Climate Resilience

Implications for Built Environments and the Bay

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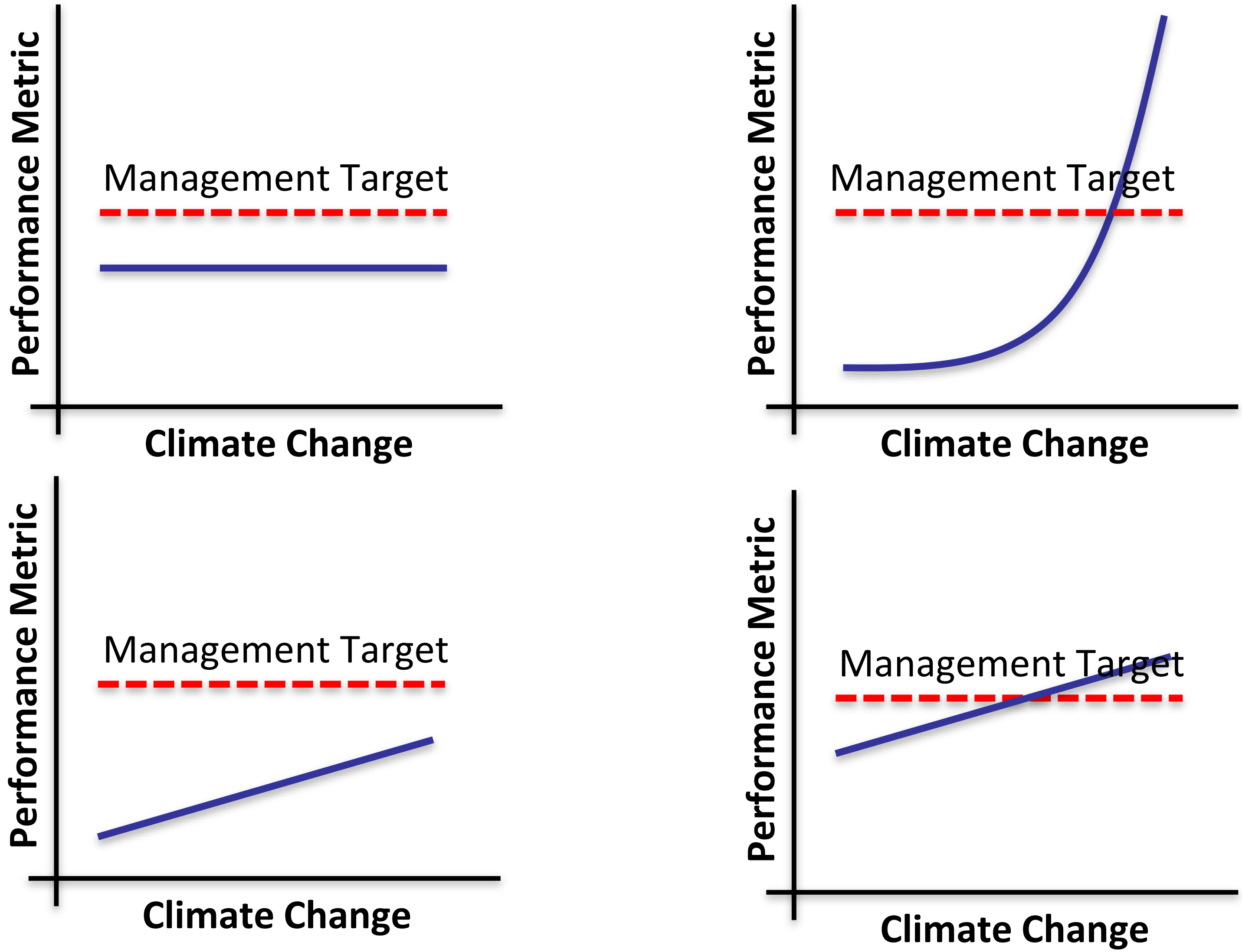
Climate Resilience

