United States
Department of
Agriculture

Soil
Conservation
Service

West National
Technical Center

Portland, Oregon

August, 1994

Technical Note

Procedures for Evaluating Flatland Flood Damages

Economics Series No. W13

WNTC - Quality technology for resource decisions

Procedures for Evaluating Flatland Flood Damages 1/

Introduction

Many watersheds with flat topography incur flood damages from floodwater lingering in low areas for an extended duration. The floodwater remains in these areas due to inadequate channel or outlet capacity, channel obstructions, or a combination of these preventing floodwater to recede in a timely manner. The focus of this technical note is the hydrologic and economic procedures used to evaluate the effects of flood control in flatland watersheds.

An evaluation team comprised of technical specialists, local sponsors and the local community should define and delineate the types and intensity of watershed problems. The problem area should be divided into evaluation reaches bases on similar flood plain characteristics such as land use, channel capacity, and problems.

Damages should be divided into two major types based on cause. The first type is damages that are being caused by depth of floodwater (situation 1). The second is based on floodwater that recedes over an extended duration (situation 2). The type of damage dictates the techniques used to formulate and evaluate alternatives. In those situations where both types of damage are evident, both of the procedures should also be applied.

The intensity of the study and survey information depends on the magnitude and complexity of the flooding problems and scope of the project alternative.

Situation 1 - Depth Damages
In this situation damages are caused by the inundation of floodwater to improvements and increase with the depth of floodwater, and peak discharges. An example is water entering a building through the low entry point, flood water depths over first floor elevations or water damage to fences or equipment.

The damages caused by flood depths (stage) can be evaluated using the standard hydrologic and economic procedures. Standard procedures include surveying cross sections and running WSP-2, TR-20, and ECON2 or URB1. Analysis can be based strictly on the depth of flooding (depth) or on the duration of flooding for various events.

To evaluate agricultural damages, use the ECON2 program with the depth or duration analyses. The ECON2 depth analysis program uses the evaluation of maximum peak discharge. The ECON2 duration analysis is frequently warranted because damages to crops and pastures increase rapidly as the duration of flooding increases.

A duration analysis will use the discharges and elevations for various lengths of time.

To evaluate urban damages, use the URB1 program. URB1 uses depth (stage) analysis because urban damages increase little with increased flooding duration. Most urban structural damages occur once sufficient depth inundates the improvement. In those rare instances where urban damages increase significantly because of duration of flood depths, the damages should be analyzed using the ECON2 duration option. Contact your NTC economist and hydrologist for assistance.

1/ This technical note was originally prepared by the South National Technical Center.

To run the ECON2 or URB1 depth analysis:

1. Survey valley cross sections.

2. Calculate water surface profiles using WSP-2.

3. Calculate flow frequencies using TR-20.

4. Calibrate models based on historical information.

5. Interview to determine stage damages by depths.

6. Calculate average annual stage damages by depths using URB-1 for urban flooding or ECON2 for agricultural flooding.

To run the ECON2 duration analysis, it is recommended to:

1. Survey valley cross sections.

2. Calculate water surface profiles using WSP-2.

3. Calculate flow frequencies by duration time using TR-20.

4. Calibrate models based on historical information.

5. Use interviews and topographic surveys to provide the areas affected and damage amounts for present condition duration flooding problems for each cross section area.

6. Evaluate damages for each cross section using the ECON2 duration option. Duration damage curves can be constructed. The curves should represent damages versus time. The length of time represented in the duration curves can range from hours to days. The duration of the flooding in the problem area will determine the length of time that needs to be used for the ECON2 duration damage factors. An example of a duration ECON2 run using hours is in the ECON2 manual. Urban or agricultural damages may be represented by the damage factors. To use ECON2 for urban duration analysis, the houses must be treated as a crop.

Situation 2 - Long duration floodwater damages

In this situation the team has identified that damage from floodwater is occurring; however, the stage damages from water inundating houses, bridges, roads, or crops and pastures are negligible. Instead, the damages are occurring as a result of frequent storms producing floodwaters that lingers in low areas for extended periods. The floodwater remains in the watershed because the channel capacity or the outlet capacity is inadequate, channel obstructions, or a combination of these, will not permit the floodwater to be removed in a timely manner. Examples of this type of damage are: 1) septic systems that will not function properly; 2) damage to house foundations; 3) damage to yard improvements caused by standing water; and, 4) drowning of crops. The water will eventually run off or dissipate; however, in many areas the water problems exist for several months during fall, winter, or spring of each year.

