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Sustainable Water Resources
Florida Challenges, Global Solutions
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A Risk Management Framework for Evaluating Climate Change Impacts on Water Supply Reliability

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Environmental Engineers & Scientists

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Main Points

- Climate change analysis must consider impacts on both demand and supply
- Climate change should be treated as one of several other planning uncertainties
- Risk-based, probabilistic, forecasting approaches offer a robust analytical platform for characterizing uncertainty
- Tampa Bay Water's long-term forecasting framework provides a good example for water supply management

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Climate Change Evaluation Must Consider Supply and Demand

- Source (surface) water supplies are determined by hydrologic factors (precipitation and run-off in watershed)
- Water use is influenced by prevailing climate and weather conditions
- Scenario planning requires consistent treatment of weather effects on demand and supply
- Reliability is target variable of interest: defined by balance of supply and demand

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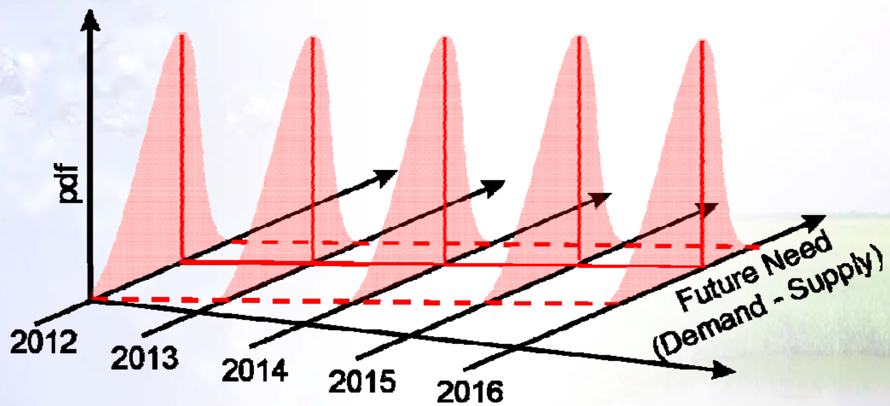
Tampa Bay Water's Risk-Based Reliability Planning Approach

- Water supply *reliability* under uncertain conditions
  - Analyze demand and supply conjointly
  - Recognize uncertainty in demand and supply
  - Characterize results to help estimate reliability and provide information for managing risks
  - Ranges of future supply needs due to uncertain growth, socioeconomics, weather



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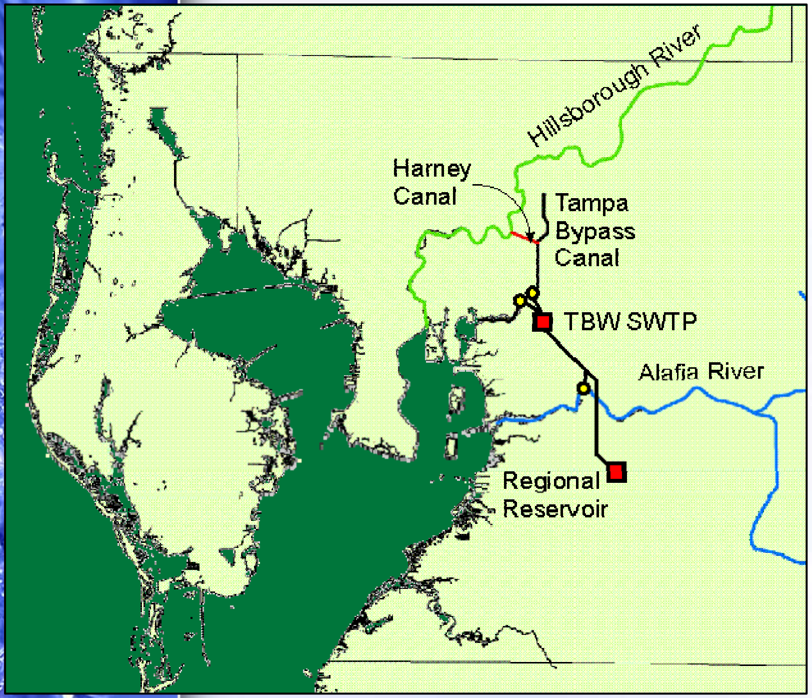
Modeling Surface Water Supply and Supply Uncertainty

Assessing Surface Water Performance Reliability for Tampa Bay Water

- Flow Modeling System (FMS)
  - Custom-built statistical models of source flows
  - Custom-built surface water system operational model
    - Pump Stations and Offstream reservoir
    - SWTP, Operational Rules
  - Stochastic time series simulation of source flows and system performance



Tampa Bay Water's Enhanced Surface Water System (ESWS)

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Statistical Model of Stream Flows

- Statistical model of Tampa Bay Water's monthly/daily source flows
  - Seasonal patterns
  - Flow autocorrelation
  - Flow cross-correlation
  - Correlation w/ rainfall
  - Random fluctuation

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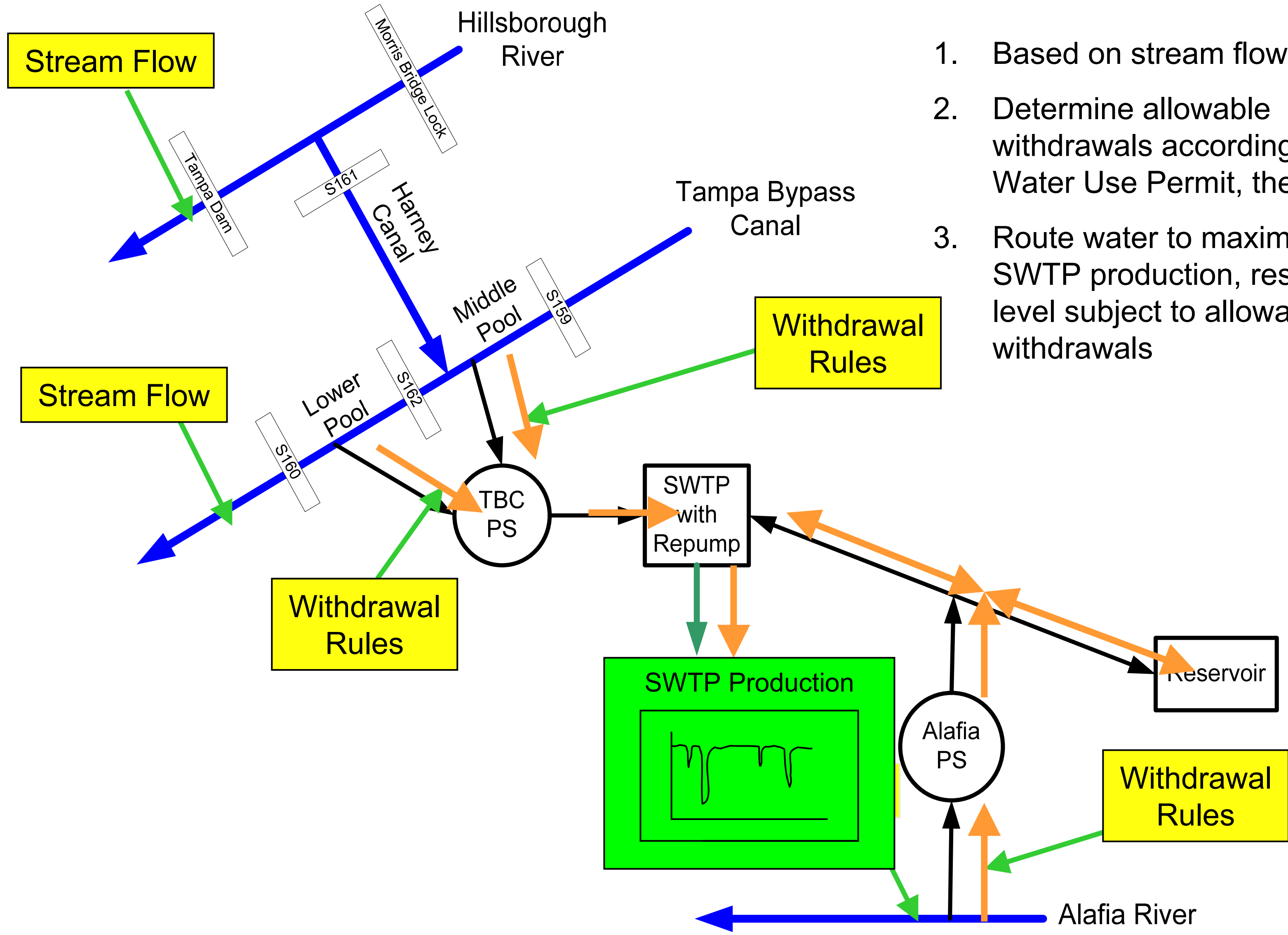
Surface water operational model

