Climate Change, Mental and Emotional Health, and Adaptation

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What we can Learn from Nunatsiavut Inuit in Canada
Background: Canada’s Inuit Regions

The Changing Climate, Changing Health, Changing Stories Project

- Multi-year, community-led, capacity development project in Rigolet, Nunatsiavut
- Examines impacts of climate change on health and well-being
- Transdisciplinary approach, multiple methods (interviews, focus groups, population survey, questionnaire, digital storytelling, and PhotoVoice)
- Data gathered between November 2009 and October 2010
Climate Change in the Canadian Arctic

- Observed changes
  - Changes in local and regional weather patterns
  - Decreased snow amounts and quality
  - Decreased ice quality and stability
  - Alterations in timing of ice formation and break-ups (later ice formation and earlier break-up)
  - Increased frequency and intensity of storms
  - Shifts in wildlife and vegetation patterns

Krupnik et al., 2002; Ford et al., 2006; Furgal and Seguin, 2006; Nickels et al., 2006; Ford et al., 2008; Furgal, 2008; Ford and Furgal, 2009; Pearce et al., 2009a,b; Prowse and Furgal, 2009; Prowse et al., 2009a,b,c,d,e; Ford et al., 2010
Climate Change and Health

• Impacts on *physical* health and well-being

  – Changes in food and water quality, safety, and availability

  – Increased death and injury due to extreme weather events & travel hazards

  – Increased respiratory and cardiovascular diseases, obesity and diabetes

Few, 2007; Tong and Soskolne, 2007; Cook et al., 2008; Fritze et al., 2008; Frumkin and McMichael, 2008; Frumkin et al., 2008; Hess et al., 2008; Sartore et al., 2008; St. Louis and Hess, 2008; Campbell-Lendrum et al., 2009; Costello et al., 2009; Ebi, 2009; Speldewinde et al., 2009; Berry et al., 2010; Ford et al., 2010; Swim et al., 2010; Tschakert and Tutu, 2010
The Land and Health

“I think to the Inuit, going out on the land is just as much a part of our life as breathing. Really, we are so close to the land. We are land people, so if we don’t get out then, for our mental well-being it’s like things... it’s like taking part of your arm away. It’s like you are not fulfilled. There is just really something missing. I think we take great pride in being able to go on the land and just to feel that energy when you get out on the land. For some people it’s just like taking medicine.”

Nunatsiavut Resident
Mental & Emotional Impacts

- Changes in Land
- Changes in Travelling & Land-Based Activities
- Changes in Sea and Ice
- Changes in Wildlife and Vegetation

- Angry
- Depressed
- Disoriented
- Upset
- Scared
- Exhausted
- Isolated
- Unsure
- Sad
- Worried
- Jittery
- Helpless
- Grumpy
- Disappointed

Angry / Jittery / Depressed

Disoriented / Scared

Exhausted

Helpless / Grumpy / Disappointed

Changes in Land

Changes in Travelling & Land-Based Activities

Changes in Sea and Ice

Changes in Wildlife and Vegetation
Implications for Health & Well-Being: *Individuals & Communities*

- Sense of place, place-based identities, and land activities affected
  - More stress at home and at work
  - Increased drug/alcohol usage
  - Increased need for counselling and support
  - Increased suicides and traumatic deaths
  - Amplification of previous trauma
  - Decreased coping abilities and adaptive resilience/capacities

“Yes, it is, it’s very stressful, it can be very stressful. When I don’t get out on the land, I’m like a caged in animal, I really can’t relax properly until I get out. I really miss it because that’s part of my natural healing process, just to get out and let everything else just float away.”
Implications for Health & Well-Being: *Health Workers & System*

- Health system over-stretched
  - Health workers over-burdened and over-stressed
  - Lack funding and systemic support
  - Health workers’ land time also decreased

