



Climate Change  
Science Institute

AT OAK RIDGE NATIONAL LABORATORY

# Assessing and Managing Climate Change Risk

Benjamin L. Preston

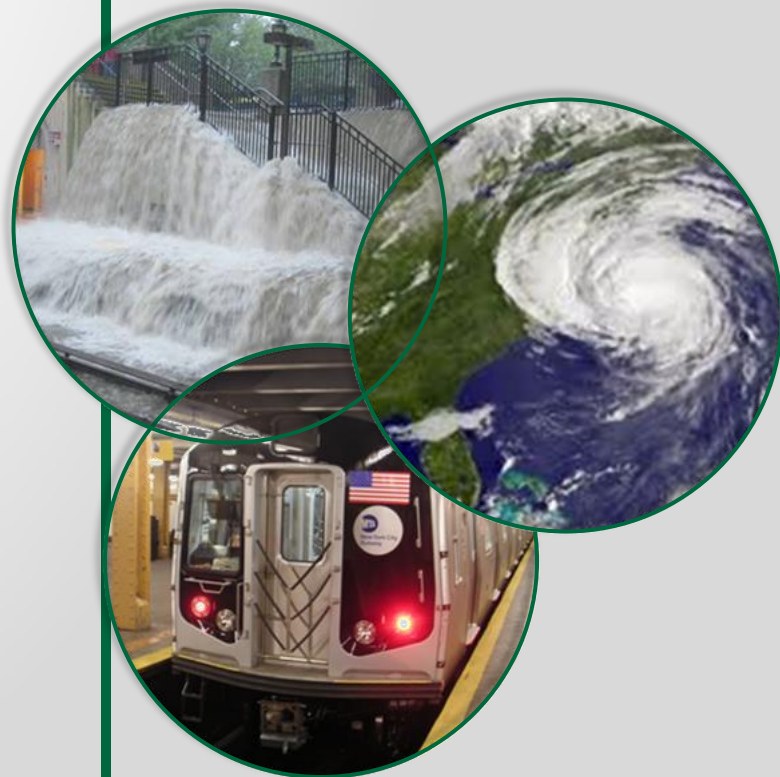
*Deputy Director*

Climate Change Science Institute

NAP Expo 2014

8-9 August 2014

UN Campus, Bonn, Germany



U.S. DEPARTMENT OF

**ENERGY**



OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY

# Outline

- Integrating adaptation and climate risk management
- Components of climate risk
- Appraisal of adaptation options
- Toward practical guidance on climate risk management

# Progress on Adaptation

*“Adaptation measures that also consider climate change are being implemented, on a limited basis, in both developed and developing countries.”*

Adger et al. (2007)

*“Adaptation to climate change is transitioning from a phase of awareness to the construction of actual strategies and plans in societies.”*

Mimura et al. (2014)

- **Developing Nations**

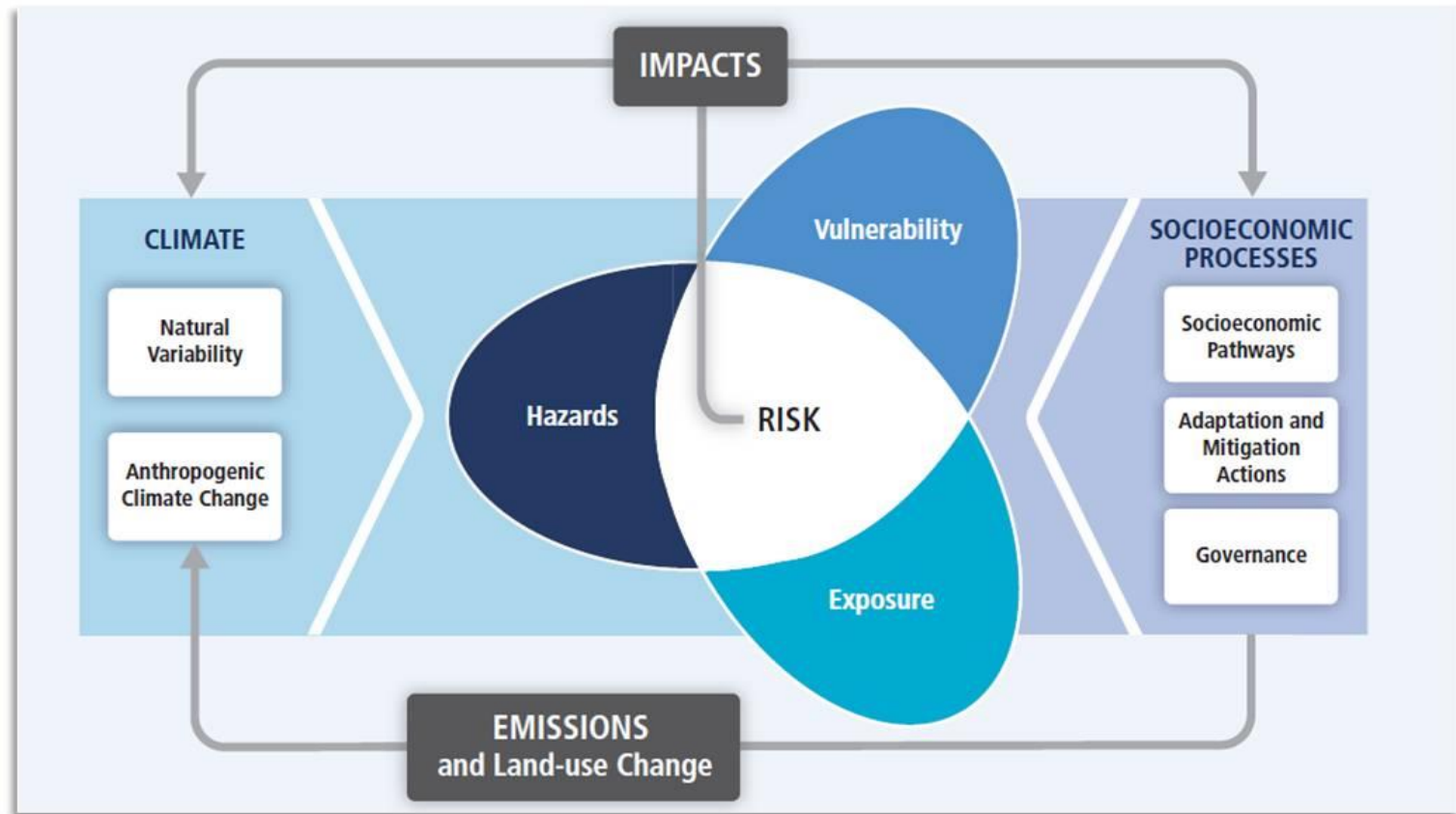
- Planning Mechanisms
  - National Adaptation Programmes of Action (NAPAs)
  - National Adaptation Plans (NAPs)
- Funding Mechanisms
  - Least Developed Countries Climate Adaptation Fund
  - Special Climate Change Fund
  - Adaptation Fund

