GeorgiaState University | SCHOOL OF PUBLIC HEALTH

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Application of the Urban Health Index to Studying Geospatial Health Disparities in Japan

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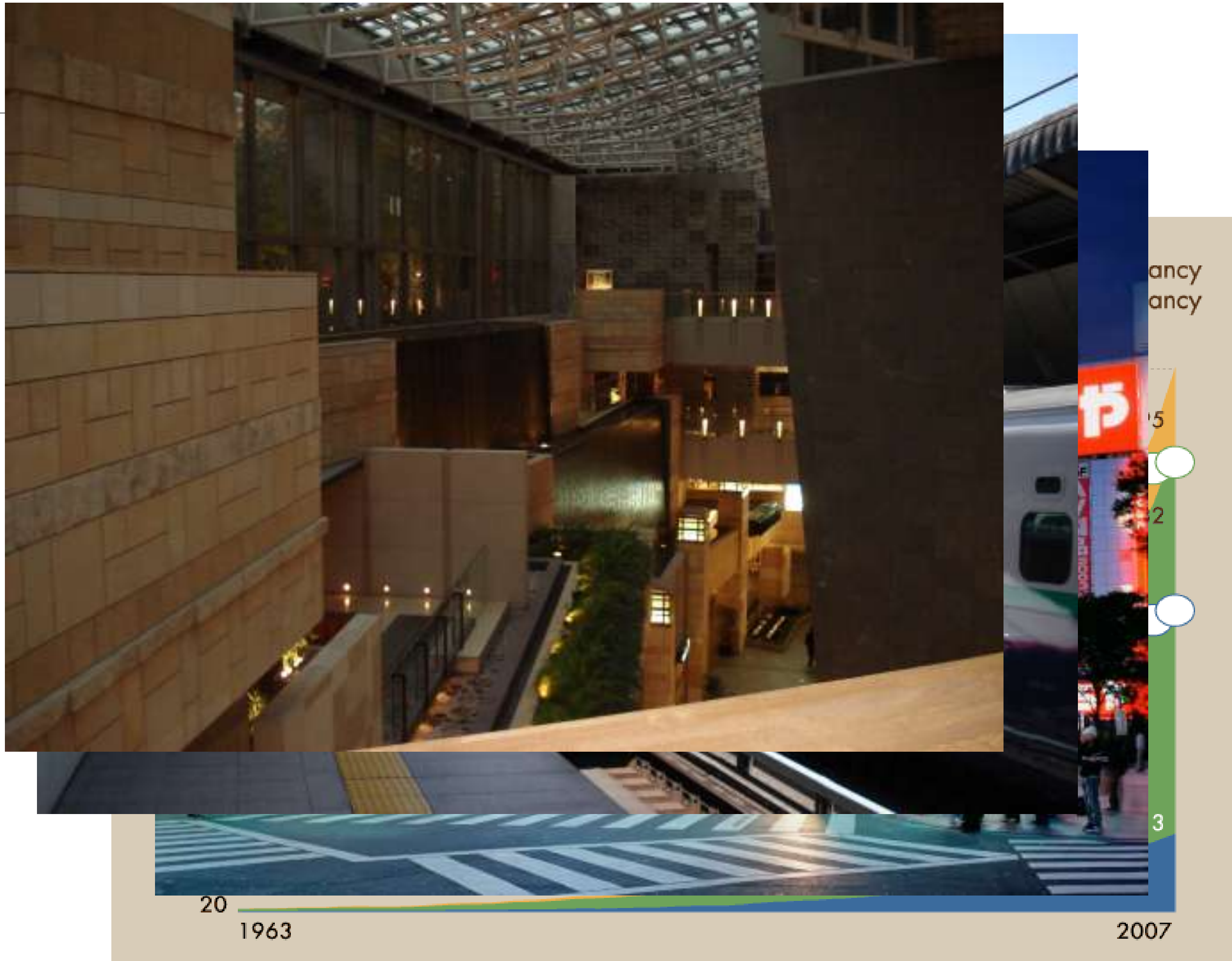
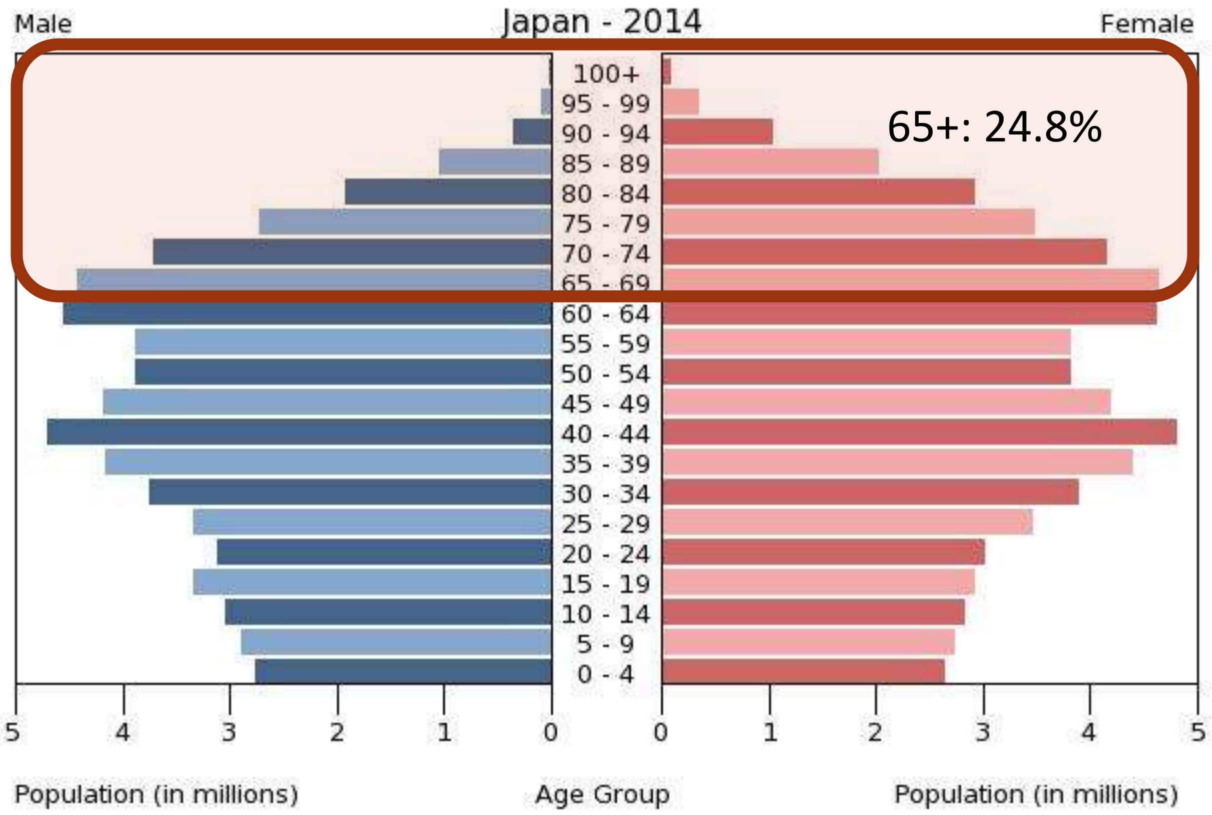
Background

