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"DoD Decision Making and Climate Change"

October 20, 2016

SERDP DOD • EPA • DOE | ESTCP

Welcome and Introductions

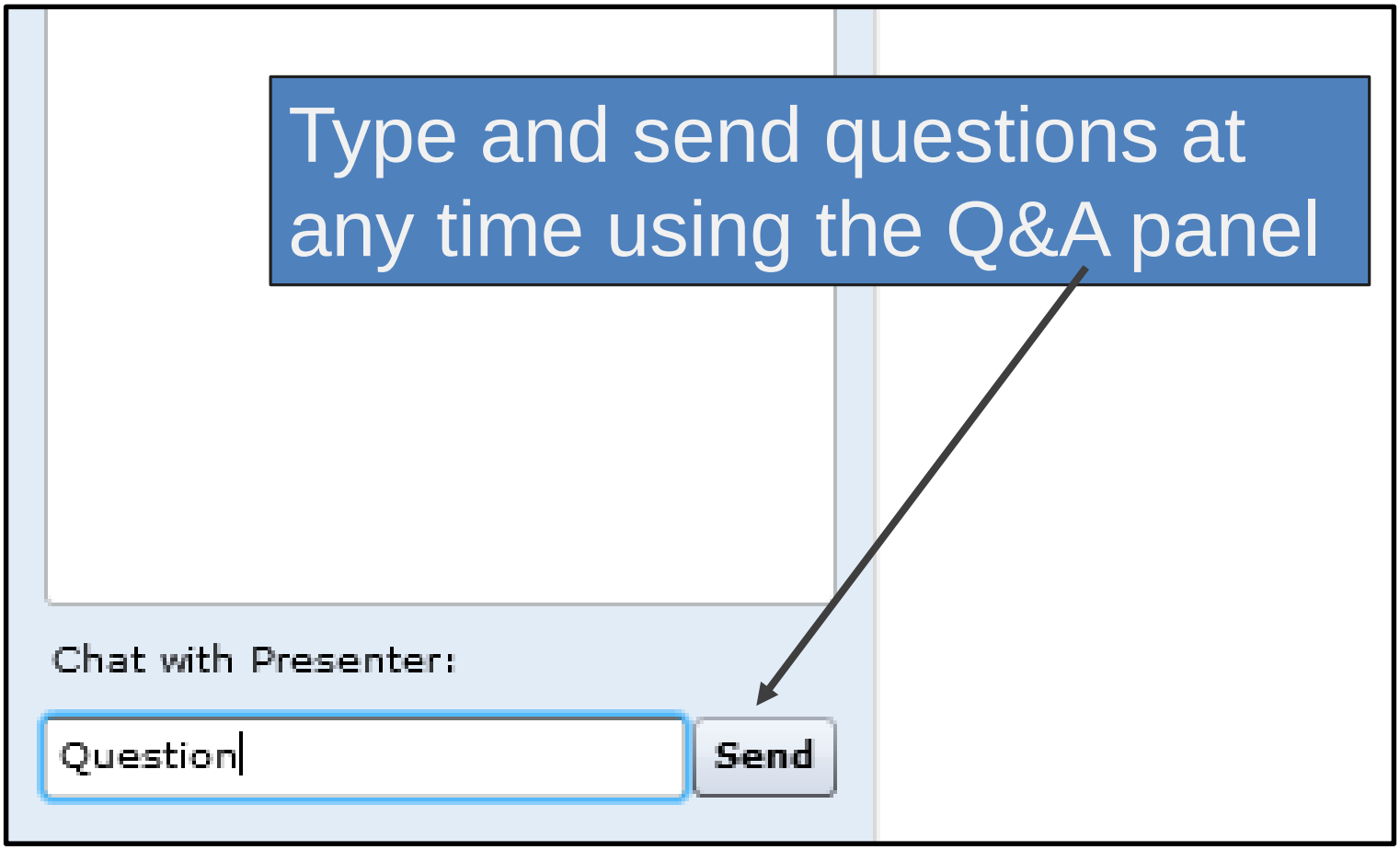
Jennifer Nyman, Ph.D., P.E.
Webinar Facilitator

SERDP DOD • EPA • DOE | ESTCP

Webinar Agenda

- **Webinar Logistics**
  Dr. Jennifer Nyman, Geosyntec Consultants (5 minutes)
- **Overview of SERDP and ESTCP**
  Dr. Herbert Nelson, SERDP and ESTCP (5 minutes)
- **Vulnerability Assessments and Resilience Planning at Federal Sites**
  Dr. Richard Moss, Pacific Northwest National Laboratory (25 minutes + Q&A)
- **Decision-Scaling: A Decision Framework for DoD Climate Risk Assessment and Adaptation Planning**
  Dr. Casey Brown, University of Massachusetts at Amherst (25 minutes + Q&A)
- **Final Q&A session**

How to Ask Questions



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SERDP and ESTCP Overview

Herb Nelson, Ph.D.
Acting Director, SERDP and ESTCP

SERDP

Strategic Environmental Research and Development Program

- Established by Congress in FY 1991
  - DoD, DOE and EPA partnership
- SERDP is a requirements driven program which identifies high-priority environmental science and technology investment opportunities that address DoD requirements
  - Advanced technology development to address near term needs
  - Fundamental research to impact real world environmental management

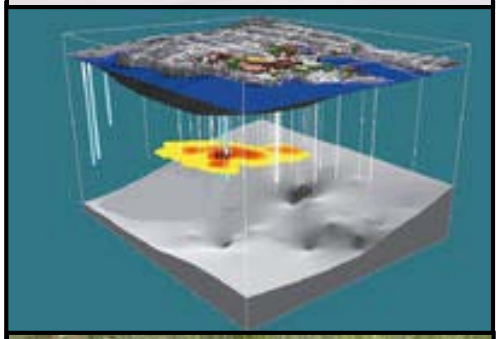
ESTCP

Environmental Security Technology Certification Program

- Demonstrate innovative cost-effective environmental and energy technologies
  - Capitalize on past investments
  - Transition technology out of the lab
- Promote implementation
  - Facilitate regulatory acceptance

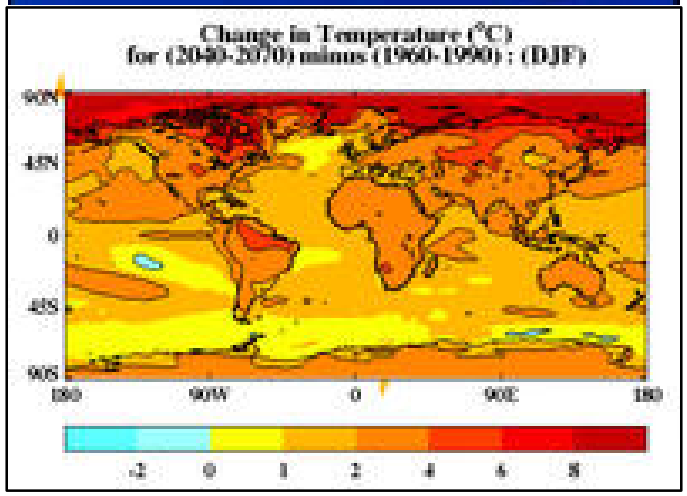
Program Areas

1. Energy and water
2. Environmental restoration
3. Munitions response
4. Resource conservation and climate change
5. Weapons systems and platforms



Resource Conservation and Climate Change

- Natural resources
  - Ecological forestry
  - Arid lands ecology and management
  - Cold regions ecology and management
  - Pacific island ecology and management
  - Coastal and estuarine ecology and management
  - Living marine resources ecology and management
  - Species ecology and management
  - Watershed processes and management
- Climate change
  - Vulnerability and impact assessment
  - Adaptation science
  - Land use and carbon management
- Air quality
  - Fugitive dust
  - Fire emissions



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Vulnerability Assessments and Resilience Planning at Federal Sites

Richard H. Moss, Ph.D.
Pacific Northwest National Laboratory

SERDP DOD • EPA • DOE | ESTCP

Presentation Outline

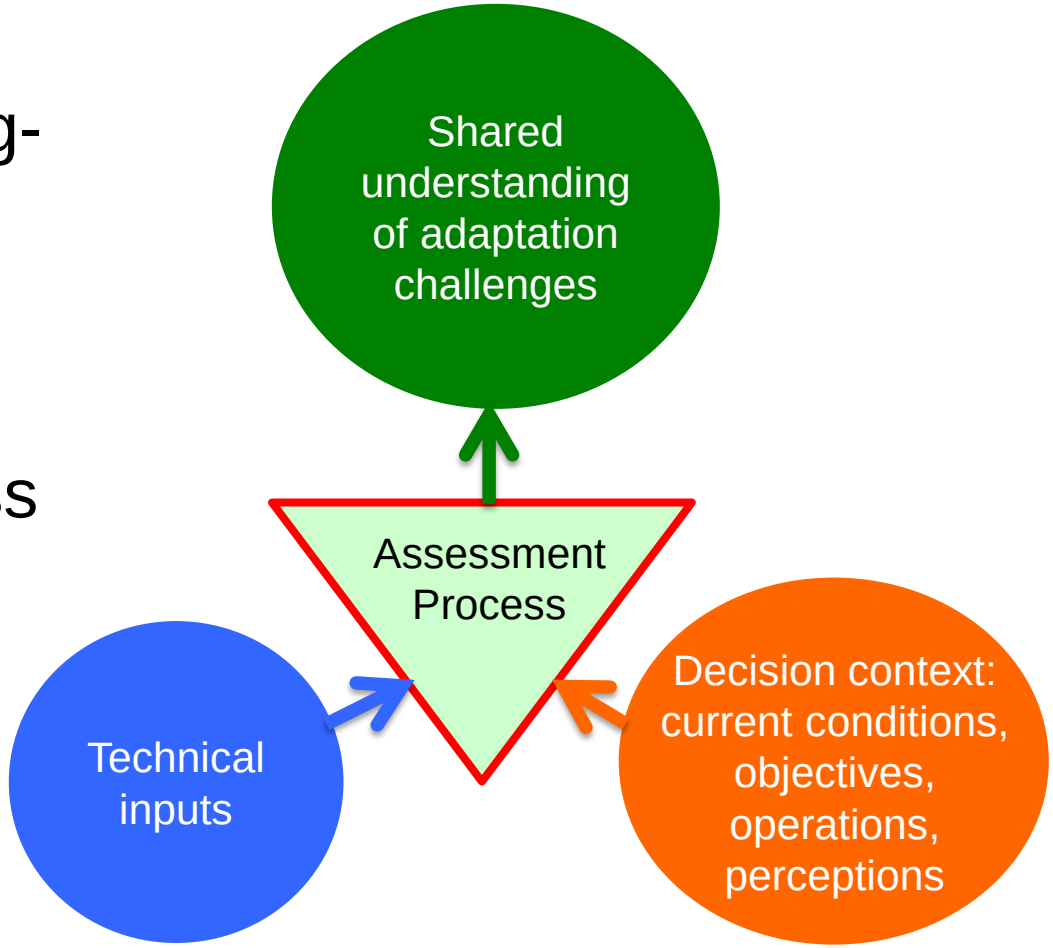
- Problem statement/objectives/method
- Key concepts
- Tiered process
  - Screening (DOE project)
  - Participatory installation vulnerability assessments (SERDP project focus)
  - Adaptation design
- Conclusions and implications

Problem Statement

- Problem
  - DoD must assess potential impacts of climate change on its missions and adapt as required
- Project objective
  - Develop, pilot and evaluate frameworks and methods to assess vulnerability at a range of military installations
- Method
  - Case studies at Mid-Atlantic installations