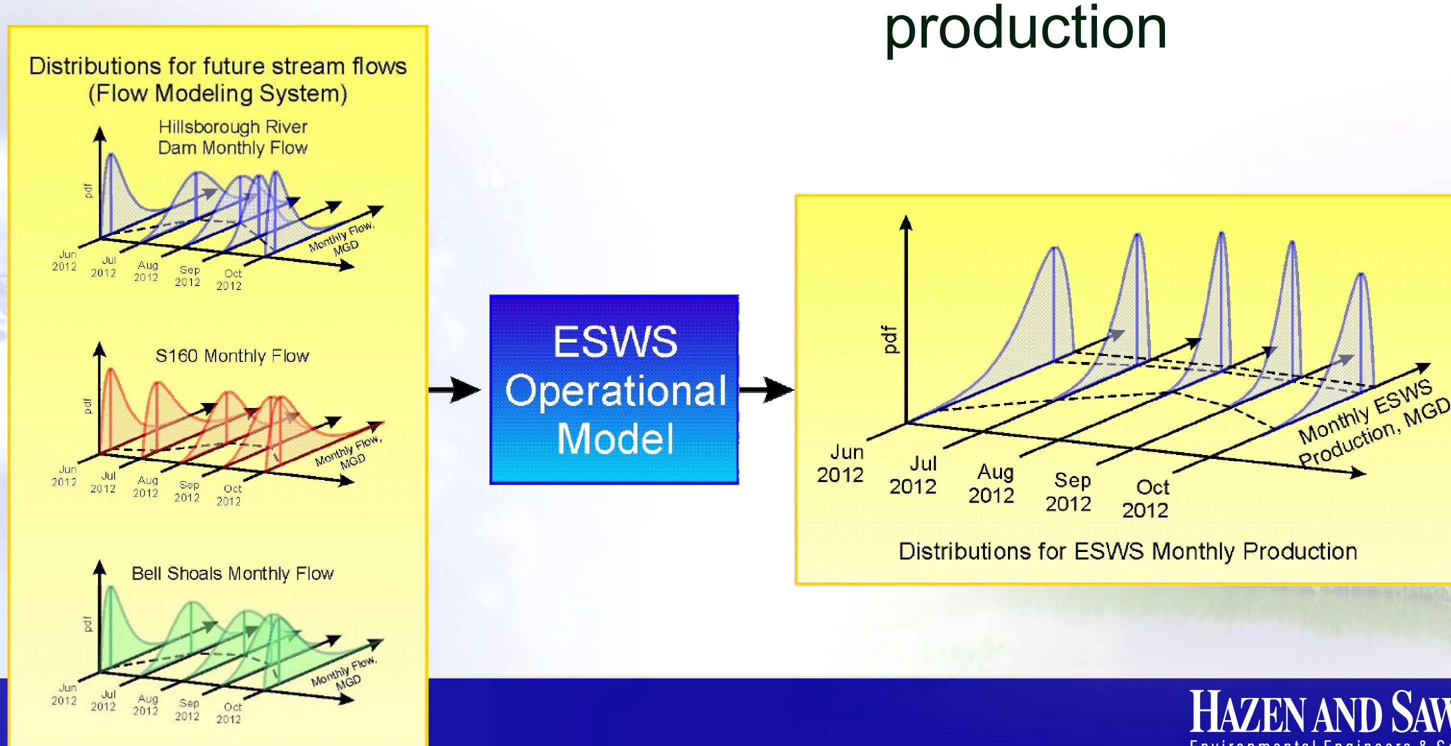


1. Based on stream flows...
2. Determine allowable withdrawals according to Water Use Permit, then...
3. Route water to maximize SWTP production, reservoir level subject to allowable withdrawals

Estimating future surface supply variability:

Combining flow and surface system models

- Operational model Input: multiple iterations of flow time series simulations
- Operational model output: distributions of surface system production



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Modeling Long-term Water Demands and Demand Uncertainty

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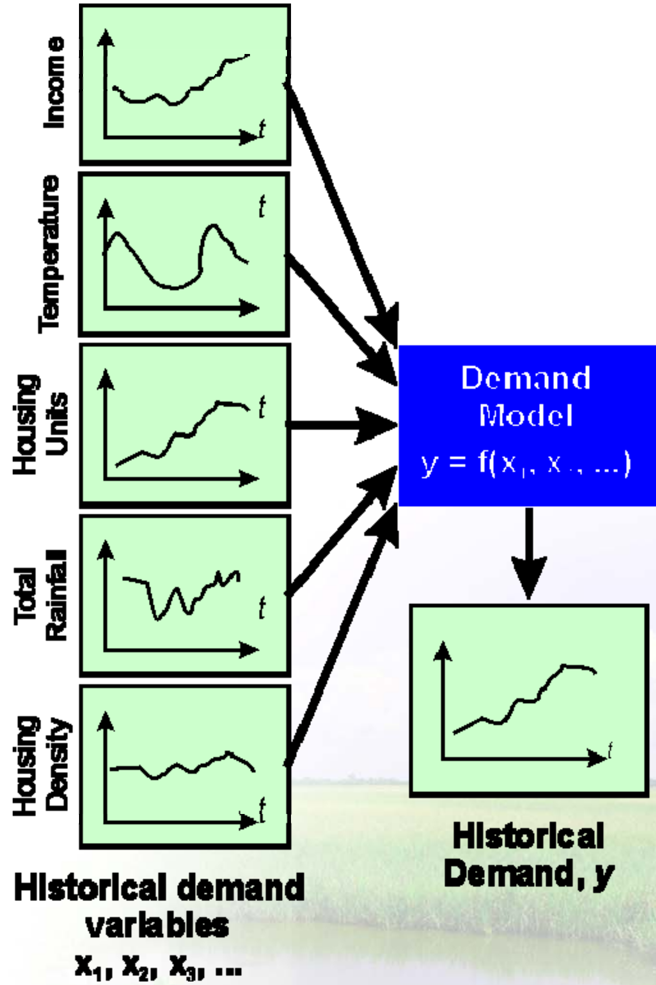
Tampa Bay Water's Regional Demand Forecasting Model