“[Climate change] puts a big strain on staff because there’s so few resources here in the community, living resources. I am talking about people resources, only a bunch of people that do this kind of work and when you have so much stress on you day after day after day you can very easily burn out. [Going out on the land] is one of the ways that we relieve the stress and stick it out. I work like a dog and do what I had to do and kind of put myself on automatic pilot because I just knew that once it calmed down a bit I could get to my cabin, I could go out on the land and that was where my healing was going to take place.”
Mental and Emotional Adaptation

• Current focus on physical/tangible adaptation strategies

• Need to also consider mental/emotional costs of these adaptations
  
  – Mental stressors and emotional impacts
  
  – Cultural and linguistic effects
  
  – Socio-economic implications
  
  – Gender variances in mental health, emotional responses

“I think [the land] means everything to us. ...for a lot of people going out on the land is a good coping mechanism, and when you can’t get there then other things seem to go wrong in your life. You don’t feel that fulfillment and the joy of just going out and just letting the earth and the land and the sea just take all of your bad energy and make it into a good energy, that’s what I find.”
Concluding Thoughts

“I don’t want to dwell on [climate change] because then I will really go crazy. It’s just that I find it sad that it’s coming to that, but I can see down the road maybe when there will be a day when there will be major changes, major, major changes here. I think that people will, there will be a different people, they will be a different people because they can’t get out on the land like they used to before. But for the local people I think there’s going to be major changes, you are going to see changes everywhere. In our diet, in our health, in our mental health. And people are going to be really sad and frustrated that they can’t do the things like they used to do before like going out on the land in a way that we could.”

Nunatsiavut Resident
Nakkumek/Thank You

• **Rigolet Inuit Community Government**: Charlotte Wolfrey, Sarah Blake, Sherri Wolfrey, Carlene Palliser, & the Council

• **My Word Storytelling Team**: Marilyn Baikie and Inez Shiwak, and formerly Joelene Pardy, Tanya Pottle, Dina Wolfrey, & Ashley Flowers

• **Student Research Assistants**: Joanna MacDonald, Liane Langstaff, Kathryn Marsilio, & Andra Zommers

• **Funders**: First Nations Inuit Health Branch, Health Canada, the Nasivvik Centre for Inuit Health and Changing Environments, & the Nunatsiavut Department of Health and Social Development

• **Supporters**: Community of Rigolet, Labrador Grenfell Health, & Centre for Digital Storytelling
Questions?
References


Resilience in Environmental and Public Health: Is it Time for a Social-Ecological Systems Approach?

Lindsay Galway MPH, Ph.D (Student)
Tim Takaro, MD/MPH
Anne Salomon MA, Ph.D.
Diana Allen M.Sc., Ph.D.
"How do we build resilience in an age of unpredictability and interconnection?"

Mr. Ban Ki-moon, the United Nations Secretary-General at the 62\textsuperscript{nd} World Health Assembly
Is it time for a social-ecological resilience approach in environmental and public health research and practice?

- What is resilience?
- How is resilience used and conceptualized in the environmental and public health literature?
- Why is social-ecological resilience a useful approach for environmental and public health research and practice?
- What are the current barriers and potential bridges to greater integration of social-ecological resilience approaches in environmental and public health?
What is resilience?

- Engineering resilience
- Ecological resilience
- Social resilience
- Social-ecological resilience
- Psychosocial resilience
What is resilience?

- **Engineering resilience:**
  - “Return rate to steady state following a disturbance” (Pimm, 1984)
  - Assumes single state of equilibrium
Ecological resilience:

- First theorized and popularized by Holling in the 1970s
- “Measure of the persistence of systems and their ability to absorb change and disturbance and still maintain the same relationships between population and state variables” (Holling, 1973)
- Multi-stable states
What is resilience?

- **Social resilience:**
  - “Ability of human communities and institutions to withstand external disturbances (i.e. climate change, war)” (Adger, 2000)
What is resilience?