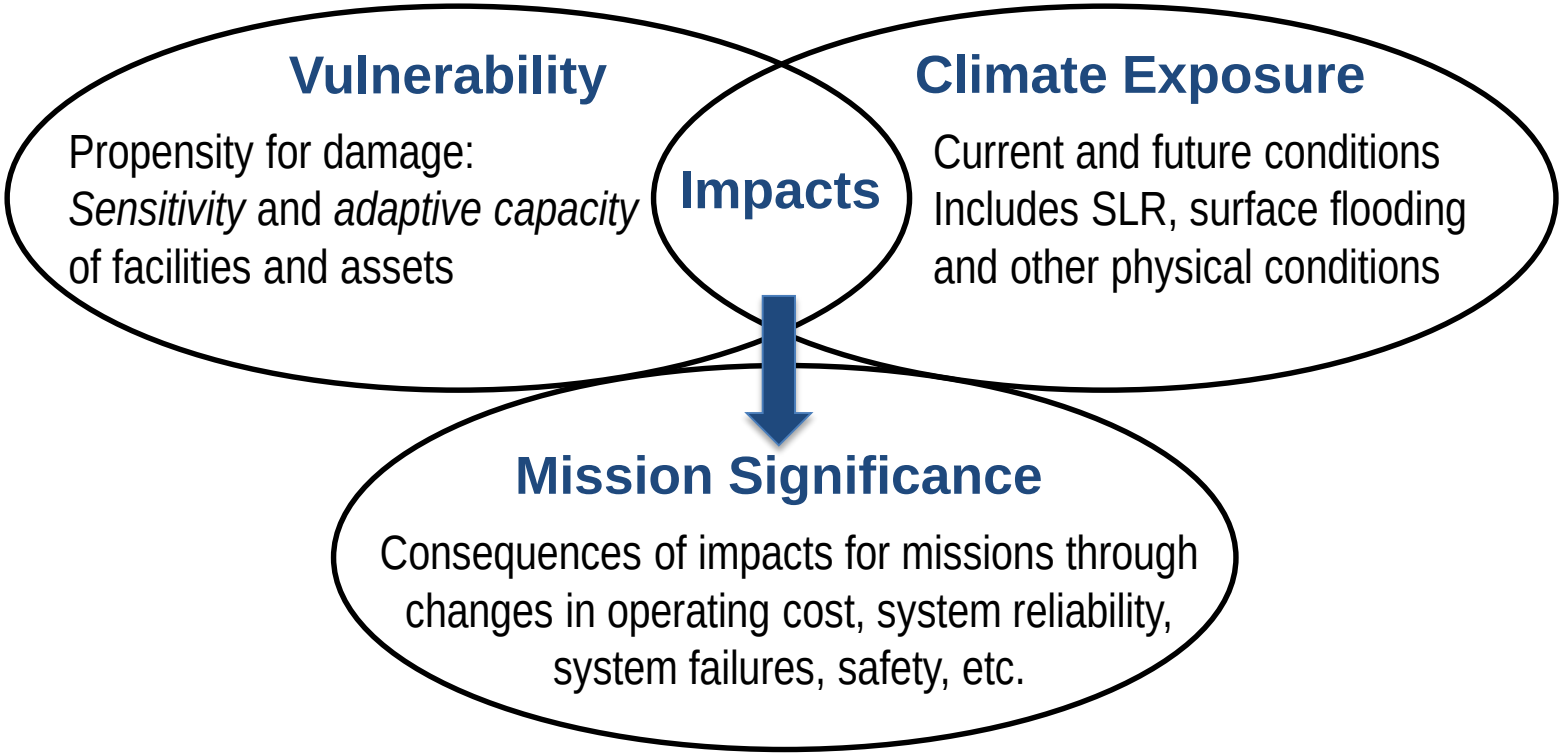
Why a Participatory Process?

- Climate risk management is a long-term challenge
- No one has “the answer”
- A participatory process can synthesize site-specific expertise and technical inputs needed to build resilience



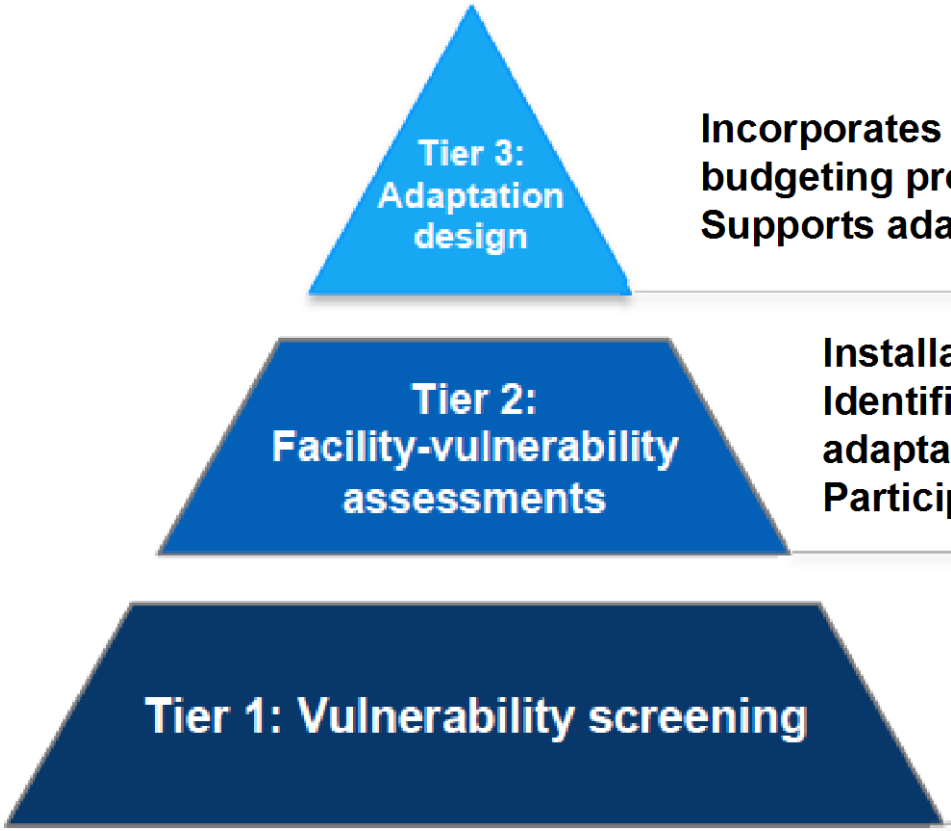
Adapted from John Robinson, UBC

Key Concepts



- Vulnerability assessments depend on knowledge of HQ and site personnel
- Not all impacts have mission significance
- The goal of “enhancing resilience” is a positive incentive

Tiered Process to Meet Needs of Multiple Governance Levels



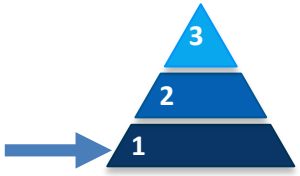
Tier 3:
- Incorporates climate into design, planning, and budgeting processes
- Supports adaptation of hard and soft infrastructure

Tier 2:
- Installation and major command
- Identifies potential consequences and adaptation options
- Participatory process based on technical inputs

Tier 1:
- HQ and major command
- Sets priorities across multiple sites
- Surveys, indicators, stress tests

Tier 1: Screening

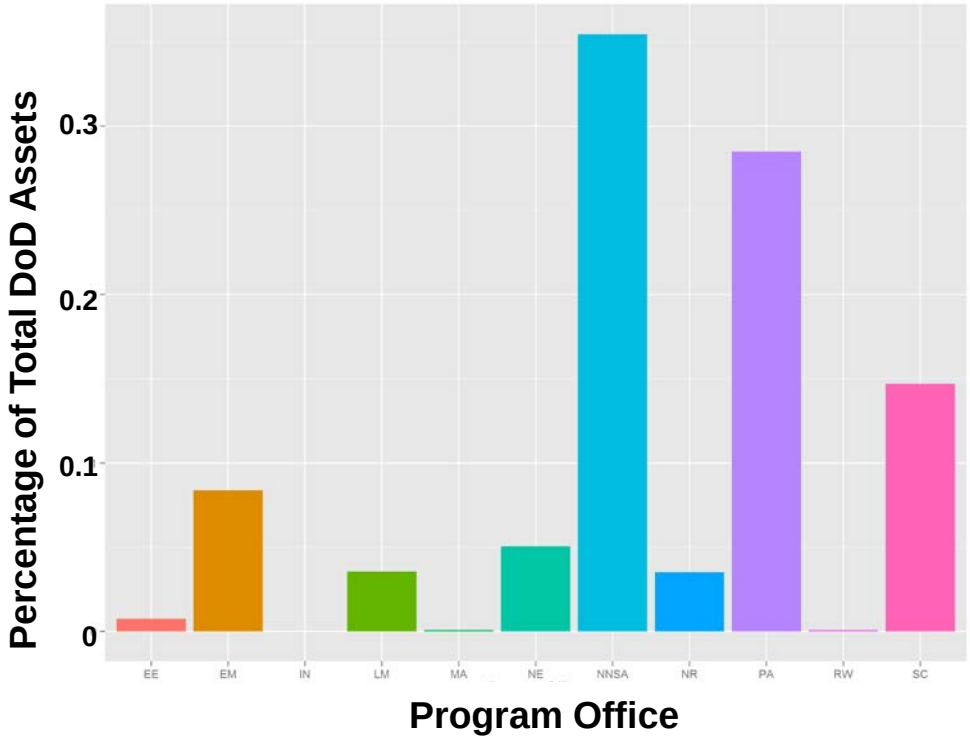
- Who: HQ, Major Command
  - Provide input to setting priorities for vulnerability assessments at installations



- Approach
  - Methods for gathering/comparing site information
    - Indicators using institutional datasets
    - Surveys
    - Stress tests

Example: Indicator Constructed with DOE Enterprise Level Database – FIMS

Asset Distribution by Program Office



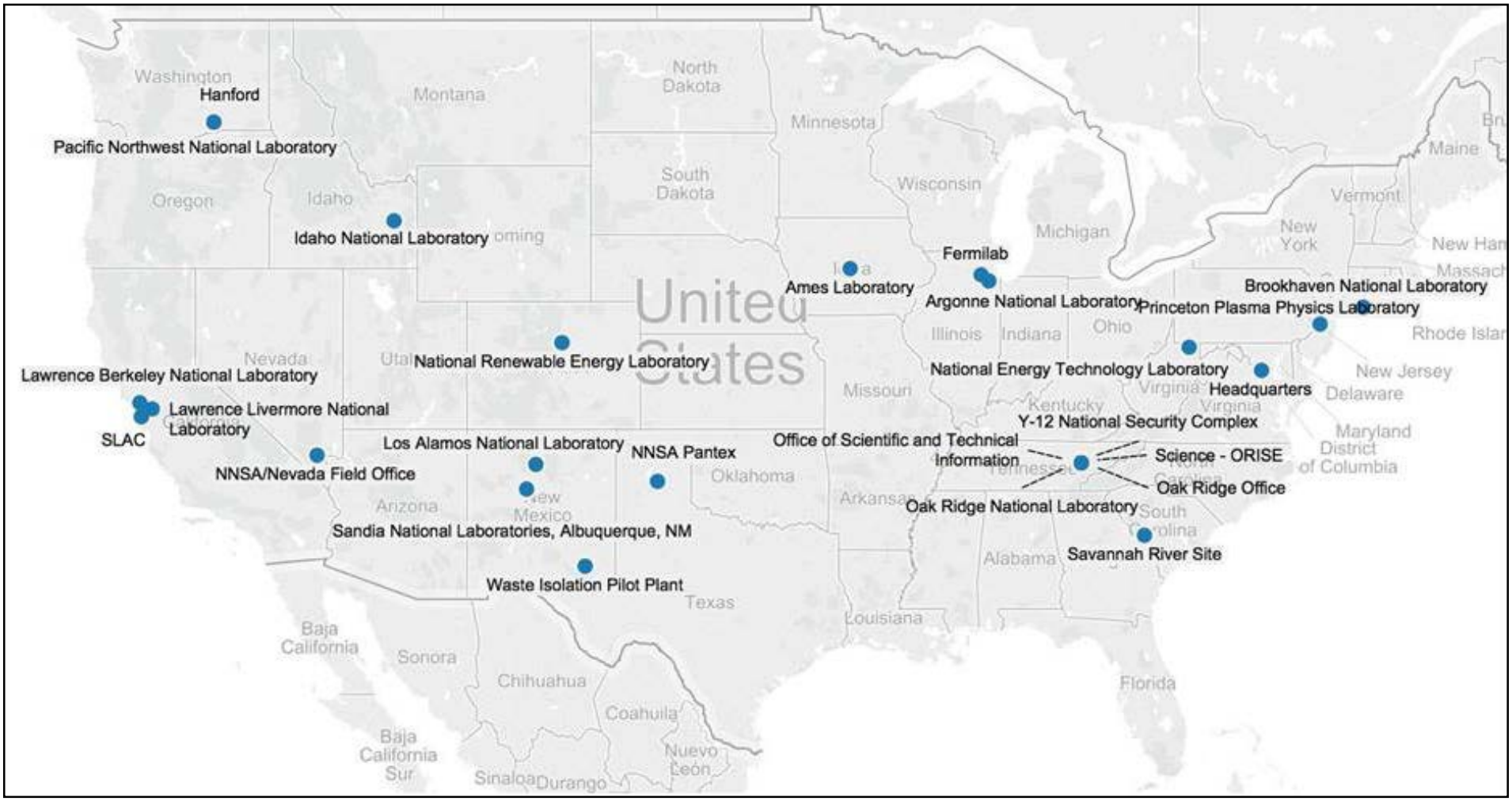
- Data on approximately 18,000 assets in 11 Program Offices, 26 asset types, and 198 variables
- Relevant variables include mission importance, replacement value, various measures of condition, planned investments, etc.
  - Lacks information on spatial characteristics of vulnerability
  - Data quality issues