- Demand is related to regional characteristics
  - Weather
  - Socioeconomic characteristics
  - Pricing
  - Reclaimed water use for irrigation, water use restrictions



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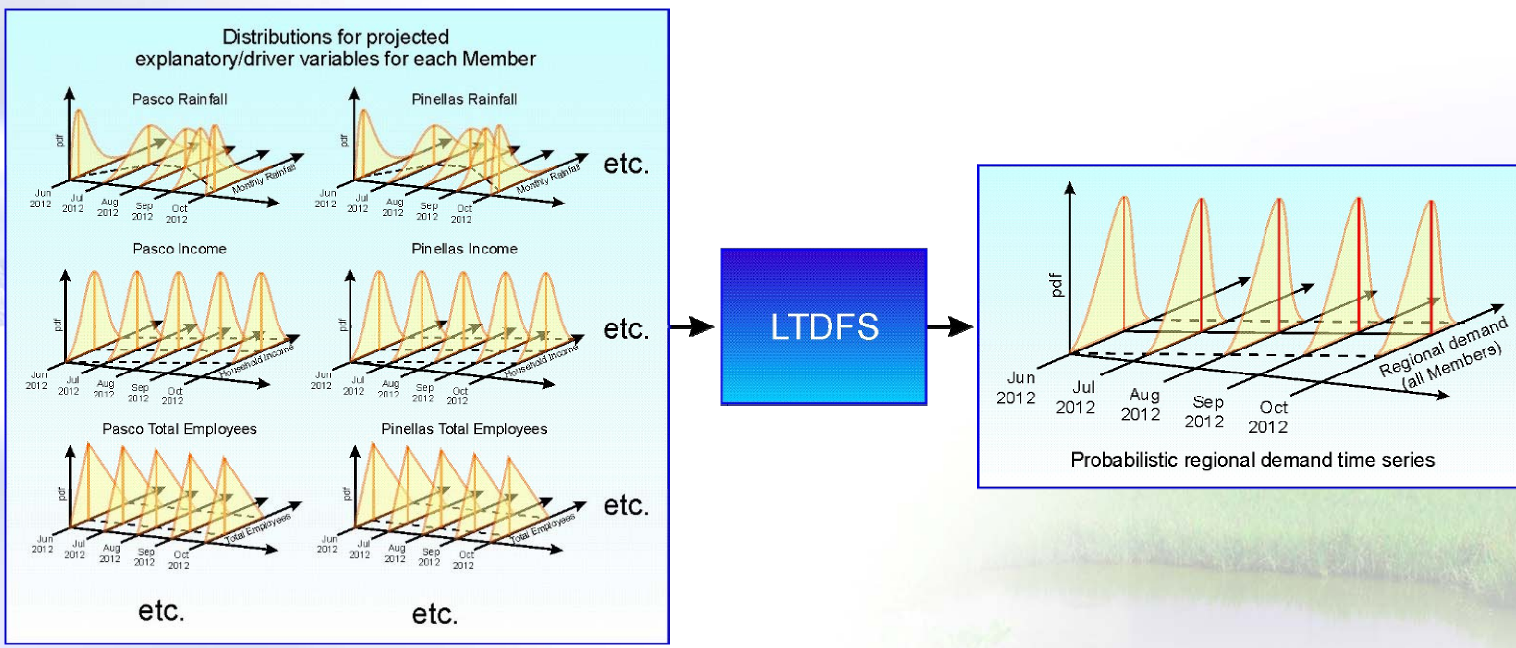
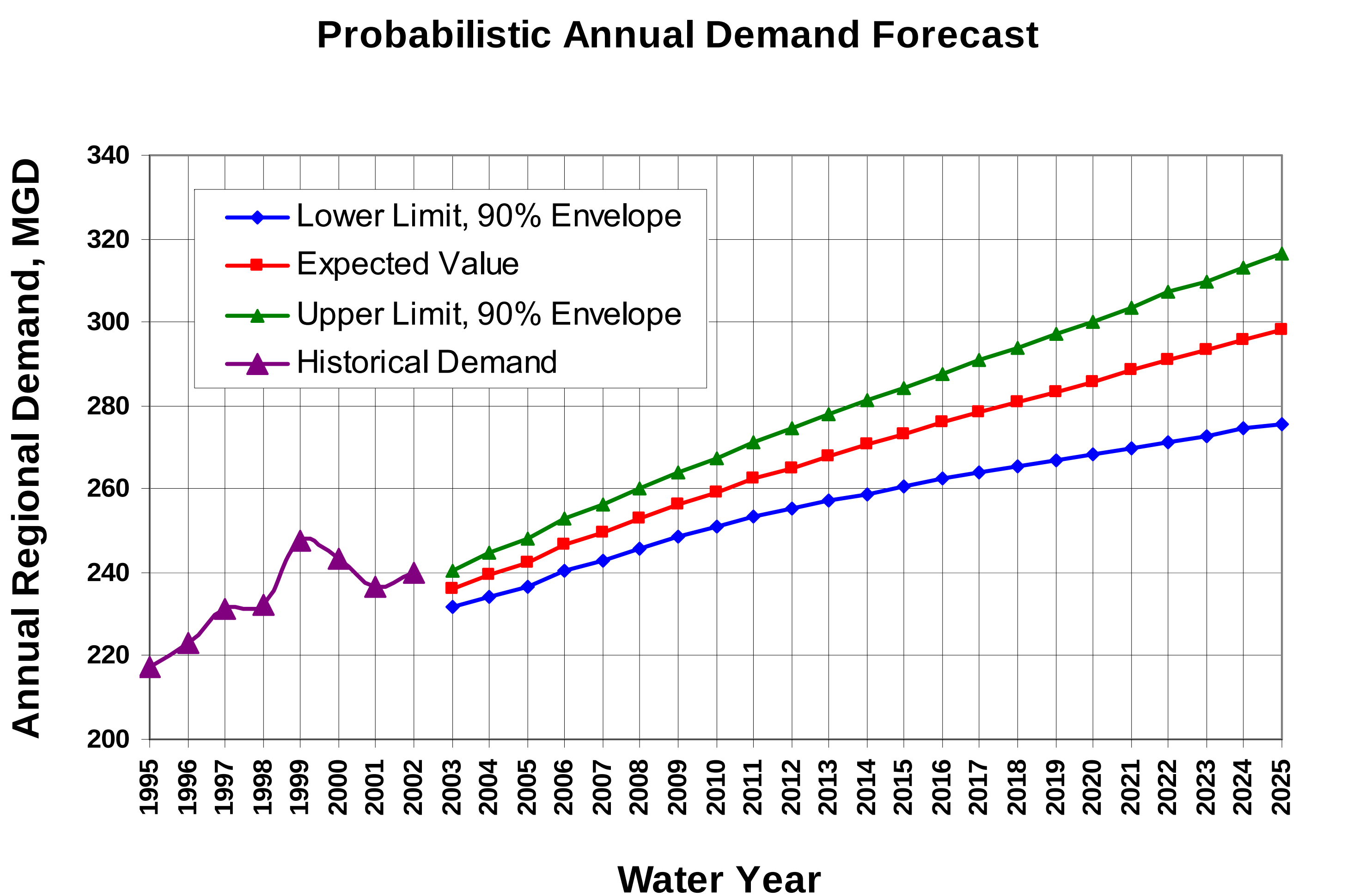
Demand model application: Forecasting demand with uncertainty