- **Developed Nations**

- Extensive national planning
  - Austria, Belgium, Denmark, Finland, France, Germany, Hungary, the Netherlands, Norway, Portugal, Spain, United Kingdom
- More extensive sub-national, local planning

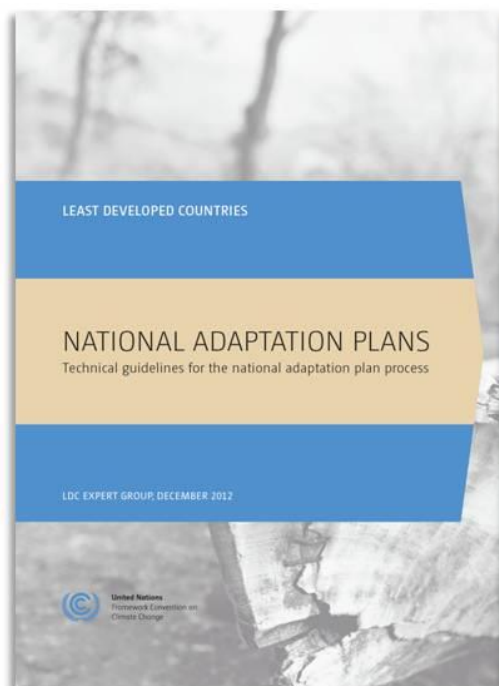
# Climate Adaptation is Increasingly being Framed in the Context of Risk Management

- **Hazard** – A situation that poses a threat
- **Exposure** – Presence of people & assets in places that could be adversely affected
- **Vulnerability** – The propensity to be adversely affected



IPCC (2014) WG II, Summary for policymakers; IPCC (2012) SREX, Summary for policymakers

# Entry Points for the Assessment of Climate Risk



## ELEMENT A

LAY THE GROUNDWORK AND ADDRESS GAPS

### STEP A.1.

Initiating and launching the NAP process

### STEP A.2.

Stocktaking: identifying available information on climate change impacts, vulnerability and adaptation and assessing gaps and needs of the enabling environment for the NAP process

### STEP A.3.

Addressing capacity gaps and weaknesses in undertaking the NAP process

### STEP A.4.

Comprehensively and iteratively assessing development needs and climate vulnerabilities

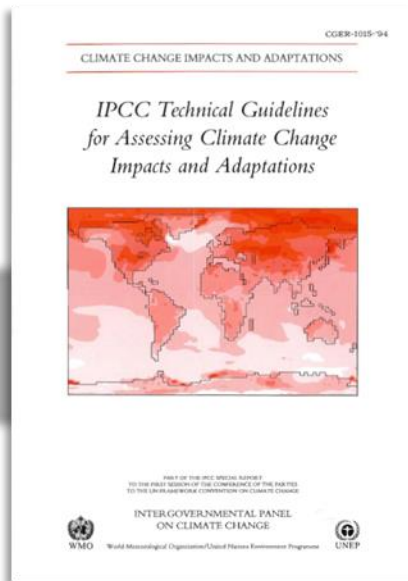
## STEP A.2.

Stocktaking: identifying available information on climate change impacts, vulnerability and adaptation and assessing gaps and needs of the enabling environment for the NAP process

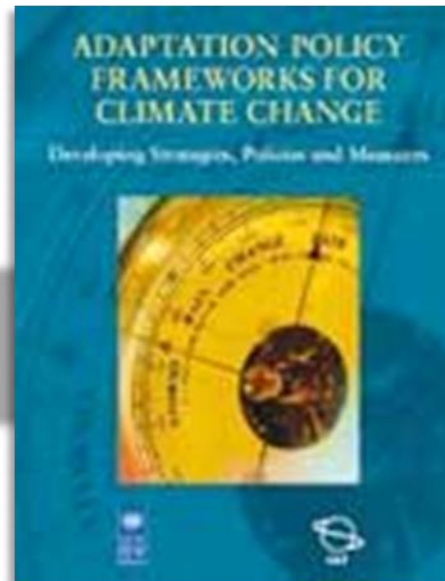
- The assessment of climate risk is a critical process in the adaptation planning process
- Extensive guidance is available to assist governments in risk assessment and management

# The Evolution of Climate Risk Management

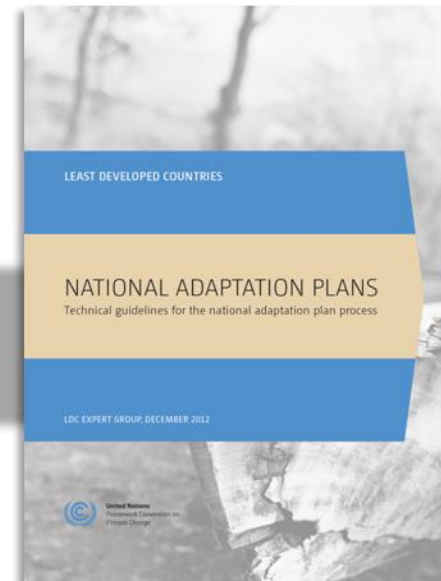
- Climate risk management has evolved to include elements beyond the assessment of impacts, vulnerability and risk
  - Appraisal of adaptation options (i.e., costs & benefits)
  - Evaluation of adaptation effectiveness
  - Integration of climate risk into management practice and development