Ranked List of Sites as Input to Program Office Discussion

site.name	program	Score	binary_mission_u	median	st_dev	count	normalize_median	normalize_std_dev	standardize_median	standardize_std_dev
SFOAL	NNSA	1.47								
SNLHawaii	NNSA	1.01								
PantexPlant	NNSA	0.59								
PPPLForrestalResrchCtr	SC	0.57								
WasteIsolationPilotPlant	EM	0.40								
RossComplex	PA	0.39								
Y12NationalSecurityComplex	NNSA	0.34								
LosAlamosNationalLaboratory	NNSA	0.34								
OfficeofSecureTransportation	NNSA	0.28								
SavannahRiverSite	NNSA	0.25								
NorthRegion	PA	0.21								
SNLNewMexico	EE	0.20								
LawrenceLivermoreLabSite300	NNSA	0.20								
ThomasJeffersonNationalAcceleratorFacility	SC	0.19								
NevadaNationalSecuritySite	NNSA	0.18								
LawrenceLivermoreNationalLaboratory	NNSA	0.17								
SNLNevada	NNSA	0.17								
LasVegas	NNSA	0.17								
ArgonneNatlLabSiteD	SC	0.15								
BrookhavenNationalLaboratory	SC	0.13								
SLACNationalAcceleratorLaboratory	SC	0.13								
IdahoNationalLabScoville	NE	0.12								
SNLCalifornia	NNSA	0.11								
EastTennesseeTechnologyPark	NE	0.10								
CalibrationPitsandPads	LM	0.09								
LawrenceBerkeleyLaboratory	EE	0.09	1	1	0.12	243	0.00	0.30	0.00	1.71
KAPLKesselring	NR	0.09	1	1	0.11	173	0.00	0.29	0.00	1.66
GrandJunctionCODisposalProcessingSite	LM	0.07	0	1	0.10	19	0.00	0.26	0.00	1.46
BettisIdaho	NR	0.06	1	1	0.09	95	0.00	0.24	0.00	1.36

- Indicator constructed through statistical processes for normalizing/ranking
  - Ranking is sensitive to weights put on indicator component variables
  - Knowledgeable staff need to participate and establish the weights
- Indicator use
  - Developed and applied in commands that own/manage infrastructure, with inputs from tenant commands
  - Process includes data collection, analysis, interpretation
- In process next step is to conduct pilots with program offices/commands

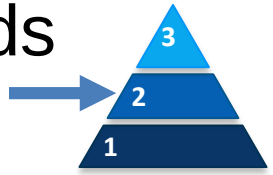
Example: DOE Survey on Current Vulnerabilities/Impacts



Survey: Data Collection Priorities

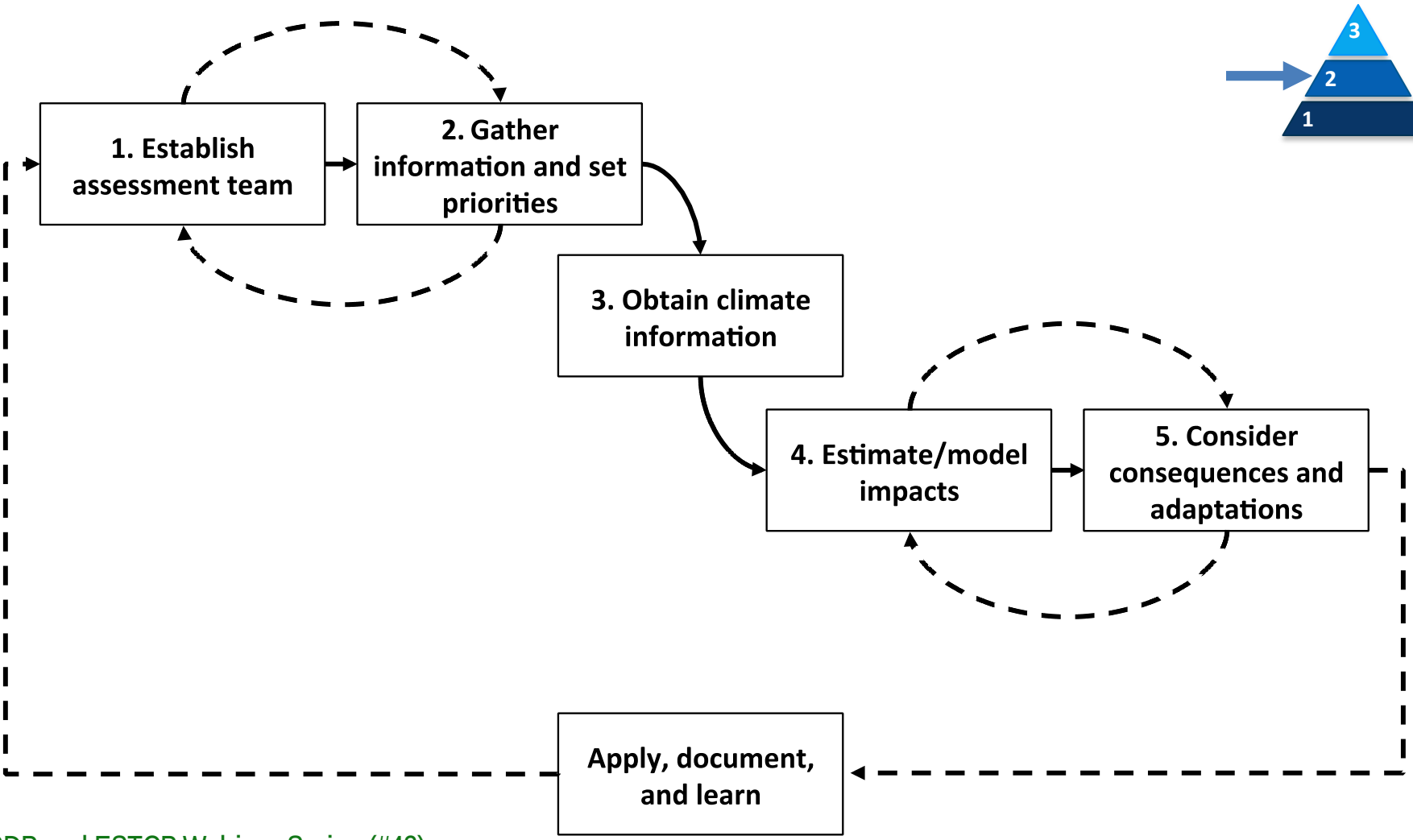
- Gather information on vulnerabilities and exposures of mission critical assets
  - Supplement information in corporate databases
  - Integrate knowledge of site managers in comparable format
  - Address spatial heterogeneity of exposure
- Key questions include
  - Relevant climate exposures
  - Facilities in flood plains or other exposed areas
  - Facilities damaged in past events (include consequences, recovery time, subsequent adaptations)
  - Pending resilience-building opportunities

Tier 2: Facility Vulnerability Assessments



- Who: Installation personnel, major commands
- Where: At high-priority installations
- Objectives
  - Clarify whether vulnerabilities need to be addressed through additional monitoring, altered management, or structural changes
  - Build capacity and shared knowledge
- Approach
  - Participatory process (guided learning) involving owners of key systems and subject matter experts (SMEs)
- Costs: Variable ($60K - $80K range for external facilitation)

Assessment Framework



Step 1: Establish Assessment Team and Engagement Process

- Goal is to define “who, what, when, how?” and set expectations for the process
- Who?
  - Team composition: include managers and technical experts related to key systems
    - Stability of civilian workforce provides “corporate memory”
    - Support of leadership improves outcome
  - Internal engagement: careful design required, especially for data collection
  - External engagement: focus on external dependencies
  - Subject Matter Experts: to facilitate expert judgment, identify SMEs for specific topics

Step 2: Gather Information and Set Assessment Priorities

- Objective is to gather/synthesize existing information and identify what topics require further assessment
  - Consider upcoming decisions related to long-lived assets or future plans, not only current infrastructure/activities
- An iterative process
  - Conference calls, document review, interviews, analysis
  - Use extant documents and reports (e.g., INRMP, Master Plan)
- Some key challenges
  - Identify climate thresholds (influence of multiple stresses)
  - Attribute cancellations and damages to climate events (information capture could be improved)
  - Assess adaptive capacity (key elements are intangible)

Priorities: Sample of Mid-Atlantic Facilities

Infrastructure

- Changes in energy demand and supply system stresses
- Water supply (drought) and management (flooding)
- Damages, increased maintenance costs for buildings and facilities
- Installation-community interactions (dependencies)
- Transportation system disruption

Training/ test ranges

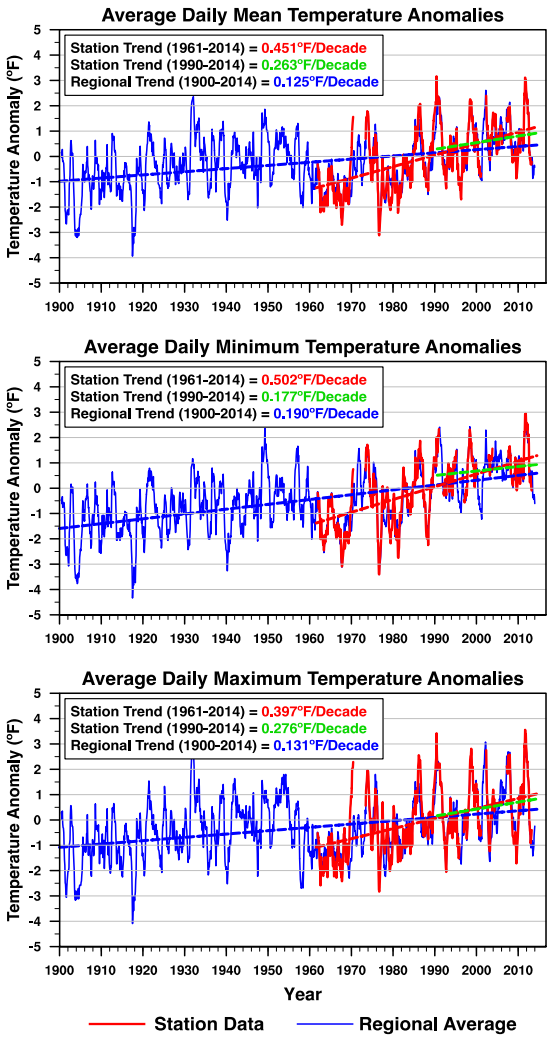
- Ecosystem shifts and range suitability
- Erosion
- Fire risk and restrictions on management/use
- Flag days/heat stress and training restrictions
- Wind speeds
- Schedule impacts due to variance in test conditions

Step 3: Obtain Climate Information

- Goal is to understand state of science for climate phenomena that will drive future impacts
  - Distinguish information for participatory process and data for modeling
- Sources
  - See SERDP report (Kotamarthi et al., 2016) https://serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/RC-2242
  - National Climate Assessment/IPCC
  - Climate Resilience Toolkit
- This project tested a climate change "outlook" approach
  - Assess impacts-relevant variables for facilities in a region
    - Historical climatology and projections
    - Regional coverage to serve multiple installations
  - Finding: potentially useful but resource intensive; would need personnel to manage/disseminate/support

Climate Outlook

- Provides state of science for key phenomena on a regional basis
- Contents
  - Methods
  - Climatology
  - Temperature analysis
  - Precipitation analysis
  - Impacts relevant variables
  - Sea level rise and flooding
  - Key messages
  - Technical appendices

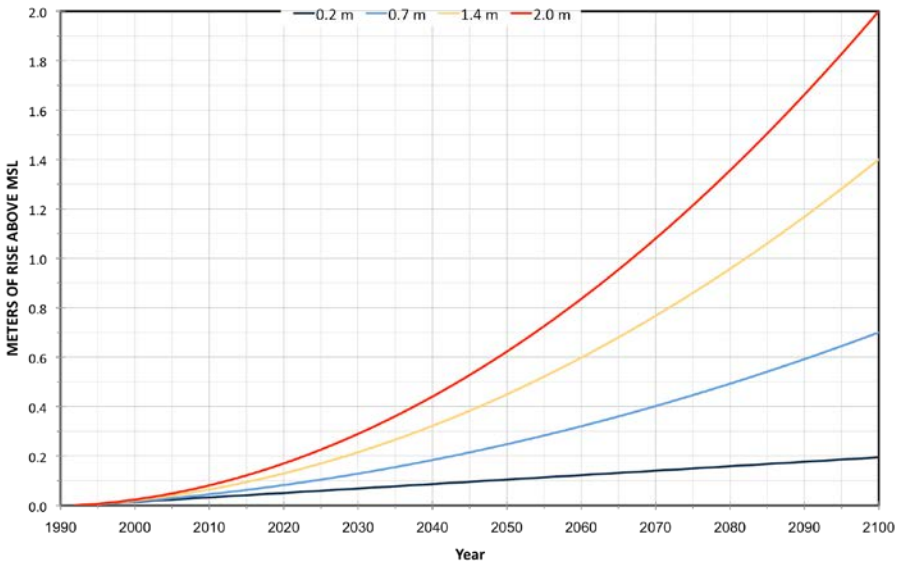


Climate Information Needs Related to Impacts and Decisions

Exposure	Impacts	Significance	Risk Management (varies by governance level)	Climate Information Inputs
Increased fire risk	Fewer burn days; ecosystem management; RCW	Costs; restrictions on ranges	Scheduling/budget; alter management; add training capacity at other installations	T, P, wind, soil moisture, (Fuel load)
Ecosystem migration (change in flora/fauna ranges)	Protected species; invasive species; movement of pests, disease vectors	Costs; range suitability or availability	Alter management; redistribute training activities	Average and extremes of T, P, and other variables
Increase in days with extreme heat	Outdoor activity and training restrictions; energy system stress	Reduced training throughput; service interruptions	Alter training regimen; redistribute training activities	T, P, wind, solar Insolation
Change in surface wind speed	Flight training, parachute drops; controlled burns	Training; ecosystem maintenance	Alter training regimen; redistribute training activities; change burn patterns	Daytime daily wind threshold exceedance

Use of Scenarios in Vulnerability Assessments

- Scenarios depict uncertainty in future climate
  - Include low probability, high consequence events
- Context: “deep uncertainty”
  - Forcing, natural variability, model differences
  - Conditional probabilities
- Decision environment drives narrowing of range considered in assessment
  - Project longevity, risk tolerance, etc.



