ABSTRACT

REGIONAL REDUCTIONS IN VALUE ADDED DUE TO FLOODING IN THE PORTLAND REACH OF THE WILLAMETTE RIVER IN OREGON

Projected economic losses resulting from unemployment of regional resources due to flooding in the Portland, Oregon, reach of the Willamette River were obtained by estimating reductions in value added by industry. Estimates were derived from secondary data such as I/O tables, employment statistics, hydrologic maps, location directories, and price indices.

Key words: Regional Economic Losses, Standard Industrial Classification Groups, Value Added Reductions, Flood Damages, Willamette River Basin.

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INTRODUCTION

In addition to physical damages, severe floods often are the cause of unemployment or underemployment of resources that otherwise would have been employed by various sectors of a regional economy. The lost contributions of these resources to the regional economic product may be approximated by a reduction in the aggregate value added[1/] by the goods and services produced with these resources. Consequently, if fewer or no goods and services are produced due to flood impacts, the aggregate regional value added will be reduced. Estimates of such reductions are useful for both de facto investigations (for a variety of public policy programs and statistical purposes) and a priori evaluations of potential damages (e.g., to evaluate the feasibility of flood prevention projects).

METHODS USED IN THE PAST TO ESTIMATE FLOOD DAMAGES

The general type of flood damages described above have been investigated by a number of researchers who labeled these damages "business losses,"

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1/ Commonly defined as the income earned from economic activities. A more precise definition of value added may be found on page 4.

"economic losses," "value added by manufacturing," "normal" profits reductions, and a "ratio method." For the latter method, all "indirect" damages, including "business" losses, are evaluated as a simple ratio of the "direct" or physical damages.[2/] These methods have serious conceptual limitations and empirical data collection problems which have impeded the development of generally accepted damage criterias such as:

Before and After Analysis

In order to estimate nonphysical flood damage losses, comparisons have to be made of the net profits that might have occurred without the flood and the net profits (or losses) observed after the flood. Problems with this approach are the determination of the proper accounting period, the projections of "normal" profits, and the sheer magnitude of the empirical work required when the affected area contains a broadly based economy.

Regional Versus National Losses

Regional economic production losses may be offset by increases in production elsewhere in the economy. Complex conceptual problems exist in the analysis of interregional economies. This applies specifically to the less-than-full capacity assumption under which no national losses are accounted if the national market can produce the lost regional production at no increase in average production costs.

2/ The following references are recommended for review of the concepts and methods listed above: O. Ecstein, Water Resource Development, Harvard University Press, Chapter 5, 1971; Robert W. Kates, "Industrial Flood Losses: Damage Estimation in the Lehigh Valley," Chicago, The University of Chicago Press, Department of Geography Res. Paper 98, 1965; The American Insurance Association, Studies of Flood and Flood Damage, 1952-1955, New York, 1965; U.S. Army Corps of Engineers, Engineering Manual, Civil Works Construction, EM 1120-2-101, Part CI, Chapter I, p. 50a; U.S. Army Corps of Engineers, "Report on Floods of December 1964 in Northern California Coastal Streams," U.S. Army Engineer District, San Francisco, California, Dec. 1965; and G. F. White et al, "Papers on Flood Problems," University of Chicago Press, Chicago 1961.

Direct Versus Indirect Effects

While direct physical damages, losses of goods and services in the flood zone area because of cessation of production, and losses of wages and incomes do not present problems with regard to their inclusion in the regional loss, one of the principal difficulties in measuring indirect damages is that of determining at which stage in the accounting of economic losses the successive effects of a specific item of flood damage will cease to be accounted.

Other Problems such as Full Employment Conditions, Mobility of Resources, and the Application of the "Proper" Discount Rate to Compare the Occurrence of Flood Damages Over Time

These miscellaneous difficulties may occur interdependent with or independent of the aforementioned problems.

The method described in this study does not purport to solve the problems outlined above. It rather suggests that certain flood damages can be estimated using a relatively objective, inexpensive method which can be duplicated in many instances without intensive costly research procedures. The method is based on the application of secondary data such as regional or local input-output studies, business directories, and employment information.

