A decision-focused approach to preparing for climate change

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

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Adaptation Paradigms

Paradigm #1

- Predict. Then act.

Paradigm #2

- Assess risk. Then act.

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, reliability, load allocations, discharge limits, comfort, etc.

Ecological Thresholds

- e.g., temperature limits

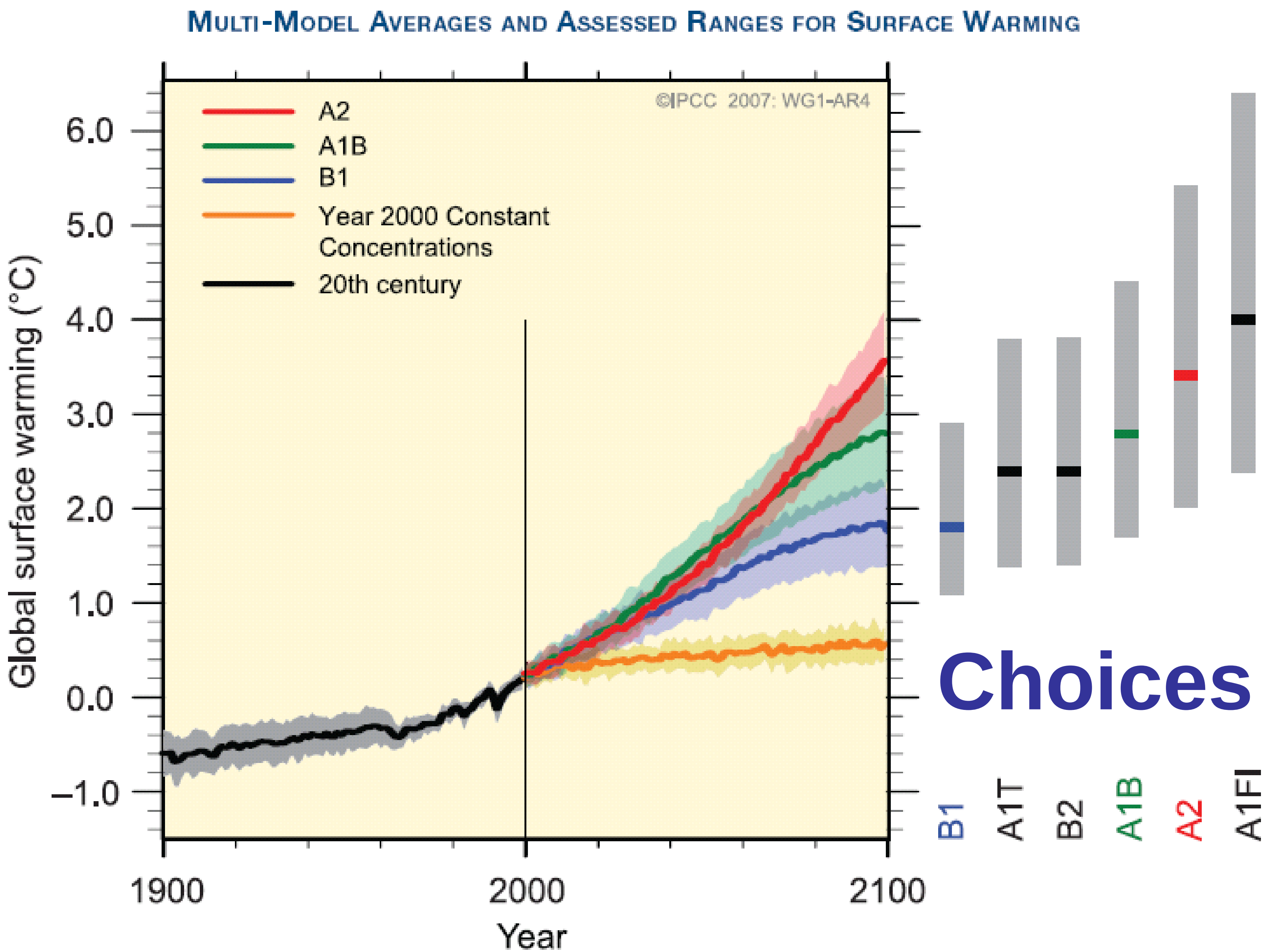
Physical Limits

- e.g., material strength

Scenarios

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

- Sea Level
- Temperature
- Precipitation
- Evapotranspiration
- Runoff


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
B1
A1T
B2
A1B
A2
A1FI

Choices

Systems

Engineered, agricultural, and ecological:

