An Analysis of Hydrologic Variability Sensitivity in the Colorado River Basin

Hydrology Days
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March 26, 2008
Recent conditions in the Colorado River Basin

- Below normal flows into Lake Powell 2000-2004
  - 62%, 59%, 25%, 51%, 51%, respectively
  - 2002 at 25% lowest inflow recorded since completion of Glen Canyon Dam
- Some relief in 2005
  - 105% of normal inflows
- Not in 2006!
  - 73% of normal inflows
- Current 2007 forecast
  - 120% of normal inflows

Colorado River at Lees Ferry, AZ
Hydrologic Sensitivity Runs

- 5 hydrologic inflow scenarios
  - Records sampled from a dataset using ISM
    - Observed flow (1906-2005)
      - 100 traces
    - Meko - paleo flow (762-2005) (Meko et al., 2007)
      - 1244 traces
    - Woodhouse - paleo flow (1490-1997) (Woodhouse et al., 2006)
      - 508 traces
  - Other
    - Meko - paleo conditioned (Prairie, 2006)
      - 125 traces
    - Woodhouse - paleo conditioned (Prairie, 2006)
      - 125 traces
  - Presented in Draft EIS
    - Parametric stochastic (Lee et al., 2006)
      - 100 traces
ISM-Based Flows

- Historic natural flow (1906-2004): averages 15.0 MAF
- Woodhouse reconstruction (1490-1997): averages 14.6 MAF
- Meko reconstruction (762-2005): averages 14.7 MAF
observed record

Woodhouse et al., 2006

Stockton and Jacoby, 1976

Hirschboeck and Meko, 2005

Hildalgo et al. 2002
Alternate Stochastic Techniques

• Paleo conditioned
  – Combines observed and paleo streamflows
  – Generates
    • Observed flow magnitudes
    • Flow sequences similar to paleo record

• Parametric
  – Fit observed data to appropriate model (i.e., CAR)
  – Generates
    • Flow magnitudes not observed
    • Flow sequences similar to observed record
Drought and Surplus Statistics

Threshold (e.g., median)

Drought Deficit

Surplus Length

Surplus volume

flow

Drought Length

time

RECLAMATION
Histograms of dry periods

Direct Natural Flow

Direct Paleo
- Meko 2007

Paleo Conditioned
- Meko 2007

- max length is 5 years at 0.125 probability
- max length is 13 years at 0.004 probability
- max length is 22 years at 0.0002 probability
Colorado River Simulation System (CRSS)

- Requires realistic inflow scenarios
- Captures basin policy
- Long-term basin planning model
- Developed in RiverWare (Zagona et al. 2001)
- Run on a monthly time step
Lake Powell End-of-July Water Elevations
Probability of being below Power Pool
Percent of Values Less than or Equal to Elevation 3,490 feet msl
Lake Mead End-of-December Water Elevations
Probability of being below SNWA intakes
Percent of Values Less than or Equal to Elevation 1,000 feet msl
Glen Canyon 10-Year Release Volume
Years 2009-2060
Final comments

• Impacts of increased variability
• Enhances risk estimates
• Need for interim guidelines

• Final Environmental Impact Statement
  – Appendix N - Sensitivity Analysis
Future direction

• Reconcile range of runoff reduction at Lees Ferry for many climate projections
• Blending climate projection data distribution with sequences generated from paleo and observed data
• Conditioning future scenarios on large scale climate features (i.e., ENSO, PDO)
Questions ?
Histograms of wet periods

Direct Natural Flow

Direct Paleo
- Meko 2007

Paleo Conditioned
- Meko 2007

max length is 6 years at 0.04 probability

max length is 10 years at 0.008 probability

max length is 23 years at 0.0002 probability