- **Social-ecological resilience:**
  - Focused on resilience in the context of interconnected social-ecological systems
  - Three defining characteristics:
    a) the amount of change a system can undergo while still retaining the same controls on function and structure;
    b) the degree to which the system is capable of self-organization
    c) the ability to build and increase the capacity for learning and adaptation (Resilience Alliance, 2010; Adger et al., 2005).
What is resilience?

- **Psychosocial resilience:**
  - Positive psychological outcome and adaptation despite suffering risk
  - May have developed around the same time as ecological resilience
How is resilience conceptualized in the literature?

- Literature review: Methods
  - Database:
    - ISIs Web of Science
  - Search strategy:
    - Keyword-based search using ‘resilience’ & ‘environment’ as keywords
    - limited to the subject area of ‘public, environmental & occupational health’.
  - Classification & review
    - Only considered publications that include ‘resilience’ in the abstract
    - Articles were classified based on the conceptualization of resilience utilized.
    - All articles using ecological, social or social-ecological resilience were examined in detail.
How is resilience used in the literature?

- Literature review: Results

**Resilience in environmental and public health literature**

- Psychosocial resilience: 55%
- Social resilience: 28%
- Ecological resilience: 13%
- Social-ecological resilience: 4%

**Trends in the use of resilience in environmental and public health literature, 1996-2010**
Why is social-ecological resilience a useful approach?

- Major threats to public health will be caused and shaped by coupled social-ecological systems.
- Policies and practice that build resilience in social-ecological systems can protect and promote human health and well-being.
- Shift policy and practice from system control towards enhancing system capacity to adapt, innovate and when needed, transform.
- Act as link across disciplines (i.e. public health and ecology).
Barriers and bridges to greater integration?

- **Barriers:**
  - Continued reliance on linear/reductionist thinking rather than systems thinking
  - Definitional issues surrounding resilience and its various conceptualizations

- **Bridges:**
  - Possibilities for learning from other disciplines (i.e. ecology and resource management)
  - Links with vulnerability and adaptation (this needs more theoretical work)
  - The development of scholarly networks and funding bodies that consider human health (i.e. Resilience Alliance, Stockholm Resilience Centre)

THANK YOU !!
Using Concrete Actions to Inform Policy on Adaptation in Sub-Saharan Africa

Johnson Nkem
UNDP Kenya

ICARUS II Conference
School of Natural Resources & Environment
University of Michigan, Ann Arbor
May 5-8, 2011
Outline

• Background
• CC DARE Programme
• Methodological approach
• Some policy Outcomes
• Conclusion
Background

• Africa’s vulnerability to climate change and their causes is well established

• Yet, current response actions are disproportionate to the urgency and magnitude of the prevailing risks

• Adaptation and development are inseparable in Africa and must be kept in the same continuum

• There are however, barriers to action or sustaining current actions on adaptation that catalyzes development processes
Adaptation Strategies are not lacking in Africa but implementation actions are scarce and disconnected.

- **2000:** 34 LDCs in Africa. All have NAPAs & priorities.

- **2010:** ~10 Priority Projects per country on average. < 5% of priority projects are under implementation; (most are in 1st priority).

- **2020:** Full implementation of priorities might only be achieved by 2025.
Jointly implemented by UNEP & UNDP, the goals of the programme are specific, realistic and measurable using timely, flexible and target actions.

**Objective:**

Improve the ability of countries in **removing barriers** for integrating adaptation into their **national development agenda** as well as **capitalizing on the emerging opportunities** from the adaptation action in achieving resilience and sustainability.
CC – DARE: Where we Are

Operational in Eleven Countries

Senegal
Ghana
Togo
Benin
Ethiopia
Uganda
Rwanda
Seychelles
Tanzania
Malawi
Mozambique
Strategic Approach

Adaptation under National Circumstances & Sustainable Development Objectives

National Level Planning
Cross-cutting benefits

- Multi Sectoral Services
- Addressing National Development Goals e.g. MDG, PRSP etc
- Gender & Youth Education
- Transition to Green Economy & Resilient Development

