

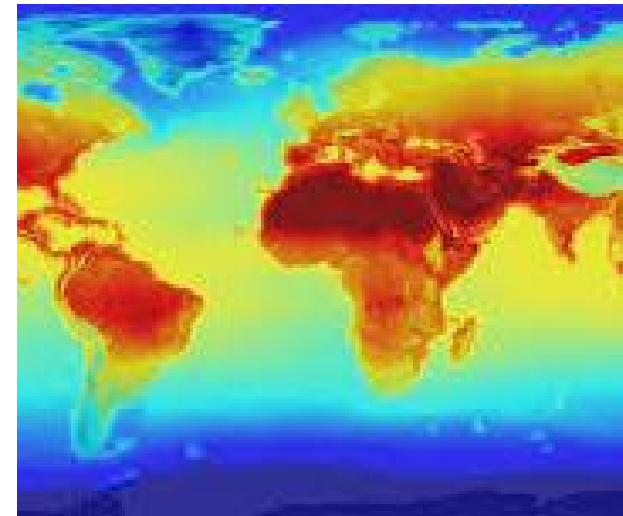
Using a Risk Management Approach for Climate Change Adaptation

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Latornell 2020

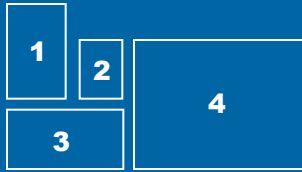
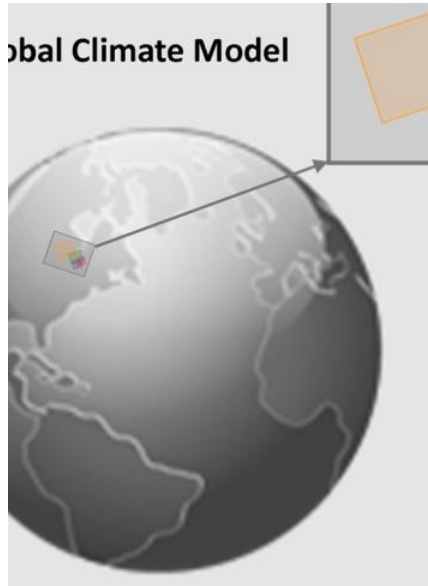


Introduction

- Climate Change Risk, Vulnerabilities, and Opportunities
 - Climate Analysis – how much? when?
 - Risk/Vulnerability Analysis – what will be impact?
 - Prioritization – what is most critical?
 - Adaptation/maintenance/coping measures



Climate Analysis and Climate Change



1. Climate trend analysis and climate model downscaling
2. Impact of subsidence – geotechnical design
3. Designing infrastructure to deal with current/future climate
4. Downstream effects of infrastructure failing to address new climate realities



Climate Data to Support Prioritization of Infrastructure Upgrades

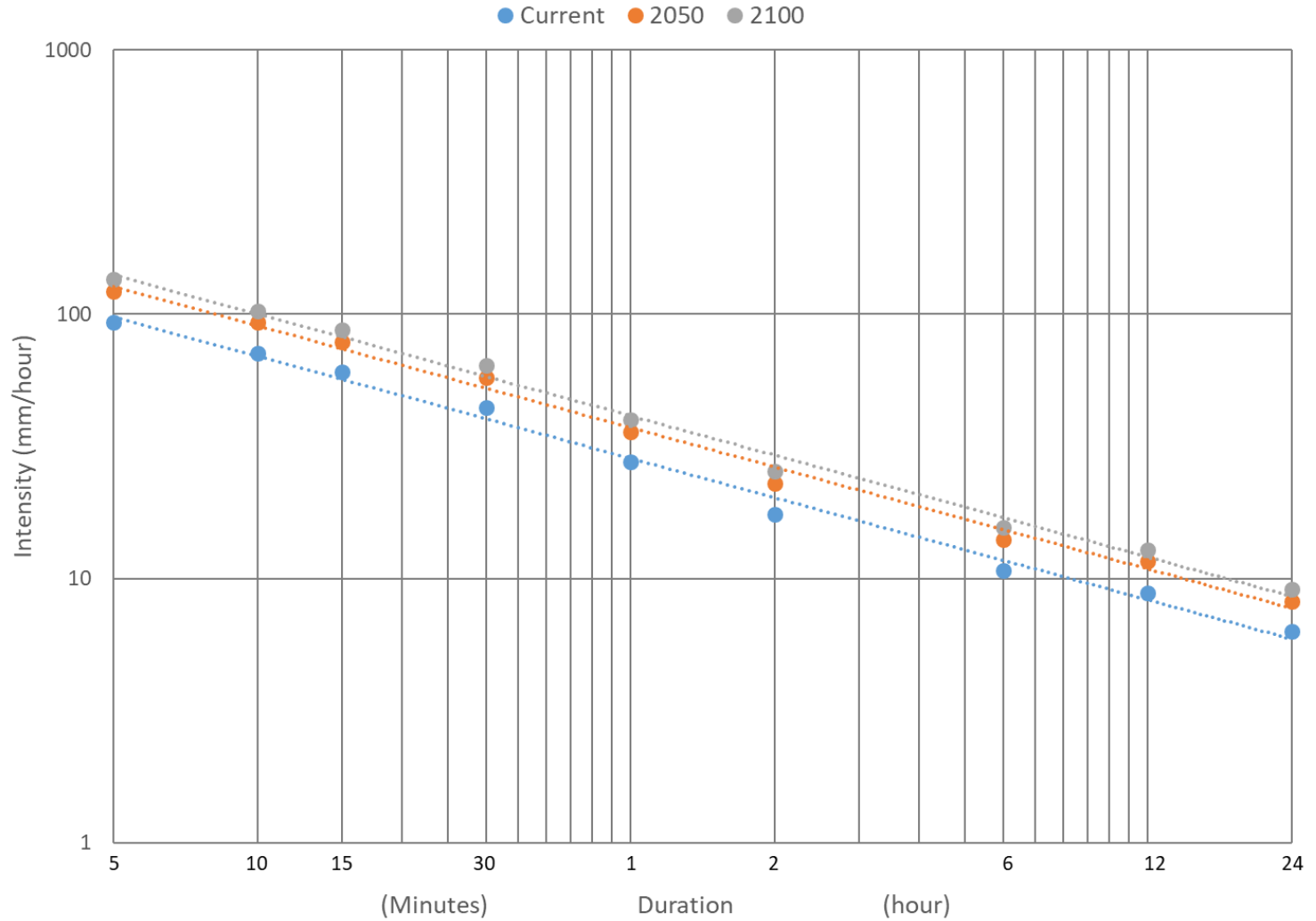
- How has the climate been changing (typically over the last 30 years)?
- What are the anticipated changes in climate over the lifetime of the infrastructure? – Frequency?
- How have past events affected the infrastructure?
 - Severity of impact?
 - Cost of clean-up or repair?
- How will the infrastructure operate in a future (changing) climate?
 - What are the likely risks for future operations?
 - What are the possible **opportunities**?
 - Which risks can be mitigated or managed and how to decide priorities?
- What other questions should be considered?

