Evaluation of Operating Criteria and Procedures (OCAP) Performance Under Paleo and Future Climate

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Introduction

The Bureau of Reclamation (Reclamation) Lahontan Basin Area Office partnered with Reclamation's Technical Service Center to conduct this WaterSMART funded Reservoir Operations Pilot Study (Study) to develop and apply new datasets to support evaluation of the performance of Reclamation's 1997 Operating Criteria and Procedures (OCAP) for the Newlands Project under a greater range of changing hydrologic conditions. The Newlands Project provides water for about 57,000 acres of croplands and wetlands in western Nevada. During scoping for an OCAP Revision, stakeholders expressed the need to understand the ability of the OCAP to satisfy water rights and the Secretary of the Interior's tribal trust responsibilities under changing hydrologic regimes in the Truckee and Carson River basins (Truckee-Carson Basin). This Study provides a 600-year hydrologic dataset (1500-2099) to assess the impacts of climate variability and change on OCAP performance to help determine what, if any, updates are required to ensure that the OCAP can meet its objectives in the future.

Background

The OCAP is a federal rule promulgated by the Secretary of the Interior, governing diversions by the Newlands Project from the Truckee and Carson Rivers. The OCAP was prompted by negative impacts from inter-basin diversions of Truckee River water to the Carson River to supplement water supplies for the Newlands Project. The decrease in Truckee River flows to Pyramid Lake, mostly from diversions to the Newlands Project, has lowered lake levels, leading to the deterioration of endangered and culturally important fisheries and associated litigation. One of the main purposes of the OCAP is to minimize diversions of Truckee River water through the Truckee Canal while serving valid Newlands Project water rights.

Pyramid Lake, Nevada.

Dataset Development

This Study used novel methods and information to develop a 600-year hydrologic dataset (1500-2099) to assess the impact of climate variability and change on OCAP performance. The long dataset helps us to better understand whether distant past and/or projected future conditions are outside the range of the more recent, observed historical record.

When possible, the Study took advantage of existing data and models, but developing a continuous, unified dataset from different sources required a significant amount of data processing. Initial steps entailed developing unregulated streamflow data from three distinct periods, described below and in Figure 1.