- Input: Time series of *probability distributions* for variables that influence demand
- Output: demand distributions – interval forecast of future demands



Tampa Bay Water
Regional Demand Forecast



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Water Supply Reliability Evaluation: Future Need Analysis

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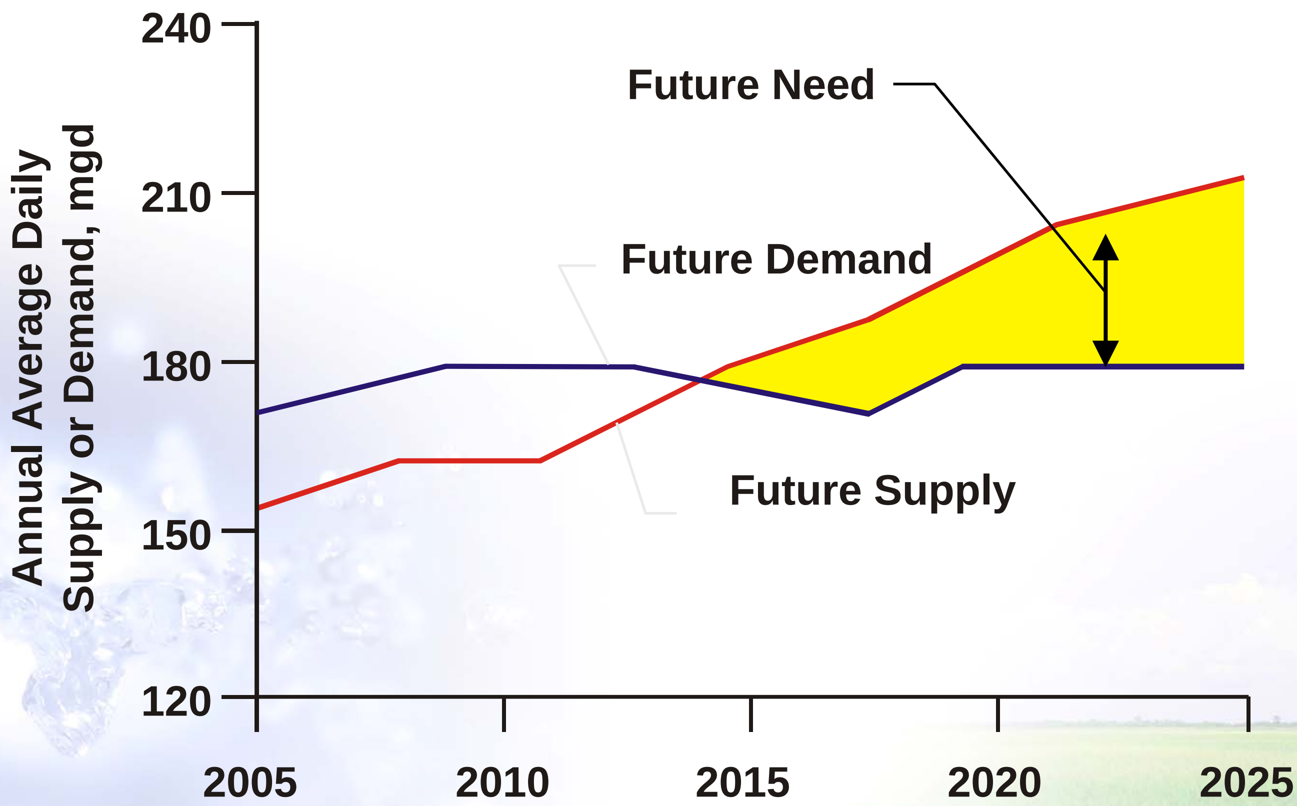
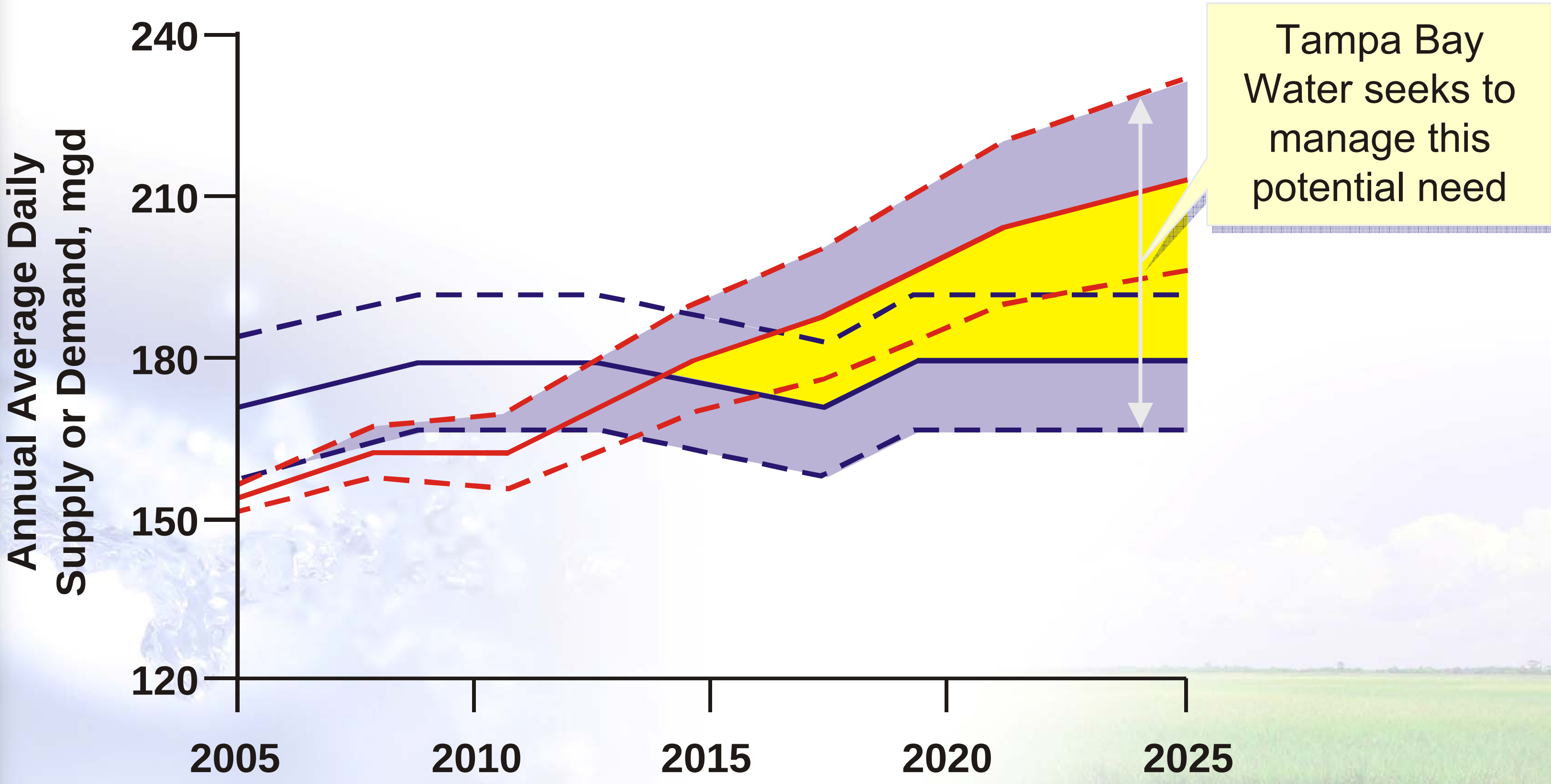
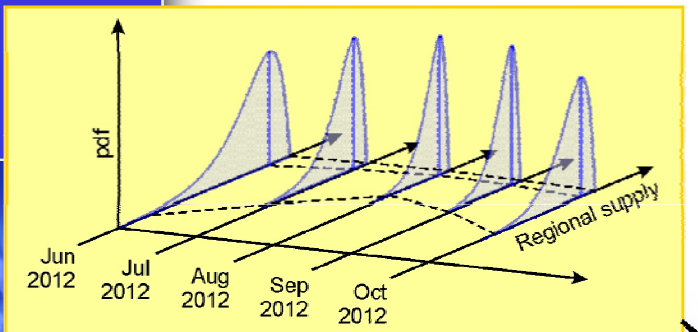
Assessing future need without uncertainty