- Buildings
- Transportation systems
- Infrastructure
- Fields and orchards
- Animal operations
- Runoff controls
- Wetlands
- 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

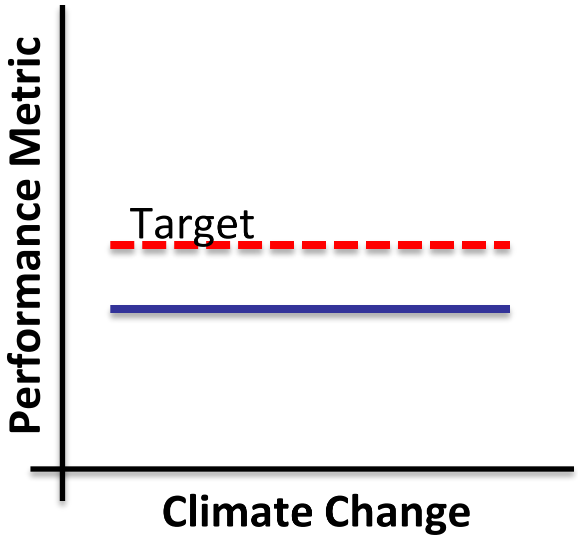
Dynamics: Runoff control systems may respond non-linearly based on system state and inputs

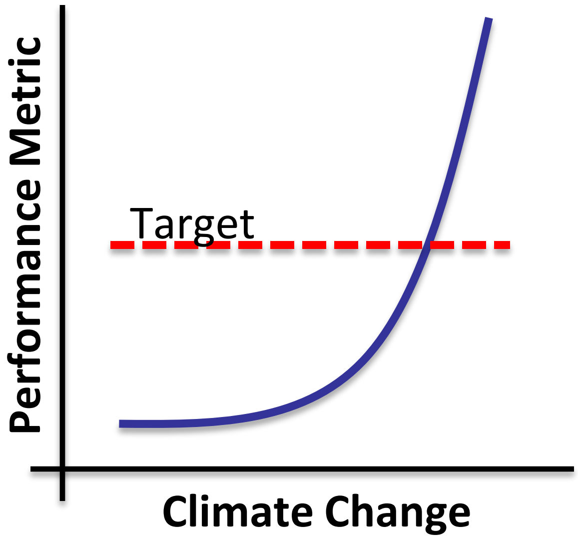
Orchard

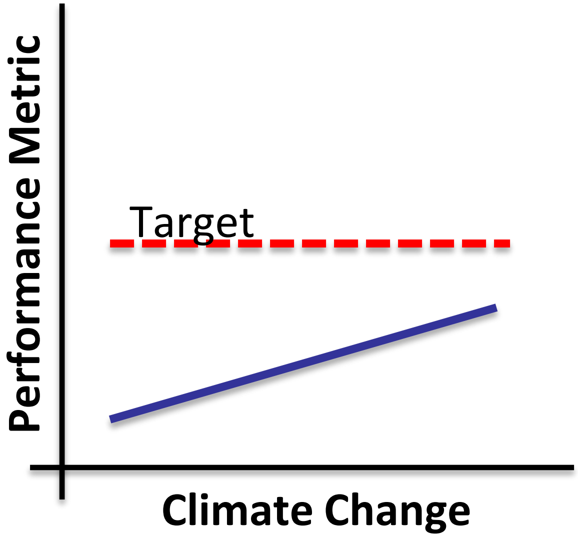
Climatic Inputs: Growing degree days, pollination conditions, precipitation

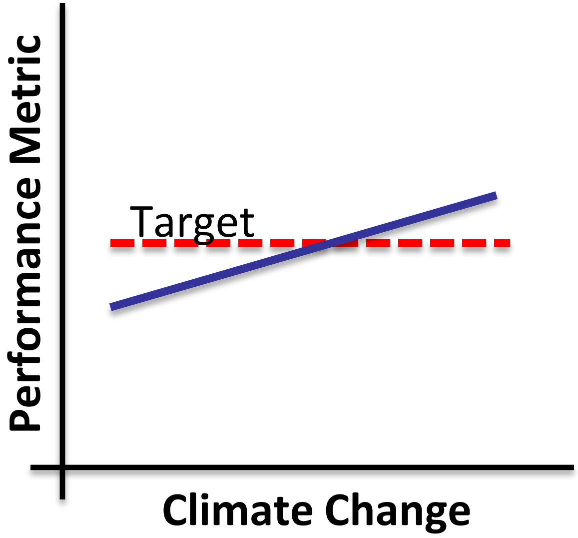
Dynamics: Meteorological conditions contribute to yield, damage, quality, timing of production

