FLOOD INSURANCE STUDIES

by

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The National Flood Insurance Act of 1968 authorized a flood insurance program by means of which flood insurance, over a period of years, can be made available on a nationwide basis through the cooperative efforts of the Federal Government and the private insurance industry. The Secretary of Housing and Urban Development administers the flood insurance program through the newly established Federal Insurance Administration. The act requires that States and local governments also contribute by adopting and enforcing land use provisions so as to restrict future development of lands in flood-prone areas.

Why is the Government involved in the flood insurance program? Congress found that (1) many factors have made it uneconomic for the private insurance industry alone to make flood insurance available to those in need of such protection on reasonable terms and conditions; but (2) a program of flood insurance with large scale participation of the Federal Government and carried out to the maximum extent practicable by the private insurance industry is feasible and can be initiated.

Insurance coverage under the program is currently available only for residential properties designed for the occupancy of from one to four families.

General definitions of a few important words and terms as used by the Federal Insurance Administration are:

a. "Actuarial rates" means the risk premium rates, estimated by the Administrator pursuant to studies and investigations necessary to provide flood insurance in accordance with accepted actuarial principles. Actuarial rates include flood damages and applicable operating costs and allowances.

b. "Chargeable rates" means the reasonable premium rates, estimated by the Administrator which are charges to prospective insureds in order to encourage them to purchase the flood insurance made available under the program. Generally, for areas having special flood hazards, chargeable rates are considerable lower than actuarial rates.

c. "Flood" or "flooding" means the general and temporary condition of partial or complete inundation of normally dry land areas (a) from the overflow of streams, rivers, or other inland waters or (b) from tidal surges, abnormally high tidal water, tidal waves, or rising coastal waters resulting from hurricanes, tsunamis, or other severe storms.

The Corps of Engineers, upon request of the Federal Insurance Administration determines risk premium or actuarial rates for various

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types of structures and contents in specific areas. These rates are based on average annual flood damages computed by the Corps and on factors furnished by the Federal Insurance Administration to make adjustments for deductibles, expense load, and a reasonable profit.

Two sets of data are needed to compute flood damages; (a) flood elevation-frequency and (b) flood depth-damage. An example of basic data needed to compute average annual flood damage for a structure is given in Table 1. The frequency data is for a specific location and the depth-damage data is for a one-story residence having a structure value of $10,000.

Table 1
Elevation-Frequency-Damage Data

Elev.	Flood Frequency Years	Damage to $10,000 Structure	Elev.	Flood Frequency Years	Damage to $10,000 Structure
(1)	(2)	(3)	(1)	(2)	(3)
193.5	6.1	$500	199.5	100	$3,200
194.5	9.0	1,300	200.5	180	3,400
195.5	13.8	1,800	201.5	330	3,800
196.5	21.8	2,200	202.5	600	4,200
197.5	34.5	2,600	203.5	Inf.	4,500
198.5	58.0	2,800	204.5		4,900

Average annual flood damages are estimated by the "frequency" procedure by the intergration process based on these two sets of data. The example in Table 2 shows the computations required to compute the average annual flood damage for the structure with the floor at elevation 193.5. The damage ($291.01) is the summation of the product of value in Column 4 and 6.

Table 2
Determination of Average Annual Flood Damages
1-Story Residence, Structure Value $10,000
Floor Elevation 193.5

Elev.	Flood Freq. Yrs.	1/Yrs.	Freq. Interval	Damage to $10,000 Structure	Average Damage in $	Product (4) x (6)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
193.5	6.1	.1639	.0528	$500	$900	$47.52
194.5	9.0	.1111	.0386	1,300	1,550	59.83
195.5	13.8	.0725	.0266	1,800	2,000	53.20
196.5	21.8	.0459	.0170	2,200	2,400	40.80
197.5	34.5	.0289	.0117	2,600	2,700	31.59
198.5	58	.0172	.0072	2,800	3,000	21.60
199.5	100	.0100	.0044	3,200	3,300	14.52
200.5	180	.0056	.0026	3,400	3,600	9.36
201.5	330	.0030	.0013	3,800	4,000	5.20
202.5	600	.0017	.0017	4,200	4,350	7.39
203.5	Inf.	.0000	.0000	4,500	4,700	0.00
204.5				4,900		

Average annual flood damage to structure with floor at El. 193.5 ---------- $291.01

The same procedure is used for this structure in which it is assumed the floor is at different elevations. The damages portion (Col. 6 of Table 2) is first lowered to a point where the first value ($900) is opposite the desired elevation. Examples are shown in Table 3.

