Chapter 1
Introduction

1-1. Purpose of Document

a. Risk involves exposure to a chance of injury or loss. The fact that risk inherently involves chance leads directly to a need to describe and to deal with uncertainty. Corps policy has long been (1) to acknowledge risk and the uncertainty in predicting floods and flood impacts, and (2) to plan accordingly. Historically, that planning relied on analysis of the expected long-term performance of flood-damage-reduction measures, on application of safety factors and freeboard, on designing for worst-case scenarios, and on other indirect solutions to compensate for uncertainty. These indirect approaches were necessary because of the lack of technical knowledge of the complex interaction of uncertainties in predicting hydrologic, hydraulic, and economic functions and because of the complexities of the mathematics required to do otherwise.

b. With advances in statistical hydrology and the widespread availability of high-speed computerized analysis tools, it is possible now to describe the uncertainty in choice of the hyrologic, hydraulic, and economic functions, to describe the uncertainty in the parameters of the functions, and to describe explicitly the uncertainty in results when the functions are used. Through this risk and uncertainty analysis (also known as *uncertainty propagation*), and with careful communication of the results, the public can be informed better about what to expect from flood-damage-reduction projects and thus can make better-informed decisions.

c. This document describes and provides procedures for risk and uncertainty analysis for Corps flood-damage reduction studies. It presents templates for display of results. Finally, this document suggests how risk and uncertainty can be taken into account in plan selection.

1-2. Applicability

The guidance presented and procedures described in this manual apply to all Headquarters, U.S. Army Corps of Engineers (HQUSACE) elements, major subordinate commands, laboratories, and separate field operating activities having civil works responsibilities.

1-3. Summary of Procedures

a. The procedures described in this document lead to:

(1) Estimation of expected benefits and costs of proposed flood-damage-reduction plans.

(2) Description of the uncertainty in those estimates.

(3) Quantitative and qualitative representation of the likelihood and consequences of exceedance of the capacity of selected measures.

The procedures generally are an extension and expansion of the traditional plan formulation and evaluation procedures described in Engineer Regulations (ER) 1105-2-100 and ER 1105-2-101 and thus do not supersede guidance contained there.

b. The analyses proposed herein depend on:

(1) Quantitative description of errors or uncertainty in selecting the proper hydrologic, hydraulic, and economic functions to use when evaluating economic and engineering performance of flood-damage-reduction measures.

(2) Quantitative description of errors or uncertainty in selecting the parameters of those functions.

(3) Computational techniques that determine the combined impact on plan evaluation of errors in the functions and their parameters.

The results of plan evaluation following these guidelines are not the traditional statements of economic benefit and probability of exceedance of an alternative. Instead the results are descriptions of the likelihood that an alternative will deliver various magnitudes of economic benefit and the expected probability of exceedance, considering the uncertainty in all that goes into computation of that probability.

1-4. Definition of Terms

To describe effectively the concepts of flood risks and uncertainty, this document uses the terminology shown in Table 1-1.

Table 1-1
Terminology Used in this Manual

Term	Definition
Function uncertainty (also referred to as distribution uncertainty and model uncertainty)	Lack of complete knowledge regarding the form of a hydrologic, hydraulic, or economic function to use in a particular application. This uncertainty arises from incomplete scientific or technical understanding of the hydrologic, hydraulic, or economic process.
Parameter	A quantity in a function that determines the specific form of the relationship of known input and unknown output. An example is Manning's roughness coefficient in energy loss calculations. The value of this parameter determines the relationship between a specified discharge rate and the unknown energy loss in a specific channel reach.
Parameter uncertainty	Uncertainty in a parameter due to limited understanding of the relationship or due to lack of accuracy with which parameters can be estimated for a selected hydrologic, hydraulic, or economic function.
Sensitivity analysis	Computation of the effect on the output of changes in input values or assumption.
Exceedance probability	The probability that a specified magnitude will be exceeded. Unless otherwise noted, this term is used herein to denote annual exceedance probability: the likelihood of exceedance in any year.
Median exceedance probability	In a sample of estimates of exceedance probability of a specified magnitude, this is the value that is exceeded by 50 percent of the estimates.
Capacity exceedance	Capacity exceedance implies exceedance of the capacity of a water conveyance, storage facility, or damage-reduction measure. This includes levee or reservoir capacity exceeded before overtopping, channel capacity exceedance, or rise of water above the level of raised structures.
Conditional probability	The probability of capacity exceedance, given the occurrence of a specified event.
Long-term risk	The probability of capacity exceedance during a specified period. For example, 30-year risk refers to the probability of one or more exceedances of the capacity of a measure during a 30-year period.

1-5. Organization of Document

This document includes the following topics:

For	See
A summary of procedures presented in this document	Chapter 1
Brief definition of terms used	Chapter 1
An overview of Corps' plan formulation and economic evaluation procedures	Chapter 2
An overview of procedures for uncertainty analysis	Chapter 2
Procedures for evaluating engineering performance of damage-reduction measures	Chapter 3
Guidance on describing uncertainty of discharge and stage frequency functions	Chapter 4
Guidance on describing uncertainty of stage-discharge functions	Chapter 5
Guidance on describing uncertainty of stage-damage functions	Chapter 6
Templates for displaying uncertainty analysis results	Chapter 7
References, including Corps publications that are pertinent to uncertainty analysis and other references that may be useful	Chapter 8
An example of plan formulation and evaluation in which uncertainty is considered	Chapter 9