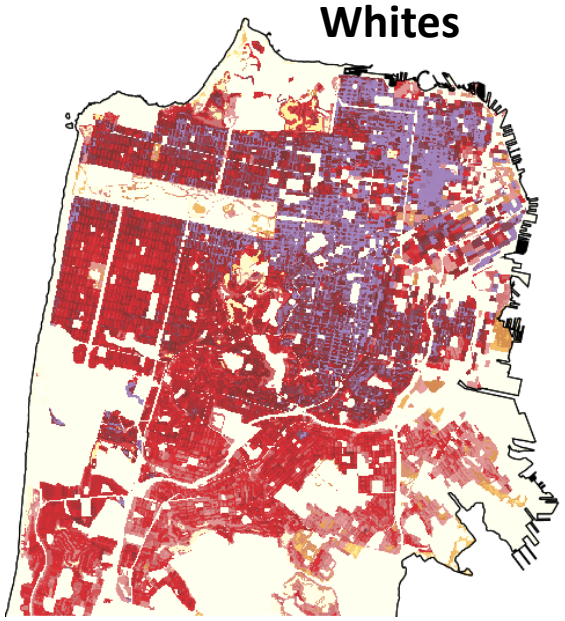
1/3 (Whites)

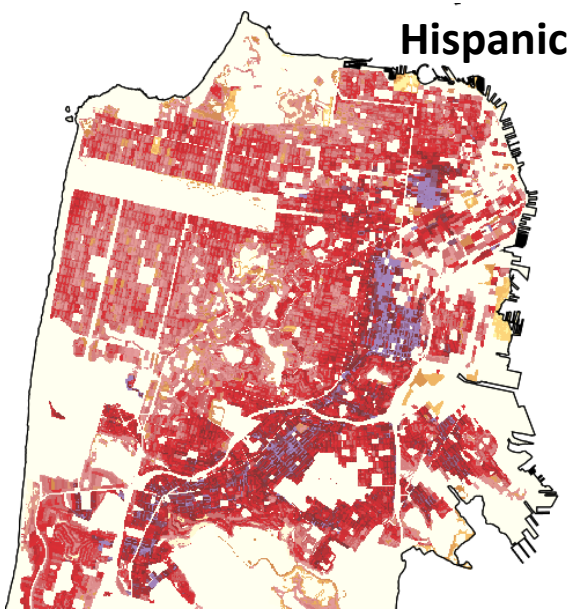
2/3 (minorities)

