Connecting
POPULATION, HEALTH, & PLACE
(with geospatial tools & data)

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*Geospatial Approaches to Cancer Control Conference
12-14 September, 2016*

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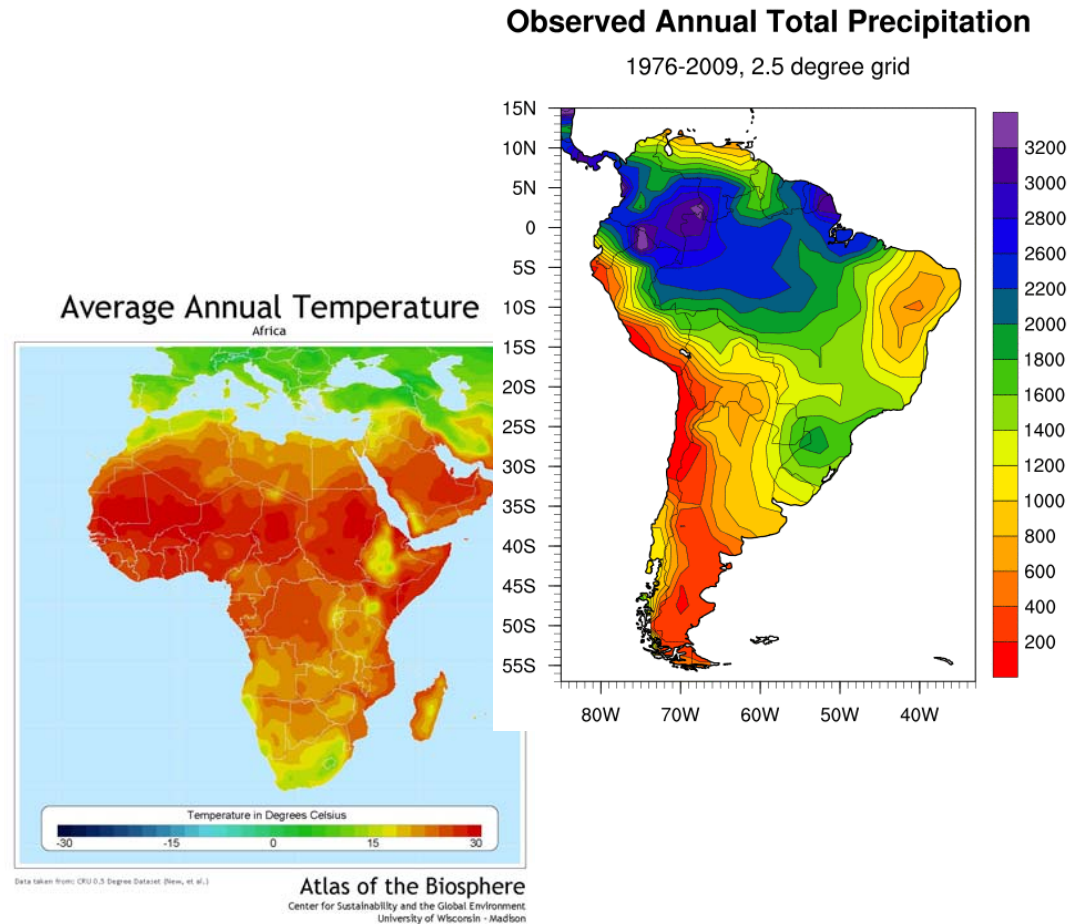College of Letters, Arts and Sciences

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Outline

o Spatial thinking

o Spatial … as an enabling science

o Geospatial tools

o Data science tools

o Geospatial data

o Connecting health & place

o Enduring challenges

o Thinking outside of the box

o One final thought

GEOG 109 – Paper #1

o **The primary task: Compare & contrast the climates of Africa & South America**

o Used mean monthly precipitation & temperature maps

o … tracing paper, pencils, square grids adjusted for scale, map projection

o … a stratified, systematic sample design

o … & spatial analysis to generate new understanding

o **My final paper was organized around a series of maps, graphs & tables**

Average Annual Temperature
Africa

Temperature in Degrees Celsius
-30   -15   0   15   30

Data taken from: CRU 0.5 Degree Dataset (New, et al.)

Atlas of the Biosphere
Center for Sustainability and the Global Environment
University of Wisconsin - Madison

Observed Annual Total Precipitation
1976-2009, 2.5 degree grid

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The spatial sciences …

All the ways in which location can be used to acquire, organize, analyze, model, visualize and interpret information

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Spatial … as an enabling science

Agronomy
Archaeology
Architecture
Civil Engineering
Data Science
Environmental Science
Epidemiology
Geography
Geology
Hydrology
…
…
…
…
Landscape Architecture
Oceanography
Political Science
Soil Science
Zoology

The Spatial Sciences

Poverty
Food & Water Security
Obesity
Social Justice Issues
Cancer
Sustainability & Climate Change
Terrorism
Cyber Security
Aging
Dementia

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Geospatial Tools – Proprietary systems

- Clark Labs
  - TerrSet Constellation
- Esri
  - ArcGIS Platform
  - ArcGIS Online
  - Business Analyst
  - GIS Apps
- MapInfo
- Maptitude
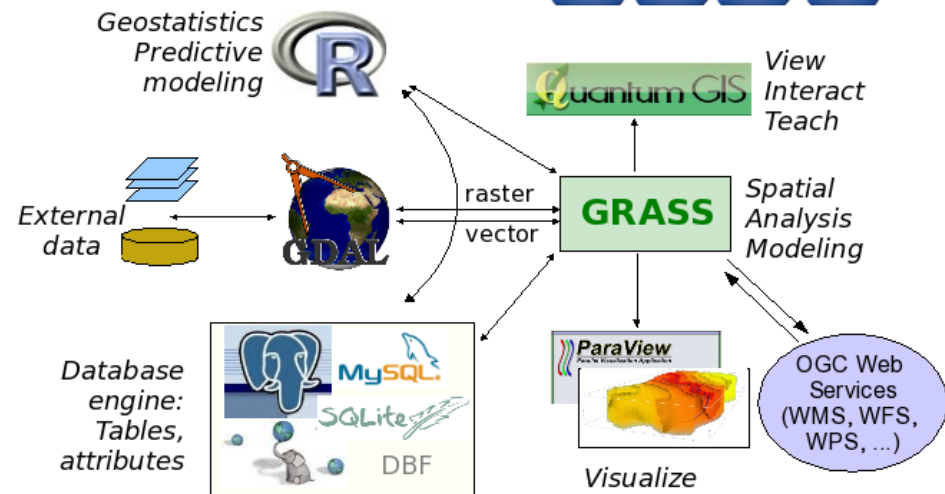- Trimble
  - e-Cognition
  - TerraSync | Pathfinder