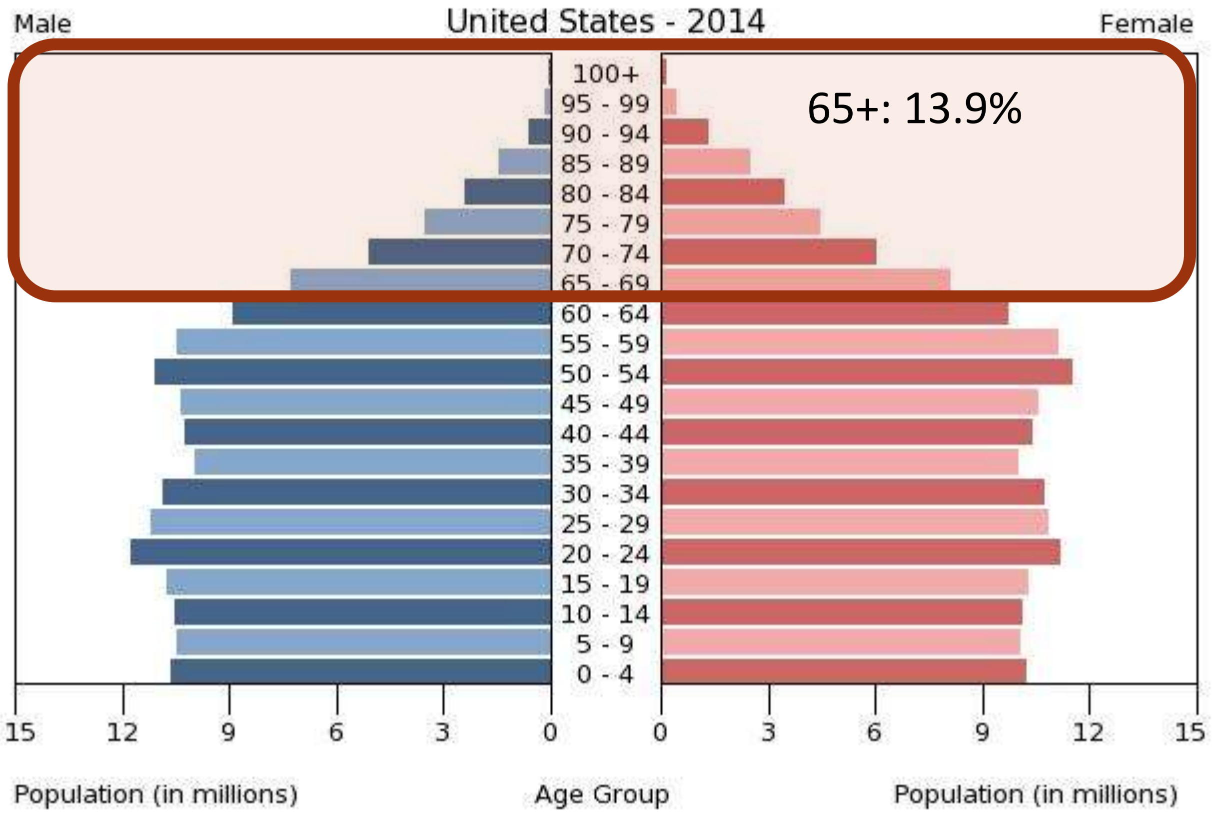
What is your image of Japan?