Adaptation and Dealing with Climate Change

- Adaptive pathways for daily lives
- Identifying approaches
- Mitigate effects of climate changes we know are happening
- Cope with climate change effects
- Risk management framework can be used to provide context
- Value, getting the most benefit out of limited infrastructure spending
- Opportunities!

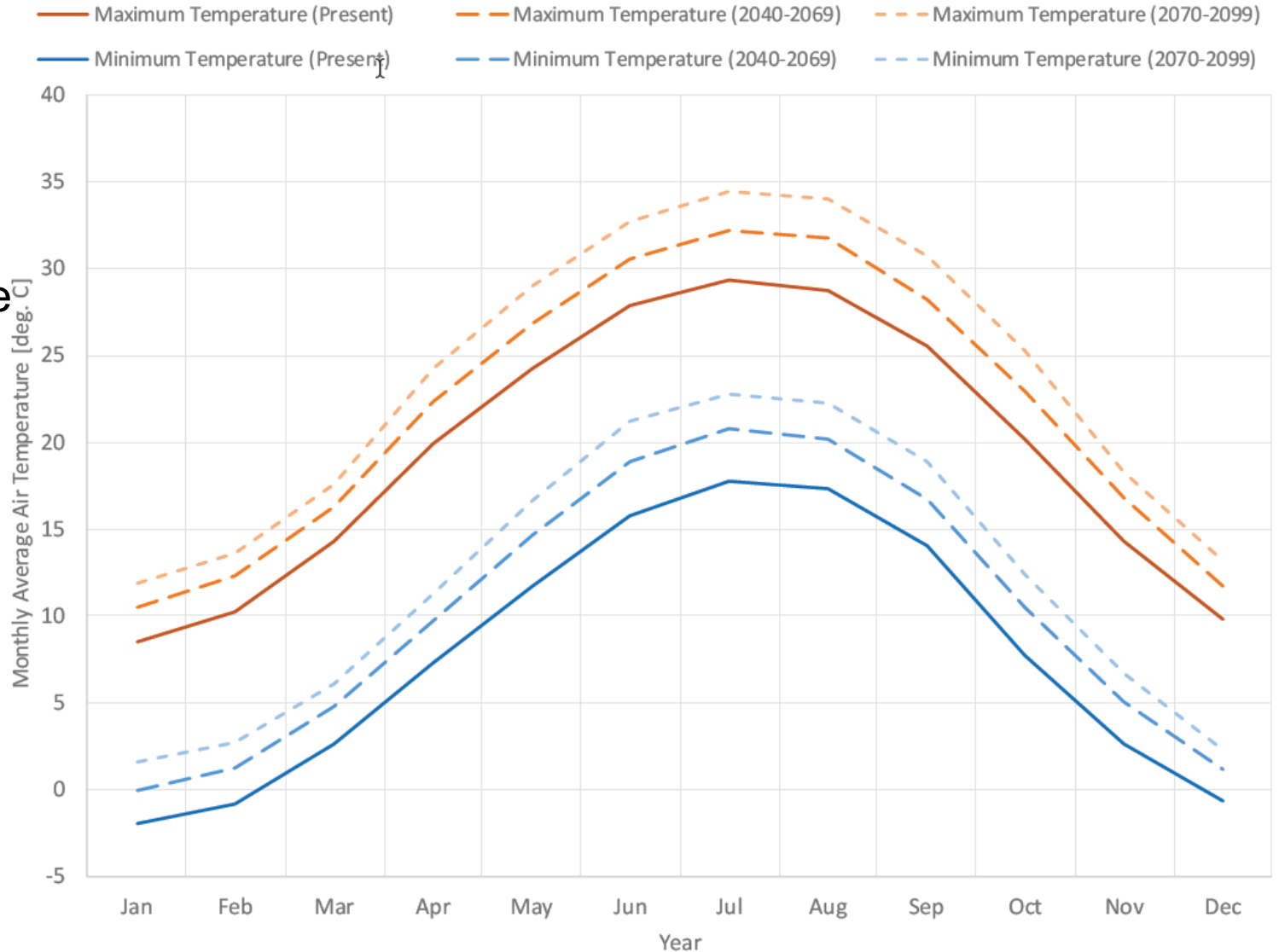
Future Projections vs. Historic Data

Compare current and future IDF curves
Impacts on water infrastructure



Future Projections vs. Historic Data

Compare current and future air temperature infrastructure impacts?



Future Projections vs. Historic Data

Increase in wind speed
Change in wind direction
Impact on infrastructure?

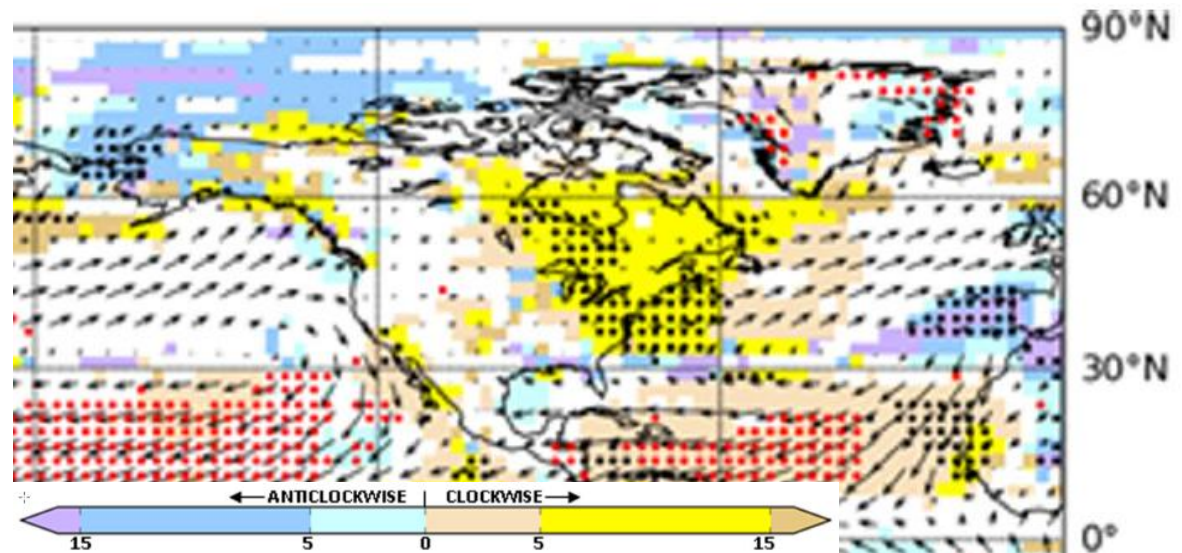
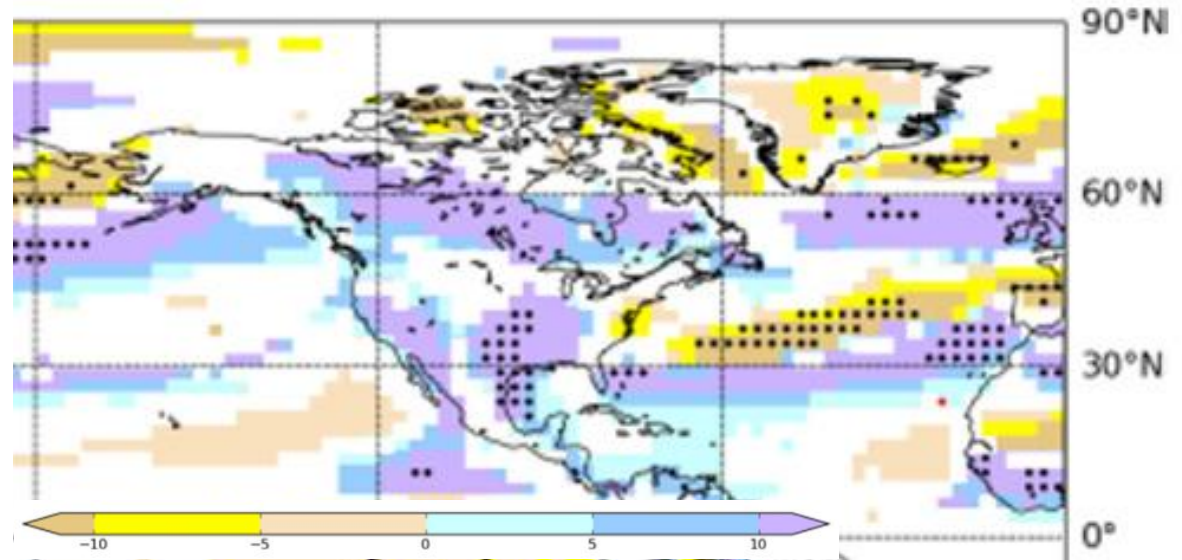