Targets x Systems x Scenarios



Systems

Buildings

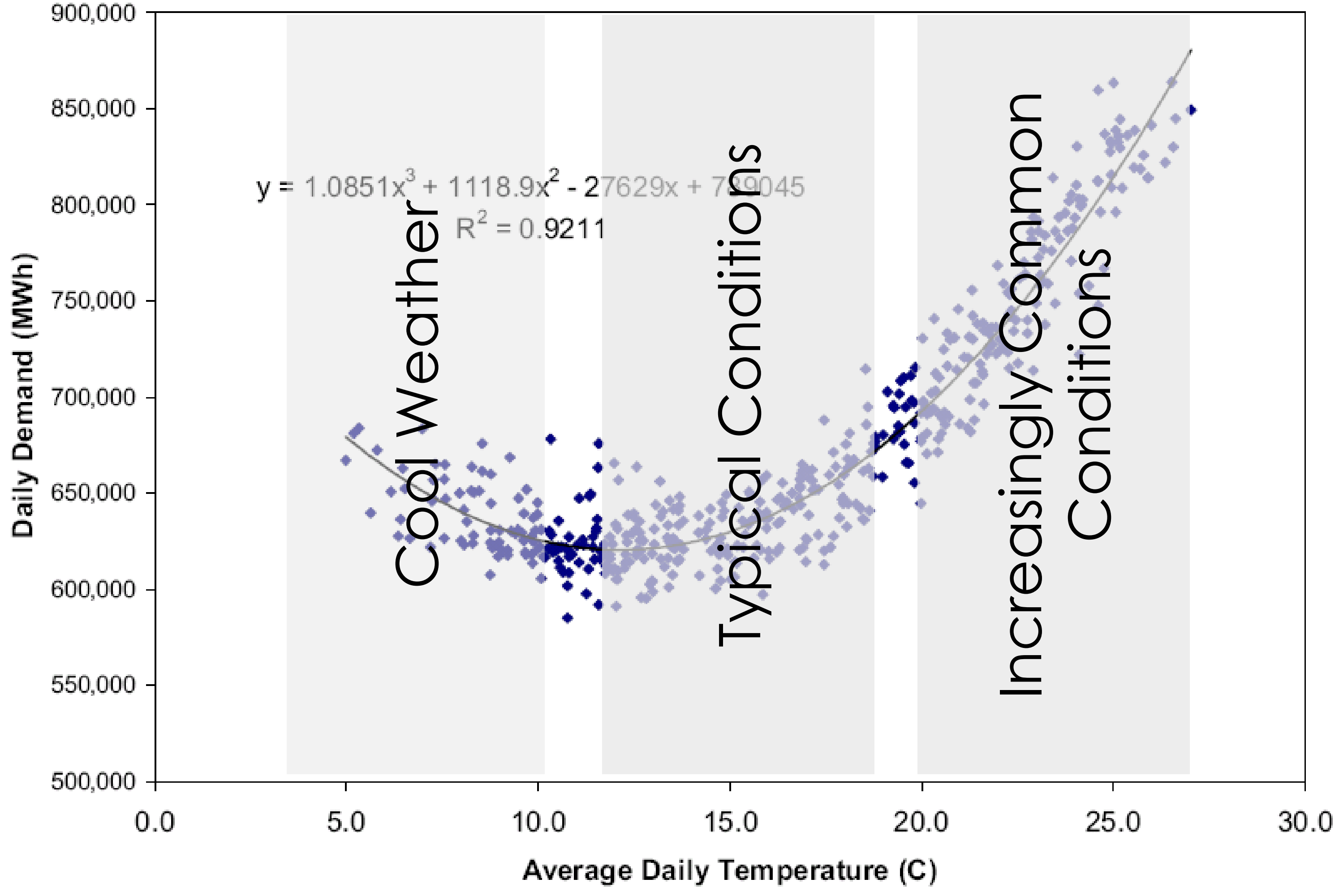
Stormwater

Buildings: Targets & Scenarios

Buildings are designed based on historic conditions
e.g., Typical Meteorological Year