VALUE-ADDED REDUCTIONS

The Bureau of Economic Analysis of the U.S. Department of Commerce employs the concept of value added as a measure of contributions made to GNP by a particular industry or economic sector. In other words, industrial value added measures the output of goods and services produced by an industry for a given period. Quantitatively, value added may be measured using either of the two following methods: (1) V.A. equals the difference between the value of the industry's total output and the

cost of the goods and services it purchases from other industries or (2) V.A. can be calculated by summing the industry's payments to the factors of production (wages, profits, etc.) and its nonfactor costs (depreciation, property taxes, sales taxes, inventory adjustments, etc.)[3/] Estimates of value added by industry are available for many regions, states, and areas. They are an integral part in input-output (I/O) studies where they are typically listed for each industrial sector incorporated in the analysis. Industrial sectors are usually classified by Standard Industrial Classification (SIC) procedures.

Empirical value-added data presented in this paper for the Portland, Oregon, reach of the Willamette River by groups of SIC industries are based on a 1969 publication by the Oregon State Bureau of Business and Economic Research.[4/] This I/O study contained a 68-sector model of the interindustrial relationships found in the Oregon State economy. The model was determined to be representative for the study area. Industrial value-added figures obtained from the Oregon I/O study were calculated on a per-employee basis by dividing the state value-added number for a particular industry by the total number of employees reported by the state for this industry in the same period. Since disclosure rules made it impossible to report employment data for several small industries, it was necessary to aggregate various industrial groups in order to obtain employment information (see the section Number of Employees by SIC for details on the sources of employment information). Industrial classification is otherwise based on the SIC groups used in the I/O model. A total of 54 groups of SIC classes

3/ For further discussion of Value Added see A. J. Walderhaug, "The Composition of Value Added in the 1963 Input-Output Study," Survey of Current Business, U.S. Department of Commerce, BEA, April 1974.

4/ Watson, D. A. and R. L. Allen, 1969 Oregon Economic and Trade Structure, Bureau of Business and Economic Research, University of Oregon, Eugene, Oregon.

was analyzed for this study. Value-added estimates were adjusted for price changes to obtain corresponding 1972 values.[5/]

These value-added estimates do not always present an accurate picture of the total value added generated within a certain industry. This may have been caused not only by deficiencies in the data sources (especially the reported labor statistics) but also by statistical shortcomings (the basic statewide industrial value-added figures could not be calculated as moving averages but as unadjusted annual statistics). To alleviate some of the obvious employment data shortcomings, average statewide value-added figures per employee were used for several industries where employment data omissions resulted in dubious figures.

Major data problems were encountered in SIC groups 1 and 54 which represent primary agriculture and miscellaneous activities, respectively. It was decided to exclude group 1, agricultural damages, since these were not considered significant for the Portland Reach. Total value added listed for group 54 represented a very high value in the study area during early runs of the computer model. This was caused by the large number of employees that were classified in this category. Further investigation revealed most of these employees could be reclassified in other SIC groups for more accurate accounting of industrial value-added figures.

5/ Adjustments were made using price indices published in the November 1973, Volume 53, No. 11, issue of Survey of Current Business, U.S. Department of Commerce, Bureau of Economic Analysis. Twenty industrial wholesale price indices obtained from this publication were matched with the 54 SIC groups reported in this paper. Reductions in value added by SIC industry are obtained by multiplying adjusted value-added figures with the number of employees classified by SIC code in a given flood zone for a given time period. See the section Application.

TIME FACTOR PERIOD

Reductions in value added occur during three distinct time periods used in flood loss analyses: warning period, duration period, and after-flood period. The warning time period in the study area varies from several hours to about 1 week.[6/] This period was included in the timespan during which businesses will sustain reductions in value added, since most employees will use this time to either floodproof their property or otherwise prepare themselves or the premises where they work. The flood duration time is also treated as a period during which business losses are incurred. It includes the total time it takes the flood to rise to its maximum height and then recede to an elevation of 5 feet below the property elevation. After-flood time, however, is too variable to estimate. This time period may vary from hours to years for different firms within the same area. For this reason, after-flood period damage estimates were not included in the calculations of value added reductions.

NUMBER OF EMPLOYEES BY SIC

For each employing unit in the study area, a code number was assigned describing the type of business and the number of people employed at a particular location. Information on employees was obtained from the Oregon State Division of Employment in a printout containing a county-by-county listing of all firms required to file income and employment data with this state agency. This alphabetically arranged data source included firm names, county code numbers indicating location, individual filing numbers assigned by the Division of Employment, a three- or four-digit SIC code, and the number of people employed by these firms during the first quarter of 1973.[7/] All this information was stored in a

6/ These flood warning times refer to flood stages with frequencies ranging between 40 years to Maximum Possible Flood. Warning times were obtained from hydrologic stage frequency curves.

