INVESTIGATION

How Would Flooding Affect This Place?

RIVERS PRESENT BENEFITS AND RISKS to people living along their banks. Meandering rivers provide floodplains with fertile soil and a relatively flat place to farm and perhaps build. Living on a floodplain is a hazardous proposition because it has flooded in the past, may be flooded in the near future, and owes its very existence to flooding. In this exercise, you will calculate the likelihood of flooding on two levels of the landscape and decide if potential economic and societal benefits are worth the risk of living there.

Goals of This Exercise:

- Observe and interpret features associated with a short stretch of a meandering river.
- Evaluate different locations for building a house and siting a farm, comparing and summarizing the advantages and disadvantages of each site.
- Calculate the risk of flooding for each location and discuss the risk versus the benefit.

Procedures

Use the available information to complete the following steps, entering your answers in appropriate places on the worksheet or answering questions online.

1. Observe the terrain below, in order to interpret the various parts of the landscape. Assign each landform feature or topographic level of the landscape its appropriate river term (for example, channel).
2. Apply your knowledge of the processes, features, and sediment associated with meandering rivers to predict what processes characterize each landform and how the landform might be affected by flow along the river.
3. Use relative elevations and other attributes to infer the order in which the features formed and the steps involved in the formation of each feature.
4. Determine which sites would be the best places to put croplands, considering all relevant factors, such as the flatness of the area, proximity to water, nature of the soil, what is growing there now, and possible added costs of growing crops in a specific site. You should also consider each site’s vulnerability to bank erosion.
5. Evaluate the benefits of building a new house at each of the different levels of the landscape and at various locations on each level, for both sides of the river. Identify five homesites that are favorable, considering each site’s proximity to croplands, to drinking water from the river, and any aesthetic considerations (e.g., just a nice place to live). Rank the five sites on the basis of your evaluation of their suitability.
6. Use the supplied elevation data on the profile on the next page and stream-flow data to calculate the river discharge required to flood two levels of the landscape.
7. Use the discharges you calculated and an exceedance probability plot for this river (provided) to estimate the probability of flooding for two levels of the landscape.
8. Evaluate the flood-risk probabilities against the other considerations (in steps 4 and 5), and describe how including the risk of flooding has changed or not changed your rankings.

Step 1: Consider the Following Observations About Different Levels Near the River

This highest flat area is a high terrace that locals call the upper bench. It is fairly dry and dusty, it does not contain many plants, and the soil is sandy.

The middle bench is a lower terrace. It has some plants and is below the dusty plain. It has a moderately good soil that could grow some crops if provided with water.

A green, plant-covered, lower flat area, called the bottomland, flanks the river channel. It has some soil composed of silt and decayed plants, but in many areas the soil is overlain by several layers of loose silt. Close to the channel, many bushes and trees on the bottomland lean over a little in a downstream direction but were not uprooted by whatever made them lean over.

The lowest part of the valley, called The Notch, contains the river, whose water flows toward you in this view. When exposed during the dry season, sediment on the river bottom within the notch is loose and displays no soil development.
Step 2: Calculate Discharge for a Profile Across the River

The diagram below on the left is a profile across the river, showing the widths of The Notch and the Bottomland. You will calculate discharges along this main profile, which crosses the river near the front of the model on the right. Your instructor may provide you with a second profile (farther back in the model), because the river has different dimensions at different places. This means that the same amount of discharge may reach different heights along different segments of the river. For your profile(s), complete the following steps:

1. To calculate the discharge needed to fill the notch, first calculate the cross-sectional area of the notch in the profile. In all these calculations, we are using averages for width, depth, and velocity.
   \[ \text{Cross-sectional Area} = \text{Width} \times \text{Depth} \]

2. Next, calculate how much discharge is needed to fill the notch and begin to spill water out onto the bottomland. To calculate discharge, multiply the cross-sectional area of the notch by the average velocity of the river, which is 0.7 m/s when the notch is filled:
   \[ \text{Discharge} = \text{Cross-sectional Area} \times \text{Stream Velocity} \]

3. Repeat the calculations, but this time determine the additional discharge needed to flood the bottomland to a height where floodwater would begin to spill onto the middle bench. The river flows faster when there is more water, so use an average water velocity of 2.0 m/s. Enter your calculated discharges in the table on the worksheet or on a sheet of paper. You should have two discharge calculations, one to fill and overtop the notch, and another that fills up the notch and bottomland and then begins to spill out onto the middle bench.

Step 3: Evaluate Flooding Risk Using Exceedance Probability

To determine the probability that each area will be flooded, compare both of your calculated discharges against the following plot, which is an exceedance probability plot. Follow the steps below and list in the worksheet or answer online the estimated probabilities for overfilling the notch and for overfilling the bottomland on the profile.

1. For each discharge calculation, find the position of that discharge value on the vertical axis of the plot.
2. Draw a horizontal line from that value to the right until you intersect the probability line (which slopes from lower left to upper right).
3. From the point of intersection, draw a vertical line down to the horizontal axis of the plot and read off the corresponding chance of exceedance (probability of flooding) on the horizontal axis. The probability of exceedance indicates the probability of the calculated amount of discharge being exceeded in any given year.
4. Repeat this procedure for both of your discharge calculations.
5. Consider the implications of each of these probabilities for your choice of site for cropland and a homesite. Use this information to choose final sites for cropland and a house. Explain your reasons on the worksheet or in the version online.