Source: Parris et al., 2012

Step 4: Estimate/Model Impacts

- Goal is to gather and synthesize information on how vulnerabilities and future conditions could interact
- Many sources/methods are available
  - Extrapolations from past incidents
  - Interpretation of assessments and research studies
  - Statistical analysis of observations: e.g., return periods
  - Impacts-relevant metrics from climate projections: e.g., WBGT, HDD/CDD, fire risk indices
  - Modeling (e.g., energy demand/capacity/distribution; water resources; surface flooding; network analysis; human health)
- How to select methods?
  - “Art of the possible”
  - Factors include mission criticality, budget, access to expertise, …
  - Models already used in management (e.g., FEDS) are being adapted for use in impacts modeling

Step 5: Consider Consequences and Adaptation

- Objective is to evaluate relative vulnerability and prioritize adaptation needs
  - Various spreadsheet and ranking tools facilitate this step
  - Importance of expert judgment of site/asset managers in considering the consequences of potential impacts
- Key questions:
  - Given potential impacts, how might missions be affected?
  - What next steps should we take?
- “Scenario planning” and other engagement methods can be useful if participants are receptive

Tier 3: Adaptation Design

- Included for conceptual completeness – not addressed in this project
- Modification of engineering/design processes to incorporate climate information
  - Relevant for hard and soft infrastructure options
- Challenge: increase mutual comprehension of climate information needs and limits/uses of climate projections produced under deep uncertainty
  - Sustained dialogue being established in several initiatives (e.g., NCAR, NIBS, Sustained NCA)

Conclusions and Implications

- In complying with the requirement to conduct vulnerability assessments, include objectives of building capacity and improving resources for climate risk management
- Indicators, surveys, and stress tests can be used to systematically prioritize vulnerability assessments
  - Consider factors such as mission criticality, condition, and location relative to exposure
- Site-level vulnerability assessments can contribute to resilience
  - Identify adaptation needs
  - Build capacity for climate risk management

Conclusions and Implications (Cont'd)

- Adaptation ("changes in practices/infrastructure") should include improved monitoring
  - Collecting better information on impacts at a site is valuable for future risk management
- Technical capacity is abundant, but more effort is required to organize it, share experience, and provide an evolving guide to resources
  - Stakeholder engagement
  - Climate information
  - Impacts estimation/modeling
- Details can be downloaded at http://www.osti.gov/scitech/servlets/purl/1211559

Acknowledgments

- Co-Pi, Dr. Linda Mearns (National Center for Atmospheric Research)
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- Dr. Melissa Bukovsky (NCAR)
- Ms. Alison Delgado (Battelle/PNNL)
- Dr. Justin Henriques (Battelle/PNNL/JMU)
- Dr. Elizabeth Malone (Battelle/PNNL)
- Dr. Rachel McCrary (NCAR)
- Ms. Joan Vandervoort (Independent analyst)
- Dr. Zhaoqing Yang (Battelle/PNNL)
- Kathleen Judd (Battelle/PNNL)

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/RC-2206

Speaker Contact Information

rhm@pnnl.gov; 301-314-6711

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Q&A Session 1

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Decision-Scaling: A Decision Framework for DoD Climate Risk Assessment and Adaptation Planning

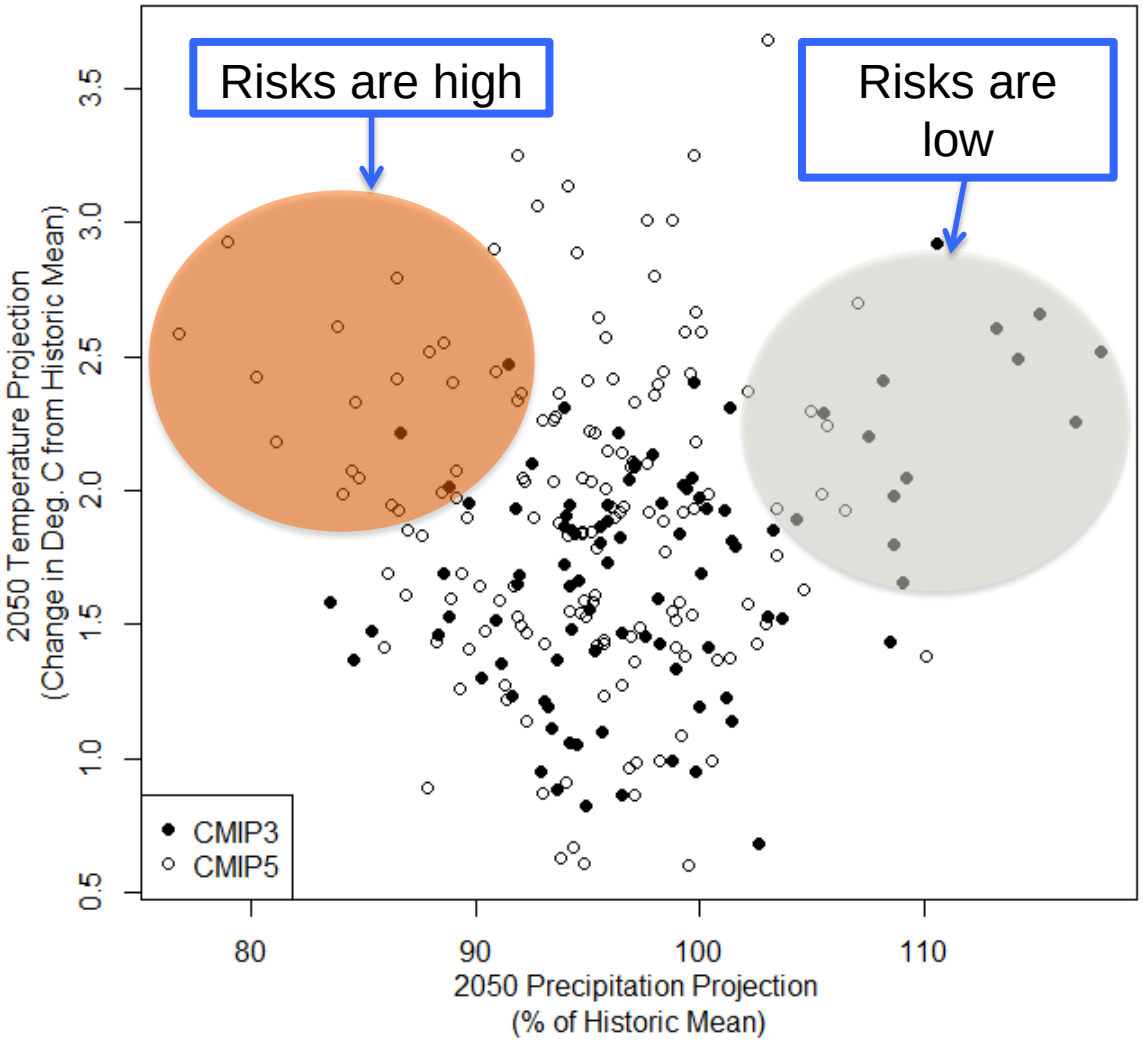
Casey Brown, Ph.D.
University of Massachusetts, Amherst

SERDP DOD • EPA • DOE | ESTCP

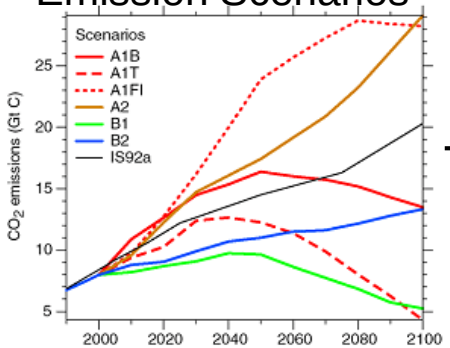
Presentation Outline

- Problem: Decision-making under climate uncertainty [Executive Order No. 13653]
- Proposed solution: “Decision-scaling”
- Case study 1: Installation water supply
- Case study 2: Extreme fire risk
- Case study 3: Evaluating adaptations
- Conclusions

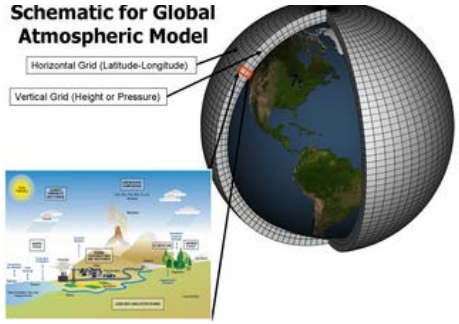
Implications of Climate Uncertainty



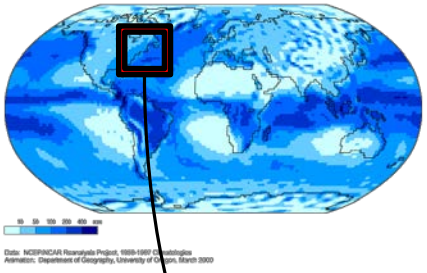
Emission Scenarios

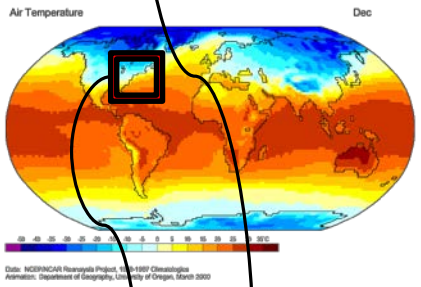


General Circulation Models (GCMs)

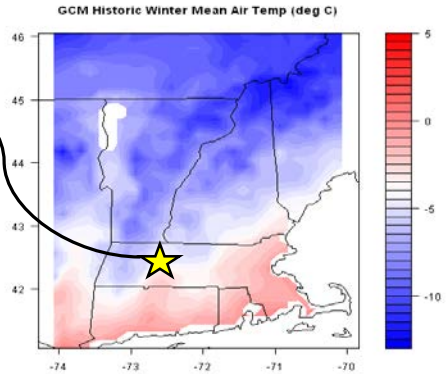


Geography Department, U. Oregon

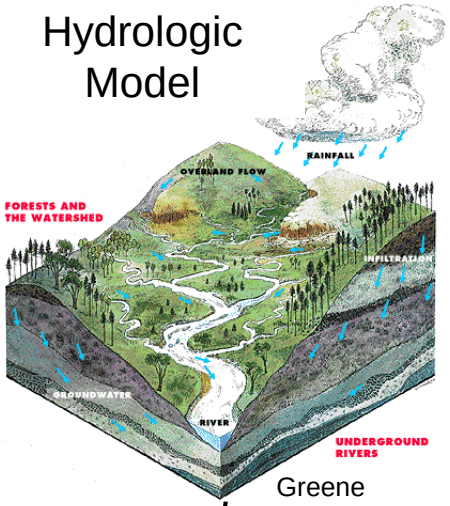




Downscaling

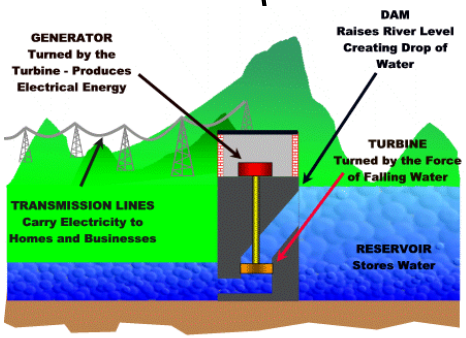


Hydrologic Model



Greene County, PA Department of Econ. Development

Water Resources System Model



Wisconsin Valley Improvement Company

Water System Performance Under Future Climate Scenarios

Climate Uncertainty Decision Making

- Non-probabilistic methods
  - Require scenarios that span range of key uncertainties
  - Minimize maximum regret
  - Scenario planning
- Probabilistic methods
  - Require probabilities assigned to possible futures
  - Maximize expected value
  - Maximum likelihood