Table 3
Determination of Average Annual Flood Damages
For Various Floor Elevations
1-Story Residence - Structure Value $10,000

Elev.	Freq. Interval	Average Damage in Dollars							
(1)	(2)	(3a)	(3b)	(3c)	(3d)	(3e)	(3f)	(3g)	(3h)
193.5	.0528	$900							
194.5	.0386	1,550	$900						
195.5	.0266	2,000	1,550	$900					
196.5	.0170	2,400	2,000	1,550	$900				
197.5	.0117	2,700	2,400	2,000	1,550	$900			
198.5	.0072	3,000	2,700	2,400	2,000	1,550	$900		
199.5	.0044	3,300	3,000	2,700	2,400	2,000	1,550	$900	
200.5	.0026	3,600	3,300	3,000	2,700	2,400	2,000	1,550	$900
201.5	.0013	4,000	3,600	3,300	3,000	2,700	2,400	2,000	1,550
202.5	.0017	4,350	4,000	3,600	3,300	3,000	2,700	2,400	2,000
Average Annual Flood Damage*---		$291	$191	$121	$75	$45	$26	$15	$8
Floor Elevation-		193.5	194.5	195.5	196.5	197.5	198.5	199.5	200.5
Damage Per $100 of Value		$2.91	$1.91	$1.21	$0.75	$0.45	$0.26	$0.15	$0.08

*Summation of products of Col (2) x Col. (3_).

About 130 separate computations are required to determine the annual damage shown in Table 3. An additional 30 computations would be required to complete the table to give damages for structures with floor elevations up to 202.5. This results in 160 computations for a one-story residence having a structure value of $10,000. For structure values of $2,000 to $60,000, by $1,000 increments, over 9,000 computations would be required to estimate average annual damages for 59 different values of one kind of structures located at 11 different elevations.

During 1968, depth vs dollar damage data were estimated for four different structure values for a one-story residence. The values derived for each one-foot of flooding above the floor, are shown in Table 4.

Table 4
Structure Damage in Dollars
1-Story Residence

Depth of Flood Above Floor in Feet	Damage in Dollars For Total Structure Value of			
	$5,000	$10,000	$20,000	$30,000
(1)	(2)	(3)	(4)	(5)
0	$300	$500	$1,000	$1,500
1	700	1,300	2,400	3,600
2	950	1,800	3,400	4,800
3	1,150	2,200	4,200	6,000
4	1,350	2,600	5,000	7,200
5	1,450	2,800	5,400	7,800
6	1,650	3,200	6,000	8,700
7	1,750	3,400	6,600	9,300
8	2,000	3,800	7,200	10,200
9	2,200	4,200	8,000	11,400
10	2,400	4,500	8,600	12,300
11	2,600	4,900	9,400	13,200

In an effort to generalize depth-damage data, and reduce the number of computations for estimating damages for various values of structure, the depth vs damage in dollars data were converted to show depth vs damages in percent of total value. These values are shown in Table 5.

Table 5
Structure Damages in % of Total Structure Values
1-Story Residence

Depth of Flood Above Floor in Feet	Damage in % of Structure Value For Total Structure Value of				
	$5,000	$10,000	$20,000	$30,000	Average
(1)	(2)	(3)	(4)	(5)	(6)
0	6	5	5	5	5
1	14	13	12	12	13
2	19	18	17	16	18
3	23	22	21	20	22
4	27	26	25	24	25
5	29	28	27	26	28
6	33	32	30	29	31
7	35	34	33	31	34
8	40	38	36	34	37
9	44	42	40	38	41
10	48	45	43	41	45
11	52	49	47	44	48

The average depth-percent values given Column (6) are considered reasonable representations of the percent damages in Columns 2, 3, 4, and 5. Therefore it was decided to use one depth vs percent damage curve for various structure values for one type of residence.

Since insurance rates are quoted as rates per $100 value all damage computations are based on a total value of $100, and the resulting computed damages are known as rates of average annual damages per $100 value.

An example for computing the rates by use of depth-percent damage is given in Table 6.

