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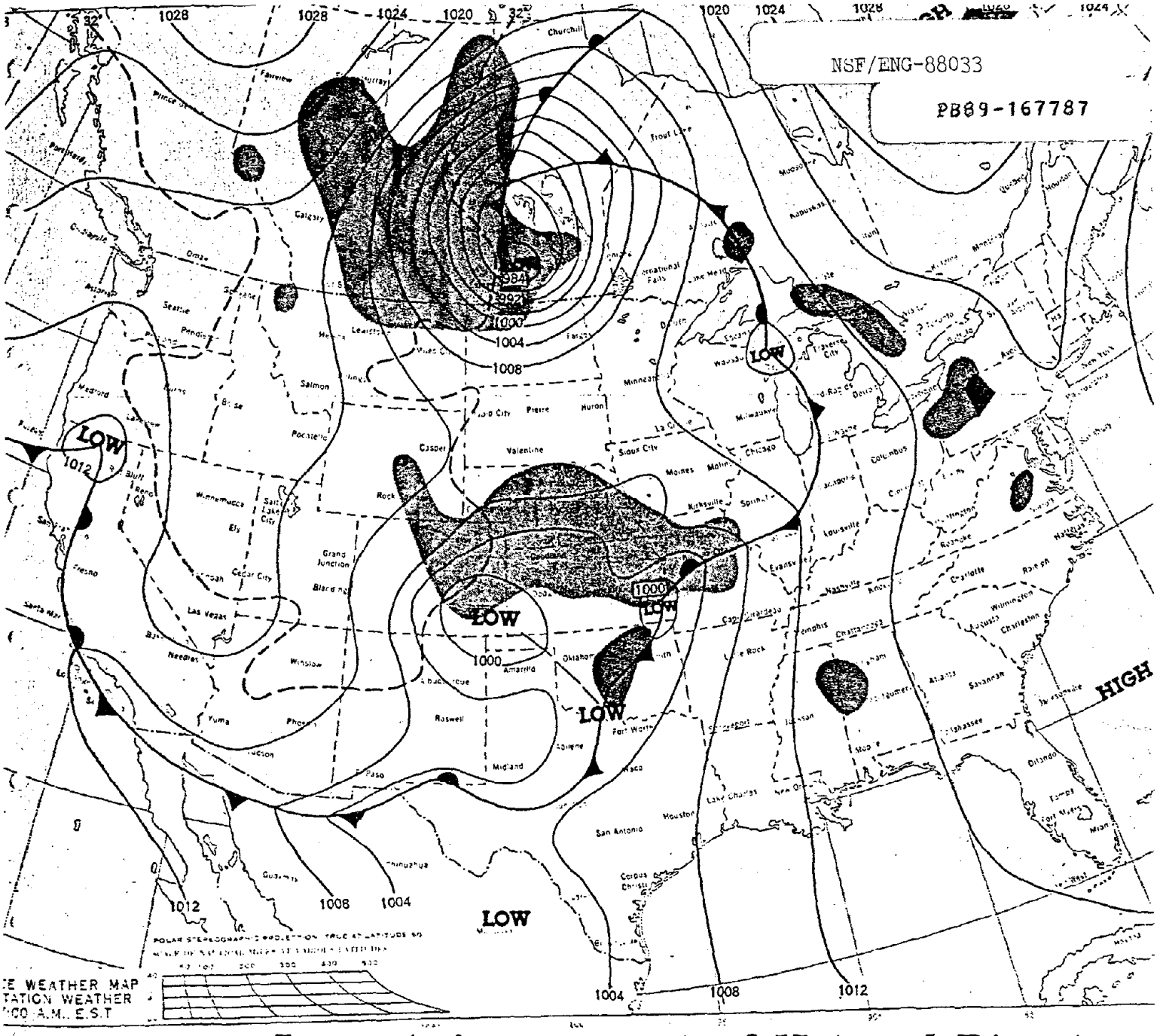

Impact Assessment of Natural Disasters on Transportation Lifelines

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The study attempts to determine the actual cost of and damage done to transportation facilities as a result of natural disasters between 1971 and 1981. It uses national data and empirical analysis to quantify the impact of various types of disasters on transportation lifelines. Its aims are: to define key issues of policy, and also data and knowledge gaps in the field of disaster impacts; to prepare a transportation damage data base; to conduct preliminary analyses of the data base; to identify a set of important next-step research questions; and to identify the general vulnerability (i.e., damage) to transportation systems and infrastructure resulting from natural disasters.

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Transportation lifelines

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IMPACT ASSESSMENT OF NATURAL DISASTERS ON TRANSPORTATION LIFELINES

Catherine L. Ross
Principal Investigator

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ACKNOWLEDGEMENTS

Natural disasters are very much a part of our reality. Coming to grips with this fact is a challenging undertaking. In this context the necessity of better understanding the impacts of such occurrences on transportation systems is obvious.

The work reported here is one effort to improve our knowledge of the performance of transportation lifelines during times of stress. A number of individuals have contributed to this study. The three members of the Project Advisory Committee included Professor James David Wright, Professor Steven B. Caldwell and Professor John Archea. They were a source of both knowledge and support for which I am grateful.

Mr. Siddhartha Senn, Mr. James Baker, Mr. Jeff Cheek and Ms Cecelia Ho were graduate research assistants that worked tirelessly. Their diligence and careful attention to work contributed significantly to the success of the project.

The support of FEMA and FHWA personnel was critical to the completion of the study. Major P. May and Bruce P. Baughman in FEMA's Region IV office made records accessible and gave generously of their time. Mr Lawrence Staron and David K. Philips of FHWA supported the project and permitted accessibility to

agency records. I am thankful for the support given by these individuals.

Professor Thomas Boston is due a special acknowledgement for the vast amount of time spent reviewing the report. He contributed tremendously to its development. Lastly I would like to thank Mr. Frederick Krimgold, former Program Officer at the National Science Foundation.

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I. INTRODUCTION

There is a general lack of information and understanding about natural disasters and public policies surrounding them. This study attempts to determine the actual cost of and damage done to transportation facilities as a result of natural disasters between 1971 and 1981. It goes beyond the standard case study approach and uses instead national data and empirical analysis to quantify the impact of various types of disasters on transportation lifelines. As such the study contributes to our attempt to develop standardized measures of impact and loss associated with disasters. The determination of disaster impacts on society and on various lifeline systems e.g. transportation is a vital issue that must be addressed before appropriate solutions can be found and public policies identified.

Each year the human suffering and property losses resulting from natural disasters are enormous. In fact one study estimates that the thirty most often occurring natural disasters have direct costs equal to one percent of the gross national product and will increase by over eighty-five percent between 1970 and the year 2000 (Atkins and Pertak, 1980). Evidence suggests that while the number of lives lost due to natural disasters has varied widely over time the damage to property is increasing. Between 1946-1955, 1956-1965, 1966-1975 and 1976-1981 the annual average annual number of lives lost were 305, 217, 320 and 207 respectively. During the same period the average annual number of

property losses of $1 million or more due to floods were 335, 272, 1,022 and 1413 respectively, see Table 1. Thus the ability to anticipate and develop appropriate strategies of intervention is mandatory if we are to reduce the costs and losses resulting from natural hazards. As such, improved monitoring of natural disasters and their resulting impacts is of great benefit in determining public policy.

In order to reduce these disastrous impacts it is imperative that we outline mitigation procedures that are potentially helpful. Emergency management encompasses such procedures; it requires assessing natural hazards and identifying ways to minimize their impact. This includes hazard mitigation, disaster response, and post-disaster recovery. Experience has demonstrated that the best strategy for reducing the number of lives lost and property damage is to reduce the exposure of the population to risk through land management and improved construction of the built environment.

Need for and Purpose of the Study

This study examines the vulnerability of and impact on transportation lifelines resulting from natural disasters. Historically not much attention has been given to the general vulnerabilities of such systems. Instead, the focus has been on specific components such as bridges, tunnels etc. and as a consequence there is little or no information on the general vulnerabilities of transportation lifelines.