7/ Flooding was assumed to occur within the period of November through April. Employment data for the first quarter of 1973 were used to reflect employment conditions during the flooding period.

computer memory system and cross-indexed with similar information obtained from other sources (for example, employment information for government agencies and services). Information on the location of employing units was stored by code for each of eight different flood zones analyzed in this study. When SIC codes were not available from these sources, code numbers were assigned based on the firm's name or description of their services. If no specific code could be determined, the firm was assigned to the category not elsewhere classified.

APPLICATION

The following formula was used to obtain the value-added reductions:

$$\text{Reduction in value added} = N_{ij} \times V_j \times \frac{W_{iz} + D_{iz}}{8{,}760}$$

N = number of employees in SIC code j located in zone i.
V = annual value added per employee in SIC code j
W = warning time in hours for zone i for flood z
D = duration time in hours for zone i for flood z
8,760 = number of hours in one calendar year

The above formula was adapted to the employment and wage data stored in a computer memory system by developing a program that applied the basic formula to each business location and accumulated these data for each SIC group and flood zone.

RESULTS FOR THE STUDY AREA

Table 1 lists the 54 industrial groups studied in the study area by group number, SIC code, and annual value added per employee.

STANDARD INDUSTRIAL CLASSIFICATION CODES FOR GROUPS OF INDUSTRIES AND ANNUAL VALUE ADDED PER EMPLOYEE IN 1972

GROUP NUMBER	SIC CODES INCLUDED 1/	ANNUAL V/A PER EMPLOYEE ($)	GROUP NUMBER	SIC CODES INCLUDED	ANNUAL V/A PER EMPLOYEE ($)
1	011-014, 019, 02	10,779	28	341, 342, 345-349	13,500
2	074, 081, 082, 084, 086, 091	10,779	29	343,344	13,800
3	071, 072, 085, 098	10,779	30	352	17,200
4	10-14	40,400	31	353	12,100
5	15-17	10,779	32	355,357	24,100
6	20, 21	10,400	33	356	20,900
7	22	10,779	34	359	10,779
8	23	10,779	35	358	34,400
9	241	17,800	36	36	9,900
10	242, 243	14,800	37	371	12,300
11	244	19,200	38	372-375, 379	10,100
12	249	10,779	39	38	9,100
13	251	7,000	40	351, 354, 39	6,700
14	252-254, 259	16,000	41	40-42, 44-47	23,400
15	261, 262	13,800	42	431, 482, 489	23,700
16	265	19,800	43	483	17,900
17	263, 264, 266	13,800	44	49	30,200
18	27	8,000	45	50, 52-59	10,200
19	281, 286, 287, 289, 33	14,700	46	60-64, 66, 67	12,700
20	282	27,800	47	65	179,000
21	283, 284	13,100	48	70, 72, 76	8,800
22	285	15,700	49	73, 80-82, 84, 86, 89	16,500
23	29	20,000	50	75	30,100
24	30	10,779	51	78,79	7,400
25	31	10,700	52	91, 92	10,779
26	321-323	11,700	53	93	10,779
27	324-329	14,400	54	99	10,779

1/ Descriptions of these industrial groups may be found in Standard Industrial Classification Manual, 1972, Executive Office of the President, Office of Management and Budget.

Table 2 presents a typical printout listing of the estimated reduction in value added by industry for the 1,000-year flood frequency. The value-added reductions are obtained by multiplying the adjusted annual value added per employee by the total down-time number in hours.

Table 3 consists of a comparison of the value-added reductions by industry for each of the eight flood frequencies. The corresponding estimates of value-added reductions range from $2.7 million for the 40-year flood to $27.5 million for the Maximum Possible Flood.