- Economic Prosperity
- Developed Infrastructure
  - 100% of urban and rural population have an improved water source and sanitation facilities
- Urban
- Longevity
  - Life expectancy: 84.2 (3rd in the world)



Background: Japan and an Ageing Population



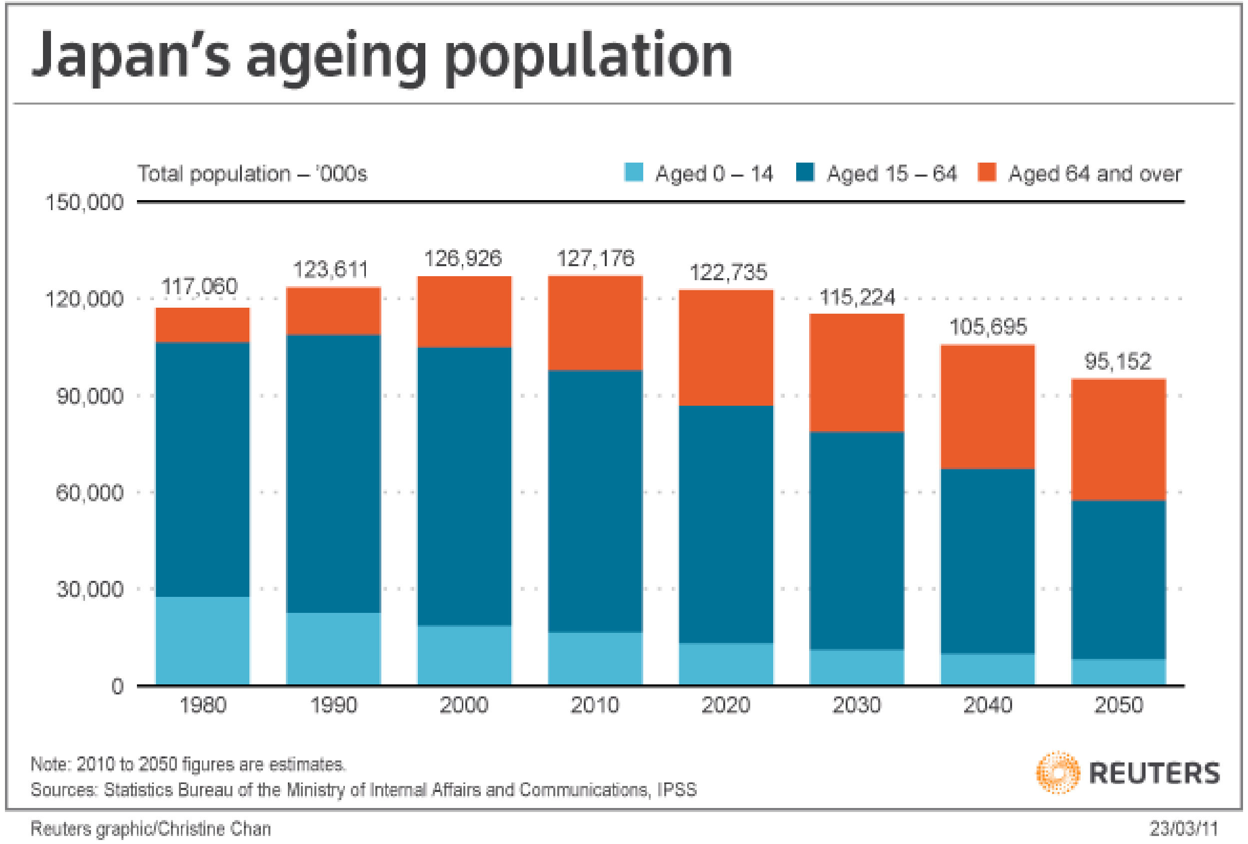


Elderly Dependency Ratio: 40.5

Elderly Dependency Ratio: 21

Source: CIA World Factbook

Background: Japan and an Ageing Population



The demographic shift will continue…

Background: Japan and Urbanization

Mostly urban population

- 91.3% of total (vs. 82% for US) (World Bank, CIA)
  - .57% annual rate of urbanization (2010-2015)
- Tokyo metro pop. = 36.5 million
  - Pop. Density 6,810/sq mile
    - 16,000/sq mile for Tokyo metropolis