The intensity of the study and the amount of survey information needed are related to the magnitude and complexity of the duration flooding problem and scope of the project alternatives. Elevation surveys of channel, flood plain, roads, culverts, buildings, yards, low areas, and other features in the project area are needed.

Hydrology or long duration flooding

Compute the water surface profiles using WSP-2 and calculate the flow frequencies using TR-20. The purpose of running these programs is to provide the existing and future with project channel capacities and hydraulic guidelines. These will be needed to design laterals to provide relief from long duration floodwater damage. The hydrologist will determine the duration required to remove floodwater with and without project conditions. This will be done by calculating the amount of water standing in areas and the project actions necessary to remove the water in a certain time. When considering channel modifications, the size of channel improvements must be matched to the outlet capacity.

Economics for long duration flooding
Interviews and topographic surveys provide the areas affected and damage amounts for present condition duration flooding problems. Present condition damages should be based on interview information obtained from the project area. The interviewer should determine the increased frequency of foundation repairs, increased operation and maintenance costs for septic tanks, additional treatment costs for well water contamination, additional operation, maintenance, and replacement to mechanical equipment (autos, mowers, air conditioners, etc.), and any other damages. they should represent actual physical damages to the improvements as a result of the flooding problems. Damages should be expressed as average annual values. Damage information should be combined with duration information provided by the hydrologist to estimate damages over time of flooding. An effective method for displaying these damages would be to illustrate the damages versus the duration on a duration curve (see figure 1). Other damages to social or environmental concerns may be displayed in the same manner. Examples of social and environmental data might include the number of days that toilets will not flush, the increased sickness because of disease and stress, and the number of days that septic tanks are delivering bacteria to streams. The difference between the days water stands without and with project improvements provides a measure for the damage reduction benefits.

The damages and benefits identified in each evaluation reach from the various alternatives considered, allow the evaluation team to formulate the rationale for choosing the recommended plan. The rationale for the size and locations of improvements should be recorded and displayed in the plan.

The following example illustrates the techniques for long duration flooding.

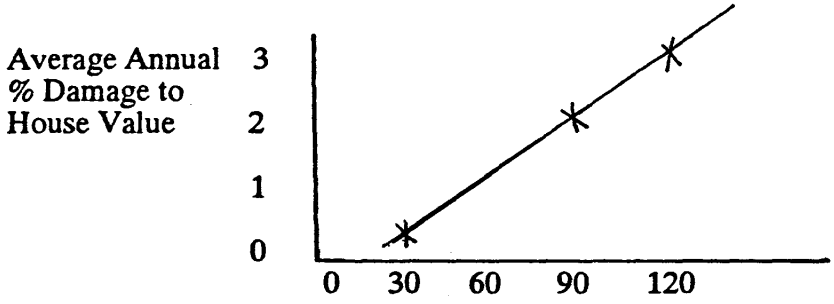
Long duration flooding in the Shawnee Watershed
Interviews with homeowners indicated that 75 houses in the watershed have between 2 and 12 inches of floodwater under and around them for periods ranging from 30 to 120 days every year. The hydrologist has provided information on the number of days that water stands around homes for different storm frequencies. This information indicates that on an average annual basis, 25 homes have water present for 105 days, 25 homes have water present for 90 days, and 20 homes have water present for 45 days. Damage information from interviews with homeowners indicate:

1. In homes where floodwater duration is 120 days per year, homeowners are required to replace a third of floor joists and floor plywood every 10 years. These flooring replacements costs are calculated to be 3 percent of the value of the home on an average annual basis. (A home valued at $20,000 would receive $600 damage on an average basis.)

2. In homes where floodwater duration is 90 days per year, the flooring costs are 2 percent of the value of the home on an average basis.

3. Homes that have 30 days or less of floodwater duration around them have no noticeable increase in operation and maintenance or replacement costs. The following graph illustrates the damage information.

Figure 1 - Floor Damages From Long Duration Damages - Shawnee Watershed



The recommended plan consists of a 1-year, 24-hour floodwater prevention channel. This channel will remove all water from an annual storm in 24 hours and all water from the entire flood plain for the 100-year storm in 10 days or less, so there are no remaining floor damages with project. Project benefits for a $20,000 home that has floodwater around and under it for 90 days every year is calculated as follows:

1. Present and future without project condition damages:
   $20,000 * .02 (damage factor) = 400 average annual damage.

2. Future with project damages = 0

3. Average annual benefit = $400 - $0 = $400

Damages and benefits for all homes and duration periods would follow the same computations and procedures. Damages for other improvements can be handled with similar procedures.