Open source solutions

o Fulcrum

o GRASS

o QGIS

o SAGA

o GeoDa
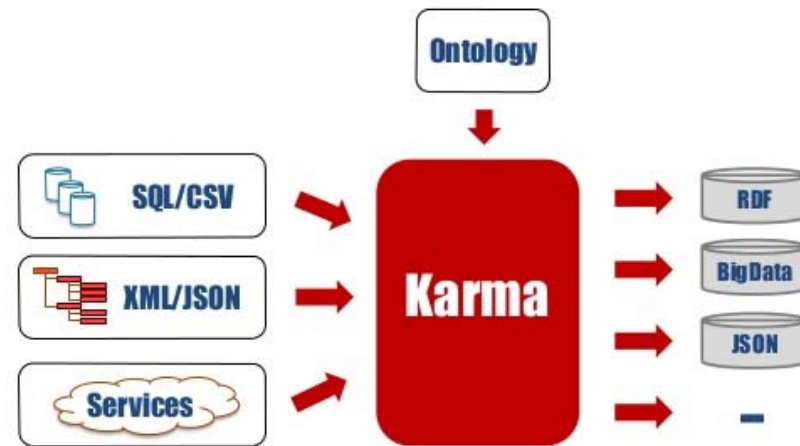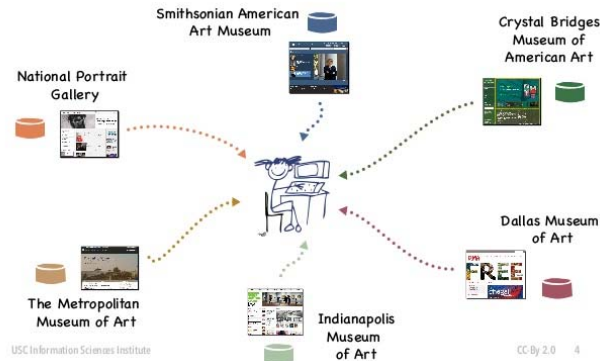
o R

o MapServer

o Open Layers

o CartoDB

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Related computational concepts & tools

Humans Browsing the Web

Smithsonian American Art Museum

Crystal Bridges Museum of American Art

National Portrait Gallery

Dallas Museum of Art

The Metropolitan Museum of Art

Indianapolis Museum of Art

USC Information Sciences Institute

CC-By 2.0   4

Steps to Create Linked Data

• Select ontologies
  … that define classes and properties for our data

• Convert data to RDF
  … from the museum database to the ontologies

• Identify links to other Linked Data datasets
  … to other museums and Link Data hubs

Ontology

SQL/CSV → **Karma** → RDF

XML/JSON → → BigData

Services → → JSON

Interactive tool for rapidly extracting, cleaning, transforming, integrating & publishing linked data in multiple formats

Pedro Szekely & Craig Knoblock
USC Information Sciences Institute
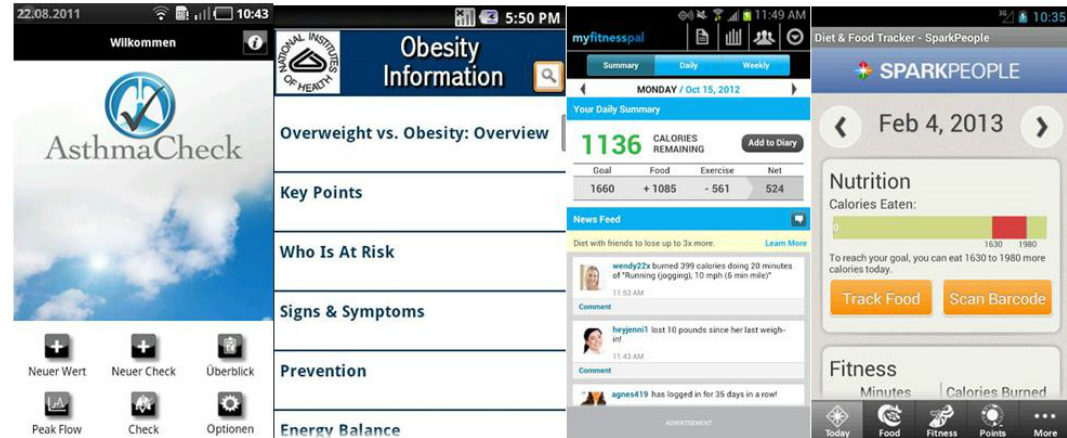
Web maps do something similar …

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… sensing systems

GPS Tracking
_____

Sensors
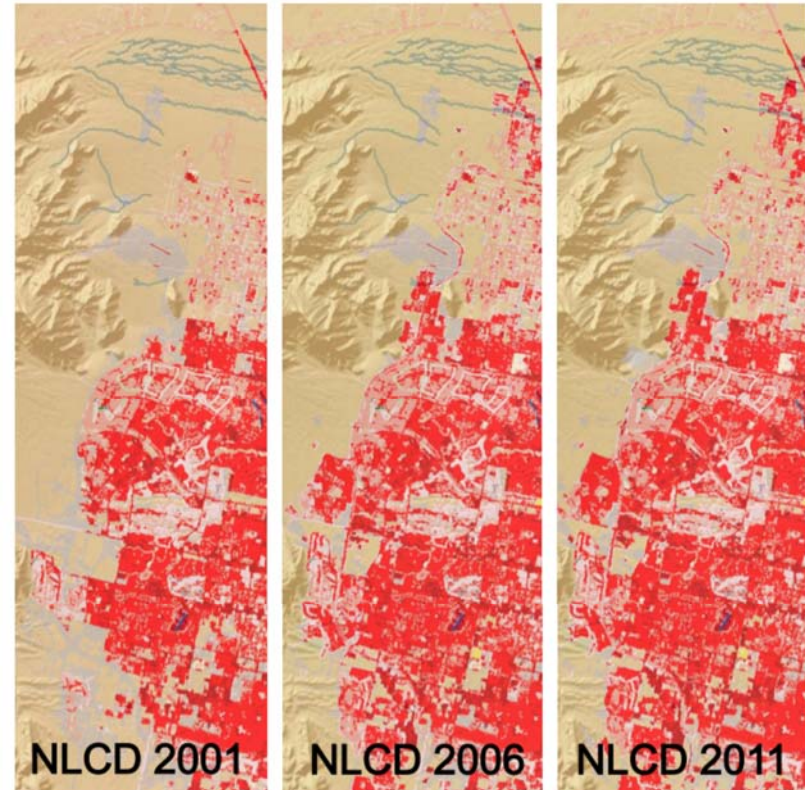_____

Ecological Momentary
Assessments

Schnall et al. (2013). Using text messaging to assess adolescents' health information needs:
An ecological momentary assessment. Journal of Medical Internet Research 15(3): e54

Many, many geospatial datasets …

o Physical World
  o Climate & weather
  o Elevation
  o Geology & soils
  o Hydrography
  o Flora & fauna

o Built Environment
  o Employment & commerce
  o Housing
  o Mobility
  o Nightlights
  o Noise
  o Transportation networks