Assessing future need with uncertainty

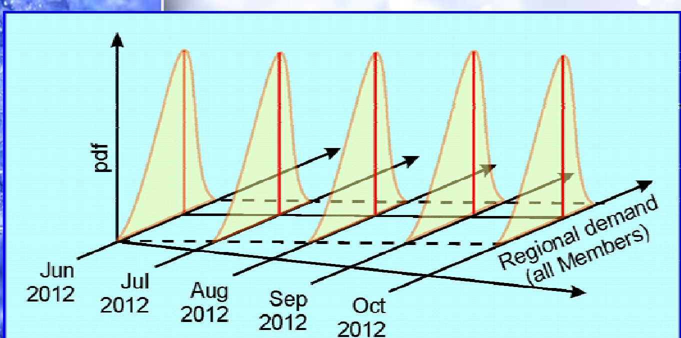


Developing Future Need Distributions



Probabilistic regional supply time series
(all sources except Consolidated Wellfields)

Supply distributions

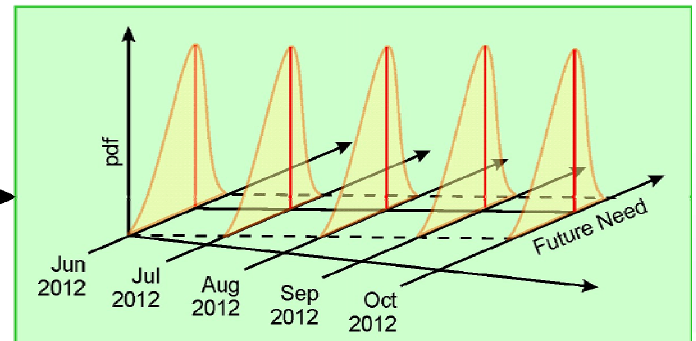


Probabilistic regional demand time series

Demand distributions

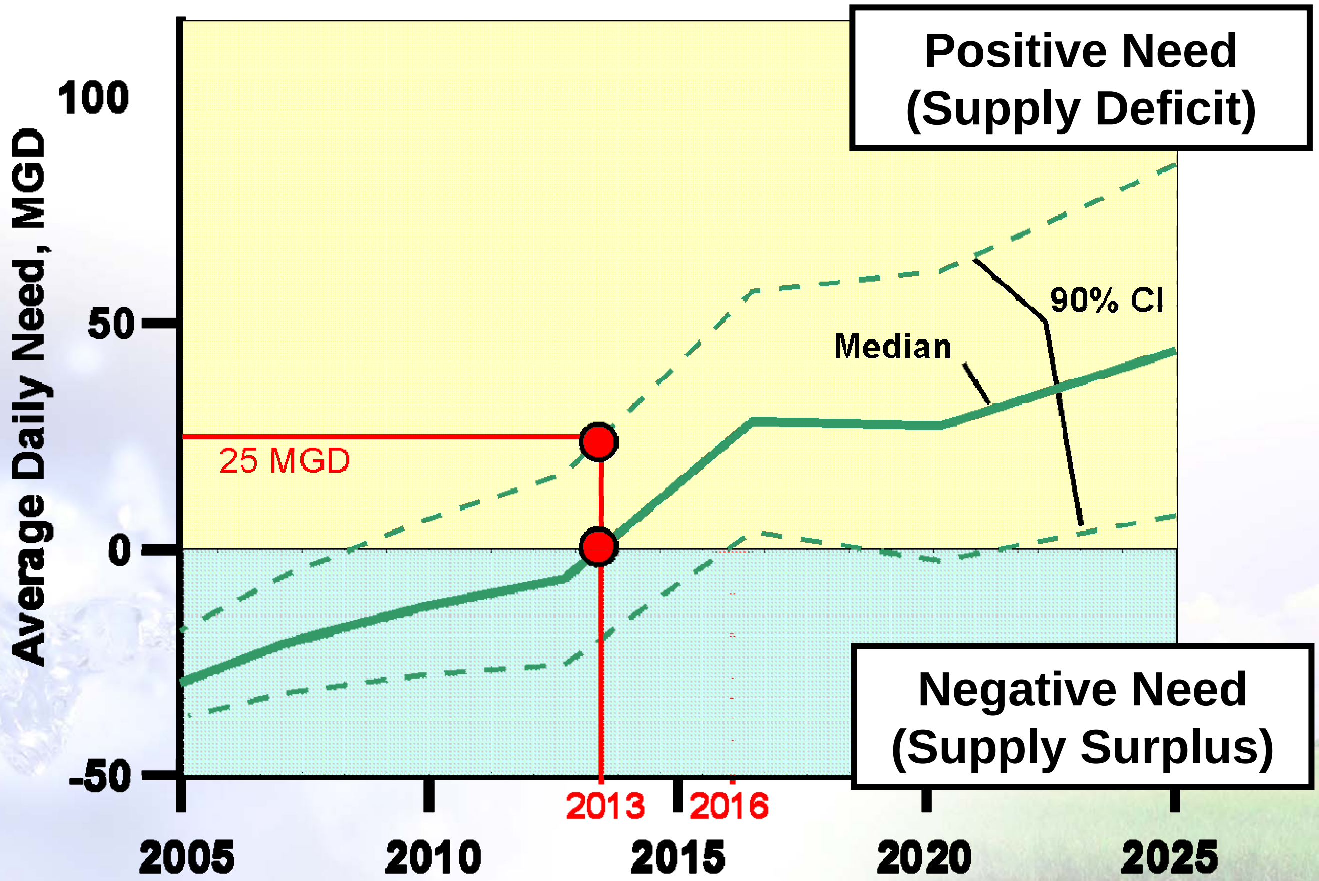
Future Need Analysis

Need distributions



Probabilistic future need time series

Interpreting FNA results