Table 6
Determination of Rates of Average Annual Flood Damages Per $100 Value
For Various Floor Elevations
1-Story Residence

Elev.	Freq. Interval	Damage in %	Avg. Damage in %	Damage in $ Per $100 Value of Structure						
(1)	(2)	(3)	(4)	(5a)	(5b)	(5c)	(5d)	(5e)	(5f)	(5g)
193.5	.0528	5	9.0	9.0						
194.5	.0386	13	15.5	15.5	9.0					
195.5	.0266	18	20.0	20.0	15.5	9.0				
196.5	.0170	22	23.5	23.5	20.0	15.5	9.0			
197.5	.0117	25	26.5	26.5	23.5	20.0	15.5	9.0		
198.5	.0072	28	29.5	29.5	26.5	23.5	20.0	15.5	9.0	
199.5	.0044	31	32.5	32.5	29.5	26.5	23.5	20.0	15.5	9.0
200.5	.0026	34	35.5	35.5	32.5	29.5	26.5	23.5	20.0	15.5
201.5	.0013	37	39.0	39.0	35.5	32.5	29.5	26.5	23.5	20.0
202.5	.0017	41	43.0	43.0	39.0	35.0	32.5	29.5	26.5	23.5
203.5	.0000	45	46.5	46.5	43.0	39.0	35.0	32.5	29.5	26.5
Rates of Avg. Annual Flood Damages in $ Per $100 Value-*------				$2.89	$1.89	$1.20	$0.74	$0.45	$0.26	$0.15
Floor Elevation				193.5	194.5	195.5	196.5	197.5	198.5	199.5

*Summation of products of Col. (2) x Col. (5_)

The average annual flood damage for the structure of a 1-story residence with the floor at elevation 193.5 is $2.89 x ($10,000/$100) or $289. Using the depth-percent damage procedure reduces the number of computations from over 9,000 to less than 200.

All the above examples are for a frequency curve at a given point on a stream where damage begins at elevation 193.5. If the stream water-surface profile has a 5-foot slope within the study area, five different sets of computations would have to be made. However, by relating the frequency data to the height below or above a given flood profile, such as the 100-year flood, only one set of computations are required. For example: In Columns 1 and 2 of Table 2, elevation 193.5 is 6 feet below the elevation of the 100-year flood.

Table 6 gives a rate of $2.89 per $100 value for a structure with floor at elevation 193.5 (or 6 feet below the 100-year flood profile). The resulting rate table for various floor elevations would be as shown in Table 7.

Table 7
Rates of Average Annual Flood Damages
In $ Per $100 Value
For Structure (1-Family Residence)

Floor Height in Feet Below or Above 100-Yr Flood	Damages In $ Per $100 Value	Floor Height in Feet Below or Above 100-Yr Flood	Damages In $ Per $100 Value
(1)	(2)	(1)	(2)
-6	$2.89	-1	$0.26
-5	1.89	0	0.15
-4	1.20	+1	0.08
-3	0.74	+2	0.04
-2	0.45	+3	0.01

Flood insurance is available for 1-4 family residences and their contents. So far, I have been discussing only one kind of structure - a one-story, no basement residence. If you let your imagination go, I would be afraid to guess how many different classes of contents and structures that could be listed. One office used 210 different classes in making a flood damage study of an area. Here again we need to generalize in establishing different classes of contents and structures. I like the word used by ALCO Aluminum "Imagineering" - Let your imagination soar and then engineer it down to something useful. Flood insurance studies at present are based on a maximum 9 classes of structures and 9 classes of content. These are listed in Table 8.

Table 8
Classes of Structures and Contents

Kind or Type of Structure 1-4 Family	Class Designation of Structure	
	No Basement	With Basement
One Story	1N	1B
Two Story	2N	2B
Split Level	3N	3B
Mobile Home on foundation	4	-
Other	5N	5B

Location of Contents	Class Designation of Contents
All on first floor	F
All on second floor	S
On first and second floor	FS
All in basement	B
Basement and first floor	BF
Basement, first, and second floor	BFS
In split level residence	T
Mobile home on foundation	M
Other	O

The computations for determining rates for flood damage less deductible are made by the same procedure used in Table 6. The only difference in the values is in Columns 4 and 5a through 5g. These values are reduced by 2.0 to allow for the 2 percent deductible. A comparison of flood damage rates and flood damage less deductible rates is shown in Table 9.

