**Summary of Climate Recommendations**

Lower Santa Cruz Basin Study Project Team Meeting May 20, 2016
Revised after September 27, Webinar

*1. What climate scenarios do the Project Team want to evaluate?*

Project Team members expressed interest in focusing on a high emissions / "worse" case climate scenario though 2060 (see Figures 1 and 2, pages 5 and 6).

Discussion:

- To date, most water planning in Arizona has assumed a climate future that is much like the past. Water providers generally feel they are well prepared for "business as usual" conditions.

- Recent analyses show that climate is already changing, and may change substantially in the future, with rising temperatures and a potential for less precipitation. In order to manage risk, water managers need to be prepared for a "worse case" scenario – so that they can provide their customers with a reliable, long-term water supply, even if an extreme level of change takes place.

*2. What is the appropriate number of climate scenarios to evaluate? Fewer scenarios make the analysis simpler, but a greater number of scenarios provide a wider range of future conditions.*

Project Team members expressed interest in a "best" and "worse" (as opposed to "worst" case scenario). In addition, members supported the calculation of a "base", or "without climate change" case, to allow the effects of climate change to be separated the effects of other driving forces (e.g. population growth).

Discussion:

- The greater the number of scenarios, the more complex the decisions and discussions will be throughout the Basin Study process.
- Focusing on fewer scenarios would make the overall project simpler and more focused, but would not encompass the full range of possible futures.
- Other Reclamation Basin Studies have typically used 3 to 5 climate scenarios (warm/dry; warm/wet; hot/dry; hot/wet; and central tendency)

- One view was that if this study is going to be used primarily as a risk-management tool, there seems to be little point of evaluating "middle of the road"/central tendency scenarios. Therefore, the "warm/dry and warm/wet" conditions are not as useful for this study as the "hot/dry" one.

- The group endorsed using the term “worse” as opposed to “worst” to emphasize that they would like to consider a “high-end” emissions scenario, but not the highest possible level of emissions, or catastrophic events.
- The group also agreed there is value in considering the “best case” that could occur in the context of climate change, using a reduced emissions scenario to “bookend” the study.
- Project Team members expressed interest in documenting a “no climate change,” or “base” case, solely for the purpose of distinguishing the effects of climate change from other driving forces.

**Other related comments:**

o With respect to environmental or agricultural considerations, it may be beneficial to focus on ways to account for seasonality (different seasonal futures, for example the possibility of a wetter summer even if there is overall a reduction in precipitation).

3. *Does the Project Team want to evaluate climate impacts at a Colorado River Basin scale, a local scale, or both?*

The group agreed to analyze water resource implications at both a local and a Colorado River Basin scale. Project Team members hope to assess the potential impacts of climate change on the hydrology of the Lower Santa Cruz River basin as accurately as possible. They support the inclusion of dynamically downscaled climate projections in the Study’s technical analyses.

Discussion:

- The Tucson Basin is reliant on both the Central Arizona Project and local groundwater supplies, so it is important to understand what the impact of climate changes may be on both sources.
- Climate change may have different impacts in the Upper Colorado basin (where the majority of the flows of the Colorado originate) than on the Lower Santa Cruz River Basin itself. It is important to analyze both, and include consideration of climate impacts on all sources of water.
- If water supply during monsoon season is a concern, dynamical downscaling may be the best method to use. Statistical downscaling is not capable of taking into account the physical processes that generate thunderstorms.
- The Study should also consider effects on reclaimed water, including treated effluent and remediated water.

*4. How will impacts to water demands (municipal, agricultural, evapotranspiration) be influenced by the different climate modeling methods and assumptions?*

The Project Team supports adjusting the Study's demand projections to include the effects of climate change. To make this process efficient, it may be useful to conduct a sensitivity analysis to focus on the sectors with the greatest impact on the water budget.

Discussion:

- If looking at the impacts of climate change on municipal demand at a cursory level (e.g. change in gpcd, change in population, location of those demands), we could conduct a sensitivity analysis to find out what parts of the current Tucson AMA water budget are most affected by increasing temperatures (for example, landscape irrigation requirements) then look at how that aggregates across the basin.

- There is flexibility in which demand assumptions are utilized by the Project Team. The working groups can discuss what assumptions should be used, including whether to use the assumptions made by DWR in the 4$^{th}$ management plan. However, the supply and demand assumptions for a specific climate scenario should be based on assumptions that are consistent.

5. *Should the team focus primarily on the effects of climate change on the basin-wide balance within the Tucson AMA, or consider impacts in specific sub-basins? How will the Project Team account for the impact of climate change-induced water supply and demand changes in the larger Colorado River Basin? Will the Project Team assume the existing infrastructure and operations of over-arching entities (i.e., CAP, ADWR) or account for their expected operations under differing climatic conditions? How will varying assumptions be streamlined?*

As outlined in the Plan of Study, the Project Team supports performing the technical analysis at the Water Accounting Area scale.

