



Climate Ready Water Utility Working Group
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Water and Climate Change: Observations from Seattle

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Purpose of Briefing

- Provide background on climate and water and Seattle
- Examine what constitutes climate vulnerability
- Describe how Seattle has assessed vulnerability and adaptation options
- Highlight involvement in climate research

Mitigation and Adaptation

- Greenhouse gas (GHG) *mitigation* can avoid, reduce or delay the impacts of climate change
- Some impacts are unavoidable due to past emissions, hence the need for *adaptation*
- Complementary approaches to a comprehensive climate strategy:
 - Mitigation limits the magnitude of climate change
 - Adaptation limits the impacts of climate change

*“A portfolio of adaptation and mitigation measures can diminish the risks associated with climate change”
- Intergovernmental Panel on Climate Change, 2007*



Effects on Water: IPCC Technical Paper VI

- Precipitation and runoff variable by location
- Supplies based on glaciers and snowpack will decrease
- Water quality affected, as well as food production and other processes
- Water infrastructure impacted, adaptation options require demand-side and supply-side strategies
- Gaps in knowledge with observations and research

“According to many experts, water and its availability and quality will be the main pressure on, and issues for, societies and the environment under climate change.”

- IPCC Technical Paper VI



Background on Seattle

Annual Rainfall

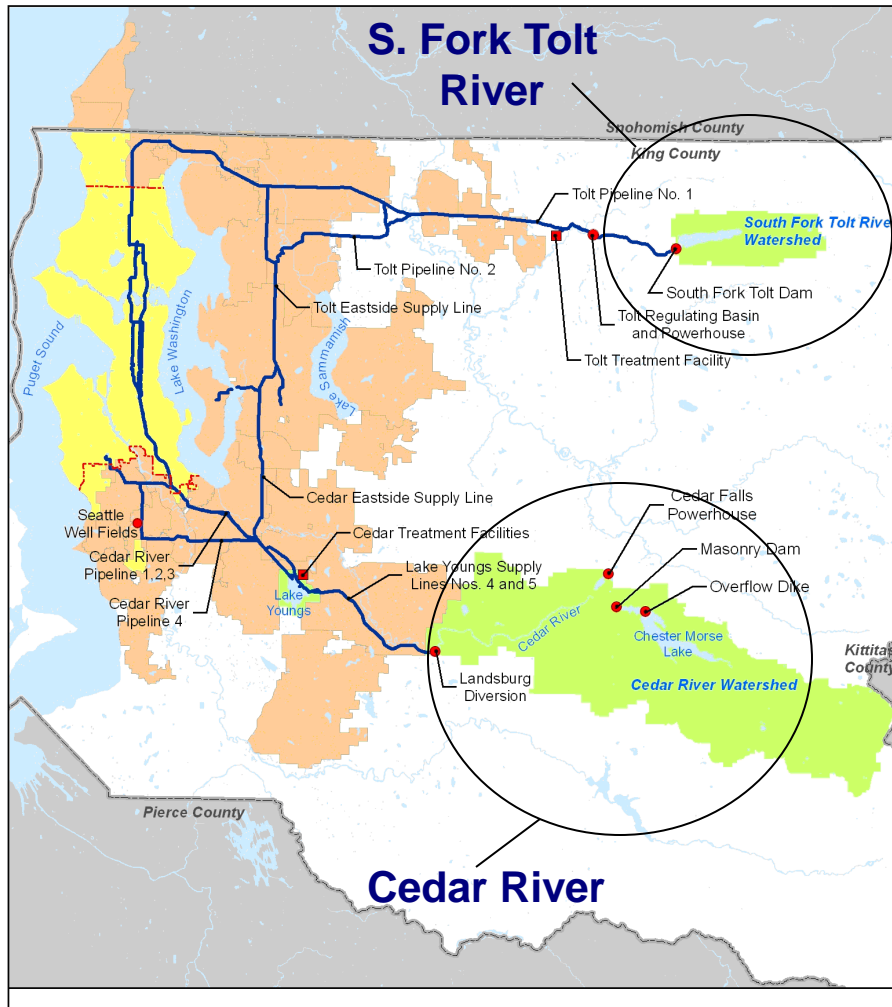
Sequim – 17"

Seattle – 37"

Cedar River Watershed – 100"

Hoh River Valley – 150-180"