TABLE 1 : TORNADOES, FLOODS AND TROPICAL STORMS, 1946 TO 1981

	1946-1955	1956-1965	1966-1975	1976-1981
TORNADOES, NUMBER	2969	6572	8030	4976
LIVES LOST	1751	924	1172	276
PROPERTY LOST OF $500,000 AND OVER	130	191	428	314
FLOODS: LIVES LOST	808	557	1528	906
PROPERTY LOST OF $1,000,000	3350	2721	10225	9893
CYCLONES AND HURRICANES REACHING U.S.	40	33	25	14
LIVES LOST	495	692	504	57

SOURCE: Statistical Abstract of the US, 1981. US Dept of Commerce, Bureau of the Census

Data for this research is extracted from records on disaster declarations processed by the Federal Emergency Management Agency (FEMA) under Public Law 93-288 and its predecessor the Federal Disaster Assistance Administration (FDAA) and records of the Federal Highway Administration (FHWA) on disasters processed under Title 23 of the United States Code, Sections 120 and 125. The time period covered is 1971 to 1981.

Data on disasters processed by these two agencies were inventoried in order to identify those involving damage to the transportation system. This information was collected by visiting both FEMA and FHWA headquarters in Washington, D.C. and FEMA's region IV office located in Atlanta, Georgia. Disasters are categorized by type i.e. flood, hurricane etc. and intensity in order to better correlate the damage to transportation systems with disaster types. Unlike previous efforts which have been largely case studies, we are concerned with taking a broader view of impact assessment. Our objective is to identify, define, and quantify the impact of natural hazards on transportation lifelines by disaster types.

A major contribution of the research is documentation of the impact of different hazards on transportation. Increasing the knowledge base for natural hazard mitigation procedures is also an important result. However, the primary task is the collection and evaluation of data on hazard related damages to transportation lifelines. Ultimately this will allow planners to identify the failure of various components in the system, improve

design criteria for transportation facilities, enhance the quality of planning for emerging response standards, establish better criteria for evaluating existing facilities and improve the budgeting process.

Aims:

-to define key issues of policy, and also data and knowledge gaps in the field of disaster impacts

-to prepare a transportation damage data base that can be used to shed light on key policy issues

-to conduct preliminary analyses of the data base

-to identify a set of important next-step research questions

-to identify the general vulnerability (i.e. damage) to transportation systems and infrastructure resulting from natural disasters.

Natural Hazard Assessment

There are a great variety of natural disasters but the fourteen most common in the United States are:

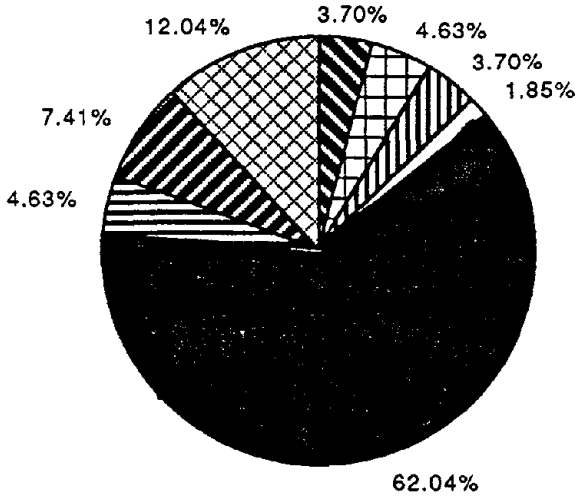
Avalanche	Storm surge
Coastal erosion	Tornado
Drought	Tsunami
Earthquake	Unstable soil
Flood	Volcano
Hurricane	Windstorm
Landslide	Winter storm

The damage caused by these natural hazards (geophysical events) varies according to the section of the country. Earthquake hazards assessment requires specification of potential impacts resulting from seismically-induced activity in proximity to the

earths surface. On the other hand damage due to floods is the most common type and relatively easier to assess.Between 1971 and 1981 there were a total of 333 natural disasters involving allocations by FEMA. Of these, 109 entailed allocations by both FEMA and FHWA. Figure 1 illustrates the distribution of occurrences of FEMA and FHWA disasters by type which are: Floods with severe storms 62.04%, Tornadoes 12.04%, Floods with snowmelts 7.41%, Typhoons and tropical storms 4.63%, Floods with landslides 4.63%, Hurricanes 3.70%, Others, dam collapse etc. 3.70%, and Earthquakes 1.85%. Later in the study we will examine the extent to which various regions experience specific kinds of natural hazards and to attempt to anticipate the magnitude its impact given that it occurs.

The location and construction of urban infrastructure will have far reaching implications for the social and economic impact of natural disasters. Within urban centers some buildings serve a pivotal role in the conduct of the economic life of a community. Increasingly the location of such critical facilities such as hospitals, schools, churches, police and fire stations are planned with a view towards reducing their vulnerability. The threat posed to critical facilities by disasters is an essential component in hazard assessment and is crucial information also to counties, cities, the federal government, regional authorities and private corporations.

FIGURE 1 : OCCURRENCES OF FEMA & FHWA DISASTERS BY TYPE, 1971-1981 (TOTAL DISASTERS= 108)

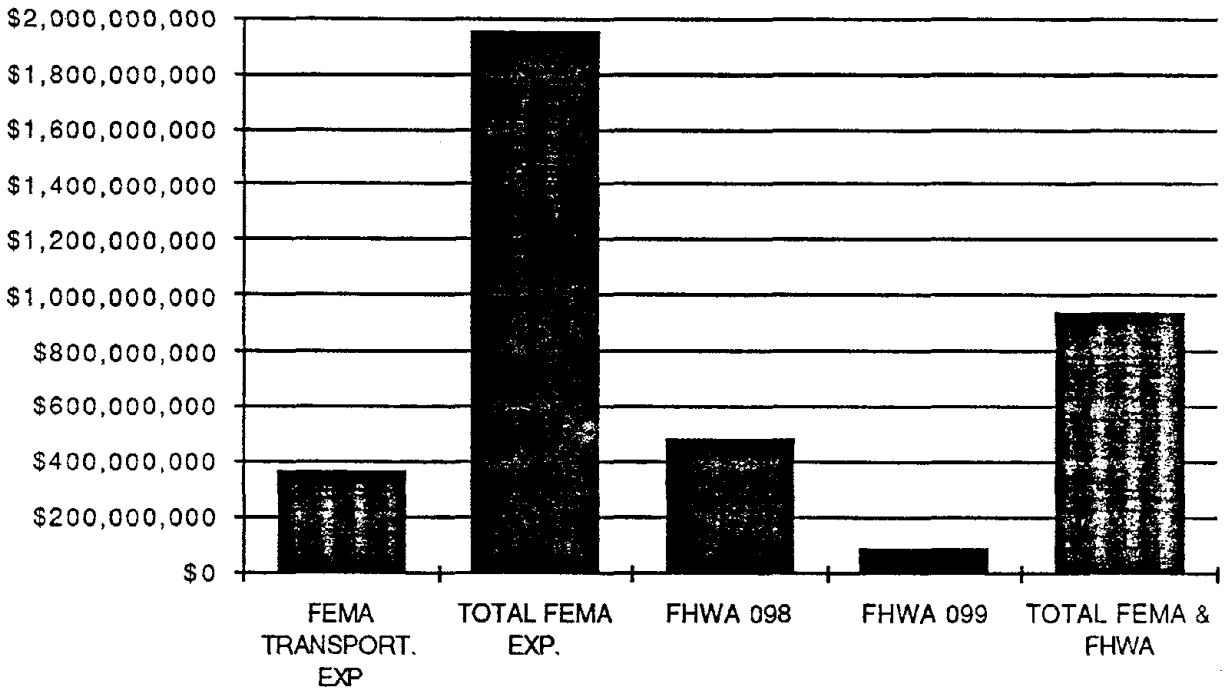


When a disaster occurs the Governors send requests for assistance to the President who selects a Federal Coordinating Officer (FCO). The Federal Emergency Management Agency then coordinates the efforts of all federal agencies involved in Presidentially-declared disasters while FHWA makes obligations for damages to federal highway systems. Figure 2 summarizes the expenditures on all disasters and transportation related damages for the years 1971-1981. Roughly $2 billion was spent by FEMA on all types of disasters; of this FEMA allocated $366 million to transportation damage. FEMA total damage expenditures consists of the total amount of FEMA money spent as of May 16, 1984 on debris clearance, emergency protective measures, road systems, water control facilities,public buildings and equipment, public utilities, facilities under construction, private non-profit facilities, park and recreational facilities, individual family grants and money given to other agencies for the purpose. Additionally FHWA allocated about $.5 billion to 098 expenditures (i.e. Federal Aid Highways) and $91 million to 099 expenditures (other Federal roads e.g. National Park roads). In total $936 million was allocated to transportation related damage.