Discussion:

- We can use the ADWR's Tucson AMA model for the groundwater impacts within the central portion of the basin.

- There is interest in evaluating water supply and demand imbalances within sub-basins, not just the overall TAMA basin. This is important if we are to set the stage for considering the benefits of alternative management options and the adequacy of existing storage and recovery infrastructure. It is also important for considering the environmental implications, e.g. the impacts on the health of riparian ecosystems.

**Final Recommendations** - After thorough discussion, the Project Team decided to:

- Explicitly focus on a "worse-case[1]" climate scenario, e.g. A2 or RCP (Representative Concentration Pathway) 8.5 emissions[2], rather than a full range of possible futures, looking at the potential for extreme conditions rather than "median" climate condition. Note that this differs in approach from other Basin Studies that have focused on a range of possible future climate scenarios and have not emphasized extremes.

- Develop a "best case" climate change scenario using lower emissions from B1 and/or RCP 4.5

- Calculate a "base case" scenario (with no climate change) to distinguish the effects of climate change from other driving forces, such as population change.

- Evaluate climate change impacts on both Colorado River Basin and local water supplies and environmental conditions as a result of the "worse and best case" scenarios.

- Explore the feasibility and implications of using dynamical downscaling to model regional climate change impacts, recognizing that the outcomes will differ from those in the overall Colorado River Basin Study. Recent dynamical downscaling results indicate that the shortages on the Colorado that are projected in the Colorado River Basin Study may be underestimated.

- Consider effects of climate change on both the demand and the supply side of the water budget, and look at implications at the "Water Accounting Area" scale.

- To the extent feasible, consider implications for all sources of water including impacts on effluent; implications of changes in seasonality of precipitation/flows; and multiple demand scenarios.

[1] We refer to a "worse case" rather than a worst case here because we are only considering a high end emissions scenario, not the highest-possible level of emissions. Further, there are many catastrophic things that can be imagined, such as dam failures that would lead to much worse cases than we are suggesting here.

[2] See attached illustrations of the implications of these emissions trajectories.