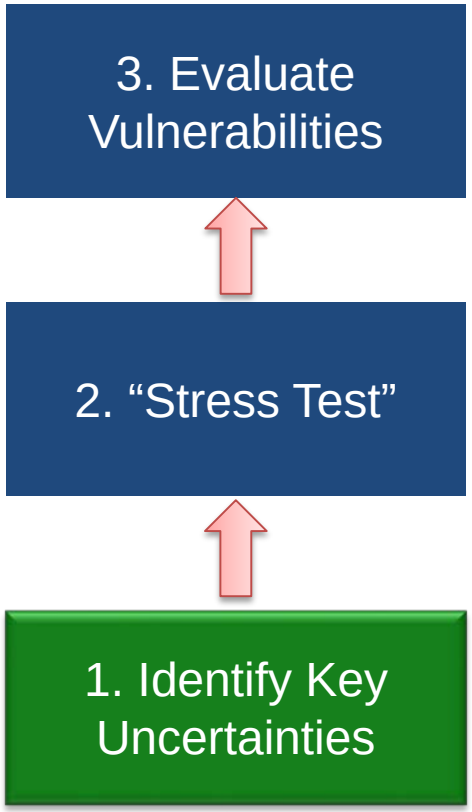
Decision-Scaling: An Alternative Approach

- Assess impacts via systematic sensitivity analysis
- “Climate stress test”
- Use climate information to assess the “level of concern”
- Results in clear prioritization of actions

References

Brown and Wilby, *EOS*, 2012; Brown et al., *WRR*, 2012; Poff et al., *Nature Climate Change*, 2015

Decision-Scaling for Vulnerability Assessment

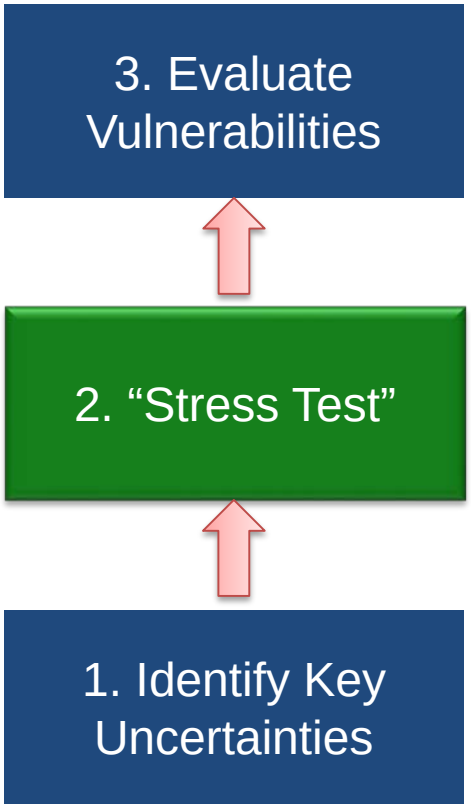


Define uncertain factors that can affect the system

References

Brown and Wilby, *EOS*, 2012; Brown et al., *WRR*, 2012; Poff et al., *Nature Climate Change*, 2015

Decision-Scaling for Vulnerability Assessment

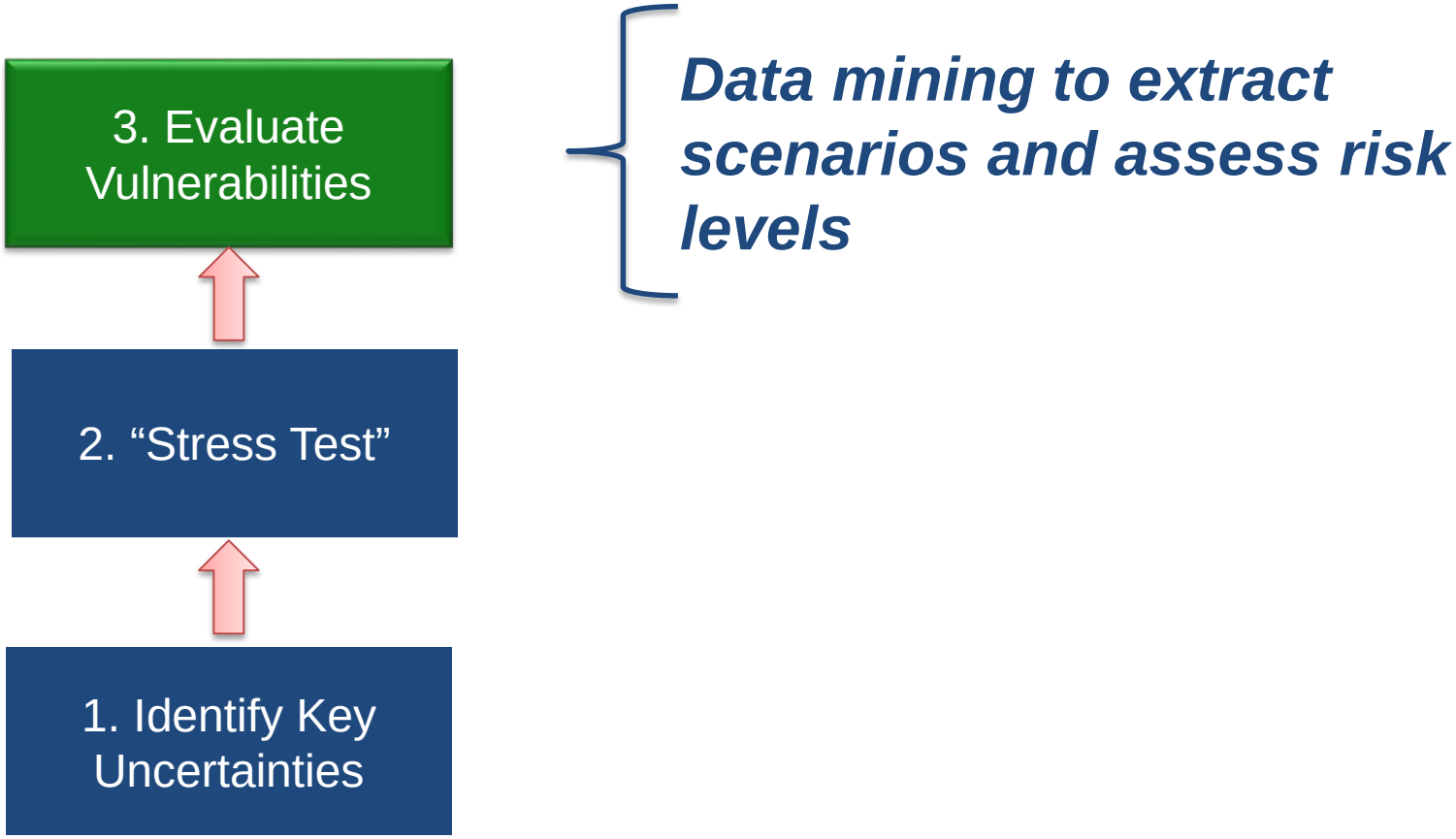


Systematic perturbation to characterize response of the system

References

Brown and Wilby, *EOS*, 2012; Brown et al., *WRR*, 2012; Poff et al., *Nature Climate Change*, 2015

Decision-Scaling for Vulnerability Assessment



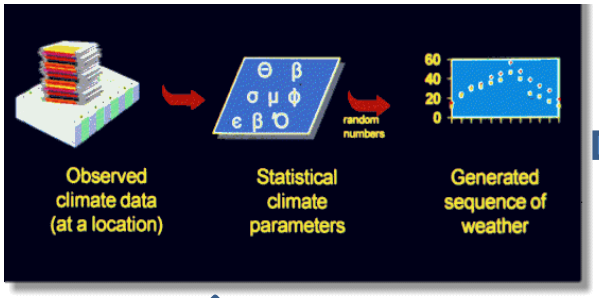
References

Brown and Wilby, *EOS*, 2012; Brown et al., *WRR*, 2012; Poff et al., *Nature Climate Change*, 2015

