NOTES
LSCR Basin Study
Project Team Meeting #10
WEBINAR
August 22, 2018 1:30-3:30 pm

Attendees:

Peter Abraham, Town of Oro Valley
Lindsay Bearup, Reclamation
Austin Carrie, Central Arizona Project
Hsin-I Chang, University of Arizona
Kathy Chavez, Pima County/OSC
Doug Greenland, CMID
Neha Gupta, University of Arizona
Eve Halper, Reclamation
Bob Hedden, USCPUG & GVDWID
Einav Henenson, AZ Dept. of Water Resources
Kathy Jacobs, University of Arizona
Jake Lenderking, Global Water
Marie Light, Pima County/Dept. of Env. Quality
John McKinney, Farmers Investment Company/Farmers Water Company
James MacAdam, Tucson Water
Sara Merrigan, University of Arizona
Mead Mier, Pima Association of Governments
Kyle Miller, AZ Dept. of Water Resources
Sue Montgomery, rep Pascua Yaqui Tribe
Asia Philbin, Town of Marana
Josh Pope, Pima Association of Governments
Ken Seasholes, Central Arizona Project
Eylon Shamir, Hydrologic Research Center
Valerie Swick, Reclamation
Hyunsoo Noh, Pima Association of Governments
Selso Villegas, Tohono O'odham Nation
Kip Volpe, Vail Water Company
Wally Wilson, Metro Water District

1. **Welcome and Introductions –** Kathy Chavez welcomed the Project Team. Participants introduced themselves (see above). There were no additions or corrections to the May 8 notes.

2. **Best and Worse-Case Future Climate Preparation for Input to the Weather Generator –** Presented by Lindsay Bearup, Reclamation Technical Services Center

   - General background: Reclamation will use downscaled climate projections as input to a weather generator. The weather generator will produce large groups (ensembles) of potential future precipitation and temperature time series for input to the surface water model and groundwater model. This method allows us to estimate the effects of changes in the statistical distribution of rain events.
   - The Weather Generator (WG) simulates plausible future weather scenarios based on climate projections for the Lower Santa Cruz River Basin. Today's presentation builds on University of Arizona (UA)'s work presented by Hsin-I Chang at May's Project Team meeting.
   - General Terms:
     - SD: LOCA – Statistically Downscaled using Localized Constructed Analogs. LOCA is an advanced method of statistical downscaling. Reclamation has applied the LOCA method across 32 different climate models, which allows for standardized comparison of model output. Each of these models has been run under a high (RCP 8.5) and low (RCP 4.5) emissions scenario.

- DD: WRF - Dynamically downscaled (DD) using Weather Research and Forecast (WRF) model. UA applied the physically based WRF model to produce downscaled climate projections from the output of selected global climate models. Dynamical downscaling uses physically based models to model local processes driven by global climate model outputs.
- RCP: Representative Concentration Pathways – scenarios of future greenhouse gas emissions
- Worse-case climate scenario: RCP 8.5 (higher emissions and based on DD projections)
- Best-case climate scenario: RCP 4.5 (lower emissions and based on SD projections – since no DD projections are available under this emissions scenario)
- The projections use *worse*-case pathways; not *worst* pathways, did not do "worst"

- Important to consider how we downscale data and use the weather generator in this study to develop the surface water model inputs. The outputs of the surface water model are needed to run the groundwater model
  - Weather Generator (WG): simulates plausible future weather scenarios
  - Surface Water (SW) model is calibrated using historical observations that were also used to "train" the WG and estimate streamflow, evapotranspiration and mountain front recharge
  - Reclamation is in the final stages of preparing the weather generator
- Why do WG?
  - Natural precipitation variability is important when considering streamflow
  - It is used to introduce/train uncertainty around broader climate projections, get "cloud of uncertainty"
  - Stochastically generates precipitation patterns

- Slide 7: Shows the projections of annual average **change** in temperature and precipitation for the far future climate (2050-2079) for the LSCR Basin. The precipitation scale is in inches per year.
  - The data shows the bulk 30-year averages and not seasonal variations
  - Gray solid points are SD LOCA projections for RCP 8.5 and are generally above the 50^{th} temperature percentile indicating a high level of temperature increase, and to the left of the median precipitation change, indicating a drier future. The open gray circles represent the SD LOCA projections for RCP 4.5. These have less severe temperature increases, and are more likely to show increasing precipitation than the RCP 8.5 projections.
  - From information presented by the UA's Dr. Hsin-I Chang, we have seen that the two climate models that appropriately represent the LSCR Basin climate metrics are HadGem2 and MPI