Image source: McInnes, K.L., Erwin, T.A., Bathols, J.M., Global Climate Model projected changes in 10 m wind speed and direction due to anthropogenic climate change, Atmospheric Science Letters, 12:325-333, 2011.

Infrastructure and Operations Assessments

Data Driven:

- Existing conditions contributing to adverse events
- General trend for those climate indicators
- Change in frequency or severity of conditions
- Quantify future risks to facility or operations
- Quantify costs due to failure
- Develop risk matrix, identify priorities
- Identify options for adaptation: upgrades, changes in operations, etc.
- Quantify costs for adaptation
- Identify options to increase coping capacity (e.g. use less water, implement additional safety measures, etc.)
- Quantify costs for coping

Climate Risk Matrix

Identifies climate factors and the observed or predicted trends

Identifies issues that should be considered

Climate Factor	Trend	Justification	Other Comments on Future Trends
Ice Storms/Freezing Rain	Unknown	Slight increase in temperature will create a vertical temperature profile that is conducive to freezing rain events.	An increase in the frequency and duration of freezing rain events has been observed and is predicted to increase in Ontario (Berry et al, 2014).
Extreme Heat	Increasing	Increase based on increase in average summer temperatures.	Rare hot extremes are currently projected to become more frequent, such that a 1-in-20 year extreme hot day is projected to become about a 1-in-5 year event by mid-century (Warren and Lemmen, 2014).
Extreme Cold	Decreasing	Decrease based on increase in average winter temperatures.	Decrease in frequency and magnitude of unusually cold days and nights (Warren and Lemmen, 2014).
Extreme Precipitation	Increasing	Appears to be increasing in many areas, with similar amounts of precipitation falling annually over fewer specific events.	Increase in formerly rare extreme precipitation events, total annual rainfall and snowfall showing less significance, indicating possibility of fewer but more extreme weather events (Warren and Lemmen, 2014).
High Winds	Increasing	Increase in predicted extreme weather (storm events), including high winds.	Extreme wind events are projected to increase with continued climate change, including the increasing incidence of extreme weather (e.g., storms), such as Atlantic hurricanes (Warren and Lemmen, 2014).

Climate – Infrastructure Matrix

Identifies where the changing climate may interact with specific infrastructure components – identify key risks

Needs regular updates as additional climate data are available

Infrastructure Component	Extreme Precipitation	Extreme Weather Events (e.g., Storms)	High Winds	Temperature
During Remediation				
Pipeline removal and/or filling	N	N	N	N
Sludge removal from settling and stabilization basins	N	N	N	N
Sludge disposal area construction	N	N	N	N
Bridge construction	N	N	N	N
Dam removal	N	N	N	N
After Remediation				
Bridge	Y	Y	N	N
Roads	Y	Y	N	N
Buildings	N	N	N	N
Abandoned pipeline(s)	N	N	N	N
Sludge disposal facility	N	Y	N	N
Estuary biodiversity/vegetation	Y	Y	N	Y