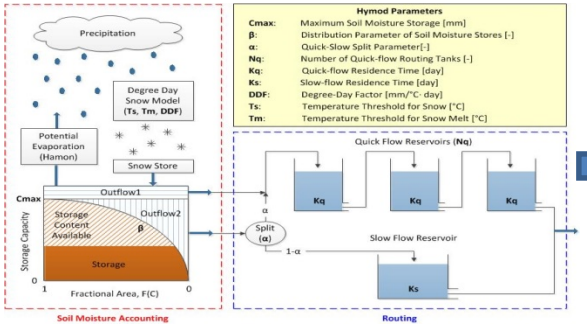
Step 2: Climate Stress Test

Non-Climate Uncertainties

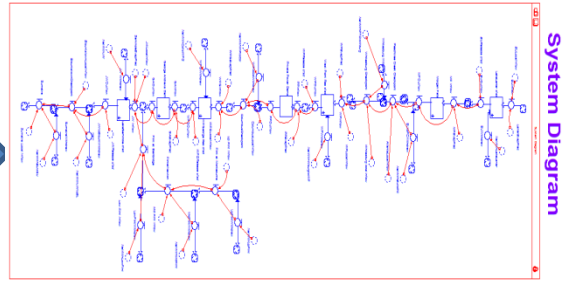
Climate/Weather Generator



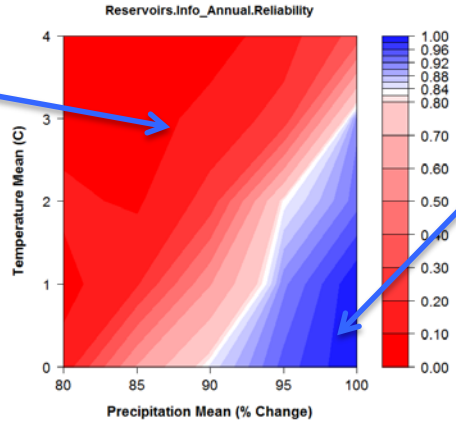
Climate Response Model



System Model



Vulnerability



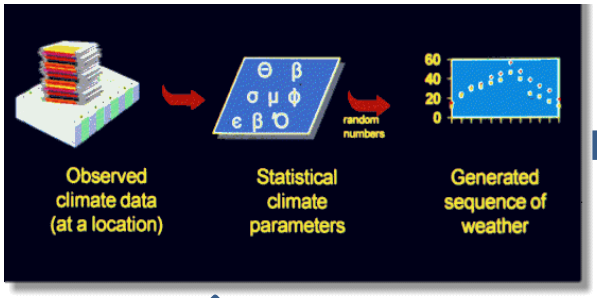
Robust

Colorado Springs, Colorado, USA
WATER SUPPLY RISK ASSESSMENT

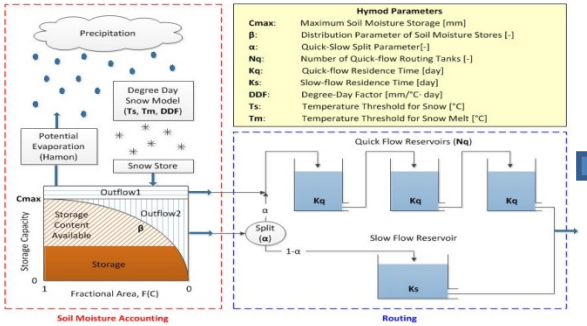
Step 2: Climate Stress Test

Non-Climate Uncertainties

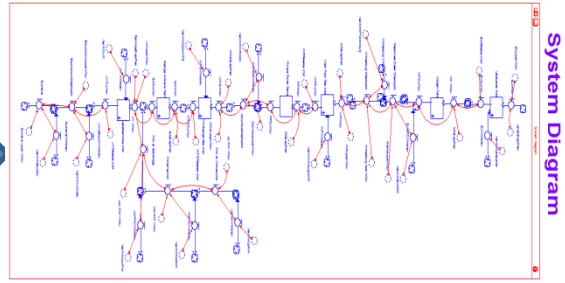
Climate/Weather Generator



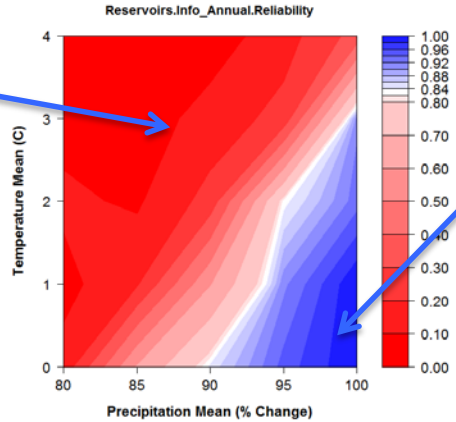
Climate Response Model



System Model

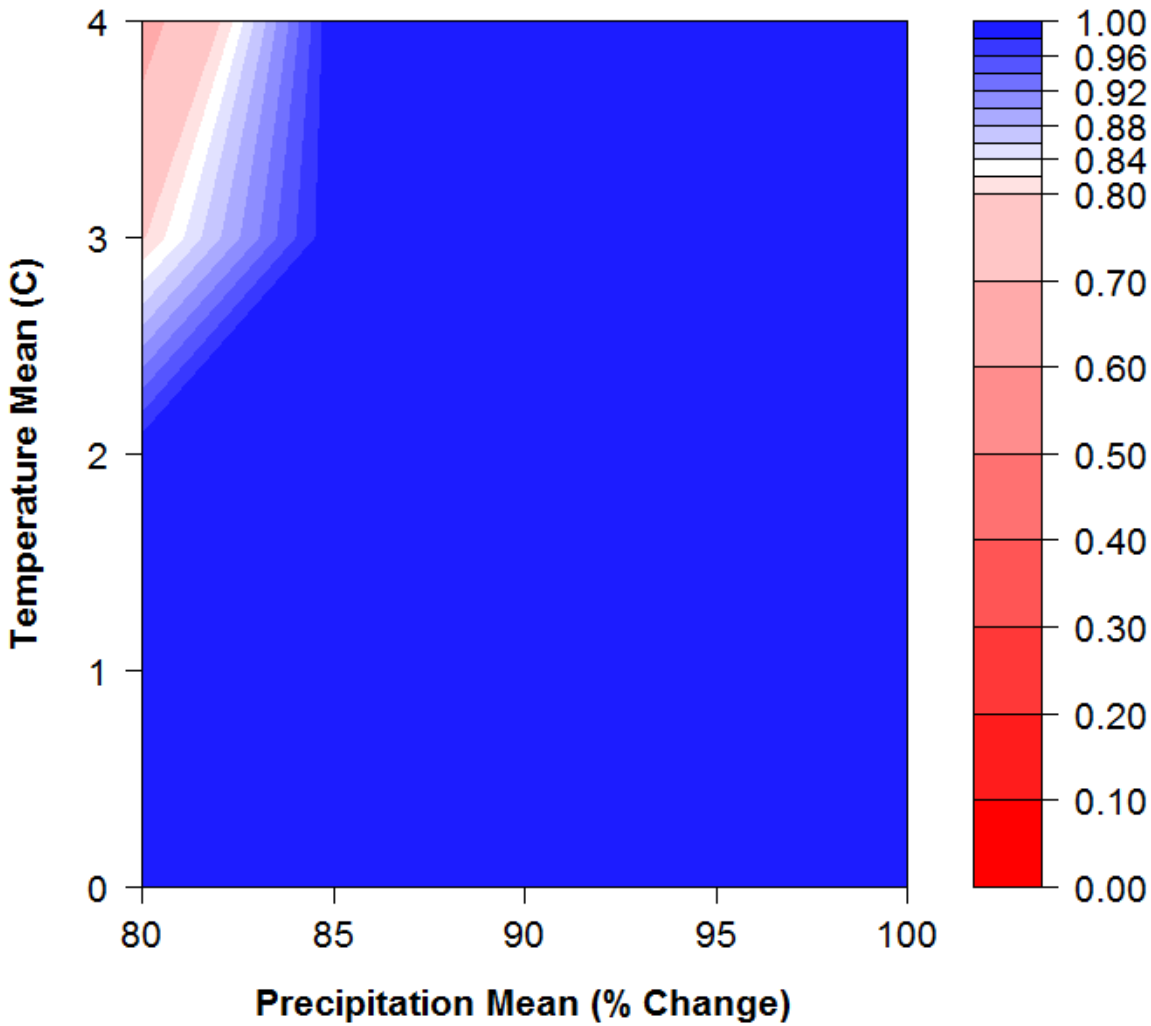


Vulnerability

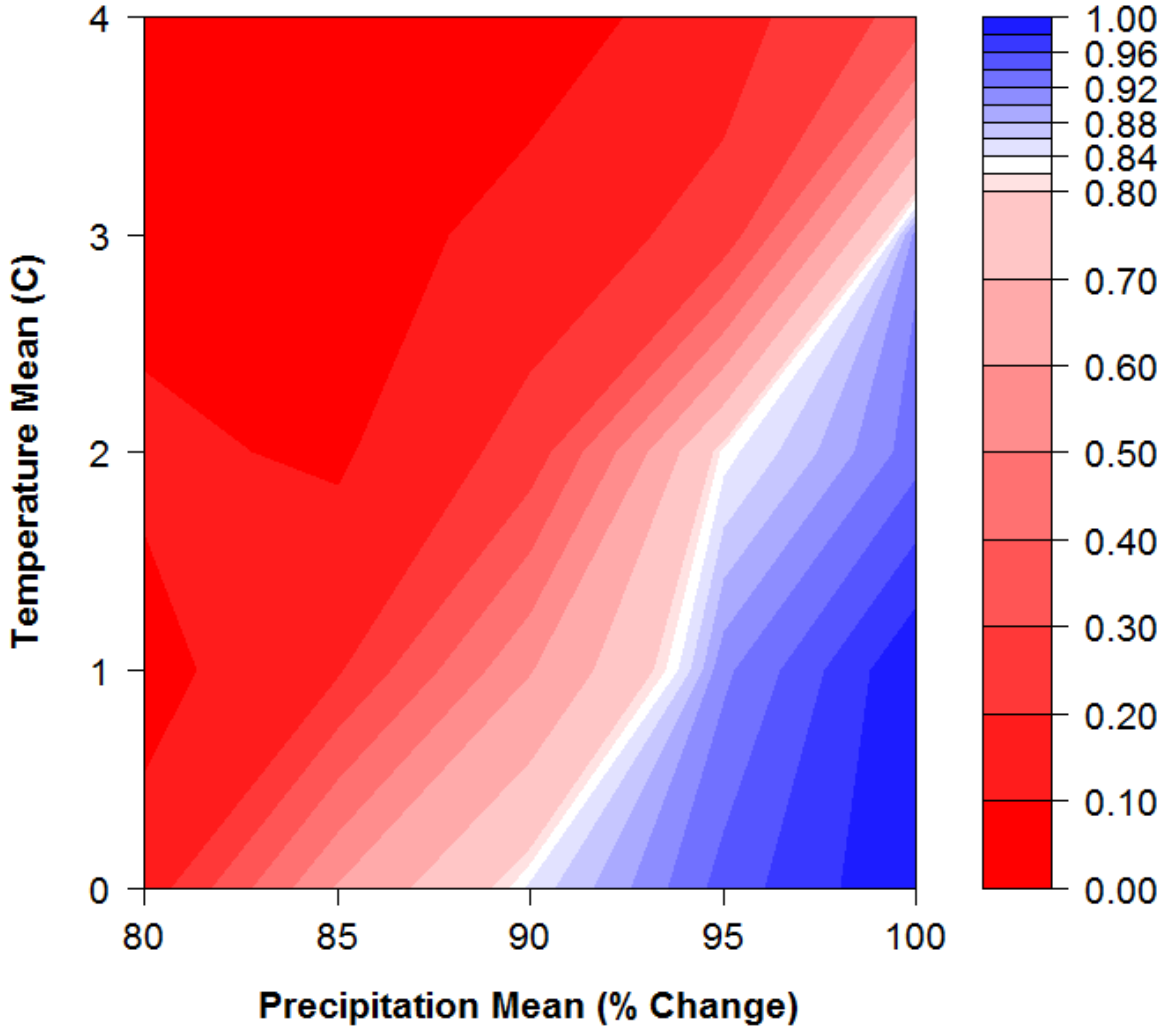


Robust

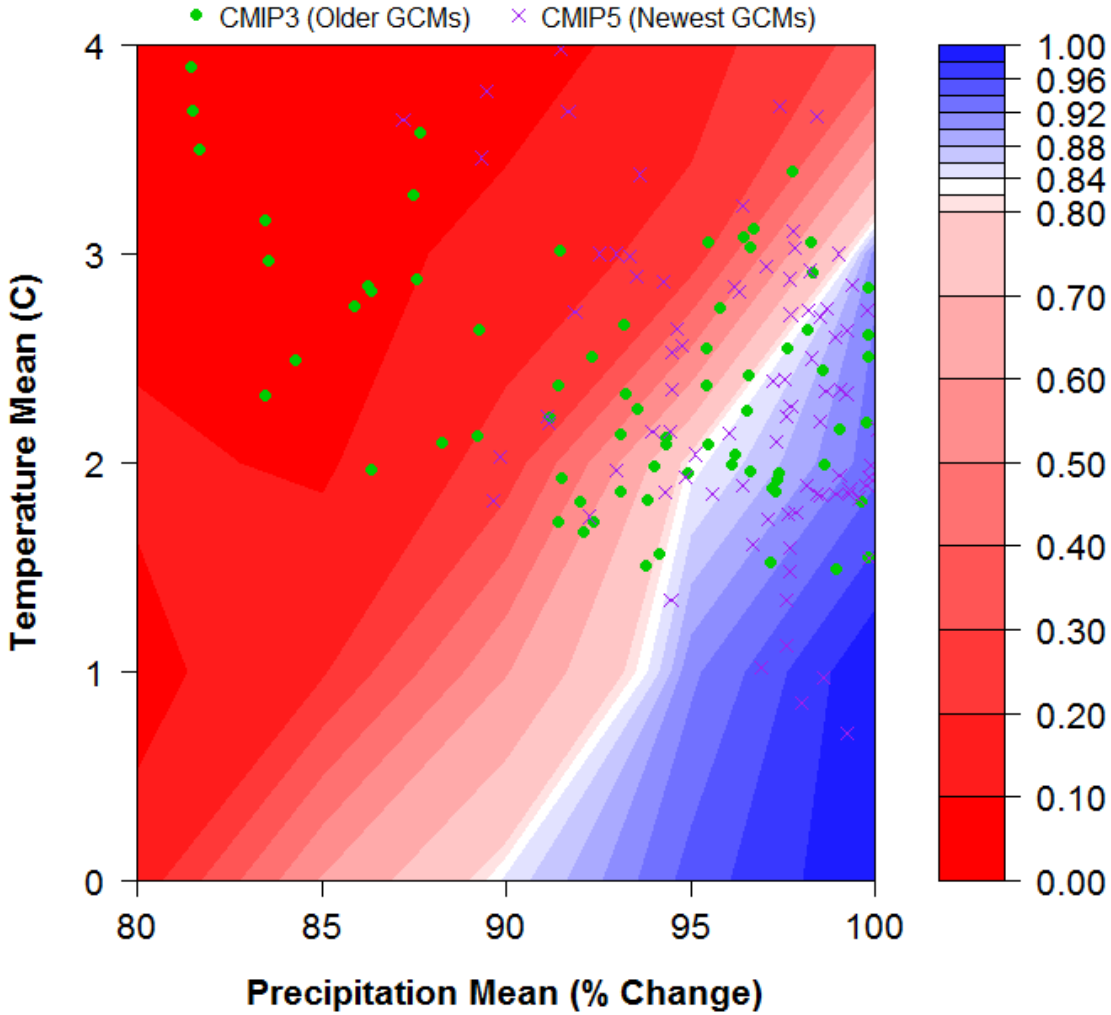
Colorado Springs Water Reliability: Current Conditions



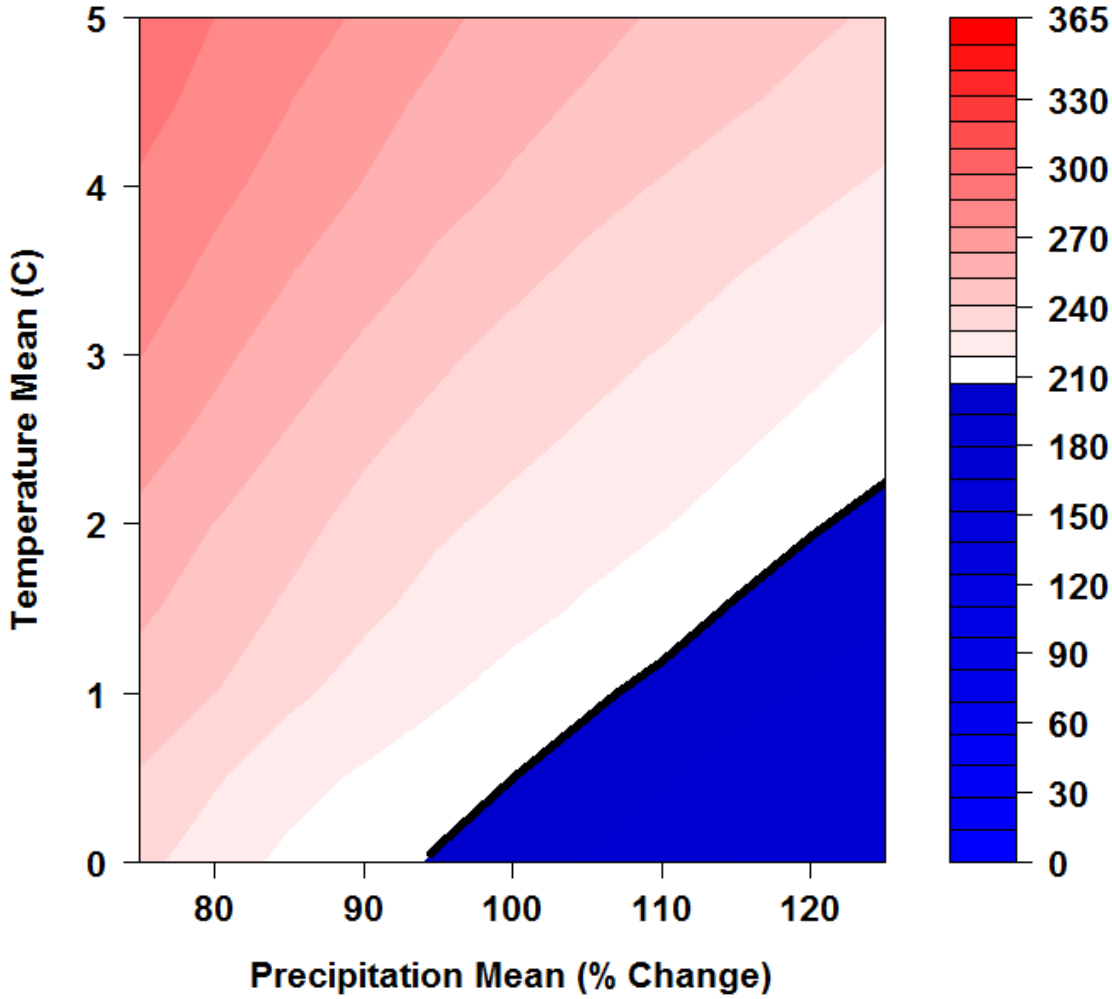
Colorado Springs Water Reliability: Future Demand