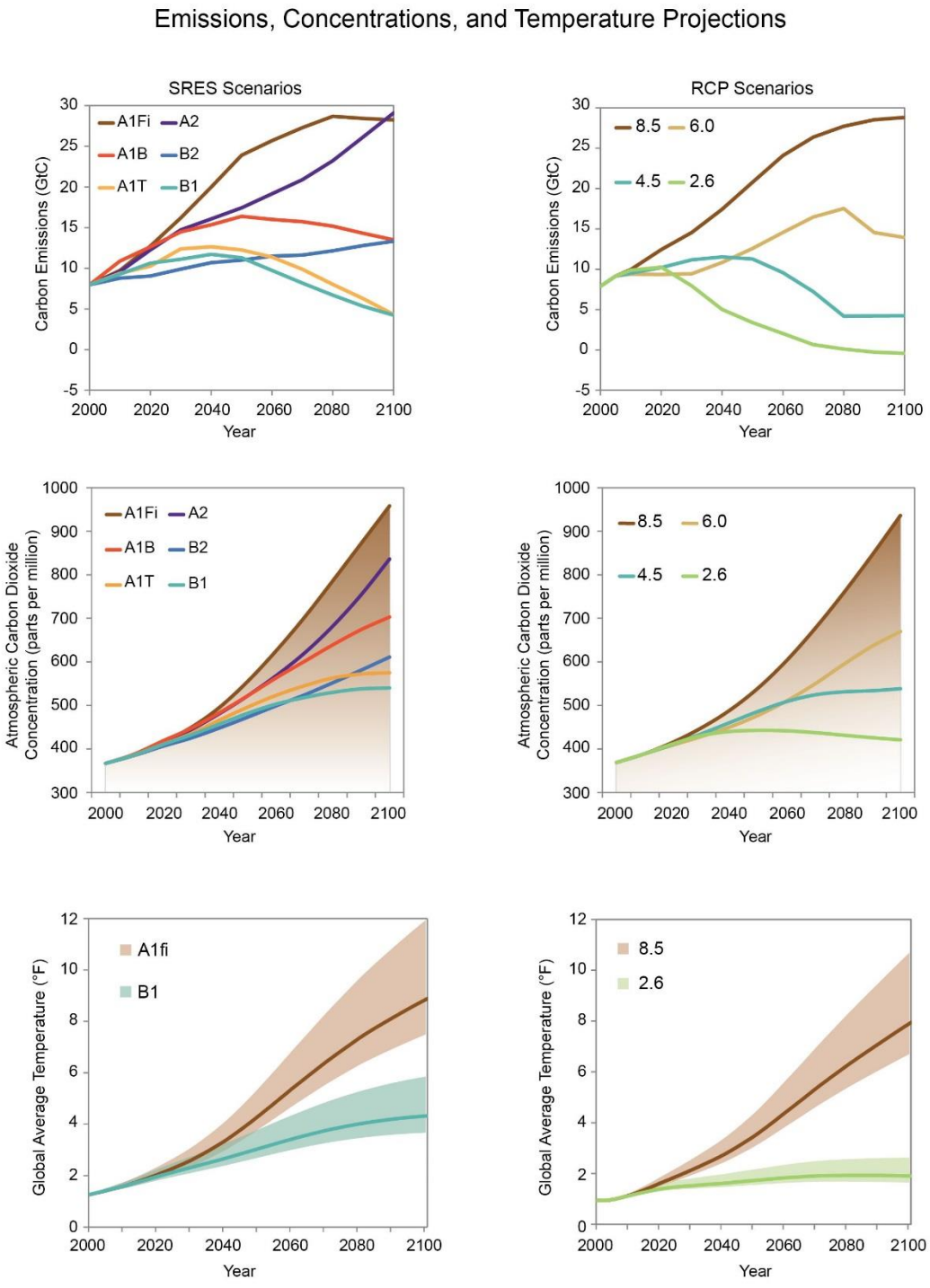


*Figure 1- Emissions, Concentrations, and Temperature Projections from National Climate Assessment, 2014*

Downloaded from: http://nca2014.globalchange.gov/report/appendices/climate-science-supplement/graphics/emissions-concentrations-and-temperature#tab1-images

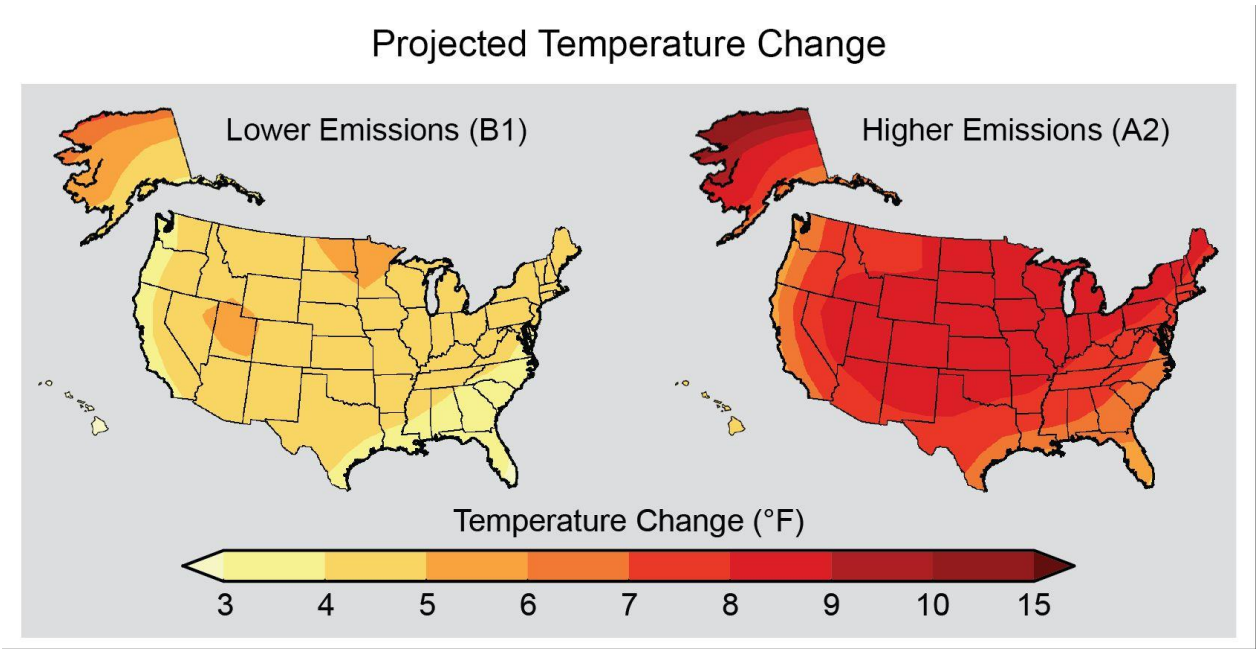


Figure 2- Maps show projected change in average surface air temperature in the later part of this century (2071-2099) relative to the later part of the last century (1970-1999), Source: National Climate Assessment, 2014.

Downloaded from: http://nca2014.globalchange.gov/highlights/report-findings/future-climate#tab2-images