Map of the Study area and the different PRMS Models

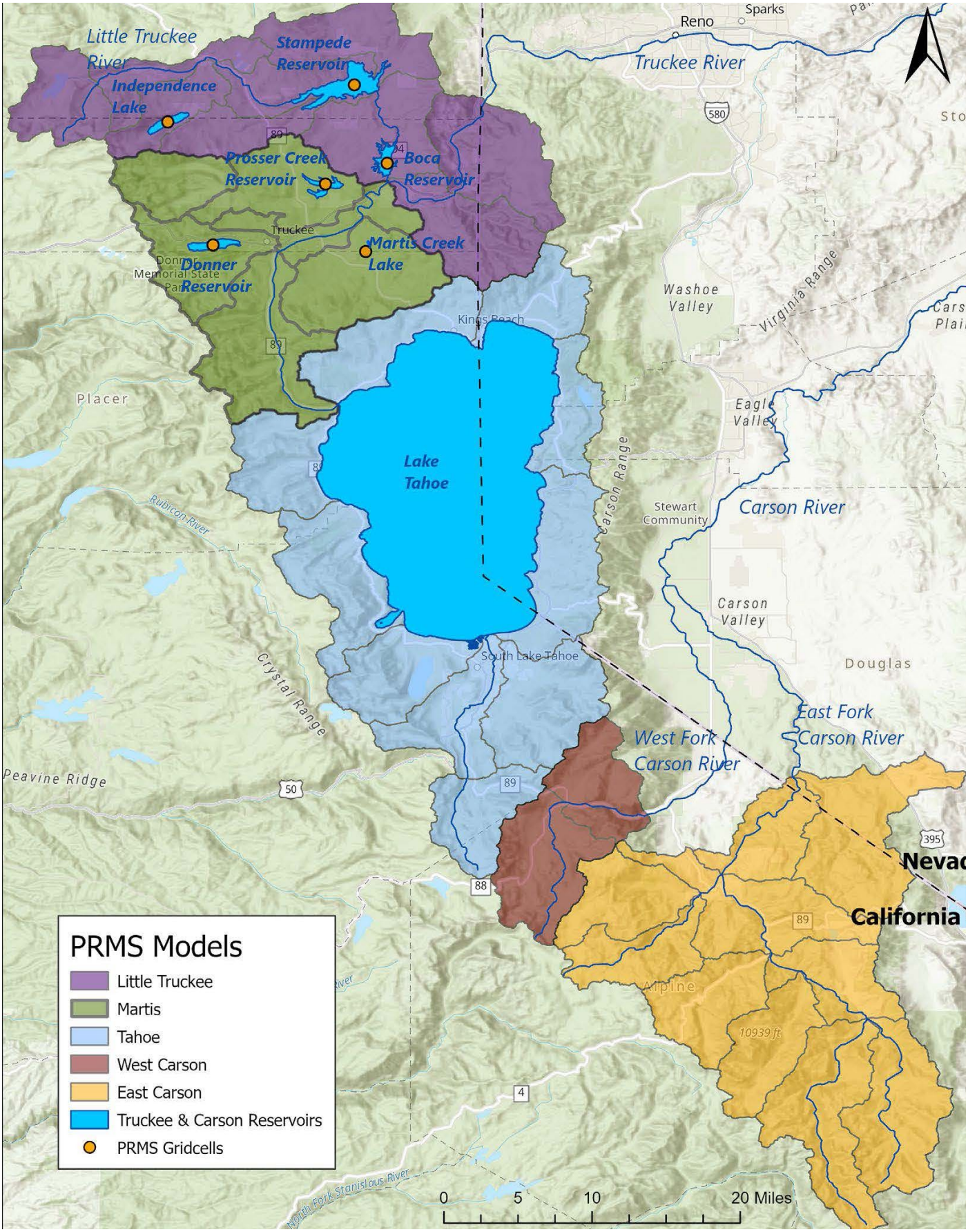

Figure 1. Map showing the study area and the boundaries of the different Precipitation Runoff Modeling Systems (PRMS) used in this pilot study.

Three different types of datasets, described below, are combined in the 600-year hydrologic dataset.

- **Distant past** (1500-1900): Existing, annual streamflow data for the distant past in the Truckee-Carson Basin, estimated from tree rings and expanded in this Study to all planning model[1] input locations at a daily timestep.
- **Recent historical** (1901-2017): Existing daily hydrology dataset[2] that water managers and operators use for planning, accounting, and operations in the Truckee-Carson, based on observations and a water balance technique.
- **Projected future** (2018-2099): Ensemble of 64 future streamflow projections developed in this Study from general circulation model (GCM) data representing a medium and high emissions scenario run through 32 GCMs. The Study developed a new bias correction method that accommodates potential shifts in the timing of climate regimes to better fit the regionally downscaled GCM data to the Truckee-Carson Basin.

The Study input these unregulated streamflow datasets into a basin planning model to simulate regulated river operations. In doing so, the Study expanded the period of record available at the start of this Study from a 117-year simulation period (1901-2017) to encompass the 400-year paleohydrology (distant past) period and almost 100-year projected future period (2018-2099). Of note, only streamflow inputs and Lake Tahoe evaporation were incorporated into the basin planning model, providing a preliminary picture of OCAP performance. Additional efforts are necessary to include future changes in evaporation at all major water bodies, as well as change in future demands to provide a more complete picture of OCAP Performance.