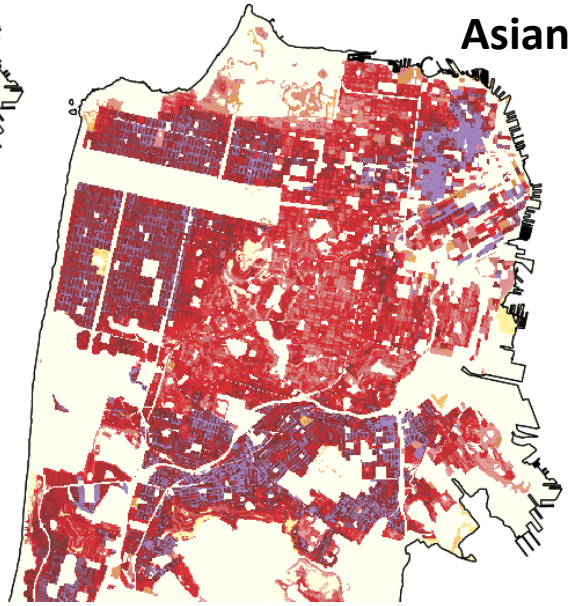
U.S-wide high resolution grids

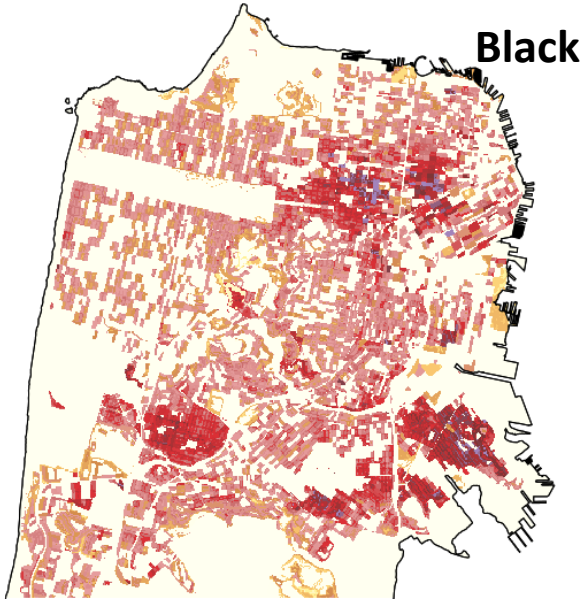


Total population

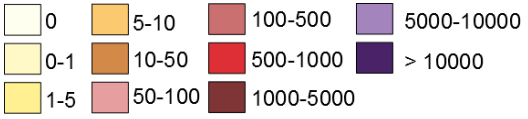








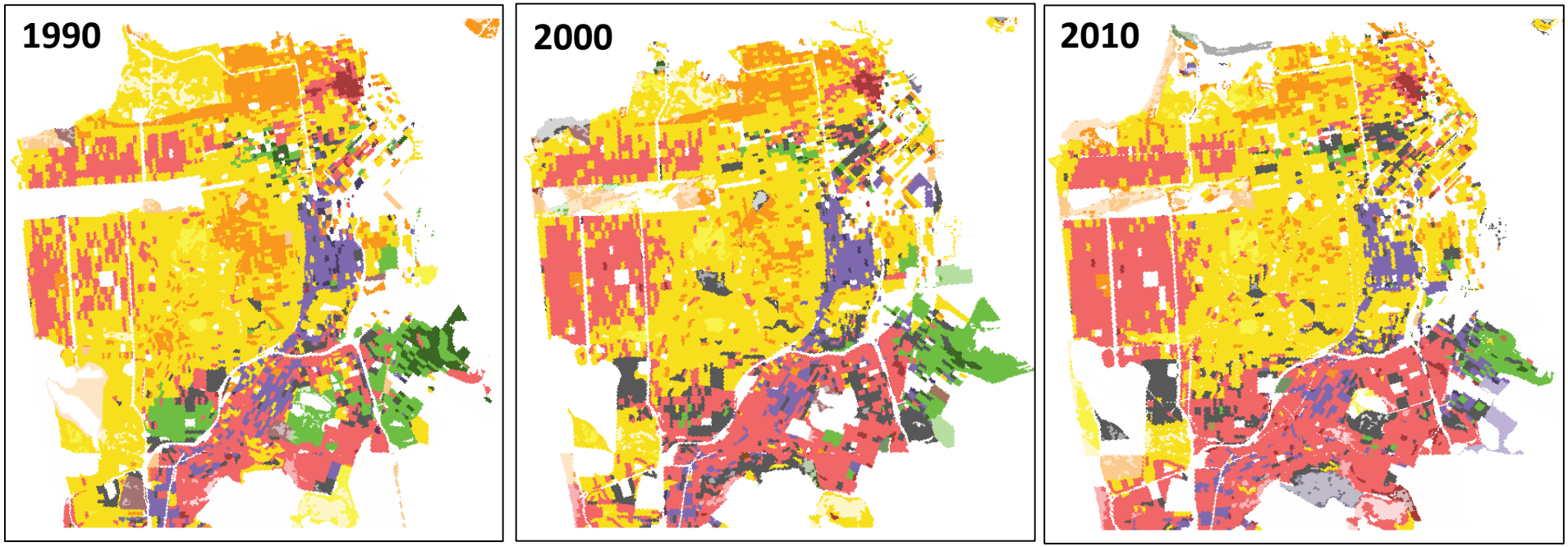
People/km^2



Method: Dissagregation of block-level data into 30m grid cells using dasymetric modeling and National Land Cover Dataset as ancillary data.

Year: 1990, 2000, 2010

Racial diversity grids



Low diversity
(Race>80%, E<0.37)

White *Black* *Asian* *American Indian* *Other race* *Hispanic*

Medium diversity
(Race = (50-80%), E =(0.37,0.73))

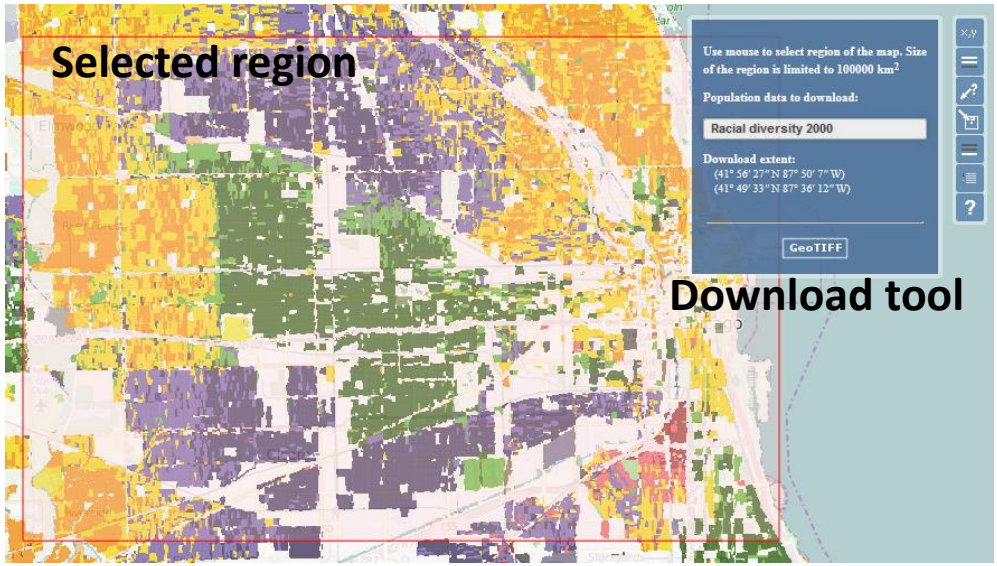
White *Black* *Asian* *American Indian* *Other race* *Hispanic*

High diversity
(Race<50%, E>0.73)

Racial diversity maps show **spatial character of racial diversity across the U.S**. It is a result of **three dimensional** (diversity, dominant race, population density) **classification** of grids cells based on population/subpopulation grids. The resultant map has **40 categories.**

Providing open access to hi-res grids

http://sil.uc.edu/webapps/socscape_usa/

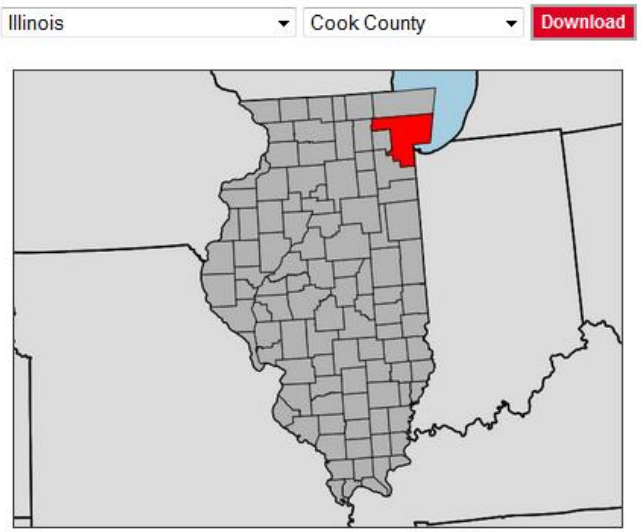


SocScape:

- **Exploring and detecting change** of population density and racial diversity **in different scales** (from U.S. down to the street)
- **Download data** for selected region (to 100 000 km^2)
- Data:
  - Population grids
  - Racial diversity classification
- Time: 1990/2000/2010

Zipped archives for counties and metropolitan areas

- Spatial extent:
  - 3100 counties
  - 363 MSA
- Data:
  - Population and race/ethnicity grids
  - Racial diversity classification
  - Racial change dataset (only MSA)
- Time: 1990/2000/2010



http://sil.uc.edu/cms/index.php?id=socscape-data

Spatial approach to assessing changes in racial composition

Measure community zones using landscape metrics

↓

Calculating change trajectories

↓

Calculating statistics of change trajectories

↓

Identyfing trends in communities

↓

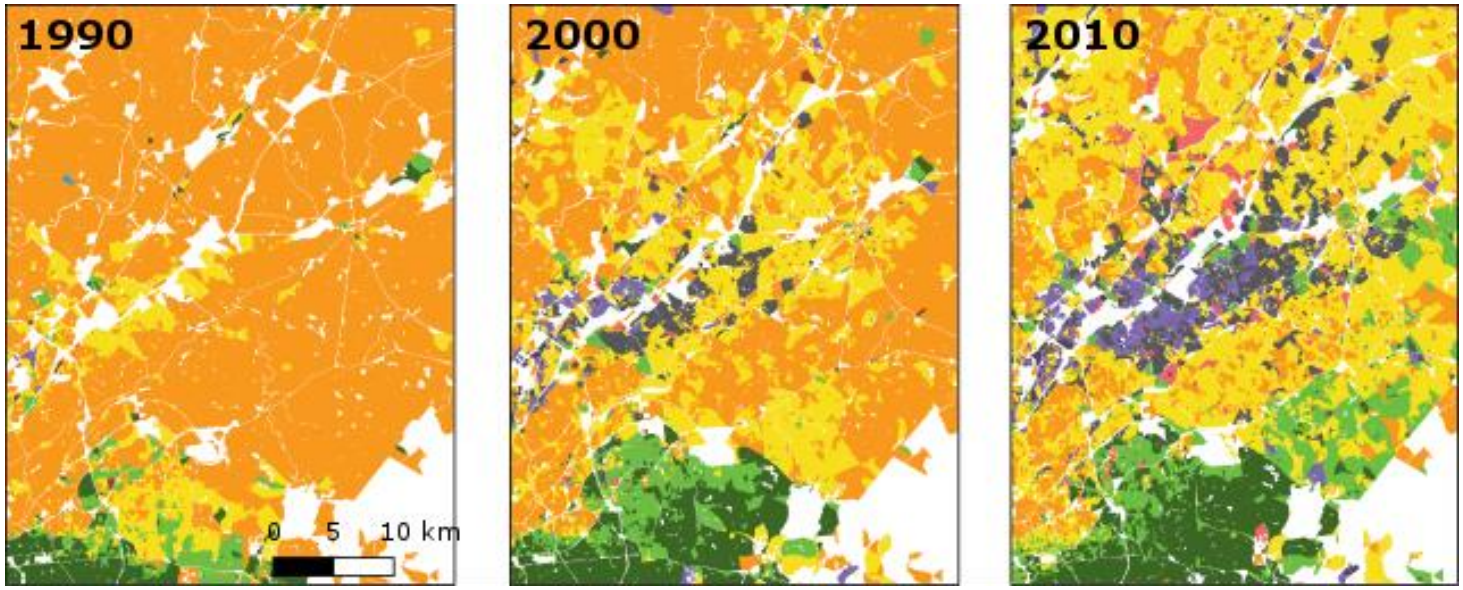
Analysing spatial distribution of trajectories

DATA

- 9 community zones
- Time: 1990, 2000, 2010
- 41 U.S cities:
  - Metropolitan areas pop > 1mln
  - All 9 communities present during 1990,2000,2010

Analyzed U.S cities

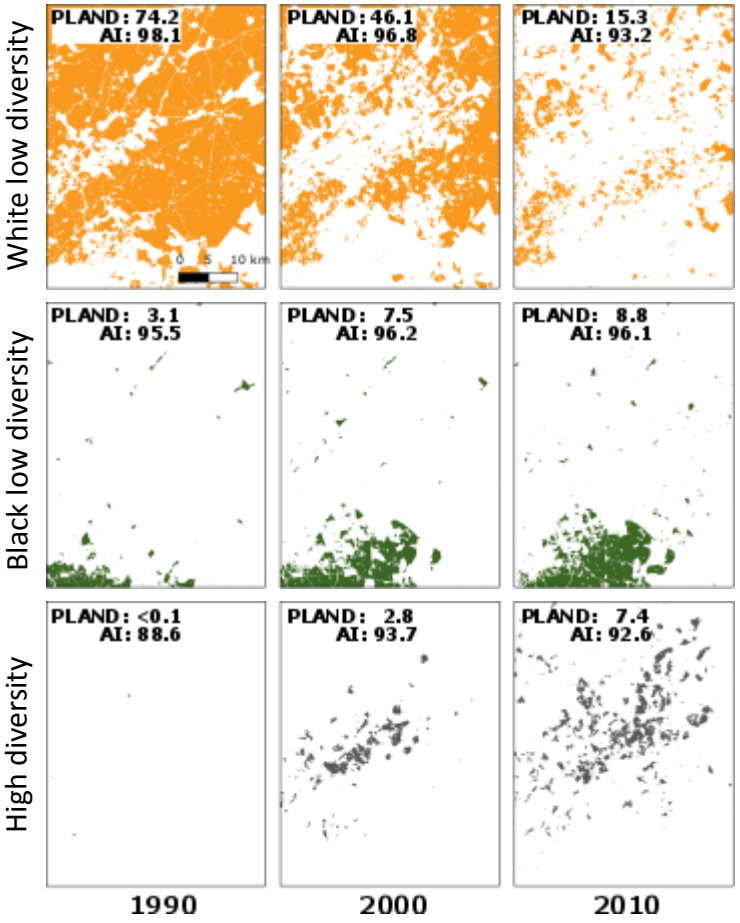
Communities



Community zone – a region containing all cells with the same diversity label in the racial diversity map