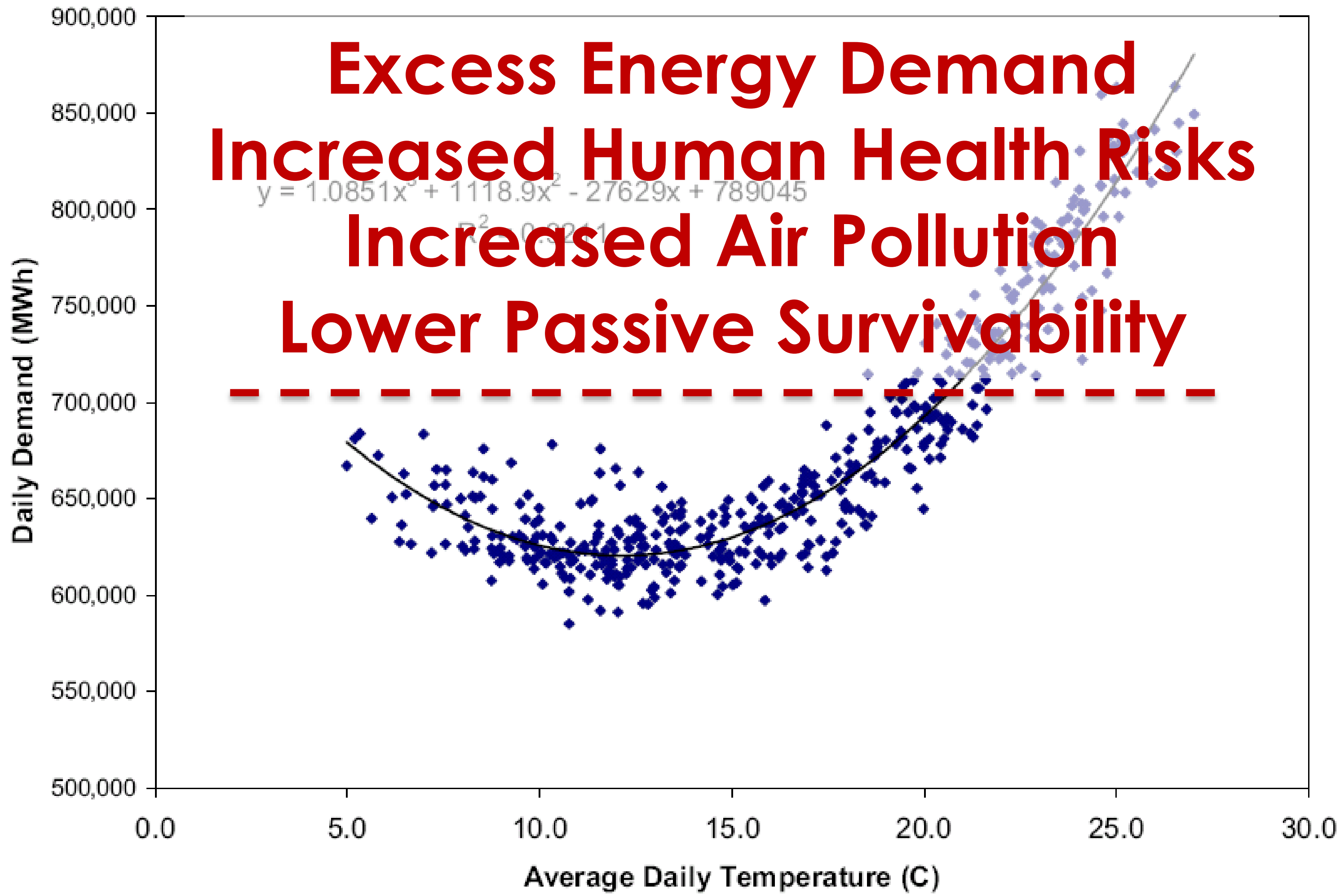
Future conditions are unlikely to match historic assumptions
e.g., *minimum* rise of 1.5° C by 2020; potential for >5° C

Buildings: Energy Demand



Source: Franco and Sanstad (2008) Climate change and electricity demand in California