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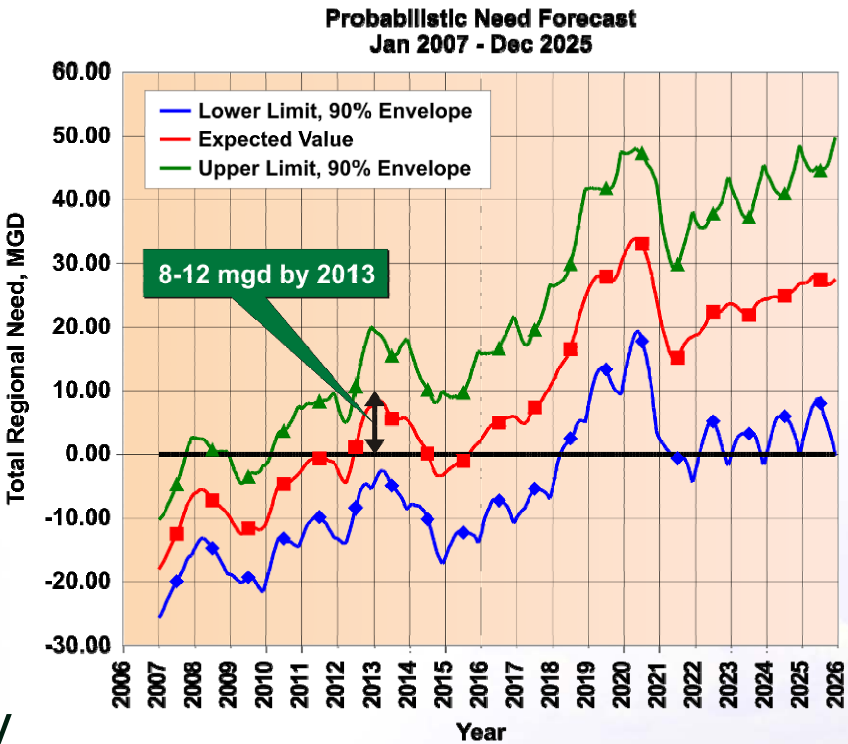
2003: First TBW Future Need Analysis

- Decided that 8-12 mgd new supply would be needed by 2013
  - Current demand model
  - Previous models of the surface system and stream flows (not the FMS)
  - Uncertainty driven by socioeconomics and drought return intervals



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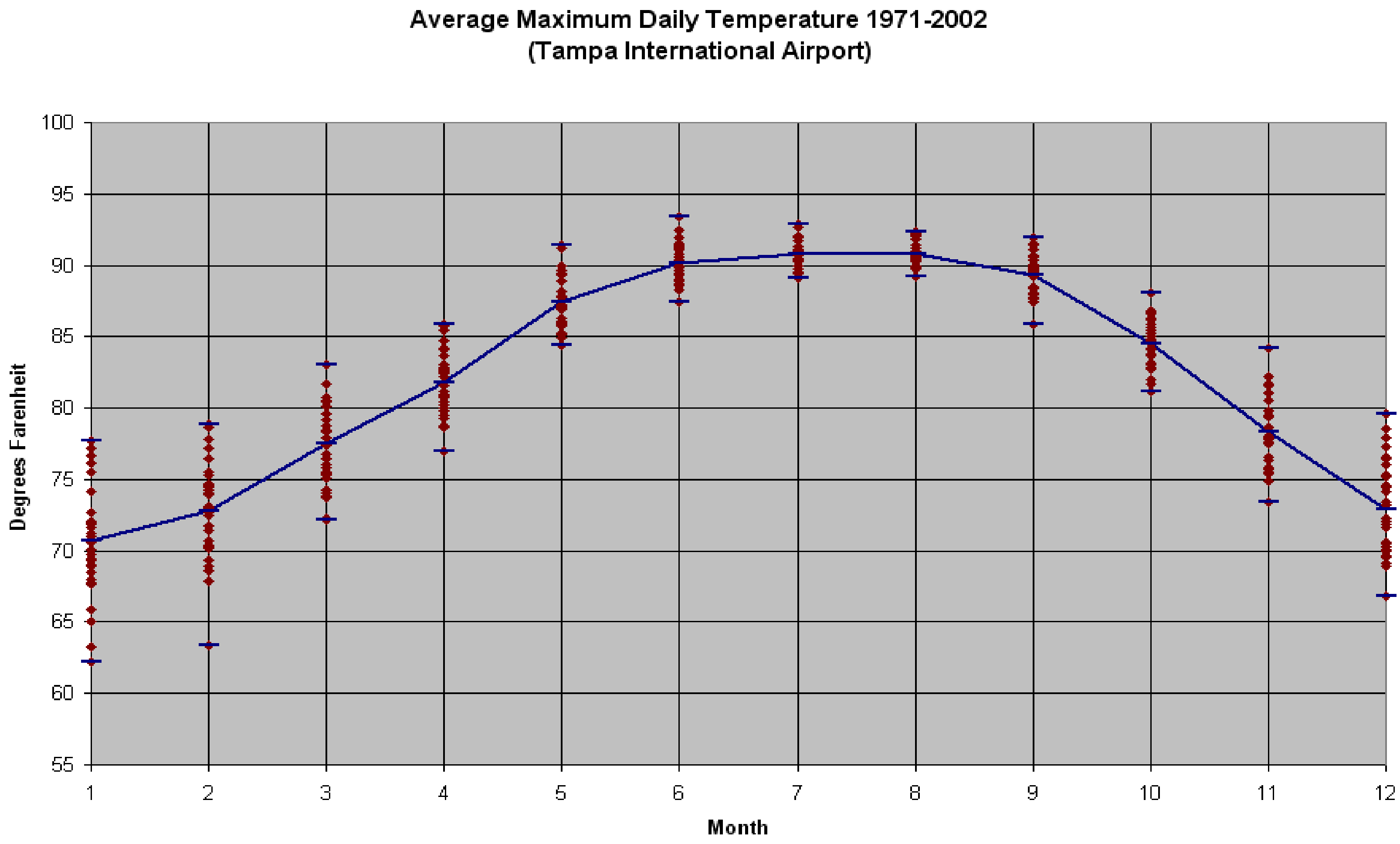
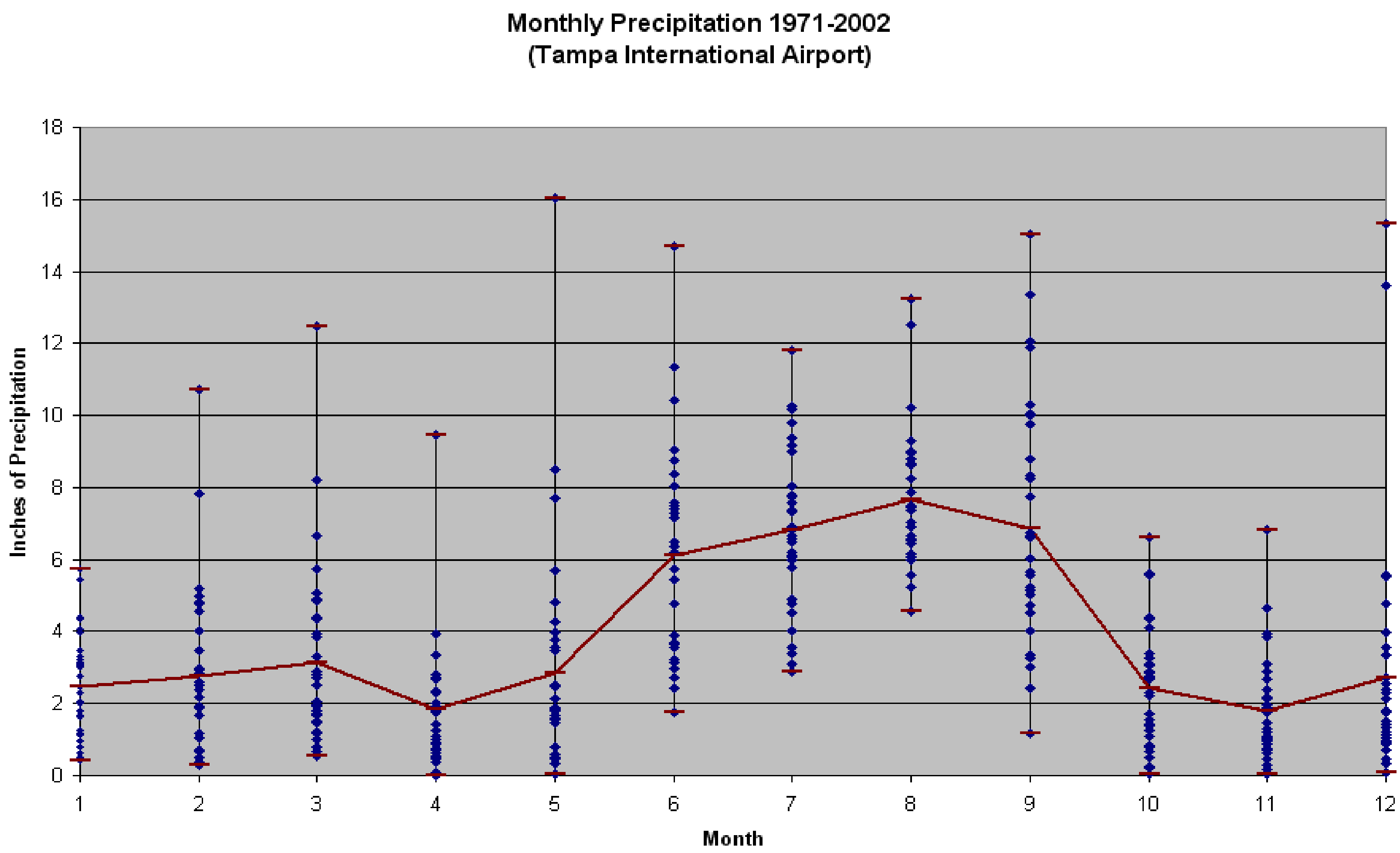
Applying Reliability Framework to Climate Change Evaluation