Targets x Systems x Scenarios









Chesapeake Bay

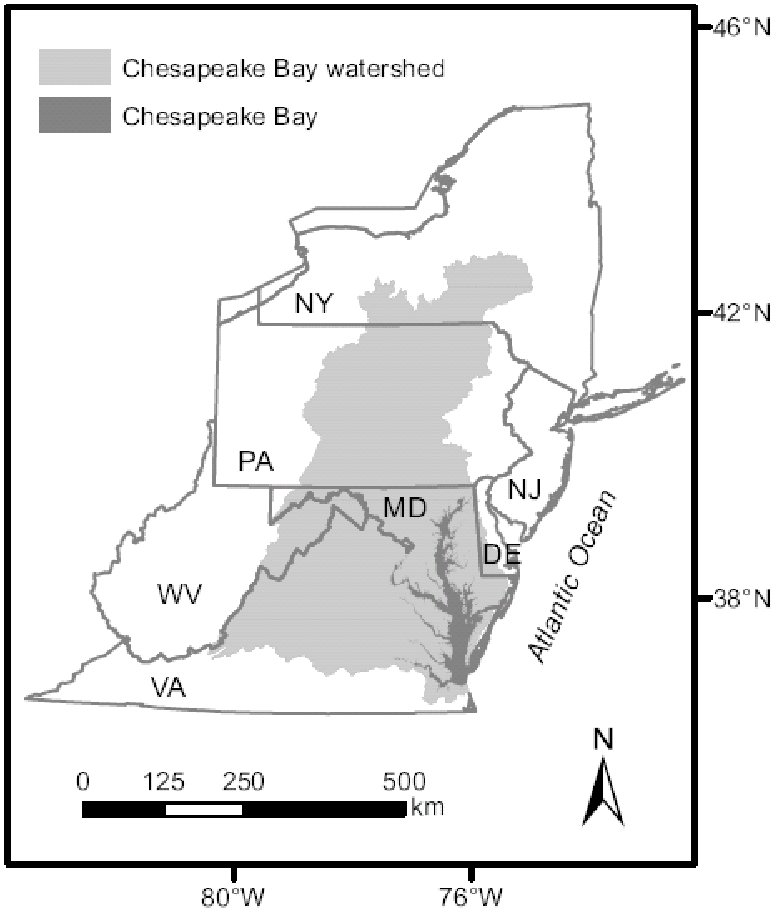
Bay Targets

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

Plausible Conditions

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

Bay Systems

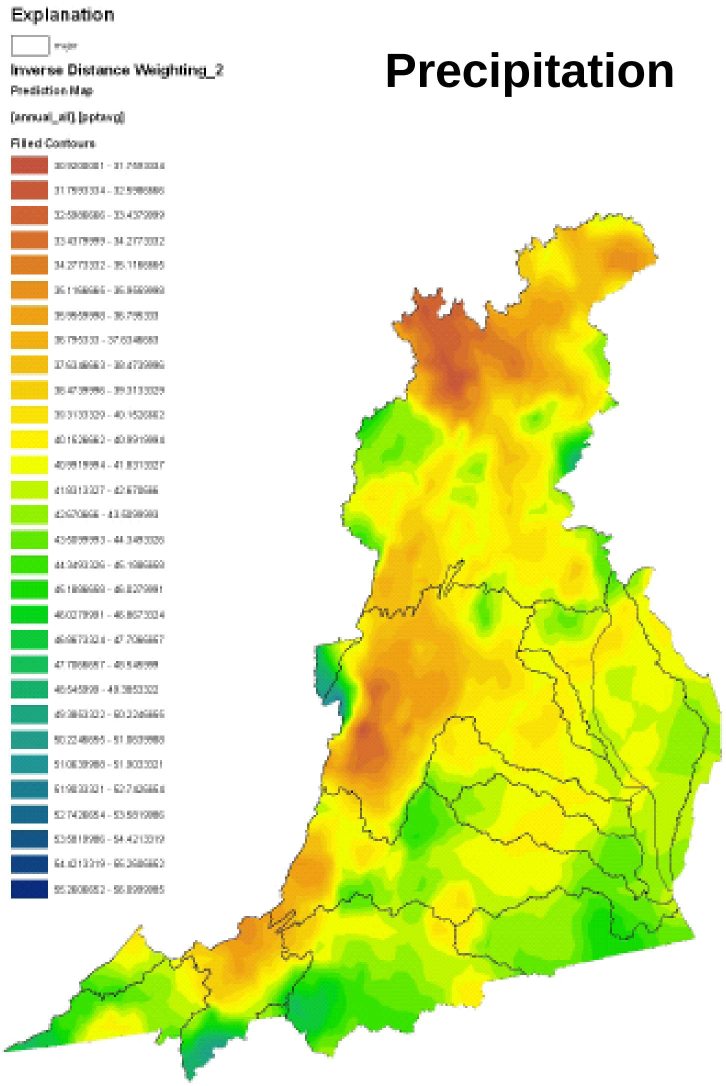
Water Quality

- Watershed
- Estuary

Living Resources

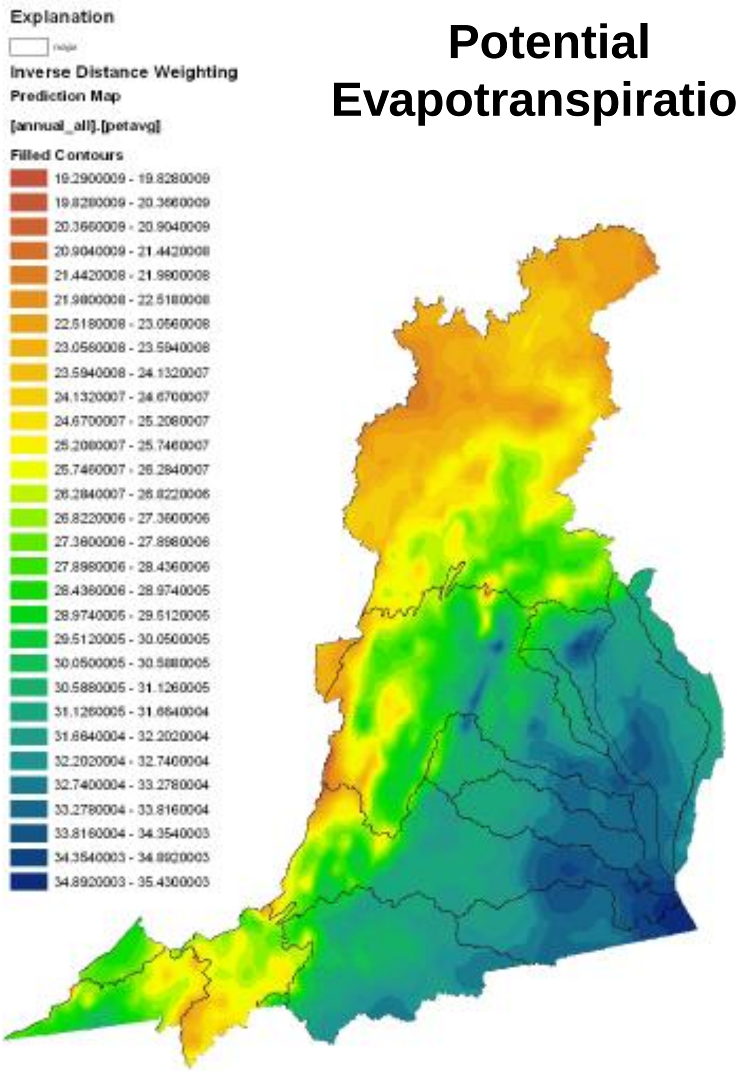
- Populations
- Communities
- Habitat

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****….*

Karl Blankenship, Bay Journal, December 2008

Monocacy Watershed Case Study

Net 10.7% increase in N loading, differential sensitivity to climate change:

- High till agricultural land with manure application
- Low till nutrient management lands
- Bare construction lands
- <u>18% of watershed, 47% of increase in total N loads</u>

Imhoff et al. 2007. Using the Climate Assessment Tool (CAT) in the U.S. EPA BASINS Integrated Modeling System to Assess Watershed Vulnerability to Climate Change

Table 1. Change in total nitrogen load contribution attributable to selected climate change scenario in Monocacy River Basin, Maryland.

