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| EENS 3050 | Natural Disasters |
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| Flooding Hazards, Prediction & Human Intervention | |

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Hazards Associated with Flooding

Hazards associated with flooding can be divided into primary hazards that occur due to contact with water, secondary effects that occur because of the flooding, such as disruption of services, health impacts such as famine and disease, and tertiary effects such as changes in the position of river channels. Throughout the last century flooding has been one of the most costly disasters in terms of both property damage and human casualties. Major floods in China, for example, killed about 2 million people in 1887, nearly 4 million in 1931, and about 1 million in 1938. The 1993 flood on the upper Mississippi River and Midwest killed only 47 people, but the U.S. Army Corps of Engineers estimates the total economic loss at between 15 and 20 billion dollars (Click [HERE](#) for U.S. Army Corps' web site).

Primary Effects

Again, the primary effects of floods are those due to direct contact with the flood waters. As seen in the video last lecture, water velocities tend to be high in floods. As discharge increases velocity increases.

- With higher velocities, streams are able to transport larger particles as suspended load. Such large particles include not only rocks and sediment, but, during a flood, could include such large objects as automobiles, houses and bridges.
- Massive amounts of erosion can be accomplished by flood waters. Such erosion can undermine bridge structures, levees, and buildings causing their collapse.
- Water entering human built structures cause water damage. Even with minor flooding of homes, furniture is ruined, floors and walls are damaged, and anything that comes in contact with the water is likely to be damaged or lost. Flooding of automobiles usually results in damage that cannot easily be repaired.
- The high velocity of flood waters allows the water to carry more sediment as suspended load. When the flood waters retreat, velocity is generally much lower and sediment is deposited. After retreat of the floodwaters everything is usually covered with a thick layer of stream deposited mud, including the interior of buildings.
- Flooding of farmland usually results in crop loss. Livestock, pets, and other animals are often carried away and drown.
- Humans that get caught in the high velocity flood waters are often drowned by the water.
- Floodwaters can concentrate garbage, debris, and toxic pollutants that can cause the secondary effects of health hazards.

Secondary and Tertiary Effects

Remember that secondary effects are those that occur because of the primary effects and tertiary effects are the long term changes that take place. Among the secondary effects of a flood are:

- Disruption of services -
 - Drinking water supplies may become polluted, especially if sewerage treatment plants are flooded. This may result in disease and other health effects, especially in under developed countries.
 - Gas and electrical service may be disrupted.
 - Transportation systems may be disrupted, resulting in shortages of food and clean-up supplies. In under developed countries food shortages often lead to starvation.
- Long - term effects (tertiary effects)-
 - Location of river channels may change as the result of flooding, new channels develop, leaving the old channels dry.
 - Sediment deposited by flooding may destroy farm land (although silt deposited by floodwaters could also help to increase agricultural productivity).
 - Jobs may be lost due to the disruption of services, destruction of business, etc. (although jobs may be gained in the construction industry to help rebuild or repair flood damage).
 - Insurance rates may increase.
 - Corruption may result from misuse of relief funds.
 - Destruction of wildlife habitat.

Predicting River Flooding

Floods can be such devastating disasters that anyone can be affected at almost anytime. As we have seen, when water falls on the surface of the Earth, it has to go somewhere. In order to reduce the risk due to floods, three main approaches are taken to flood prediction. Statistical studies can be undertaken to attempt to determine the probability and frequency of high discharges of streams that cause flooding. Floods can be modeled and maps can be made to determine the extent of possible flooding when it occurs in the future. And, since the main causes of flooding are abnormal amounts of rainfall and sudden thawing of snow or ice, storms and snow levels can be monitored to provide short-term flood prediction.