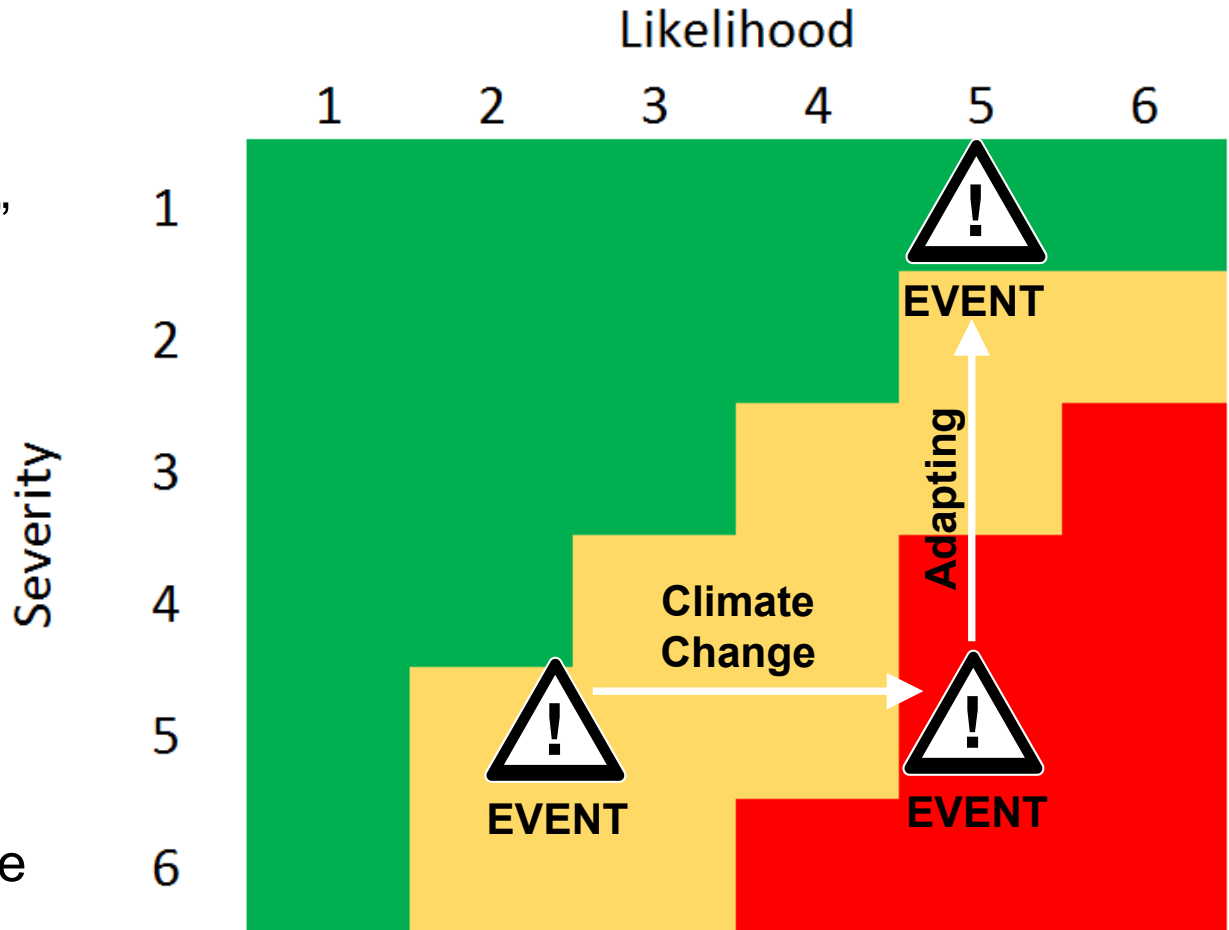
Risk Reduction

Perform risk assessment for climate-infrastructure interactions with “yes”

Climate change can increase likelihood of an event

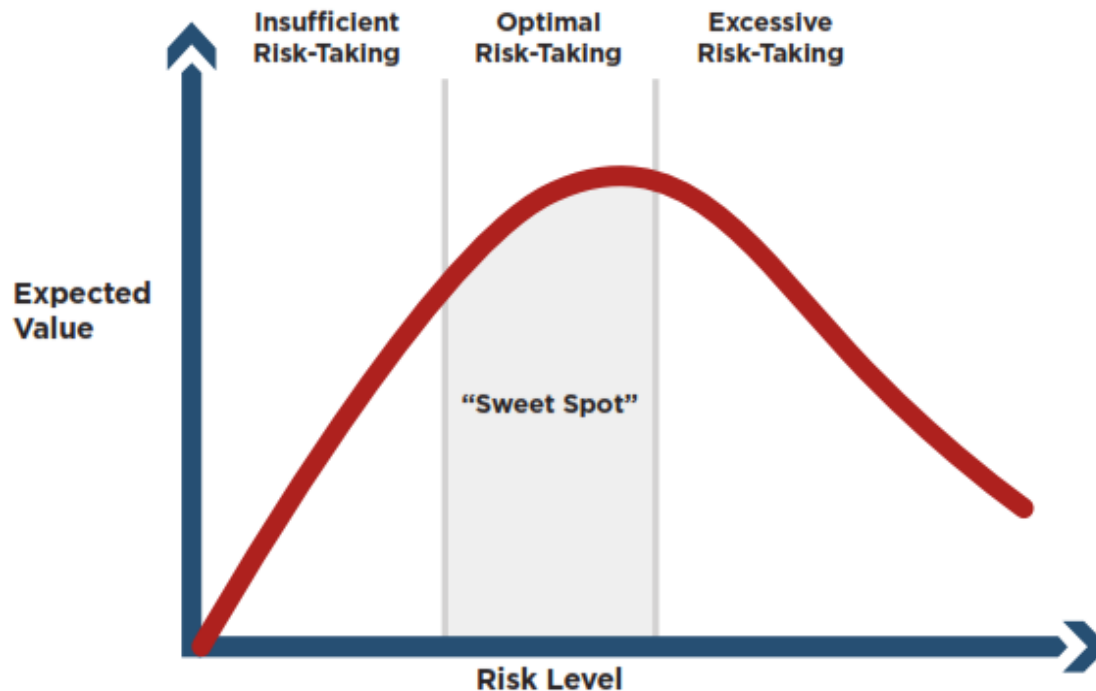
Adaptation reduces severity of impact

- Cost for adaptation?
- Can we cope?
- Options to increase coping capacity?



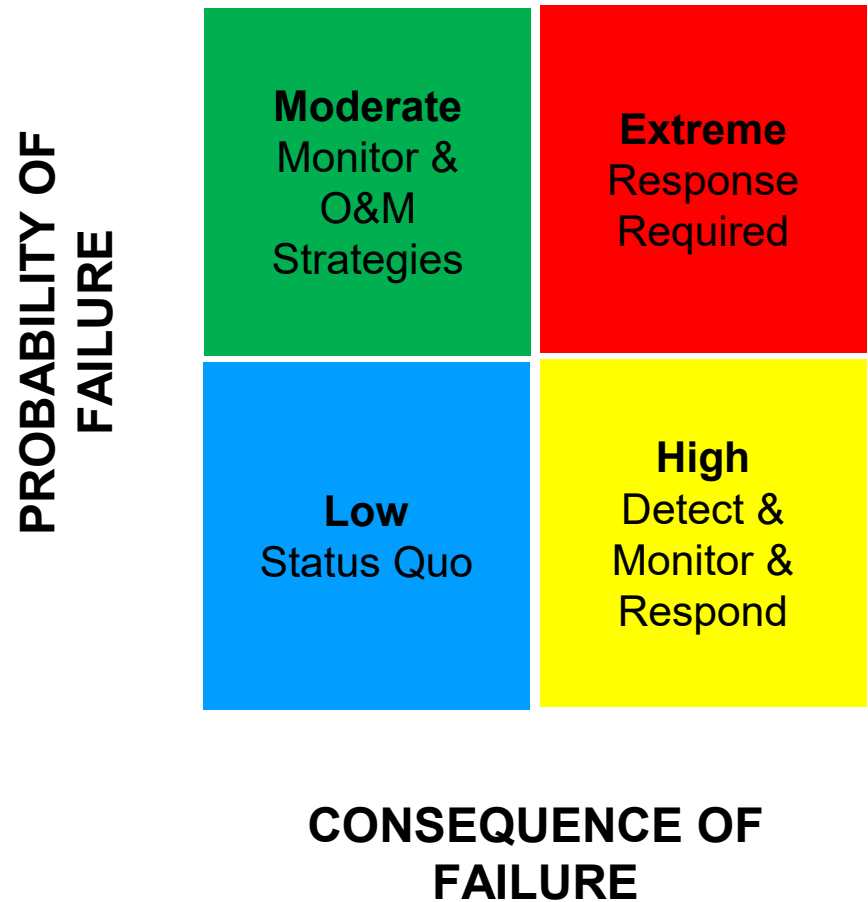
Optimal Risk Management

- Strategic organizations do not strive to eliminate or minimize risk.
- They manage risk across the organization to incur just enough of the right kinds of risks
- Quantify cost to mitigate risks vs. cost to cope with the outcome (the “cost” of climate change)
- Quantify expected value and risk level for each option