Table 2

REDUCTION IN VALUE ADDED BY SIC GROUP
1,000 YEAR FLOOD FREQUENCY, PORTLAND REACH OF THE WILLAMETTE RIVER
(IN 1972 DOLLAR VALUES)

SIC Group	Number of Firms	Number of Employees	Annual V/A Per Employee ($)	Warning Time (Hrs.)	Fld. Duration Time (Hrs.)	Down Time (Hrs.)	Reduction In V/A ($)
1	1	8	10,779	768	1,239	2,007	2,470
2	0	0	10,779	0	0	0	0
3	6	27	10,779	2,662	3,390	6,052	7,447
4	1	5	40,400	470	1,365	1,835	8,463
5	51	1,724	10,779	173,479	234,441	407,920	501,937
6	22	957	1,400	95,343	171,495	266,838	316,794
7	3	61	10,779	6,100	7,107	13,207	16,251
8	12	1,306	10,779	129,792	202,356	332,148	408,701
9	2	233	17,800	22,458	50,805	73,263	148,868
10	12	1,041	14,800	102,369	178,779	281,148	474,999
11	1	50	19,200	5,000	3,450	8,450	18,521
12	3	92	10,779	9,363	13,287	22,650	27,870
13	5	228	7,000	23,008	25,098	48,106	38,441
14	1	2	16,000	200	204	404	738
15	3	834	13,800	77,939	222,339	300,278	473,041
16	2	70	19,800	7,156	9,141	16,297	36,836
17	3	16	13,800	1,600	1,848	3,448	5,432
18	33	324	8,000	32,372	35,625	67,997	62,098
19	33	4,782	14,700	481,419	360,903	842,322	1,413,486
20	1	45	27,800	4,590	3,780	8,370	26,562
21	3	148	13,100	14,856	17,934	32,790	49,035
22	7	204	15,700	20,432	19,632	40,064	71,804
23	3	217	20,000	22,134	24,681	46,815	106,884
24	3	162	10,779	15,940	17,343	33,283	40,954
25	1	4	10,700	400	549	949	1,159
26	3	7	11,700	688	1,170	1,858	2,482
27	12	548	14,400	54,603	104,352	158,955	261,296
28	17	426	13,500	42,624	56,427	99,051	152,647
29	13	1,166	13,800	118,855	118,380	237,235	373,726
30	0	0	17,200	0	0	0	0
31	3	156	12,100	15,856	15,612	31,468	43,466
32	5	307	24,100	31,178	69,690	100,868	277,502
33	4	158	20,900	15,486	42,090	57,576	137,367
34	16	459	10,779	45,108	61,893	107,001	131,663
35	0	0	34,400	0	0	0	0
36	9	1,735	9,900	175,476	267,675	443,151	500,821
37	8	939	12,300	95,688	137,961	233,649	328,069
38	7	1,929	10,100	195,112	264,048	459,160	529,397
39	1	8	9,100	800	552	1,352	1,404
40	13	342	6,700	34,034	46,419	80,453	61,534
41	97	4,802	23,400	486,561	723,399	1,209,960	3,232,085
42	0	0	23,700	0	0	0	0
43	2	5	17,900	506	900	1,406	2,873
44	4	32	30,200	3,248	3,783	7,031	24,239
45	974	19,024	10,200	1,903,569	2,442,255	4,345,824	5,060,206
46	58	1,957	12,700	194,848	245,724	440,572	638,729
47	46	183	179,000	18,129	21,831	39,960	816,534
48	109	964	8,800	95,936	110,835	206,771	207,715
49	277	1,956	16,500	194,666	214,419	409,085	770,537
50	56	771	30,100	76,900	86,832	163,732	562,595
51	15	157	7,400	15,424	32,892	48,316	40,815
52	20	3,517	10,779	351,160	508,692	859,852	1,058,030
53	7	374	10,779	35,953	50,940	86,893	106,920
54	0	0	10,779	0	0	0	0
TOTALS	1,988	54,462		5,452,258	7,235,562	12,687,820	19,581,443
Adjusted (Total Minus SIC Group 1)							
Totals	1,987	54,454		5,451,490	7,234,323	12,685,813	19,578,973

Table 3

ESTIMATED REDUCTIONS IN VALUE ADDED BY SIC GROUPS AND FLOOD FREQUENCY FOR THE PORTLAND REACH OF THE WILLAMETTE RIVER
(IN 1972 DOLLARS)

