HEALTH IMPACTS OF PROJECTED CLIMATE WARMING:
NEW AND OLD TOOLS FOR COMMUNITIES

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A TODAY OR FUTURE WHAT IF TOOL

\[ \Delta Y = Y_0 (1 - e^{-B \Delta T}) \times \text{Pop} \]
INTRODUCING THE TOPIC AND TOOLS

• CAME TO BENMAP AS A RESEARCH SOLUTION FOR LOOKING AT IMPACTS OF CLIMATE CHANGE ON OZONE AND PM$_{2.5}$

• ONE OF THE FIRST WAYS THAT MAPPING HAD PRACTICAL BEARING ON ANYTHING THAT I WAS INVOLVED WITH
FOR EXAMPLE, THE COUNTIES OF RESIDENCE OF ELDERLY WHITE FEMALES

• RUDIMENTARY MAPPING IN BENMAP
COOLING (VS 2050 HEATING) OF 4km BLOCKS OF ATLANTA FROM HEAT MITIGATION STRATEGIES

• Darkest color 1.15° to 1.30° C cooler
BENMAP REQUIREMENTS/HISTORY

• A SETUP INVOLVING GEOGRAPHY, POLLUTANT, METRICS, SEASON, POPULATION PROFILES, POPULATIONS, INCIDENCE/PREVALENCE FILES, CONCENTRATION RESPONSE FUNCTIONS (ECONOMIC VALUATIONS, ETC.)

• OF INTEREST:
  – USUALLY THE POLLUTANT IS ONE OF THE CRITERION AIR POLLUTANTS (OZONE, NO₂, PM₂.₅, CO, SO₂, LEAD – BUT ALSO HEAT
  – SCIENTIFIC (EPIDEMIOLOGIC) RATIONALE OF THE CONCENTRATION RESPONSE FUNCTION IS THE RISK RATIO, ALSO KNOWN AS RELATIVE RISK
BENMAP MAKES SENSE

• **APPROXIMATE** RISK FROM OUR INDIVIDUAL LIFE, BUT **CHARACTERIZED** REAL OR MODELED EXPOSURES SUMMED AT THE GEOGRAPHY OF CHOICE
  – WHERE YOU AND OTHERS LIKE YOU LIVE
    • **RECTANGULAR GRID-LIKE BLOCKS** LIKE FROM TEMPERATURE GRID JUST SHOWN, OR
    • **AGGREGATED** BY BUILT IN GIS FUNCTION TO THE LEVEL CHOSEN...I.E., CENSUS TRACT, COUNTY, STATE, REGION, NATION
    • **CAN DO A BREAK DOWN** BY RACE, GENDER, SEX, AGE IF THE SCIENCE MERITS...SOMETIMES IT DOES, OFTEN IT REQUIRES THINGS ARE POOLED
  – **A SEASON OF CHOICE** CAN BE TAKEN INTO CONSIDERATION...I.E., HOT SEASON TAKEN/MODELED AS MAY 1-SEPT. 30 OR JUNE 1-AUG. 30
THE “MAGIC” WITHIN BENMAP IS IMPRESSIVE

- GIGABYTES OF DATA
- REFERENCE MORTALITY RATES FOR A BUNCH OF US ACROSS OUR LIFESPANS (UP TO 99 YEARS OLD)
- REFERENCE DISEASE INCIDENCE (MORBIDITY) RATES FOR A BUNCH OF US ACROSS OUR LIFESPANS
- FOR THE ABOVE (MORTALITY AND MORBIDITY):
  - SEX
  - AGE GROUPS
  - RACES
  - ETHNICITY (HISPANIC, NONHISPANIC)
  - GEOGRAPHY OF RESIDENCE AT TIME INCIDENT OCCURS
I WONDERED WHETHER THIS POWER, INCLUDING THE GEOGRAPHY COULD BE “TWEAKED”

• MORE INTRIGUING TO PLANNERS?
  – CERTAINLY AM NOT CLAIMING TO BE ONE, BUT LIKE THEIR THINKING

• LOCAL ADVOCATES (HEALTH IMPACT ASSESSMENTS?)
  – A REAL NEWBIE AND WANNABE

• ENVIRONMENTAL CONCERNS
  – SOMETIMES FEEL SOUTHEAST IS A “TRAINWRECK”