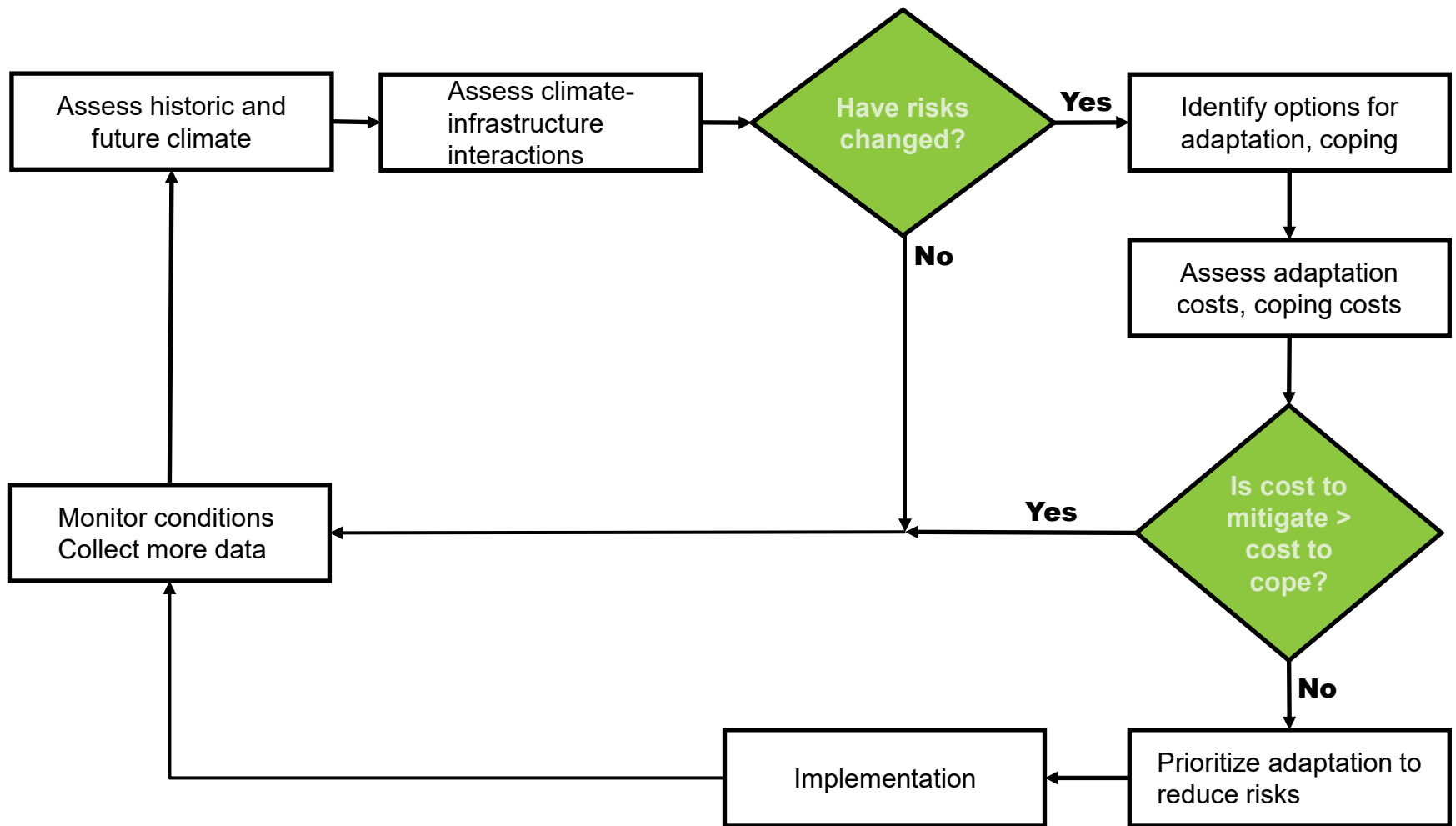


Risk Management

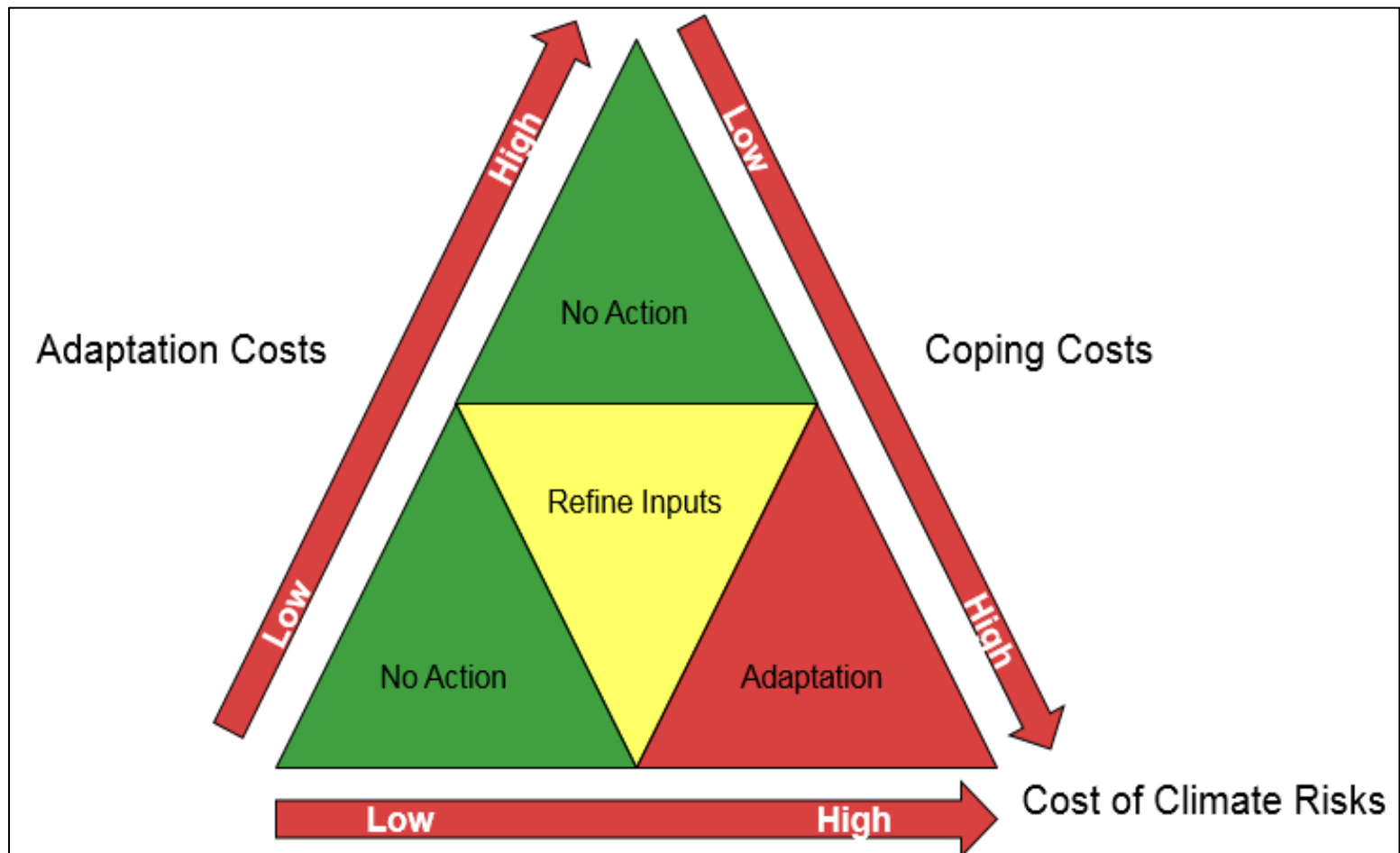
- Identify critical infrastructure
- Lower level of risk: lower level of response
- Prioritize infrastructure for adaptation
- Identify coping strategies