Table 9
Rates of Average Flood Damages and
Rates of Average Annual Flood Damages Less Deductible
in $ Per $100 Value
For Structure (1 Family Residence)

	First Flood Height in Feet Above or Below 100-Yr Flood									
	Above				Below					
	3	2	1	0	1	2	3	4	5	6
Flood Damage	0.01	0.04	0.08	0.15	0.26	0.45	0.74	1.20	1.89	2.89
Flood Damage Less Deductible	0.01	0.03	0.07	0.13	0.23	0.39	0.65	1.06	1.67	2.56

Actuarial rates are determined by multiplying flood damage less deductible rates by an appropriate adjustment factor. Factors furnished by the Federal Insurance Administration include applicable operating cost and allowances, in which the factors vary according to the amount of flood damage less deductible rates. The following minimum actuarial rates are used in all flood insurance studies:

Types of Residences	Structure	Contents
Residence without basement	$0.05	$0.10
Residence with basement	0.10	0.20

Table 10 is an example of an actuarial rate table that was included in the report FLOOD INSURANCE STUDY, AREA NO. 1, ST. BERNARD PARISH, LOUISIANA.

Table 10
ACTUARIAL RATE TABLES
(RATES FOR $ PER $100 VALUE)

	STRUCTURE									
	First Floor Level, Feet Above or Below Base Flood [100-Yr. Flood]									
	ABOVE			BELOW						
	2.0	1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Class*										
1N	0.05	0.16	0.49	1.15	2.26	3.86	5.75	7.68	9.18	10.46
2N	0.05	0.08	0.26	0.61	1.23	2.14	3.24	4.49	5.73	7.01
4	0.05	0.36	1.08	2.47	4.47	7.94	10.84	13.59	15.40	16.84

	CONTENTS									
	First Floor Level, feet Above or Below Base Flood									
	ABOVE			BELOW						
	2.0	1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Class*										
F	0.10	0.16	0.60	1.50	3.09	5.50	8.21	10.94	13.30	14.97
FS	0.10	0.10	0.26	0.63	1.29	2.26	3.47	4.84	6.22	7.68
M	0.10	0.35	1.06	2.43	4.72	7.90	10.82	13.60	15.44	16.88

*Class

Designation	Description
1N	Structure - 1 story, no basement, on slab
2N	Structure - 2 stories, no basement, on slab
4	Structure - Mobile home on foundation
F	Contents - All on first floor, on slab
FS	Contents - On first and second floor, on slab
M	Contents - Mobile home on foundation

After a flood insurance study is transmitted to the Federal Insurance Administration, insurance tables are prepared and furnished to the National Flood Insurers Association (consisting of private companies). Flood insurance in the study area can then be purchased from a local insurance agent.

Rates, that could reasonably be charged to prospective insureds in order to encourage them to purchase flood insurance, are estimated by the Federal Insurance Administration. These rates are referred to as "chargeable rates."

Table 11 lists applicable flood insurance rates and limitations of policy amounts.

TABLE 11
FEDERAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATES IN $ PER $100 VALUE

	Contents	1 Family Structure	2-4 Family Structure
Existing residences			
Chargeable rates for policies up to:			
$5,000	$0.50 *		
$17,500		$0.40	
$30,000			$0.40
Actuarial rates for policy values:			
$5,001 to $10,000	A		
$17,501 to $35,000		A	
$30,001 to $60,000			A
Future residences			
Actuarial rates for policies up to:			
$10,000	A		
$35,000		A	
$60,000			A

* Actuarial rates will be used when less than chargeable rates.
A-Actuarial rates will be determined during flood insurance study for each individual study area.

All computations for flood insurance studies are made by an electronic computer. The input data consist of name of project, elevation-frequency data, and depth-percent damage data for each class of structure and contents. The computer output is satisfactory for use in the final report without any modification of the format or any retyping.

To date the Corps of Engineers has completed studies for 15 different areas from Alaska to Florida and from Washington State to South Carolina. In addition to the actuarial rate tables, each report contains maps showing limits of flooding of a 100-year flood and limits of a larger flood generally 1 to 3 feet higher. These maps are useful in developing prudent uses of flood plains and in establishing flood plain regulations that are a prerequisite for flood insurance.