Lifelines Engineering

"Lifelines engineering" is concerned with the protection of a community's lifelines from the dangers posed by natural hazards. Lifelines include waste water systems, energy systems, water

FIGURE 2 : SUMMARY OF FEMA & FWHA DISASTER EXPENDITURES, 1971-1981



systems, communication and transportation systems. Generally, lifelines have distribution systems, transmission lines, and a storage capability. These require extensive financial investment and are critical to a region's ability to survive a disaster. Because urban areas could not function without lifelines it is imperative that they be able to function in the event of a natural disaster.

The failure of lifelines over an extended period may significantly affect survival rates and the ability of the community to respond to the disaster. On the other hand the ability to protect and secure lifelines is made even more problematic by the fact that both the public and private sectors own them. Hence extensive coordination is required when developing policies and procedures to minimize their vulnerability.

Natural Hazard Research

There is a general lack of information and understanding about natural disasters and the public policies surrounding them. While public sector data collection is formidable; the challenge to access information held in the private sector is even more stringent because insurance companies, mortgage lenders, consultants and private land owners often hold such information. Hence even where data has been collected it is not always accessible or easy to locate. More importantly, the natural

disaster data bases are generally of poor quality, when they exist at all, record keeping is inadequate and inconsistent and there is a great deal of duplication of effort (Tubbesing, 1979). The variance in the data we have for different types of disasters is great. For example relatively good exists data on tornadoes but not on floods; one of the most devastating types of disasters. Thus it goes with saying that an improvement in the quality of data is critical to our effort to better respond to the impact of disasters on our society. Wiggins' (1980) " Building Losses From Natural Hazards: Yesterday, Today and Tomorrow" provides a comprehensive examination of building damage and related losses resulting from earthquakes, landslides, expansive soil, hurricane wind/storm surge, tornado, floods, local wind , local flood and tsunami. Data from a number of different studies are summarized and each hazard is modelled and damages calculated. These are forecast and potential loss reductions determined on a state and national bases if specific mitigation procedures are implemented and public policy implications are identified. Unfortunately fragmentary information forces Wiggins to construct different models for each disaster. But his primary focus on building damage, expands substantially our knowledge about the impact of disasters on structures. While tornadoes take more lives than any other type of hazard, riverine flood were found to cause the most damage to buildings although it is felt that hurricane wind/storm surge and expansive soil may replace it in the future. Results suggest it

is possible to reduce building damage by approximately thirty-five percent for some hazards and eleven percent for earthquakes. A primary conclusion is that much more data is required on all natural hazards and a deeper study made of each. In Natural Hazards Data Resources: Uses And Needs (Tubbesing, 1979) recommends: improving current natural hazard data collection; improving recording and storage of data; and increasing cooperation between agencies collecting information on natural hazards. One section of his study outlines the difficulties encountered by a group of social scientists who undertook a study very similar to our current effort. They wished to determine the following:

1. Precise location of disasters
2. Magnitudes of Disaster Damage and Injury
3. Dates of Disaster Event Occurrences
4. Housing and Population Counts for Comparable SMSA's and Counties for 1960 and 1970

A major problem they encountered was the lack of a single source for data at an adequate level of specificity. Because of this they were unable to perform analysis at the disaggregated level. Further hazards inflicting insignificant damage were not recorded and it was difficult to determine exactly where disasters occurred.

In "Urban Design Vulnerability Components" Lagorio, (1984) assesses the components which must function when an earthquake occurs. These factors, referred to as urban scale

vulnerability components are detailed below. They constitute one basis for assessing the vulnerability of metropolitan areas and inadequate performance of any have tremendous consequences for urban areas and their residents.

LISTING OF URBAN SCALE VULNERABILITY COMPONENTS

Component	Function/Implication
Existing Building Stock Classes	Urban Pattern
Adjacency of Buildings	Urban Density
Hazardous Contents	Fire/Explosion/Toxic Fumes
Location of Buildings/Systems	Land Use/Site Planning
Emergency/Critical Facilities	Response/Recovery
Lifelines	Life Support/Circulation
Bridges/Overpasses	Transportation
Communication Lines	Mass Media/Public Information
District Zoning	Urban Character
Street Patterns	Access/Egress
Reservoirs/Dams	Water Supply/Downstream Population
Open Spaces	Evacuation