Land Use	Area (ha)	base conditions Load (kg/ha)	base conditions Total Load (kg)	climate change scenario Load (kg/ha)	climate change scenario Total Load (kg)	% Change in Unit Load	% of Total Change
forest	86581	2.34	202287	3.20	276935	36.9%	26.0%
nutrient management hitil with manure	17900	32.29	577995	35.76	640043	10.7%	21.6%
nutrient management lotil	24539	21.56	529020	23.36	573168	8.4%	15.4%
bare-construction	2535	40.62	102959	52.27	132488	28.7%	10.3%
lowtill with manure	5210	44.89	233892	48.93	254954	9.1%	7.3%
hightill with manure	3792	73.96	280488	78.81	298906	6.6%	6.4%
pasture	23079	5.37	123919	5.96	137598	11.0%	4.8%
nutrient management hay	16002	8.77	140300	9.56	153060	9.1%	4.4%
low intensity pervious urban	31408	5.71	179259	5.86	184027	2.7%	1.7%
harvested forest	875	49.54	43330	53.05	46399	7.1%	1.1%
high intensity pervious urban	8533	5.67	48401	5.80	49524	2.3%	0.4%
alfalfa	5505	12.21	67239	12.39	68199	1.4%	0.3%
nursery	1147	23.40	26845	24.08	27625	2.9%	0.3%
extractive	115	17.28	1988	22.03	2535	27.5%	0.2%
hightill without manure	183	50.91	9294	54.03	9863	6.1%	0.2%
hay with nutrients	4581	8.15	37324	8.23	37692	1.0%	0.1%
nutrient management hitil without manure	944	27.50	25966	27.68	26138	0.7%	0.1%
trampled	116	65.37	7582	65.38	7583	0.0%	0.0%
natural grass	3348	3.19	10680	3.07	10265	-3.9%	-0.1%
hay without nutrients	7245	6.24	45238	6.05	43838	-3.1%	-0.5%
total load			2694006		2980840	10.7%	

Implications

The Chesapeake Bay is vulnerable to changing climatic conditions:

- Pollution inputs are sensitive to changes in temperature, precipitation, and sea level
- Restoration strategies rely on assumptions about climatic conditions
- Land use/management practices vary in their relative sensitivity

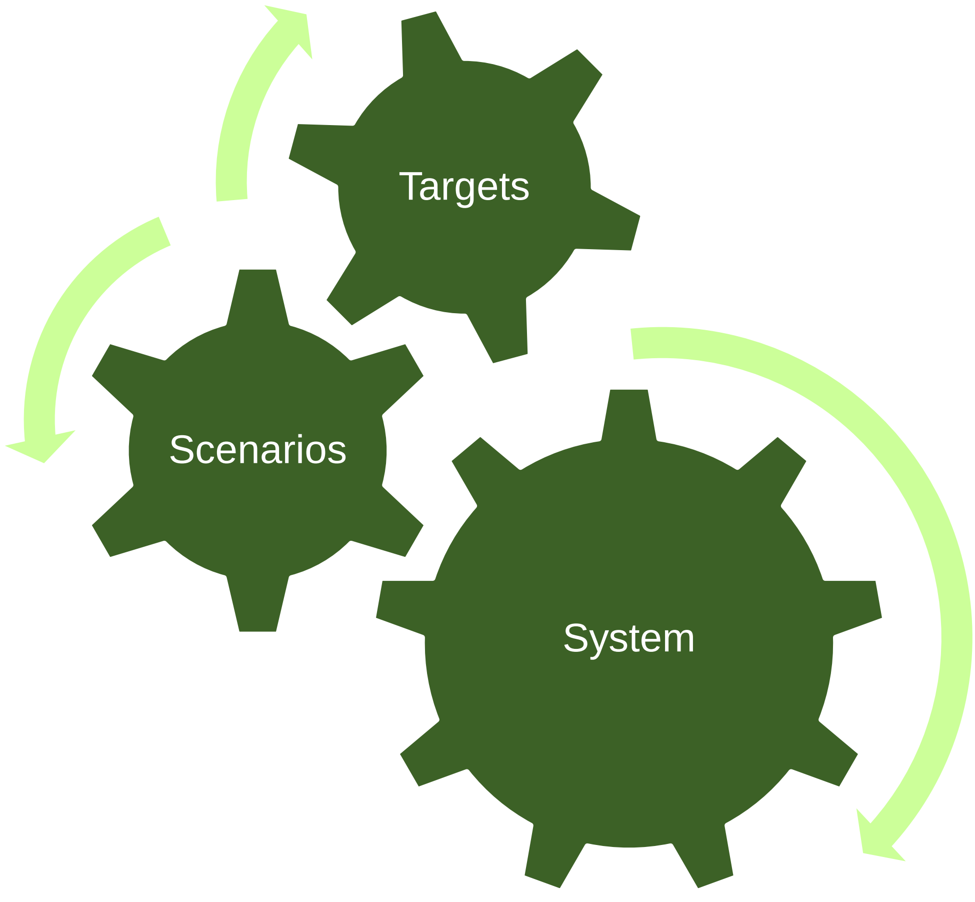
Assess risk.