Frequency of Flooding

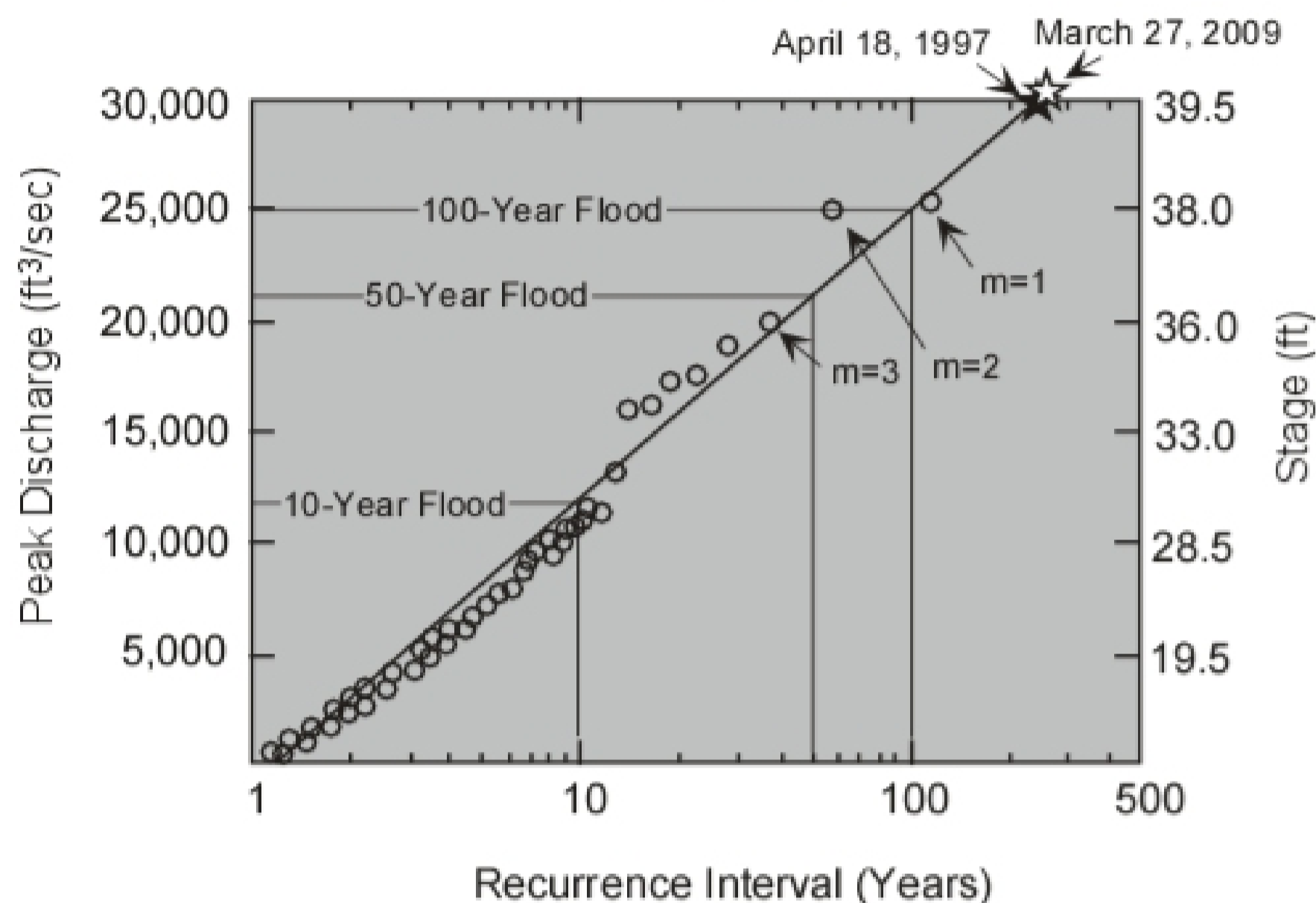
In your homework exercise you will see how flood frequencies can be determined for any given stream if data is available for discharge of the stream over an extended period of time. Such data allows statistical analysis to determine how often a given discharge or stage of a river is expected. From this analysis a recurrence interval can be determined and a probability calculated for the likelihood of a given discharge in the stream for any year. The data needed to perform this

analysis are the yearly maximum discharge of a stream from one gaging station over a long enough period of time.

- In order to determine the recurrence interval, the yearly discharge values are first ranked. Each discharge is associated with a rank, m , with $m = 1$ given to the maximum discharge over the years of record, $m = 2$ given to the second highest discharge, $m = 3$ given to the third highest discharge, etc.
- The smallest discharge will receive a rank equal to the number of years over which there is a record, n . Thus, the discharge with the smallest value will have $m = n$.
- The number of years of record, n , and the rank for each peak discharge are then used to calculate recurrence interval, R by the following equation, called the *Weibull equation*:

$$R = (n+1)/m$$

Red River of the North at Fargo, North Dakota
1882-1994



- A graph is then made plotting discharge for each year of the record versus recurrence interval. The graph usually plots recurrence interval on a logarithmic scale. An example of such a plot is shown here for the Red River of the North gaging station at Fargo, North Dakota.
- A best-fit line is then drawn through the data points. From the best-fit line, one can determine the discharge associated with a flood with a recurrence interval of say 10 years. This would be called the 10-year flood.

For the data on the Red River, above, the discharge associated with the 10-year flood is about 12,000 cubic feet per second. Similarly the discharge associated with a flood with a recurrence interval of 50 years (the 50-year flood) would have a discharge of about 21,000 cubic feet per second. The 100-year flood would have a discharge of about 25,000 cubic