Source: Eighth World Conference On Earthquake Engineering,1984, pp. 625-629

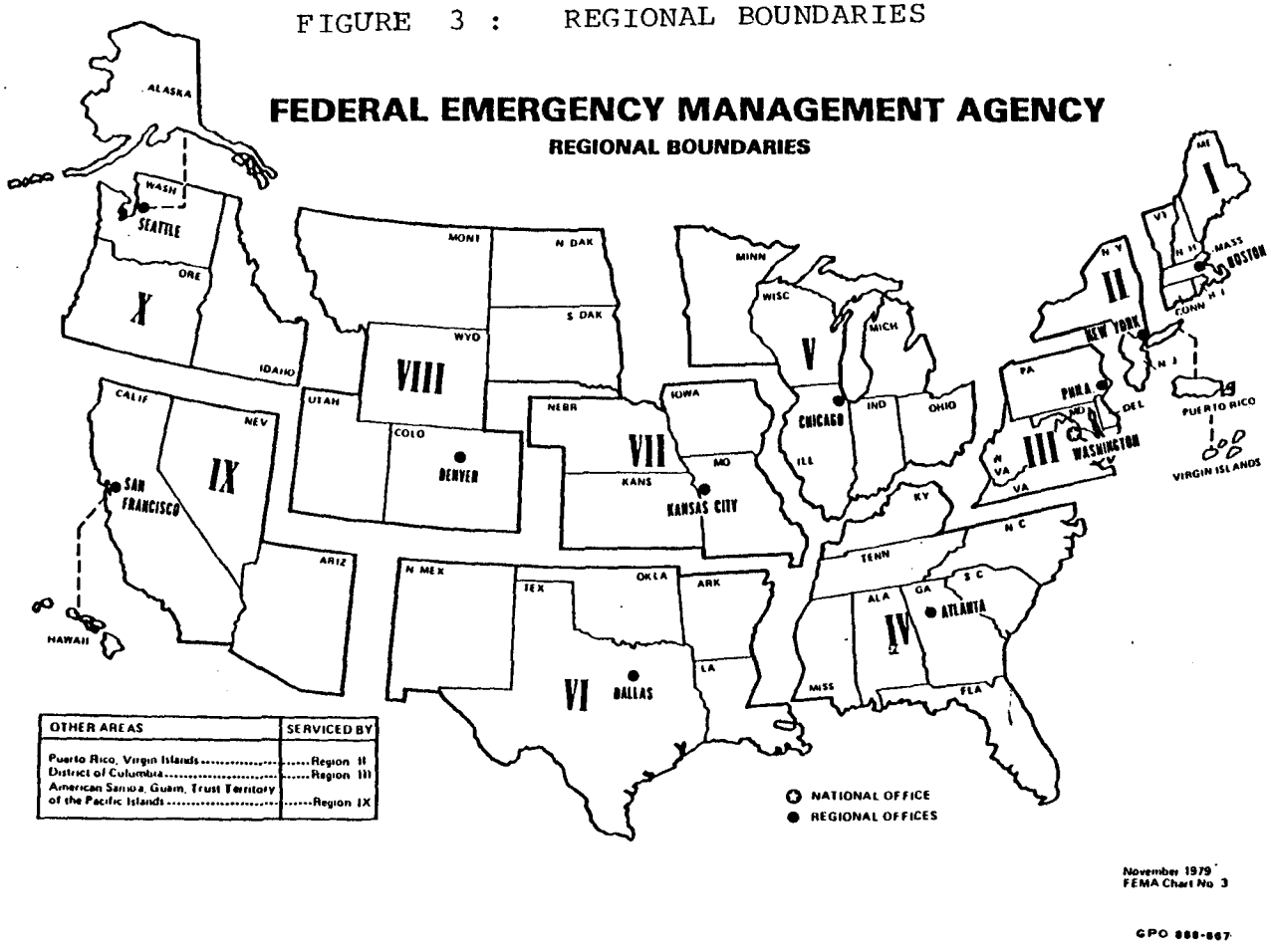
II. THE NATIONAL DATA BASE

The impetus for aid to states is contained in Public Law 93-288, the Disaster Relief Act of 1974. A major disaster is defined as any " hurricane, tornado, storm, flood, high water, wind-driven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, drought, fire, explosion, or other catastrophe in any part of the United States which, in the determination of the President, causes damage of sufficient severity and magnitude to warrant major disaster assistance above and beyond emergency services by the Federal Government to supplement the efforts and available resources of States, local governments, and private relief organizations in alleviating the damage, loss, hardship or suffering caused by a disaster" (FEMA, 1980). An emergency is any situation where the different types of major disasters necessitate Federal emergency aid to local and State governments in order to assure public health, safety, protect lives and property, and reduce or lessen the danger posed by the occurrence. When the State or local government resources are inadequate the Governor may ask the President to declare an emergency or major disaster. Once this occurs a number of disaster relief programs are put into effect. The Federal Emergency Management Agency (FEMA) is the Federal agency responsible for coordination.

FEMA has regional offices throughout the country , see Figure 3 Regional Boundaries. Each of the ten regions has a Regional Director who works very closely with the Governor's office and other State disaster officials. A list of the states by region is included in Appendix I. A Federal Coordinating Officer (FCO) is appointed to identify the kinds of emergency relief needed. Applications may be made to fund a number of projects including:(FEMA,1980)

A. Clearance of debris on public or private lands or waters;
B. Emergency protective measures for the preservation of life and property;
C. Repair or replacement of roads, streets and bridges;
D. Repair or replacement of water control facilities (dikes, levees, irrigation works, and drainage facilities);
E. Repair or replacement of public buildings and related equipment;
F. Repair or replacement of public utilities;
G. Repair or restoration (to pre-disaster condition) of public facilities damaged while under construction;
H. Repair or restoration of recreational facilities and and parks, and
I. Repair or replacement of private nonprofit educational, utility, emergency, medical, and custodial care facilities, including those for the aged or disabled, and facilities on Indian reservations.

FIGURE 3 : REGIONAL BOUNDARIES



• U. S. GOVERNMENT PRINTING OFFICE : 1981 727-156/1531 (1302)

Federal assistance may be given in the Emergency Work or the Permanent Work category. Typically Emergency Work involves an action that is immediately necessary in order to save lives; protect public health and property and assure safety. Permanent Work involves the restoration, repair or replacement of facilities to pre-disaster standards. Road systems eligible for assistance (Category C) on Damage Survey Reports ,(DSR forms), " include any construction features within the public right of way that are essential to make the road or street itself a functional whole. They include but are not limited to bridges, drainage structures, traveled way, shoulders, embankments, and safety features. This applies to roads not on the federal aid system or on federal lands. Only those facilities regularly maintained and kept in repair are eligible for disaster assistance, when damaged or destroyed" (FEMA, 1981). Figure 4 is a copy of a Damage Survey Report.

Surveys of damage are typically conducted by inspection teams having both Federal and State representatives. Information on their findings is recorded on DSR's. These form the basis for determination of eligible work and must include information on extent of damage; scope of work; description of damage and cost

of damage. These DSR forms are the primary source of FEMA data on natural disaster damage to the transportation system.

Table 2 lists all Fema disasters by disaster number. Also given are the declaration date, state and region of occurrence, type of disaster, number of counties impacted, FEMA Category C expenditures, total FEMA expenditures, Category C as a percent of total expenditures and capital outlays for highways and vehicles registered in the state during the year the disaster occurred. In all there were 333 FEMA disasters between 1971 and 1981 for which $3.00 billion was allocated. Of this amount 18.9% or $568 million was allocated to Category C damage. In subsequent sections we will attempt to approximate the total damage on transportation lifelines for disasters by type and region of occurrence and the extent of transportation infrastructure development in the state.

FIGURE : 4 DAMAGE SURVEY REPORT

Form Approved
OMB No. 3067-0027

FEDERAL EMERGENCY MANAGEMENT AGENCY
DAMAGE SURVEY REPORT
DISASTER RESPONSE AND RECOVERY
(See instructions on reverse)

3. DECLARATION NO. FEMA
4. INSPECTION DATE

1. TO ➡ REGION _____ FEDERAL EMERGENCY MANAGEMENT AGENCY

5. WORK ACCOMPLISHED BY
☐ CONTRACT
☐ FORCE ACCOUNT

2. APPLICANT *(State Agency, County, City, etc.)* | PA NO.

7. WORK CATEGORY *("X" Applicable Box)*
☐ EMERGENCY ☐ A ☐ B
☐ PERMANENT ☐ C ☐ D ☐ E ☐ F ☐ G ☐ H ☐ I
DSR NO. 100002

6. PERCENTAGE OF WORK COMPLETED TO DATE
%

8. DAMAGED FACILITIES *(Location, identification and description)*

8A. FACILITY IN OR AFFECTS FLOOD PLAIN OR WET LANDS
☐ YES ☐ NO

9. DESCRIPTION OF DAMAGE

10. SCOPE OF PROPOSED WORK

11. ESTIMATED COST OF PROPOSED WORK

QUANTITY (a)	UNIT (b)	MATERIAL AND/OR DESCRIPTION (c)	UNIT PRICE (d)	COST *(dollars)* (e)

12. EXISTING INSURANCE *(Type)* | AMOUNT $ | TOTAL ➡ $

13. RECOMMENDATION BY FEDERAL INSPECTOR *(Signature, Agency, date)* | ELIGIBLE ☐ YES ☐ NO | ATTACHMENTS

14. CONCURRENCE IN REPORT BY STATE INSPECTOR *(Signature, Agency, date)* | CONCUR ☐ YES ☐ NO | ATTACHMENTS

15. CONCURRENCE IN REPORT BY LOCAL REPRESENTATIVE *(Signature, Agency, date)* | CONCUR ☐ YES ☐ NO | ATTACHMENTS

16. FEDERAL REVIEW *(Signature, Agency, date)* | FEMA REVIEW *(Initials and date)*

FEMA Form 90-52, JAN 81 (Formerly HUD Form 484)

D-1

COPY 1 = FEMA REGION

FIGURE 4 : (Continued)

INSTRUCTIONS

1. The Damage Survey Report (DSR) is not a Federal approval of this proposed project and does not obligate Federal funds. DSR's are field recommendations which are attached as supporting justification to the applicant's project application, which must be approved by the Governor's Authorized Representative and the FEMA Regional Director. The applicant can be given no assurance of Federal reimbursement for any of the proposed work prior to approval of the project application by the Regional Director.