- Red solid point: SD (LOCA) HadGem2 RCP 8.5 data and shows average temperature above the 90th temperature percentile and near the 50th precipitation percentile, indicating a hotter future 7.8°F warmer than the historical period (1970-1999).
- Red open point: SD HadGem2 RCP 4.5 data and is near the 50th percentile for both temperature and precipitation, indicating a warmer future 5.62°F warmer than our historical climate, but only slightly drier
- Black solid point: SD MPI RCP 8.5 hotter (by about 6 F) and drier future
- Black open point: SD MPI RCP 4.5 is near the 10th temperature percentile of the temperature increases (about 3.7 F) and near the 50th precipitation percentile of precipitation change.
- Generally, the SD HadGem2 data for both RCP 8.5 and 4.5 forecast hotter futures than the comparable SD MPI projections
- For both SD MPI and HadGem2, data at RCP 8.5 project slightly drier futures than the RCP 4.5 data
- Black triangle: DD MPI is the RCP 8.5 dataset, a favorite coming out of UA analysis. The DD HadGem2 RCP 8.5 dataset is not shown; it will be added in later.
- Temperature increase of the DD MPI data is not as large as SD MPI data. This may be due to warm biases in MPI that result in a warmer than observed historical period and thus an artificially high reference period.
- SD HadGem2 4.5 and SD MPI 4.5 are have lower temperature increases and are wetter compared to the rest of the projections discussed.
- Many climate models project a wetter future, potentially due to more intense storms

- The weather generator uses three seasons/states to "sample history": Monsoon season, Dry Pre-monsoon and Winter wet season

- Slide 8: These charts are similar to the one on slide 7, but for specific seasons. Graph on the left is for the pre-monsoon dry season and graph on the right is for the winter wet season. Note that the precipitation scale is inches per day (not inches per year). This allows us to compare seasons of different lengths.
  - Of note is that SD HadGem2 RCP 8.5 for both the pre-monsoon and winter seasons show a hotter, drier future (red solid points)
  - Pre-monsoon season has a larger range of modeled change in precipitation than the winter-wet period. Lindsay noted after the meeting that this may reflect changes in monsoon timing that are not dynamically handled in these summary plots.
- Slide 9: The two graphs compare the monsoon season (on the left) and wet winter season (on the right)
  - Monsoon projections are very different from winter and pre-monsoon, with several RCP 8.5 SD projections suggesting extreme increases in temperature.
  - During the monsoon season, the averaged behavior of the DD-MPI model closely represents a condition Reclamation often selects from model ensembles as "Hot-Dry" case, representing nearly the hottest 90% of change in temperature and only 10% of

models drier. This provides additional support for the use of the DD-MPI model to represent the 'worse' case monsoon season.

- Slide 10: Climate metrics of concern: monsoon onset, extreme events, length of dry period
- Slides 11 & 12: The weather generator breaks the year into three seasons, "wet-winter" (September 1 – April 1), "dry" (April 1 – July 15) and "monsoon" (July 15 – September 1). The climate models may also show a shift in the timing of seasons, but this investigation is ongoing.
- Slide 13:
    - The weather generator uses climate metrics to generate future conditions by directly perturbing the historical climate
    - The method allows us to shift timing of states to reflect changes in seasonality.
    - HDE (Hybrid Delta Ensemble) Method: shift quantiles differently, not just wholesale translation of cumulative density distribution
- Slide 14: Both the DD MPI and HadGem2 models project less precipitation in August in the far future (2050-2079), representing an example from the UA analysis of the changes that will be incorporated into the weather generator.
- Questions
    - Did Reclamation consider bias correction? Reclamation is hesitant to bias correct UA's DD models (due to input issues) beyond "differencing model from itself"
    - Would Reclamation consider using different models for different seasons? The purpose is to look at worse-case scenarios. Caution is needed when discussing single climate signals, so we will evaluate the changes relative to the DD HadGem2 data and individual model biases as well. The MPI model was chosen for its ability to capture monsoon season dynamics. We expect the MPI model to be the "worse-case" choice, particularly with respect to metrics involving monsoon season onset and storm magnitude.
- Next steps
    - Reclamation will add DD HadGem2 8.5 data and will look at averaging DD MPI and DD HadGem2 models for the worse-case climate scenario. SD 4.5 counterparts of the MPI and HadGem2 models will most likely be used for the best-case climate scenario.

3. **CAP Service Area Model Projections –** Presented by Ken Seasholes, Central Arizona Water Conservation District

- Shared excel sheet as background
- Based on input from the last meeting:
    - Changed how Vail Water Company will deal with accrued long term storage credits
    - Worked with Asia Philbin to ensure Marana's CAP entitlement and effluent utilization are reflected accurately
- Updated version to projections of population trends distribution in 2045 (housing units)
    - Housing units are used as a proxy driver for municipal and agricultural water demand
    - Made changes in the number of housing units in one water provider's (WP) service area to another
    - Feedback from process: too many housing units being allocated to existing WPs