NLCD 2001   NLCD 2006   NLCD 2011

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Elevation

NED
National Elevation Dataset

1 arc-second

1/3 arc-second

LiDAR   SRTM   ASTER

Maps courtesy of Dean Gesch

People │ Residences

LandScan USA – Houston, TX

Los Angeles

1118 S SUNSET DR
BOUNTIFUL
84010

Utah GIS Framework Data

LA County Building Outlines

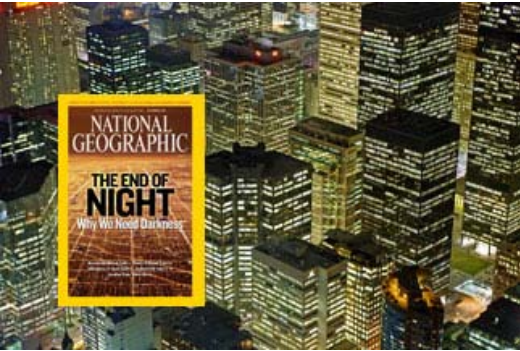# Digital Soil Geographic Databases

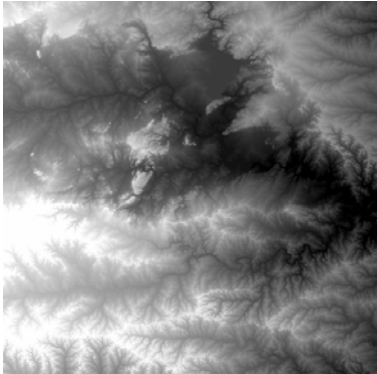# Nightlight │ Noise

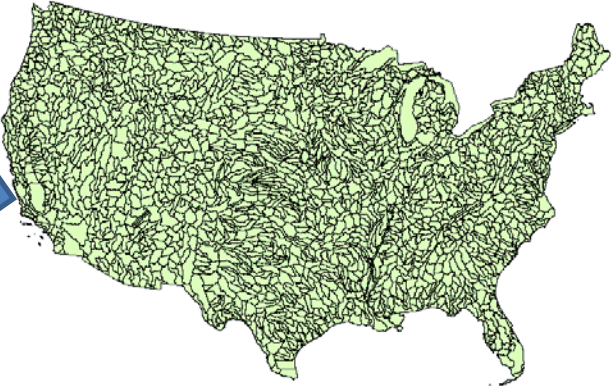Los Angeles Soundscores in Residential Areas
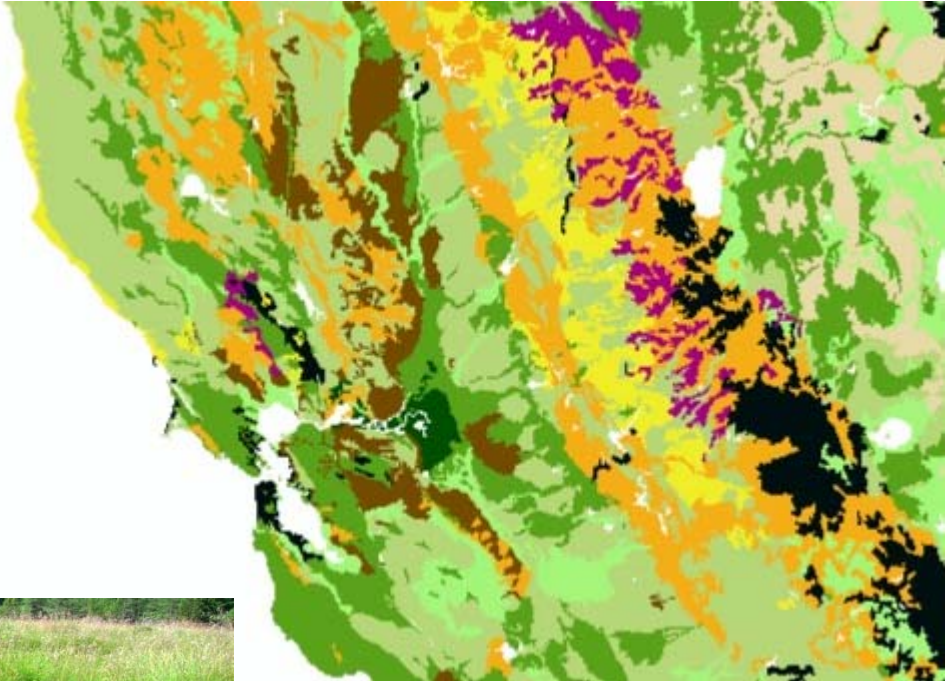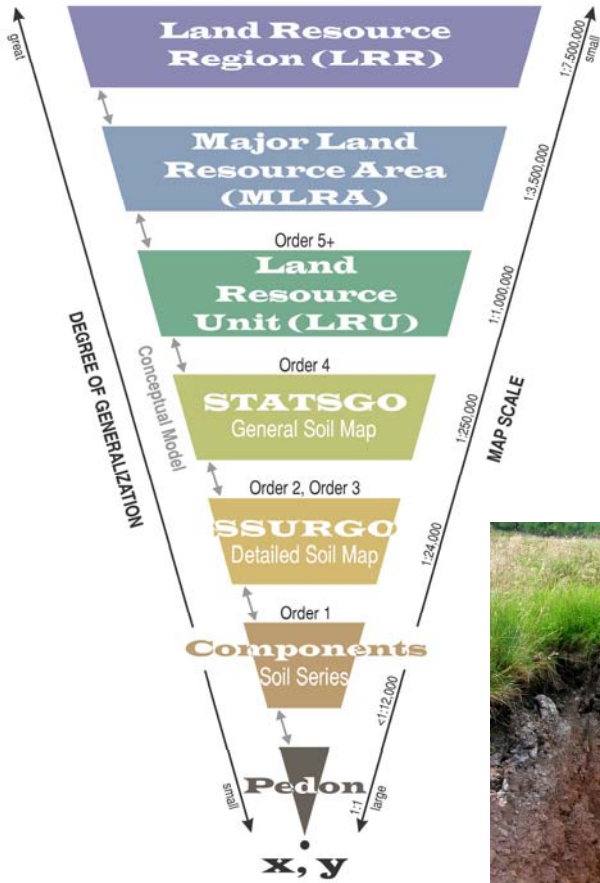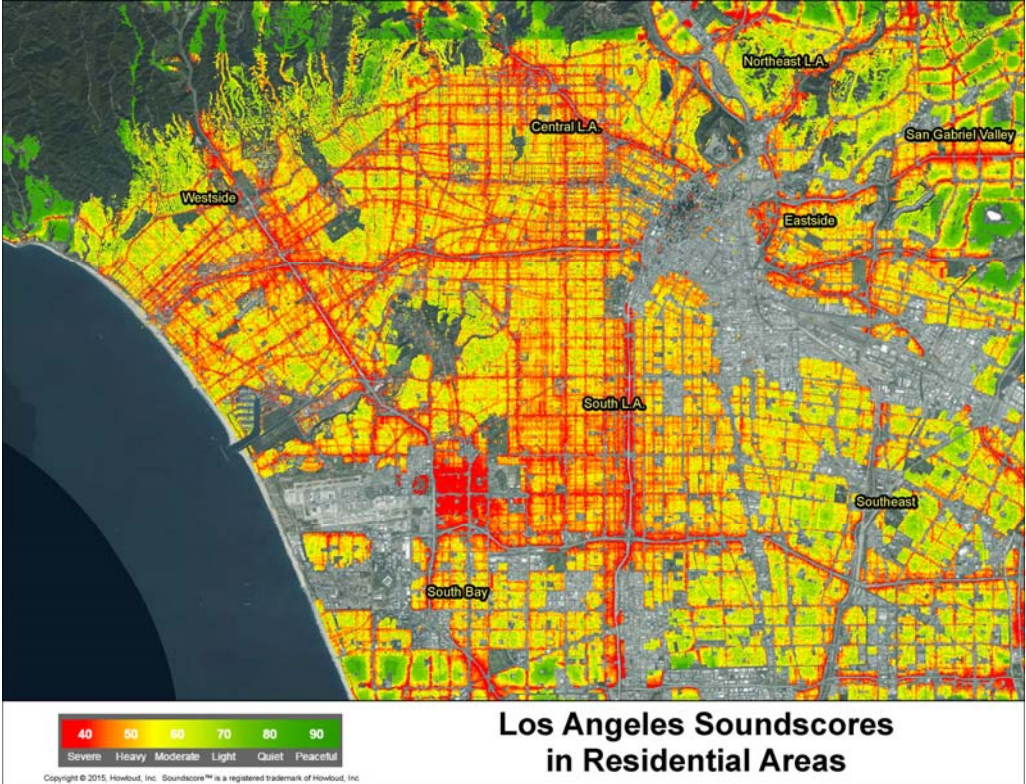
NHDPlus Version 2.1

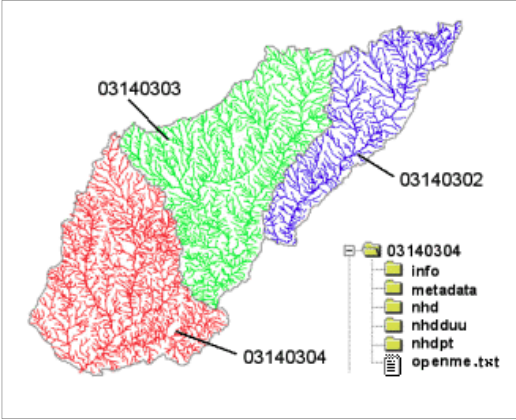Foundation for a Geospatial Hydrologic Framework for the United States