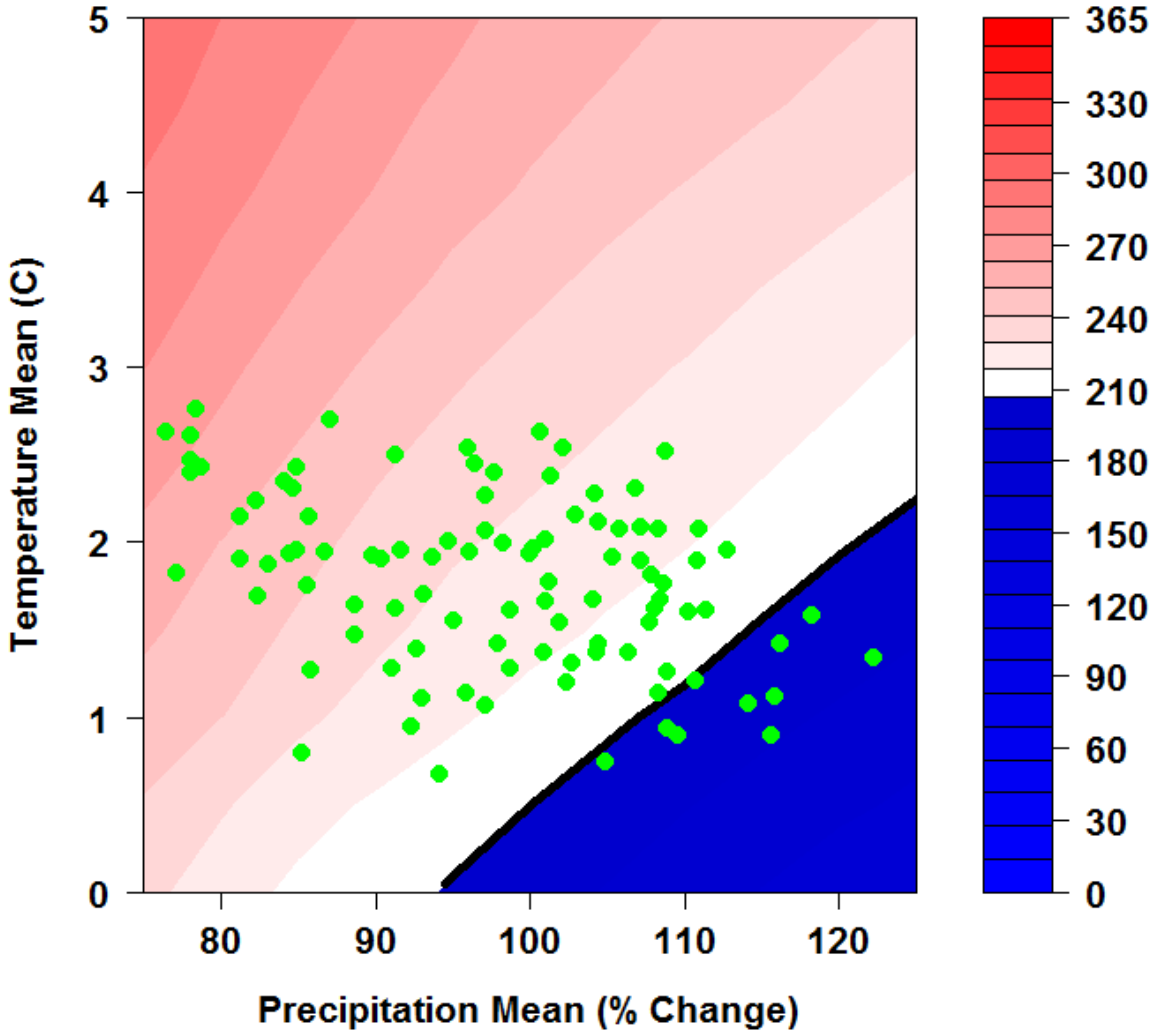
Step 3: Evaluate Vulnerabilities



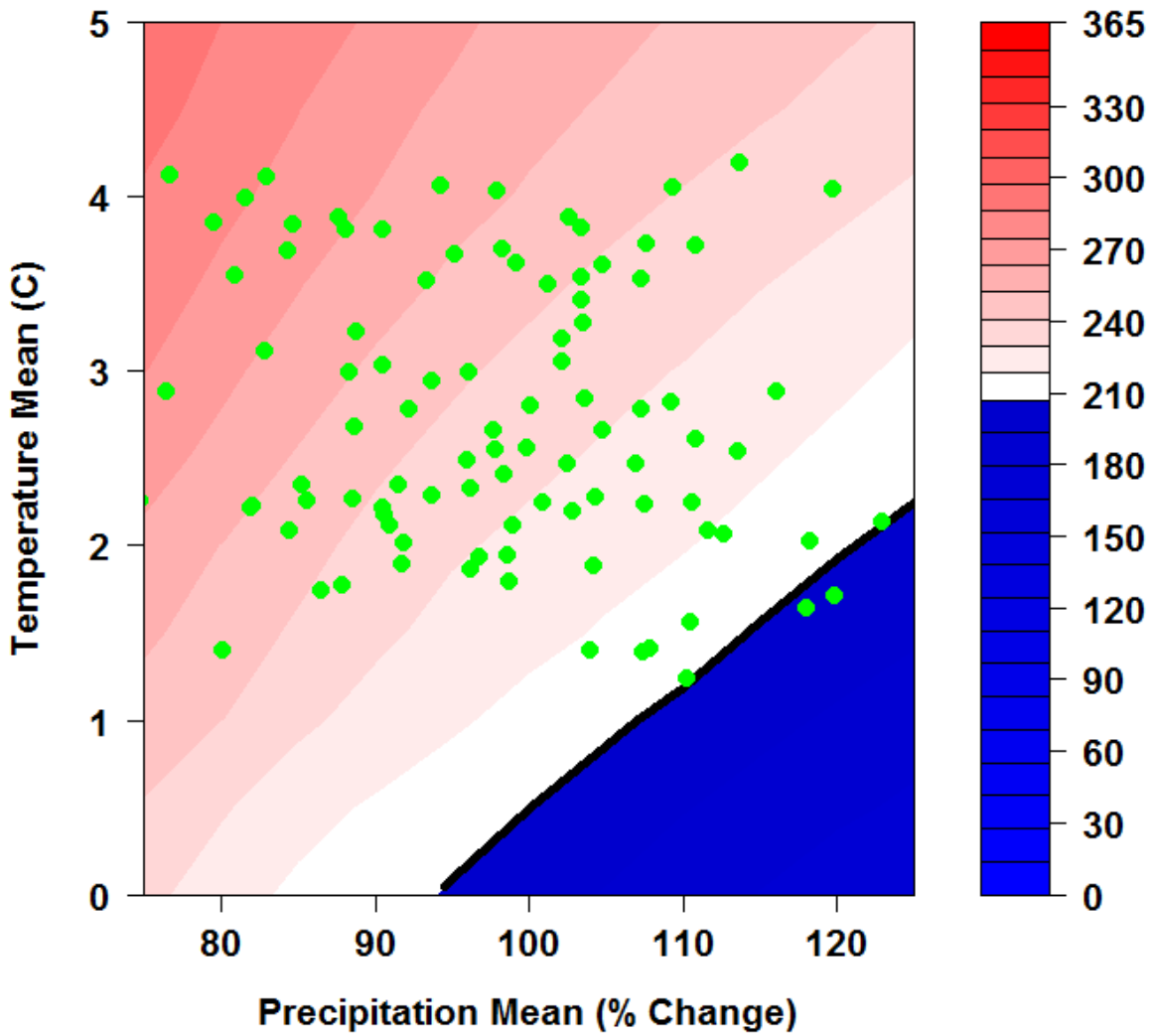
Extreme Fire Risk Days under Climate Change (Edwards AFB)