2. Use this form for the Federal Inspector's Damage Survey Report when required for emergency assistance, debris removal, temporary housing, or permanent repairs, replacement, or other restorative work. Separate DSR's will be prepared for emergency and for permanent work.

3. The Federal Inspector will attach properly captioned and cross referenced maps, sketches, or photos, as necessary to locate or describe the damages and the proposed scope of work. Additional sheets reporting comments by the DSR team members or any other pertinent information may be attached by the Federal Inspector to the original DSR.

4. Description of damages and "Scope of Proposed Work" should be stated in quantitative terms. For example, provide estimated quantities of debris removal or earth movement in cubic yards or tons; provide paving estimates in square feet or square yards; and provide principal dimensions of bridges, retaining walls or other structures as appropriate.

5. The Federal Inspector will attach his comments on each question of eligibility that arises. He should contact the Regional Director for guidance when necessary.

6. Cost estimates must be realistic; based on local conditions for the eligible scope of work without any contingency allowances. Cost breakdown should be sufficiently detailed for professional review including deductions such as salvage or insurance when appropriate. Under DSR Item 12 record the type of insurance coverage in force such as flood or casualty.

7. Under DSR Item 16, the "Federal Review" will be accomplished normally at the FEMA field office by a Federal engineer designated by the Regional Director. The FEMA review will be accomplished prior to distribution of the completed DSR's as indicated below. Based on these DSR reviews, a Federal Inspector may be required to correct errors in the DSR or to repeat field inspections when necessary.

8. Three copies of the DSR will be completed and signed at the time of the inspection. The applicant's representative will retain copy 3. The Federal Inspector will submit copy 1 to the Regional Director for review and copy 2 for automated data entry. The Regional Director will distribute two reproduced copies of the reviewed DSR to the Governor's Authorized Representative and two reproduced copies to the Federal agency which provided the inspector. The original (copy 1) will be retained for FEMA record file.

9. Force Account in Item 5 means work performed by Applicant's own forces.

TABLE 2: ALL FEMA DISASTERS BY DISASTER NUMBER AND OTHER INFORMATION
1971-1981

DISASTER NUMBER	DECLARATION DATE	STATE	REGION	DISASTER TYPE	NO. COUNTIES IMPACTED	FEMA TRANSPORT. DAMAGE EXPEND.
299	1971, FEB 9	CA	9	EARTHQUAKE	1	$939,228
300	1971, FEB 9	WA	10	HEAVY RAINS, MELTING SNOWS & FLOODS	7	$597,450
301	1971, FEB 13	OR	10	STORMS & FLOODING	2	$222,068
302	1971, FEB 22	MS	4	STORMS & TORNADOES	23	$159,718
303	1971, FEB 23	NE	7	FLOODS	19	$259
304	1971, MAR 15	FL	4	FREEZE	6	$0
305	1971, MAY 10	KY	4	TORNADO	8	$0
306	1971, MAY 18	TN	4	TORNADO	3	$0
308	1971, JUL 7	NE	7	FLOODS	9	$5,420
309	1971, AUG 17	MD	3	SEVERE STORMS & FLOODING	9	$214,815
310	1971, SEP 4	NJ	2	SEVERE STORMS & FLOODING	21	$4,436,959
311	1971, SEP 13	NY	2	SEVERE STORMS & FLOODING	13	$1,393,342
312	1971, SEP 18	PA	3	FLOODS	7	$459,019
313	1971, SEP 18	TX	6	HEAVY RAINS, HIGH WINDS & FLOODS	15	$13,170
314	1971, SEP 28	OK	6	HEAVY RAINS & FLOODS	6	$0
315	1971, OCT 13	LA	6	HURRICANE EDITH	21	$0
316	1972, JAN 11	CA	9	WINDS, FLOODING & MUDSLIDES	1	$32,991
317	1972, JAN 14	OK	6	SEVERE STORMS & FLOODING	12	$0
318	1972, JAN 19	MS	4	HEAVY RAINS & FLOODING	9	$679,594
319	1972, JAN 21	OR	10	SEVERE STORMS & FLOODING	10	$4,886,669
320	1972, JAN 27	TX	6	HEAVY RAINS & FLOODING	6	$0
321	1972, JAN 27	AR	6	SEVERE STORMS & FLOODING	27	$0
322	1972, FEB 1	WA	10	SEVERE STORMS & FLOODING	9	$696,449
323	1972, FEB 27	WV	3	FLOODS	7	$430,287
324	1972, MAR 2	ID	10	SEVERE STORMS & EXTENSIVE FLOODS	1	$244,409
325	1972, MAR 6	MA	1	SEVERE STORMS & FLOODING	4	$450,274
326	1972, MAR 7	ME	1	SEVERE STORMS & FLOODING	7	$139,298
327	1972, MAR 18	NH	1	COASTAL STORMS	1	$47,514
328	1972, MAR 24	WA	10	HEAVY RAINS & SEVERE FLOODING	3	$476,184
329	1972, APR 5	CA	9	SEVERE STORM & FLOODING	2	$1,879,091
330	1972, APR 5	MI	5	SEVERE STORM & FREEZING	9	$0
331	1972, MAY 15	TN	4	HEAVY RAINS & FLOODING	4	$275,694
332	1972, MAY 15	KY	4	HEAVY RAINS & FLOODING	10	$586,655

333	1972, MAY 20	TX	6	SEVERE STORMS & FLOODING	7	$473,388
334	1972, JUN 10	WA	10	SEVERE STORMS & FLOODING	3	$162,634
335	1972, JUN 10	ND	8	FLOODS	7	$277,849
336	1972, JUN 10	SD	8	HEAVY RAINS & FLOODING	4	$7,484,684
337	1972, JUN 23	FL	4	TROPICAL STORM AGNES	14	$628,601
338	1972, JUN 23	NY	2	TROPICAL STORM AGNES	26	$16,786,539
339	1972, JUN 23	VA	3	TROPICAL STORM AGNES	*106	$4,212,985
340	1972, JUN 23	PA	3	TROPICAL STORM AGNES	67	$71,544,268
341	1972, JUN 23	MD	3	TROPICAL STORM AGNES	23	$7,976,684
342	1972, JUN 27	CA	9	FLOODING CAUSED BY LEVEE BREAK	1	$290,642
343	1972, JUL 3	AZ	9	SEVERE STORMS & FLOODING	3	$124,576
344	1972, JUL 3	WV	3	TROPICAL STORM AGNES	15	$267,614
345	1972, JUL 19	OH	5	TROPICAL STORM AGNES	7	$58,326
346	1972, AUG 1	NM	6	SEVERE STORMS & FLOODING	1	$70,300
347	1972, AUG 1	MN	5	SEVERE STORMS & FLOODING	13	$1,642,966
348	1972, AUG 18	IA	7	SEVERE STORMS & FLOODING	4	$574,617
349	1972, AUG 23	WV	3	HEAVY RAINS & FLOODING	4	$166,984
350	1972, AUG 25	MN	5	SEVERE STORMS & FLOODING	5	$1,945,399
351	1972, SEP 4	IL	5	SEVERE STORMS & FLOODING	3	$92,971
352	1972, SEP 10	WI	5	HEAVY RAINS & FLOODING	4	$313,245
353	1972, SEP 20	NM	6	HEAVY RAINS & FLOODING	2	$357,663
354	1972, SEP 26	IA	7	SEVERE STORMS & FLOODING	17	$615,819
355	1972, SEP 28	PA	3	HEAVY RAINS & FLOODING	1	$102,371
356	1972, SEP 28	ME	1	TOXIC ALGAE	8	$0
357	1972, SEP 28	MA	1	TOXIC ALGAE	8	$0
358	1972, OCT 7	VA	3	SEVERE STORMS & FLOODING	*3	$6,316
359	1972, OCT 10	VA	3	SEVERE STORMS & FLOODING	*31	$593,986
360	1972, OCT 25	AZ	9	HEAVY RAINS & FLOODING	2	$24,380
361	1972, NOV 20	NM	6	HEAVY RAINS & FLOODING	3	$146,556
362	1972, NOV 24	OH	5	SEVERE STORMS & FLOODING	5	$421,309
363	1972, DEC 1	MI	5	SEVERE STORMS & FLOODING	9	$36,779
364	1973, FEB 8	CA	9	SEVERE STORMS, HIGH TIDES & FLOODS	6	$2,416,978
365	1973, MAR 12	TX	6	TORNADOES, HIGH WINDS & FLOODS	5	$31,767
366	1973, MAR 21	TN	4	HEAVY RAINS & FLOODING	47	$3,875,609
367	1973, MAR 21	NY	2	HIGH WINDS, WAVE ACTION & FLOODS	8	$211,495
368	1973, MAR 27	MS	4	HEAVY RAINS, FLOODS & TORNADOES	52	$3,775,901
369	1973, MAR 27	AL	4	SEVERE FLOODING & TORNADOES	28	$1,335,607
370	1973, APR 4	GA	4	SEVERE FLOODING & TORNADOES	14	$523,351
371	1973, APR 12	MI	5	SEVERE STORMS & FLOODING	14	$188,425