Seattle's Water Supply System

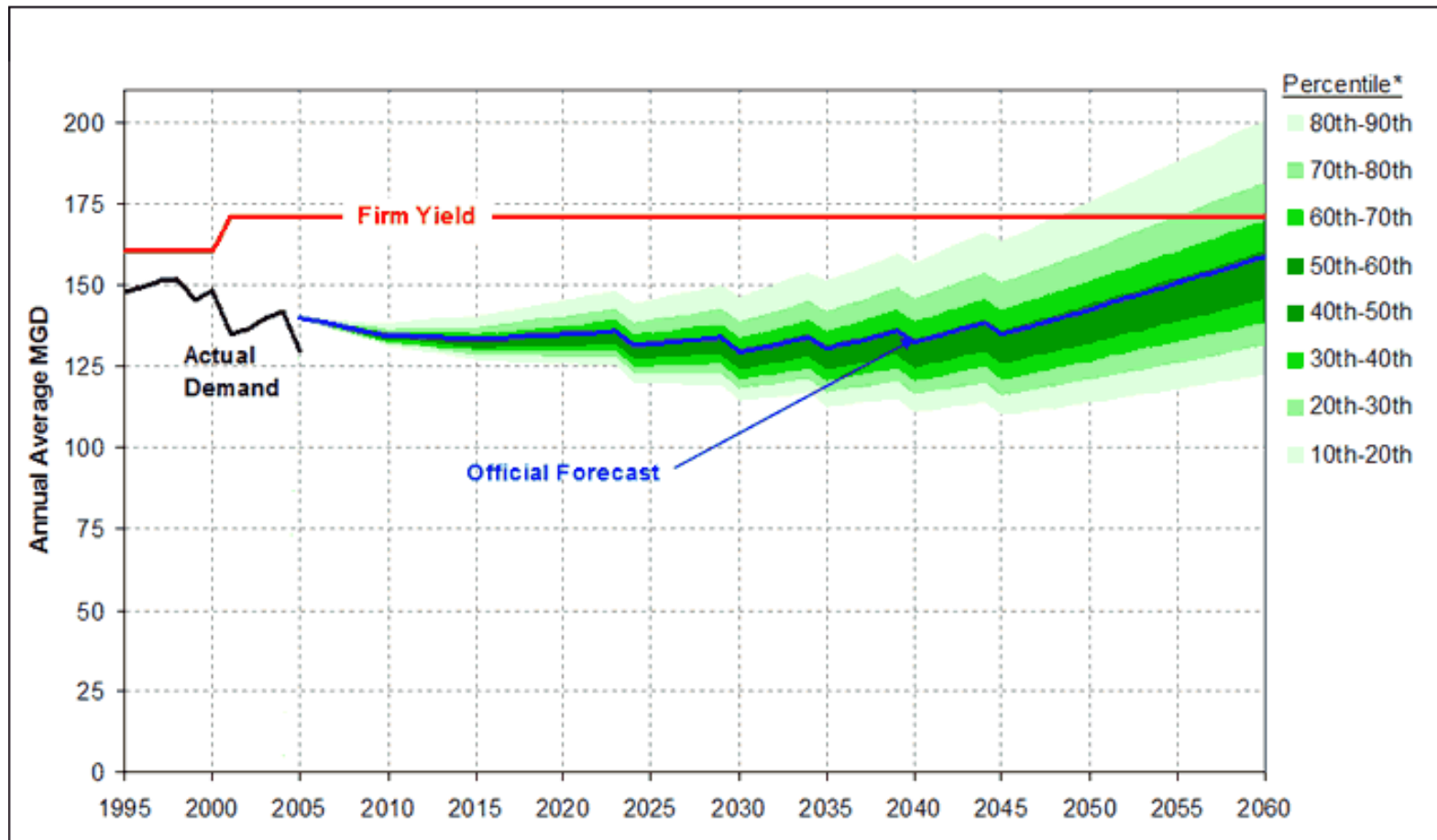


- Responsibilities:
 - Retail and wholesale water to 1.4 million people
 - Instream flows for salmon habitat in perpetuity
 - Flood management
 - Hyrdopower generation
- Asset replacement value: \$3-4 billion
- Mountain-based surface water supplies, nominal groundwater
- Largest supply is unfiltered
- Rely on snowpack and rain, may be more dependent on rain than snow

Official Demand Forecast

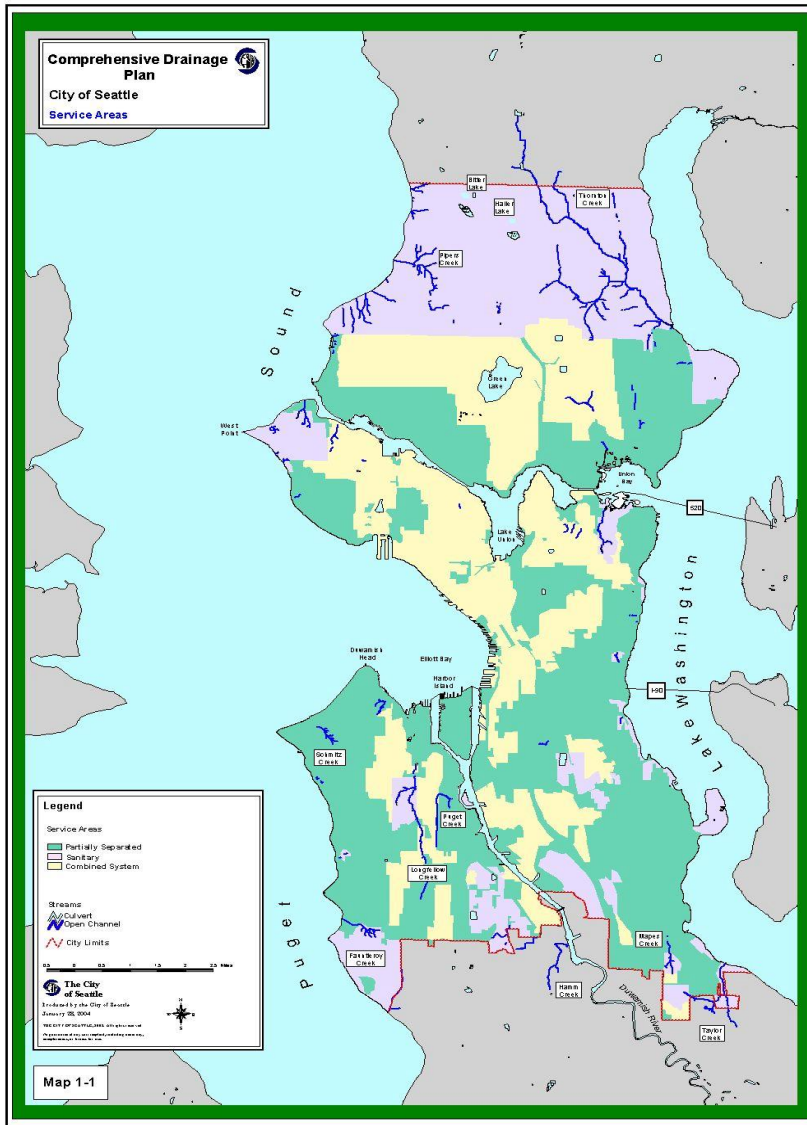
Water Demand and Supply Options

Uncertainty in Water Demand Forecast*



Note: Percentiles represent the probability that actual demand will be less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth, price elasticity, income elasticity, and conservation. Note that the Official Forecast is at about the 57th percentile.