Low diversity (Race>80%, E<0.37)	**Medium diversity** (Race = (50-80%), E =(0.37,0.73))	**High diversity** (Race<50%, E>0.73)
White low diversity (WL)	White medium diversity (WM)	High diversity (Hdiv)
Black low diversity (BL)	Black medium diversity (BM)	
Asian low diversity (AL)	Asian medium diversity (AM)	
Hispanic low diversity (HL)	Hispanic medium diversity (HM)	

(1) Measuring community zones



Each community in each city is described by the **pair of class level landscape metrics**:

Percentage of landscape PLAND (0-100%)

- refers to the percentage of the city area occupied by a given community zone.
- Change in PLAND indicates growing or shrinking of the community (*we assume that population is proportional to an area).*

Aggregation index AI (0-100)

- describes a level of aggregation (low to high) of an area occupied by a given community
- Change in AI indicates merging (agglomerationg) or fragmenting of the community.

Calculation of PLAND and AI was performed using SDMTools (Species Distribution Modeling Tools) in **R software.**
We calculate **1107** (41 cities x 9 communities x 3 time instances) **pairs of (PLAND,AI) values.**

(2) Calculating change trajectories

Step 1: Calculating relative change in PLAND and AI

Step 2. Simplify change data into 8 categories

Step 3. Construct a change trajectory

Step 1: Calculating relative change in PLAND and AI for each change period (1990-2000, 2000-2010):

$$\delta^{X}_{i+10,i} = \frac{(X_{i+10} - X_i)}{X_i}$$

δ^X $-relative\ change;\ X\ -refers\ to\ PLAND\ or\ AI;$
$i\ -1990\ or\ 2000$

Change in each community in each city is described by the pairs of values

$$(\delta^{PLAND}_{1990,2000}, \delta^{AI}_{1990,2000}), (\delta^{PLAND}_{2000,2010}, \delta^{AI}_{2000,2010})$$

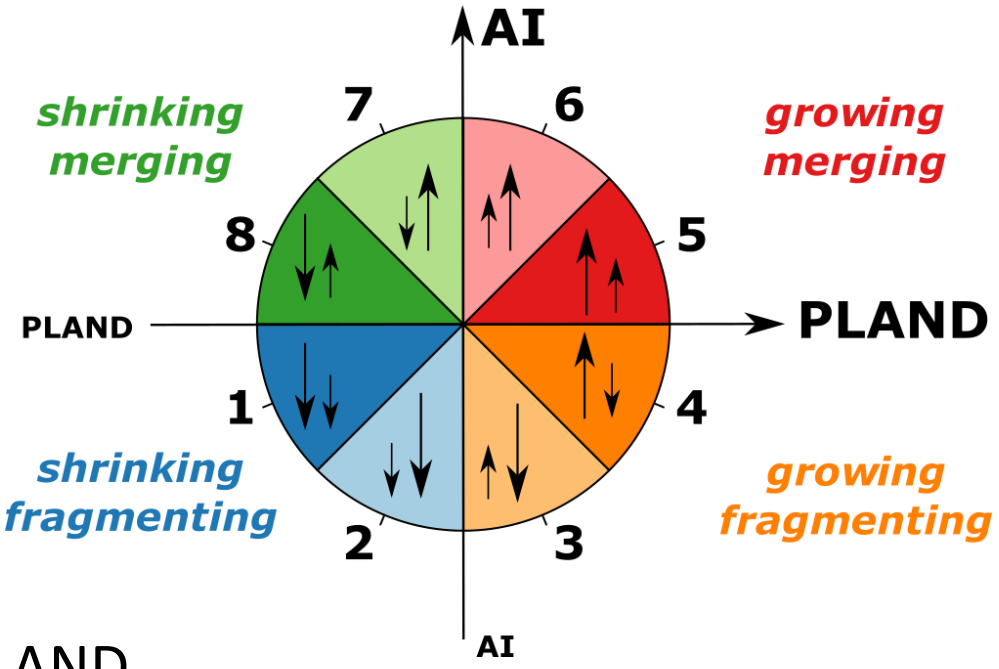
(2) Calculating change trajectories

Step 1: Calculating relative change in PLAND and AI

Step 2. Simplify change data into 8 categories

Step 3. Construct a change trajectory

Step 2: Simplify change data by classifing the pairs of values (δ^{PLAND}, δ^{AI}) into 8 categoties labeled by numbers 1 to 8.