Buildings: Energy Demand



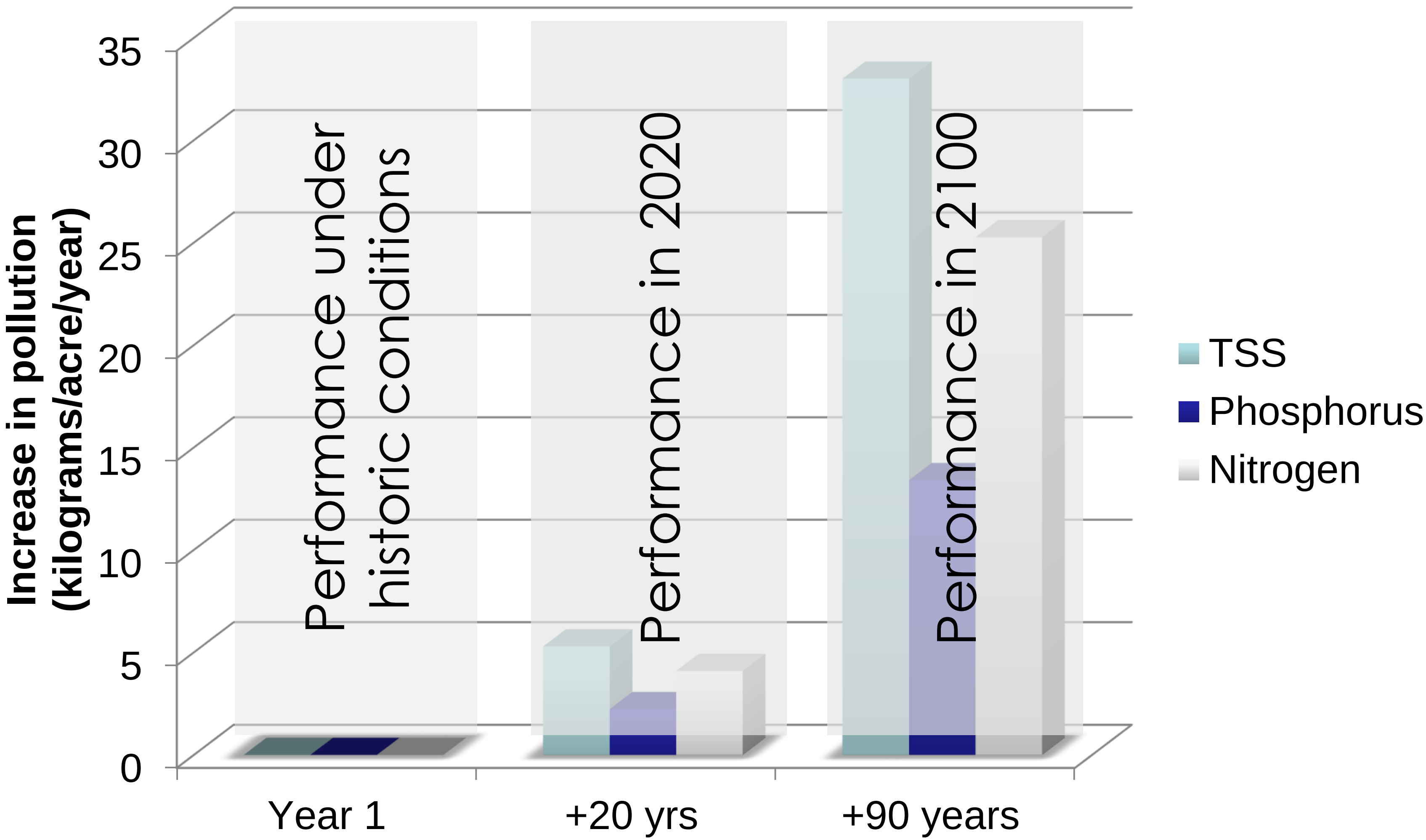
Source: Franco and Sanstad (2008) Climate change and electricity demand in California

Stormwater: Targets & Scenarios

Stormwater control strategies are based on historic design storms
e.g., storm intensity, frequency