Sub – National Level Actions

Mitigation

Adaptation

Intervening Approaches

- Ecosystem-based Adaptation
- Infrastructure – Technological Adaptation
- Community-based Adaptation
Framework for Implementation

- **Entry Point**
  - National Stakeholders Consultation
  - Setting National Action Programmes
  - Developing National Project Proposals
  - Prioritizing & Selection of Projects
  - Funding & Technical Backstopping

- **Scoping**
  - Addressing Targeted Risks – Capitalizing on Emerging Opportunities
  - Adaptation Actions as Demonstrations
  - Action Points & Ground Actions

- **Screening**
  - Feedback
  - Implementation
  - Replication & Up scaling

- **Feedback**
  - Action Learning
    - Lessons learnt
    - Sharing experience & knowledge
    - Capacity building
    - Matching skills & need
    - Network (CALNET)

- **Country Driven**
  - CC DARE Driven

- **Adaptation Approach**
  - E&I
  - CBA
  - Infrastructure
  - Regional etc

**CC DARE: Climate Change and Development – Adapting by REDucing Vulnerability**
# Diversification of Actions & Actors

<table>
<thead>
<tr>
<th>Country</th>
<th>Raising Awareness</th>
<th>Education &amp; Training</th>
<th>Building capacity</th>
<th>National Planning &amp; Strategy</th>
<th>Restoring Ecosystem</th>
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## Diversity of Actors

- **Private Sector**: 39%
- **NGOs**: 18%
- **Research & Academic Institutions**: 3%
- **National Gov't**: 3%
- **Local Gov't**: 5%
- **Meteorological Services**: 32%
IMPACTS ON POLICY PROCESSES

Seychelles

• The Education Ministry has adopted Rainwater Harvesting in all schools.
• A bill is currently being legislated into law for rainwater harvesting be integrated into the national building codes.

Ghana

• CC DARE activity has inspired the setting up of the Climate Change Adaptation Unit within the Environment Protection Agency (EPA).

Senegal

• The Finance Ministry is integrating Climate Change Adaptation into budgetary allocations using tools developed under the CC DARE activities.
Providing Rural Development Stimulus with Adaptation Actions

Mozambique

- Locally developed bricks & reforestation techniques for floods & erosion benefiting 15,000 people

Togo

- Year-round water supply in the dry northern region following the rehabilitation of the small dams.
- The cost estimate for budgeting nationwide application have been determined
- One dam is serving 13 villages with ~20,000 people & expanding their livelihood opportunities into market gardening, fisheries etc

Tanzania

- Equitable & sustainable woodlot management serving women as collaterals to access credit banking on trees.

Others
Trees in woodlots serve rural women in Tanzania as collaterals to access bank credits in addressing poverty and climate change adaptation.

Capitalizing on carbon credit in the system with cash credits, will empower rural women and offer a win-win opportunity for REDD+ and Adaptation.
Measures for coping with the risks

- 1 Week
- 1 Month
- ≥ 6 Months
- ≥ 12 Months

Measures for resilience to the risks

- BUCKET
- DRUMS
- TANKS
- SMALL DAMS

Household

- Single Use
- Drinking
- Limited Sanitation
- Etc

- Family use
- Drinking
- Sanitation
- Laundry
- Etc

Communities

- Family
- Communities
- Etc

- Ecosystem
- Livestocks
- Biodiversity
- Fisheries & Wildlife
- Recharging Subsoil aquifer
- Etc

Vulnerable to variability in rainfall and groundwater re-charge

Transition to market-base/green economy

Emerging Opportunities

- Recreation
- Livestock
- Construction
- Agriculture
- Fisheries

CC DARE: Climate Change and Development – Adapting by REducing Vulnerability
Conclusion

• Concrete actions provide evidence-based information for institutional and regional policy processes in supporting countries