Seattle's Drainage and Wastewater System



- System Drivers:
 - Combined Sewer Overflow (CSO) and Stormwater Permit Compliance
 - Sediment cleanup
 - Urban flooding
- Urban Flooding and climate change:
 - Significant life safety and property impacts in '04, '06, and '07
 - Projected climate change impacts more intense winter storms
 - Historic system design = 25yr event
- Asset replacement value: \$3-4 billion

Areas of Interest

- water supply
 - Snowpack
 - Timing, distribution of precip
- water quality
- water demand
- precipitation intensity – urban drainage
- sea level rise
- CSO and stormwater design standards
- effectiveness of green stormwater infrastructure
- ecosystem impacts
- forest fires



Climate vulnerability and adaptation

Climate Vulnerability and Adaptation

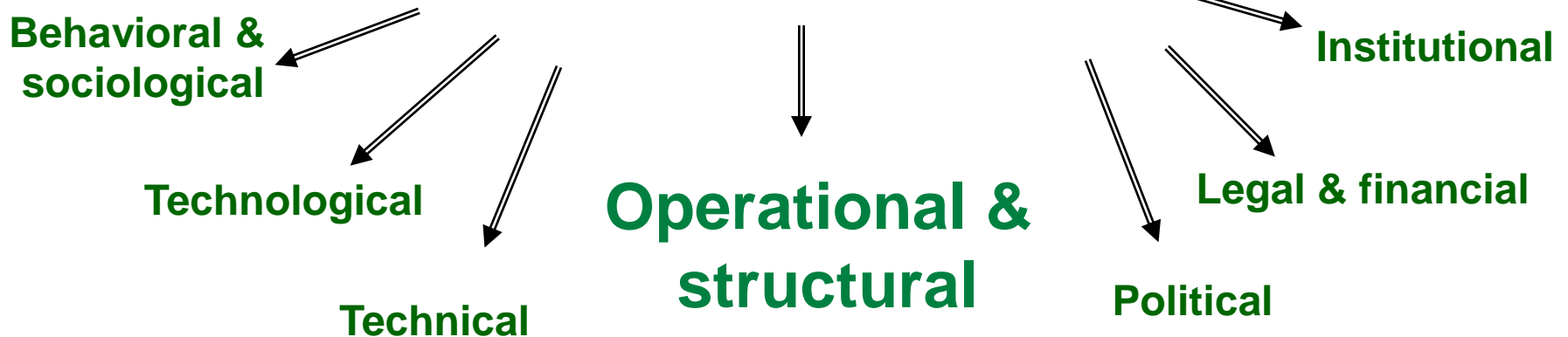
- Vulnerability is a function of location and capacity to cope*
- Location
 - assess potential impacts in our region and to our system
 - incorporate information into planning and decision-making
- Capacity to Cope
 - identify and assess adaptation options
 - reduce vulnerability and increase resiliency
 - enhance capacities in multiple realms

Climate Vulnerability is a function of:



AND

CAPACITY TO COPE



SPU's Involvement with Downscaling Studies

Statistical Downscaling – Water Supply

- **2002-2006: SPU-funded project with University of Washington – Climate Impacts Group (UW CIG)**
 - Methods and Uncertainties
 - Supply Impacts
- **2006-2008: Regional study with UW CIG - *Will focus on this study***
 - Regional Datasets
 - Supply and Demand Impacts
 - Adaptation Strategies
- **2008: UW CIG study for State of Washington**
 - Supply Impacts