- Urban Health Challenges
  - Pollution (air, water, noise)
  - Built Environment (e.g., walkability, traffic)
  - Disrupted social cohesion
  - Homelessness
  - Gentrification
  - Natural Disasters
  - NCDs

Background: Increasing Inequalities in Japan

GINI coefficient (0 – 100) for family income

- 1993: 24.9 (on par with Scandanavian countries)
- 2008: 37.6 (on par with Vietnam, slightly lower than UK)
  - 77th in the world

Kano, Hotta, & Prasad (2013, J Urban Health)

- Significant inequalities in relative mortality from NCDs, especially cerebrovascular and heart disease, within Japan's urban areas
- These inequalities are increasing over time

Study Aims

Apply the Urban Health Index (UHI) to Japan

Examine differences in the distribution of the UHI for health outcomes between:

- Major cities, smaller cities, and rural areas
- The three largest cities in Japan: Tokyo (core), Osaka city, Yokohama city

Examine changes in UHI for health outcomes over time

Data

Selected from the 1998-2002 and 2003-2007 National Japanese Health Statistics Databases

- Source: National Statistics Center and the Statistics Bureau, Ministry of Internal Affairs and Communications

Selected 4 Standardized Mortality Ratios for each sex (8 indicators)

- All causes of death
- Heart Disease (excluding hypertension)
- Malignant Neoplasm
- Cerebrovascular Disease

$$SMR = \frac{\text{number of deaths by region (1/1/03-12/31/07)}}{\sum_{i=1}^{P}\left[\text{national mortality rate(03-07)}_i \times \text{population(10/1/05)}_i\right] \times 5} \times 100,$$

where i denotes the age group.

Geographic Unit of Analysis (1)

Smallest-area subdivisions and municipalities within each of the 47 prefectures of Japan

- Villages 村 (-son, -mura)
- Towns 町 (-chō, -machi)

- Cities 市 -shi (pop > 50,000)
- Special cities 特例市 – tokurei-shi(pop > 200,000)
- Core cities 中核市 – chuokaku-shi (pop > 300,000)

- Wards 区 (-ku)
  - Some designated cities, 政令指定都市 -- seirei-shitei-toshi (pop > 500,000), are subdivided into wards (sub-municipal unit)
- Special wards for Tōkyō 特別区 (tokubetsu-ku)
  - Tōkyō-to contains 23 special wards, each a municipality

Geographic Unit of Analysis (2)

1998 – 2002

- Based on 2002 (December 31) municipal boundaries
- 3,355 areas or units
- **3,336** units remaining after those with missing data are dropped

2003 - 2007

- Based on 2007 municipal boundaries
- 1,970 areas or units
- **1,894** units remaining after those with missing data are dropped

Japan has undergone a massive consolidation of its municipalities during the past decade

Calculating the UHI (Rothenberg et al., in press, JUH)

1. Standardize Indicators

$$SMR^{s} = \frac{SMR - 0}{\max(SMR) - 0}$$

Instead of observed minimum, 0 is chosen for the lower goal post, as SMRs are on a ratio scale and choosing 0 for min*(*I*) retains the ratio properties for the geometric mean.