• It facilitates experience sharing among practitioners

• It provides incentives for action & builds confidence through Learning-by-doing approach
MESSAGE OF APPRECIATION

“This UNEP/UNDP CC DARE is a worthwhile project which I fully endorsed. It is the way forward. If we all do our part in harvesting rainwater and are serious about it, we could all contribute to alleviating the serious shortages we face in the dry season”

President James Alix Michel
President of the Republic of Seychelles
Thank you
Assessing Health Risks and Vulnerabilities From Extreme Weather in a Changing Climate

Arie Ponce Manangan, MA | Health Scientist - Geographer

Climate Change Program
Division of Environmental Hazards and Health Effects (EHHE)
National Centers for Environmental Health (NCEH)
Centers for Disease Control and Prevention (CDC)

Work Phone: 770-488-0191    Fax: 770-488-3450
Email: amanangan1@cdc.gov
4770 Buford Highway, Bldg 106 - MS F-58
Chamblee, GA 30341-3717
Where are Existing Health Risks?

• Health risks vary geographically.

• Distinct regional patterns of extreme precipitation, heat waves, drought, and severe snowstorms are a contributing factor to certain health risks (climate-sensitive health outcomes).

• This analysis focuses on the direct health impacts of extreme weather events (injury and death from excessive heat events, winter weather, flooding, and wildfires)
• Climate change will not occur with geographic uniformity, and will include changes in the frequency and intensity of extreme heat events (heat waves), extreme precipitation (heavy downpours), drought, and winter storms \(^1,2\).

Source:
\(^1\) US Climate Change Research Program (US Global Change Research Program) – Synthesis and Assessment Project 3.3
\(^2\) Christensen, et al., 2007. Regional Climate Projections. Fourth Assessment Report, IPCC.
\(^3\) Wehner, M. et al., (2005)

\(^3\) Projected extreme precipitation.
Greater likelihood of more frequent, longer lasting, and more intense heat waves, but a decreased likelihood of extreme cold events (Kharin et al., 2007).

The heat-index (i.e. maximum temperature combined with relative humidity) is projected to increase even more than temperatures, especially in the Southeast US (Delworth et al., 2000).

Rare extreme heat events that normally occurs once every 20 years are projected to occur once every 3 years by 2050 (Wehner 2005).
Precipitation Projections

• The intensity of heavy rainfall is projected to increase throughout much of N. America. (Kharin et al., 2007).

• Extreme downpours that occurred once every 20 years will occur once every 12 to 15 years by 2090 (Wehner, 2005).

• The number of dry days per year are projected to increase since precipitation will be concentrated into less frequent but more intense events.
Health Risk and Vulnerability in a Changing Climate

• Determine a geographic baseline for climate sensitive health outcomes (injury and death from excessive heat events, winter weather, flooding, and wildfires).

• Qualitatively assesses how the geographic distribution of climate sensitive health may shift in a changing climate, according to future climate models and scenarios.

Source:
US Climate Change Research Program (US Global Change Research Program) – Synthesis and Assessment Project 3.3
• Assessing health vulnerability is complex
• There are numerous factors contributing to the incidence of injury and death from hazardous weather and disease
• This study focuses on the ‘Risk’ of hazardous health events

Vulnerability =

\[
\begin{bmatrix}
\text{Hazard Risk} \\
\text{Resilience}
\end{bmatrix} \times \begin{bmatrix}
\text{Socio - Economics} \\
\text{Demo - graphics}
\end{bmatrix} \times ?
\]
We used historical data of injuries and deaths (1996-2009) to define the risk to natural hazards, as provided by SHELDUS\(^1\), a county-level database of hazards.

Aggregated county data to metropolitan areas using Core Based Statistical Areas (CBSA).