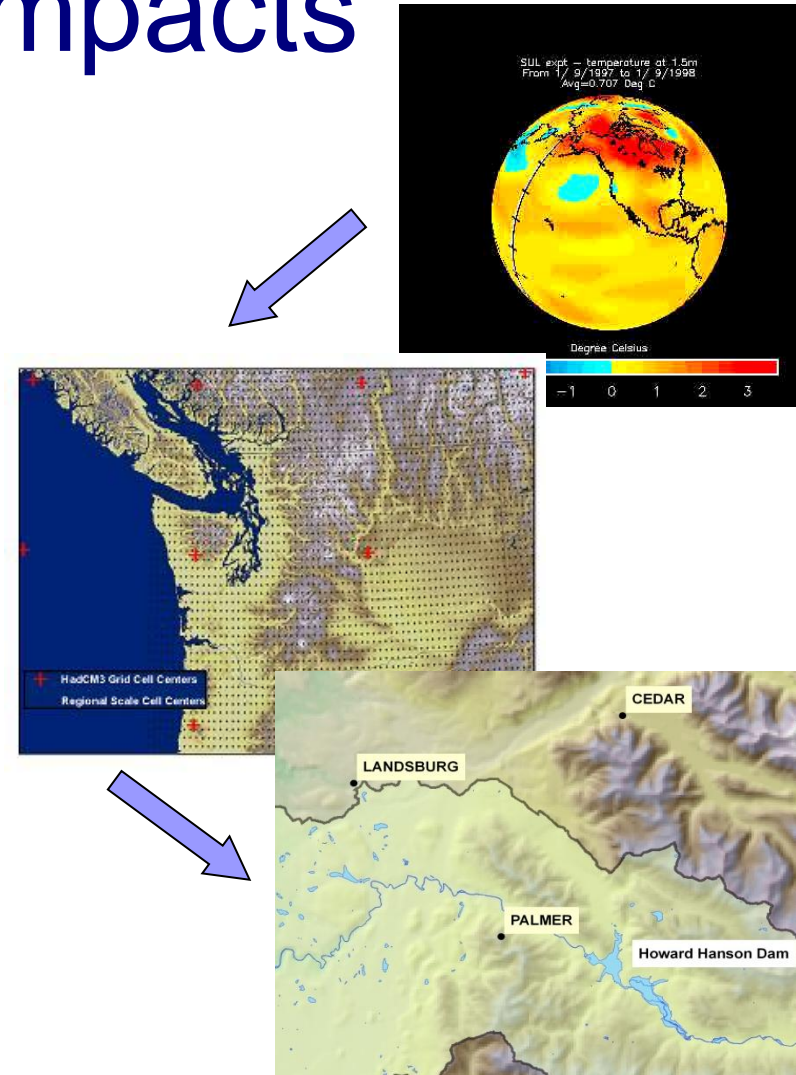
Dynamical Downscaling – Urban Drainage

- **2008: UW CIG study for State of Washington**

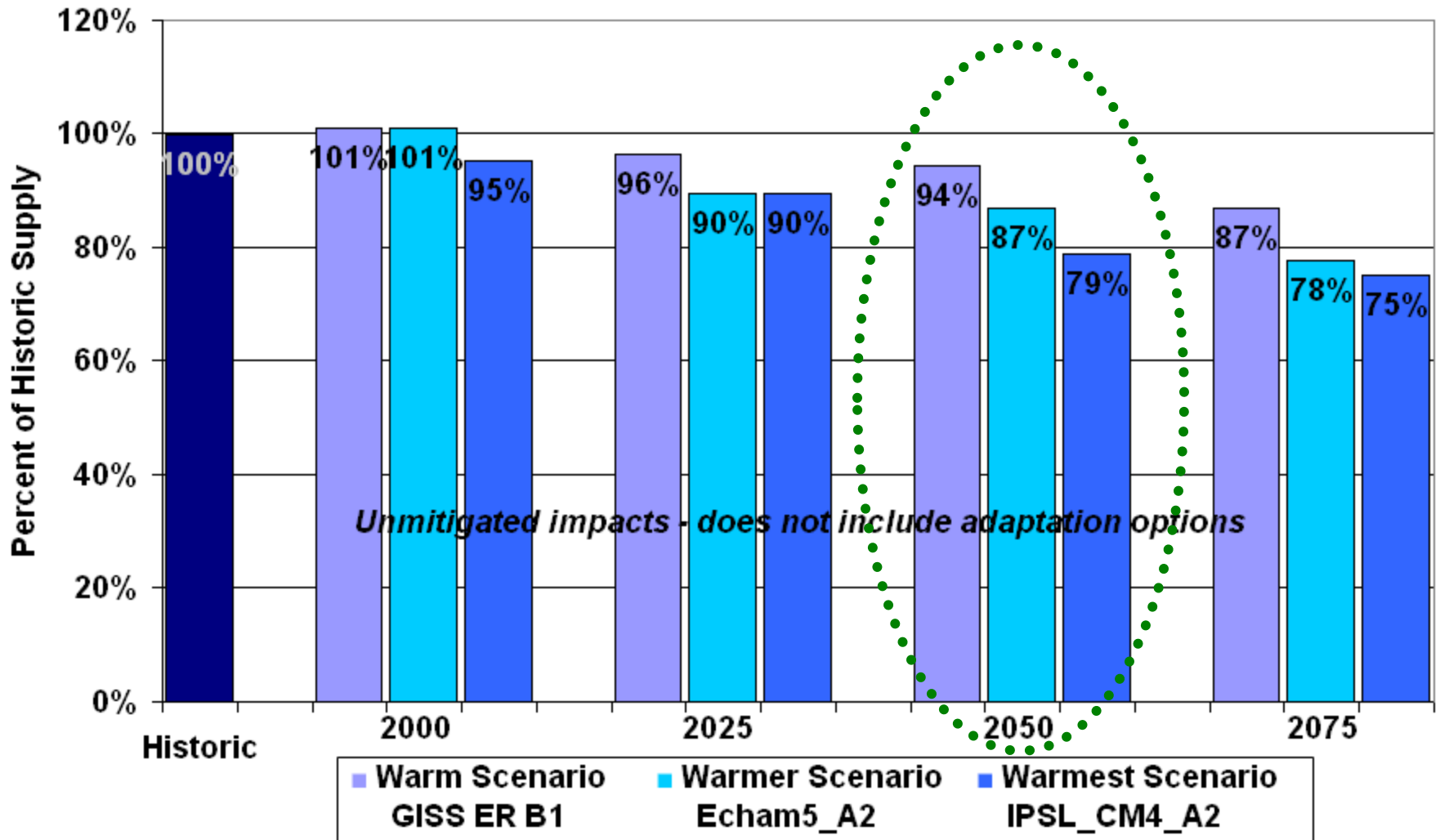
Regional Climate Impacts

Downscaled GCM outputs to regional scale

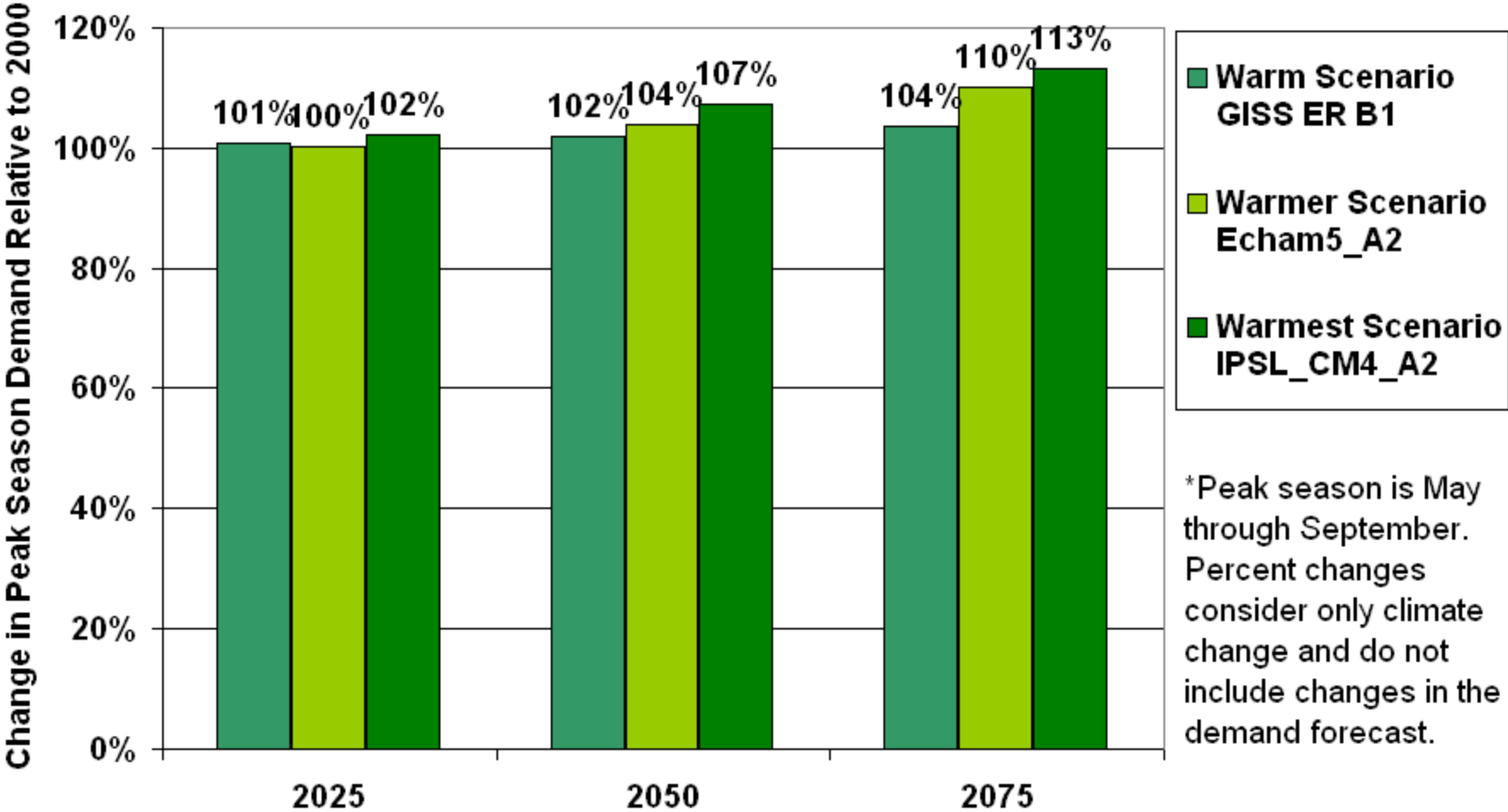
- 3 Climate Change Scenarios for 2000, 2025, 2050, 2075:
 - Warm: GISS_ER-B1
 - Warmer: Echam5-A2
 - Warmest: IPSL_CM4-A2
- Temperature
 - Warming trend, primarily in winter and summer
 - Average warming is generally 1°C per 25-year period
- Precipitation
 - Less agreement between models than there is with temperature
 - In general, more precipitation in winter, less in summer
- Hydrology
 - Shift towards higher winter flows and lower spring/early summer flows
 - Substituted *future* hydrology for *historic* in SPU's systems models



Change in Water Supply with Climate Change Scenarios *Baseline Operations*



Change in Peak Season Consumption* with Climate Change Scenarios



Portfolio of Operational Adaptation Options

- SPU identified a series of intra-system modifications and new supply options – and grouped them into Tiers.
- Applied the effects on supply using Tier 1 intra-system modifications.
 - Restore available supply to current levels, or better.
 - Generally add more storage to system.
 - No or low cost, or already in place but not in models.
- Where Tier 1 modifications did not restore supply fully, identified the need for subsequent Tiers.
 - Options become more costly and complex.

Tier 1 Modifications

- Refill Chester Morse Lake 1 m higher
 - Adds **12%** more useable storage
- Raise Overflow Dike to 1.2m
 - Reduces seepage losses
 - New project under development
- Lake Youngs – model 1.5m of storage
 - Current practice but not modeled
 - Adds **7%** more useable storage
- Drawdown Tolt additional 6 m
 - Adds **18%** more useable storage

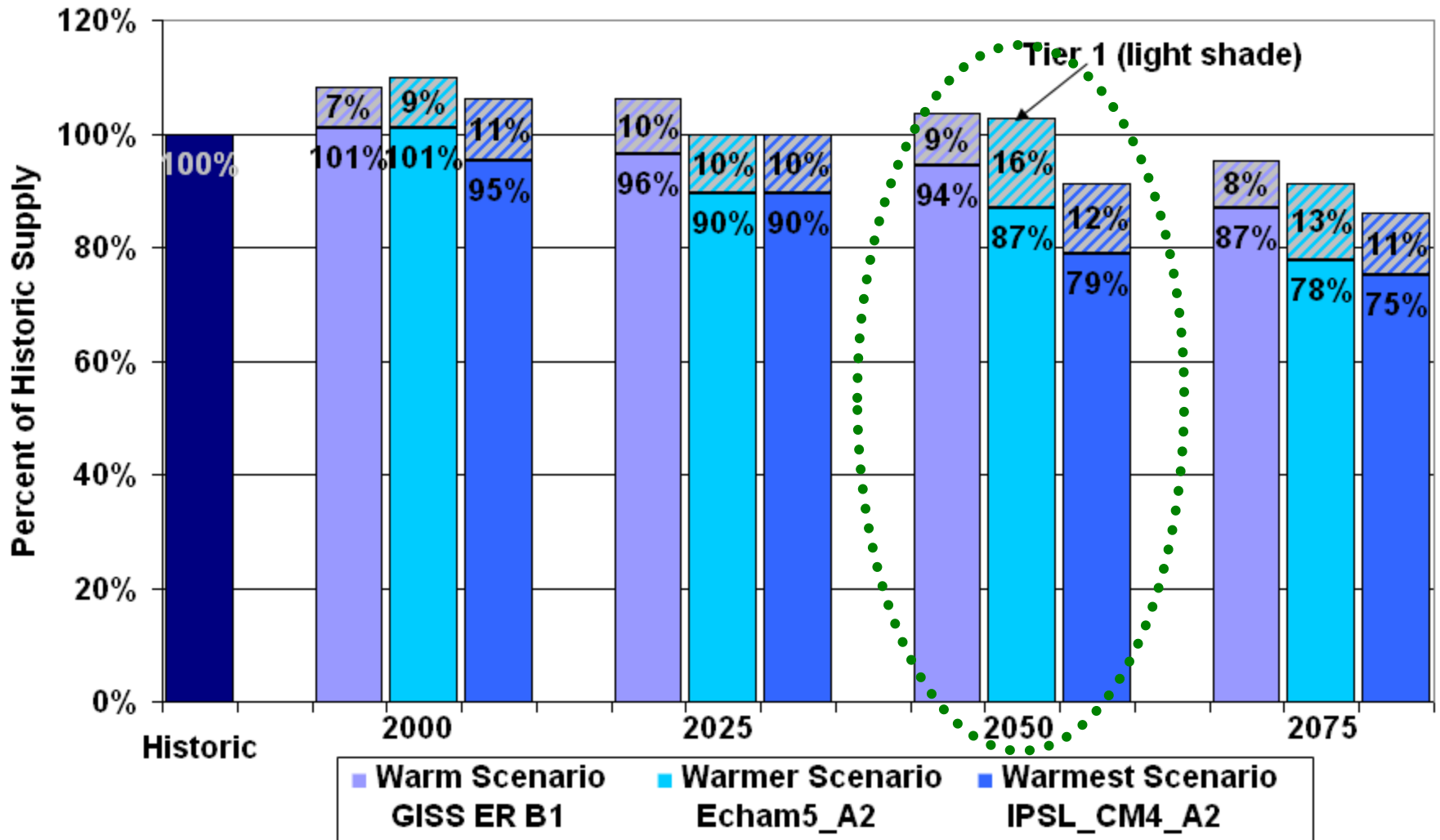


Low cost, first step actions

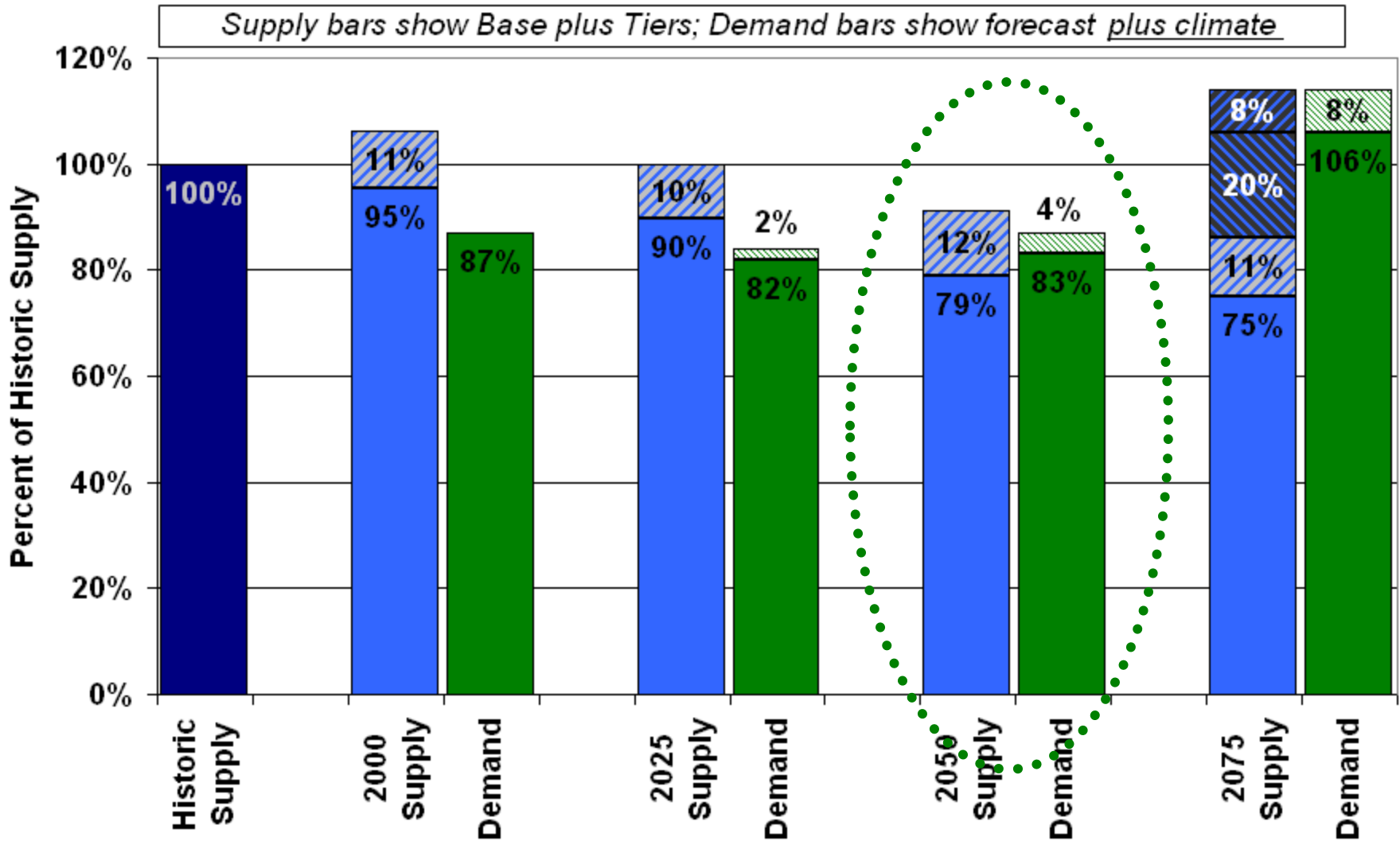
Enhance flexibility, operational capacity of current assets and infrastructure to reflect dynamic conditions

Offset loss of storage from *reduced snowpack* by accessing more *reservoir* storage

Change in Water Supply with Climate Change Scenarios *Baseline Operations plus Tier 1*

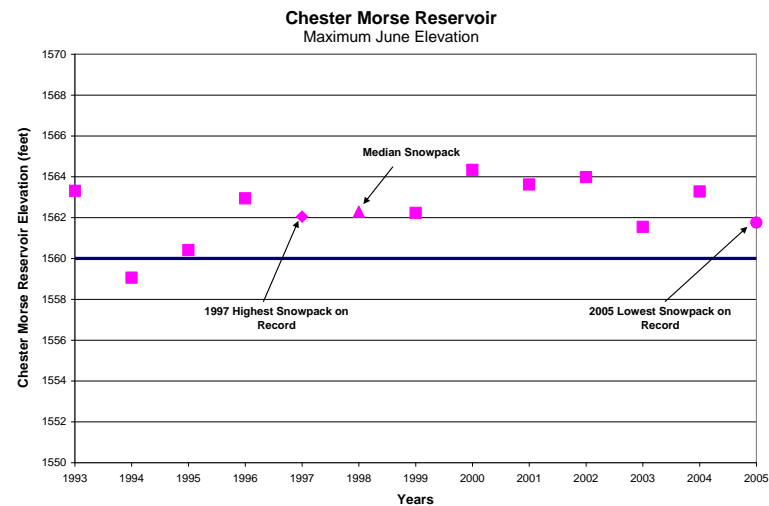
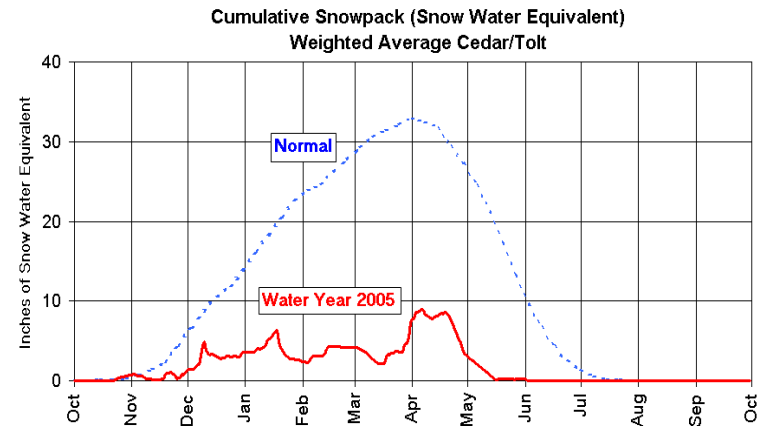


Warmest Scenario Results from Monthly CUE and Demand Forecast Model - IPSL_CM4_A2



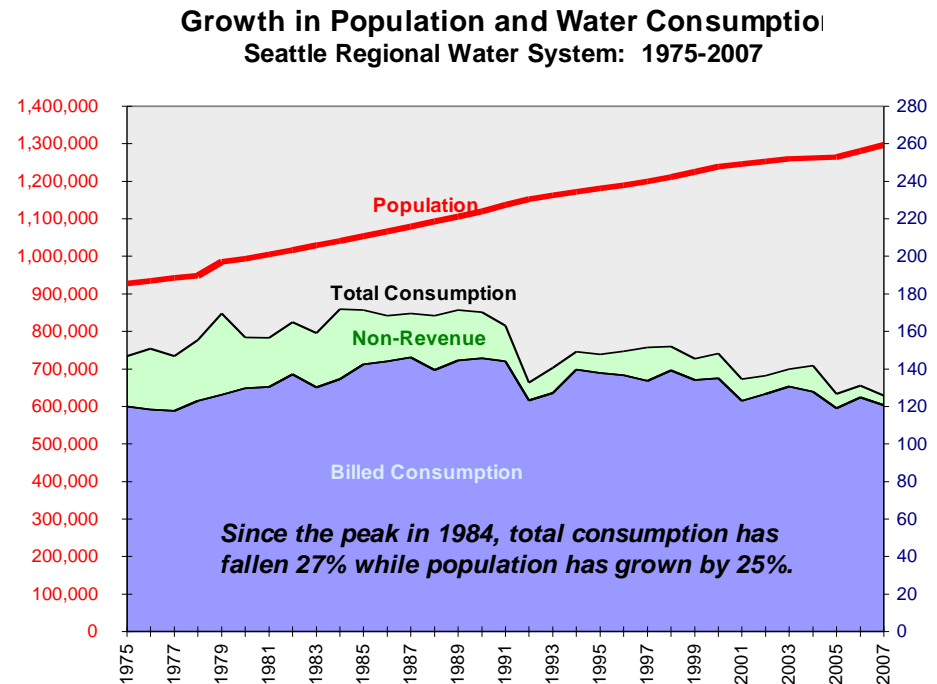
Testing Operational Flexibility: Low Snowpack

- Snowpack:
 - Lowest snow water equivalent on record (61 yrs)
- Precipitation
 - Spring - 26th driest (75 yrs)
- Temperature
 - Spring - 23rd warmest (75 yrs)
- Reservoir levels in June same as year with largest snowpack on record, 1997
- Refill level higher than assumed in water supply models



Conservation as Adaptation

- Since mid 80's:
 - Population up, consumption down ~ 25%
- Significant reductions in water use
 - 44 mgd of savings since 1980
 - Another 15 mgd of savings through 2030
- Delayed impacts of climate change
- Future conservation seen as hedge





Involvement in climate research

Research Objectives

- Address *location* and *capacity to cope* issues
- Identify Seattle specific climate impacts
 - develop an understanding of the implications of climate change on the systems we manage
 - inform adaptation options
- Leverage ongoing efforts and collaborate
 - enhance SPU's and water sector's knowledge and adaptive capacity;
 - learn from others, contribute to others
- Establish relevance of water sector
 - important user of climate research
 - Important *shaper* of climate research

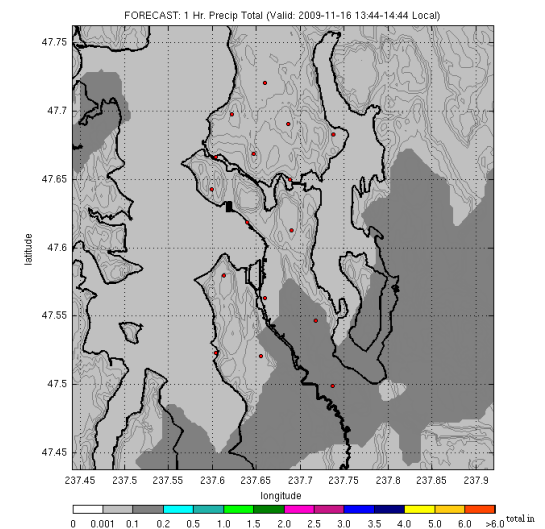
University of Washington

■ Impacts Assessments

- 2005 study
 - 4 climate scenarios
 - Results included in 2007 water system plan
- 2007 study
 - 3 climate scenarios
 - Assessed impacts on supply and demand
 - Evaluated effectiveness of adaptation options
- 2009 sea level rise (SLR) analysis
 - Created sea level rise scenarios in GIS
 - Identified infrastructure that would be inundated

■ Tool Development

- Nowcasting
 - Integrates in-city rain gage data with radar forecasts
 - Provides 60-90 min rain forecasts at neighborhood scale
 - Improve preparation for and response to storms
 - Deploy late '09



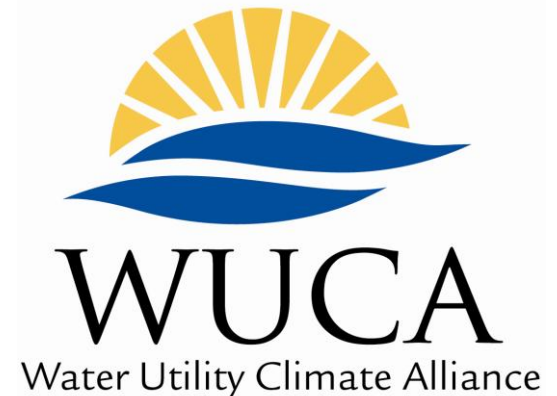


Water Research Foundation

- **Climate Change Strategic Initiative**
 - Developing multi-year climate research program for water sector
 - 2009 Projects:
 - Climate Change Impacts on the Regulatory Landscape
 - Analysis of Changes in Water Use Under Regional Climate Scenarios
 - Impacts of Underground Carbon Geologic Sequestration on Water Quality of Groundwater
 - Identifying and Developing Climate Change Resources for Water Utilities
 - Vulnerability Assessment and Risk Management Tools for Climate Change
 - Changing Mindsets to Promote Design of Sustainable Water Infrastructure under Climate Change
 - 2010 Projects:
 - Drinking Water Pump Station Design and Operation for Maximum Life Cycle Energy Efficiency
 - Water Quality Impacts of Extreme Weather-Related Events
 - Analysis of Reservoir Operations Under Climate Change
 - Ground Water Sustainability Under Climate Change
 - <http://www.theclimatechangeclearinghouse.org>

Water Utility Climate Alliance (WUCA)

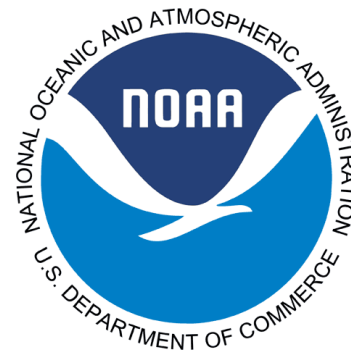
- 10 water suppliers
- Focus on adaptation
- 2009 Projects
 - White Paper on Climate Modeling and Downscaling
 - How can climate models be improved so they are more useful for the water sector?
 - Recommends 7 investments in climate models and downscaling
 - Collaborating with research groups that manage US GCMs
 - White Paper on Decision Support
 - Overview of five methods
 - Case studies and future research needs



Central Arizona Project
Denver Water
Metropolitan of So. CA
NYC Dept. of Env. Protection
Portland Water Bureau
San Diego County Water Authority
San Francisco PUC
Seattle Public Utilities
Southern NV Water Authority
Tampa Bay Water

US and European Union

- National Oceanic & Atmospheric Administration (NOAA)
 - Focused on “knowledge to action” – transfer of climate science to decision-making
 - Three cities: Denver, Tucson and Seattle
 - Led by researchers at the University of Arizona
- MARE
 - Flood risk management, adaptation, learning alliances
 - Cities from the Germany, The Netherlands, Norway and the U.K.
- Prepared
 - Focus on urban water cycle adaptation, real time control/monitoring
 - 12 city utilities, several research institutes
 - Seattle and Melbourne non-EU participants





Conclusions

- Will work on this on my flight

Thank You

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