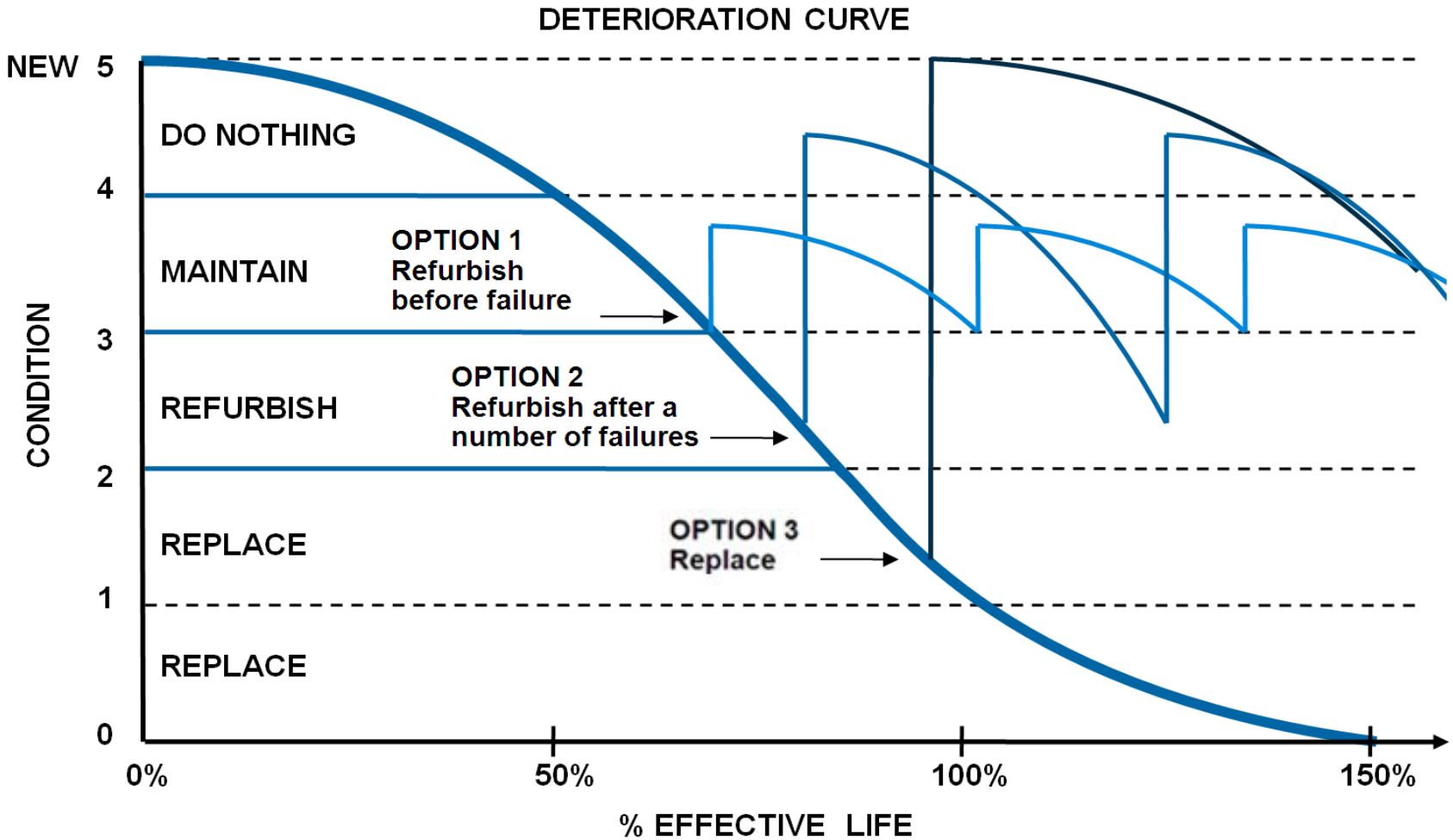
Costs of Adaptation vs. “Coping”



Adaptation vs. Coping



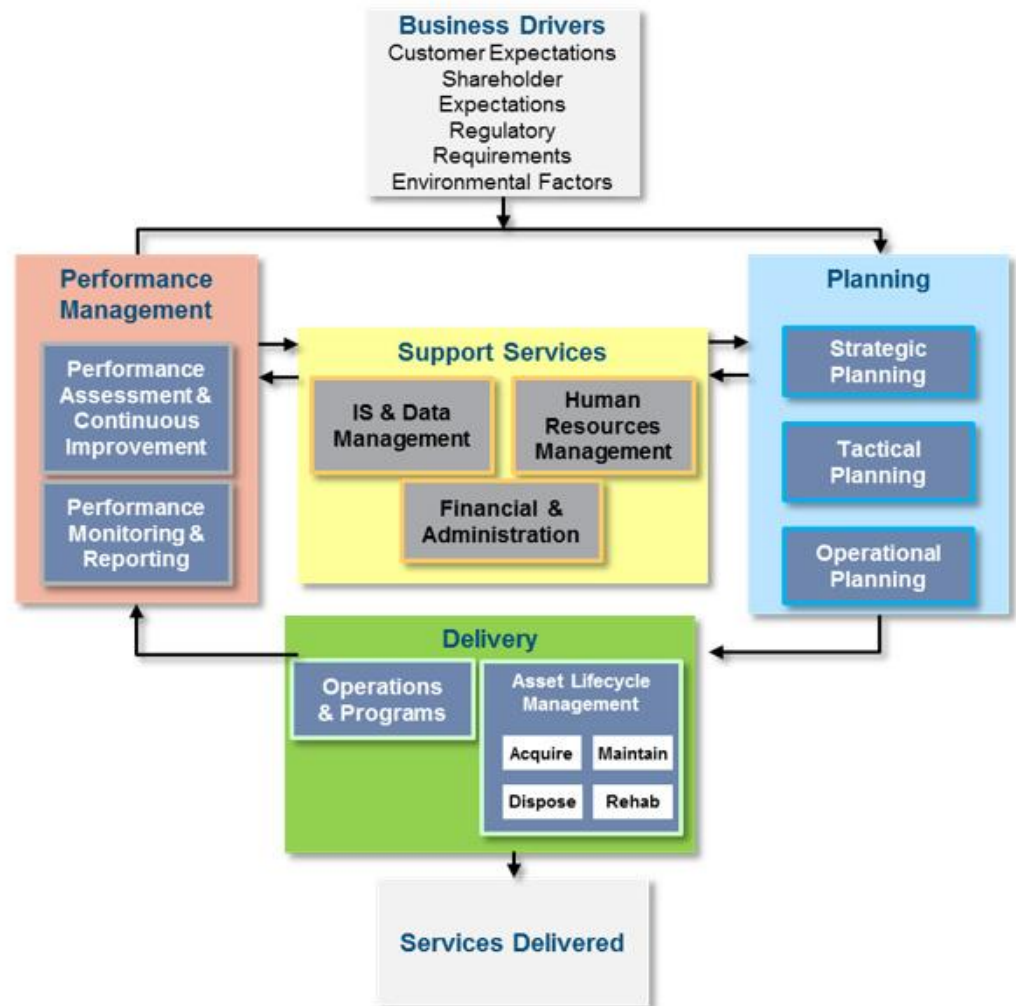
Maintenance Options



Business Process Framework

Strategic Climate
Change Business Plan
Integrate climate change
planning in four main
areas