National Elevation Dataset

NHDPlus

2.7 million reach catchments in U.S.
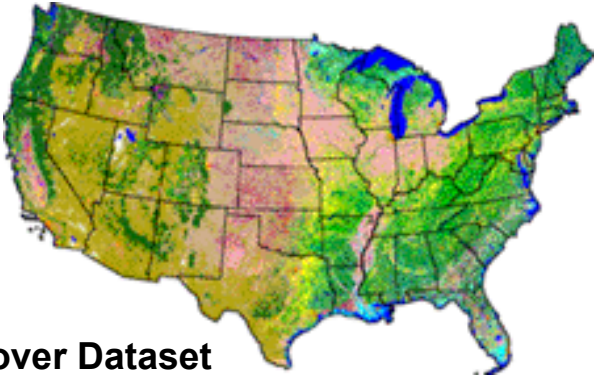Uniquely labeled
Average area 3 km^2
Reach length 2 km

Watershed Boundary Dataset

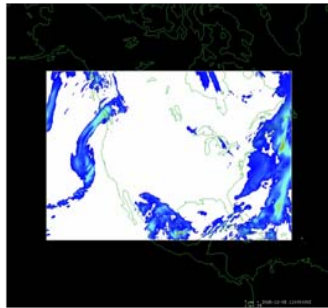**National Hydrography Dataset**

National Land Cover Dataset

Slide courtesy of David Maidment

NCAR Water Research & Forecasting Model

Weather model and forecasts (HRRR)

Probabilistic flood forecasts

Place-based catchment-level forecasts

Weather   Precipitation
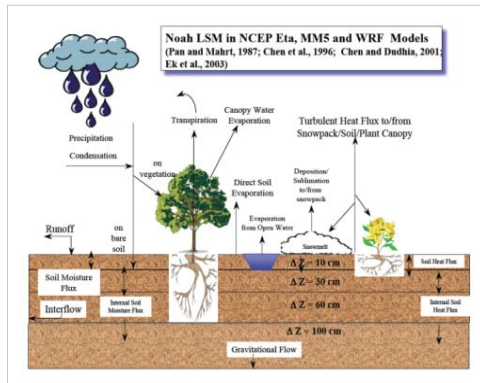
Streamflow

Land-Atmosphere Model (NOAH-MP)

Runoff
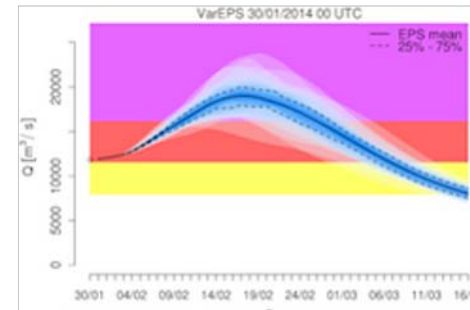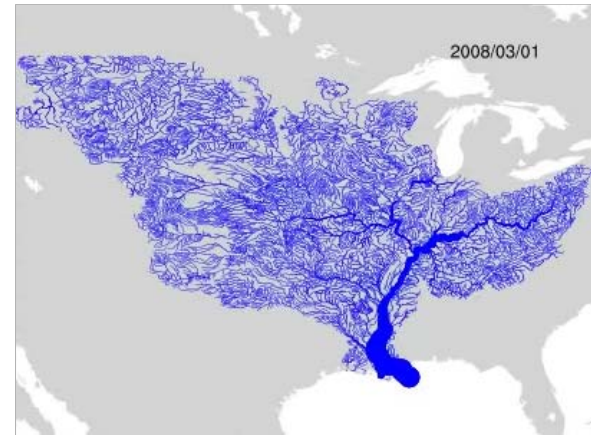
RAPID flow routing (for continental US)

Slide courtesy of David Maidment

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Modeling the connections between health & place

o Need to identify the people of the place & the 'place' itself

o People are mobile & mode of travel will likely vary from one individual to next and with place & time

o Their behavior will likely vary with life stage, their journey thus far & connections with family & friends

o Need to focus on the life course of individuals as well as the social & economic trajectories of the places they inhabit (Cummins et al., 2007; Delmelle, 2016)

o Need to situate people's lives in time as well as place (Kemp, 2011)

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Community Vital Signs

Incorporating geocoded social determinants into electronic records to promote patient and population health (Bazemore et al. 2015)

IOM recommended social & behavioral domains for inclusion in all EHRs
Individual level (patient reported)
Race-ethnicity
Education
Financial resource strain
Stress
Depression
Physical activity
Tobacco use & exposure
Alcohol use
Social connections & isolation
Exposure to violence (intimate partner violence)
Community-level (geocodable)
Neighborhood & community characteristics (residential address, census tract median income)

Indicators selected for ADVANCE pilot by Community VS type

Community VS	No. of indicators
Built environment	3
Environmental exposures	5
Neighborhood economic conditions	5
Neighborhood race/ethnic composition	2
Neighborhood resources	8
Neighborhood socio-economic composition	6
Social deprivation index	1

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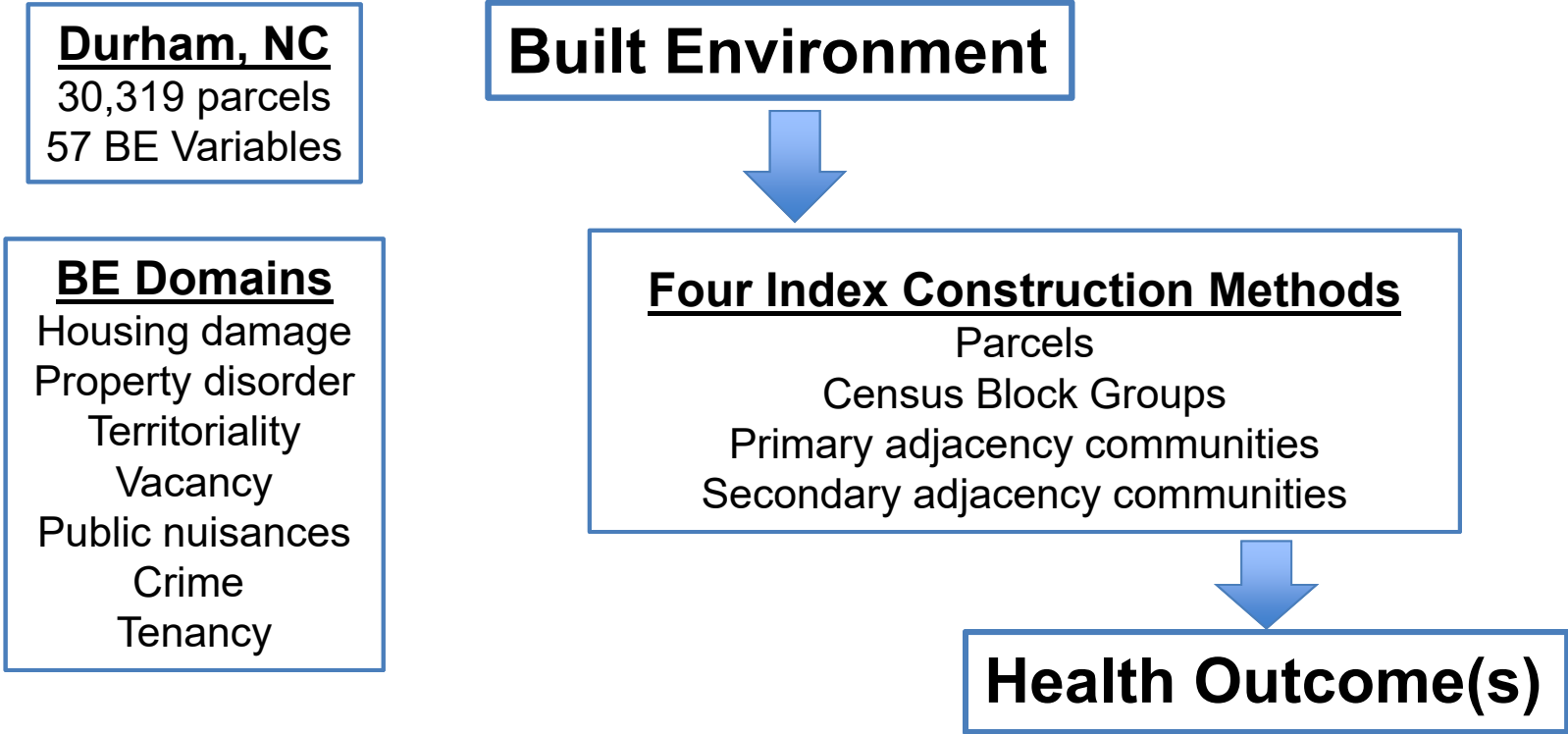
Spatial scales