**Impact-Based**



**Adaptation-Based**



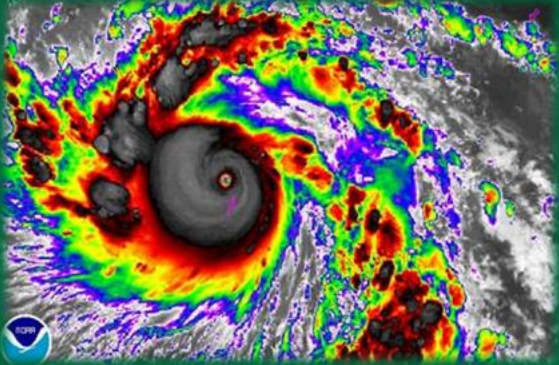
**Development-Based**

Jones and Preston (2011) Adaptation and Risk Management

# Outline

- Integrating adaptation and climate risk management
- **Components of climate risk**
- Appraisal of adaptation options
- Toward practical guidance on climate risk management

# Risk = Hazard, Exposure & Vulnerability



**Hazard**



**Exposure**



**Vulnerability**

Image Credits: <http://washingtonpost.com>; <http://darkroom-cdn.s3.amazonaws.com/>; <http://msutoday.msu.edu/>



**Climate Change  
Science Institute**  
AT OAK RIDGE NATIONAL LABORATORY

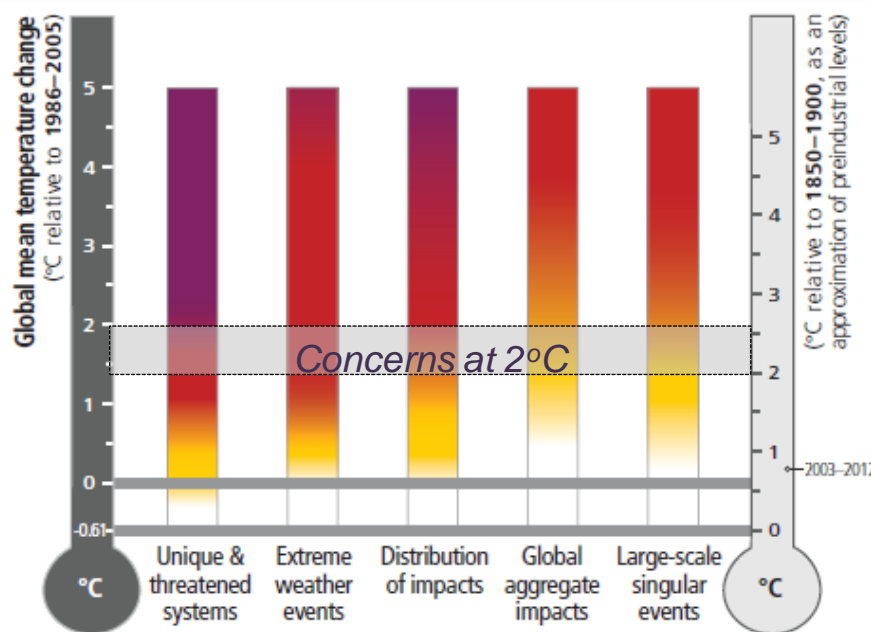


**OAK RIDGE NATIONAL LABORATORY**  
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

# Understanding Hazards – 2°C Target

*“recognizing the scientific view that the increase in global temperature should be below 2 degrees Celsius”*

Copenhagen Accord (2009)



- The 2°C global target is an entry point for the assessment of climate risk
- But, the 2°C global target needs to be translated into national contexts
- Adaptation to more than 2°C (e.g., 4°C?) may be necessary, requiring greater effort

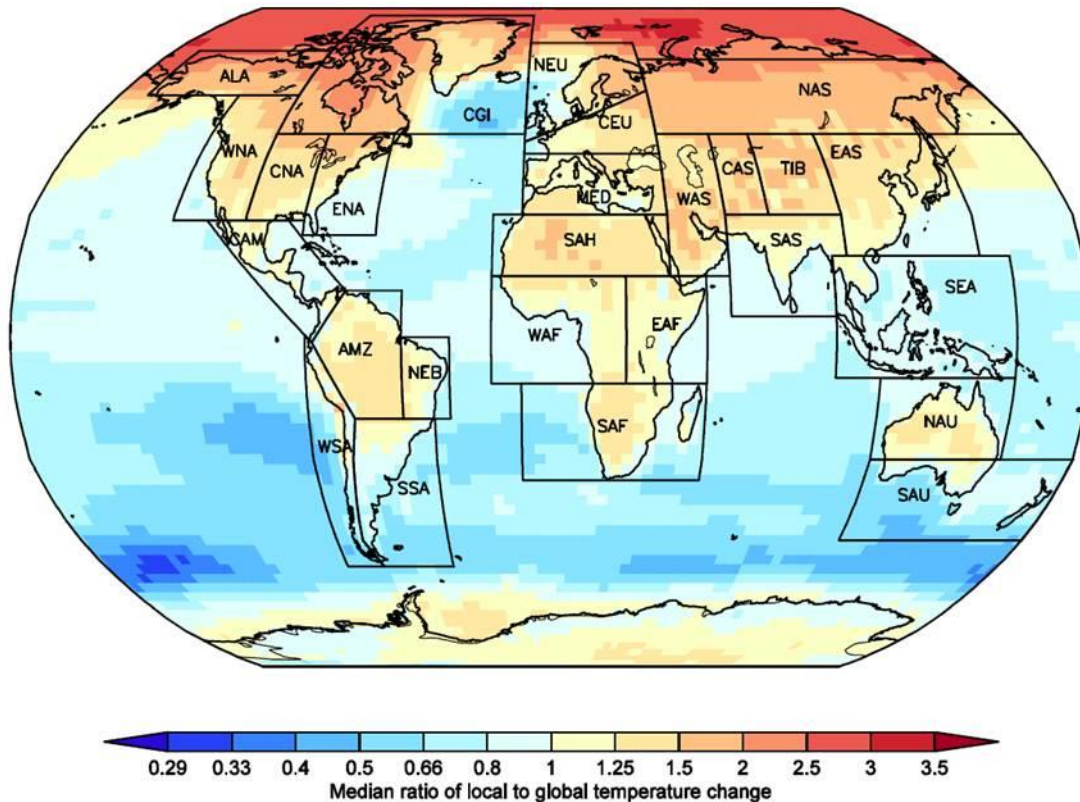
*“Estimated global GHG emissions levels in 2020 based on the Cancún Pledges are not consistent with . . . mitigation trajectories that . . . limit temperature change to 2 °C . . .”*