    - Pulled down housing unit numbers for all of the projections
- 2017 to 2045:
    - Densification in urban area and growth in peripheral areas
    - Pronounced in the Southeast/Houghton corridor and extended areas of I-10 which will be served by Tucson Water
    - Discussion about whether new growth will be in existing WPs (TW) or in new WPs' areas
- Factors include shortages on the Colorado River (CR) and how it affects CAP supply
    - The observed record includes fairly deep shortages that correspond to drought contingency plan levels
    - More aggressive/frequent/increasing levels of shortages will result in reductions to CAP supply
- Review of water supply projections for WPs
    - Tucson:
        - Because of the magnitude of their renewable supply, Tucson Water is slightly insulated from imbalances in water supply/entitlement
        - Dropping housing units drops projected risk
        - Larger and more sustained reductions per capita
        - High series projection: pushing housing units further out, challenging to fit them in projection
        - Accrued long-term storage credits become a supply to supplement in later parts of decades
        - Spikes down that correspond to reductions in CAP supply
    - Green Valley: constraints are "much tighter"
        - Trend/downward projection in per capita use is offset by climate and increased heat
        - Flat housing units (low risk): less shortages projected
    - First year of CAP shortage was updated to 2020
- Description of demands becomes important in documentation
    - Green areas in the chart represent assured water supply (AWS) Demand that is typically satisfied using the Groundwater Replenishment District.
- General takeaway is that demand/housing units are less concentrated in the Green Valley and Vail areas than the previous projections, in large part because the PAG projections now place greater proportion of growth in the Houghton Corridor, with Tucson Water being the provider.

- Questions:
    - <u>Are we ready to send to the projections to the WPs for review and input on how and where they will pump to meet future demand?</u> Yes and two weeks is a reasonable review time. WPs have reviewed previous work and they should make sure previous input is incorporated.

- Regarding Community Water of Green Valley on current (2018) AWS use and water demand. Response: Ken clarified that even though some demand is shown as AWS Demand it is in fact groundwater being pumped in Green Valley

- Regarding Vail Water Company and shifting projected units into TW service area makes sense since they have biggest allocation, versus shifting to Vail. Response: The new graph reflects intentions to have developable land brought into play with some spillover into the Vail area. There is checked/scattered projected development in the Southwest, along Ajo Way where Tucson Water and Metro Water have isolated service areas -- fair amount of development is projected in Southwest area. The two water providers in that area are Tucson Water and Metro Water's-Diablo Village service area.

- Ken: that area gets a little crazy in the high demand scenario, many units built in short period. If there really is that kind of growth in Tucson region, a fair amount may sprawl out into that corridor and into state land block south of freeway. May not happen until 2075
- Metro Water relinquishing its NIA allocation and will use CAP long-term storage credits to serve the Diablo Village service area. Metro Water will be pumping groundwater into that area-offset by long-term storage credits. Demand will not be met with direct delivery CAP water unless it is absolutely necessary. Ken will update CAP:SAM to reflect the change in Metro Water's NIA allocation
- The high-risk scenario will reflect CAP shortages throughout most of the entire planning period. However, the shortage impacts in the Tucson area are more subtle because there is less reliance on NIA water, but the impact will be reflected in groundwater areas

    - Will CAP:SAM use each wells capacity until it is all "used up" and needs another well? Ken looked at various categories of those contributing and withdrawing groundwater. The translation to well pumping will be done by a consultant. Ken can provide entity-based pumping data but has not completed the well-by-well (cell by cell) analysis

    - Can we get entity-by-entity demand? Ken can retool and help provide input file for entire period of modeling. Ken and Wally will coordinate on Metro Water data, first, and then Wally will coordinate with the other water providers.

- We will need to simulate how much effluent supply is discharged to SCR and how much is reused and recharged. Water providers will also need to provide recovery of recharged effluent

- Next steps: Ken will provide datasheets and the co-study managers will share them with the water providers. They will have two weeks to get comments back to Ken

    - How did Ken prepare projections after 20245? Control totals were kept at the county level, tracking state totals. It involved changes in traffic analysis zone (TAZ) levels extrapolated beyond 2045. CAP:SAM can speed up or slow down time, depending on rate of growth.

    - How is the land-carrying capacity addressed in projected populations? Response: CAP is embarking on an effort to have a more unified way to develop high-resolution three-county service area spatial projections. Issues in smaller areas can be speculative, but CAP is looking to improve how we do this.

4. **Basin Study Sub-team Updates --** Presented by Eve Halper, Reclamation. Reclamation received approved to an increase in the study schedule and budget. Changes to the study that required the extension were:

- Climate work described earlier was a departures from the traditional method of study used in other basin studies and was considered a study enhancement
- Timeline of study was updated; starting in February 10, 2016 and completed in September 30, 2020 (Additional 1 year + 7 months extension)
- The federal-share budget increased by $325,000. The in-kind local cost-share has also been increased. Reclamation needs to gather information to calculate in-kind local share.
- ***Eve needs hourly rates with overhead that will count towards local cost share. Hours spent at meetings count towards cost share. Please check with your finance department to calculate overhead! Send to Eve.***
- Many key upcoming dates. The revised schedule was included in the meeting materials. Please review for key dates upcoming in September, November, December 2018

- The revised Plan of Study will include semi-annual reporting, instead of quarterly reporting
- In order to finalize study changes, an amendment to the memorandum of agreement is required. The study partners will need to sign the amendment.

5. **Next Meeting Date and Topics –** A follow up meeting for climate projections and CAP:SAM projections will be scheduled soon. Meeting was adjourned