• ACADEMIC INTERESTS
  – PAYS MY LIGHT BILLS AND MORE 😊
…and so I found this…
IT HAD A ‘WOW’ FACTOR FOR ME!
A BROOKINGS TYPOLOGY (DIVERSE GIANTS) GRID OF 2050 minus 2000 TEMPERATURE DIFFERENCES ($\Delta T$'s)

...ready for me to go to work.....
BenMAP REQUIREMENTS FOR OUR STUDY

- BROOKINGS SHAPEFILES
- MEAN OF MAY 1 – SEPT 30 DAILY 24 HOUR MEANS
- 1 ΔT PER 36 KM GRID FOR YEAR 2050 – 2000 FOR A1B CLIMATE MODEL (GISS II MM5)
- VARIOUS (ICLUS, ETC.) POPULATION FILES USING 36 KM CLIMATE GRID
- BASELINE DISEASE AND MORTALITY RATES BY AGE, RACE, ETHNICITY, SEX
- RELATE RISK FUNCTIONS OF DYING, PNEUMONIA, RESPIRATORY HOSPITAL ADMISSION, ETC

....ALONG CAME RESPIRATORY DISEASE HOSPITAL ADMISSIONS IN 2013
TODAY’S BROOKINGS CAROLINAS CLIMATE RESILIENCY DISCUSSION

Brookings typology factors of population growth, diversity, educational attainment

- Border Growth
- Diverse Giants
- Skilled Anchor
- Industrial Core
- New Heartland
- Mid-Sized Magnets
- Next Frontier

Driving alone in work commutes?
Earning equally?
Educated equally?
% Foreign born?
Population growth rate?
Population density?
% Population > 45 years old?

THE ELDERLY DON’T JUST PLAY GOLF AND END UP IN CEMETERIES, THEY USE UP HEALTH CARE COSTS
IN 2008, TOP 100 METROS HAD NEARLY 200 MILLION → POPULATION TOMORROW?

• BenMAP HAS WOODS AND POOLE 2040 → 2050

• SOME REASONS TO USE EPA’S ICLUS (INTEGRATED CLIMATE AND LAND USE SCENARIOS)
DOMESTIC COUNTERPART TO MESH OUTCOMES WITH OLD GLOBAL CLIMATE CHANGE SCENARIOS

COUNTY LEVEL ECONOMIC DEVELOPMENT, FERTILITY, MIGRATION, IMMIGRATION VARY – BUT ODDLY THE UNDERLYING GHG SCENARIO ITSELF IS CONSTANT
### Land-Use Scenarios:  
#### National-Scale Housing-Density Scenarios Consistent with Climate Change Storylines

<table>
<thead>
<tr>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast economic development</td>
<td>Continued economic development</td>
<td>Environmentally sustainable economic growth</td>
<td>Local solutions</td>
</tr>
<tr>
<td>Low population growth</td>
<td>High population growth</td>
<td>Moderate population growth</td>
<td></td>
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<tr>
<td>High global integration</td>
<td>Slow regional convergence</td>
<td>Regionally oriented world</td>
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<tr>
<td>Declining fertility</td>
<td>High fertility</td>
<td>Low fertility</td>
<td>Medium fertility rate</td>
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<tr>
<td>Women participate in labor force</td>
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<tr>
<td>Rising divorce rates</td>
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<td>Later marriages</td>
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<td>Delayed childbearing</td>
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<td>Substantial aging</td>
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<tr>
<td>Low death rate</td>
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<tr>
<td>Demand for immigration</td>
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<tr>
<td>Global economic growth</td>
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<tr>
<td>Free movement across borders</td>
<td>Restricted movement across borders</td>
<td>Free movement across borders</td>
<td>Low international migration</td>
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<td></td>
<td></td>
<td></td>
<td>High international migration</td>
</tr>
<tr>
<td>Domestic migration high</td>
<td>Domestic migration high</td>
<td>Domestic migration lower</td>
<td>Domestic migration lower</td>
</tr>
<tr>
<td>Flexible and mobile workforce</td>
<td>Information economy stays put in urban centers</td>
<td>Jobs stay in urban centers</td>
<td>Reduced subsidies for rural development</td>
</tr>
</tbody>
</table>