Vector World

- **Address Points**
  - Residential – 134,789,944
  - Commercial – 13,340,398
- **Census Units**
  - Blocks – 6,690,931
  - Block groups – 217,210
  - Tracts – 72,753
- **Road segments**
  - NAVTEQ 2014, Q3 – 30,588,582
  - TIGER/Line 2015 – 19,531,813
- **ZIP codes**
  - 5-digit – 32,989 (US CB 2015)
  - 5-digit – 42,000+ (incl. universities & institutions with their own ZIP codes)
  - 9-digit – 14,000,000

Raster World

- 1 km – 9,605,900
- 500 m – 38,231,482
- 100 m – 931,356,172
- 30 m – 10,249,721,719
- 10 m – 91,783,949,400
- 3 m – 1,004,369,815,663
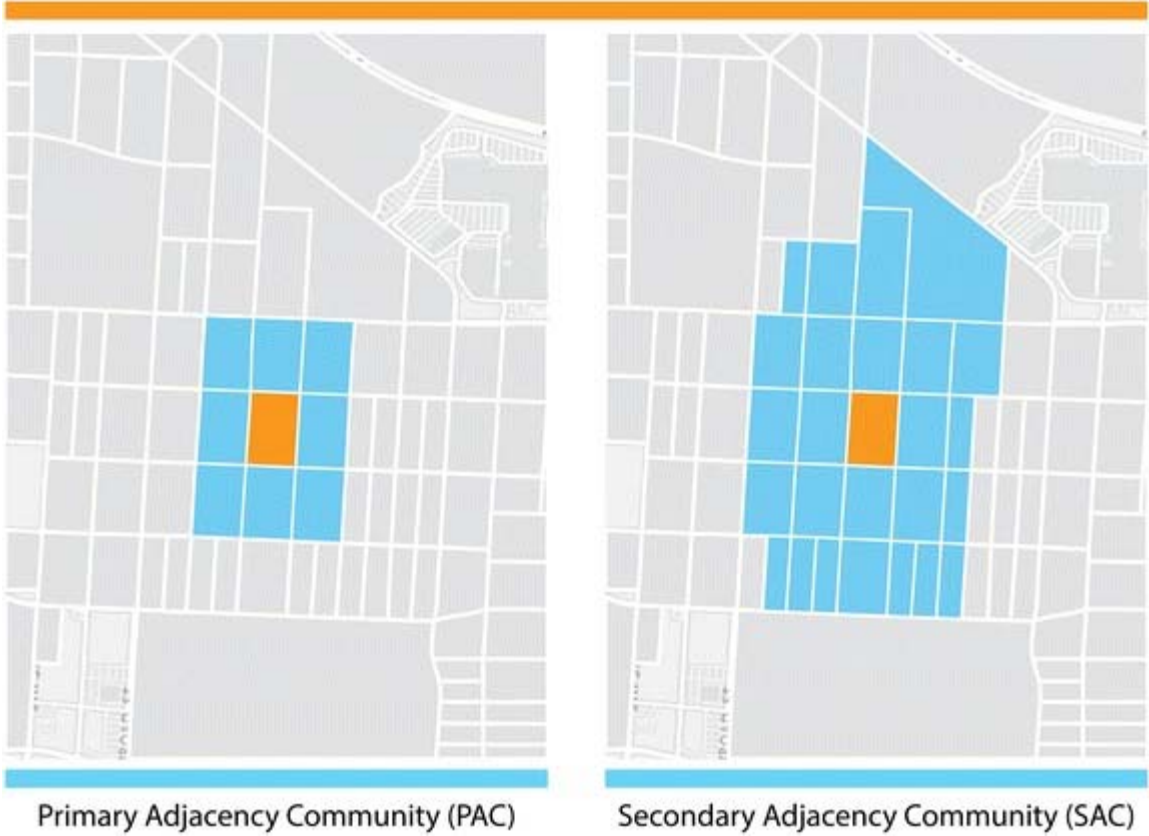- 1 m – 8,807,550,700,000

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Impact & consequences of spatial scale …

Durham, NC
30,319 parcels
57 BE Variables

BE Domains
Housing damage
Property disorder
Territoriality
Vacancy
Public nuisances
Crime
Tenancy

Built Environment

Four Index Construction Methods
Parcels
Census Block Groups
Primary adjacency communities
Secondary adjacency communities

Health Outcome(s)

Strominger, Anthopolos, & Miranda (2016) Implications of construction method and spatial scale on measures of the built environment. *International Journal of Health Geographics,* 15, 15.

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Primary & secondary adjacency communities …

Primary Adjacency Community (PAC)
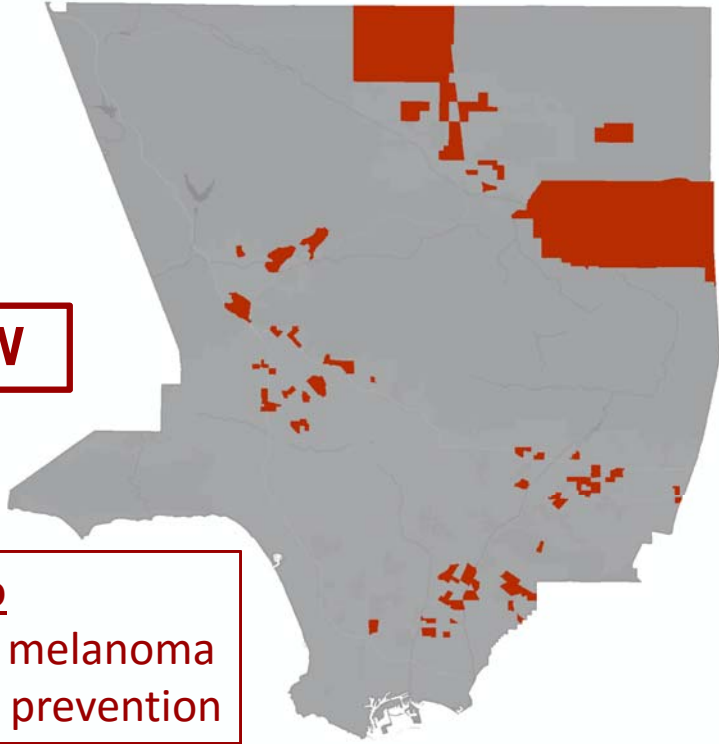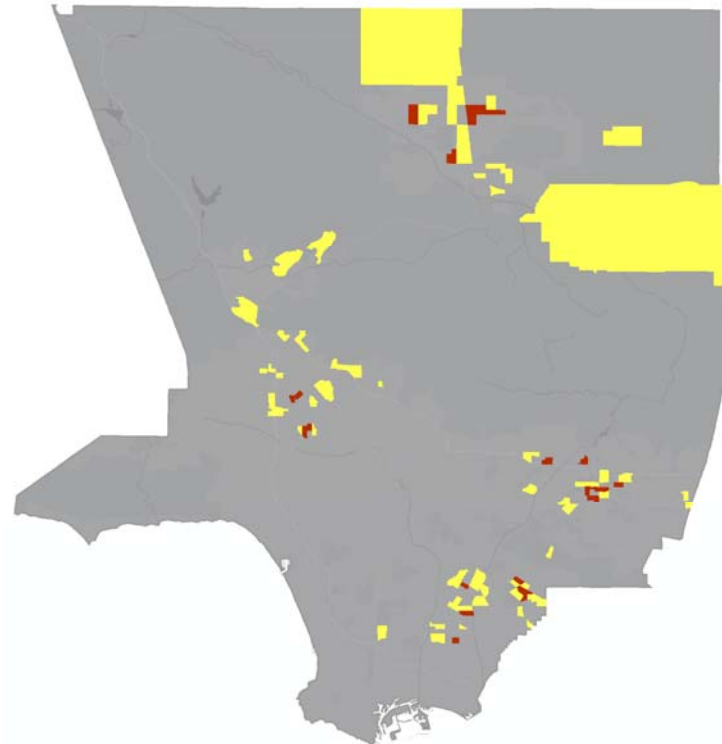
Secondary Adjacency Community (SAC)