IPCC WG III (2014)

IPCC WGII (2014) Summary for policymakers

# Understanding Hazard – *Regional Warming Trends*

- Most land areas are projected to warm more rapidly than the global mean and therefore exceed 2°C more rapidly



- Nations face differential climate hazards
  - Coastal regions
  - Small islands
  - Arid regions
  - Arctic regions
- Hazard assessment requires placed-based information on historical and future climate conditions
  - Extreme weather events are a key driver of risk

IPCC WGII (2014) *Regional Context*

# Understanding Hazards – *Adaptation Planning Tools*

- Sources of Knowledge

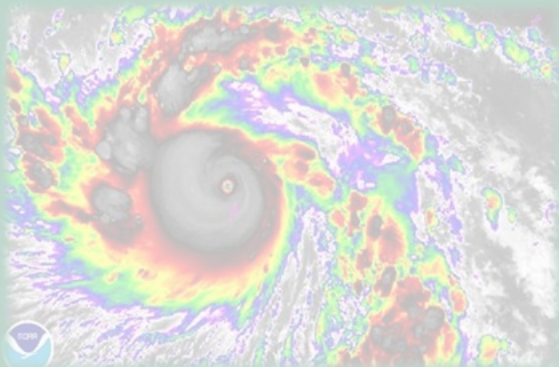
- Experience, including traditional & local knowledge
- Technical documents (e.g., IPCC assessment reports)
- Weather/climate monitoring & services
- Climate modeling (global & regional)

- Tools

- Climate Scenarios (deterministic & probabilistic; arbitrary & model-based)
- Climate Model Intercomparison Project (U.S. Department of Energy)
- Climate Change Knowledge Portal (World Bank)
- WorldClim – Global Climate Data
- Climate Predictability Tool (IRI)
- FetchClimate (Microsoft)
- Pacific Climate Futures (CSIRO/BOM)
- Caribbean Climate Online Risk and Adaptation Tool

*Enhanced understanding of the future dynamics of extreme weather events is a high priority for adaptation*

# Risk = Hazard, Exposure & Vulnerability



**Hazard**



**Exposure**



**Vulnerability**

Image Credits: <http://washingtonpost.com>; <http://darkroom-cdn.s3.amazonaws.com/>; <http://msutoday.msu.edu/>

## Understanding Exposure – *Key Elements*

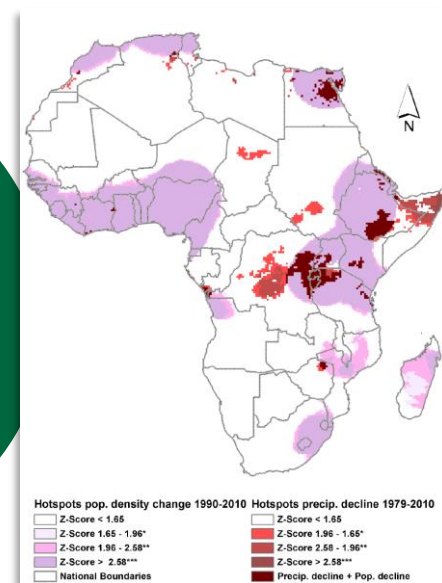
- Ecosystem services
- Infrastructure
- Demography
- Land use



- Storms
- Drought risk
- Flood zones
- Extreme heat events

- Temporal Dimension

- Near-term: Day/night dynamics
- Long-term: Migration, development



- Spatial Dimension

- Local: Flood risk, urban heat island
- Regional: Heat wave, drought

Lopez-Carr et al. (2014) A spatial analysis of population dynamics and climate change in Africa

# Understanding Exposure – *Adaptation Planning Tools*

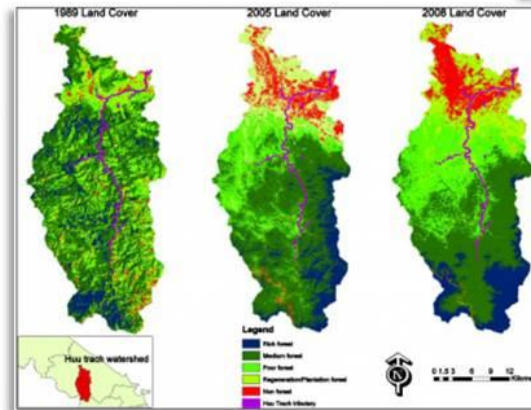
- Sources of Knowledge

- Oral/written histories
- Census surveys
- Geospatial data
- Disaster planning informatio

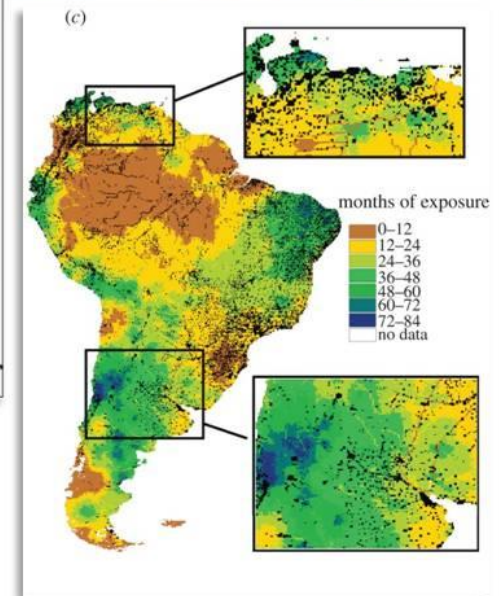


- Tools

- Development scenarios
- Global positioning systems
- Remote sensing
- GIS
- Participatory mapping
- Community surveys