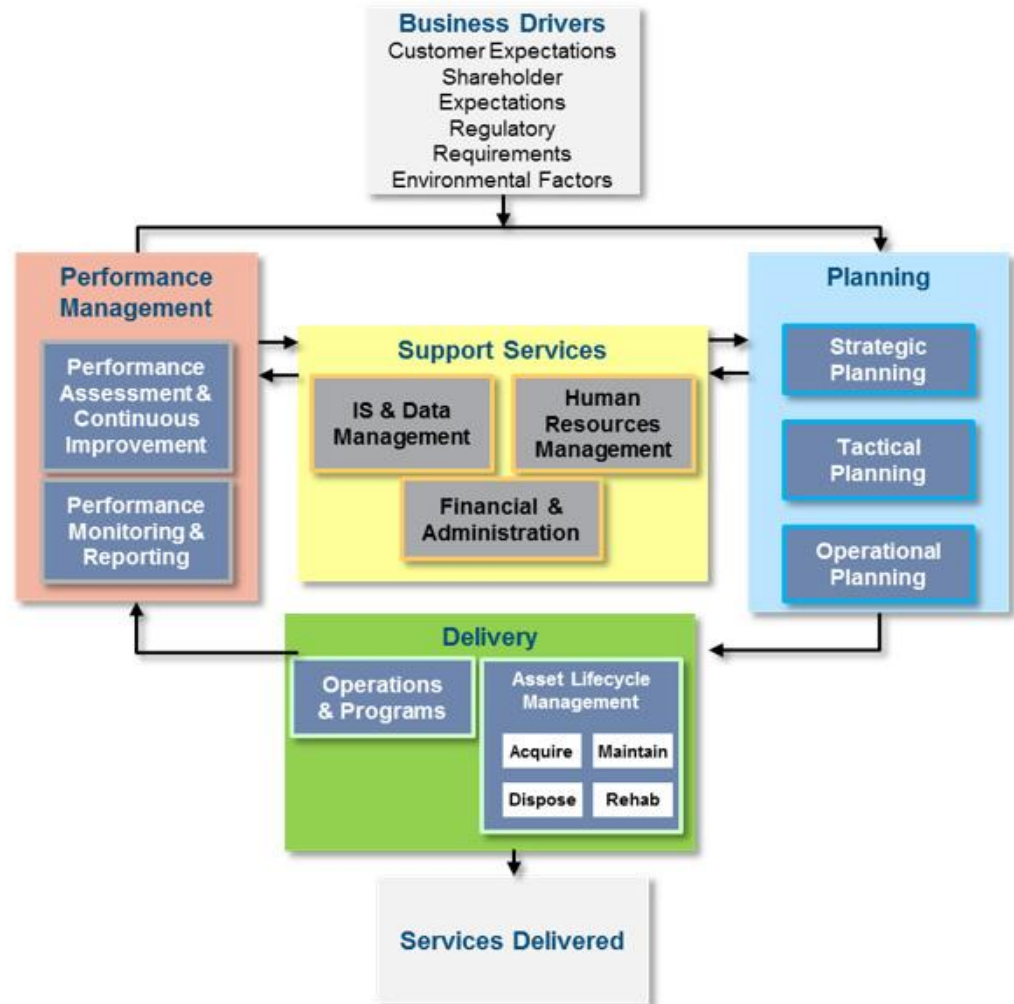
- Build consistency
- Supported within organization
- Opportunity to improve over time



Business Process Framework

Planning

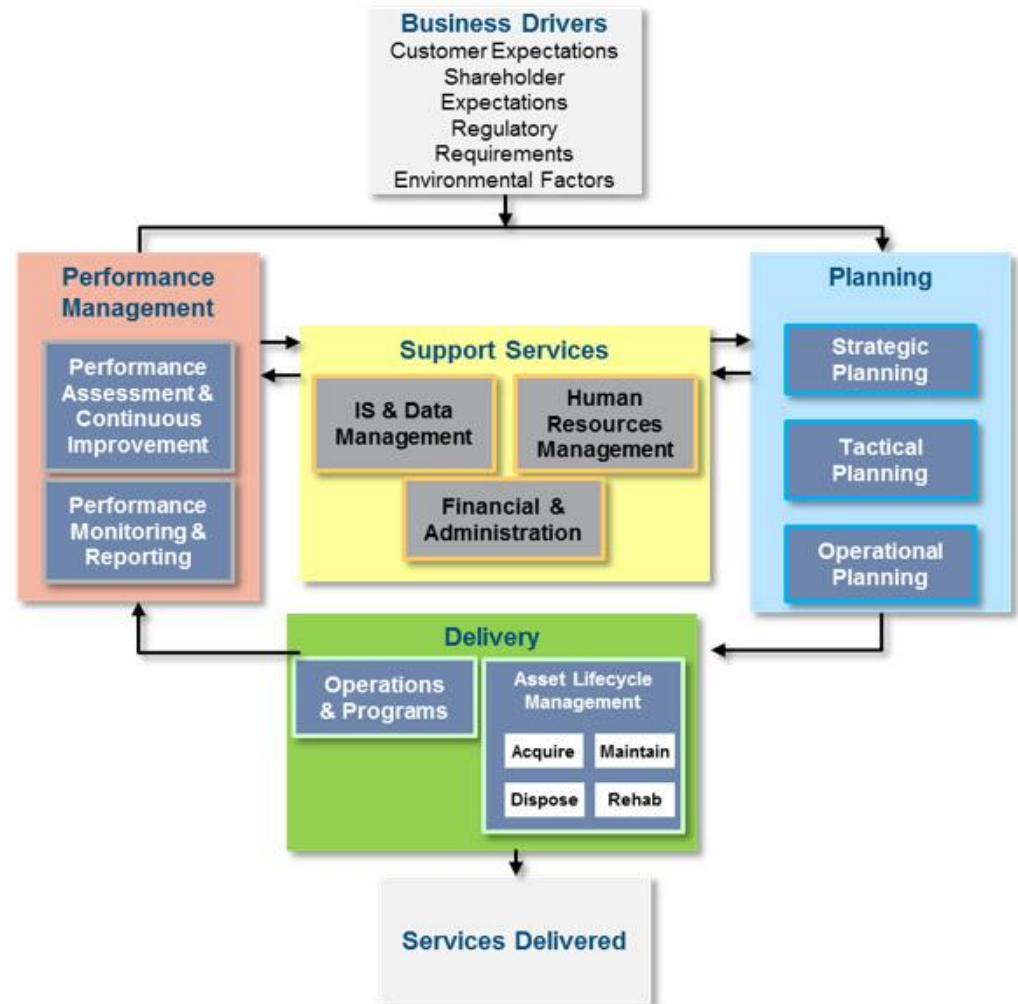
- Develop future climate data
- Perform risk analyses
- Prioritize infrastructure changes
- Develop 10-year capital plan



