Challenges to the Use of Climate Information by the Department of Defense: When Does "Resolution" Matter?

Dr. John A. Hall
Program Manager for
Resource Conservation and Climate Change

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SERDP
DOD ▪ EPA ▪ DOE

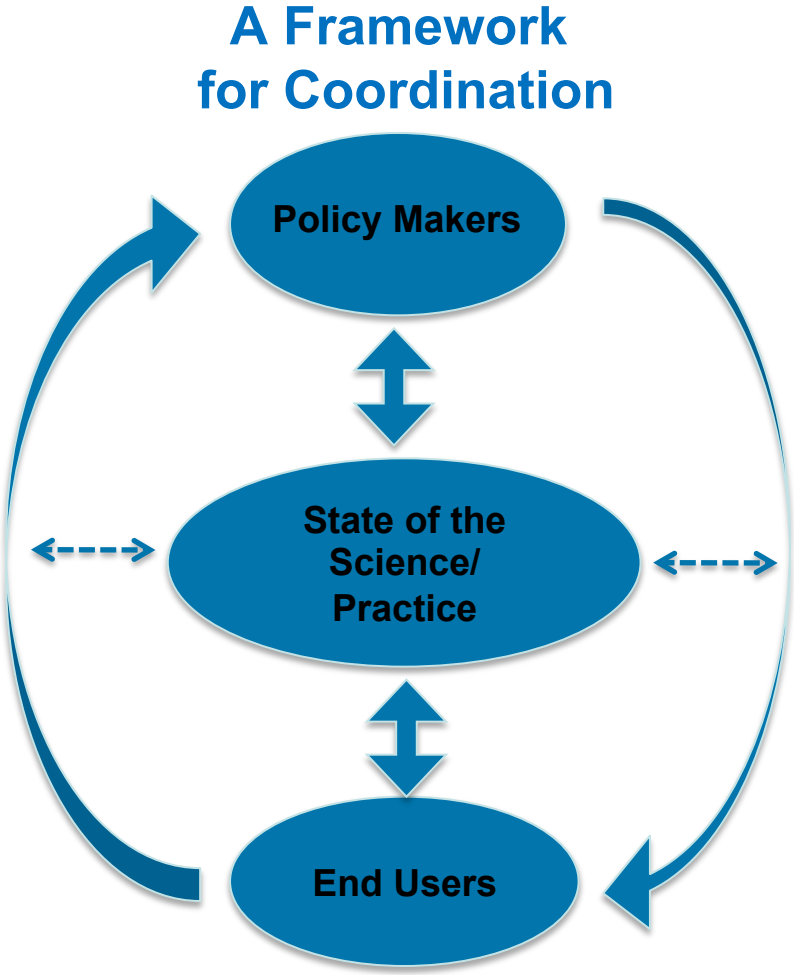
ESTCP

SERDP Climate Change-Related Research

- Areas of Focus
  - Permanent installations
    - Mostly US and territory focus
    - Some aspects applicable to DoD sites (as defined in the real property database) worldwide
  - Built and natural infrastructure
  - Readiness and installation operations
- Time horizons of interest
  - Less than 2 years out: generally don't address in terms of providing "predictive" climate change information; best practices dominate
  - Less than 20 years out: future projections from climate modeling confounded by natural variability and small emission pathway divergence, but new approaches may still be informative in cases in which a climate signal is already present
  - Greater than 20 years out and greater: use of model-projected, multiple plausible future scenarios (emission pathway dependent) key to address uncertainties

Roles of the DoD SERDP R&D Effort

- Develop the science and tools DoD requires
  - Assess vulnerability and impacts to military assets and adapt
- Leverage the larger national efforts/use for framing
  - National Climate Assessment
- Provide a technical voice regarding the "right" pace, spatial scale, and assumptions
  - Prepare for future impacts, minimize costs and impacts, and avoid inconsistency and maladaptive responses
- Provide actionable science



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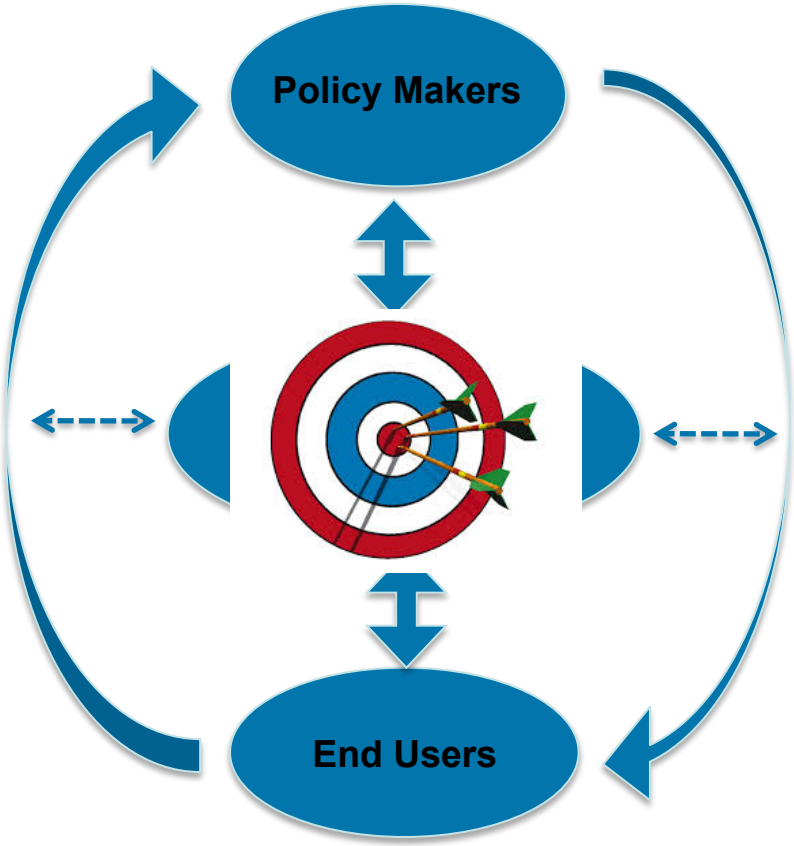
A Framework for Coordination



SERDP Coastal Installation Impact Assessment Tool Development

Physical Impacts

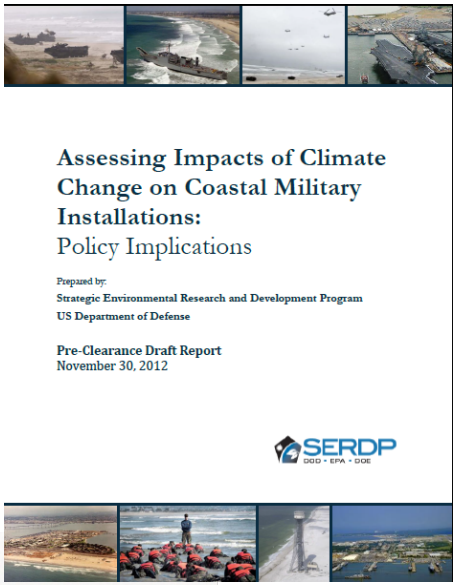
- Inundation
- Wetlands
- Erosion patterns & rates
- Surface/ground water supplies
- Water tables
- Tidal flows & currents
- Storm & flood damage

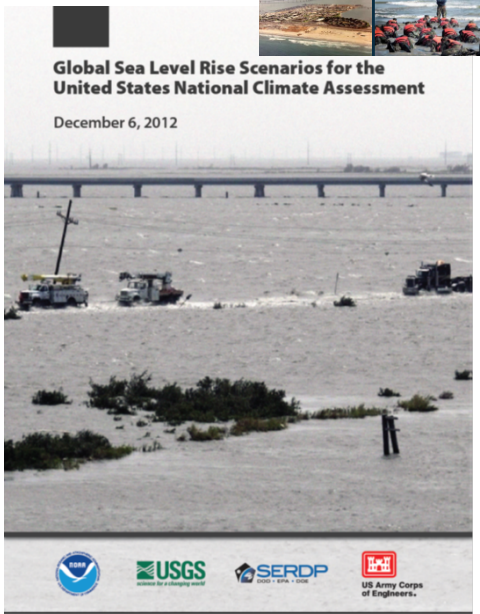
- Focus on assessment model/ tool/process development
- Four projects started in FY09

- SLR/storm surge significant threats to coastal military installations
  - New methodologies required to fully assess threat
  - Adaptation approaches required
  - Prescribed scenarios to 2100
    - 0.5m, 1.0m, 1.5m, 2.0m
    - Reflected plausible scientific assessment range

Outcomes of Coastal Assessment Research (Are we behaving as a boundary organization?)

- SERDP's initial investment supported the development of models and tools
  - Site specific studies also generated key lessons learned
- Resulted in a January 2013 SERDP Report: Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications
- Preceded by release of the National Climate Assessment-chartered report on global sea level rise scenarios (NOAA-led effort)





When Does Resolution of Climate Change Information Matter to DoD?

- DoD has over 500 permanent installations (fiefdoms?) worldwide and over 7000 individual asset sites
- Top-down governance structure, but still highly complex
- Installations range in size, but are the size of and function—urban and rural areas, intensive and non-intensive land uses—much like a typical US county
- Information is needed at various resolutions to enable:
  - General land-use planning
  - Infrastructure design and maintenance
  - Land, ecosystem, watershed, and species management
  - Managing training and testing lands
  - Day to day operations

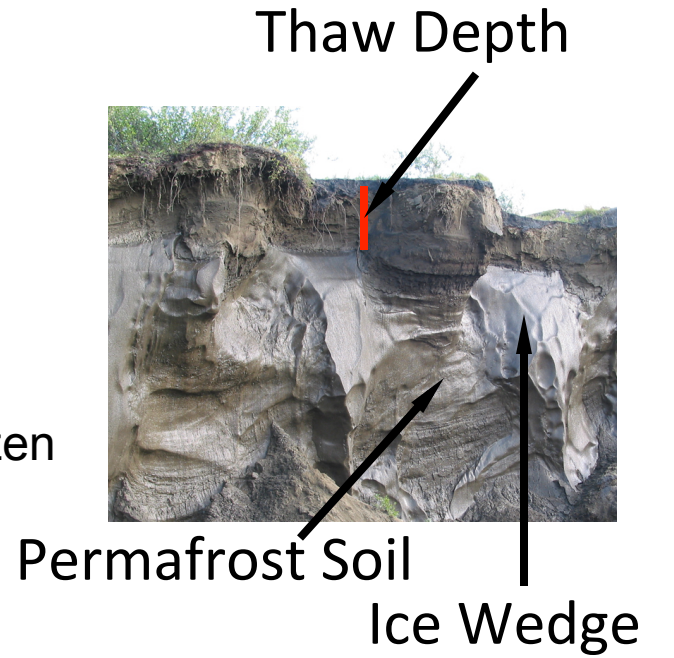
SERDP Regional Studies—Pacific Islands

- **Department of Defense Pacific Island Installations: Impacts of and Adaptive Responses to Climate Change**
  - Projects address:
    - Potential impacts of climate change and climate variability, including extreme events, on Pacific Island coastal processes and infrastructure and water resources and their adaptive capacity or resilience
  - Scale issues:
    - Islands not resolved in GCMs
    - Change in storm tracks; precipitation amounts

Kwajalein Atoll

SERDP Regional Studies—Alaska

- Impacts of Climate Change On Military Training Lands and Built Infrastructure in Alaska
  - Initial focus on permafrost dynamics
    - Mechanistic links among fire, soils, permafrost, and vegetation succession
    - Hydrologic model that can account for frozen soil, snow, and permafrost
    - Role of permafrost in controlling groundwater fluxes and flow patterns
  - Focus for ongoing projects is on impacts to built infrastructure
  - Scale issues
    - Potential changes in snow loads
    - Warming of thaw-unstable permafrost
    - Changes in hydrology



SERDP Decision Framework Projects —Training and Testing Lands

- Loss of training/testing mission days is a key concern; op tempo actually higher when troops aren't deployed overseas
- How might climate affect key weather metrics that affect training and testing and at what scale can the information be provided?
  - Fire Hazard Index—live fire training; composite of temperature, humidity, and wind speed
  - Wet-Bulb Globe Temperature (WBGT) Index—soldier/marine training limitations; composite of temperature, humidity, wind speed, and infrared radiation
- Changes in these indices could affect decisions at multiple scales

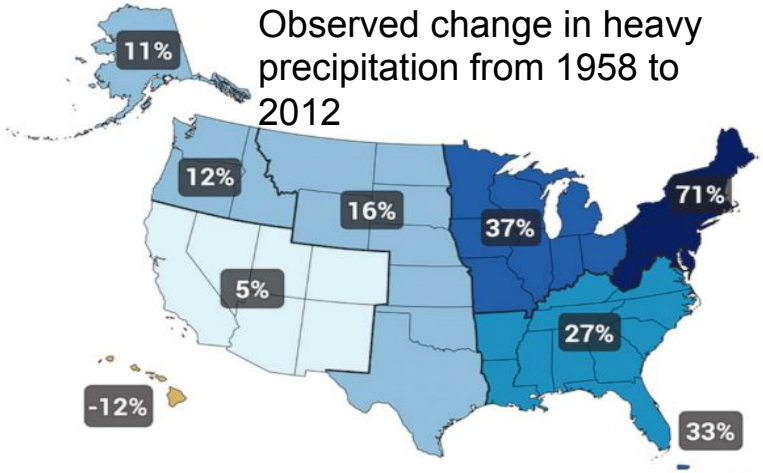
Adapting to Changes in the Hydrologic Cycle under Non-Stationary Climate Conditions: New SERDP Research Area

- Research Objectives: Improve our fundamental and applied understanding of:

  (1) the non-uniform spatial and temporal distribution of potential climate-induced changes in the intensity and variability of heavy precipitation and run-off events and

  (2) the implications for adaptation of these changes for geographic regions and applications of interest to the Department of Defense (DoD).

- Products
  - Intensity-duration-frequency curves
  - Future updates to Atlas 14?
- Scale issues
  - How much spatial coherence?
  - Rain versus snow
  - Temporal resolution key
  - Process model uncertainty



Observed change in heavy precipitation from 1958 to 2012

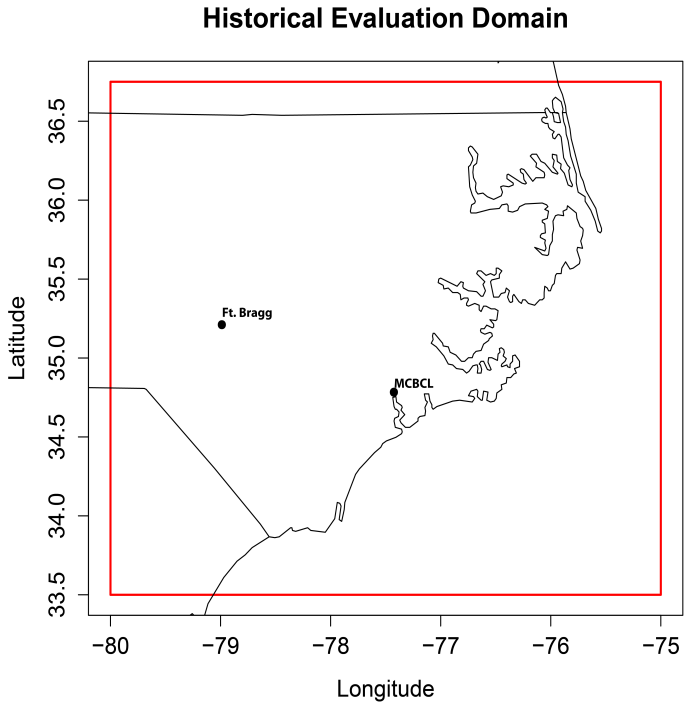
Source: National Climate Assessment Report, 2014

Defense Coastal/Estuarine Research Program (DCERP): CC-1 Research Project

Geographical Focus: Marine Corps Base Camp Lejuene, Fort Bragg, NC

Technical Objectives

1. Integrate climate change data and science into the research process through extensive engagement with team researchers and installation managers
2. Identify and document critical climate variables (at the appropriate temporal and spatial scales for the ecosystem module modeling efforts) and thresholds for the ecosystems being studied
3. Develop uniform historical climate data and future climate scenarios at ecosystem process scales sufficient to adequately test and evaluate ecosystem process models.
4. Test whether spatial scale matters.



Technical Background for CC-1

Process Model (Module)	Climate Sensitivities	Temporal Resolution	Spatial Resolution
ESM (TSP)	**temperature, precipitation**, sea level rise, **winds**, relative humidity, total **solar radiation** or photosynthetically active radiation	Daily	~40km
Marsh Model (Coastal Wetlands)	Sea Level Rise	Annual	~10 km
CSHORE-C15 (Coastal Barriers)	Wave height, wave period, water level (surge, tides, sea-level)	hourly	300 m
LANDIS (Terrestrial)	**Temperature (average minimum, average, average maximum, standard deviation), Precipitation (average and standard deviation)**, average photosynthetically active radiation.	Monthly	~10km
RCW Productivity (Terrestrial)	**Drought, precipitation (total and variance), temperature (average maximum, average minimum)**	Monthly	Base level ~20km

So When Does "Resolution" Matter?

- First, it's not just about spatial resolution
  - Undisclosed uncertainty (Jeff A and others already covered)
  - Temporal resolution, or continuous temporal information, may be important in certain contexts
  - Is "resolving" more climate variables of interest more important?
  - What are the trade-offs in trying to add more output variables and temporal resolution/continuity—is it poorer spatial resolution?
  - Does it even matter if process model uncertainty is large?

So When Does "Resolution" Matter?

- What does increased spatial resolution cost me?
  - Am I going to lose other information just to gain spatial resolution?
  - Is gaining spatial resolution always necessary?
- What does spatial resolution get me anyway (depending on how it's accomplished)?
  - Are we more accurate OR more precise but possibly wrong?
  - Are physical processes resolved better? Always important?
  - What are the benefits to the practitioner?

In Conclusion

- In deciding the question of what path(s) to follow (and resource)
  - Can the **decisions** policy makers and practitioners need to make contribute to the choices?
  - Can we be innovative in our approaches?
    - Hybrid approaches?
    - Match the problem/question?
- What is the impetus to make these happen?