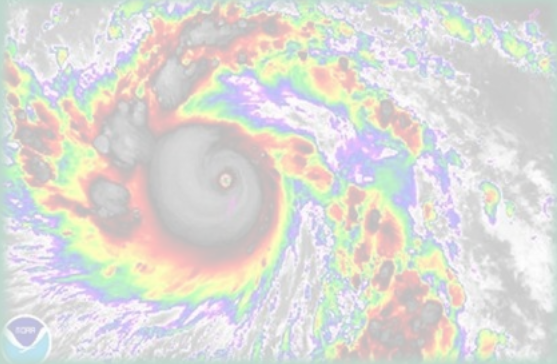


Tran (2009) Application of GIS and remote sensing for Environment and Flood Risk Management in Central Vietnam



Vörösmarty et al. (2013) Extreme rainfall, vulnerability and risk: a continental-scale assessment for South America

# Risk = Hazard, Exposure & Vulnerability



**Hazard**



**Exposure**



**Vulnerability**

Image Credits: <http://washingtonpost.com>; <http://darkroom-cdn.s3.amazonaws.com/>; <http://msutoday.msu.edu/>



**Climate Change  
Science Institute**  
AT OAK RIDGE NATIONAL LABORATORY



**OAK RIDGE NATIONAL LABORATORY**

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

# Understanding Vulnerability – *Determinants*

- A broad range of factors can contribute to vulnerability
  - Location
  - Sensitivity/fragility
    - Physiological (e.g., thermal tolerance)
    - Physical (e.g., infrastructure)
  - Entitlements to capital
    - Financial
    - Human
    - Social
    - Physical
    - Natural
  - Governance arrangements
    - Effectiveness, cooperation
  - Social equity
    - Class, ethnicity, gender, religion

Felipe Dana ~ Associated Press

























































ccafrs.cgiar.org
















- Collectively, these factors influence the likelihood of harm in the event of exposure to a hazard

# Understanding Vulnerability - *Constraints & Limits*

- Conditions that constrain or limit the capacity to plan and implement adaptation responses enhance vulnerability

Regions (Chapter)	Constraints	Limits
Africa (22)	     	 
Europe (23)	  	  
Asia (24)	   	
Australasia (25)	    	 
North America (26)	     	
Central & South America (27)	     	
Polar Regions (28)	   	
Small Islands (29)	      	
Open Oceans (30)	 	

Icon legend														
														
Awareness	Capacity	Tools	Policy	Learning	Innovation	Economic	Human capacity	Social/Cultural	Governance	Financial	Information	Physical	Biological	Biophysical

IPCC (2014) *Adaptation Opportunities, Constraints, and Limits*

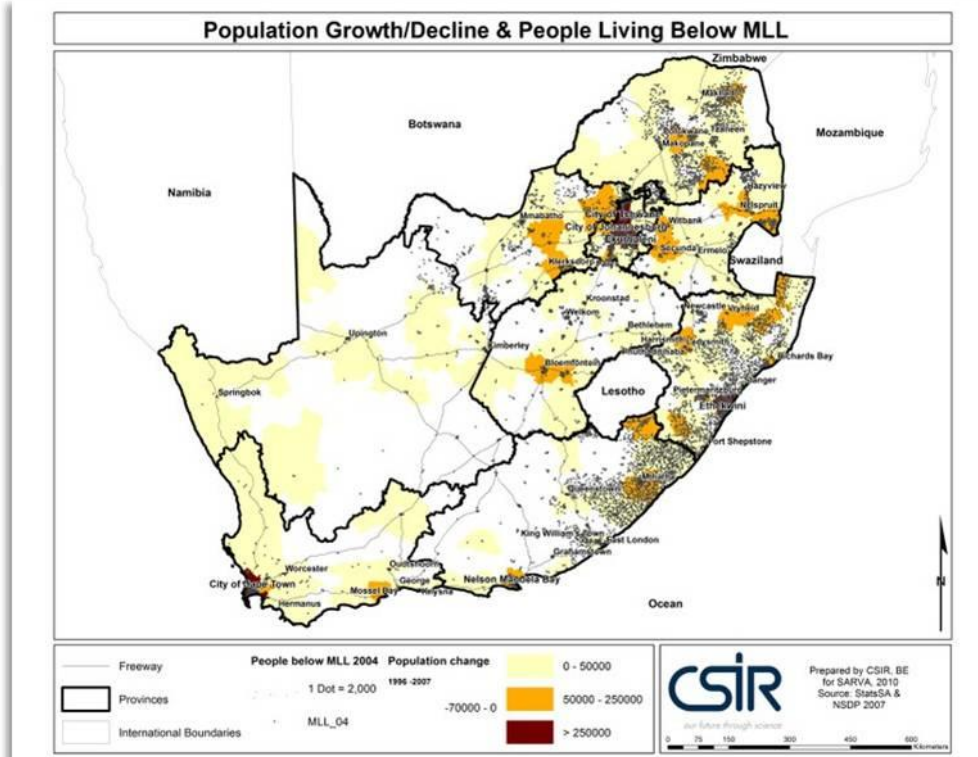
# Understanding Vulnerability - *Adaptation Planning Tools*

- Sources of Knowledge

- Local/traditional knowledge
- Design principles/standards
- Models
- Governance indicators
- Financial/economic analysis
- Ethnographic studies

- Tools

- Vulnerability indices
- Literature review
- Socioeconomic scenarios (e.g., Shared Socioeconomic Pathways)
- Impact modeling (e.g., agricultural, hydrological systems)
- Stakeholder interviews, focus groups, surveys
- Social network analysis

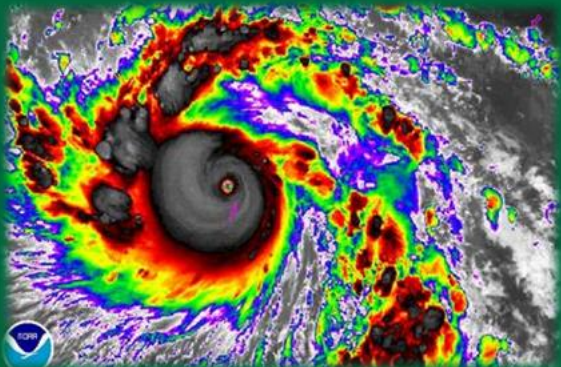
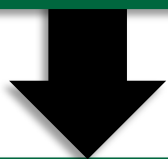