Working with the American Community Survey (ACS)

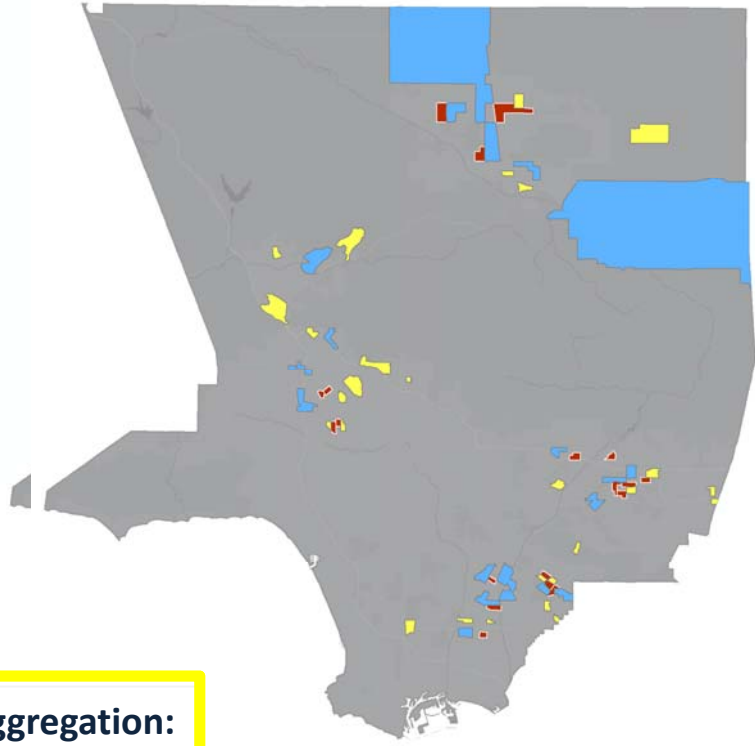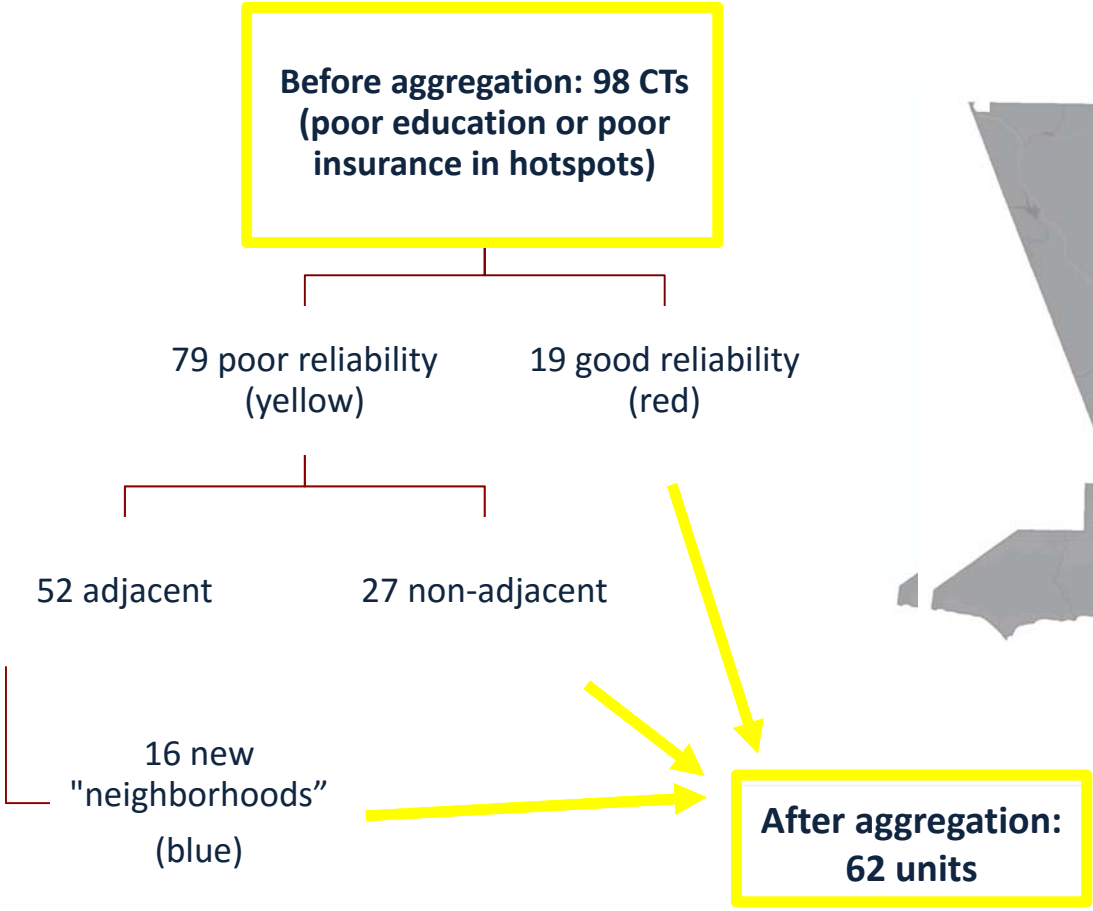**NHW**

Escobedo
Targeting melanoma control & prevention

Among hotspot CTs,
CTs with poor education or poor insurance coverage

Among the CTs on the left, yellow indicates poor reliability (CV>15)

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Before and after aggregation (NHW)

Before aggregation: 98 CTs
(poor education or poor
insurance in hotspots)

79 poor reliability
(yellow)

19 good reliability
(red)