2. Compute Geometric Mean Standardized Indicators

$$UHI = \left(\prod_{i=1}^{k} SMR_i^{S} \right)^{\frac{1}{k}}$$

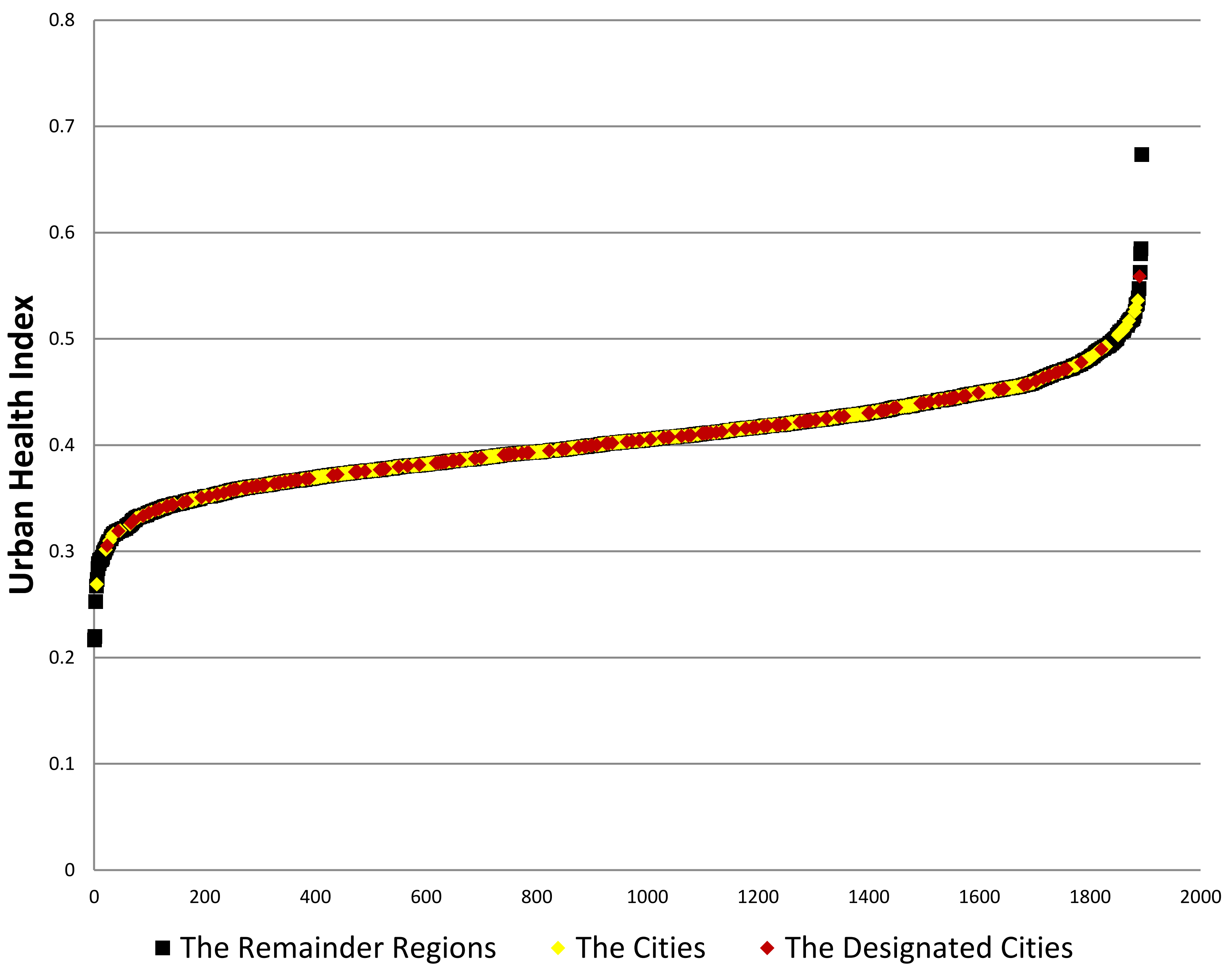
***Importantly, higher values indicate higher relative mortality**

3. Calculate health disparities (HD) ratio and slope
   - HD Ratio: ratio of mean UHI for top decile to mean UHI for bottom decile
   - HD Slope: linear gradient for the central 80% of UHI values