# Outline

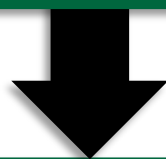
- Integrating adaptation and climate risk management
- Components of climate risk
- **Appraisal of adaptation options**
- Toward practical guidance on climate risk management

Risk = Hazard, Exposure & Vulnerability

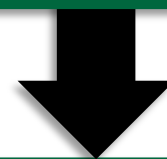
## Managing Risk through Adaptation



**Hazard**



**Exposure**



**Vulnerability**

Image Credits: <http://washingtonpost.com>; <http://darkroom-cdn.s3.amazonaws.com/>; <http://msutoday.msu.edu/>



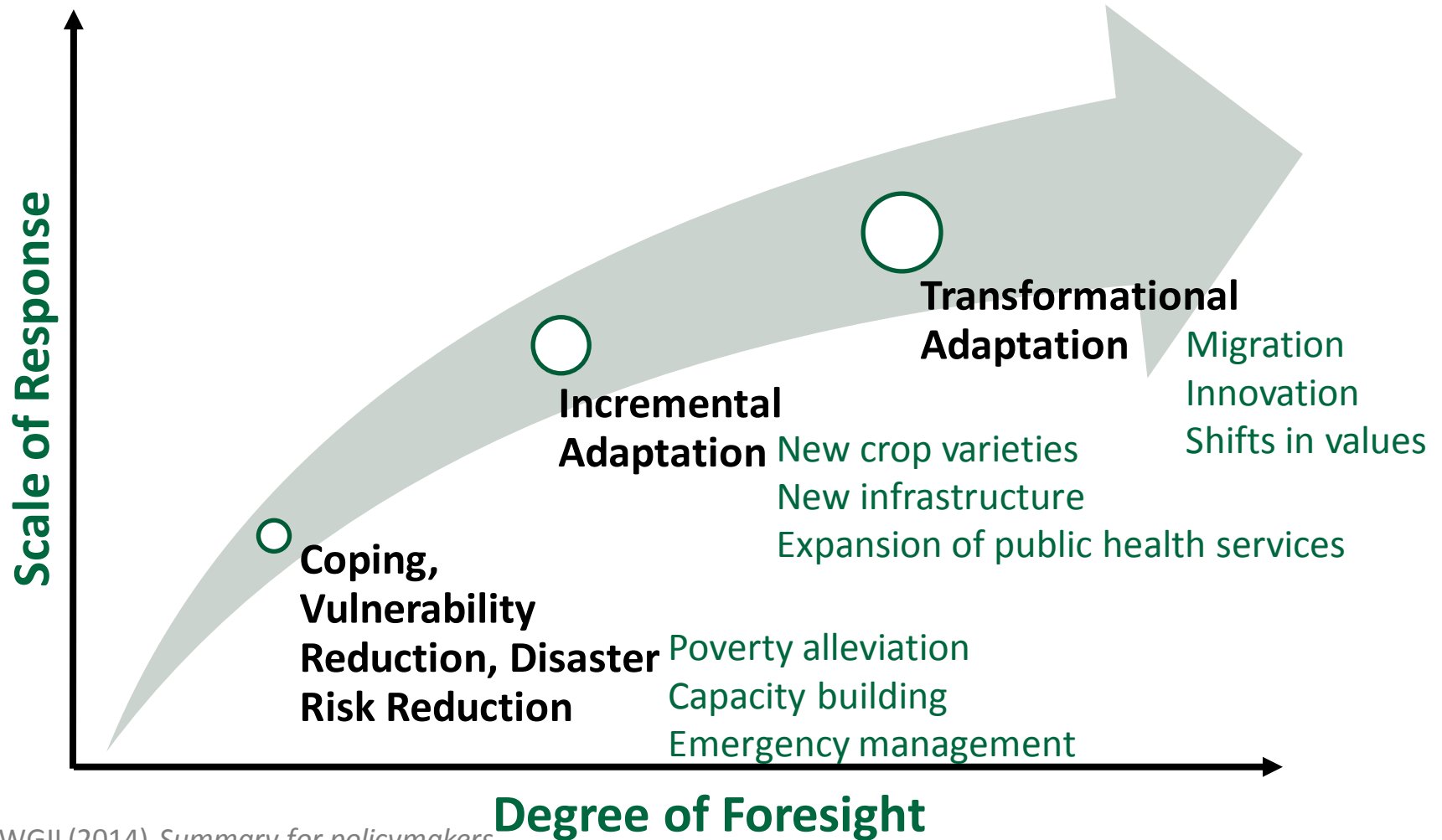
**Climate Change  
Science Institute**  
AT OAK RIDGE NATIONAL LABORATORY



**OAK RIDGE NATIONAL LABORATORY**  
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

# Managing Risk – *Approaches to Adaptation*

- A wealth of knowledge and information exists on potential adaptation responses



IPCC WGII (2014) *Summary for policymakers*

# Managing Risk – *Prioritisation of Adaptation Responses*

- The appraisal and evaluation of responses that are appropriate for distinct national circumstances is a current challenge
  - **Cost/Benefit Analysis**
    - Established methodology for option appraisal
    - Sensitive to assumptions (e.g., discounting of future benefits)
  - **Life Cycle Analysis**
    - Consideration for direct and indirect effects of options
    - Cradle-to-grave appraisal
    - Long-term fate of some options may be highly uncertain
  - **Multi-Criteria Analysis**
    - Appraisal of market and non-market costs and benefits
    - Appraisal of trade-offs among objectives
    - Opportunities for stakeholder participation

