Tutorials for Visualization Tools that compare gage records with the streamflow reconstructions

A. Drought Analogue (Sequence of Years) Visualization Tool

Have you ever wondered how the set of years that comprised the 1950s or the most recent drought – the sequence of years and how the drought evolved-- compares to droughts of similar length and magnitude in the past?

For example, the period 1950-1956 was the driest 7-year period in the Rio Grande near Del Norte record, 1890-2004. That period was characterized by two years of flows below 500,000 AF in 1950 and 1951, one year of higher flows in 1952 (about 800,000 AF), and very low flows from 1954 though 1956. At least there was a break in 1952! What do other 7-year periods of low cumulative flows look like in the past?

By using this tool, you can compare the 1950s sequence of years—or other sequences from the gage record--with (a) 7-year periods in the Rio Grande reconstruction that have similar average flows over that period, or (b) with the lowest 7-year average flow in the full reconstruction (in other words, to see how bad can a 7-year stretch be, and what does it look like?

To do this, open the DroughtAnalogueVisualizationTool (davt_sequence of years.jar) file by downloading it onto your desktop or laptop, and clicking on it to open and run with Java (make sure you have the correct version).

Follow the step-by-step directions:
1. Select Rio Grande nr Del Norte (the only option at the moment)
2. Select 7 years
3. Select the first set of years in the list, 1950-1956
4. Select Plot with "the 5 closest 7-yr average periods to the selected period in the gage record."

You'll see the 1950s years plotted in the heavy dark line, and the 5 closest periods (in terms of 7-year averages) plotted in other colors. The 1950s period is a bit unusual in that it does have that year of recovery in the third year of the 7-year sequence. In two of the other periods, 1876-1882 and 1620-1626, there is a stead decline over the first 4 years on the sequence, then a slight and very gradual recovery over the remaining 3 years. In the 1875-1881 sequence, flows are extremely low for the first 5 years, but there is a good recovery the 6th year, and a slight drop in year 7.

What about the 7-year periods that had the lowest averages in the entire reconstruction (in this case, going back to 1536)? Go back to step 4 and select the 2nd option, Plot with "the 5 lowest 7-year average periods in the reconstruction."

Again, you'll see the 1950-1956 period plotted in the heavy dark line, and the 5 lowest flow periods (in terms of 7 year averages) plotted in other colors. Most have some variability over the course of the 7 years, but the period 1878-1884 has no year of recovery until the 7th year! In the period, 1772-1778, the second year in this sequence dips to an extremely low value (only

100,000 AF), but recovers a bit in the third year, then gradually declines over the rest of this period. (Something we could add is that 7-year average, so you can compare it to the 1950s period.)

B. Low-frequency Variability Visualization Tool

Over a period of 10, or 20 or 50 years, or even the whole period of the gage record, how has streamflow varied? How does the generally dry period at the turn of the 20th century compare to the decade of the 1950s, and how does that compare to the last 10 years (that we have data for here, 1996-2005)? And finally, how do these periods and their variability compare to the range of variability in a centuries-long reconstruction? This tool is designed to explore these types of questions.

It's hard to assess general trends and variability looking at the annual values, and it can be easier to examine these periods with some of the year to year variability (high frequency variability) smoothed out a bit. With this tool, we ask you to select a period of interest, and level of smoothing (running averages of years, so each point plotted represents an average of 3, 5 or 10 years). The plot is then shown against a background that allows a comparison of these gage values in the context of the longer reconstruction.

To use this tool:

Open the LowFrequencyVariabilityTool (davt_lowfrequencyvariabilitytool.jar) file by downloading it onto your desktop or laptop, and clicking on it to open and run with Java (make sure you have the correct version).

Follow the step-by-step directions:
1. Select Rio Grande nr Del Norte (the only option at the moment)
2. Select a period length;10 years
3. Select the start year for the period to plot: let's look at 1950s again, so click on 1950
4. Select the number of years to average for each point plotted: 3
5. Choose to display the gage record relative to the reconstruction in 3 categories, wet, dry average.

The plot will show the decade of the 1950s, smoothed with a 5-year average. Each point represents the average of 3 years, and the first point starts with the average of 1948-1950. You can see that the first point, again the average of 1948-1950, falls within the wettest third of all the 3-year averages in the reconstruction, going back to 1569. But if we move up one year, to the average of 1949-1951, we are just below the range that represents the average third, and stay there through the average of the 3 years, ending in 1957. 1957 was pretty wet, so that pulls up the 3-yr averages that end in 1958 and 1959 to the middle range once again.

How does this decade compare to the most recent one (again, ending in 2005)? Change the settings to select 10 years starting in 1996. The decade 1996-2005 did not have the persistent low flows of the 1950s, but once the drought begins, it is more severe, relative to the 1950s, and

quite severe in the context of the centuries-long reconstruction. The 3-yr average doesn't drop below the middle range until 2002 (representing 2000-2002), but stays there through the end of the period. The 3-yr average ending in 2004 is especially severe, about as low as any 3-yr period in the full reconstruction?* It will be interesting to see what the decade that starts in 2000 looks like compared to the long-term reconstruction!

Click through other 10 year periods, watching how they appear in the graph. What other 10-yr periods are characterized by persistent low flows? You'll notice that no other period has as persistent lows flows as the 1950s, though a second most persistent period occurs around the turn of the 20th century. You may also notice the long stretch of years with values in the wettest third, and some of these plot above the blue band. This is because the gage values are greater than any in the reconstruction (without considering the uncertainty in the reconstruction).*

*Remember that the reconstructions are just estimates of actual flow. In developing the reconstruction models, the trees do not replicate 100% of the variance in the gage record. Because of this, there is uncertainty or error related to the reconstructed values. We have not taken this into account, but there are probability or confidence intervals that can be added to these graphs for the maximum and minimum values that show the 80% confidence limits of these values which will help in assessing the likelihood of an extreme value in the gage record falling outside of the range of values in the reconstruction.