372	1973, APR 19	MO	7	HEAVY RAINS, FLOODING & TORNADOES	94	$6,046,872
373	1973, APR 26	IL	5	SEVERE STORMS & FLOODING	52	$3,118,325
374	1973, APR 27	LA	6	SEVERE STORMS & FLOODING	38	$3,404,437
375	1973, APR 27	AR	6	SEVERE STORMS & FLOODING	43	$1,673,661
376	1973, APR 27	WI	5	SEVERE STORMS & FLOODING	34	$1,273,829
377	1973, APR 27	OH	5	SEVERE STORMS & FLOODING	8	$809,188
378	1973, MAY 2	KS	7	SEVERE STORMS & FLOODING	64	$1,393,251
379	1973, MAY 8	CO	8	DAM FAILURE	1	$107,680
380	1973, MAY 11	NM	6	SEVERE STORMS, SNOW MELT & FLOODS	11	$1,059,139
381	1973, MAY 11	KY	4	SEVERE STORMS & FLOODING	5	$95,533
382	1973, MAY 11	TN	4	SEVERE STORMS & FLOODING	6	$711,412
383	1973, MAY 16	HA	9	EARTHQUAKE	1	$982,751
384	1973, MAY 23	ME	1	HEAVY RAINS & FLOODING	3	$231,406
385	1973, MAY 23	CO	8	HEAVY RAINS, SNOWMELT & FLOODING	16	$2,570,727
386	1973, MAY 23	IA	7	SEVERE STORMS & FLOODING	26	$848,486
387	1973, MAY 26	FL	4	SEVERE STORMS & FLOODING	13	$892,440
388	1973, MAY 29	AL	4	SEVERE STORMS & FLOODING	12	$2,100
389	1973, MAY 29	AR	6	SEVERE STORMS & FLOODING	5	$6,816
390	1973, JUN 4	OH	5	MUDSLIDES	2	$1,690,775
391	1973, JUN 11	GA	4	SEVERE STORMS & TORNADOES	1	$0
392	1973, JUN 13	OK	6	SEVERE STORMS, FLOODING & TORNADOES	31	$1,326,577
393	1973, JUN 25	TX	6	SEVERE STORMS & FLOODING	4	$1,236,908
394	1973, JUN 25	NC	4	SEVERE STORMS & FLOODING	9	$240,084
395	1973, JUN 28	TN	4	SEVERE STORMS & FLOODING	12	$1,780,665
396	1973, JUL 6	CO	8	SEVERE FLOODING & LANDSLIDES	16	$271,781
397	1973, JUL 6	VT	1	SEVERE STORMS, FLOODS & LANDSLIDES	14	$11,377,880
398	1973, JUL 11	TX	6	SEVERE STORMS & FLOODING	13	$1,362,496
399	1973, JUL 11	NH	1	SEVERE STORMS & FLOODING	10	$3,143,970
400	1973, JUL 17	PA	3	SEVERE STORMS & FLOODING	10	$4,188,051
401	1973, JUL 20	NY	2	SEVERE STORMS & FLOODING	6	$2,587,515
402	1973, AUG 7	NJ	2	SEVERE STORMS & FLOODING	4	$2,471,649
403	1973, SEP 28	KS	7	SEVERE STORMS, TORANDOES & FLOODS	53	$2,516,128
404	1973, OCT 13	OK	6	SEVERE STORMS & FLOODING	5	$719,185
405	1973, OCT 16	MA	1	FIRE (CITY OF CHELSEA)	1	$25,170
406	1973, OCT 20	NE	7	SEVERE STORMS & FLOODING	15	$1,639,342
407	1973, NOV 1	MO	7	SEVERE STORMS & FLOODING	36	$1,477,333
408	1973, NOV 7	AK	10	HEAVY RAINS & FLOODING	1	$0
409	1973, DEC 10	OK	6	SEVERE STORMS & FLOODING	15	$341,436
410	1974, JAN 18	ME	1	SEVERE STORMS & FLOODING	12	$1,355,572

411	1974, JAN 21	NH	1	HEAVY RAINS & FLOODING	4	$231,758
412	1974, JAN 25	CA	9	SEVERE STORMS & FLOODING	7	$5,632,504
413	1974, JAN 25	OR	10	SEVERE STORMS, SNOWMELT & FLOODING	19	$2,793,398
414	1974, JAN 25	WA	10	SEVERE STORMS, SNOWMELT & FLOODING	13	$1,883,130
415	1974, JAN 25	ID	10	SEVERE STORMS, SNOWMELT & FLOODING	9	$2,163,893
416	1974, JAN 29	WV	3	SEVERE STORMS & FLOODING	5	$28,530
417	1974, JAN 29	MT	8	SEVERE STORMS, FLOODS & LANDSLIDES	7	$666,094
418	1974, FEB 23	LA	6	FLOODING	6	$706,694
419	1974, MAR 22	OK	6	HEAVY RAINS & FLOODING	6	$131,515
420	1974, APR 4	KY	4	TORNADOES	34	$127,246
421	1974, APR 4	OH	5	TORNADOES	14	$485,428
422	1974, APR 4	AL	4	TORNADOES	20	$91,564
423	1974, APR 4	IN	5	TORNADOES	39	$301,081
424	1974, APR 4	TN	4	TORNADOES	45	$350,319
425	1974, APR 5	GA	4	TORNADOES	20	$70,258
426	1974, APR 11	WV	3	SEVERE STORMS & FLOODING	4	$0
427	1974, APR 11	IL	5	TORNADOES	4	$495
428	1974, APR 12	NC	4	TORNADOES	6	$0
429	1974, APR 12	MI	5	TORNADOES	1	$1,341
430	1974, APR 18	MS	4	HEAVY RAINS & FLOODING	30	$1,096,992
431	1974, APR 26	WI	5	TORNADOES	4	$651
432	1974, MAY 7	CA	9	SEVERE STORMS & FLOODING	1	$2,811,236
433	1974, MAY 7	HA	9	HEAVY RAINS & FLOODING	2	$0
434	1974, MAY 14	ND	8	HEAVY RAINS, SNOWMELT & FLOODS	18	$991,170
435	1974, MAY 31	AR	6	HEAVY RAINS & FLOODING	1	$86,523
436	1974, MAY 31	OH	5	SEVERE STORMS & FLOODING	3	$208,640
437	1974, JUN 8	AR	6	SEVERE STORMS & FLOODING	8	$1,231,068
438	1974, JUN 10	IL	5	SEVERE STORMS & FLOODING	47	$3,459,799
439	1974, JUN 10	MO	7	SEVERE STORMS & FLOODING	22	$1,876,961
440	1974, JUN 10	MN	5	HEAVY RAINS & FLOODING	12	$846,102
441	1974, JUN 10	OK	6	SEVERE STORMS & FLOODING	20	$1,095,639
442	1974, JUN 10	KS	7	SEVERE STORMS & FLOODING	1	$432
443	1974, JUN 24	IA	7	SEVERE STORMS & FLOODING	39	$1,347,466
444	1974, JUN 24	AK	10	FREEZE-IN	2	$0
445	1974, JUL 11	OH	5	HEAVY RAINS & FLOODING	1	$198,310
446	1974, JUL 13	MN	5	SEVERE STORMS & FLOODING	6	$503,545
447	1974, JUL 23	NY	2	SEVERE STORMS & FLOODING	4	$543,401
448	1974, SEP 23	LA	6	HURRICANE CARMEN	10	$528,440
450	1974, NOV 1	LA	6	SEVERE STORMS	1	$3,210