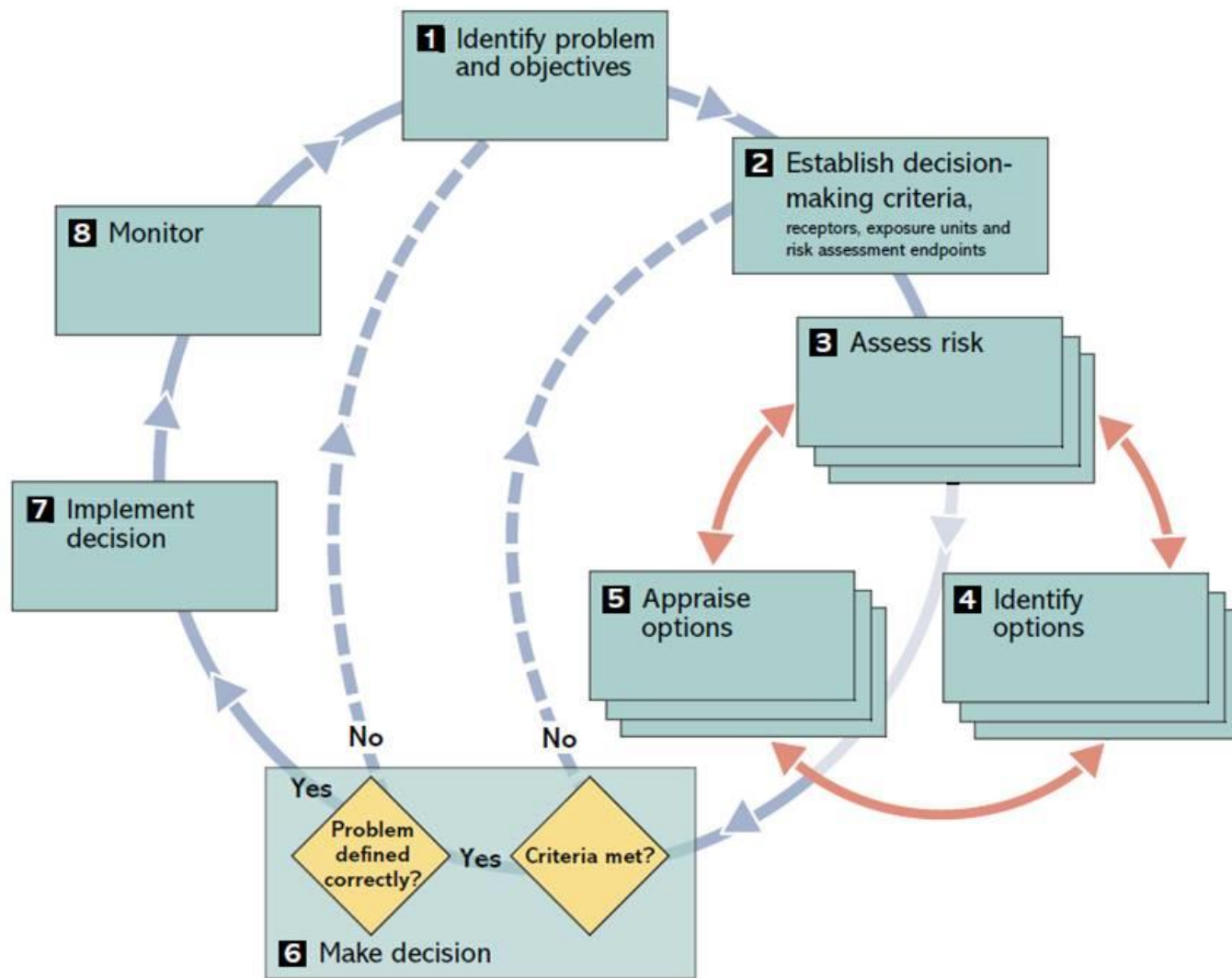
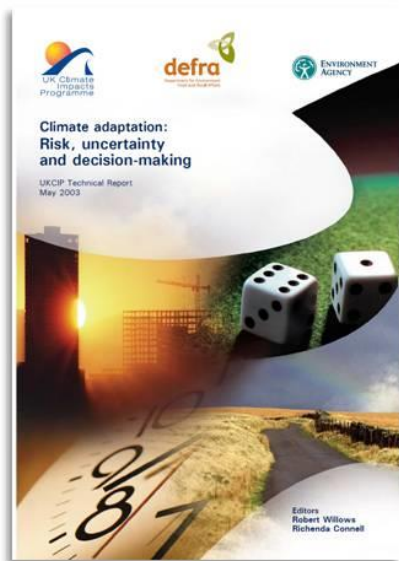
*“...a systematic approach to monitoring and evaluation for climate change adaptation has yet to emerge, and the capacity to undertake such monitoring and evaluation and incorporate it into adaptation policy is lacking.”*

Preston et al. (2011)

