Risk Assessment Techniques for Infrastructure, Cultural and Natural Resources in the Terrestrial Environment

a.k.a., Assess risk. Then act.

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Mitigation & Adaptation

Greenhouse Gas Mitigation

- A fundamentally **new issue** to address a global externality.

Climate Change Adaptation

- A new dimension to **existing responsibilities.**

Adaptation Paradigms

Paradigm #1

- Predict. Then act.

Paradigm #2

- Assess risk. Then act.

Elements of Paradigm #2

1. Targets

2. Scenarios

3. Systems

Targets

- Targets represent **desired states** of the built or natural environment.
- The state of **climate-sensitive targets** is directly or indirectly dependent on climatic conditions.
- Targets are **necessary** to have significant climate impacts.

Types of Targets

Management Targets

- e.g., abundance, population density, water supply reliability, load allocations, discharge limits, occupant comfort, etc.

Ecological Thresholds

- e.g., temperature limits

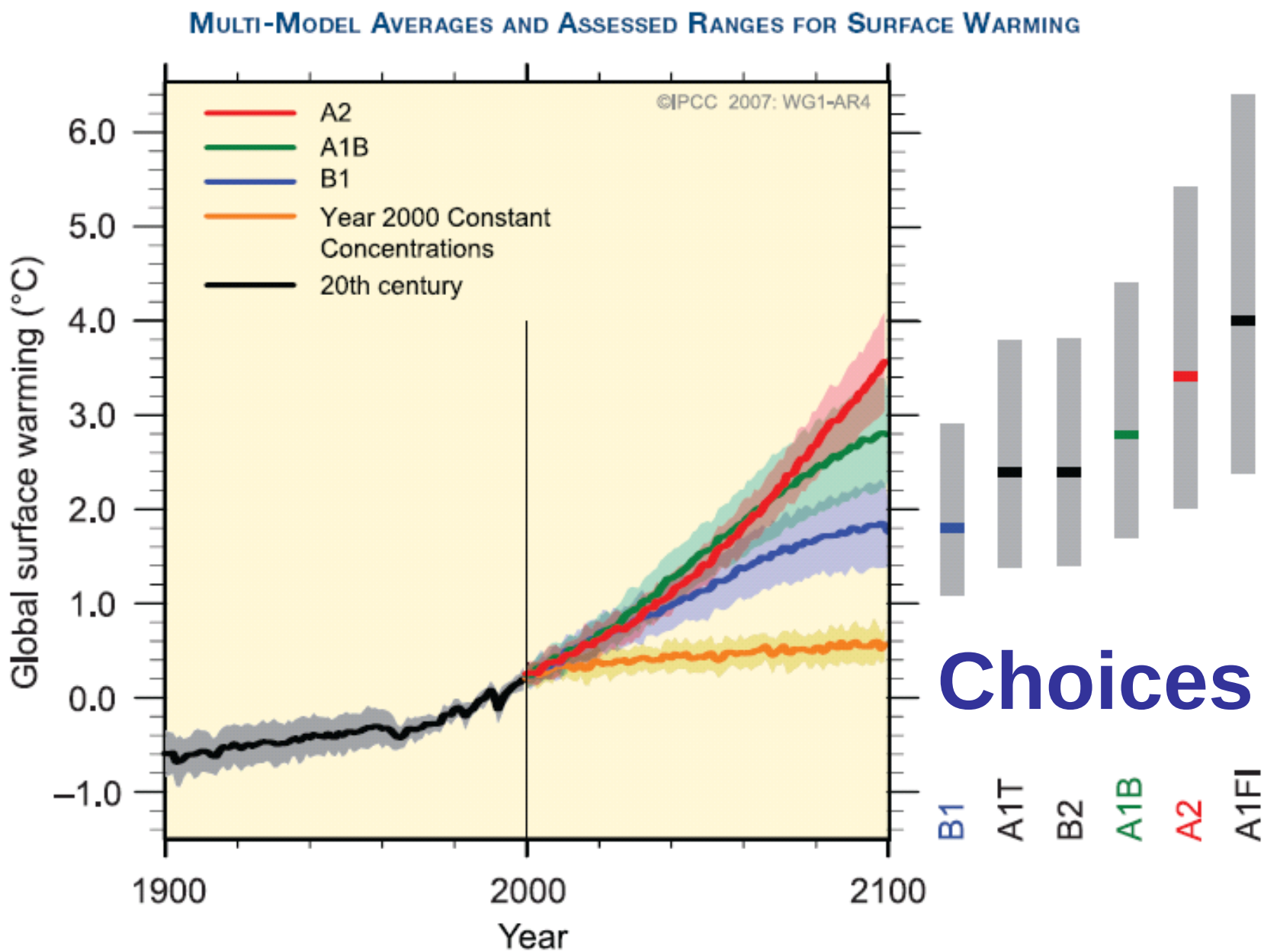
Physical Limits

- e.g., material strength

Scenarios

Relevant climate change scenarios have the potential to alter the state of targets

- Sea Level
- Sea Ice
- Temperature
- Precipitation
- Runoff
- Stream Flow
- …


Multi-Model Averages and Assessed Ranges for Surface Warming
©IPCC 2007: WG1-AR4
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
–1.0
1900
2000
2100
Year
Choices
B1
A1T
B2
A1B
A2
A1FI

Systems

Engineered and ecological systems:

- Buildings
- Transportation
- Coastal infrastructure
- Runoff controls
- Wetlands
- Food webs
- Watersheds

Buildings

Climatic Inputs: “Typical Meteorological Year” used in building design and simulation

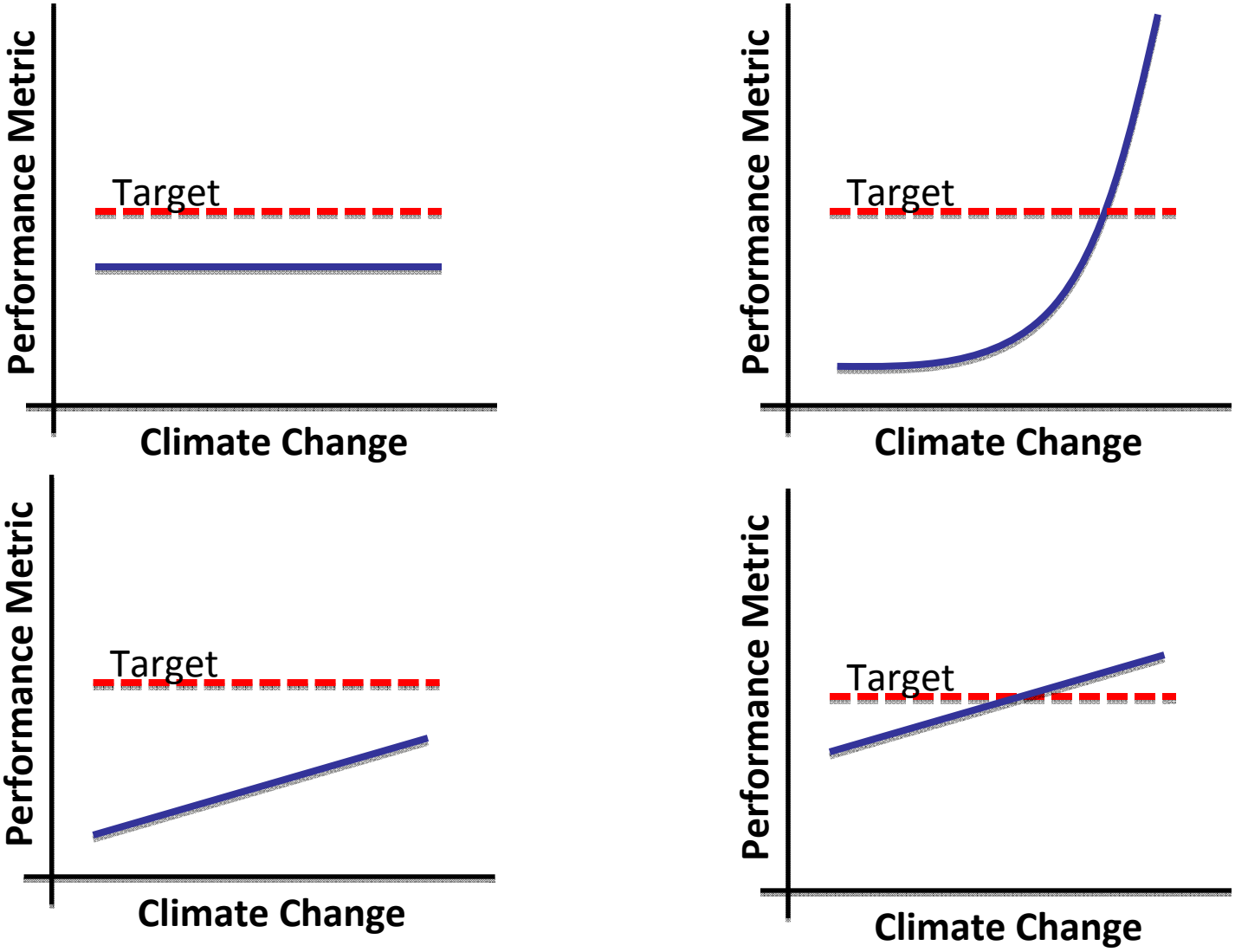
Dynamics: Building components interact in response to changing loads and occupant demand

Runoff

Climatic Inputs: Design storm set a precipitation volume that must be detained for a period of time

Dynamics: Runoff control systems may respond non-linearly based on system state and inputs

Targets x Systems x Scenarios



Chesapeake Bay

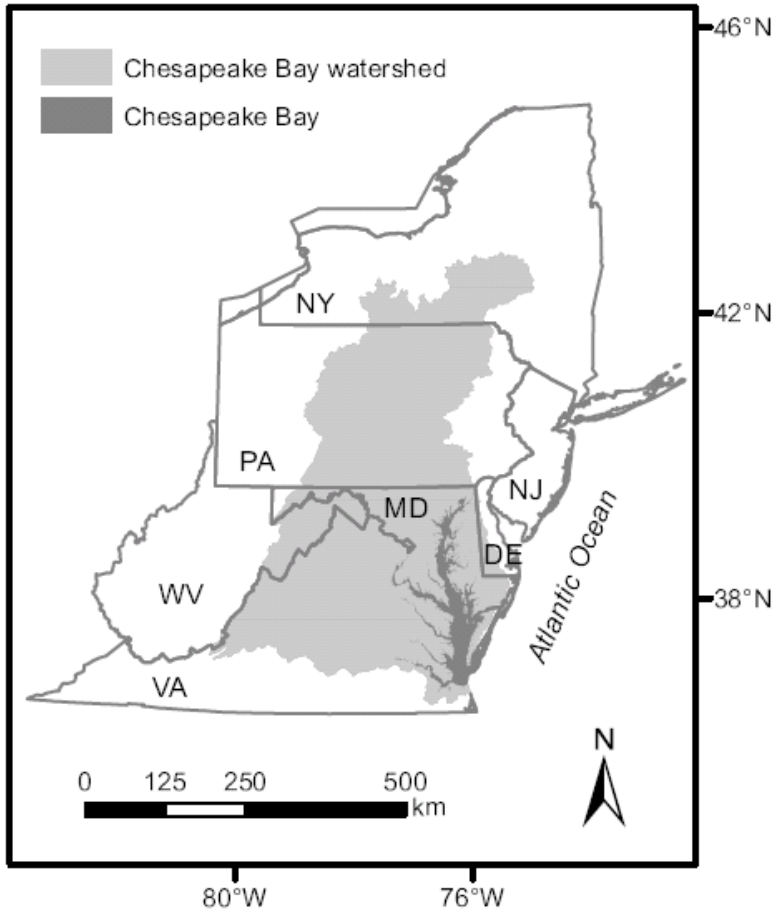
Bay Targets

Water Quality

- e.g., pollutant load allocations, designated uses, etc.

Living Resources

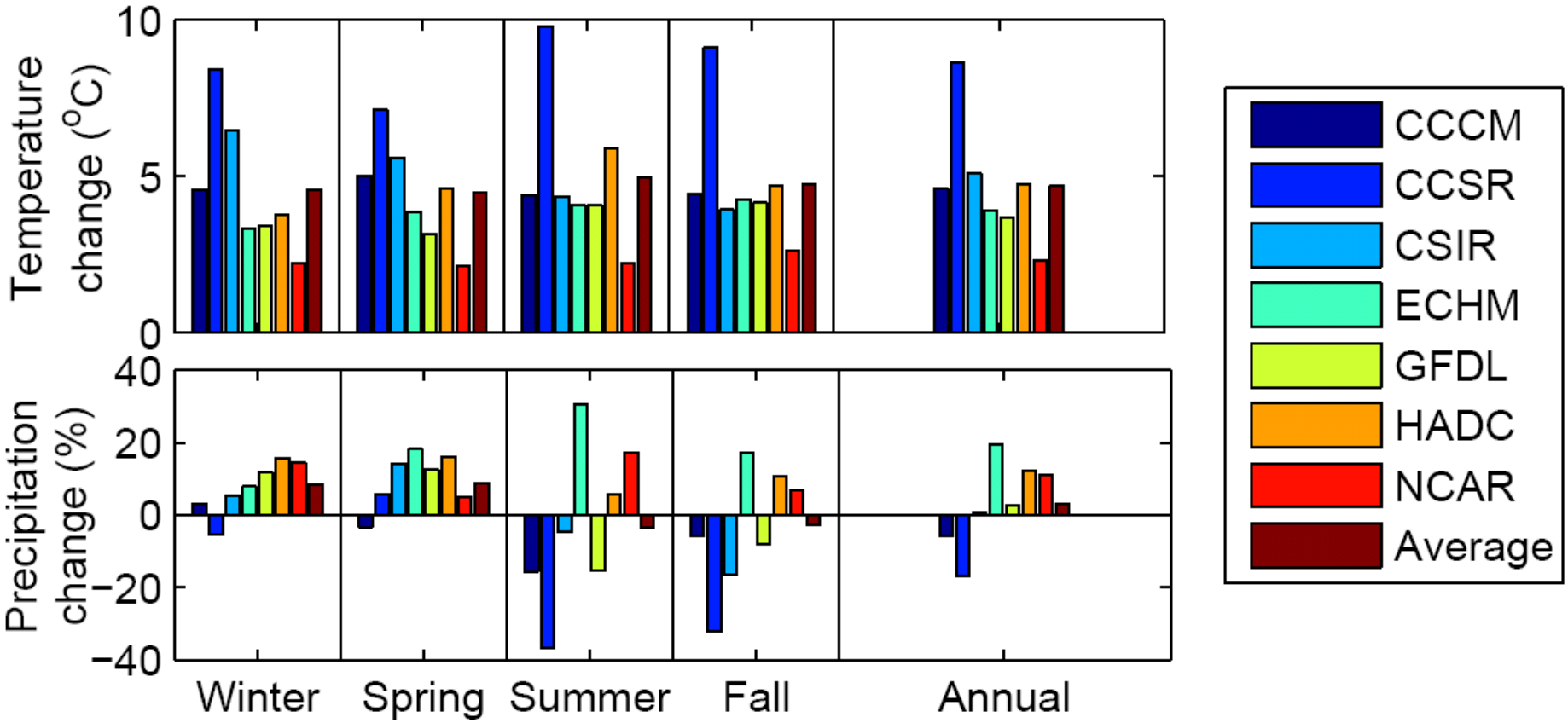
- e.g., SAV restoration, oysters, fisheries, wetlands, etc.



Bay Scenarios

Relevant climate change has the potential to alter the state of targets:

- Sea Level
- Temperature
- Precipitation
- Runoff



Najjar et al. 2010. Potential climate change impacts on Chesapeake Bay.

Bay Conditions

A **plausible** future conditions:

- Sea level: +0.5 to >1.0m
- Temperature: +2 to >8°C
- Annual precipitation: -10% to +20%
- Spring runoff: higher
- Summer runoff: lower

Bay Systems

Water Quality

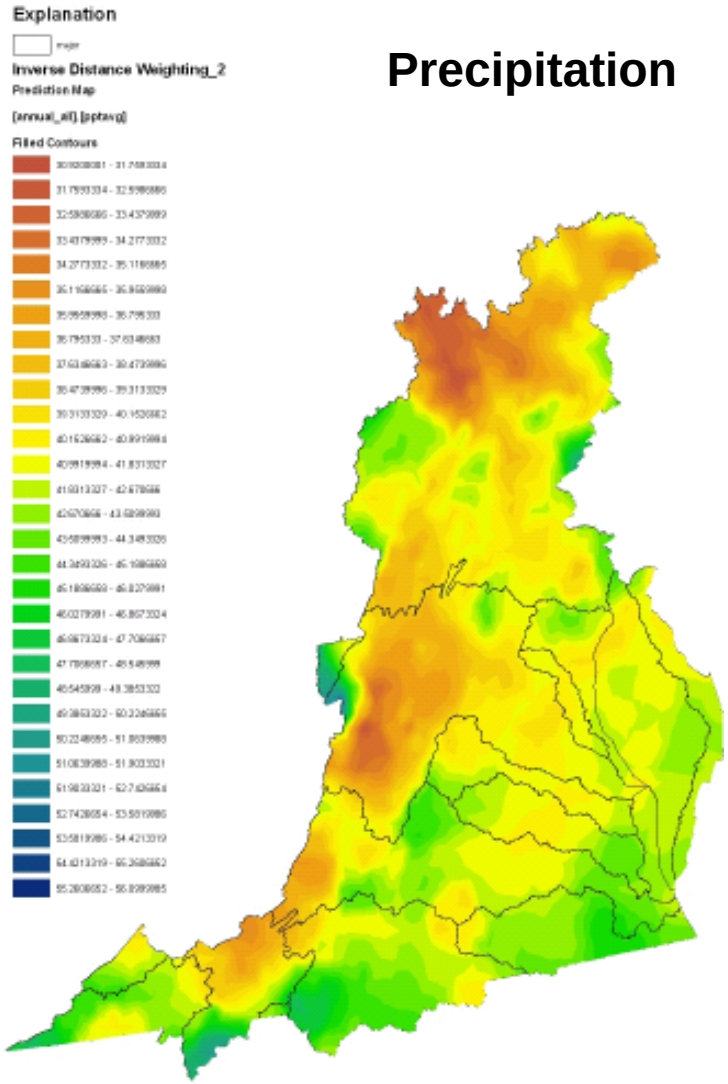
- Watershed
- Estuary

Living Resources

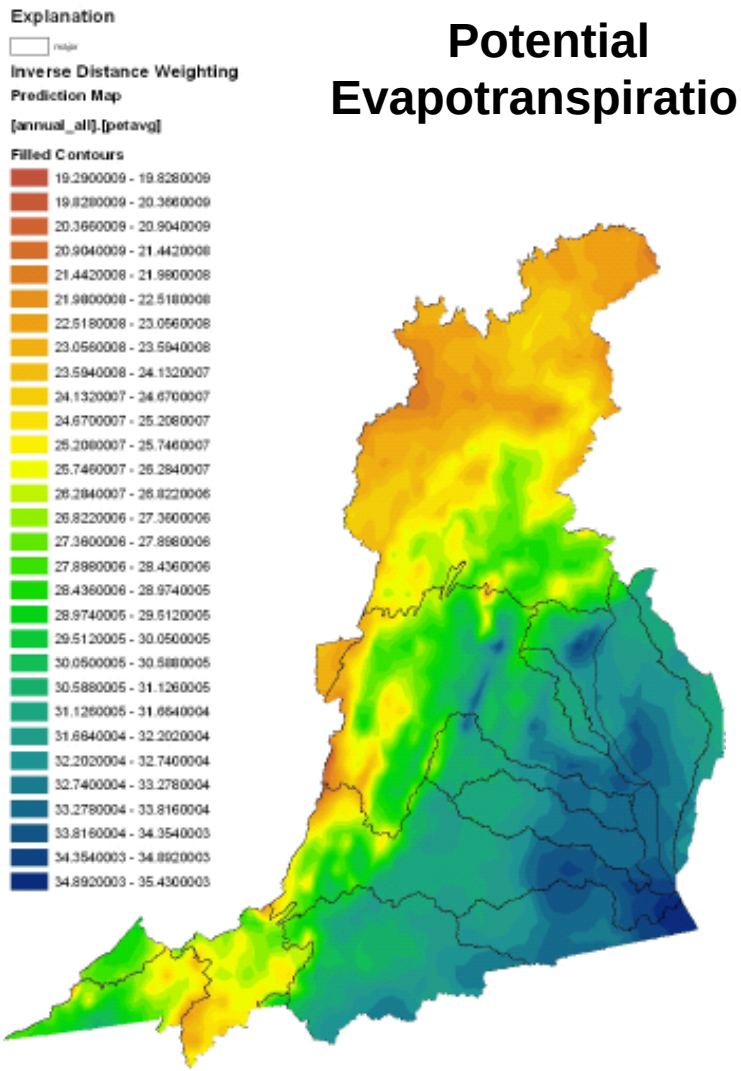
- Populations
- Communities
- Habitat

Chesapeake Bay Watershed Model

Precipitation



Potential Evapotranspiration



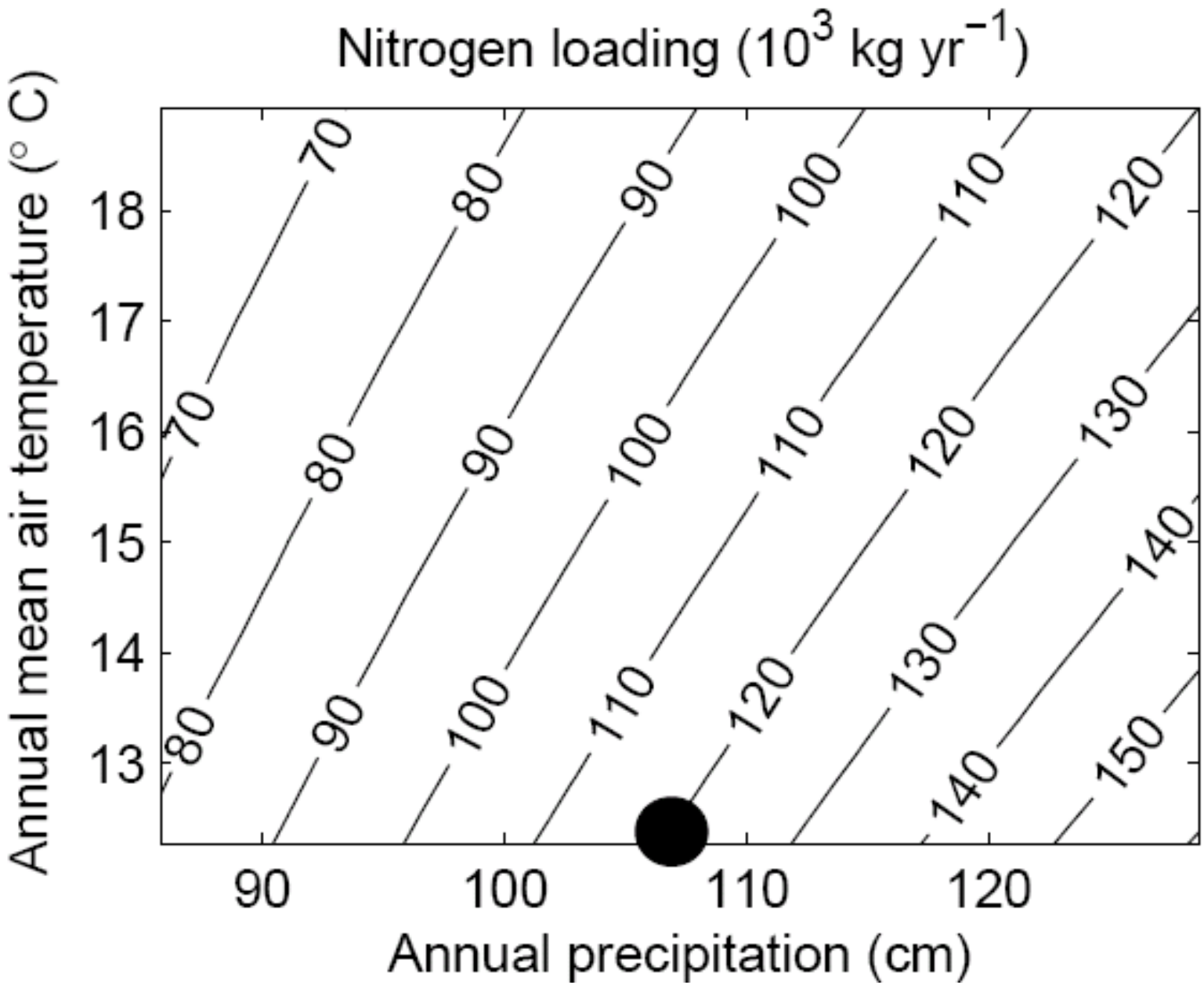
"Normal" based for 18 year simulation period based on meteorological data for 1984-2002

The model uses a ***10-year span of meteorological information****, including a mix of wet, dry, and average rainfall years, to estimate the amounts of nutrients washed off the landscape….*

The output is then averaged over the ***10 years*** *to determine the amount of nutrients delivered to streams and the Bay under* ***"normal" conditions****…*

The old model [Phase 4.3] used meteorology from 1985 through 1994, the most recent data available at the time. ***But a recent, longer-term analysis covering 30 years of data, found that 1985-94 was actually about 5 percent drier than normal.***

A switch to using data from 1991 through 2000 [Phase 5.1], which is ***more representative*** *of long-term hydrology, increases estimates of nutrient runoff-wet conditions drive* ***more nutrients into streams****….*



Najjar et al. 2010. Potential climate change impacts on Chesapeake Bay.

Implications

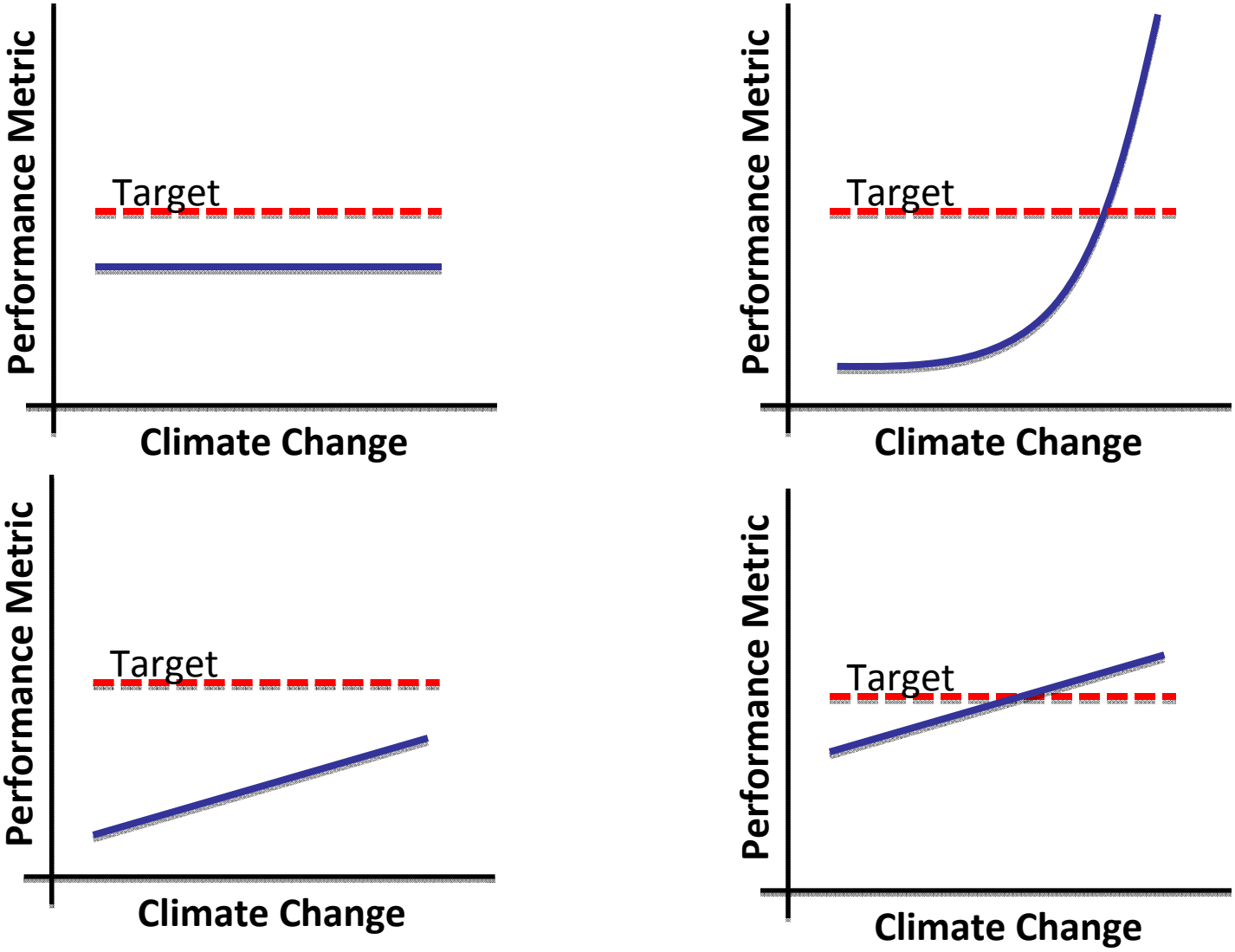
The protection and restoration of the Chesapeake Bay is highly vulnerable to climatic change:

- Pollution inputs are sensitive to change in temperature, precipitation, and sea level
- Restoration strategies rely on assumptions about climatic conditions

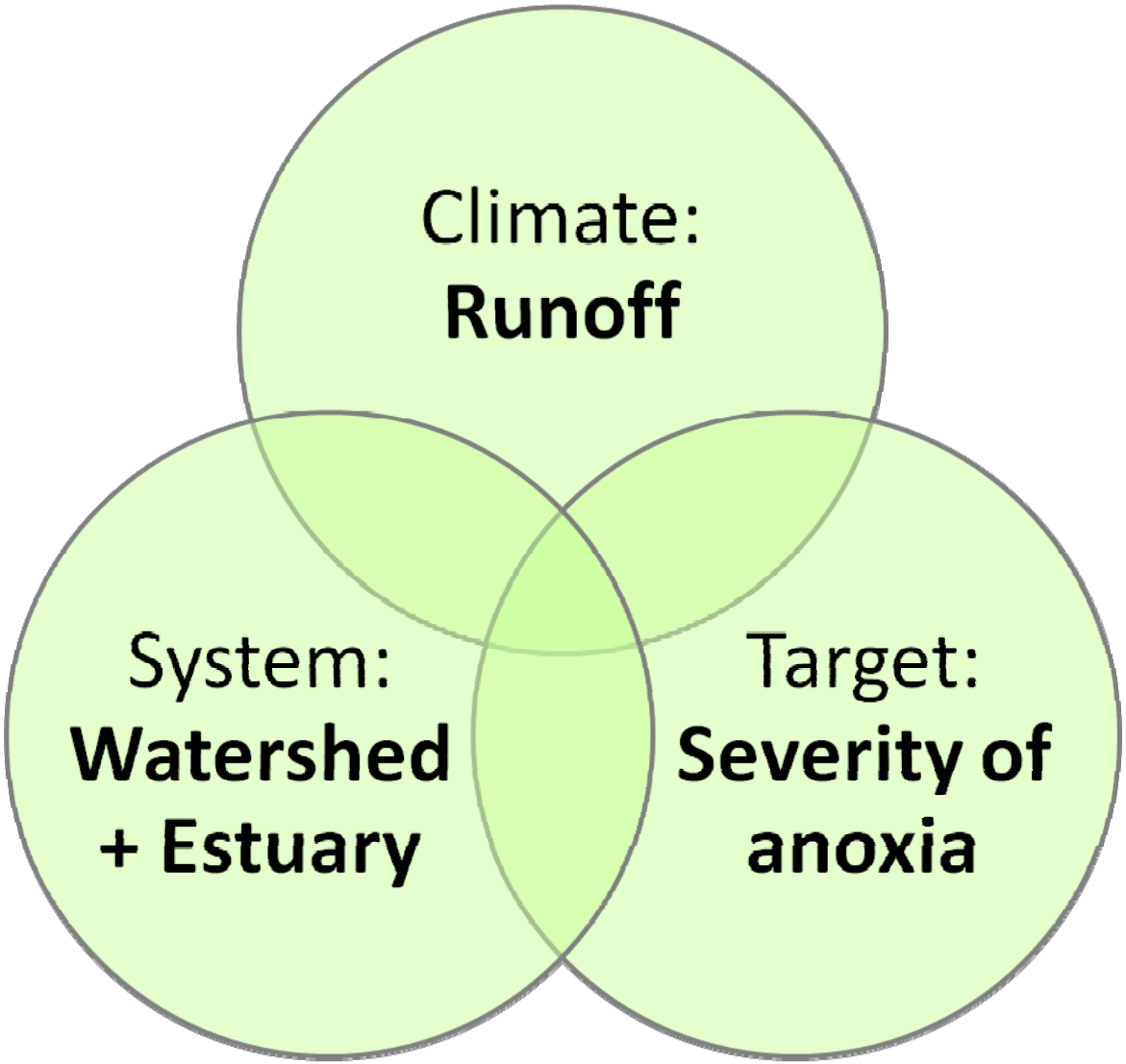
Assess risk.