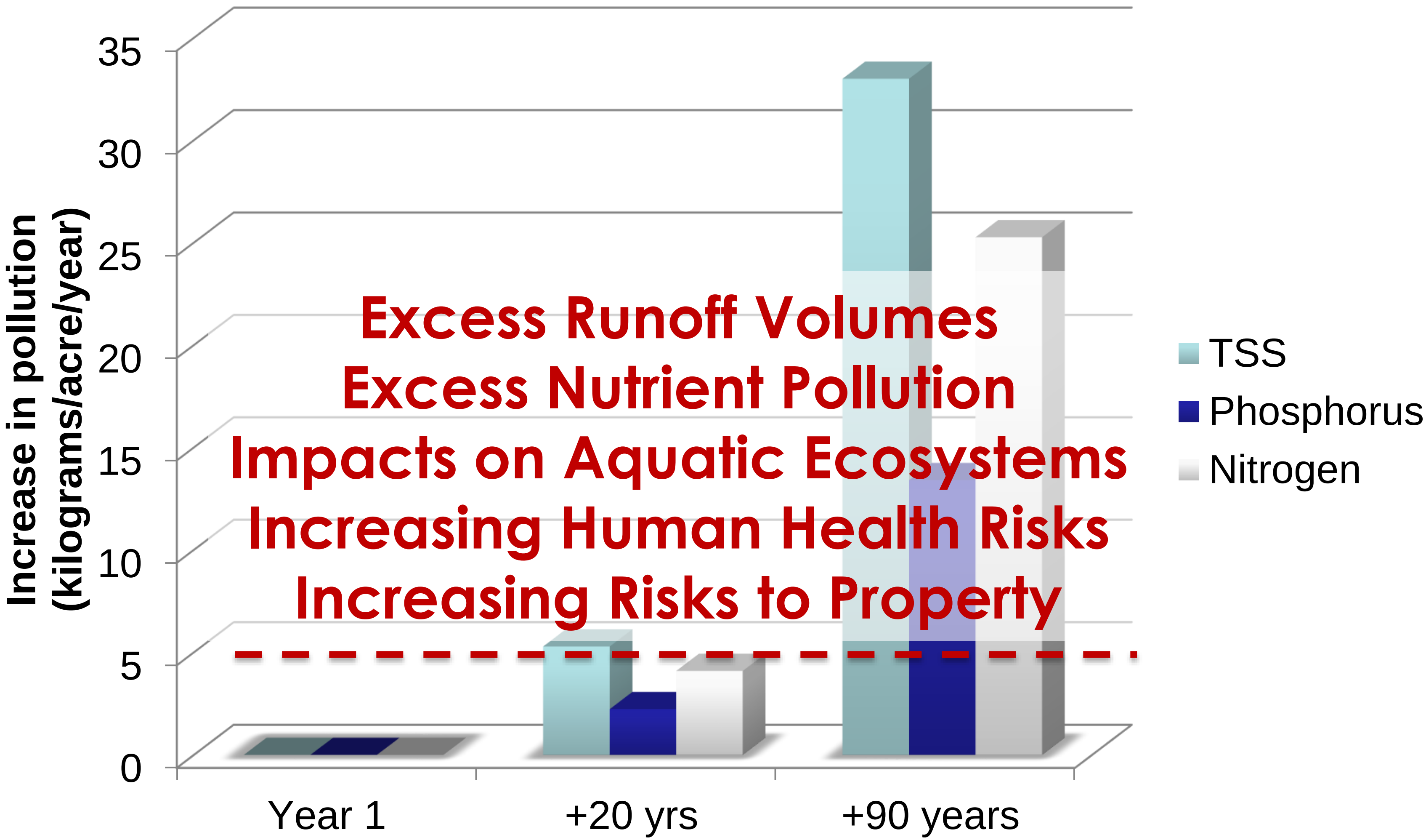
Trends indicate an increased frequency of high-intensity precipitation events
e.g., in New England +28% in 20 years, +127% in 90 years

Stormwater: Runoff



Source: Pyke, Warren, et al. (2011) Assessment of low impact development for managing stormwater due to climate climate

Stormwater: Runoff



Source: Pyke, Warren, et al. (2011) Assessment of low impact development for managing stormwater due to climate climate

Climate Resilience is…

- A new dimension to everyday decisions.
- An opportunity to prepare for future conditions.
- Needed to meet performance targets across the lifetime of investments.