# Outline

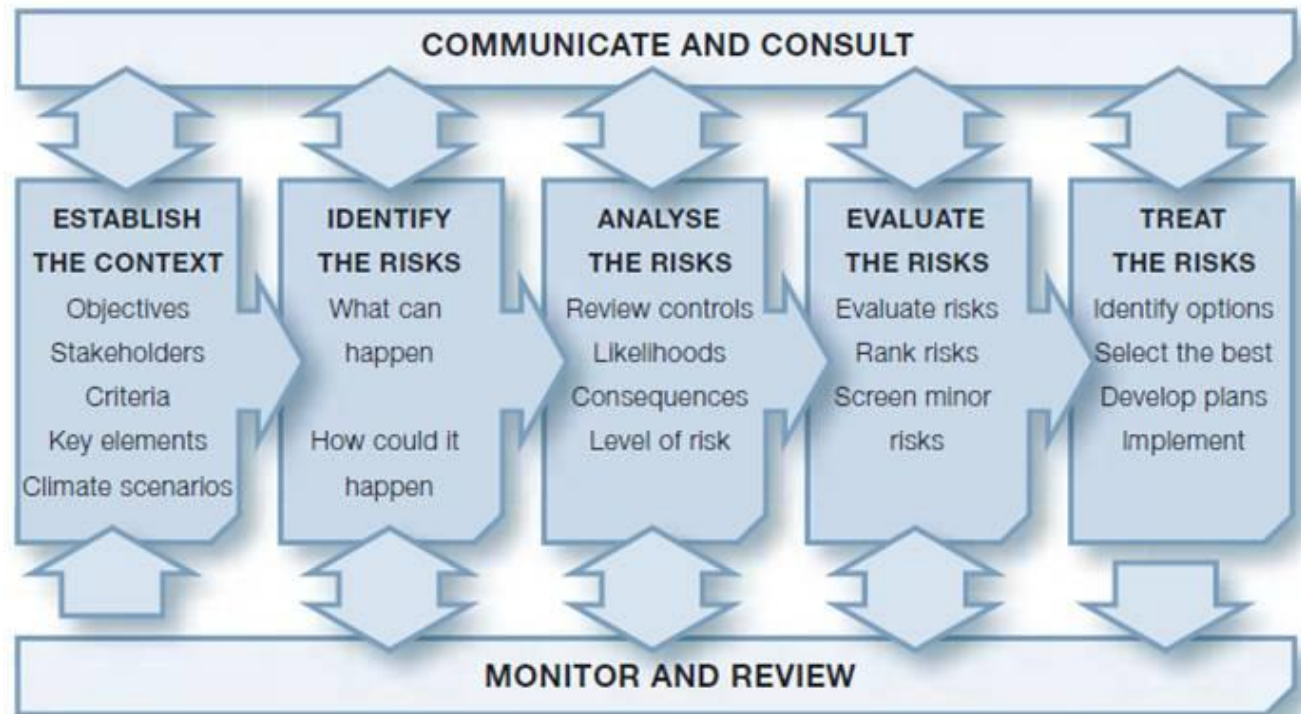
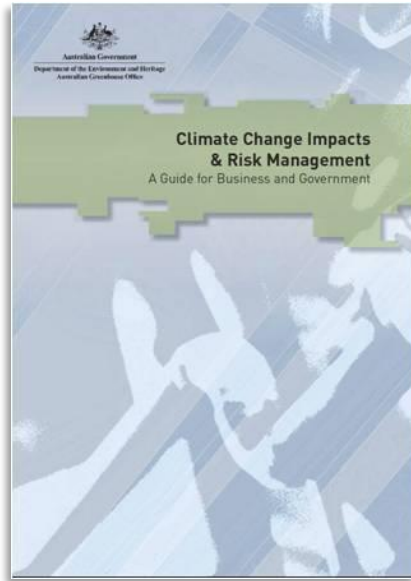
- Integrating adaptation and climate risk management
- Components of climate risk
- Appraisal of adaptation options
- Toward practical guidance on climate risk management

# Risk Management – *Practical Guidance (example 1)*



UKCIP (2003) Climate adaptation: risk, uncertainty and decision-making

# Risk Management – *Practical Guidance (example 2)*



Australian Greenhouse Office (2010) Climate Change Impacts & Risk Management

# Managing Risk – *Building Capacity*

- The issue of capacity for climate risk management should be recognised in two different contexts:
  - 1) Additional capacity is needed to enable rigorous assessment of vulnerability and risk at the national level
    - Access to and evaluation of climate information and data
    - Application of different methodological approaches
    - Iterative risk assessment as new knowledge emerges
  - 2) Consideration of capacity should be an integral component of the assessment of climate vulnerability and risk within the NAP process
    - Capacity was largely neglected in the National Adaptation Programmes of Action

# Summary

- Climate risk management is evolving within a broader framework of climate resilient development
- Existing guidance instruments and methods should be synthesized to inform risk assessment and management in the context of the NAP process & the UNFCCC
- Researchers and practitioners face a number of persistent challenges:
  - Incorporating useful insights regarding climate uncertainty and climate extremes into adaptation planning
  - Developing best practices for the appraisal of adaptation options
  - Evaluating the success of adaptation planning and implementation
  - Identifying potential limits to adaptation
- To be effective, national adaptation planning processes must be supported with adequate capacity



# Climate Change Science Institute

AT OAK RIDGE NATIONAL LABORATORY

## Thank You

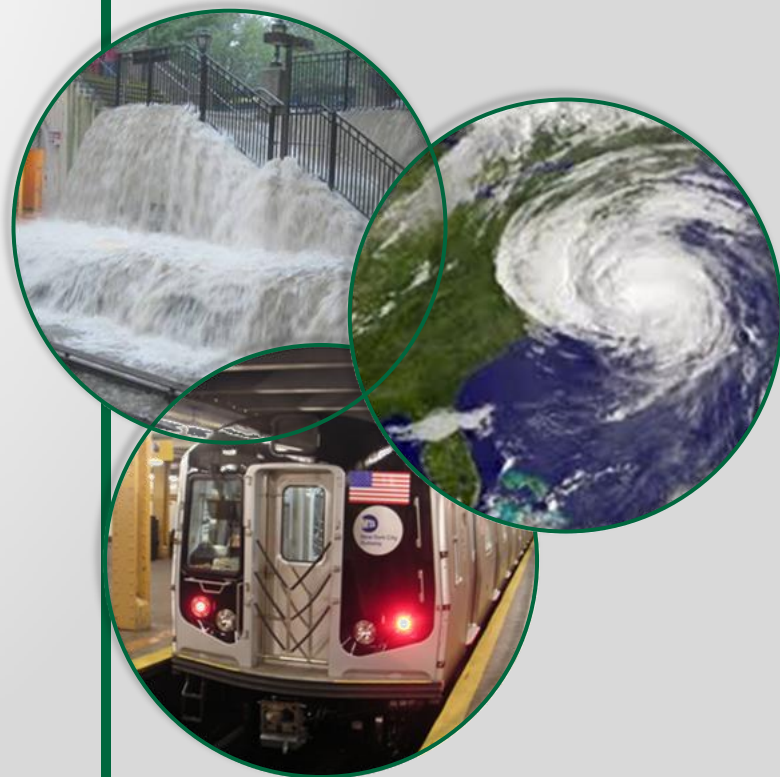
Benjamin L. Preston

Deputy Director

Climate Change Science Institute

Oak Ridge National Laboratory

[prestonbl@ornl.gov](mailto:prestonbl@ornl.gov)



U.S. DEPARTMENT OF  
**ENERGY**



**OAK RIDGE NATIONAL LABORATORY**

MANAGED BY UT-BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY