WATER TOMORROW

2020 Integrated Resources Plan

IRP Joint Workshop on Demands

Metropolitan Board of Directors and Member Agency Managers

March 23, 2021

Ed Means
Facilitator

- President of Means Consulting LLC
- 40 years in water in California
- Experienced facilitator on technical issues
  - Over 15 strategic plans
  - 8 scenario plans
  - Numerous expert panels
- Consultant since 1999 on numerous planning projects including scenario planning, resource plans, and strategic plans across the country
- Worked at Metropolitan from 1980-1998 including as Director of Resources during first MWD IRP

Workshop Logistics

Meeting Logistics

Objectives

Approach

Meeting Logistics

- Limited time – be succinct; focus on water demand issues
- Staff will consider all comments and questions as planning moves forward
- Staff will provide written guidance to process related questions
- Mute audio / turn off video unless talking
- Use the chat feature to submit questions you haven't already submitted
- The meeting is being recorded
- May also submit questions during meeting to: MWDIRP@mwdh2o.com

Workshop Objectives

- Opportunity for workshop participants to pose questions to the panel of demand experts
- Feedback on charge questions on drivers of water demands
- Obtain expert feedback prompted by participant questions to improve quantification of scenarios

Workshop Approach

- Panel member discussion of charge questions related to demand
- Panel member feedback on questions submitted by the Board and member agency managers in advance
- Panel member feedback for clarification or additional demand-related questions from Board members or member agency participants

Staff Presentation

Recap of Work Effort

Refinement Approach

Charge Questions for Workshop

Brief Recap of Work Efforts

- Preliminary scenario assumptions presented in October
  - Initial assessment to illustrate potential for supply/demand ranges across scenarios and types of analytics available
- Currently refining scenario assumptions and analysis
  - More robust modeling and evidence-based effort
  - Identify plausible supply/demand ranges across scenarios
  - Update “gap analysis”
  - Serves as the basis for identifying the actions needed to achieve 100 percent reliability for each scenario

How We Are Refining the Scenarios

- Collaborative Approach
  - Scenario refinements are grouped into three areas
    - Local Supply, Imported Supply and Demands
  - Engage with experts (demand and climate)
    - Contracted to help staff with technical support
    - Expanded to include Board and Member Agencies interaction
- Today's workshop focuses on retail demands
  - Demands on Metropolitan are determined by taking the retail demand and subtracting the local supply
- Next month we will focus on climate impacts
  - Discuss demand, local and Imported supply impacts in a similar workshop format

Charge Questions Posed to the Demand Experts

- Drivers
  - Verify survey results and identify new demand drivers not previously considered
- Ranges
  - Identify approaches to determine demand driver uncertainties and apply to differentiate one scenario from the other
- Methodologies
  - Identify techniques, data sets, modeling tools or methodologies to quantify effect of demand drivers
- Interrelations
  - Ensure plausibility of each scenario and avoid double counting or omission of demand driver effects

Panel Introductions

Lisa Maddaus

Stephen Levy

Dan Rodrigo

Dr. Thomas Chesnutt

Dr. Kurt Schwabe

Lisa Maddaus

- Co-owner and senior water resources engineer with Maddaus Water Management Inc.
- B.S. and M.S. in Civil and Environmental Engineering from UC Davis
- Focuses on integrated resource planning, specializing in land-use based demand forecasting, conservation, drought and climate change planning.
- Co-author of the American Water Works Association, Manuals of Water Supply Practices, including:
  - M36 – Water Audits and Loss Control Programs
  - M50 – Water Resources Planning
  - M52 – Water Conservation Programs - A Planning Manual
  - M60 – Drought Preparedness and Response
- She has completed more than 250 water resources, conservation and drought planning studies in the United States, Canada, Australia and New Zealand

Stephen Levy

- Director and Senior Economist of the Center for Continuing Study of the California Economy in Palo Alto
- Degrees in economics from MIT and Stanford University
- Works with public agencies and nonprofit institutions that require an explanation and analysis of California growth trends
- Has prepared growth forecasts for regional agencies including ABAG, SACOG, SCAG, AMBAG and SBCAG and for the City of San Jose

Dan Rodrigo

- Senior Vice President and Global One Water Practice Leader for CDM Smith
- BS in Economics and MS in Environmental Planning from Southern Illinois University, Carbondale
- Over 30 years of experience in water demand forecasting, integrated water resources planning and climate resiliency
- Developed scenario-based water demand forecasts for over 50 municipalities and four large regional water agencies similar in structure to MWD, these being: MWDOC (CA), Valley Water (CA), Tarrant Regional Water (TX), and Metro Vancouver (BC,CAN)

Dr. Thomas Chesnutt

- CEO of A & N Technical Services, Inc.
- Ph.D. and M.Phil. in Policy Analysis from the RAND Graduate School, an M.S. in Technology and Science Policy from the Georgia Institute of Technology and a B.A. in Economics from Kenyon College
- National consulting practice specializing in empirical policy analysis.
- Provides state-of-the-art financial expertise applied to water resources and water efficiency programs

Dr. Kurt Schwabe

- Expert on economic issues and water use, agricultural production, urban water conservation, ecosystem services, and environmental regulation
- B.A. in Mathematics and Economics at Macalester College, M.S. in Economics at Duke, and Ph.D. in Economics from N. Carolina State
- Professor of Environmental Economics and Policy at the School of Public Policy at the UC Riverside, and an Adjunct Policy Fellow at the Public Policy Institute of California's Water Policy Center
- Co-editor of two recent books on water titled, Drought in Arid and Semi-Arid Regions: A Multi-Disciplinary and Cross-Country Perspective, and The Handbook of Water Economics.

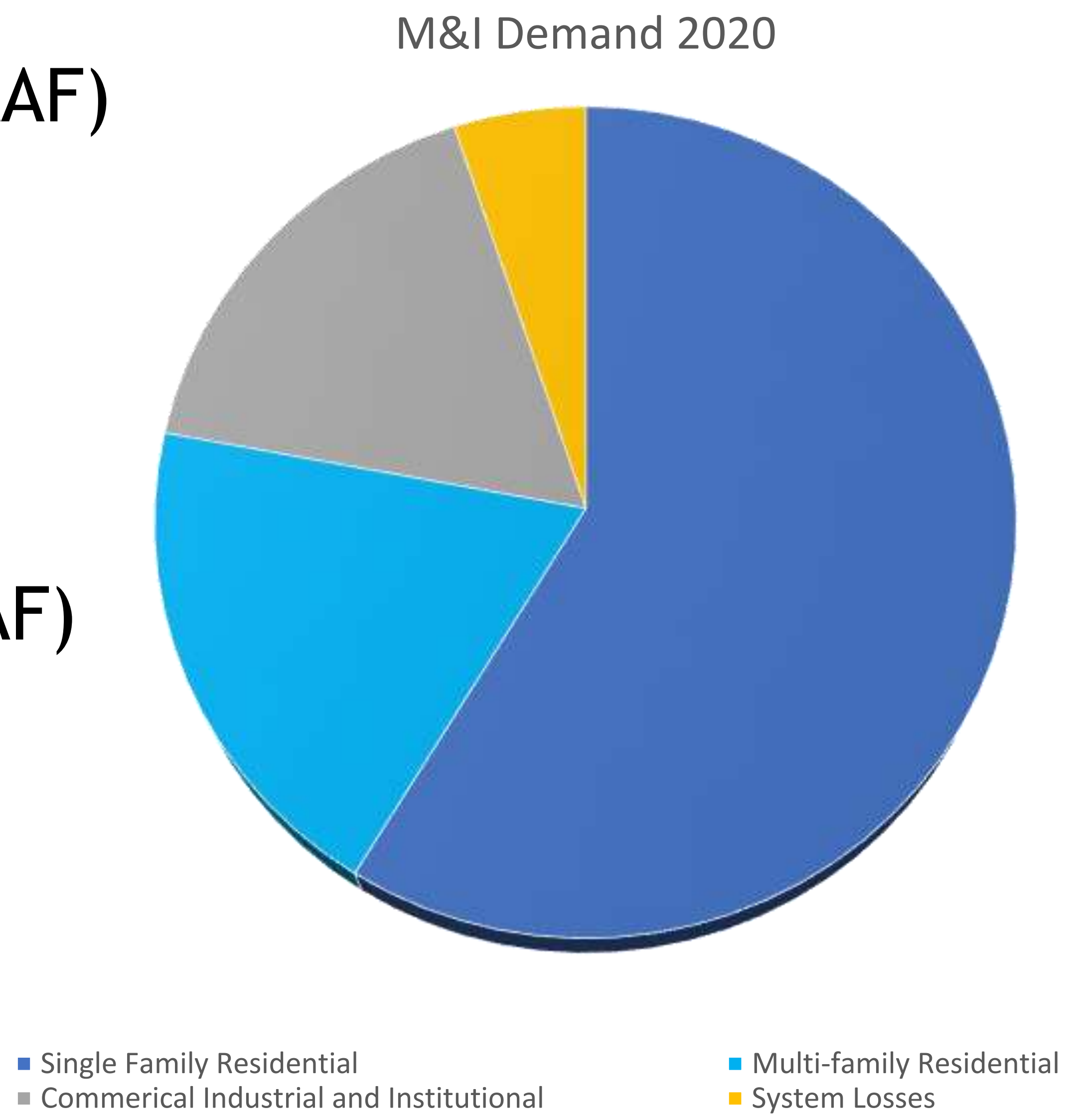
Expert Statement: Question 1

What are the most important underlying drivers (5-10) that influence demands, and how do they affect demands, in each of the three major demand sectors (single family residential, multi-family residential, Commercial/Industrial)?

M&I Demands Are 78% Residential

- Current 2020 Demands (3.149 MAF)
  - Single-Family, 59%
  - Multi-Family, 19%
  - Non-Residential, 17%
  - System Losses, 5%

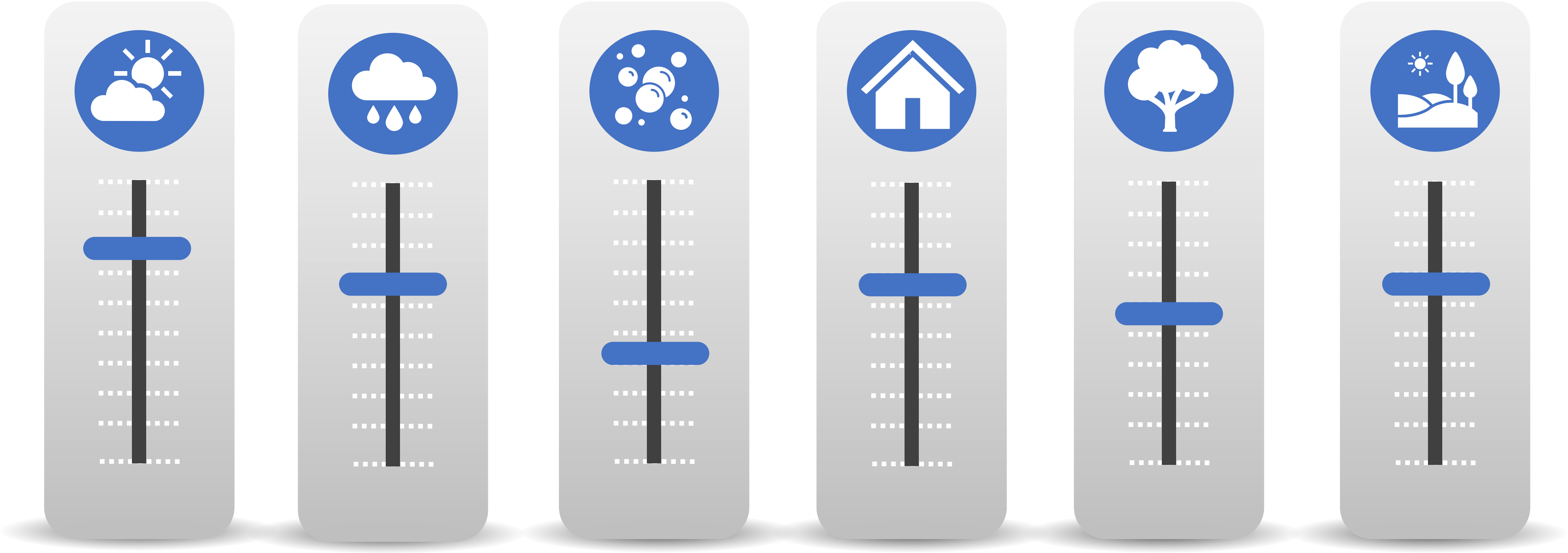
- Future 2045 Demands (3.464 MAF)
  - Single-Family, 58%
  - Multi-Family, 23%
  - Non-Residential, 14%
  - System Losses, 5%



Source: MWD 2020 UWMP Draft (March 2021)

Principal Drivers

Other Important Drivers With Shifting Trends



Weather

Climate

Price of Water

Affluence and Income

Compliance with Policy (Landscape Ordinances)

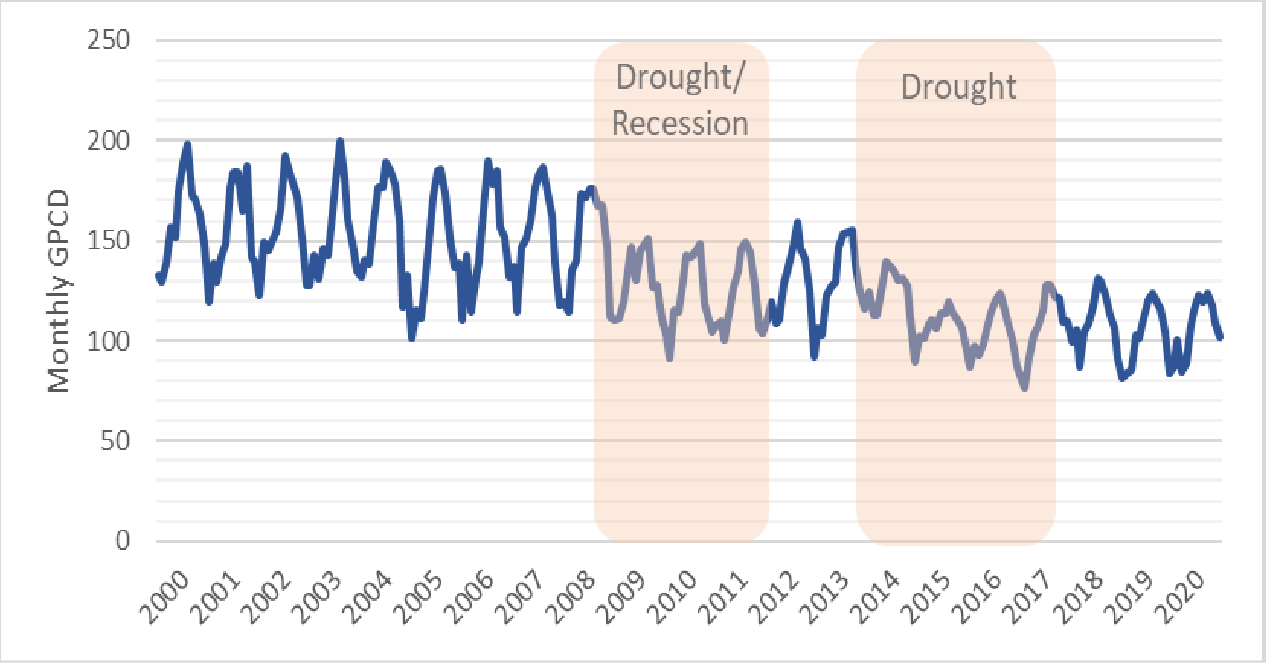
Other Shock Drivers

Drivers Vary With Effect

- Temporal
  - Near-term, medium, long-term trends with shock inflections
- Scale
  - Rate of population growth, magnitude of economic change
- Composition
  - Housing type/land use
- Intensity
  - Weather and climate shifts, housing mix
- Although effects are interrelated, relationships may not be linear
- Relationships can be explained, but often not intuitive

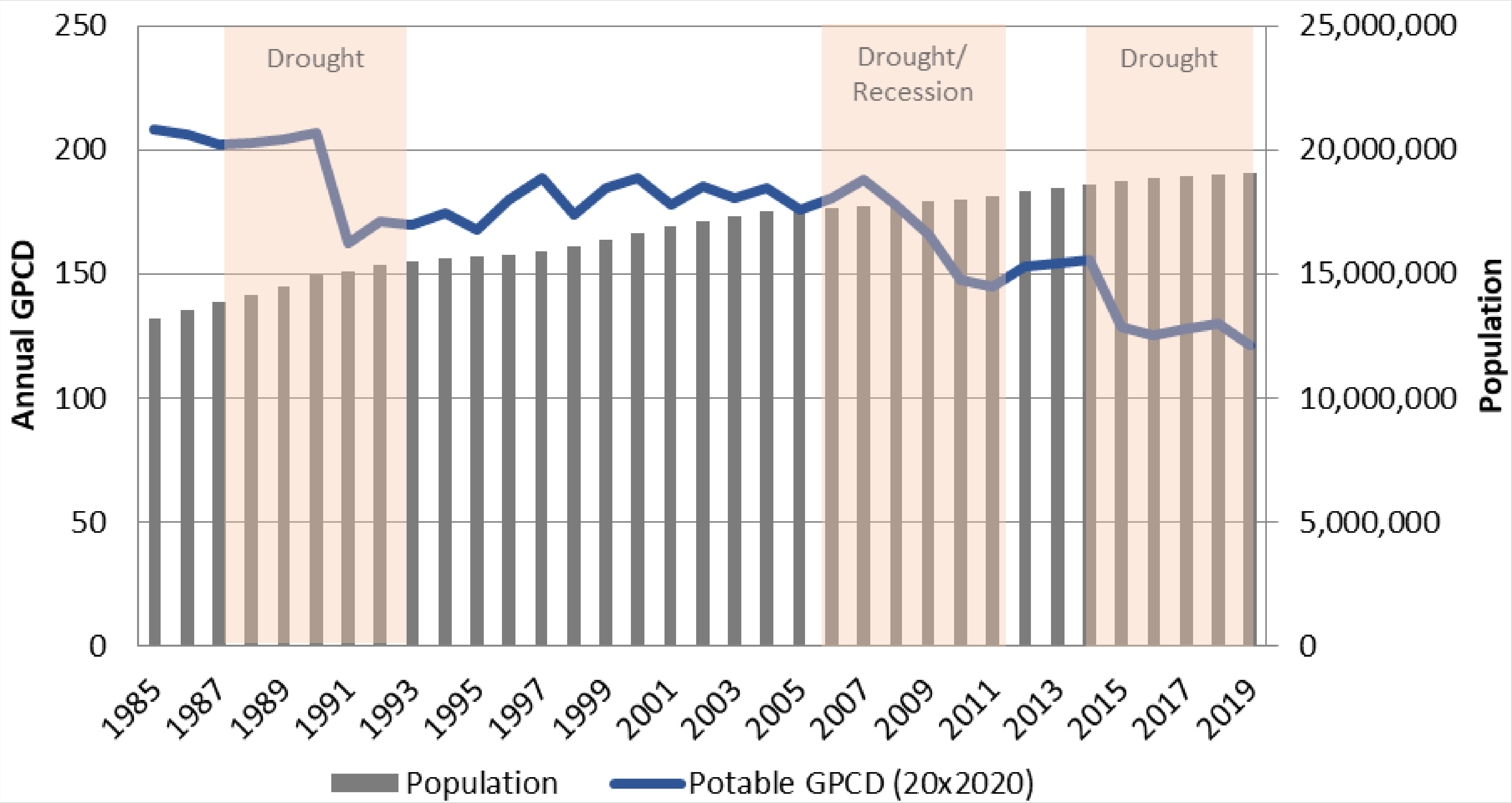
2020 Alliance for Water Efficiency Research Study: Use and Effectiveness of Municipal Irrigation Restrictions During Drought – Case Study LADWP (permanent 3-day week watering since 2009)

Los Angeles Department of Water & Power Annual GPCD Trend



Los Angeles Department of Water & Power Monthly GPCD Trend

Population Has Grown and Water Use Declined

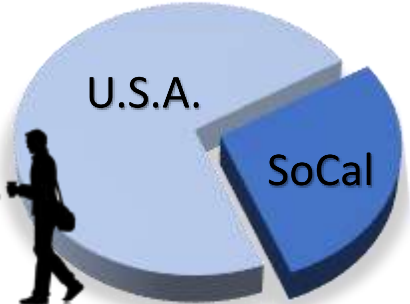


Source: 2020 Alliance for Water Efficiency Research Study: Use and Effectiveness of Municipal Irrigation Restrictions During Drought - Case Study for Metropolitan Water District of Southern California

Expert Statement: Question 1 (Demographics)

How do we account for uncertainties in future demographic factors and how can they be measured?

Framework for Demographic Projections



U.S. Population

range based on U.S. Census Bureau projections

U.S. Jobs

based on U.S. Population

Regional Jobs

based on share of U.S. Jobs

Regional Population

based on Regional Jobs

Regional Households

related to Population Growth and Housing Growth

Major Drivers of Service Area Demographic Growth

- U.S. Population and Job Growth
- Service Area Economic Competitiveness
- Success in Expanding Housing Supply and Affordability
- Focus on Major Drivers and Uncertainties
- Identify the “Drivers” of these Drivers of water demand

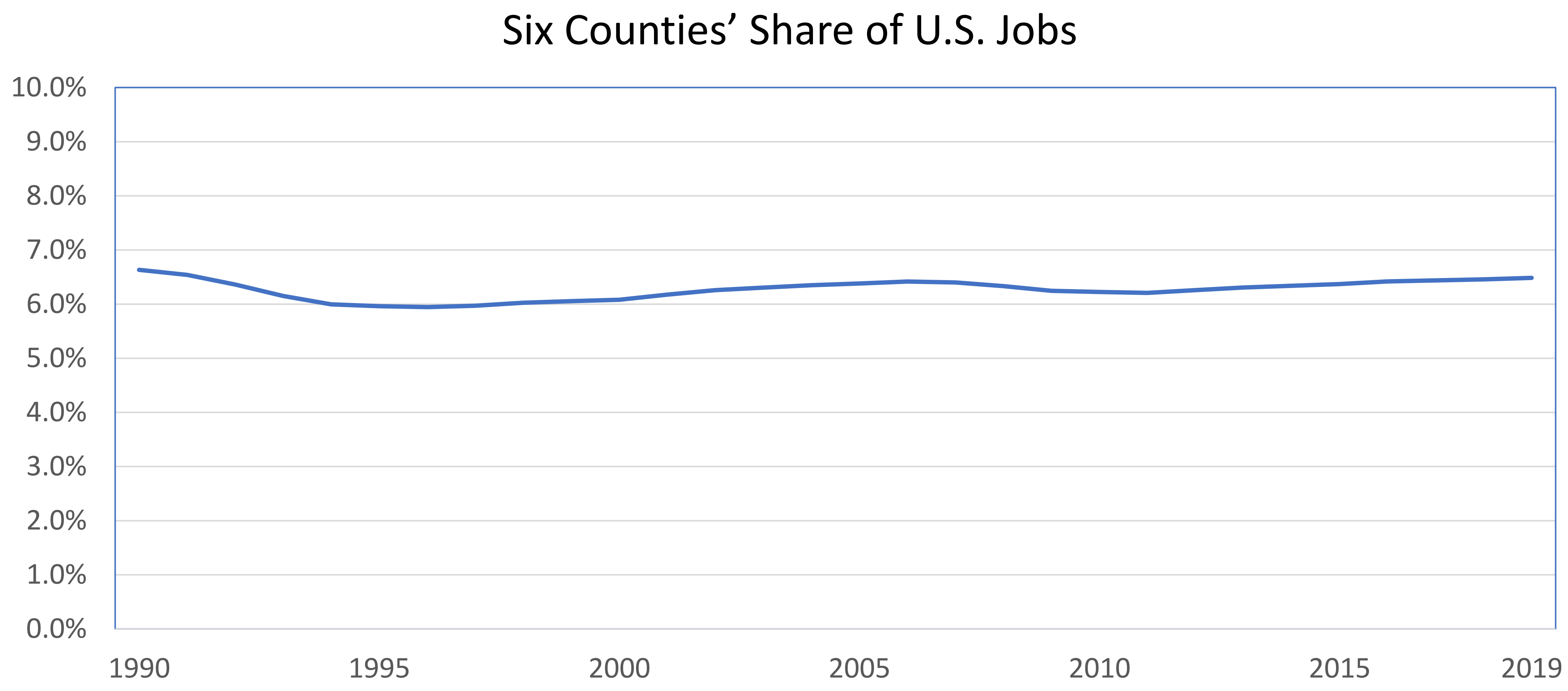
Major Drivers of U.S. Population and Job Growth

- The **level of immigration** is the major driver of U.S. population growth and the one with the largest uncertainty
- In 2020 the Census Bureau prepared growth projections based on alternative plausible levels of future immigration
- The low projection kept immigration at near recent levels and the high projection assumed a 50% increase from the immigration levels prior to the recent restrictions
- The range of U.S. growth to 2045 was 11% (low) to 24% (high) or growth of 36 million (low) and 79 million (high)
- Other demographic drivers are smaller or have less uncertainty including agreement on birthrates are falling and level of deaths will increase

Major Drivers of MWD’s Service Area Job and Population Growth

- The level and composition of U.S. job growth
  - Favorability to MWD Service Area
  - Focus on trade, tourism, technology and creativity
- The competitiveness of the service area economy for the location of these jobs
  - Housing supply and affordability
  - Improvement in the movement of people and goods
  - The level of immigration and welcoming attitude of the region toward talent and diversity

The Resilience of MWD’s Service Area Economy



Major Uncertainties in Service Area Competitiveness

- Regional and state agencies have set aggressive targets for expanding housing supply and affordability, especially for low-and-moderate income residents
  - Success requires funding, zoning changes and local compliance
  - Modest success will limit job growth while major success will spur growth
- The same is true for success in reducing congestion, long commutes and expanding capacity at airports and seaports
- The service area economy benefits from immigration, tourism and being a welcoming community. What is the range of uncertainty?

Housing has the Widest Range of Uncertainty and is Complicated

- There are two components of housing growth
    1. housing to meet the growth in population and
    2. “catch up” housing to reduce the amount of overcrowding and cost burdens
- There are both regional and state goals for expanding housing but the “catch up” component that focuses on housing that is affordable for low-and-moderate income residents is the most challenging
- While job and population growth relative to the nation are likely to stay within or close to the historical range, success in housing which feeds back into competitiveness likely has a wider range
- And for water use, the size and location of housing also matters

Key Takeaways

- Immigration is the primary driver for U.S. population
- Competitiveness is in the hands of the local area (residents and policy makers)
- Biggest competitiveness challenge is about housing (amount, affordability, location and size)

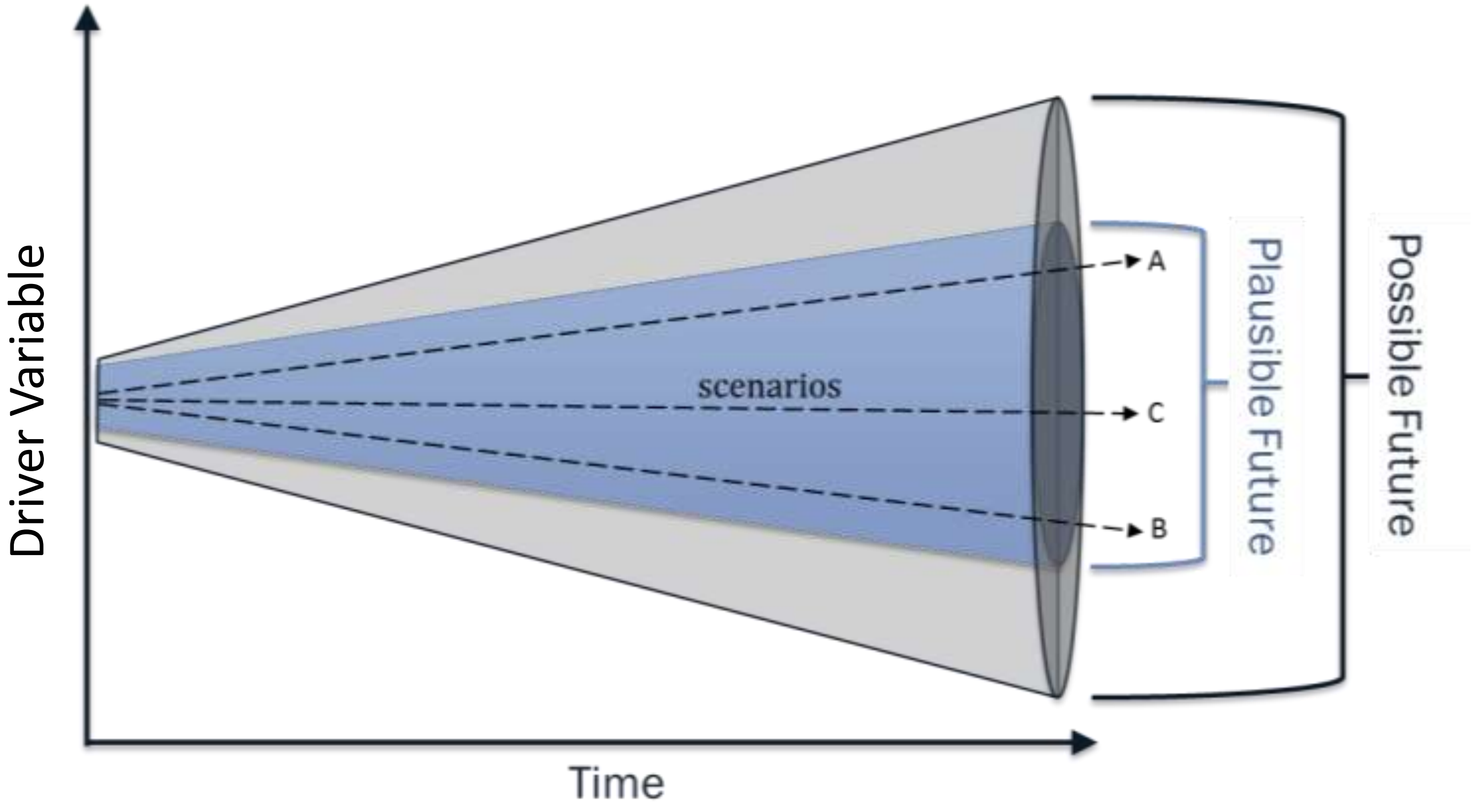
Expert Statement: Question 2

Given what is known about these drivers, provide guidance on estimating a plausible range of future outcomes for each driver and why?

Forecasting is Important but Often Elusive

- The truth is that demand forecasting isn't easy. While we try to be as careful, serious and scientific as possible, it is a mixture of **art** and **science**. ***Professional judgement with insights goes along way.***
- So, what makes a "good" water demand forecast?
  - **Robust** statistical model, with high correlation, and statistically-significant variables with the right direction of influence (e.g., greater temperatures predicts higher water demand)
  - **Defensible** projections of driver variables, some of which are not always in direct control of forecaster (e.g., use of SCAG/SANDAG demographic projections)
  - **Backcasting** accuracy is a nice test to see if your model can account for important variations in future demands

Forecasting Drivers



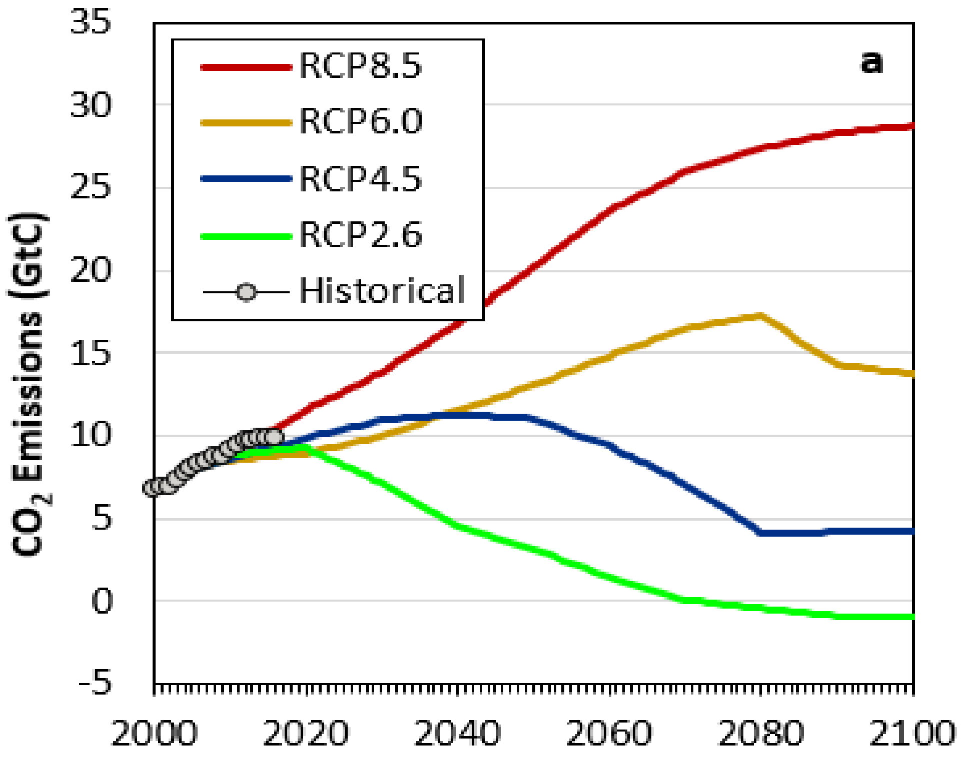
- Plausible range includes things that are likely to occur but with considerable variability into the future.
- Possible range includes things that could happen, although we haven't seen evidence of it just yet. **Black Swan Events* often fall in this range.**

** A black swan is an unpredictable event that is beyond what is normally expected with potentially severe consequences. They are characterized by their extreme rarity, severe impact, and the widespread insistence they were obvious in hindsight.*

Climate Forecasting 101

- Coupled Model Intercomparison Project (CMIP), Global Climate Models (GCMs) are the starting point, downscaled to local region.
- CMIP5 are the most widely used GCMs for forecasting: 31 different models, each run for at least one or more RCP scenarios → 97 model combinations.
- Which to use for demand forecasting?
    - Don't use a singular model, not enough data points
    - Don't use ensemble of "all" model combinations, as climate future will be muted, as variability is averaged away

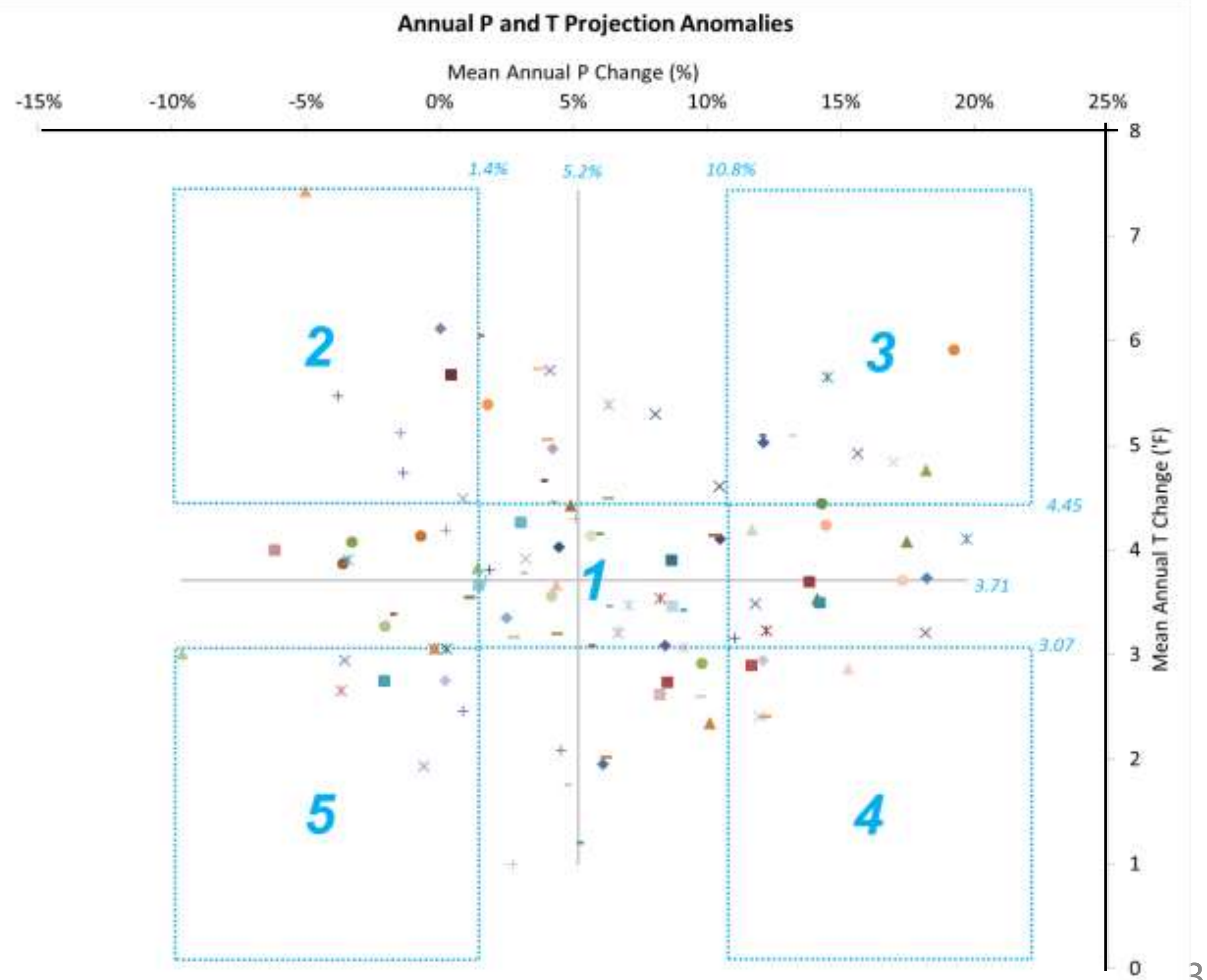
CMIP5 GCMs under Representative Concentration Pathways (RCPs)



Climate Forecasting: Develop Climate Scenarios from Subset of GCM/RCP Combinations

For a climate resiliency study for Metro North Georgia Water Planning District, 97 downscaled climate models were ensembled in five different climate scenarios:

1) *central tendency*
2) *hot/dry*
3) *hot/wet*
4) *warm/wet*
5) *warm/dry*



Forecasting Housing Characteristics

- While SCAG/SANDAG forecasts of single-family and multifamily are easily obtainable, other important housing characteristics require more effort to project into the future. These being:
  - **Density** – Will future SF homes have smaller lot sizes? Will future MF homes be smaller in size, with fewer bathrooms?
  - **Accessary Dwelling Units (ADUs)** – How will this new California initiative* materialize into the future? Will ADUs be added to existing building footprints or as a new footprint structures reducing irrigable landscape areas? Will ADUs result in greater housing than forecasted by SCAG/SANDAG or do ADUs facilitate greater assurance that housing forecasts are accurate?

* The California Health and Safety Code (HSC), Section 65583(c)(7), requires that cities and counties develop a plan that incentivizes and promotes the creation of ADUs that can be offered at affordable rent for very-low to moderate-income households (new law effective Jan 1, 2021).

Forecasting Housing Characteristics

- Some ideas for forecasting housing density:
  - **Land Use in General Plans** – Compare current single-family land use divided by current SF housing with ultimate build-out condition single-family land use divided by forecasted SF housing (do this by county to get more accurate results).
  - **Historical Trends** – Use historical sampling of County Assessor data over last decade to estimate change in lot size, including changes building footprint and irrigable area.
  - **ADU Monitoring** – Track sample of building permits to understand how ADUs are occurring and where.
  - **Professional Judgement** – Under higher forecasts of housing, consider increasing density (at least for more developed urban centers).

Water Efficiency Projections

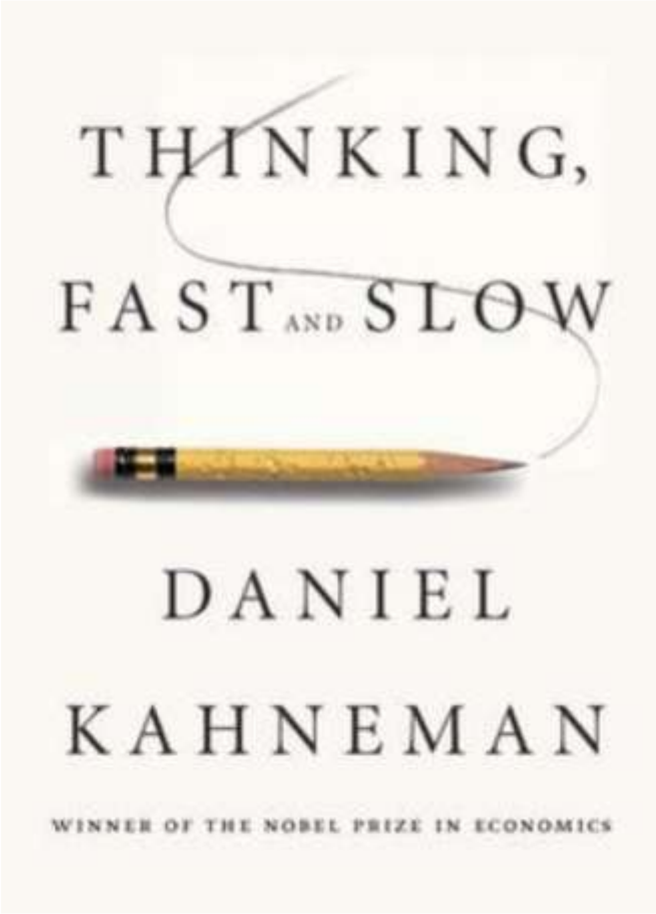
- California water codes and ordinances require some thought in terms of forecasting:
  - **Existing SF Homes** – Based sampling of SF homes in San Diego, Orange and parts of Los Angeles Counties, average indoor water use is currently **55 to 58 gpcd**; while outdoor water use currently ranges from **25 to 70 gpcd**.
  - **New SF Homes** – Based on plumbing codes and MWELO ordinance, indoor water use is roughly at or below **50 gpcd** for new development; while outdoor use ranges from **20-50 gpcd**.
- Splitting forecast between existing and new homes might improve accuracy of residential water demand forecast.
  - **Future Water Efficiency for Existing Homes** – Based on remodeling rates and participation in utility rebates, it is entirely realistic to assume that existing homes (SF and MF) will be at **50 gpcd between 2030-2040** for indoor use.

Internal Consistency for Scenario Planning

- When combining drivers into scenarios, its important to be "internally consistent." For example:
  - **Lower Housing Growth Scenario** – Its certainly plausible under this type of scenario that lot sizes and density of new development may not be drastically different than today's level. Also, ADUs might not materialize as aggressively.
  - **Higher Housing Growth Scenario** – Under this scenario, it is more likely that lot sizes will be less and density of development greater, at least for more urban centers of MWD's service area. So, while there will be more homes, they will likely use less water per home. Also, more homes will likely be ADUs under this type of scenario.

Expert Statement: Question 3

Given what is known about these drivers, provide guidance on approaches or methodologies to measure and quantify the effect of the drivers on demands, in each of the three major demand sectors?



Warning: This may require the System 2 Part of your brain! (Kahneman *Thinking, Fast And Slow*) … The ability to think logically about effects of demand drivers

Estimating Effects of Demand Drivers: Weather

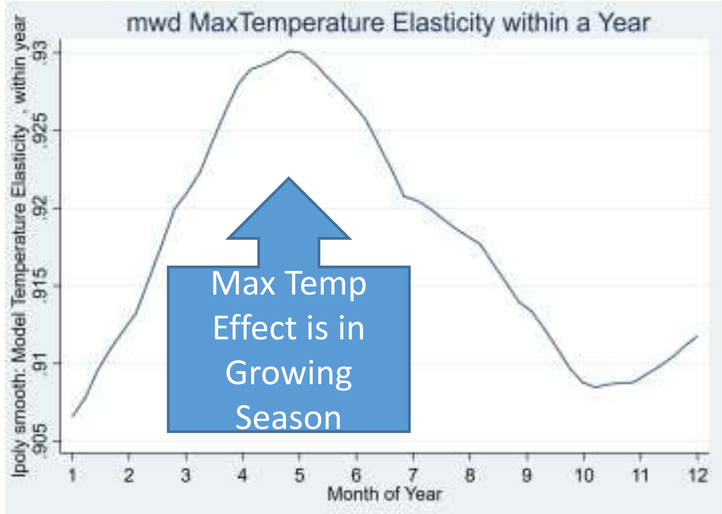
Statistical inference:

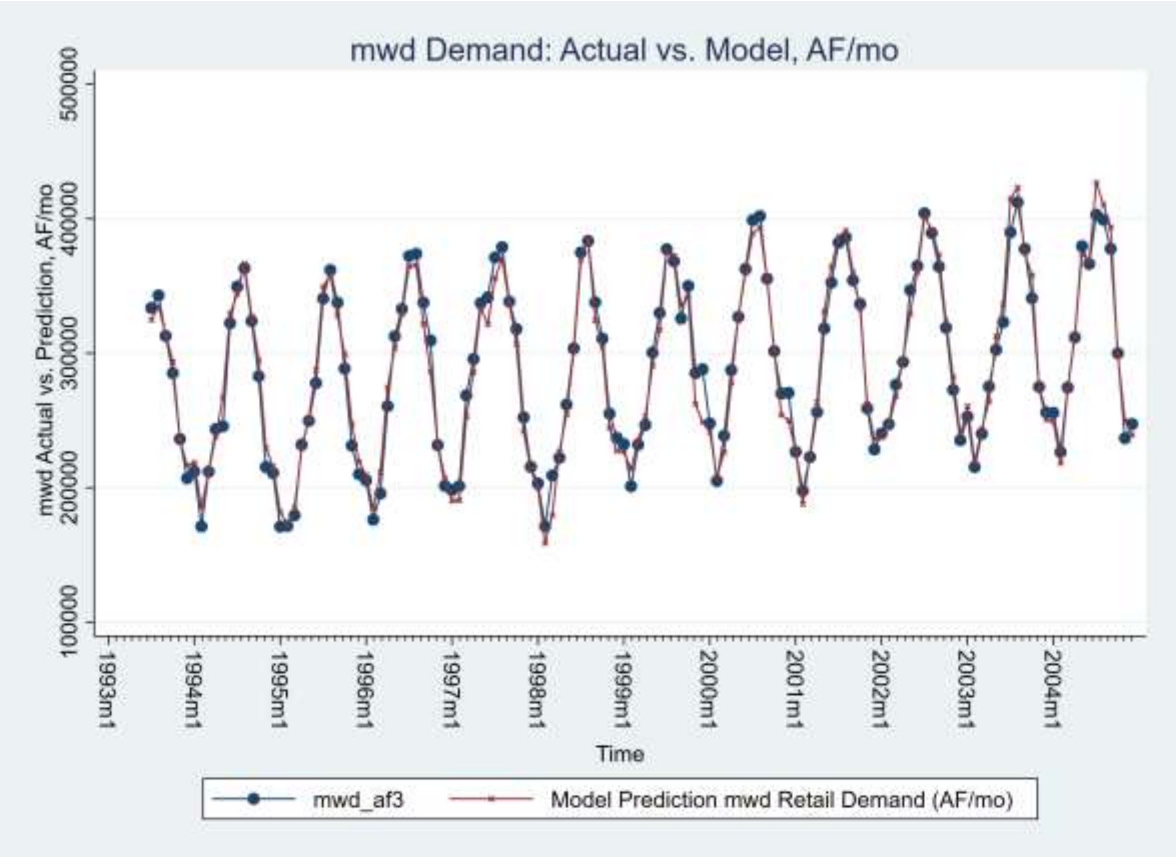
Demand=$\hat{f}$(…Temp…)

Demand=…Effect of Temp*Temp…

Translation:

%Effect of Temperature=Elasticity

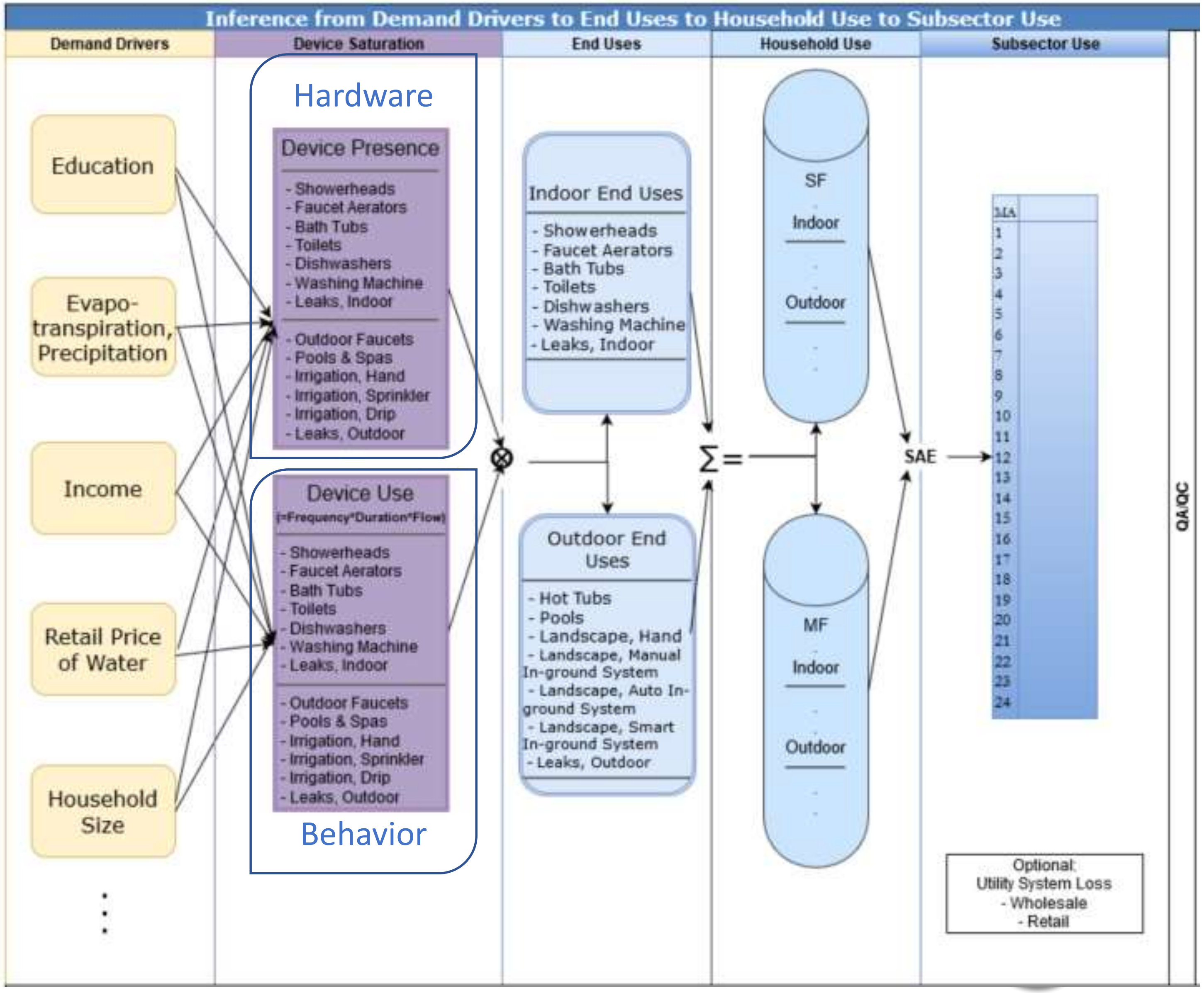




Estimating Effects of Drivers on Demand

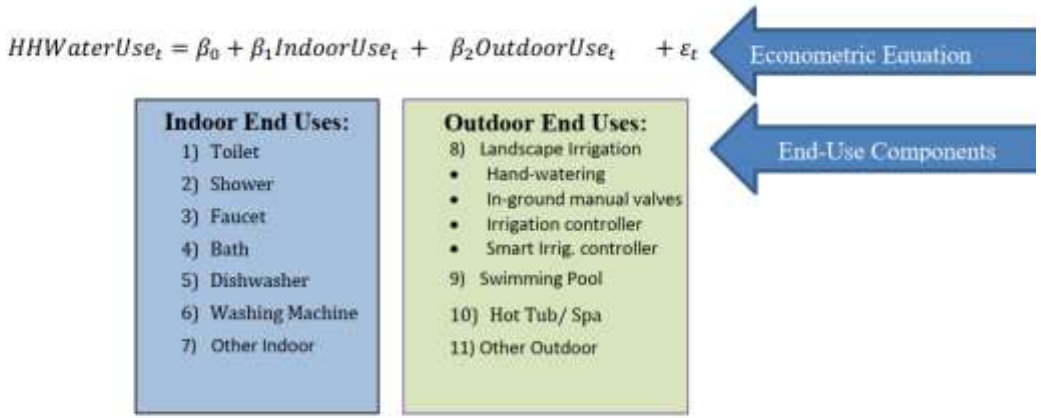
Drivers→

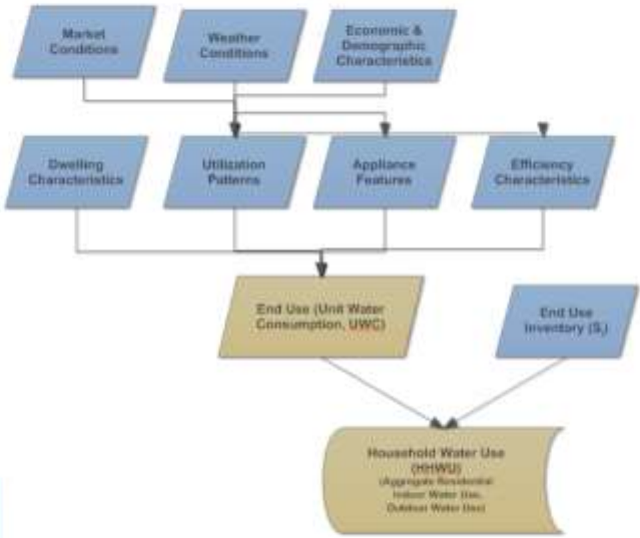
←Demand



A Range of Methods for estimating Driver Effects

- Prior Knowledge
  - End Uses
- Multivariable
  - Econometric
- A combination
  - Bayesian Prior +
  - Statistically adjusted

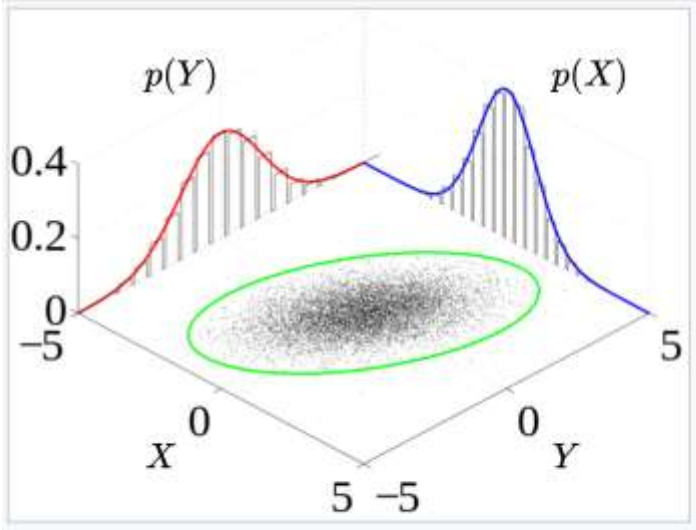




Comparison of Model Advantages		
Econometric Model	**End Use Model**	**SAE Model**
Least data and time requirements	Understanding of system	Understanding of system
Least cost	Accurate over long term	Most Accurate over long term
Statistical diagnostics		Statistical diagnostics
	Easier to incorporate WUE	Incorporates WUE
		Compromise on Cost/Data

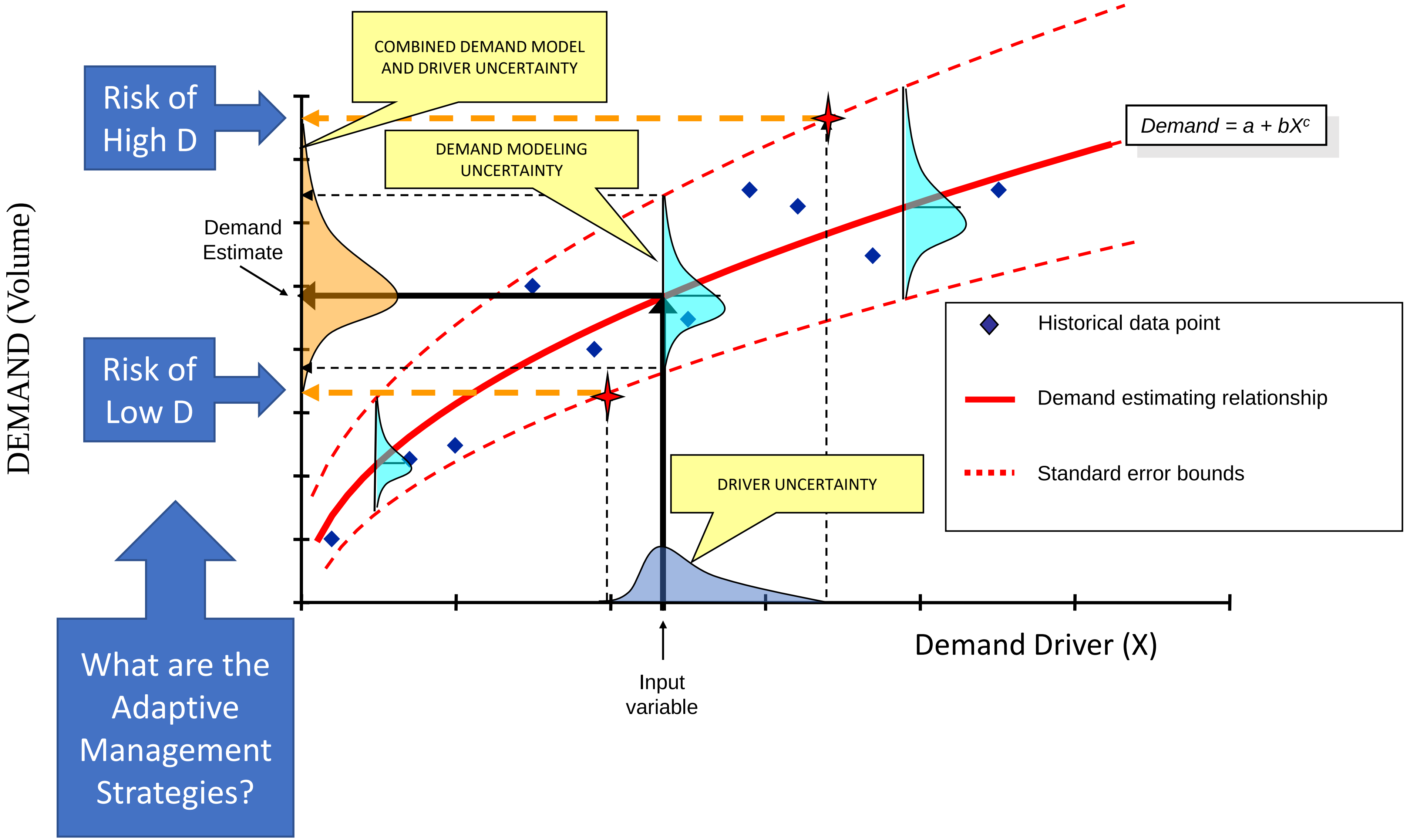
Measuring and Quantifying Effects of Drivers

Quantifying Demand Drivers



- *Long-term Trend Drivers*
  - *Population Growth, Dwelling Units/Density*
  - *Employment Growth Population*
  - *Regulations, MWELO, and Plumbing Code*
  - *Climate Change*
- *Mid-term Trend Drivers*
  - *Densification: SF/MF mix, Lot Size and Landscape Transformation, ADU's*
- *Shock Drivers*
  - *Drought/Weather Variation, Drought response, Recession*

Quantifying Effect of Driver on Demand: Demand Driver Uncertainty



Hot Takes on Demand Driver Effects

CLIMATE CHANGE → WEATHER → WATER SUPPLY AND DEMAND, DIFFERENTLY

- Average Precipitation May Be The Same, Pattern Differs→ Bigger Effect on Supply
- Increase In Mean Temperature→ Large Effect on Future Demand via Outdoor Water Use
- Increase In Weather Variability→ Predictable Increase in Drought Likelihood and Duration

HIGH POPULATION GROWTH SCENARIOS

- Effect On Demand Dampened By ADU’s, Densification, And Landscape Transformation

LOW GAP SCENARIOS

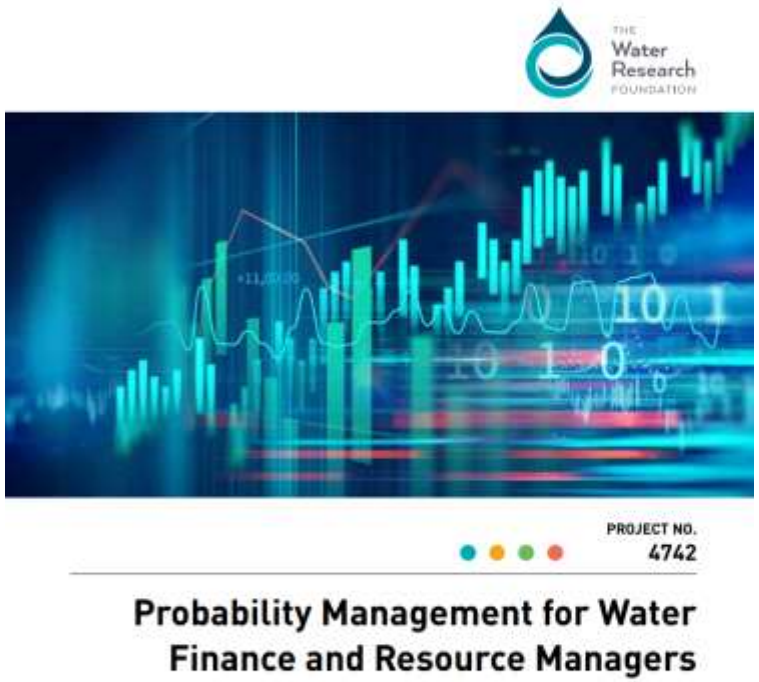
- Slower Adaptation

INTERVENTIONS CAN CHANGE THE EFFECT OF DRIVERS ON DEMAND

- Example: Customer Engagement/Information Can Change Response To Price

Guidance on Consistent Treatment

- Cannot be assumed away
  - The infamous “Declaration of Independence”; Saying it is so does not make it so
- There are **Standards** for how to combine Uncertainties, while reserving interrelationships



Probability
Management

Probability Management https://www.probabilitymanagement.org
SIPmath Standards https://www.probabilitymanagement.org/sipmath

Report https://www.waterrf.org/research/projects/probability-management-water-finance-and-resource-managers
Webinar https://www.waterrf.org/resource/probability-management-water-finance-and-resource-managers-1

Key Takeaways

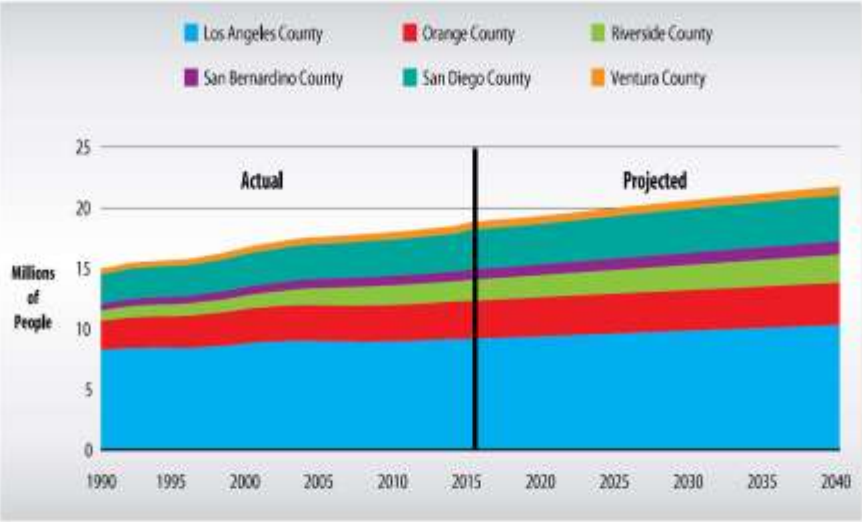
- The estimation method should depend on the measures available
  - Demand on wholesaler looks like volume per unit time
  - Retail demand comes from customers (meters) and demand per customer
- Different methods can be combined to estimate effects of drivers
  - Prior information
  - Estimation from data alone
  - Bayesian methods combine the two
- Improved demand monitoring is possible

Expert Statement: Question 4

What are any major interrelations between ranges and direction of future outcomes for these drivers and provide guidance on how to treat these drivers in an internally consistent fashion within the IRP scenarios?

Demand Assumption Refinements- *Interrelations*

Issue 1: When developing models to predict future water demand, need to ensure that the assumptions that comprise individual drivers of demand are consistently applied



MWD (2015)

Demand Assumption Refinements- *Interrelations*

Example of Internal Consistency

Consider aggregate water demand….

Aggregate Water Demand = f (population, individual water demand)

- Population = g (employment opportunities, *housing type*,…)
- Individual water demand = h (prices, *housing type*, codes/ ordinances, income,…)

⇒ Because *population* and *individual water demand* BOTH are influenced by *housing type*, they are interrelated

⇒ Consistency needs to be maintained across drivers with respect to *housing type* when predicting future water demand

Demand Assumption Refinements- *Interrelations*

Take Away 1

Assumptions made about population growth (e.g., demographics, housing density/type) should be consistent with assumptions behind drivers of individual water demand (e.g., demographics, housing density/type)

Demand Assumption Refinements- *Interrelations*

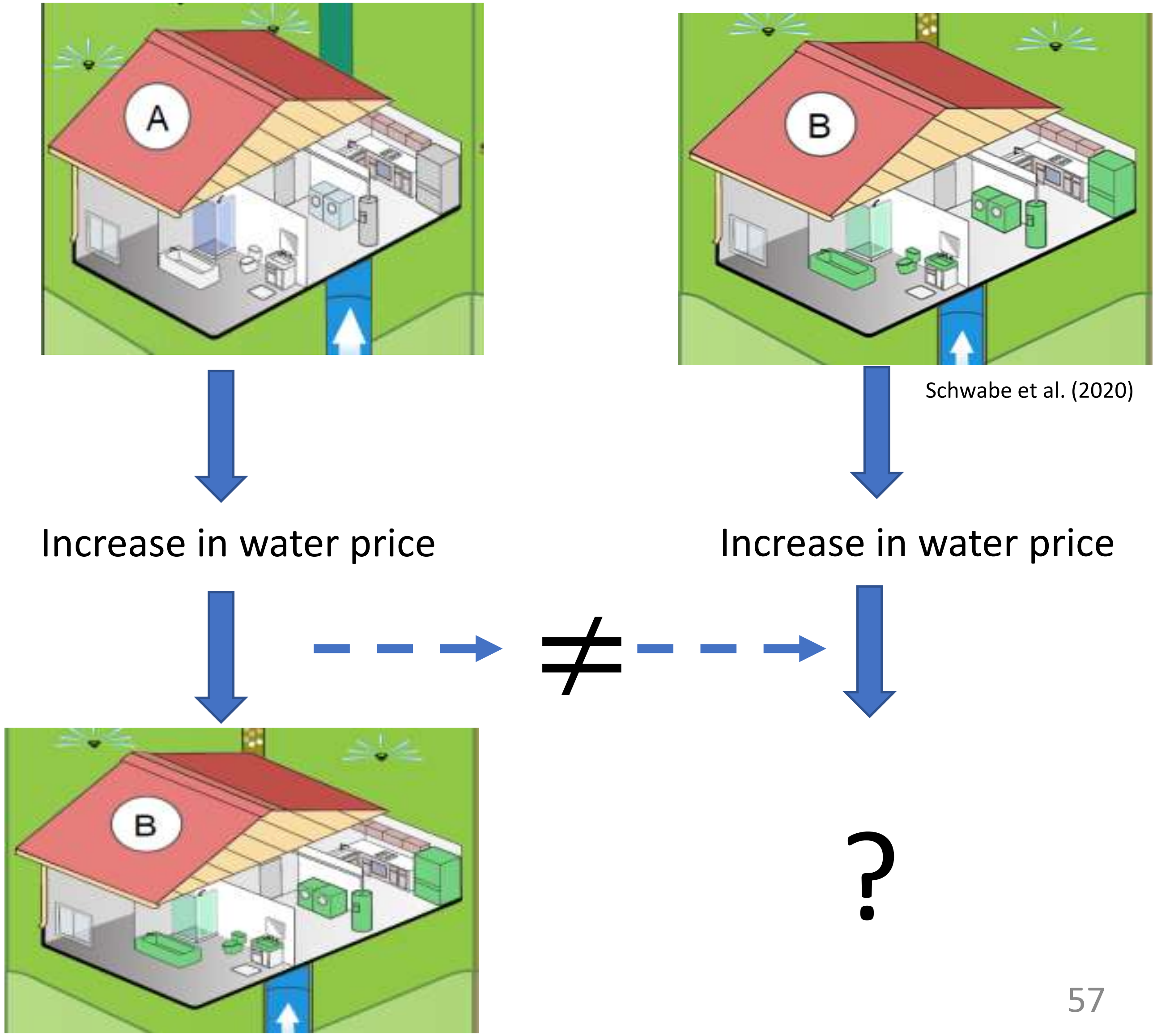
Issue 2:

Understanding interrelations (interdependence) across drivers can help avoid double-counting / over-estimating water savings

Demand Assumption Refinements- *Interrelations*

Examples of Interrelation Across Drivers and <u>Impact on Water Savings</u>

- *Water pricing and plumbing codes and/or landscape ordinances*
- Growth of ADUs, landscape ordinances, and savings in irrigated water use



Demand Assumption Refinements- *Interrelations*

Take Away 2:

Water savings associated with one particular driver may be illusory if savings have already been subsumed by another driver

=> Understanding interrelations can avoid this “double counting”

Demand Assumption Refinements- *Interrelations*

Issue 3: "Caveat Researcher" – Understand the degree to which data used to generate parameters (e.g., elasticities) are consistent with future contexts that influence water demand

=> Up-to-date "parameters" are essential for *adaptive management* to work

Demand Assumption Refinements- *Interrelations*

Example of how price elasticity for water varies (Dalhuisen et al. 2003)

- 314 price elasticities for residential water demand
- 64 distinct studies (1963-2001)

Price elasticity ~ How responsive demand is to changes in price

- Typically < 0
- More "elastic" => more demand moves with a change in price
- Less "elastic" => less demand moves with a change in price