Chesapeake Bay

Chesapeake Bay Systems

Water Quality

- Watershed
- Estuary

Living Resources

- Populations
- Communities
- Habitat

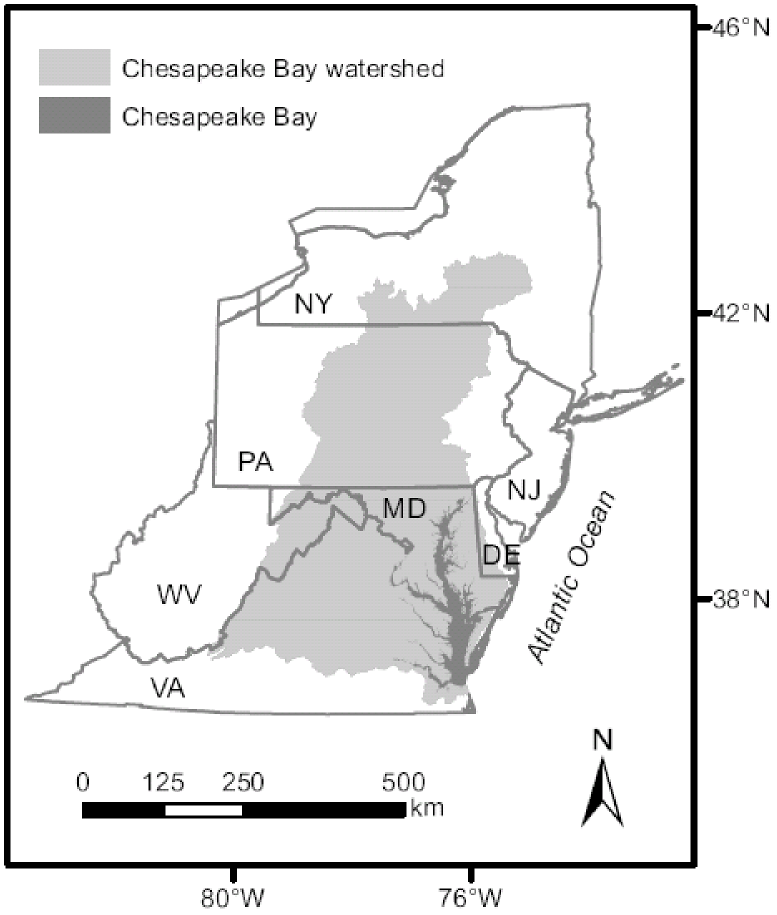
Chesapeake Bay Targets

Water Quality

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

Living Resources

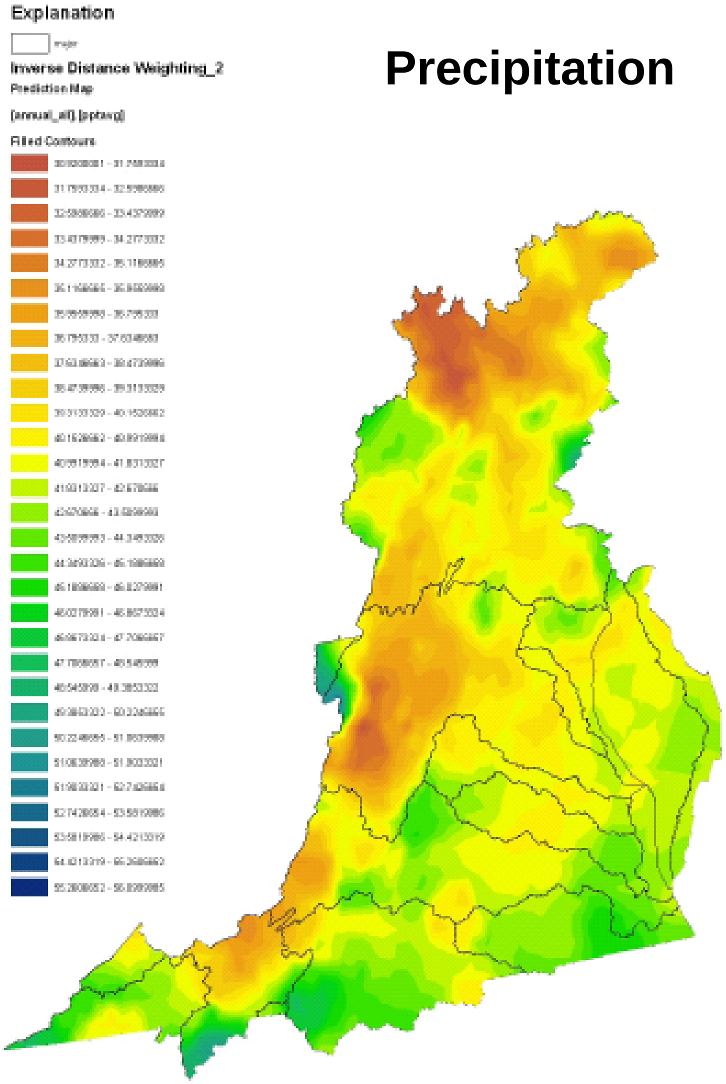
– e.g., SAV restoration, oysters, fisheries, wetlands, etc.