Extreme Fire Risk Days, Year 2050



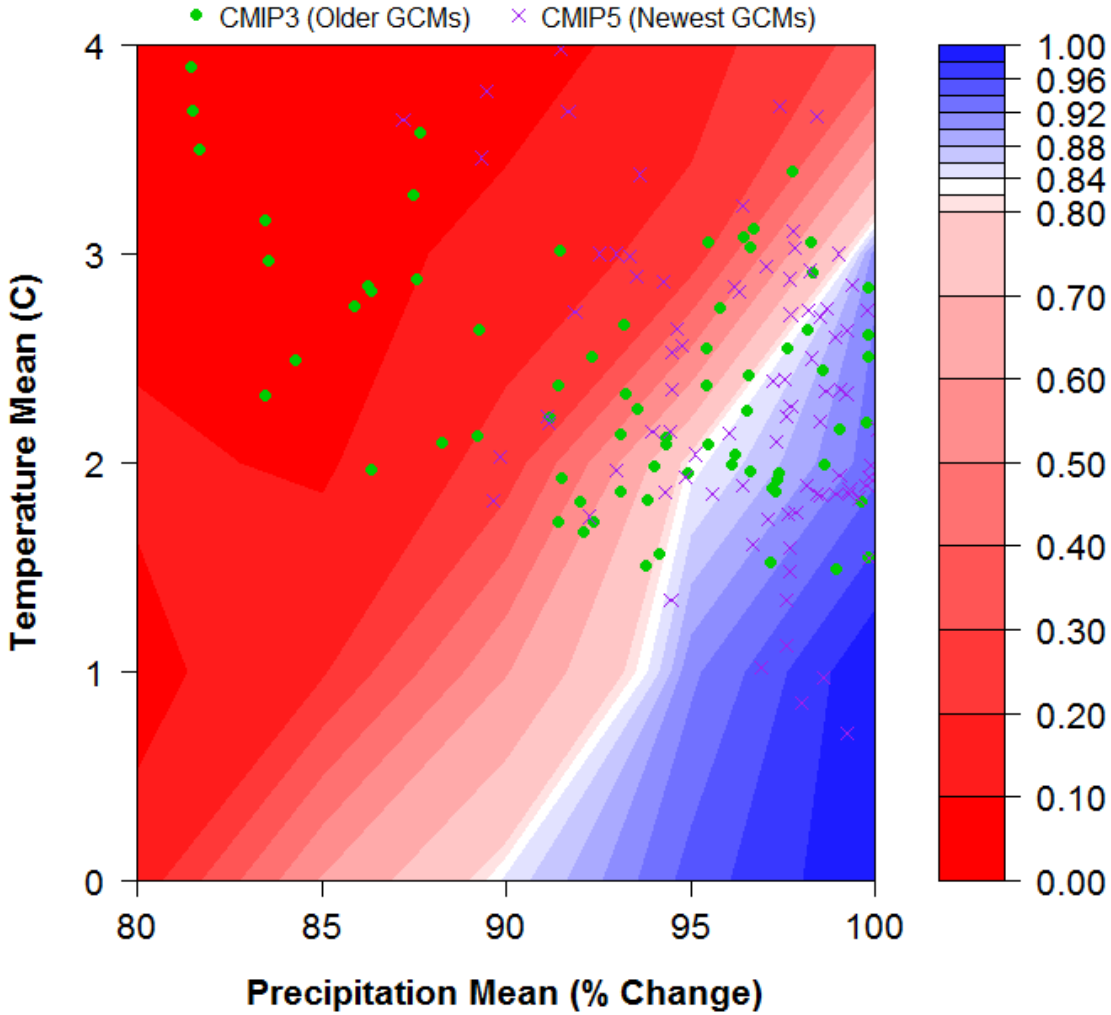
Extreme Fire Risk Days, Year 2070



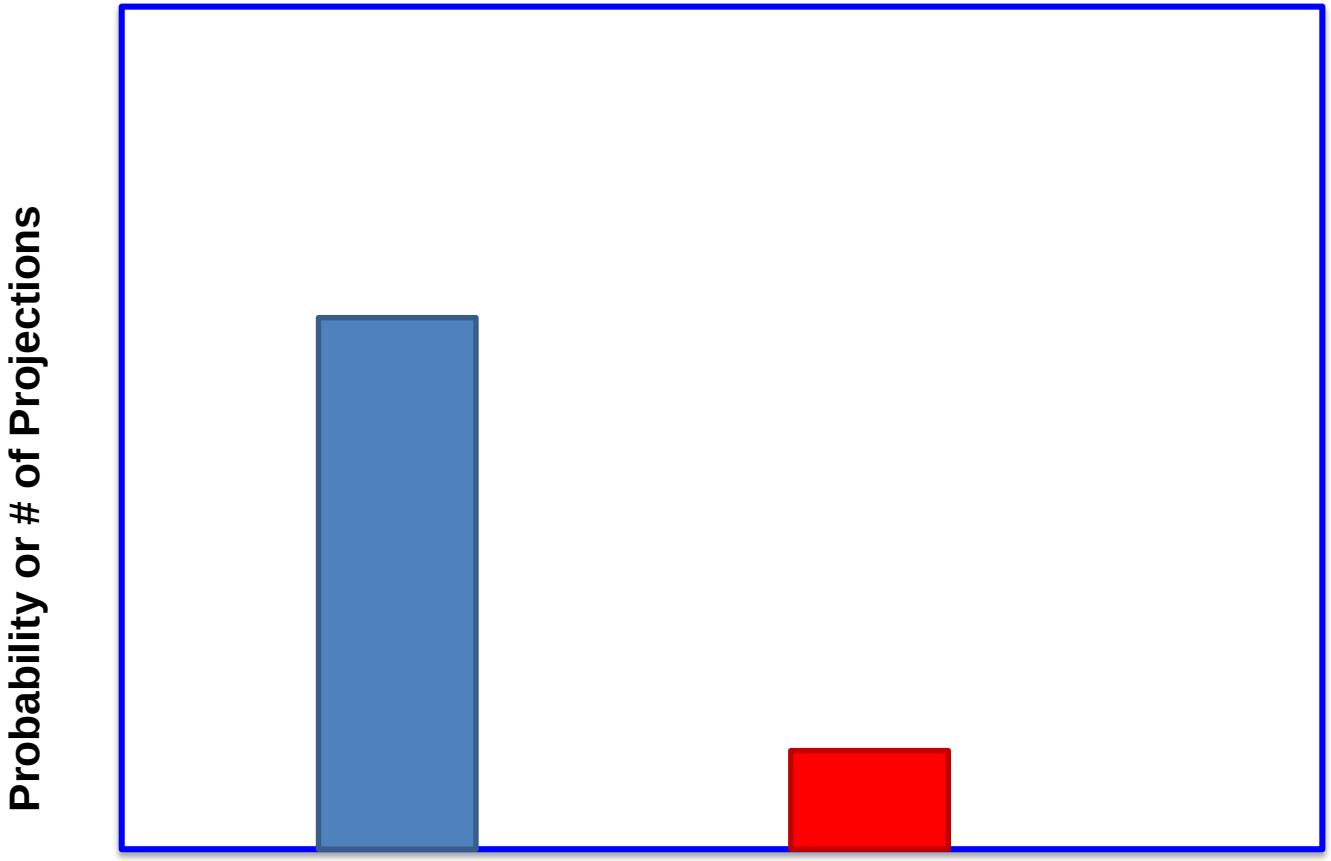
Step 3: Evaluate Vulnerabilities

- Data mining algorithms identify vulnerabilities
- Climate information used to assess risk level
- Three considerations
  - Does observations indicate trend?
  - Does theory imply such a change?
  - Do projections indicate that change?

Step 3: Evaluate Vulnerabilities



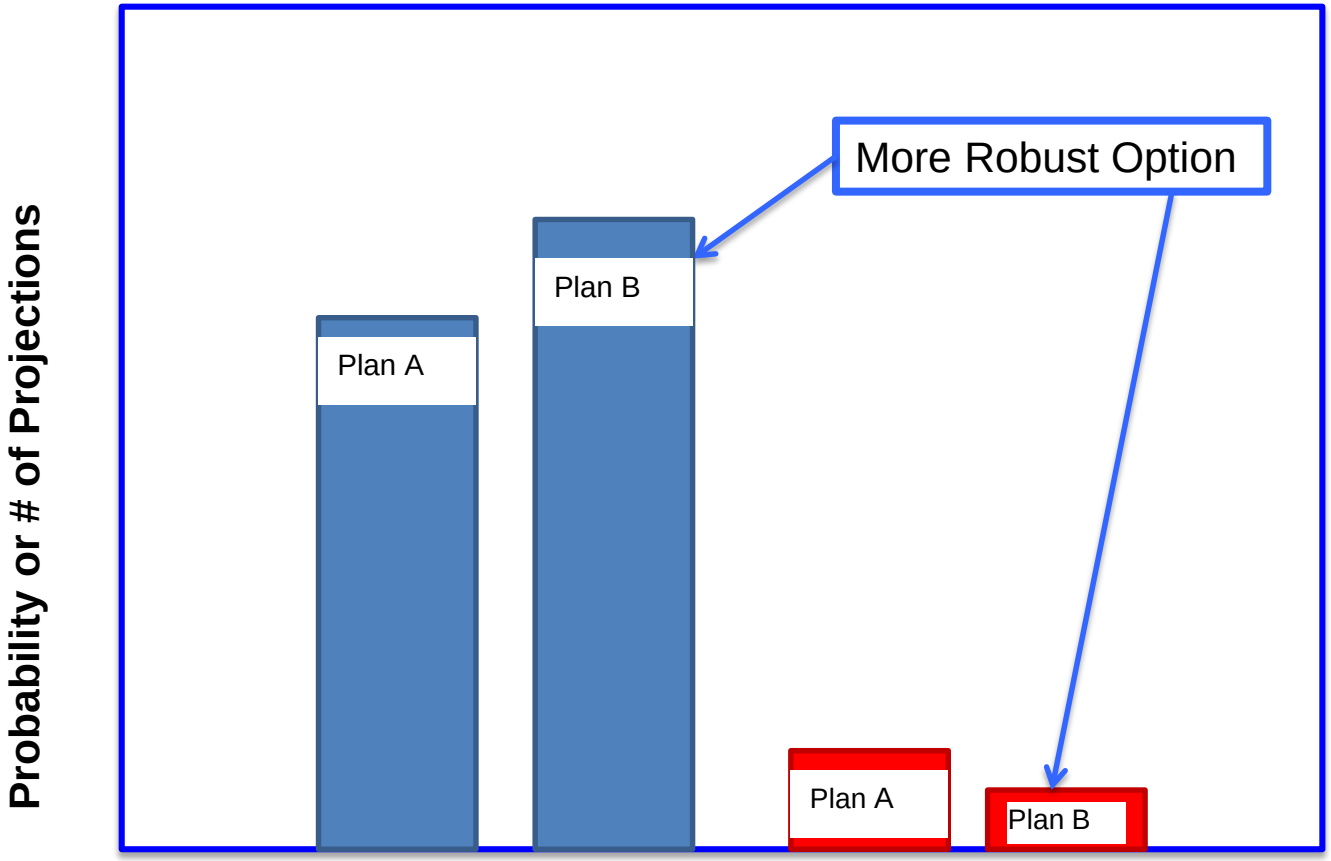
“Level of Concern”



# of projections indicating acceptable performance

# of projections indicating unacceptable performance

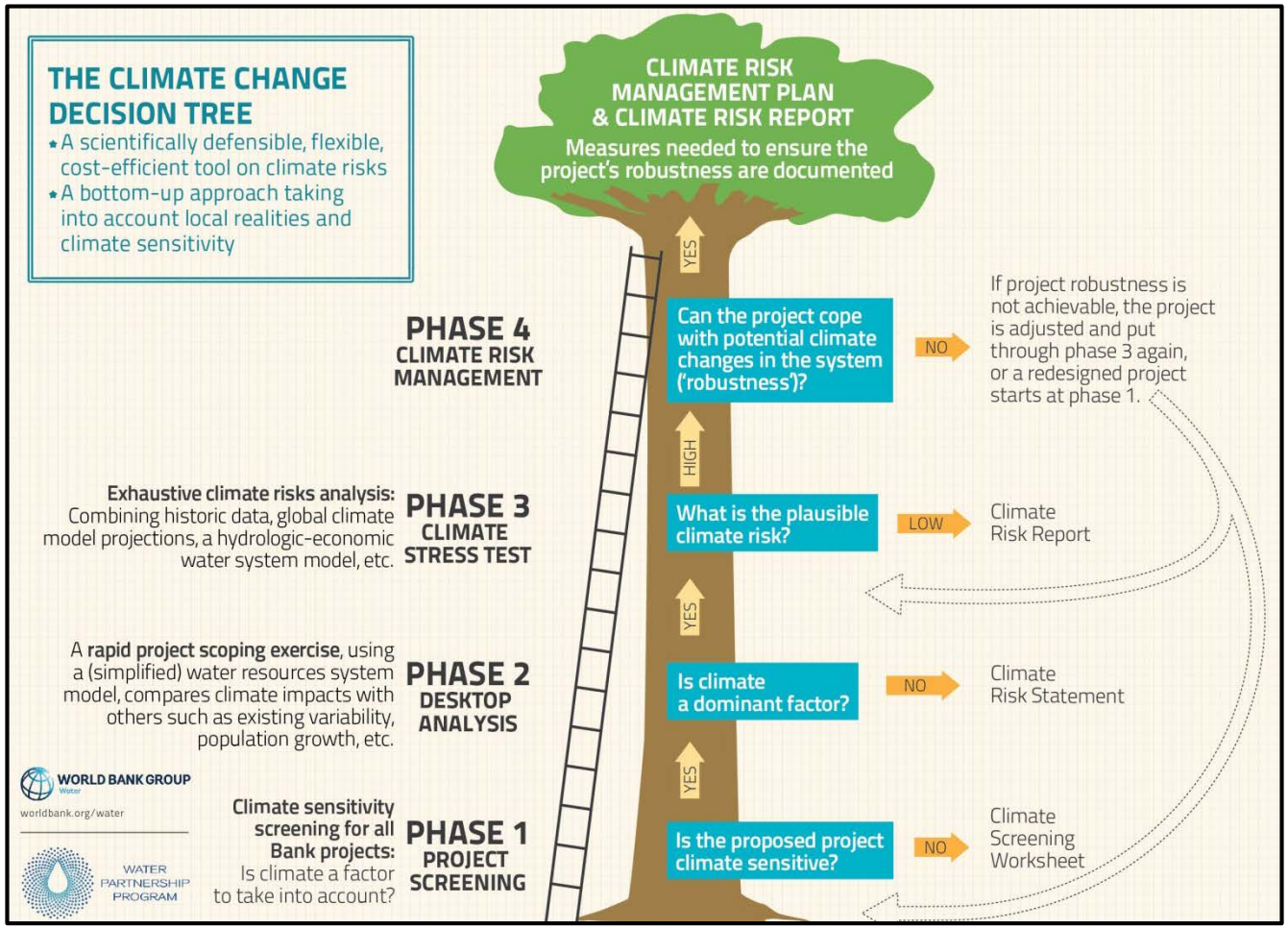
Evaluating Alternatives



# of projections indicating acceptable performance

# of projections indicating unacceptable performance

Identifying and Managing Climate Risks



Ray and Brown (2015)

Confronting Climate Uncertainty in Water Resources Planning and Project Design - the Decision Tree Framework

Summary of Benefits

- Framework for climate risk assessment of DoD installations demonstrated
- General methodology widely applicable for assessing climate risks to infrastructure
- Foundation for planning under climate uncertainty and adaptation

Conclusions

- Federal requirements to assess climate risks
- Decision-scaling is straight forward assessment of climate risks
- Not impeded by uncertain climate projections
- Can be tailored for application to specific interests (installations, missions, systems)

For additional information, please visit

https://www.serdp-estcp.org/Program-Areas/Resource-Conservation-and-Climate-Change/Climate-Change/Vulnerability-and-Impact-Assessment/RC-2204

Speaker Contact Information

casey@umass.edu; 413-577-2337

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Q&A Session 2

SERDP DOD • EPA • DOE | ESTCP

The next webinar is on November 3, 2016

“Bioavailability of Contaminants in Soils”

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Survey Reminder

Please take a moment to complete the survey that will pop up on your screen when the webinar ends

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