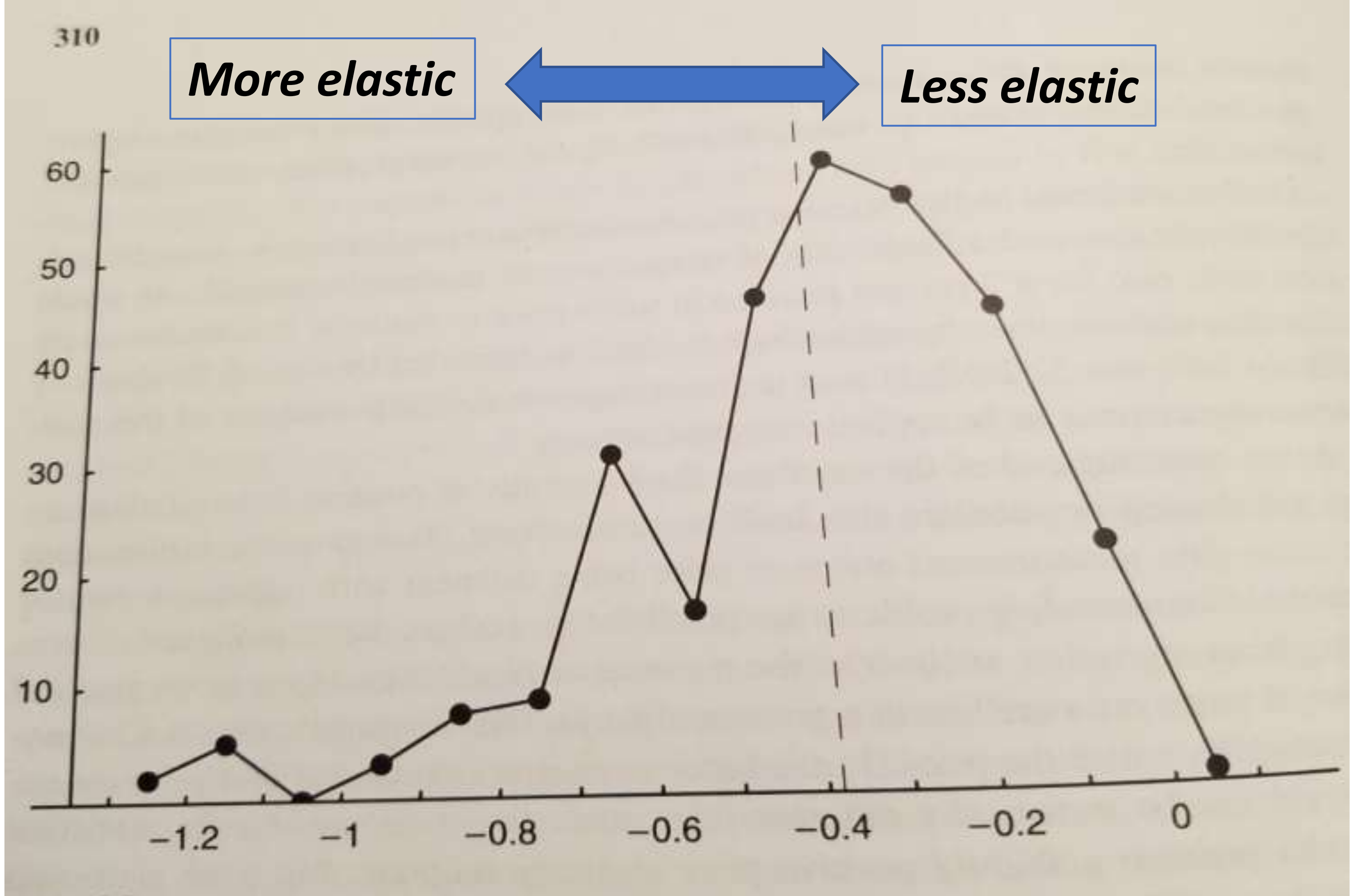


Figure 9.7
Counts of residential elasticity estimates

Demand Assumption Refinements- *Interrelations*

More elastic ↔ ***Less elastic***

More opportunities & willingness to "reduce" water use from price increase

Perhaps represented by:
- Inefficient landscaping
- Inefficient indoor appliances

=> Significant opportunities to reduce water use

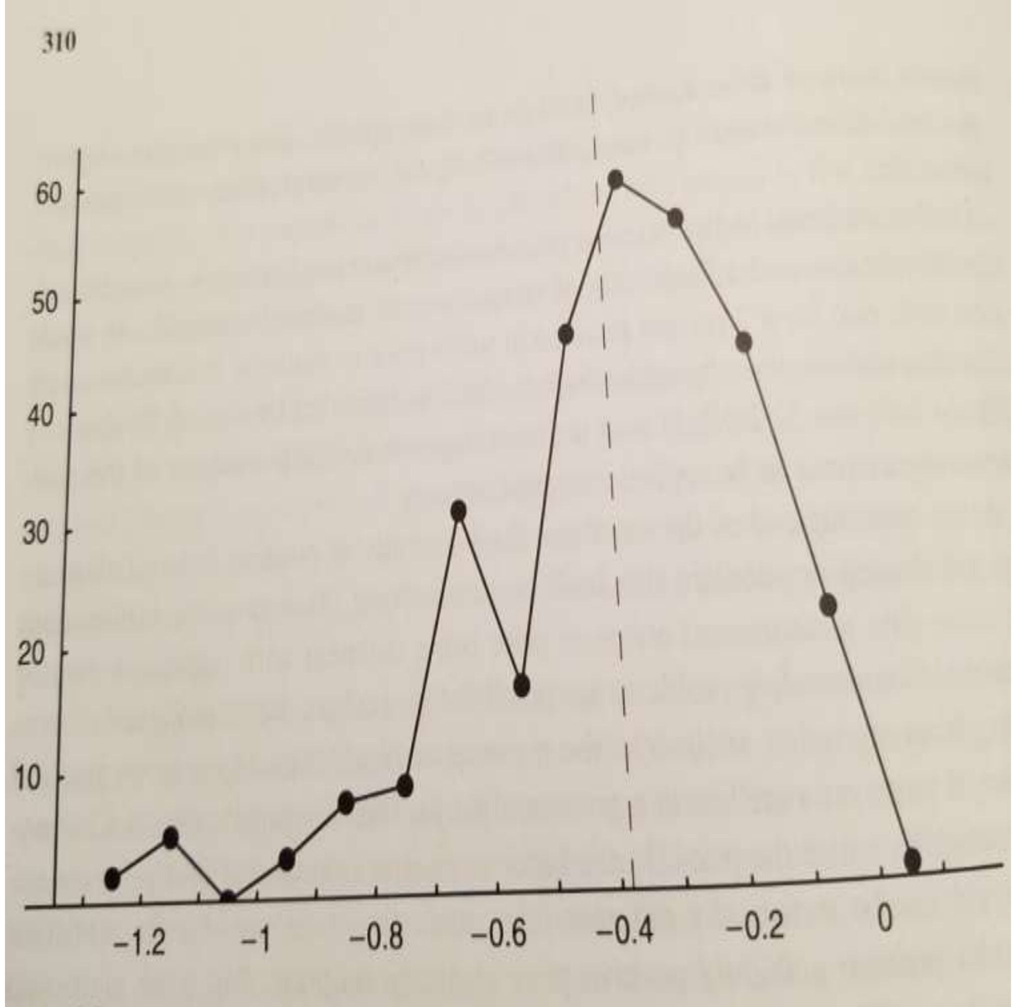


Figure 9.7
Counts of residential elasticity estimates

Dalhuisen et al. (2003)

Fewer opportunities & less willingness to "reduce" water use from price rise

Perhaps represented by:
- Landscape ordinances / efficient landscaping
- Plumping codes / efficient indoor appliances

=> Few opportunities to reduce water use

Demand Assumption Refinements- *Interrelations*

Take Away 3: When using models to predict future water demand, care must be taken to understand how the contexts that were used to generate model parameters compare to the contexts upon which the predictions are being applied

=> Representative and up-to-date data are critical to ***adaptive management***

"Contexts" to consider [all drivers identified in Question 1]:

- Pricing structure and pricing levels
- Landscape ordinances and plumbing codes
- Socioeconomic and demographic factors
- Climate
- Efficiency satiation
- Housing type
- et cetera, et cetera, et cetera

Key Takeaways

- Assumptions that comprise drivers need to be consistent across drivers
- Avoid “double-counting” water savings by understanding how particular drivers may be interrelated
- The accuracy of model predictions depend on how well the data and contexts used to generate the model parameters represent future conditions / contexts

Questions

Questions submitted prior to the workshop pertaining to charge questions

Question #1

- *What factors have driven Metropolitan demands down recently and what do those factors say about a rebound?*

- *How can we measure the length and extent of the demand rebound?*

Question #2

- *Given the pattern of increased direct intervention by state legislation and regulation on demand patterns, why wouldn't it be reasonable to expect additional state intervention in the future and cumulative shock-adjustments?*

Question #3

- *How has SCAG/SANDAG population forecasts incorporated immigration?*
- *If US Census Bureau numbers are to be used, is information specific to MWD's service area available?*
- *Can the expert panel provide input on magnitude and duration on drivers, as well as how (data would be scaled down to the MWD service area and/or each Member Agency's service area, if it's not already available?*

Question #4

- *How can MWD address short term "shock" drivers that already may be in the model/scenarios?*
- *If the plan is not to remove these drivers, what are the magnitudes and durations of these "shock" short-term drivers?*

Question #5

- *How do you determine the magnitude impacts from regulatory requirements and (non) compliance?*

Question #6

- *How can we estimate plausible ranges of future outcomes for each driver?*

Question #7

- *Will causal relationships between the drivers of demand and the expression of those drivers as demands remain uniform over time?*

Question #8

- *How is GPCD being used, or should it be used, in the scenarios' demand forecasts?*

Question #9

- *Should there be an acknowledgement of what scenario we may reside in now to establish the signposts?*

Question #10

- *To simulate the effects of various drivers as described, is there a need for absolute consensus on the assumptions, or can "differing degrees" of assumptions be captured within the distribution of outcomes? Is averaging appropriate?*

Question #11

- *What issues will constrain a model that is calibrated for history and use in a future that seems to be moving out of historical patterns of equilibrium?*

Question #12

- *What insights can be drawn from the point at which in Metropolitan’s general demand history that the positive relationship between demand and population diverged?*

Question #13

- *How do you safeguard against double counting conservation when you have many retail agencies with different water rates/pricing mechanisms, conservation messaging strategies, and conservation rebates and incentives?*

Question #14

- *Is there an ability to distinguish total regional demands for water vs. total demands on MWD to meet member agency demands as per capita demands have different drivers from that of member agency demands on MWD?*

Other Questions

Submit questions through chat (preferred) or raised hand function

Conclusion

Facilitator summary

Staff Wrap up and next steps

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

1928