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Source:

Two factors in defining hazardous risk per Metropolitan Area:

1) Frequency of exposure to a hazardous events (e.g. heat waves per year)

2) Sensitivity per hazardous event (e.g. average deaths/injuries per heat wave)
Frequency (Annual) $\times$ Sensitivity = Hazard Risk

Total Hazard Count

$\frac{13 \text{ years of data}}{\text{Total Hazard Count}} \times \frac{\text{Injuries} + \text{Deaths}}{\text{Total Hazard Count}} = \text{Hazard Risk}$
Frequency of Exposure to Hazardous Heat in US Metropolitan and Micropolitan Areas

Annual Frequency of Loss Causing Heat Events* per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Event Frequency

Num. Events per Year

- 3.52 - 3.64 (>99.9th Percentile)
- 1.37 - 3.51 (99th-99.9th Percentile)
- 0.43 - 1.36 (97th-99th Percentile)
- <0.43 (0-97th Percentile)
- No Data (Areas not within a CBSA)

* A distinct Loss Causing Event was defined as those heat events occurring within the same CBSA and week of the year.
Source: SHEL DUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)

Cartography by: AP Manangan, (Climate Change Program; National Center for Environmental Health)
Sensitivity to Hazardous Heat in US Metropolitan and Micropolitan Areas

Injuries and Deaths Per Loss Causing Heat Event* Within Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Event Sensitivity
Injury and Death per Hazardous Event

- 34.7 - 38.9 (>99.9th Percentile)
- 10.4 - 34.6 (99th-99.9th Percentile)
- 5.6 - 10.3 (97th-99th Percentile)
- <5 persons (0-97th Percentile)
- No Data (Areas not within a CBSA)

*A distinct Loss Causing Event was defined as those heat events occurring within the same CBSA and week of the year.
Source: SHELDUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)

Cartography by AP Manangan, (Climate Change Program/National Center for Environmental Health) MAR 31, 2011
Potential for Hazardous Heat in US Metropolitan and Micropolitan Areas

Annual Hazard Potential for Heat Related Injury and Death per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Heat Risk*
Injuries and Deaths per Year

- 51.5 - 141.7 persons (>99.9th Percentile)
- 8.2 - 51.4 persons (99th-99.9th Percentile)
- 2.5 - 8.1 persons (97th-99th Percentile)
- <2.5 persons (0-97th Percentile)
- No Data (Areas not within a CBSA)

*Hazard Potential is calculated by multiplying annual hazardous event frequency by average severity (injuries and deaths combined), per Metropolitan/Micropolitan area.
Source: SHELDS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)
Potential for Hazardous Heat in US Metropolitan and Micropolitan Areas

Annual Hazard Potential for Heat Related Death per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Heat Risk

Deaths per Year

- 19.6 - 20.5 (>99.9th Percentile)
- 2.8 - 19.5 (99th-99.9th Percentile)
- 0.5 - 2.7 (97th-99th Percentile)
- <0.5 persons (0-97th Percentile)
- No Data (Areas not within a CBSA)

*Hazard Potential is calculated by multiplying annual hazardous event frequency by average severity (injuries and deaths combined), per Metropolitan/Micropolitan area.
Source: SHELDSUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)
• Three Risk Maps:

• Heat Related Injury and Death

• Flooding Related Injury and Death

• Wildfire Related Injury and Death
Potential for Hazardous Flooding in US Metropolitan and Micropolitan Areas

Annual Hazard Potential for Flooding Related Injury and Death per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Flood Risk*

<table>
<thead>
<tr>
<th>Category</th>
<th>Hazard Potential</th>
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<tr>
<td>90.0 - 227.9 (&gt;99th Percentile)</td>
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<td>3.1 - 89.9 (99th - 99.9th Percentile)</td>
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<td>1.1 - 3.0 (97th - 99th Percentile)</td>
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<td>&lt; 0.93 persons (0 - 97th Percentile)</td>
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*Hazard Potential is calculated by multiplying annual hazardous event frequency by average severity (injuries and deaths combined), per Metropolitan/Micropolitan area. Source: SHELDSUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)
Potential for Hazardous Wildfires in US Metropolitan and Micropolitan Areas