Historical Avg. Maximum Temperatures



Historical Precipitation



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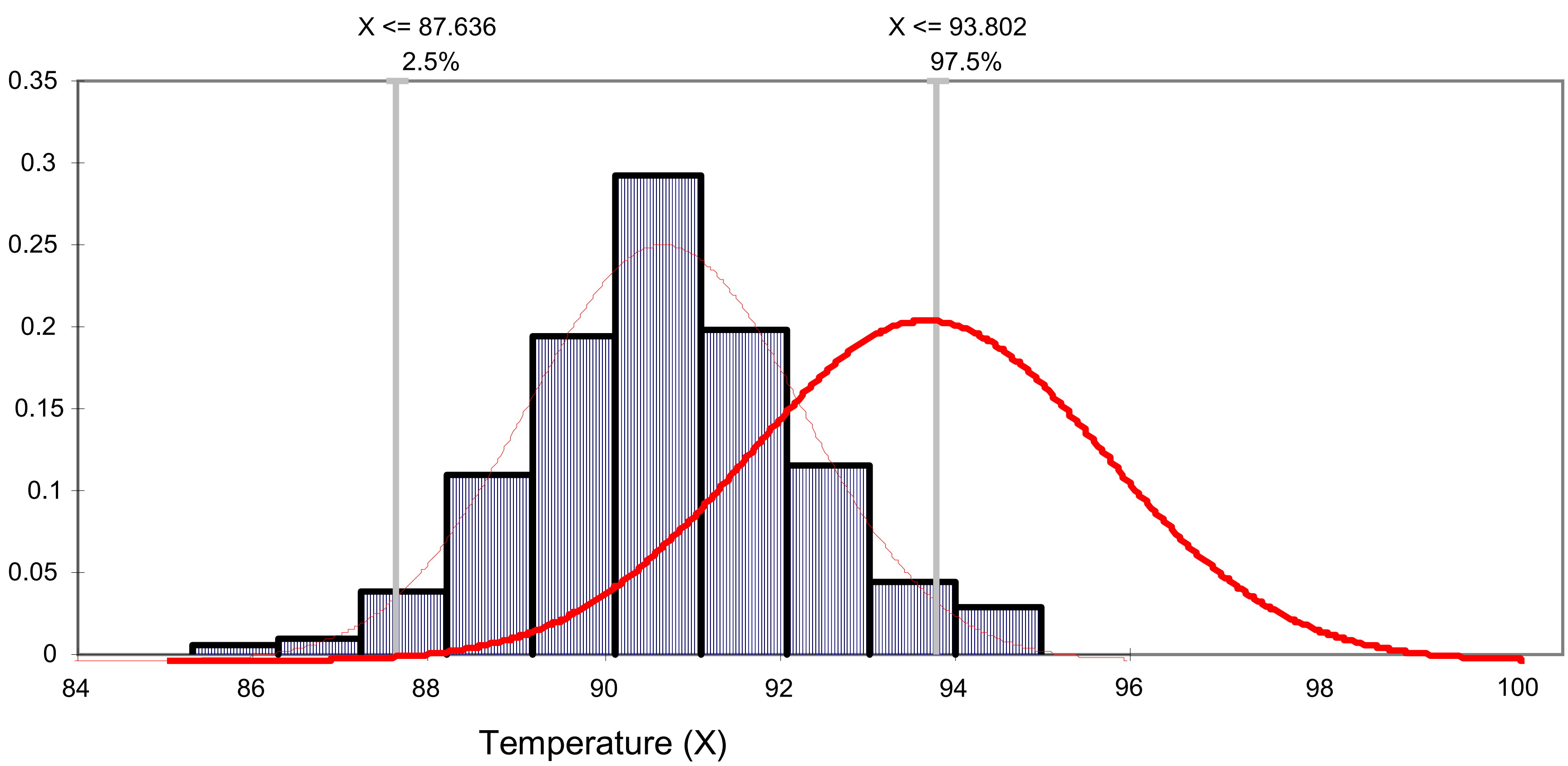
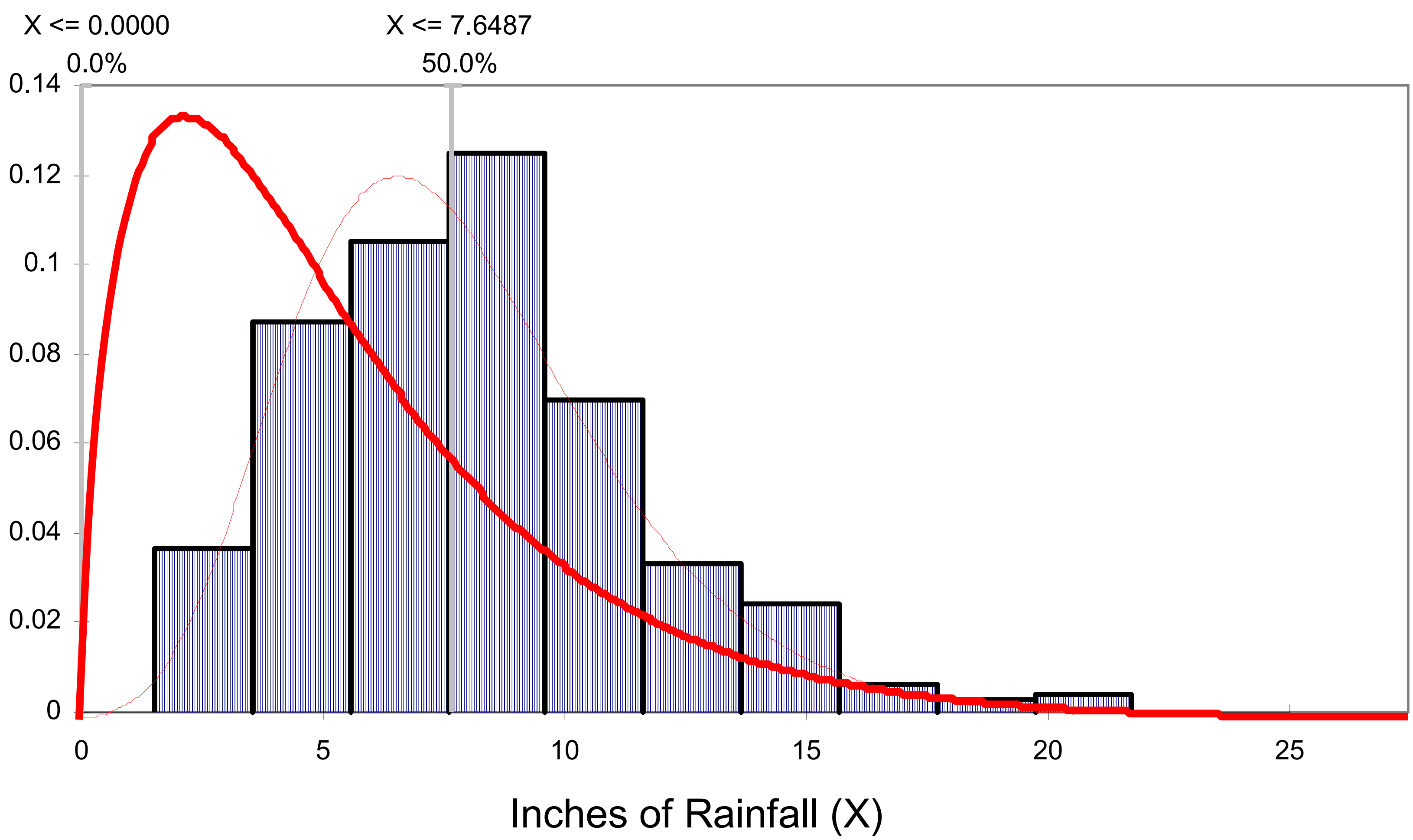
July Average Maximum Daily Temperature