452	1974, NOV 14	AK	10	SEVERE STORMS & FLOODING	1	$118,027
453	1974, NOV 26	OK	6	SEVERE STORMS & FLOODING	13	$1,223,218
454	1974, NOV 30	TX	6	SEVERE STORMS & FLOODING	10	$751,100
456	1975, JAN 30	MS	4	TORNADOES	2	$5,300
457	1975, FEB 15	TX	6	SEVERE STORMS & FLOODING	1	$115,523
458	1975, MAR 14	AL	4	SEVERE STORMS & FLOODING	23	$692,358
459	1975, MAR 22	TN	4	SEVERE STORMS & FLOODING	46	$5,514,297
460	1975, MAR 29	GA	4	TORNADOES, HIGH WINDS & HEAVY RAINS	1	$0
461	1975, MAR 29	KY	4	SEVERE STORMS & FLOODING	17	$1,323,111
462	1975, APR 1	TX	6	TORNADOES	1	$2,958
463	1975, APR 1	AR	6	SEVERE STORMS & TORNADOES	1	$60,338
464	1975, APR 23	AL	4	SEVERE STORMS & FLOODING	8	$1,006,413
465	1975, APR 26	MI	5	SEVERE STORMS, HIGH WINDS & FLOODING	17	$1,392,761
466	1975, MAY 3	MO	7	TORNADOES, HAIL & HEAVY WINDS	4	$4,516
467	1975, MAY 7	NE	7	SEVERE STORMS & TORNADOES	3	$50,758
468	1975, MAY 24	KY	4	SEVERE STORMS & FLOODING	4	$1,240,429
469	1975, MAY 24	ND	8	FLOODING FROM RAINS & SNOWMELT	15	$766,623
470	1975, JUN 6	LA	6	HEAVY RAINS, FLOODING & TORNADOES	12	$1,542,675
471	1975, JUN 7	AR	6	HEAVY RAINS & FLOODING	7	$323,455
472	1975, JUN 28	MT	8	RAINS SNOWMELT SEVERE STORMS & FLOODS	14	$1,364,859
473	1975, JUL 5	MN	5	FLOODING	1	$160,817
474	1975, JUL 9	OK	6	SEVERE STORMS, FLOODING & TORNADOES	10	$600,772
475	1975, JUL 11	ND	8	SEVERE STORMS & FLOODING	13	$2,006,232
476	1975, JUL 17	MN	5	SEVERE STORMS, TORNADOES & FLOODING	17	$1,507,493
477	1975, JUL 23	NJ	2	HEAVY RAINS, WINDS, HAIL & FLOODS	13	$1,809,008
478	1975, JUL 25	IL	5	TORNADO	1	$1,334
479	1975, AUG 22	FL	4	FLOODING	8	$920,954
480	1975, SEP 11	OH	5	HEAVY RAINS & FLASH FLOODING	4	$711,062
481	1975, SEP 12	WV	3	HEAVY RAINS & FLOODING	2	$372,343
482	1975, SEP 15	WI	5	HEAVY RAINS, TORNADOES & FLASH FLOODS	4	$428,953
484	1975, SEP 26	FL	4	HIGH WINDS, HEAVY RAINS & FLOODS	6	$338,246
485	1975, SEP 26	PA	3	SEVERE STORMS, HEAVY RAINS & FLOODS	30	$16,843,664
486	1975, SEP 30	MI	5	SEVERE STORMS, HIGH WINDS & FLOODS	16	$268,779
487	1975, OCT 2	NY	2	STORMS, RAINS, FLOODS & LANDSLIDES	16	$2,226,912
488	1975, OCT 2	AL	4	WINDS, TORNADOES, RAINS & FLOODING	15	$266,335
489	1975, OCT 4	MD	3	HEAVY RAINS & FLOODING	16	$1,103,219
490	1975, DEC 7	HA	9	EARTHQUAKES, SEISMIC WAVES & VOLCANOES	1	$12,511
491	1975, DEC 10	OK	6	SEVERE STORMS & TORNADOES	2	$1,802
492	1975, DEC 13	WA	10	SEVERE STORMS & FLOODING	12	$1,814,539

493	1975, DEC 18	AK	10	FIRE & FREEZING	1	$798
494	1976, MAR 19	NY	2	ICE STORMS ,SEVERE STORMS & FLOODS	7	$308,067
495	1976, MAR 19	MI	5	STORMS, ICE, WIND, FLOODS, TORNADOES	29	$208,209
496	1976, MAR 23	WI	5	SEVERE STORMS, ICING, WINDS & FLOODS	22	$11,737
497	1976, APR 1	OK	6	SEVERE STORMS & TORNADOES	2	$364
498	1976, APR 1	AR	6	TORNADOES	4	$6,563
499	1976, APR 1	MS	4	SEVERE STORMS, TORNADOES & FLOODS	4	$76,587
500	1976, APR 8	NE	7	ICE STORMS & HIGH WINDS	20	$0
501	1976, APR 16	ND	8	FLOODING	9	$1,810,849
504	1976, JUN 5	OK	6	SEVERE STORMS & FLOODING	2	$36,967
505	1976, JUN 6	ID	10	DAM COLLAPSE, FLOODING	5	$3,547,817
507	1976, JUN 11	GA	4	SEVERE STORMS & FLOODING	8	$406,556
509	1976, JUN 18	IL	5	SEVERE STORMS, TORNADOES & FLOODS	2	$2,676
510	1976, JUN 19	TX	6	SEVERE STORMS & FLOODING	1	$51,009
511	1976, JUN 25	SD	8	FLASH FLOODING & MUDSLIDES	4	$960,065
512	1976, JUN 29	NY	2	FLASH FLOODING	2	$1,114,848
513	1976, JUL 7	PA	3	HIGH WINDS & FLASH FLOODING	2	$2,085,632
514	1976, JUL 13	KS	7	SEVERE STORMS, HIGH WINDS & FLOODS	10	$1,128,275
515	1976, JUL 21	NY	2	SEVERE STORMS & FLOODS	7	$1,483,057
516	1976, JUL 21	MO	7	SEVERE STORMS & FLOODING	4	$201,607
517	1976, AUG 2	CO	8	SEVERE STORMS & FLASH FLOODING	4	$3,630,821
518	1976, AUG 5	VT	1	SEVERE STORMS, WINDS & FLOODING	12	$6,147,905
519	1976, AUG 21	NJ	2	SEVERE STORMS, WINDS & FLOODING	4	$126,501
520	1976, SEP 3	NY	2	HURRICANE BELLE	3	$302,473
521	1976, SEP 21	CA	9	FLOODS FROM TROPICAL STORM KATHLEEN	3	$1,992,713
522	1976, OCT 14	MD	3	SEVERE STORMS & FLOODING	2	$1,193,422
523	1976, OCT 20	PA	3	SEVERE STORMS & FLOODING	21	$4,144,704
524	1977, JAN 26	MD	3	ICE CONDITIONS	16	$0
525	1977, JAN 26	VA	3	ICE CONDITIONS	** 39	$0
526	1977, JAN 31	FL	4	SEVERE WINTER WEATHER	35	$0
527	1977, FEB 5	NY	2	SNOWSTORMS	9	$4,112,607
528	1977, FEB 8	NJ	2	ICE CONDITIONS	10	$0
529	1977, APR 6	KY	4	SEVERE STROMS & FLOODING	15	$4,109,422
530	1977, APR 7	VA	3	SEVERE STROMS & FLOODING	* 16	$10,684,916
531	1977, APR 7	WV	3	SEVERE STROMS & FLOODING	11	$6,209,734
532	1977, APR 9	AL	4	SEVERE STROMS & FLOODING	9	$805,090
533	1977, APR 29	TN	4	SEVERE STROMS & FLOODING	6	$2,341,553
534	1977, MAY 2	LA	6	SEVERE STROMS & FLOODING	8	$273,986
535	1977, MAY 7	MO	7	TORNADOES & FLOODING	7	$29,362