52 adjacent

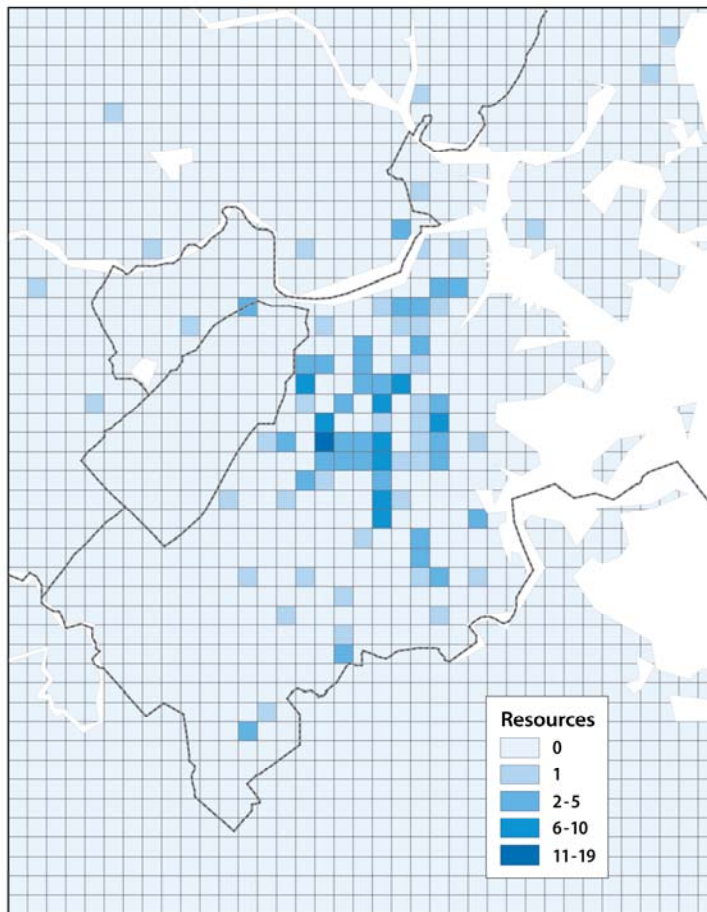27 non-adjacent

16 new
"neighborhoods"
(blue)

After aggregation:
62 units

Logan et al. (2016)

Matthews (2011)

Spatial polygamy and the heterogeneity of place: Studying people and place

Resources
- 0
- 1
- 2-5
- 6-10
- 11-19

Gridded surface of total family activities or resource sites (n=222) based on 10 families in one Boston, MA neighborhood

Square grid cells measure 500 m on a side

Burton, Kemp, Leung, & Matthews (Eds.) 2011. Communities, neighborhoods, and health: Expanding the boundaries of place. Berlin, Springer

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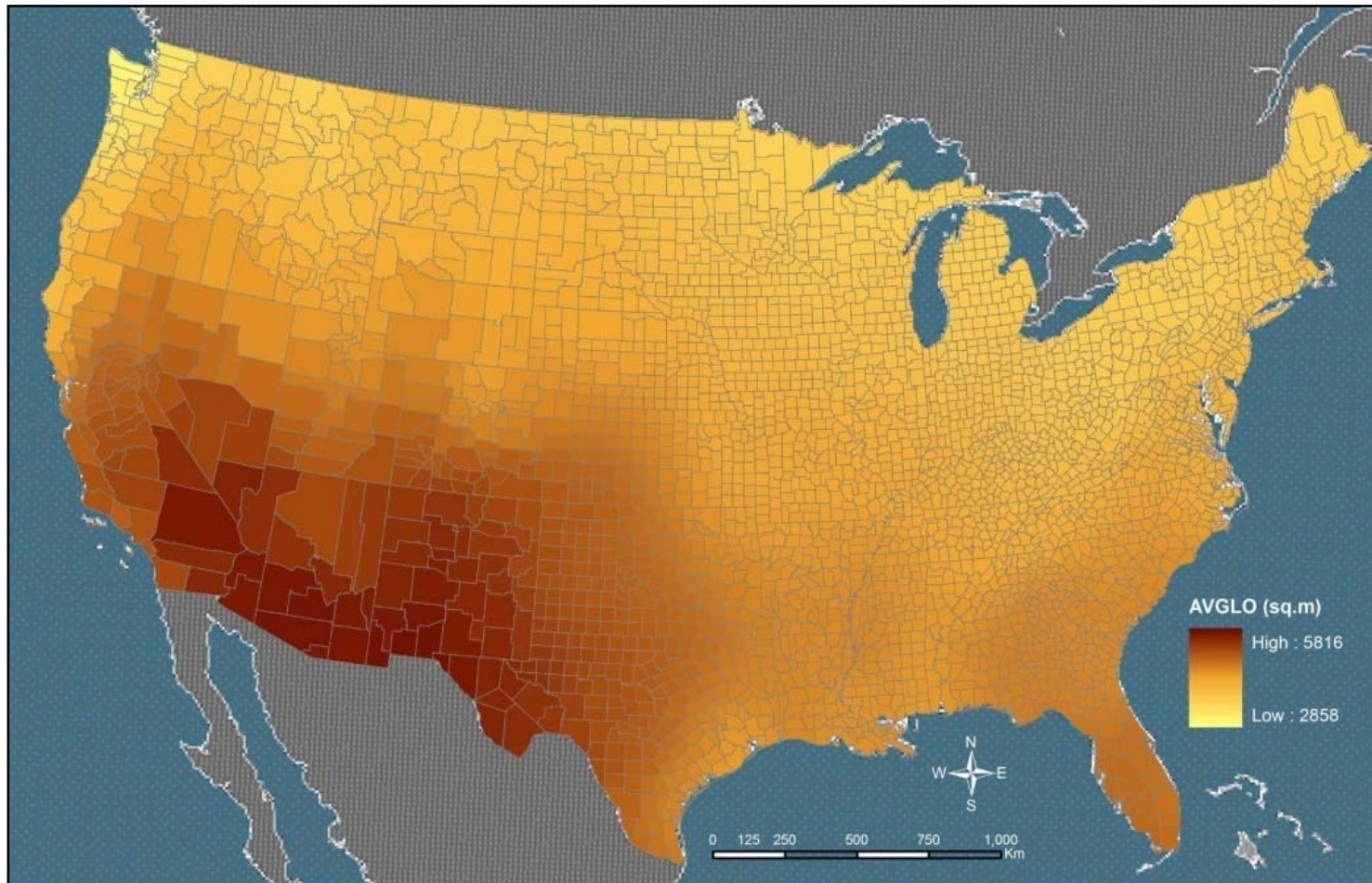
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Matthews (2011)

Residential, adjacent, & non-adjacent activity domains (rank-ordered by percent of activities in nonadjacent tracts; highest to lowest)

Domain	N	Residential tract	Adjacent tract	Non-adjacent tract
Social services	22	4.55	9.09	86.36
Work	11	9.09	9.09	81.82
Nonfood shopping	22	4.55	18.18	77.27
Childcare	15	0.00	26.67	73.33
Health services	45	6.67	20.00	73.33
Education	26	7.69	19.23	73.08
Social network	18	22.22	5.56	72.22
Other services	12	0.00	33.33	66.67
Food shopping	37	5.41	29.73	64.86
Recreation	14	0.00	42.86	57.14
Totals	**222**	**6.31**	**21.17**	**72.52**

