APPLIED HYDROLOGY - JOINT HYDROLOGY/ENV. FLUID MECHANICS ASSIGNMENT

Transport of pollutants in rivers (hydrology part)

An accident may occur next February at the Fort Calhoun nuclear power plant (Nebraska, USA), which is located on the right bank of the Missouri river, because of a dangerous maintenance operation. The accident would involve an instantaneous release in the river of uranium in dissolved form. We are interested in the concentration before and after the confluence of the Missouri and the Platte rivers.

In order to get an idea on what are the possible average flow and low flow conditions for the two rivers (in the month of February), use the data in the files

`Missouri_Omaha_dailyQcfs_1929_2018.asc` and
`Platte_Louisville_dailyQcfs_1954_2018.asc`

to perform the following analyses:

- Plot the daily streamflow timeseries for the Missouri river at Omaha and for the Platte river at Louisville. Can you recognise changes in the flow regime? Regarding low flows, identify visually whether there are changes in time by plotting the timeseries of the log of the daily streamflows. Identify what part of the timeseries may be used as representative of the current flow regime and what part can be representative of (quasi) pristine conditions.
- Compare the mean annual discharge, the mean regime curve and the mean annual flow duration curves, in pristine and current conditions, of the two rivers. Comment on the potential causes of the differences in the flow regimes. Is the month of February critical in that the effects of the accident can have larger consequences than in other months? What month would be the most critical one?
- Select the long-term average flows in the month of February for both rivers (Q_{Mavg} for the Missouri river and Q_{Pavg} for the Platte river in m^3/s) using only the data representative of the current flow regime. Use these values for the dispersion part of the exercise.
- Select low-flows in the month of February corresponding to the return period of 100-yr (Q_{Mlow} for the Missouri river and Q_{Plow} for the Platte river in m^3/s). Use the following procedure:
    1. Consider the annual minimum daily flow in the month of February as variable for the analysis;
    2. Plot the time series in order to identify potential non-stationarities, the frequency hystogram and the empirical non-exceedence frequency function;

3. Use probability plots to compare the empirical data with the exponential, normal, log-normal and Gumbel distributions, assessing how well data aligns to the distributions, prior of parameter fitting;
4. Estimate the parameters for those distributions that successfully comply with the preliminary assessments. Estimate the parameters with the methods of moments and L-moments;
5. Run the Pearson test with a significance level of 10% on the distributions with estimated parameters;
6. On the distributions passing the Pearson test, run the Anderson-Darling test with a significance level of 10%;
7. Plot the distributions passing both statistical tests together with the data on low-flow frequency diagrams for the two rivers, with return periods on the x-axis (in log-scale) and discharge on the y-axis. Note that, for low-flows, the return period T is related to the non-exceedence probability P of annual values by $T = 1/P$;
8. Provide an estimate of the low-flows (Q_{Mlow} for the Missouri river and Q_{Plow} for the Platte river in m^3/s) corresponding to a return period of 100 years.

Use these values for the dispersion part of the exercise.