CHAPTER 7

DAMAGE-FREQUENCY RELATIONSHIPS

7-1. Introduction.

a. There are three methods that may be used to compute average annual damage and are herein termed the historic method, the simulation method and the frequency method. If 50 years of damage information were available for an area that has remained in essentially the same land use with a reasonably constant level of economic activity, historic damage could be scaled to the present to account for price differences (inflation) and the average simply computed. This approach is termed the historic method and is the most direct but is seldom used because sufficient data usually do not exist and the land use and economic activity of an area are usually changing.

b. A hydrologic simulation model could be developed, or the historic record used, along with damage functions to generate a time trace of simulated damage. The average of the time trace of damage would be the average annual damage. This would be termed the "simulation" method. The simulation method has the advantage of permitting the use of complex damage functions that can consider more than a single parameter and thus enable a more accurate computation of damage. The disadvantage of this method is that the future floods are assumed to exactly duplicate the historic floods and no consideration given to the possibility of larger floods.

c. The most widely used approach within the Corps of Engineers is the frequency technique. This technique is described in detail in Section 7-2. This technique addresses the disadvantages of the previous two methods, and yet is fairly easily applied. Experience in the development and application of damage functions is essential to computation of reasonable estimates. Care should be taken to assure the rating curve is not looped so that discharge is a unique function of stage. Otherwise more complex functions that correctly relate stage and discharge should be developed and applied. Damage functions in agricultural areas are often a function of the season and the duration of flooding. Sensitivity analysis may be useful in determining the reliability of the computed expected annual damage considering the uncertainties involved.

7-2. Computation of Expected Annual Damage.

a. Figure 7-1 shows a schematic of the application of the three basic damage evaluation functions used to compute the expected value of the annual damage. The term "expected" is used rather than "average" because a frequency curve is used to represent the distribution of future flood events and the expected value of damage is computed by the summation of probability weighted estimates of damage.

b. The steps involved in determining the reduction in annual damage due to project measures are:

(1) Develop the basic relationships (stage-damage, stage-discharge, and discharge-exceedance frequency functions) for each index location for existing conditions.

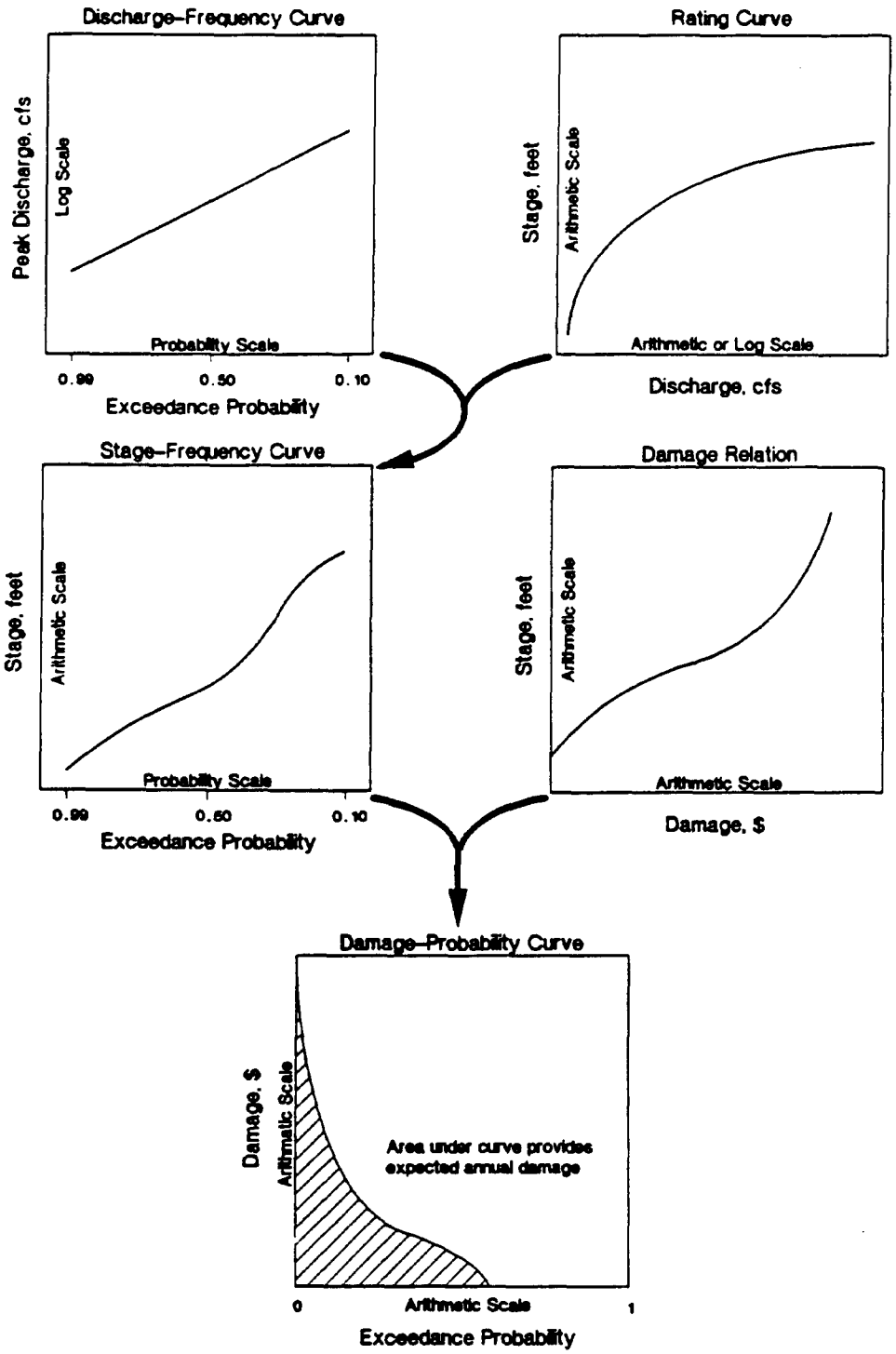

Figure 7-1. Schematic for Computation of Expected Annual Damage.

(2) Combine the stage-damage and the stage-discharge relations into an intermediate discharge-damage function. Make certain that the stage datum for the stage-damage and stage-discharge functions is consistent for the index location.

(3) Combine the discharge-exceedance frequency (in events per year) and discharge-damage function into a damage-exceedance frequency relationship.

(4) Compute the area beneath the damage-exceedance frequency relation (expected annual damage) for each index location and sum to obtain the total expected annual flood damage.

(5) Repeat step (1) for each alternative flood plain management plan under investigation, i.e., revise the three basic evaluation functions as necessary.

(6) Repeat steps (2)-(4).

(7) Subtract results of step (4) (with project) for each plan from results of step (4) for without-project measures. The differences will be expected annual damage reduction (raw damage reduction benefits) for each plan.

7-3. Equivalent Annual Damage.

a. To determine the expected annual benefit it is necessary to account for the changes in expected annual damage that might occur over the life of the project. This adjustment can be of substantial significance. Watershed runoff characteristics may be changing with time due to changes in land use, there may be long-term adjustments in alluvial channel flow regimes that would cause the rating curve to change with time, and the damage potential of structures and facilities will certainly change with time resulting in changed stage-damage functions.

b. To develop a single measure of the damage potential, the expected annual damage must be evaluated over time, at say 10 year intervals with revised evaluation functions at each interval. The revised expected annual damage is discounted to the base period and then the raw damage value is amortized over the life of the project to obtain equivalent annual damage. The computer program "Expected Annual Flood Damage Computation" (54) has the capability to make these computations, and describes in detail the basic concepts presented in this chapter.