Results

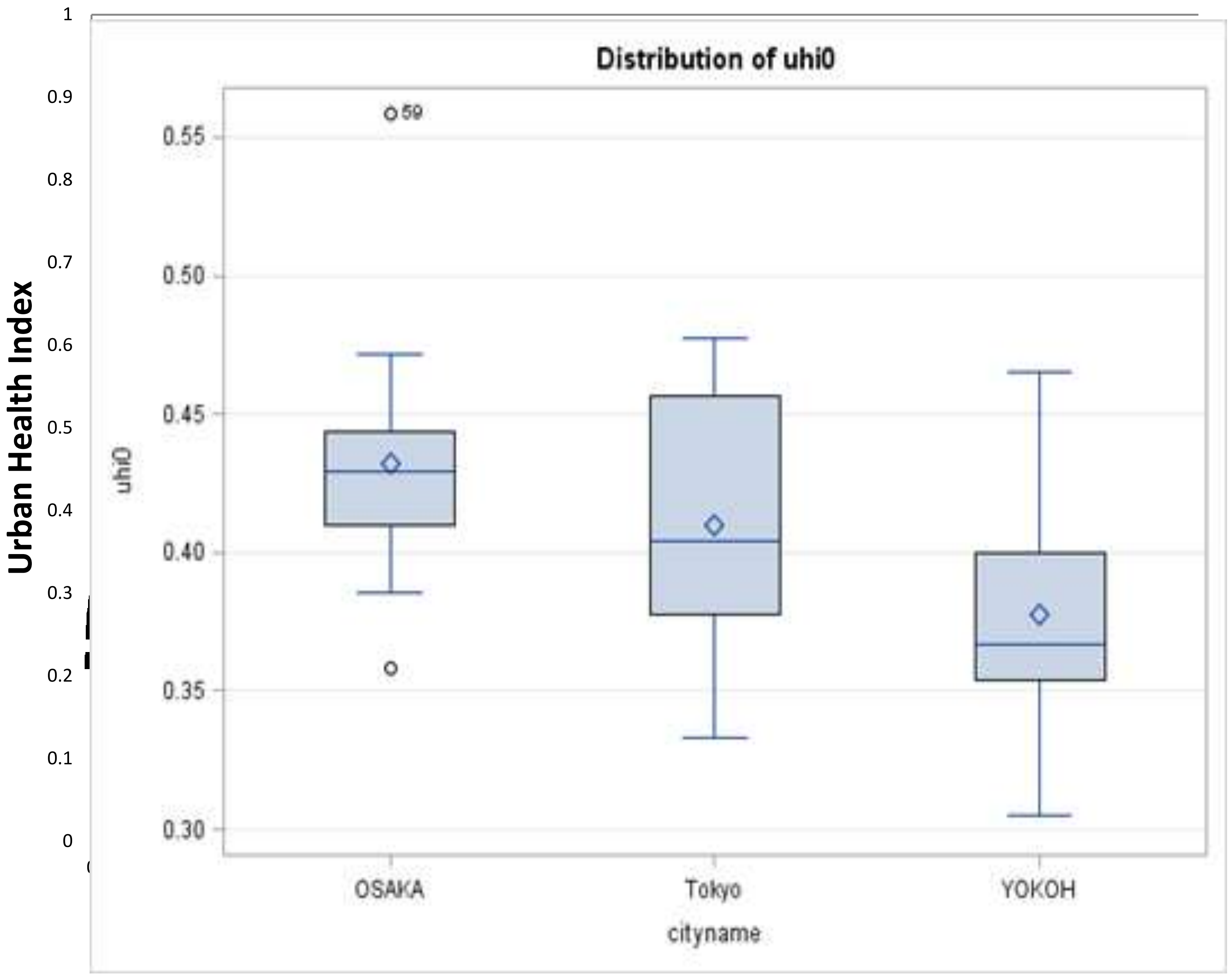
Index Plot of the UHI for Japan (2003-2007) by Municipality Type

- <u>No differences </u>in mean UHI between designated cities, non-designated cities, and villages/towns
  - Note: Red markers are for the wards of the designated cities
- More variability among towns and villages than cities.



Index Plot of UHI for Japan (2003-2007) by 3 Largest Cities

Comparison	Difference Between Means
Osaka - Tokyo	0.02202
Osaka - Yokohama	**0.05437**
Tokyo - Yokohama	**0.03235**



Examining Change in the UHI's Distribution

	Mean	Std Dev	Minimum	P10	Median	P90	Maximum	HD Ratio	HD Slope
UHI (2003-2007)	0.40	0.05	0.22	0.35	0.40	0.46	0.67	1.49	0.10
UHI (1998-2002)	0.40	0.05	0.18	0.33	0.39	0.47	0.67	1.57	0.11

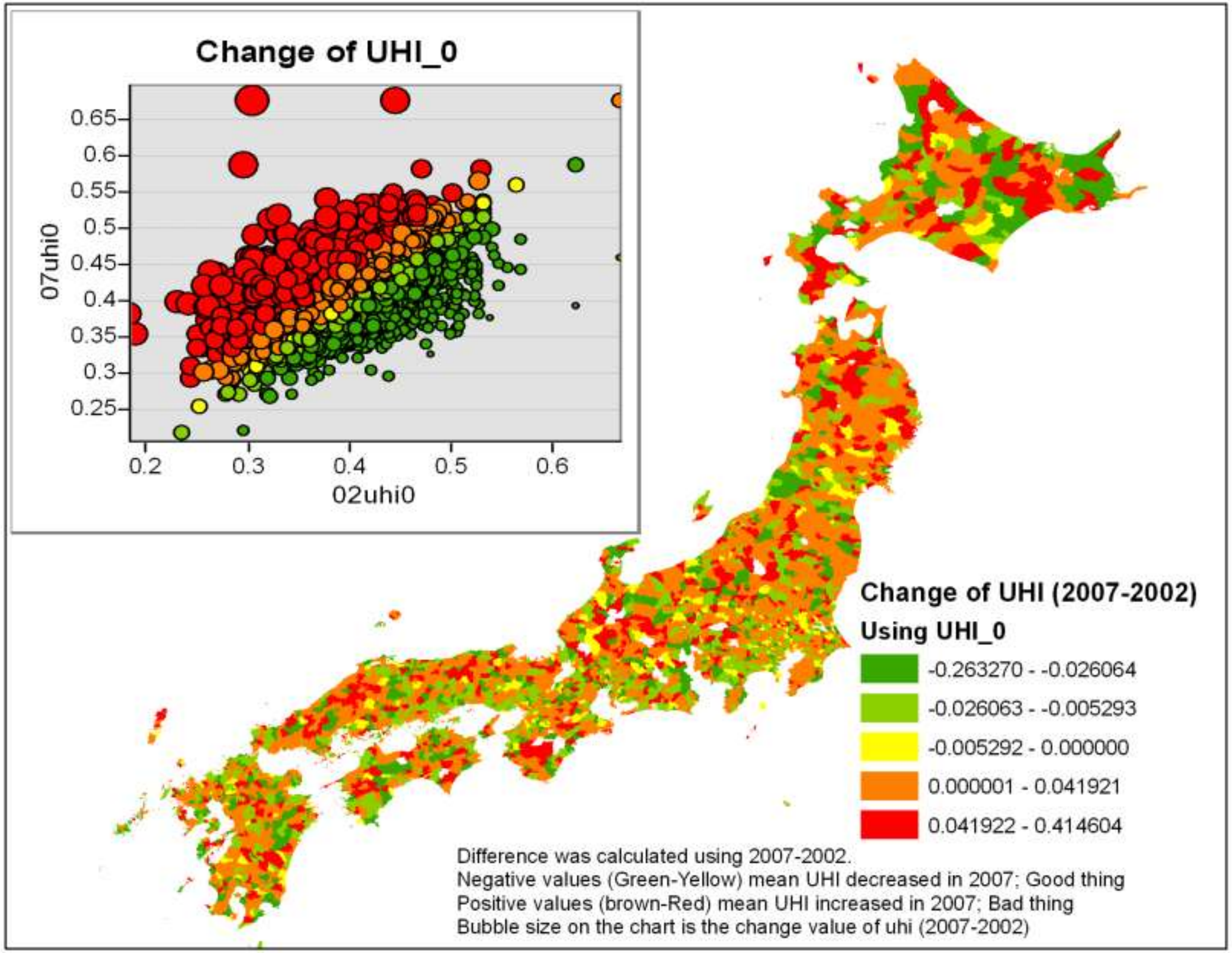
UHI summary statistics for both periods based on maximum goalpost (standardization) from 1998-2002

The 1,000+ changes in Japanese municipalities (mostly mergers and dissolutions) made statistical comparisons difficult.

- Therefore, we used GIS software to compare the periods based on 2002 boundaries.

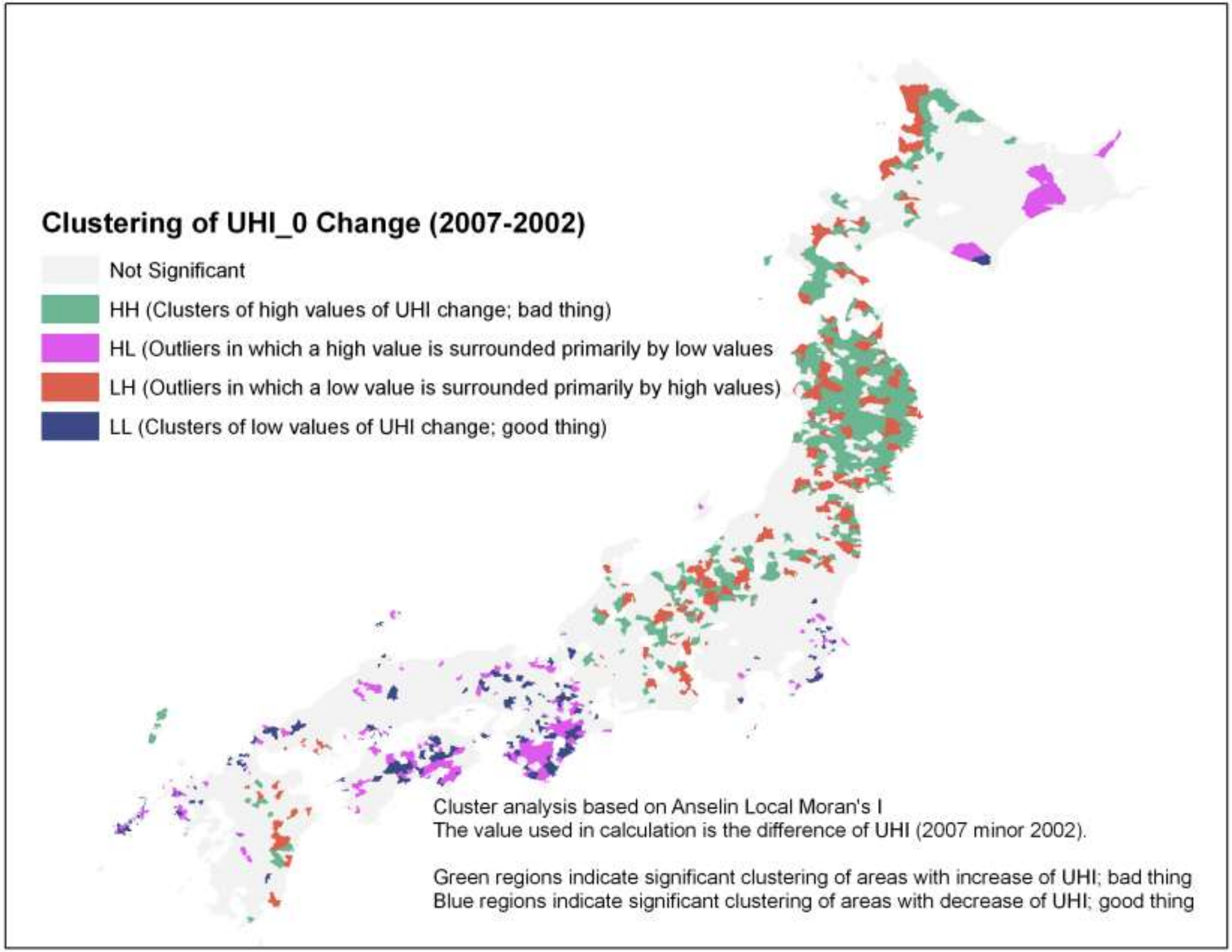
Japan Map for Change in UHI (2003-2007 period – 1997-2002 period)

- Yellow/Green: areas where UHI decreased (good!)
- Orange/Red: areas where UHI increased (NOT good!)
- Positive correlation between periods
- Some areas got much worse (see big red bubbles near top of scatter plot)



Clusters of UHI Change

- Blue: clusters of areas where UHI decreases (good)
  - Mie, Nara, and Wakayama prefectures
  - Shikoku Island
- Green: clusters where UHI increases (bad)
  - Central and northern Honshu and eastern Hokkaido
  - Oita and Miyazaki prefectures
- But pockets of areas (purple and orange) that differ in UHI from their neighbors (outliers)



Discussion

The Urban Health Index can be an useful tool for exploring geographic disparities in health outcomes

- In Japan, evidence of disparities within and between cities; Most variation was within cities (cf. Kano et al., 2013)
- No evidence that UHI in Japan's rural areas is worse than cities; But rural areas also show great variation
- On average, UHI and UHI disparity not worsening nationally, but municipal-level changes are observed (cf. Kano et al., 2013)

Future Work and Challenges

- Explore relationships between UHI for health outcomes and social determinants of health
- Examine more closely the municipalities, especially cities, with the greatest positive and negative changes in UHI and clusters.
  - Are there policies that might explain the patterns?
- The numerous mergers and dissolutions of municipalities makes it difficult to track changes in UHI over time or correlations with other variables

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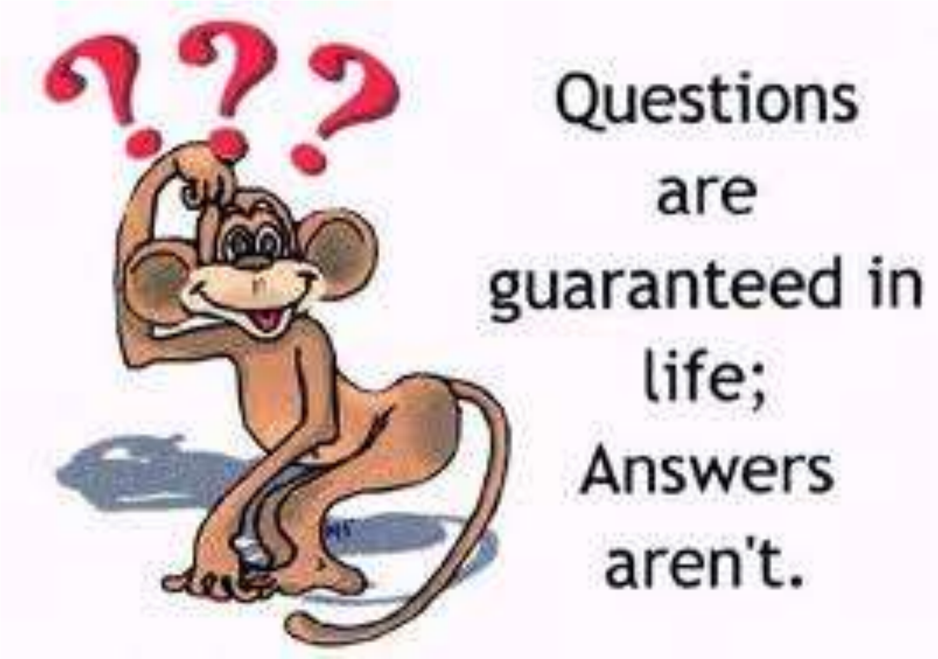
Thank you!



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