Then Act.

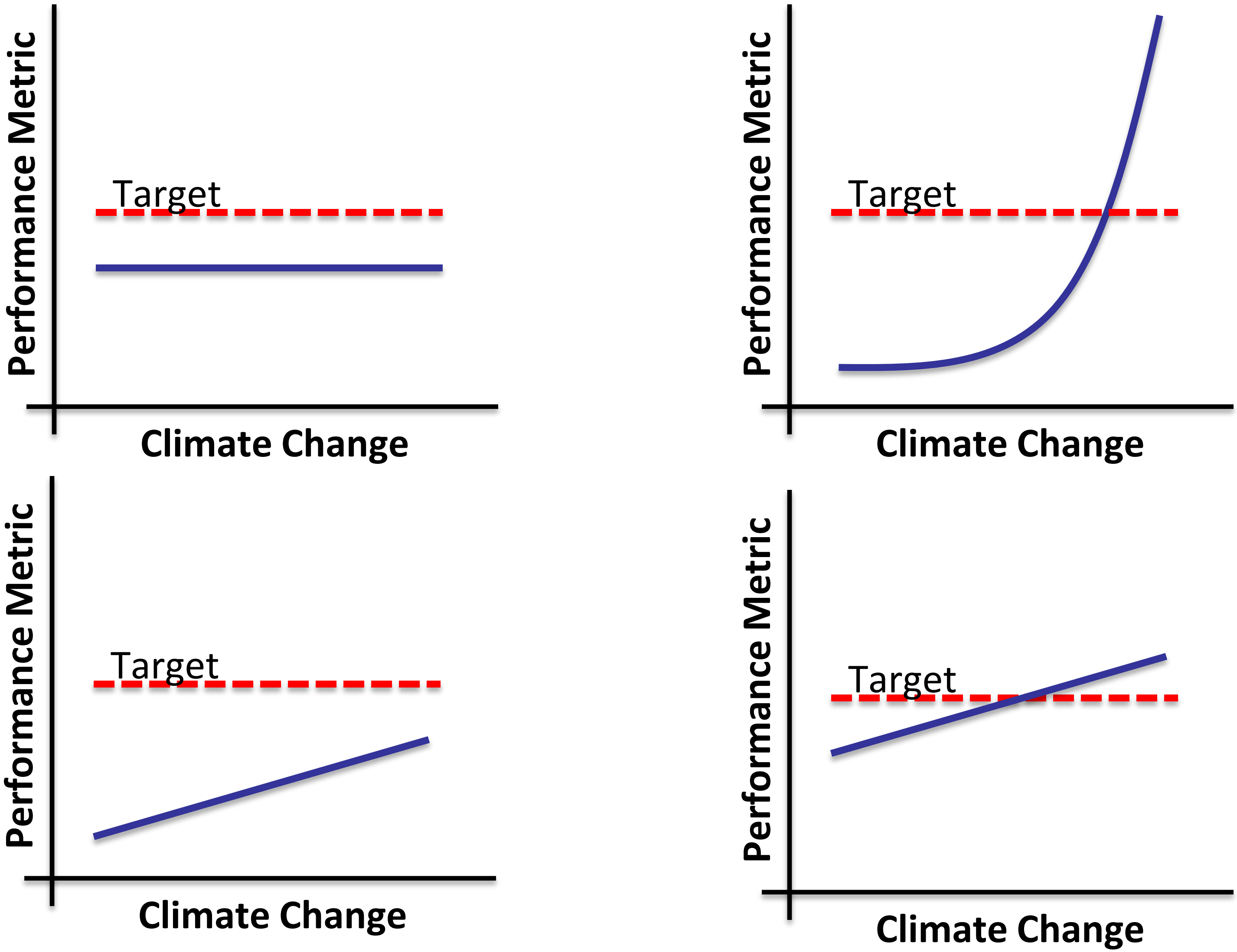
Climate change risk is…

…a function of:

- Targets
- Scenarios
- Systems



Understand & Prioritize



Questions

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