10 families; 222 unique non-home places

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Spatiotemporal modeling …

Spatiotemporal trajectories

Single Participant GPS Data with Land Use
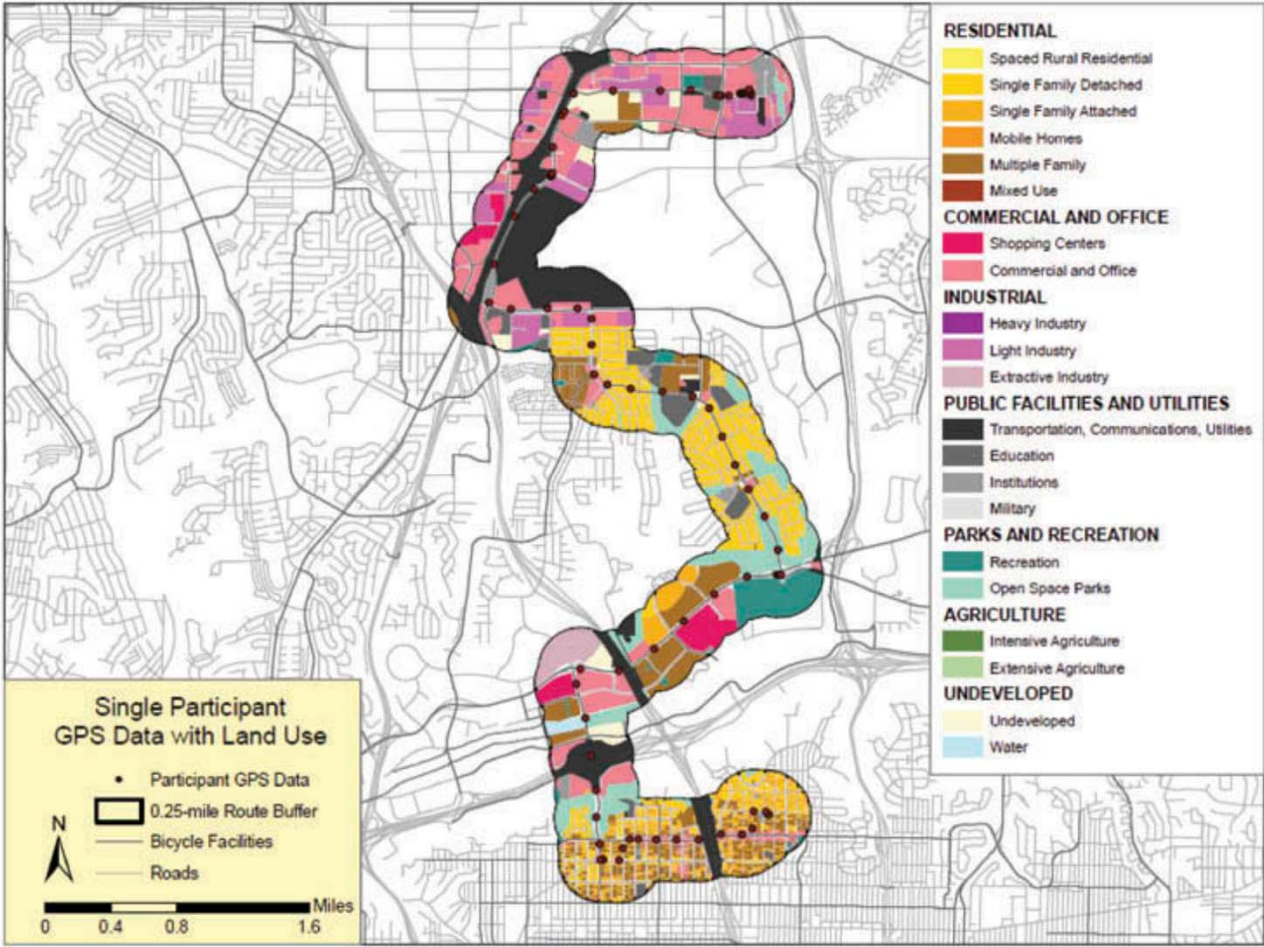
Haislip L. (2011). An examination of utilitarian bicycle trip route choice preference in San Diego. Master of City Planning Thesis, San Diego State University.

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Human activity

Piedmont Park, Atlanta, GA

Public Pools in Tulsa

Parks

Raise a series of issues connected with definition & granularity of data


Coliseum, Los Angeles, CA

Thinking outside of the box

o Integrate the spatial sciences in health research projects from the start to the finish like we do now with biostatistics

o Shift some of our focus from problems to solutions

o Build new cross-cutting academic programs to support these goals:

  o B.S. in GeoDesign

  o Ph.D. in Population, Health & Place

St. Augustine Catholic Elementary School

Close ǁ Questions
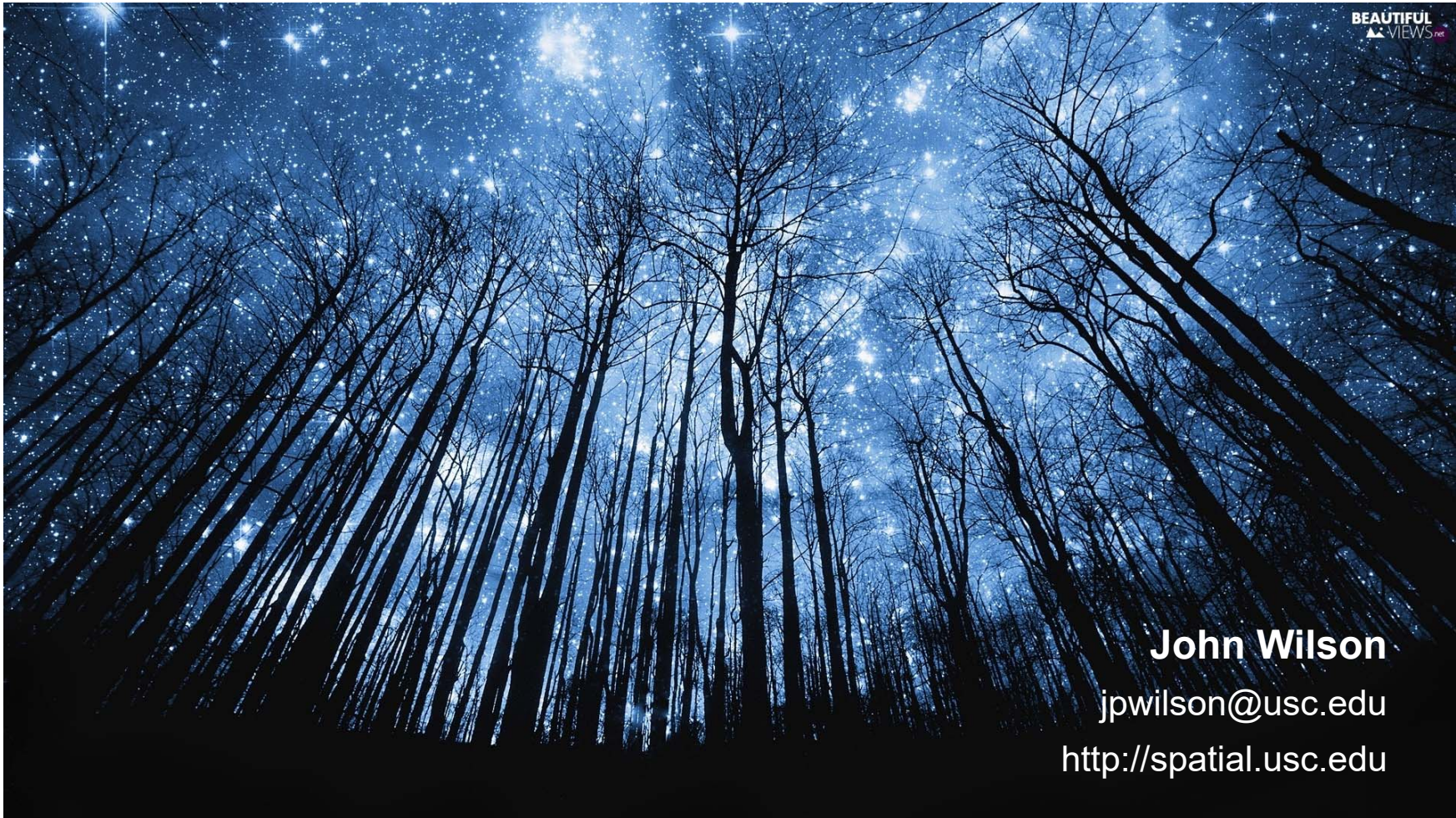
John Wilson

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http://spatial.usc.edu