*Note: EPA image and table content.*
SELECTED ICLUS A1 DESCRIPTORS

DOMESTIC MIGRATION HIGH

SUBSTANTIAL AGING

RISING DIVORCE RATES

WOMEN PARTICIPATE IN LABOR FORCE
SELECTED ICLUS A2 DESCRIPTORS

- Domestic Migration High
- Continued Economic Development
- Restricted Movement Across Borders
- High Population Growth
- Slow Regional Convergence
- High Fertility
SELECTED ICLUS B1 DESCRIPTORS

- Environmentally Sustainable Economic Growth
- High Immigration
- Free Movement Across Borders
- Reduced Subsidies for Rural Development
- Domestic Migration Lower
- Information Economy Stays in Urban Centers

- Reduced Subsidies for Rural Development
- High Immigration
- Free Movement Across Borders
- Domestic Migration Lower
- Information Economy Stays in Urban Centers
- Environmentally Sustainable Economic Growth
SELECTED ICLUS B2 DESCRIPTORS

- Local Solutions
- Moderated Population Growth
- Jobs Stay in Urban Centers
- Regionally Oriented World
- Low Domestic Migration
- Medium Fertility Rate
- Low International Migration
TODAY’S BROOKINGS CAROLINAS DISCUSSION

Brookings typology factors of population growth, diversity, educational attainment

Greeneville SC Plus

Greensboro, High Point NC Plus

Charlotte NC

Columbia SC

Raleigh, Cary NC Plus

↑BY 6 COUNTIES

↑BY 5 COUNTIES

↑BY 7 COUNTIES

A plus allowed another metro or micro(s) to add to the mix...
WHERE THE GIS SKILLS COME IN

DATA MANAGEMENT, GENERAL, MERGE

CARTOGRAPHY TOOLS, AGGREGATE POLYGONS, 0.1 DECIMAL DEGREES

IN BENMAP OR BENMAP CE THE GRID IS MADE

ATTRIBUTE TABLE OF RESULTANT LAYER IS EXPORTED AS .TXT

ANALYSIS, OVERLAY, SPATIAL JOIN, JOIN FEATURES ARE METROS, TARGET FEATURE IS TEMPERATURE GRID

DATA MANAGEMENT, GENERAL, MERGE
TIME TO DISCUSS RESULTS

<table>
<thead>
<tr>
<th>Yearly Increased Morbidity (Hospitalizations for Pneumonia Among Seniors) Associated with Warmer Climate – Variations With ICLUS Scenario Population Attained in 2050</th>
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<tbody>
<tr>
<td>Type of future scenario on which US county level populations are based</td>
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<tr>
<td>Economic scenarios</td>
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<tr>
<td>Scenarios favoring global cooperation</td>
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<tr>
<td>A1</td>
</tr>
<tr>
<td>Scenarios favoring regionalism</td>
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<tr>
<td>A2</td>
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### Mid-Sized Magnets

<table>
<thead>
<tr>
<th>Brooking Metro Name</th>
<th>Charleston, SC</th>
<th>Columbia, SC</th>
<th>Greensboro-Winston Salem, NC</th>
<th>Greenville-Anderson, SC</th>
<th>Raleigh-Cary-Durham, NC</th>
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<td>22</td>
<td>9</td>
<td>11</td>
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TIME TO DISCUSS RESULTS

• **EVEN IN A GLOBALLY COMPETITIVE WORLD, OUR DEVELOPED COUNTRY, OUR SUCCESSFUL METROS IN THE SOUTHEAST HAVE HIGH SOCIETAL COSTS SINCE THE ELDERLY MAY SUFFER ILLNESSES RELATED TO INCREASING EVENTS ($100K PER PNEUMONIA HOSPITALIZATION)**

• **LEVELS MAY NOT BE AS HIGH IN SCENARIOS WHERE POPULATION IS NOT AS RURAL...SCENARIOS LIKE B1 WHICH DO NOT FAVOR THE ATTRACTION AMENITIES OF RURAL COUNTIES FOR DEVELOPMENT, BUT**

• **THERE IS MUCH TO LOVE ABOUT SCENARIO B2 WHICH IS THE SUSTAINABLE, “THINK LOCAL” WAY OF LIVING...THE WHOLE PLANET WINS**
THANK YOU

...find me at netmtman (twitter), on LinkedIn (Tony DeLucia), and email me at delucia@mail.etsu.edu