PLAND

AI

First arrow – PLAND, second arrow – AI. Lenght of arrow - which index change more (i.e PLAND chage more rapidly than AI)

Examples: 4 - increase value of δ^{PLAND} and decrease value of δ^{AI} PLAND change more rapidly

(2) Calculating change trajectories

Step 1: Calculating relative change in PLAND and AI

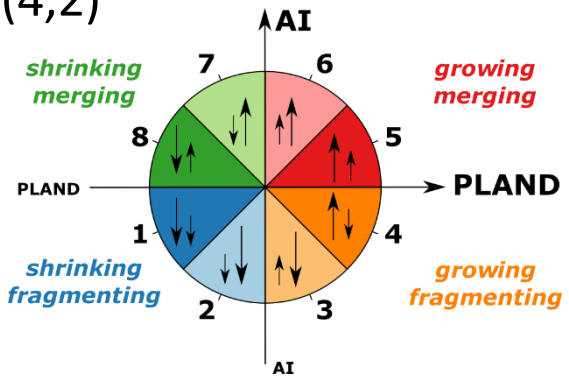
Step 2. Simplify change data into 8 categories

Step 3. Construct a change trajectory

Step 3: Construct a change trajectory

A change trajectory is a pairs of this 8 categories where the first element is the change category in the period 1990-2000 and the second element is the change category in the period 2000-2010.

- There are 64 possible combination of change trajecotory
- Example:
  - A community which grew and fragmented during 1990-2000 but shrinked and fragmented during 2000-2010 is labeled (4,2)



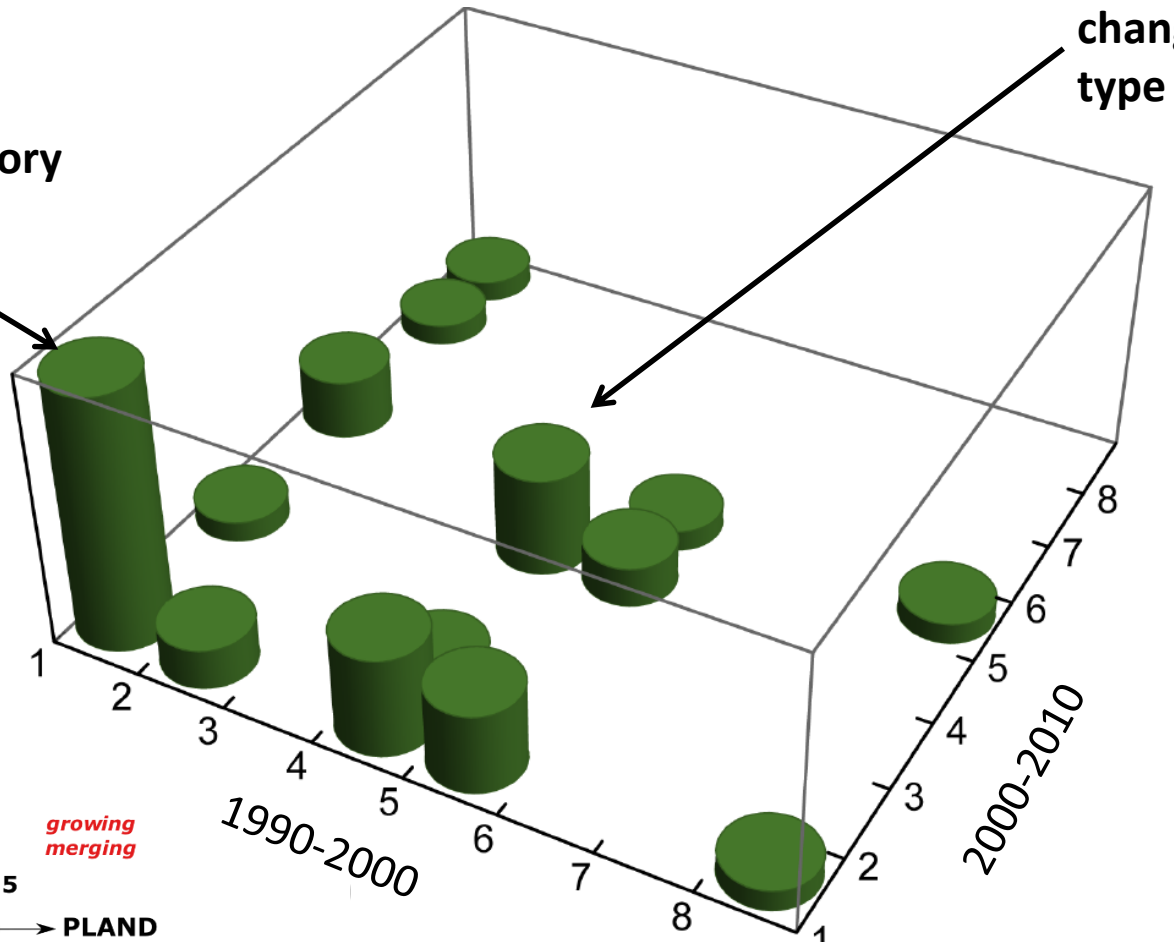
A frequent change trajectory is defined as a change trend.

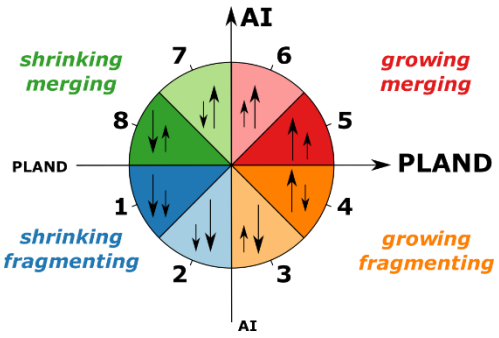
(3) Statistics of change trajectories

Histogram of change trajectory types constructed for "black low diversity" communities in 41 cities

5 cities with change trajectory type (4,4)

13 cities with change trajectory type (1,1)

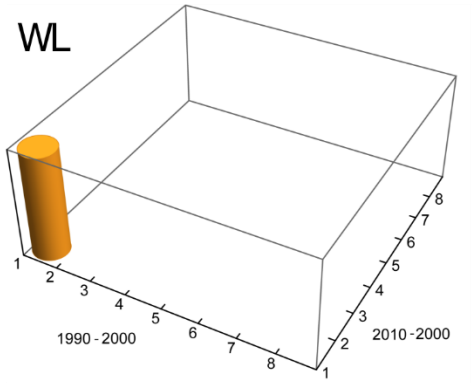


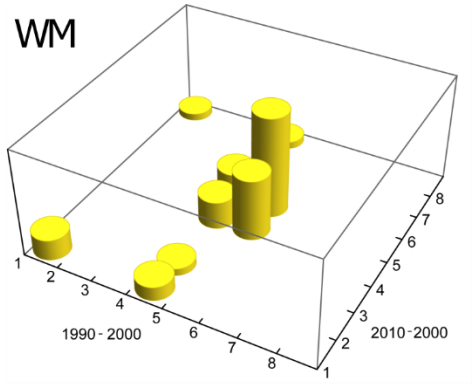


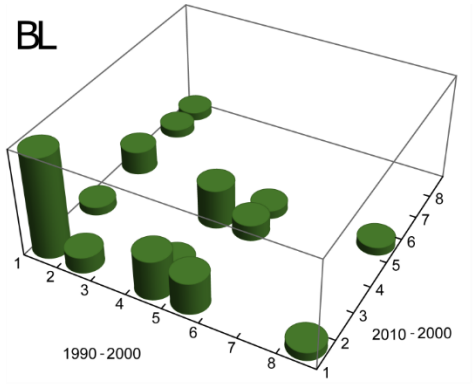
Histogram illustrates a range of different change trajectory types for "black low diversity" communities in large U.S. cities.

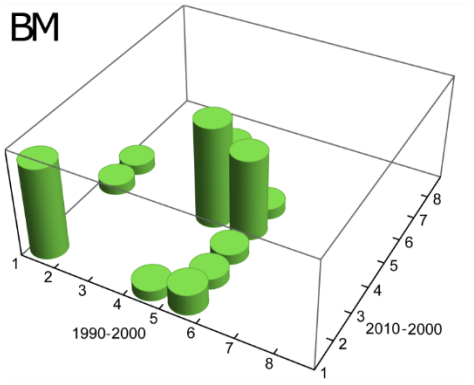
Prevailing type is "shrinking & fragmenting".

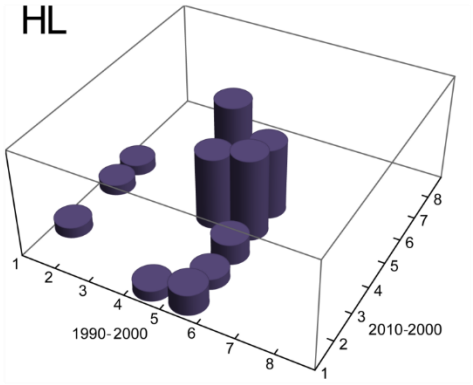
(3) Statistics of change trajectories for all communities

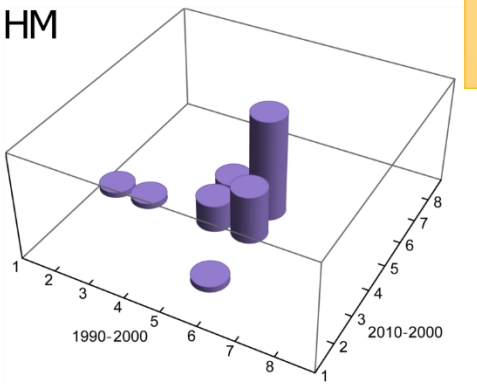


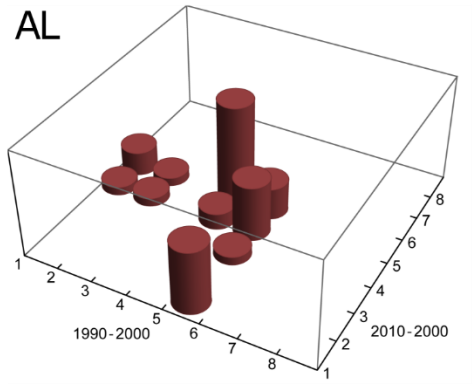


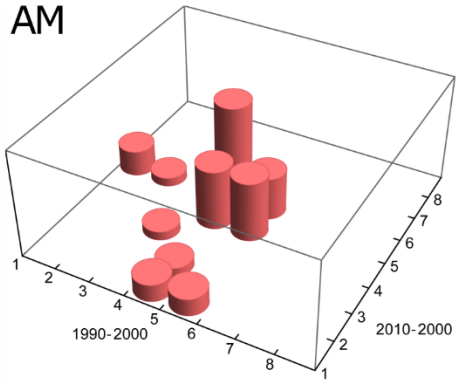


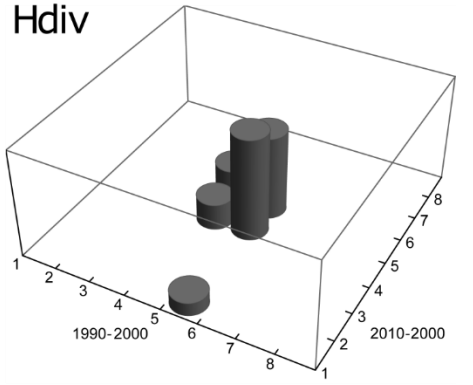










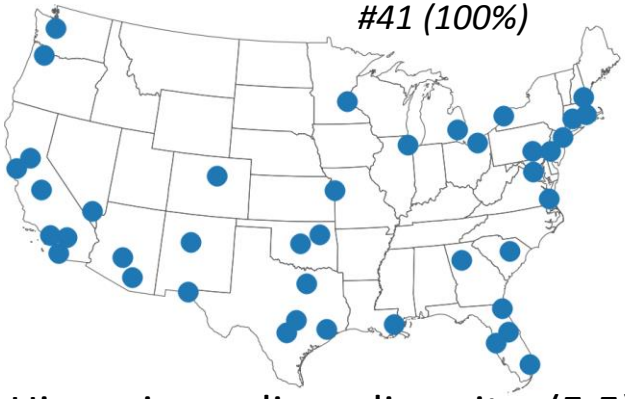


Trend – frequent change trajectory containing > 30% of cities (12), there are 8 such trends

Visually: trends are prominent peaks in histograms

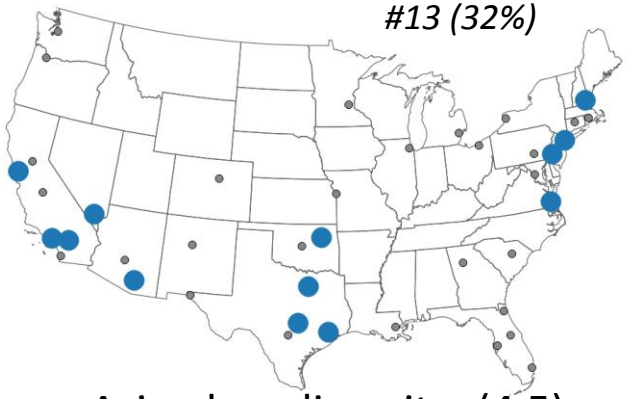
White low diversity: (1,1)

#41 (100%)



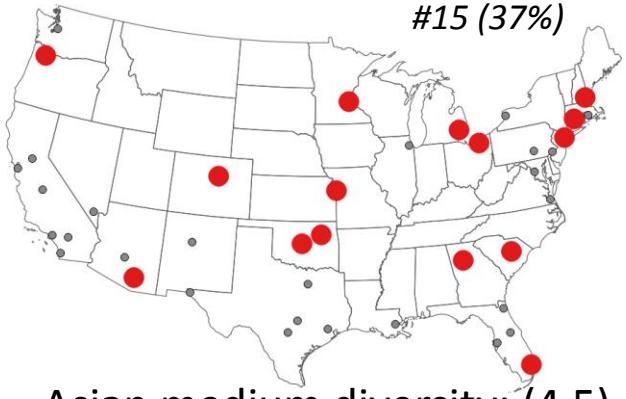
Black low diversity: (1,1)

#13 (32%)



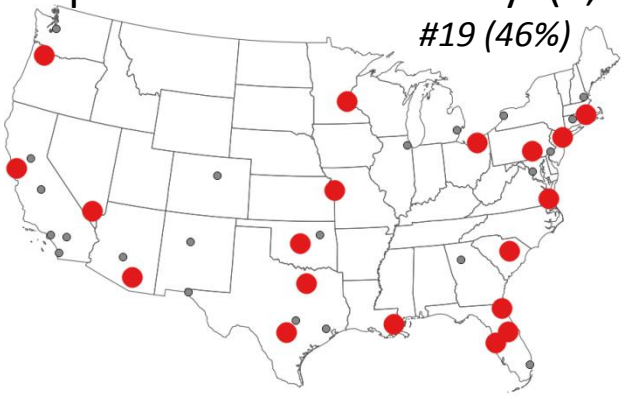
White medium diversity: (5,5)

#15 (37%)



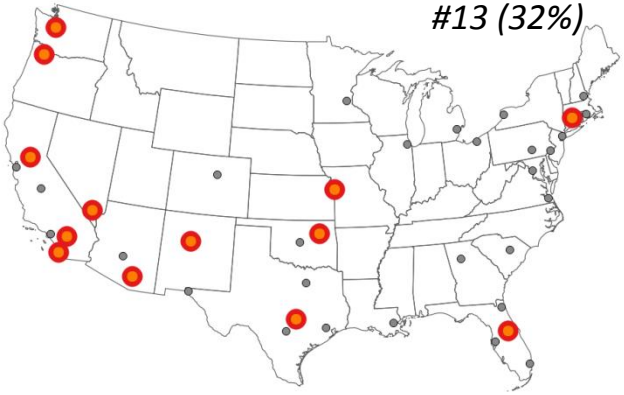
Hispanic medium diversity: (5,5)

#19 (46%)



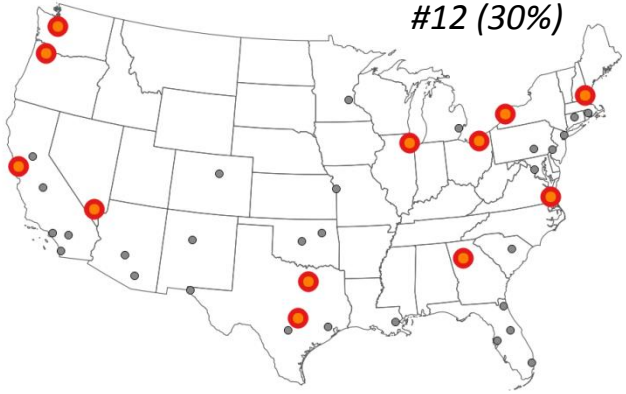
Asian low diversity: (4,5)

#13 (32%)



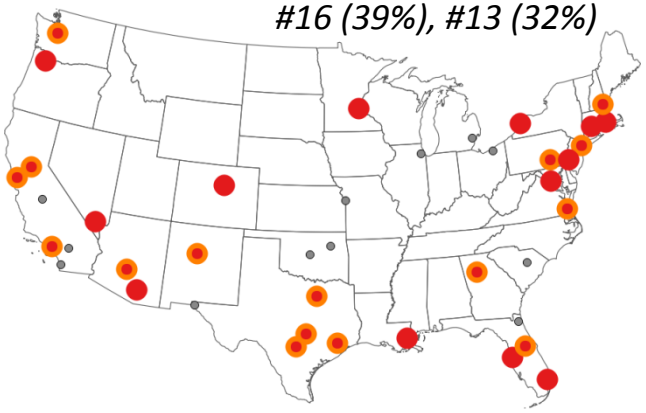
Asian medium diversity: (4,5)