July Precipitation



Example Scenario

- Increase in temperatures
  - +3 degrees: June, July, August
  - +2 degrees: January, February, December
  - +2.5 degrees: remainder
  - Assume proportional increase in variance
- Decrease in Precipitation
  - 95% of normal: June, July, August
  - 97.5% of normal: January, February, December
  - 96.25% of normal: remainder
  - Assume increase in skewness
  - Assume no change in precipitation frequency

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Scenario Results

- Positive median need occurs 1 year earlier
- Maximum of 95th percentile need of 95 MGD (versus 72 MGD)
- Median regional demand forecast 21 MGD higher (+7%) by end of forecast horizon

- Large enough changes to affect decisions
- Speed-up decisions to invest by about 4 years

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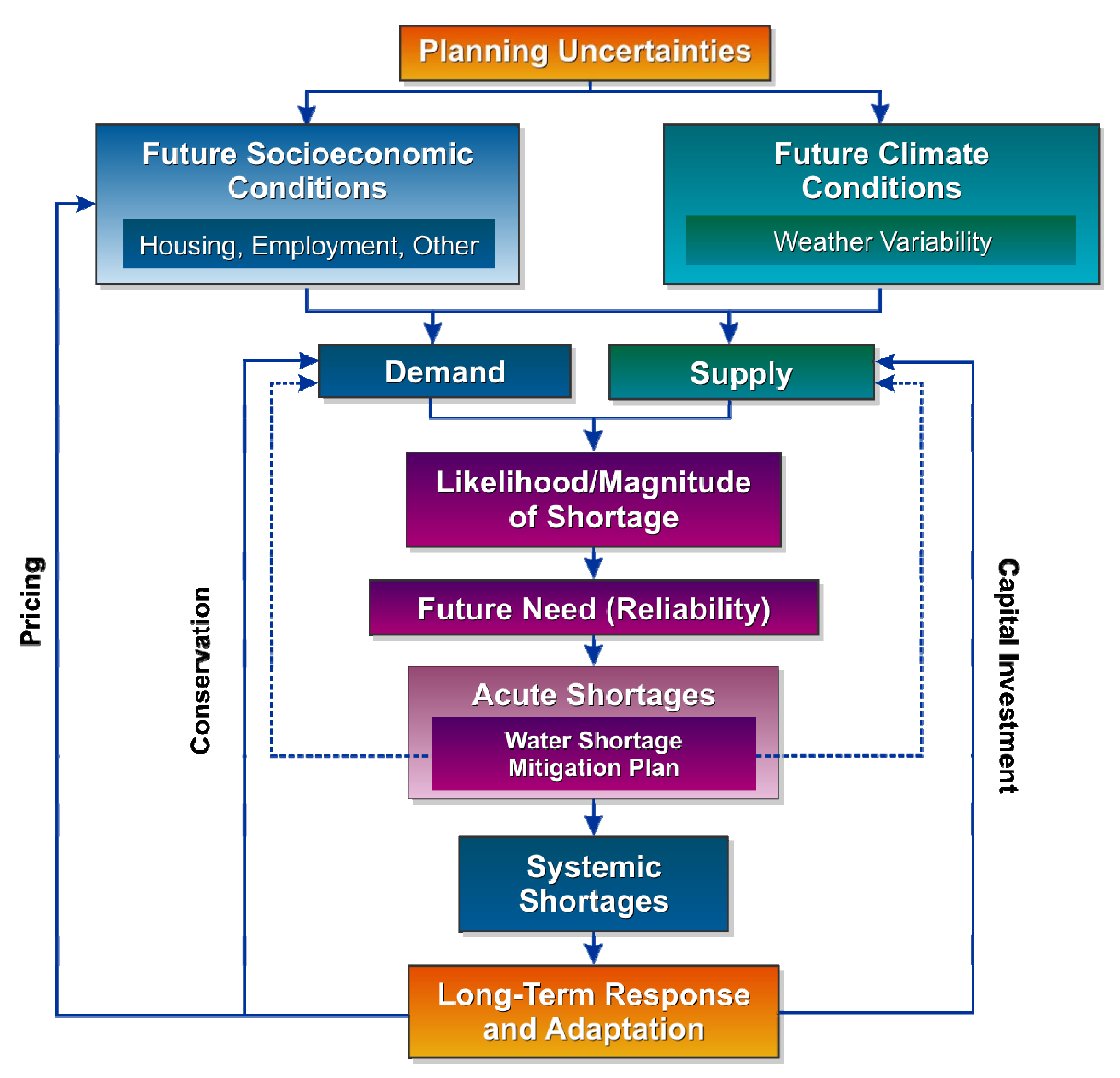
Evolving Risk-Based Model



Conclusions

- Climate change analysis must consider impacts on both demand and supply
- Tampa Bay Water's evolving risk-based framework can treat climate change as one of several other planning uncertainties
- Risk-based, probabilistic, approaches for predicting water supply reliability offer a robust analytical platform
- Climate forecasts need to be disaggregated to local/regional and monthly/daily basis, expressed in terms of variables influencing supply and demand

Questions?

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