Annual Hazard Potential for Injury and Death From Wildfires per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Wildfire Risk*

Injuries and Deaths per Year

- **19.6 - 34.7 ( >99.9th Percentile)**
- **1.0 - 19.5 (99th-99.9th Percentile)**
- **0.4 - 0.9 (97th-99th Percentile)**
- **<0.4 persons (0-97th Percentile)**
- **No Data (Areas not within a CBSA)**

*Hazard Potential is calculated by multiplying annual hazardous event frequency by average severity (injuries and deaths combined), per Metropolitan/Micropolitan area. Source: SHELDUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)
Health Risk and Extreme Temperature Projections

1 in 20yr Extreme Temp. Event Return Values (Wehner, 2005)

Avg. Annual Num. of Heat wave Days (Kunkel, 2010)

Heat Sensitivity
Flooding Risk and Extreme Precipitation Projections

Projected US Extreme Precipitation (2046-2065)

From (Kharin et al., 2007)

ΔP_{20}, \%, 2046–2065, SRES A1B, avg=+7.7%

Flooding Sensitivity

(Kharin et al., 2007)
Wildfire Risk and Drought Projections

(Milly et al., 2005)
Conclusions – Current Risk

• Distinct geographic variations in the risk to hazardous weather.

• Hazardous Heat Risk is greatest in St. Louis, Chicago, and in the northeast US, NYC-Baltimore, MD

• Hazardous Flooding Risk is greatest in central TX, (Metro-Dallas and surrounding areas)

• Hazardous Wildfire Risk is greatest in Southern CA, and eastern FL (Jacksonville and Palm Bay)
Conclusions – Risk in a Changing Climate

• Highly sensitive cities to extreme weather may be the most at risk to climate change.

• Heat related injury and death will likely increase in heat-sensitive areas such as Phoenix, AZ and St. Louis, MO in changing climate.

• Western AZ may have an increased risk for hazardous flooding due to climate change.

• Drier future climate conditions in the Western US may increase the risk for hazardous wildfires in Southern CA.
Limitations and Further Research

• The need to incorporate more factors in assessing the vulnerability of place due to Climate changing climate.

• We do not account for adaptive capacity, or resilience

• Develop quantitative projections of health outcomes.

• We assume a constant geographic distribution in the measure of ‘sensitivity’ when assessing health risk in a changing climate

• Utilize an ensemble of climate models
Thank You.

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National Centers for Environmental Health (NCEH)
Centers for Disease Control and Prevention (CDC)

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Frequency of Hazardous Flooding in US Metropolitan and Micropolitan Areas

Annual Frequency of Loss Causing Events From Flooding per Core Based Statistical Areas (CBSA), From 1996-2009

Hazardous Event Frequency*

<table>
<thead>
<tr>
<th>Num. Events per Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4 - 7.4</td>
<td></td>
</tr>
<tr>
<td>4.2 - 5.3</td>
<td></td>
</tr>
<tr>
<td>3.4 - 4.1</td>
<td></td>
</tr>
<tr>
<td>&lt;3.4</td>
<td></td>
</tr>
<tr>
<td>No Data (Areas not within a CBSA)</td>
<td></td>
</tr>
</tbody>
</table>

*A distinct Loss Causing Event was defined as those flooding events occurring within the same CBSA and week of the year.

Source: SHELDUS Version 8.0. (Hazards & Vulnerability Research Institute, Department of Geography, University of South Carolina)
Heat Related Deaths – To calculate severity, used only those metropolitan areas that experience two or more hazardous event, to avoid the small number problem.

Source:
2. Delworth, T.L. and M.E. Mann, 2000: Observed and simulated multidecadal variability in the Northern Hemisphere. Climate Dynamics, 16(9), 661-676.