#12 (30%)



High diversity: (5,4), (5,5)

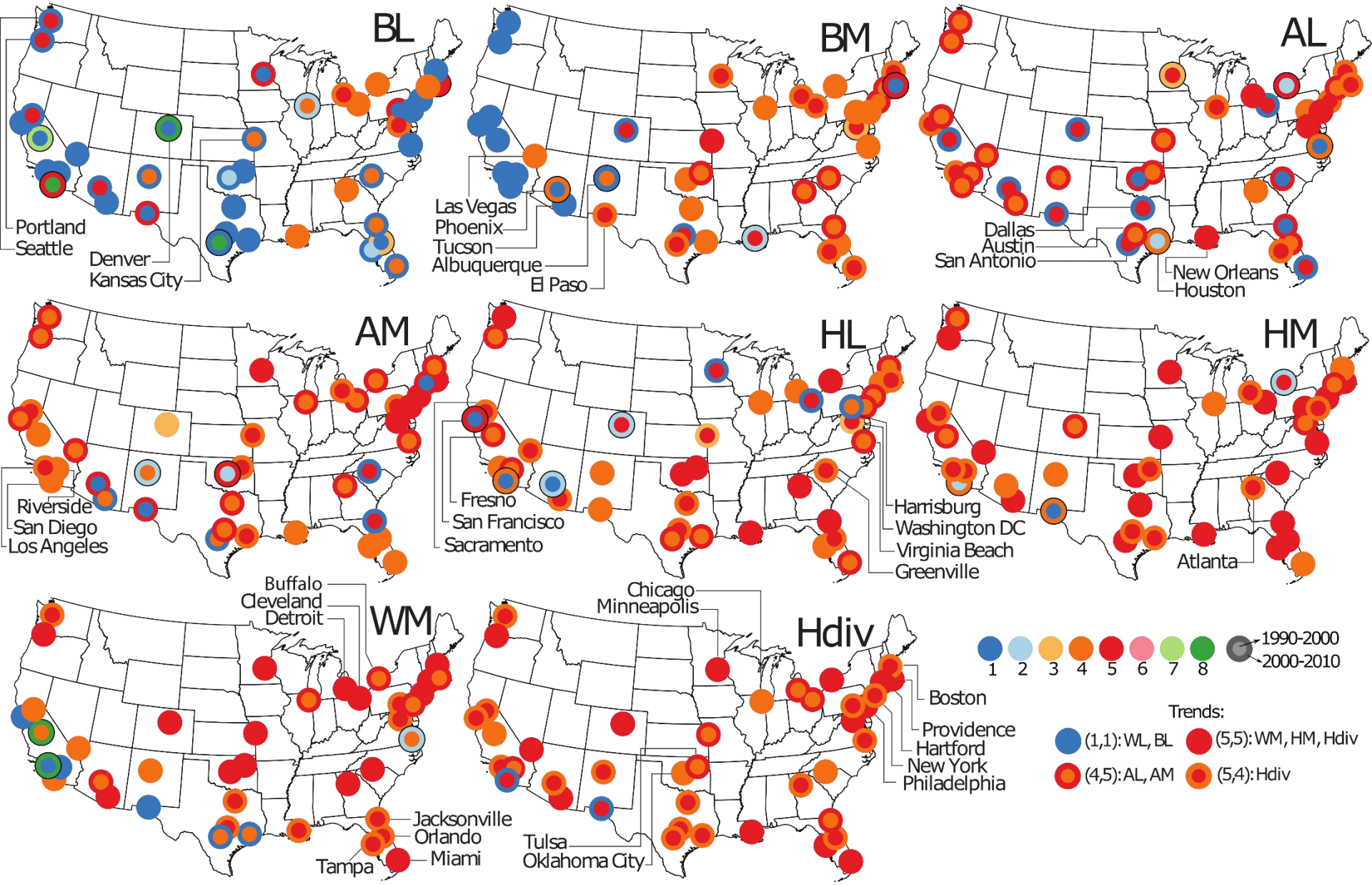
#16 (39%), #13 (32%)



(4) TRENDS

- (1,1) – shrinking/fragmenting in both decades
- (5,5) – growing/merging in both decades
- (4,5) – growing/fragmenting + growing/merging
- (5,4) – growing/merging + growing/fragmenting

(5) Analysing spatial distribution of change trajectories



Conclusion

- We present **a spatial approach to a demographic problem** of analysis changes in racial composition in American cities.
- Our approach is based on **landscape metrics** (PLAND and AI) calculating **using high resolution categorical raster map** of racial diversity.
- We identified **change trajectories** that contain information about changes from two change periods instead of one.
- Spatial approach makes possible **more detailed information** for demographers and policymakers to better understand the changes in racial composition.
- **The main findings** from the survey of 9 communities in 41 US cities during 3 times points (1990,2000,2010) are:
  - **23 out of 64** theorethical possible **change trajectories** were identified (6 growing types (237 instances), 6 shrinking types (73 instances), 11 mixed types (59 instances))
  - **Trends** for 7 out of 9 communities were identified.
  - Only **4 different** trends (1,1), (5,5), (4,5), (5,4) are identified
  - **No strong spatial geographical difference** in the trajectories is observed, except for BM community (BM communities shrink in the West Cost and grow everywhere else).

Acknowledgments

Participation in the conference is funded by the ***PLOSE Early Career Travel Award Program.***

(https://www.plos.org/ecr-travel-awards)