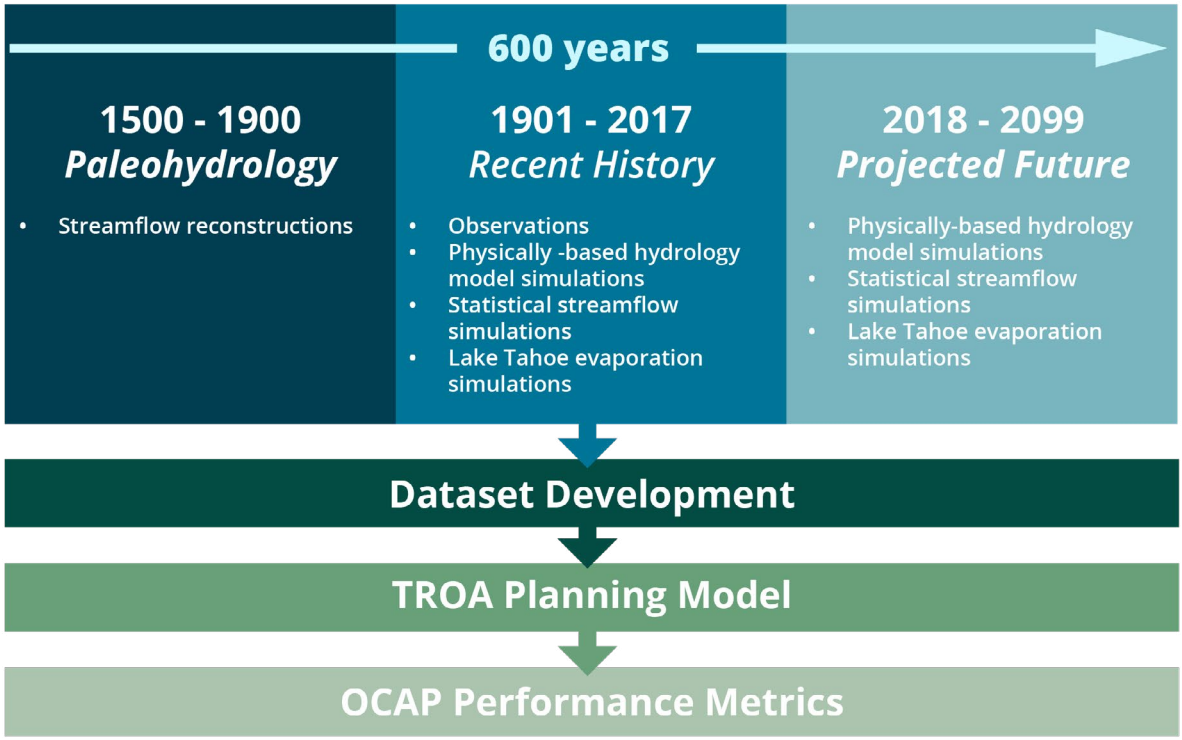

Figure 2. Time series components and workflow used to develop the stream flow dataset and assess OCAP performance metrics.

1 Truckee River Operating Agreement (TROA) Planning and Accounting Model.

2 TROA Daily Historical Planning Model Dataset.

Key Findings

Analysis of the 600-year hydrologic dataset provided a big-picture, preliminary view of how conditions in the recent historical period compare to those in the distant past and projected future. From this, we show how OCAP might perform under climatic and hydrologic conditions that differ from the recent historical period, as illustrated by the following key findings.

Distant past (1500-1900) compared to recent historical (1900-2017) streamflow

- The recent historical period experienced lower annual average flow and overall drier conditions than the distant past; however, the greater variability in the recent period shows wetter, wet years and a larger portion of wet years compared to the paleo-record evidence in the distant past.
- In both the Carson and Truckee Basin, the most severe droughts in the distant past exceeded the most significant cumulative deficit and average annual deficit droughts experienced in the recent historical period.
- The paleo-record evidence suggests that significantly longer droughts occurred in the distant past, including a 30-year drought from 1651 to 1680, which resulted in an approximate 37-foot drop in Lake Tahoe elevation.

Projected future (2018-2099) compared to recent historical (1900-2017) climate and streamflow

- Projected future climate impacts align with those found in other studies, with median values from the 32 GCMs and 2 emissions scenarios indicating warmer, wetter winters and hotter, drier summers with little change in annual average precipitation, but increased variability.
- Projected future changes in unregulated streamflow projections align with precipitation projections, and show higher winter-spring flows and lower summer-fall flows, as well as an earlier peak runoff compared to the recent historical period.

Trends in OCAP performance from the distant past to projected future period

- A trending increase in annual average water storage at Lake Tahoe, Lahontan Reservoir, and Pyramid Lake from the distant past and recent historical periods to the near future aligns with:
    - Greater ability to meet water demands including Carson Division Demand and the Floriston Rate, a required average daily flow to meet basin demands; and,
    - Increased Truckee River flow into Pyramid Lake, leading to an increase in average lake elevation from 3830 feet in the historical period to an average of 3860 feet across all climate models in the far future, medium emissions scenario (Figure 2).
- Under some future scenarios, Truckee River Diversions to the Project increase, in opposition to the OCAP objectives. However, on average, a greater portion and volume of Truckee River flows above Derby Dam reach Pyramid Lake in the future.
- Importantly, as a result of using a wide range of 64 future streamflow projections, the performance metrics exhibit increasing levels of variability and uncertainty in the future, with ranges often including scenarios showing both overall improvements and declines in OCAP performance. The preliminary analysis based on the mean, variance, and long-term trends, does not capture all of the nuances associated with the different future scenarios and models, such as the specific climate instances that stress the OCAP. Future efforts intend to explore the characterization of these uncertainties and nuances.

Project Benefits and Future Applications

The Study developed a robust climate and hydrology dataset to begin to evaluate the ability of OCAP to meet its objectives under a changing hydrologic regime. This will help basin stakeholders determine what, if any, operational and regulatory updates are required to ensure OCAP meets its objectives in the future.

The Study also revealed opportunities to improve upon this dataset and its use in the evaluation of OCAP performance. Inclusion of future changes in evaporation at all major water bodies within the Truckee-Carson Basin as well as changes in future demands is necessary to provide a more complete picture of future OCAP performance. Further, to ensure that the performance results reflect the values and concerns of basin stakeholders, we recommend working with stakeholders to refine and update the metrics list and assessment process. We also recommend applying a bottom-up vulnerability assessment to complement the primarily top-down approach taken in this Study. This bottom-up assessment would use stakeholder input to identify management concerns around which sensitivity and vulnerability of OCAP are then characterized over the range of future conditions.