Business Process Framework

Delivery

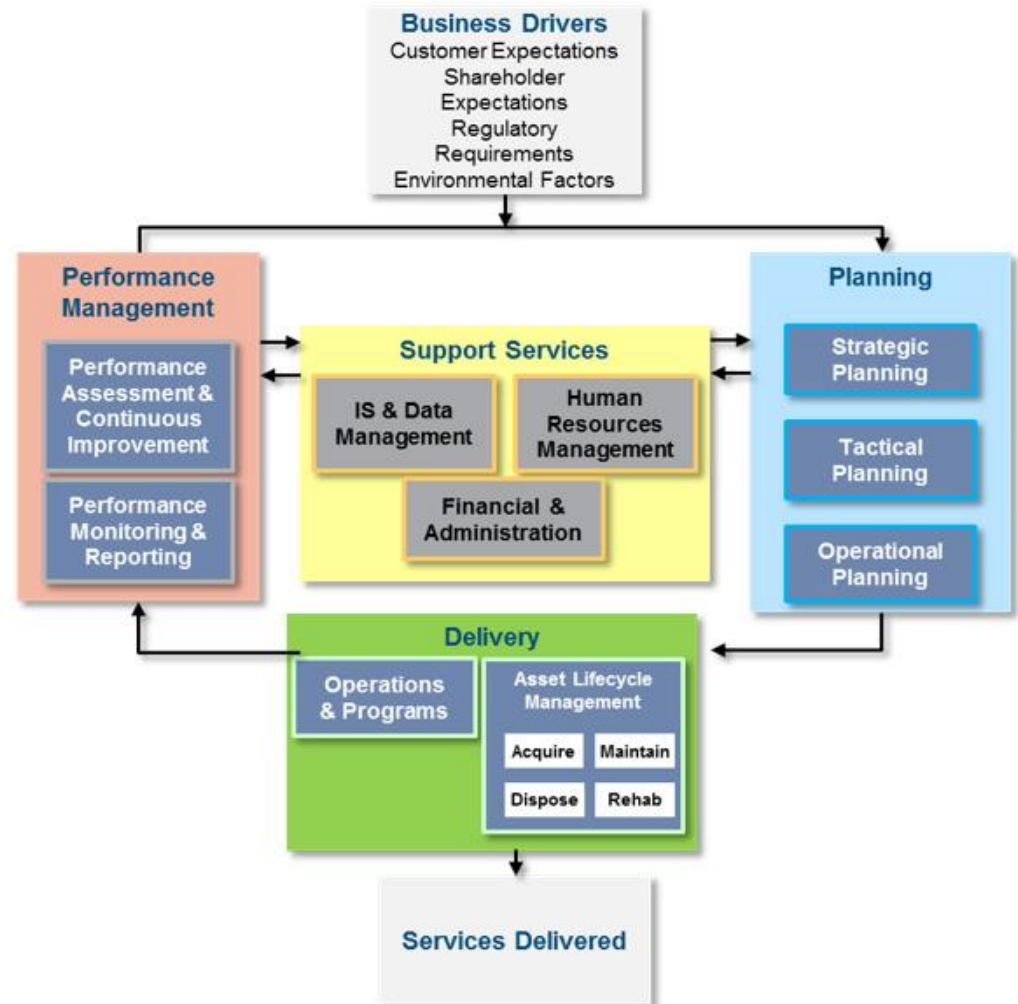
- Review and update design guidelines to incorporate climate change considerations
- Asset management plan



Business Process Framework

Support Services

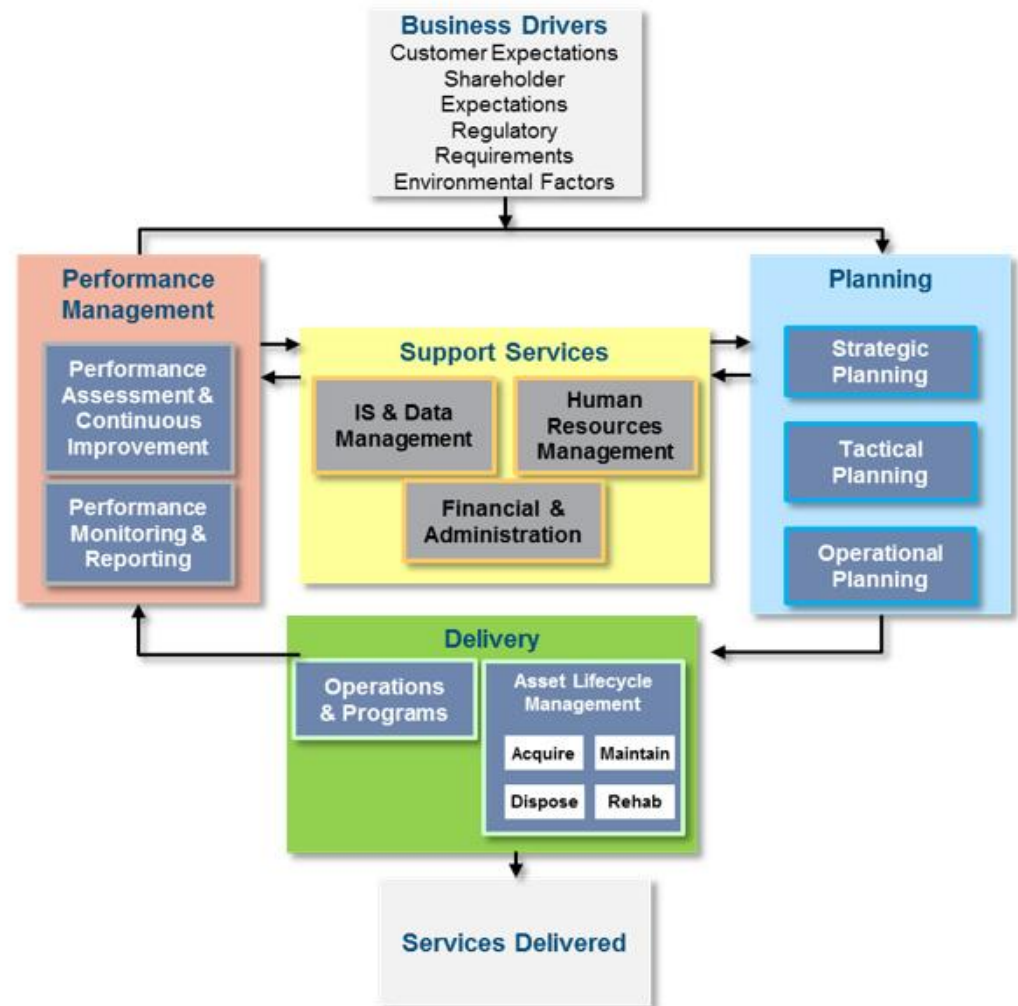
- Data management
- Succession of knowledge
- Budgetary considerations



Business Process Framework

Performance Management

- Develop and implement monitoring plan
- Establish “triggers”



Questions and Discussion



Questions

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