Spring 2015

Analysis of rainfall time-series

Stefano Galelli
Singapore University of Technology and Design, stefano_galelli@sutd.edu.sg

40.232 Water Resources Management
Term 7, 2015

Homework 1
Due date: February 20, 2015, at 11.55 pm

Part 1 – Analysis of rainfall time-series *[35 marks]*

Download the file *data_canning.txt*, which contains a complete record of daily precipitation (mm/day) for the period 1st January 1977 – 31st December 1987 for the Canning River catchment, a major tributary of the Swan River in South-Western Australia. The data columns are organized as follows: day, month, year and rainfall (mm/day).

(a) For each year, tabulate the maximum, minimum and average daily precipitation. (Notice that these three indicators are measured in mm/day.)

(b) Tabulate the total precipitation cumulated in each year (mm/year). What is the average annual total precipitation (mm/year)?

(c) Look up the Köppen climate classification and identify to which class the Canning River catchment belongs to. (Hint: you may consider using the temperature data available in the file *temperature_canning.txt*. The data columns are organized as follows: day, month, year and average daily temperature in degrees Celsius).

(d) Tabulate the average daily precipitation for each calendar month (mm/day) and illustrate the results with a bar chart.

(e) Which months have the highest and lowest average precipitation?

(f) Which probability distribution function would you recommend to fit the daily rainfall data (explain your reasoning)?

Part 2 – Indicators of rainfall events (dry and flood events) *[35 marks]*

We define a rainfall event as an event that produces at least 0.5 mm/day.

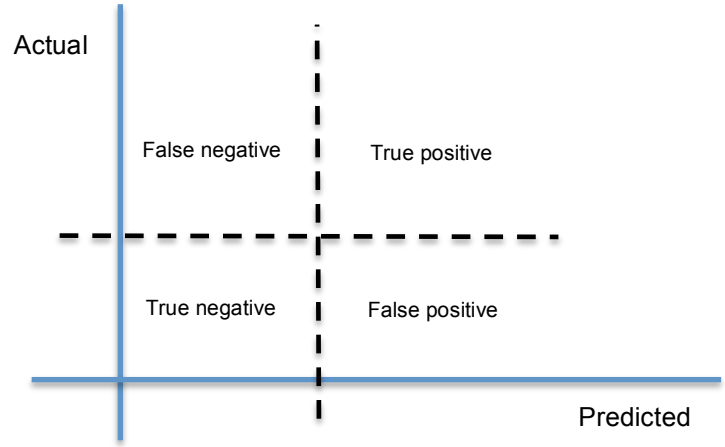
(a) For each year, tabulate the number of rainfall days.

(b) How long was the longest dry period during the entire historical record?

Suppose that the catchment authority employed a numerical weather prediction system to predict the precipitation with a 24-hour lead-time, and that you have a record of all the predictions that have been made during the period 1st January 1977 – 31st December 1987. The record is available in the file *data_canning_pred.txt*. The data columns are organized as follows: day, month, year and rainfall (mm/day).

(c) Produce a scatter plot of predicted (x-axis) vs. measured (y-axis) precipitation.

The plot can help show the uncertainty in the predictions and assist in some decision-making processes, e.g., flood warning. To analyze the quality of the predictions, we can add a horizontal line representing a boundary between the events requiring an action (which, assuming we are interested in flood events, are above the line) and the events requiring no actions (which are below the line). This line is referred to as *threshold criterion line*. We can then add a vertical line, called *decision cutoff line*. The quality of the predictions can then be assessed by counting the number of points in the scatter plot that lie in each quadrant defined by these cut-offs.



- True positive: appropriate action is taken. Prior warning of an extreme event is provided and the observed event occurs.
- False positive: inappropriate action is taken that leads to a false alarm. Prior warning provided with the actual extreme event not occurring.
- False negative: no prior warning was provided and action was not taken when it was actually needed.
- True negative: no priori warning or action was taken and there was no realization of a severe event.

Assume that the threshold value for the Canning catchment is equal to 25 mm/day.

(d) Calculate the number of true positive, false positive, false negative and true negative that occurred in the given period.

(e) Provide some basic statistics that could help the catchment authority understand the overall quality of the predictions.

Part 3 – Rainfall in Singapore *[30 marks]*

Download the zip file named *Singapore rainfall data.zip*, which contains the following:

- A record of monthly total rainfall (mm/month) from January 1984 through November 2014;

- A record of number of rainy days in each month from January 2009 through November 2014;
- A record of maximum rainfall recorded in a single day for each month (mm/day) from January 2009 through November 2014.

Use some or all of these data to analyze and describe the Singaporean precipitation regime. Provide graphs and discussion. You can consider seasonal distribution of rainfall, trends, simple statistics (such as those introduced in the previous questions) or any other metrics you deem appropriate.

Further climate data (e.g., temperature records) for Singapore are available at http://www.data.gov.sg/ should you wish to extend your analysis.