SIC Group	Flood Frequency in Years							
	40	100	300	400	500	1,000	2,000	MPP
1	0	0	1,575	1,940	2,066	2,470	2,689	2,834
2	0	0	0	0	0	0	0	0
3	1,513	2,024	2,872	3,181	5,420	7,447	14,521	16,979
4	6,088	7,587	7,536	8,278	8,417	8,463	8,929	9,454
5	118,099	144,891	211,716	293,687	399,796	501,937	626,467	703,183
6	120,697	145,904	189,143	248,578	288,931	316,794	381,310	425,939
7	0	0	7,441	11,080	13,357	16,251	18,110	87,330
8	79,851	104,053	250,855	303,350	350,721	408,701	459,284	496,323
9	0	74,862	110,425	122,659	133,717	148,868	159,282	179,260
10	209,300	283,227	294,817	347,339	395,067	474,999	529,379	706,654
11	0	0	0	0	0	18,521	22,139	24,875
12	0	720	17,598	21,532	24,211	27,870	45,167	49,628
13	0	1,670	9,384	21,456	31,745	38,441	47,112	51,502
14	0	0	0	464	605	738	838	15,808
15	328,552	409,753	417,483	460,013	468,438	473,041	499,443	528,003
16	0	0	21,271	23,857	26,680	36,836	40,882	43,666
17	0	0	1,676	3,844	4,526	5,432	110,430	132,874
18	0	898	28,945	35,555	44,148	62,098	84,074	151,625
19	197,593	308,371	421,335	576,460	687,208	1,413,486	1,755,813	2,056,894
20	0	0	0	0	20,707	26,562	31,418	34,274
21	0	0	24,136	29,834	41,065	49,035	55,108	59,647
22	0	0	584	41,467	54,289	71,804	85,526	93,867
23	0	0	20,158	77,651	87,228	106,884	119,703	129,119
24	0	0	0	27,649	33,858	40,954	71,637	84,493
25	0	0	727	928	995	1,159	1,272	1,352
26	705	879	1,525	1,720	2,242	2,482	2,706	2,890
27	99,717	126,229	191,385	214,200	241,823	261,296	294,054	314,579
28	15,224	37,962	67,492	90,891	123,409	152,647	233,683	298,771
29	0	0	43,387	233,302	289,463	373,726	430,859	566,522
30	0	0	0	0	0	0	0	0
31	0	0	12,043	18,452	34,543	43,466	50,196	54,703
32	171,479	211,975	218,066	242,989	252,527	277,502	335,463	371,943
33	62,271	88,868	108,847	133,598	136,415	137,367	177,316	235,836
34	3,592	4,478	60,755	83,076	106,614	131,663	156,288	185,657
35	0	0	0	0	0	0	487	652
36	2,450	40,405	329,755	404,193	437,062	500,821	597,705	658,592
37	0	42,967	207,985	258,876	281,778	328,069	361,321	388,593
38	0	30,737	297,526	399,568	454,259	529,397	581,066	623,955
39	0	0	0	0	0	1,404	1,680	6,975
40	762	13,444	33,017	39,640	44,696	61,534	67,399	93,560
41	530,587	876,741	1,871,225	2,478,664	2,792,354	3,232,085	3,776,835	4,278,844
42	0	0	0	0	0	0	0	1,015
43	1,661	2,054	2,047	2,244	2,287	2,873	3,169	3,414
44	0	0	13,256	15,883	18,882	24,239	27,128	29,311
45	631,288	1,011,676	2,299,489	3,123,718	3,821,888	5,060,206	6,084,060	6,810,411
46	22,562	29,955	318,152	363,179	476,230	638,729	802,025	987,136
47	46,855	87,845	379,292	507,535	633,141	816,534	1,330,056	1,646,882
48	6,904	11,061	63,813	80,861	165,437	207,715	261,529	301,411
49	1,963	21,333	304,227	395,725	519,409	770,537	1,018,809	1,226,436
50	0	15,851	228,956	347,026	414,129	562,595	682,524	845,807
51	19,832	25,457	31,776	35,643	37,802	40,815	46,648	51,007
52	0	19,037	677,021	794,384	918,053	1,058,030	1,190,980	1,268,611
53	0	0	61,520	76,391	90,058	106,920	121,443	131,258
54	0	0	0	0	0	0	388	465
TOTALS	2,679,565	4,182,914	9,862,234	13,002,560	15,419,696	19,581,443	23,815,350	27,470,819
Adjusted (Total Minus SIC Group 1)								
Totals	2,679,565	4,182,914	9,860,659	13,000,620	15,417,630	19,578,973	23,812,661	27,467,985