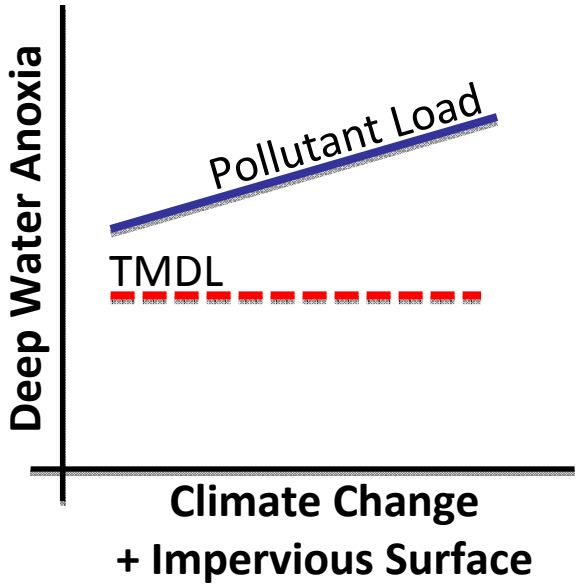
Then Act.

Understand & Prioritize

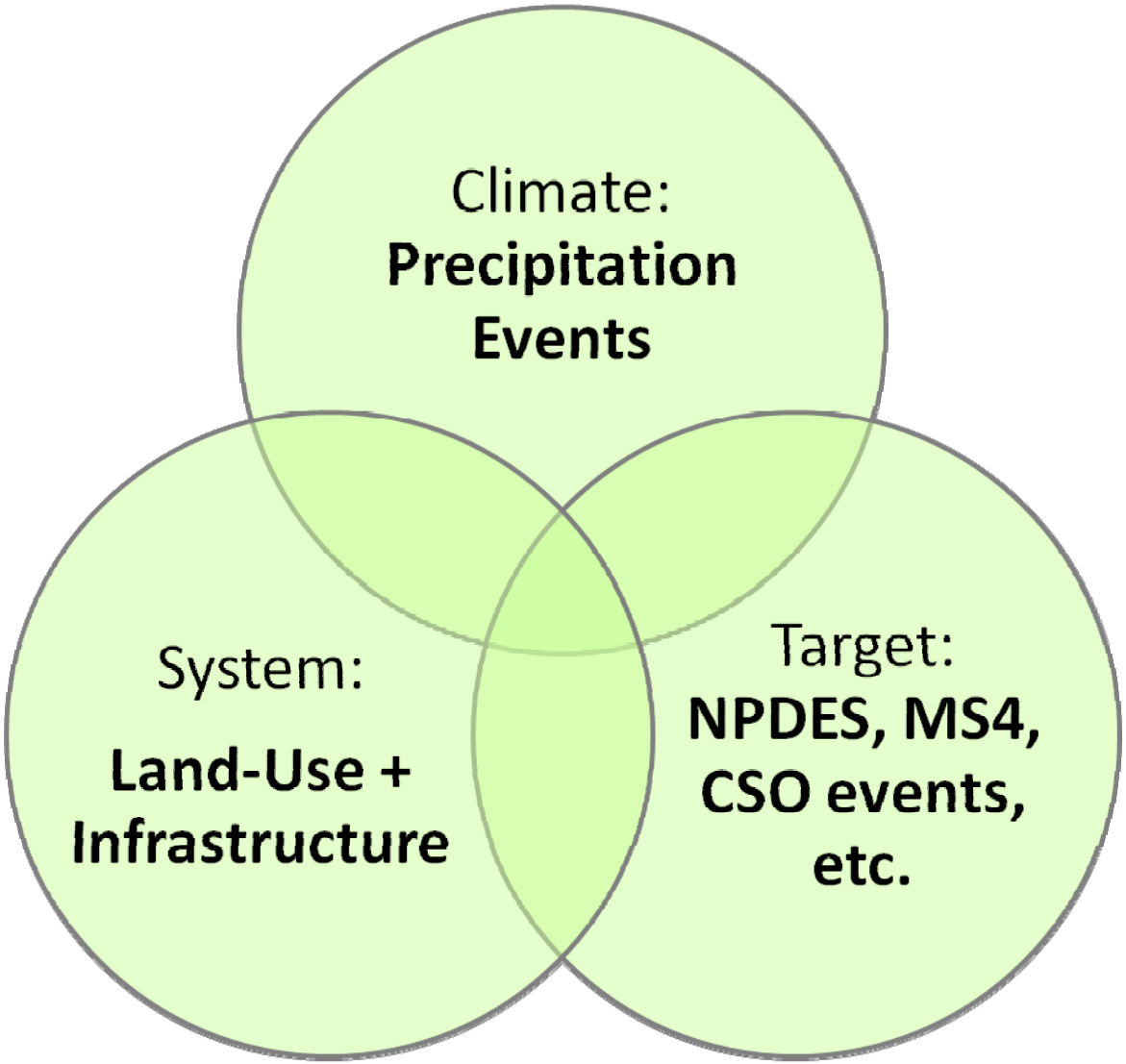


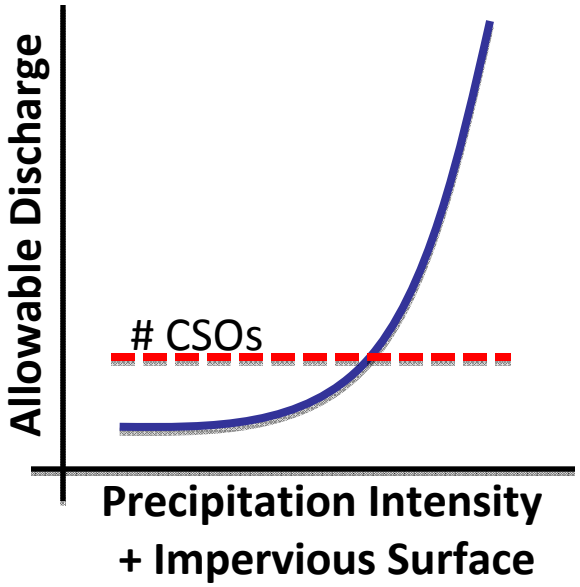
Pollutant Load Allocations





Urban Stormwater





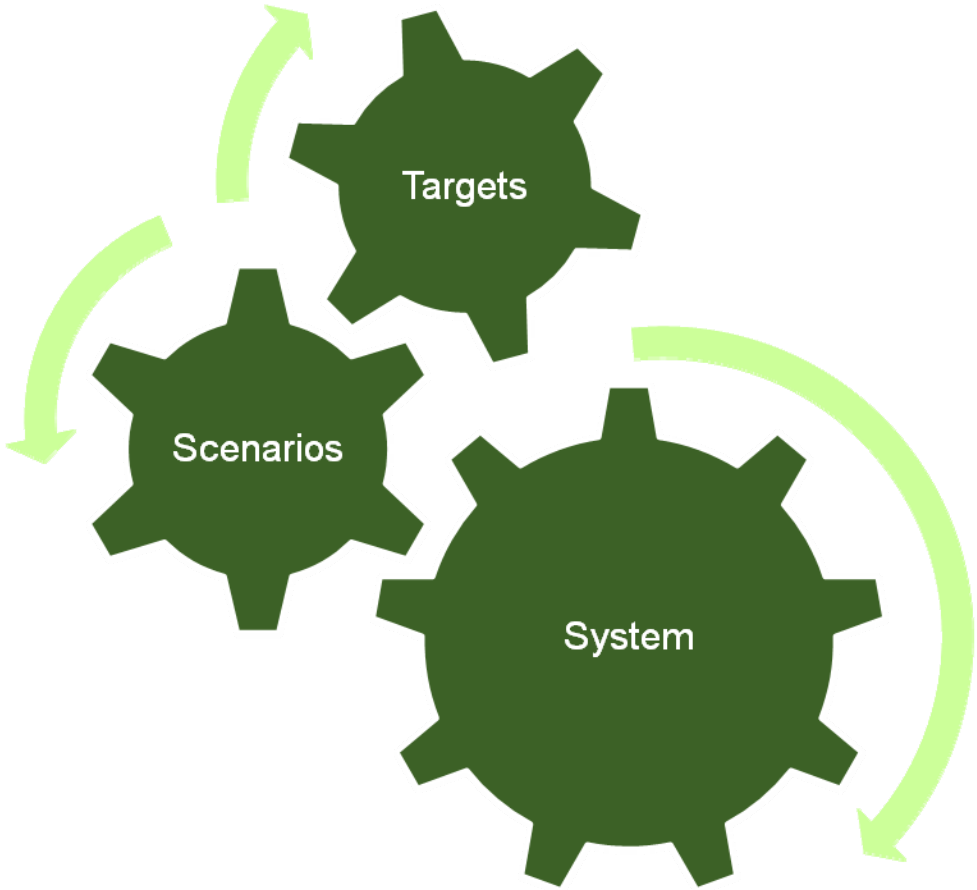
Wrap Up

Global climate change is relevant to the protection and restoration of the Chesapeake Bay

Climate change risk is…

…a function of:

- Targets
- Scenarios
- Systems



Adaptation is…

- A process of systematic assessment.
- Action to increase the likelihood of acceptable performance under changing conditions.
- Action to reduce the risk of unacceptable outcomes.

Questions

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