Chesapeake Bay Scenarios

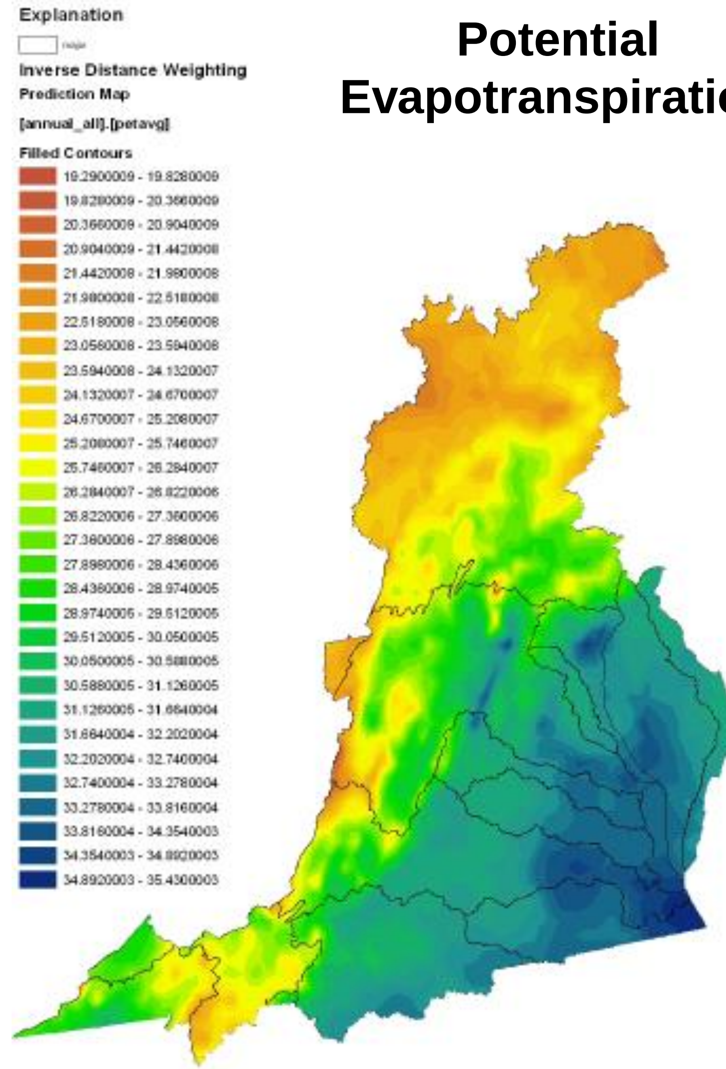
- Sea level: +0.5 to >1.0m
- Temperature: +2 to >8° C
- Annual precipitation: -10% to +20%
- Winter runoff: higher
- Summer runoff: lower

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 11% increase in N loading, variation in 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	[illegible]	[illegible]	[illegible]
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	[illegible]	27.5%	0.2%
hightill without manure	183	50.91	9294	54.03	[illegible]	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%	

Max: +37%

Min: -4%

Implications for Restoration

- Pollution inputs are **sensitive** to climate.
- Restoration strategies rely on **assumptions** about current and future climate.
- The sensitivity of **individual practices varies**.
- Some restoration practices offer **immediate opportunities** to increase resilience.

Bay Program Actions

- Meet 2009 Executive Order **requirements**:
  - A comprehensive **climate change assessment**
  - **Implement a plan** to address climate change in decision making
- Create and use new tools to **identify climate sensitivities** and **adaptation opportunities**
- Create and apply new metrics to track adaptation **implementation** and **outcomes**