536	1977, JUN 2	GA	4	SHRIMP LOSS FROM COLD WEATHER	6	$0
537	1977, JUL 21	PA	3	SEVERE STORMS & FLOODING	8	$18,615,244
538	1977, SEP 14	MO	7	SEVERE STORMS & FLOODING	6	$1,238,855
539	1977, SEP 20	KS	7	SEVERE STORMS & FLOODING	10	$1,509,329
540	1977, NOV 4	AZ	9	SEVERE STORMS & FLOODING	3	$1,268,127
541	1977, NOV 7	GA	4	DAM COLLAPSE, FLOODING	1	$206,442
542	1977, NOV 9	NC	4	SEVERE STORMS & FLOODING	16	$12,340,280
543	1977, NOV 12	VA	3	SEVERE STORMS & FLOODING	* 8	$1,361,071
544	1977, NOV 12	TN	4	SEVERE STORMS & FLOODING	6	$1,696,056
545	1977, DEC 10	WA	10	SEVERE STORMS, MUDSLIDES & FLOODS	19	$1,283,640
546	1978, FEB 10	MA	1	COASTAL STORMS, FLOOD, SNOW & ICE	8	$1,408,618
547	1978, FEB 15	CA	9	COASTAL STORMS, MUDSLIDES & FLOODS	14	$19,551,415
548	1978, FEB 16	RI	1	SNOW & ICE	5	$0
549	1978, FEB 16	NH	1	WINDS, TIDAL SURGE & COASTAL FLOODS	1	$31,354
550	1978, FEB 17	ME	1	WINDS, TIDAL SURGE & COASTAL FLOODS	4	$762,891
551	1978, MAR 4	AZ	9	SEVERE STORMS & FLOODING	11	$2,054,131
552	1978, MAR 24	NE	7	STORMS, ICE JAMS, SNOWMELT & FLOODS	21	$3,088,438
553	1978, MAR 29	IN	5	SEVERE STORMS & FLOODING	2	$176,444
554	1978, APR 17	ND	8	STORMS, ICE JAMS, SNOWMELT & FLOODS	25	$2,439,860
555	1978, APR 22	MN	5	STORMS, ICE JAMS, SNOWMELT & FLOODS	10	$1,293,377
556	1978, MAY 9	LA	6	SEVERE STORMS & FLOODING	4	$413,368
557	1978, MAY 29	WY	8	SEVERE STORMS, FLOODS & MUDSLIDES	12	$1,163,297
558	1978, MAY 29	MT	8	SEVERE STORMS & FLOODING	7	$2,482,578
559	1978, JUL 7	WI	5	SEV STORMS, FLOODS, HAIL & TORNADOES	16	$4,011,732
560	1978, JUL 8	MN	5	SEV STORMS, FLOODS, HAIL & TORNADOES	17	$3,312,945
561	1978, AUG 8	TX	6	SEVERE STORMS & FLOODING	8	$3,022,702
563	1978, AUG 20	AL	4	SEVERE STORMS & FLOODING	1	$284,443
564	1978, SEP 15	AR	6	SEVERE STORMS & FLOODING	2	$343,035
565	1978, SEP 20	LA	6	SEVERE STORMS & FLOODING	2	$197,429
566	1978, OCT 9	CA	9	LANDSLIDES	1	$3,106
567	1978, DEC 6	LA	6	SEVERE STORMS & TORNADOES	2	$12,808
568	1978, DEC 12	KY	4	SEVERE STORMS & FLOODING	37	$1,715,908
569	1978, DEC 14	WV	3	SEVERE STORMS & FLOODING	5	$291,784
570	1978, DEC 21	AZ	9	SEVERE STORMS & FLOODING	6	$2,061,032
571	1979, JAN 29	NM	6	FLOODING	5	$954,632
573	1979, MAR 7	HA	9	SEVERE STORMS & FLOODING	1	$987,783
574	1979, APR 11	AR	6	TORNADO	8	$106,888
575	1979, APR 11	TX	6	SEVERE STORMS & TORNADOES	5	$120,392
576	1979, APR 13	OK	6	SEVERE STORMS & TORNADOES	6	$15,571

577	1979, APR 16	MS	4	SEVERE STORMS, TORNADOES & FLOODS	38	$6,830,723
578	1979, APR 18	AL	4	STORMS, WIND & FLOODING	28	$1,752,853
579	1979, APR 21	MO	7	TORNADOES, TORR RAINS & FLOODS	17	$1,923,059
580	1979, APR 26	TX	6	SEVERE STORMS, TORNADOES & FLOODS	7	$1,935,137
581	1979, APR 26	ND	8	SEVERE STORMS, SNOWMELT & FLOODS	42	$13,296,341
582	1979, APR 30	MN	5	SEVERE STORMS & FLOODING	11	$2,974,061
583	1979, APR 30	IL	5	SEVERE STORMS & FLOODING	29	$4,920,580
584	1979, MAY 2	LA	6	SEVERE STORMS & FLOODING	10	$0
585	1979, MAY 7	TN	4	SEVERE STORMS, TORNADOES & FLOODS	14	$3,999,701
586	1979, MAY 15	FL	4	SEVERE STORMS, TORNADOES & FLOODS	4	$0
587	1979, JUN 14	TX	6	SEVERE STORMS & FLOODS	1	$0
588	1979, JUN 15	KS	7	SEVERE STORMS & FLOODS	2	$109,025
589	1979, JUN 23	NM	6	SEVERE STORMS, SNOWMELT & FLOODS	6	$1,675,653
590	1979, JUL 1	IA	7	HIGH WINDS & TORNADOES	6	$22,946
591	1979, JUL 19	WY	8	SEVERE STORMS & TORNADOES	1	$6,600
592	1979, JUL 19	KY	4	SEVERE STORMS & FLASH FLOODS	1	$813,653
593	1979, JUL 20	VA	3	SEVERE STORMS & FLASH FLOODS	1	$2,425,090
594	1979, JUL 27	CA	9	HEAVY RAINS, FLASH FLOODS & MUD FLOWS	1	$415,846
595	1979, JUL 28	TX	6	SEVERE STORMS & FLASH FLOODS	7	$2,407,672
596	1979, JUL 31	IN	5	SEVERE STORMS & FLOODING	18	$1,517,284
598	1979, SEP 13	AL	4	HURRICANE FREDERIC	11	$3,004,081
599	1979, SEP 13	MS	4	HURRICANE FREDERIC	16	$198,684
600	1979, SEP 13	FL	4	HURRICANE FREDERIC	5	$209,389
601	1979, SEP 14	MD	3	SEVERE STORMS, TORNADOES & FLOODS	5	$1,562,253
603	1979, SEP 25	TX	6	SEVERE STORMS & FLOODING	8	$0
604	1979, SEP 25	LA	6	SEVERE STORMS & FLOODING	3	$0
605	1979, SEP 29	NC	4	SEVERE STORMS & FLOODING	1	$0
606	1979, SEP 29	VA	3	SEVERE STORMS & FLOODING	1	$0
607	1979, SEP 29	FL	4	SEVERE STORMS & FLOODING	3	$0
608	1979, OCT 4	CT	1	TORNADO & SEVERE STORMS	1	$0
609	1979, OCT 19	CA	9	EARTHQUAKE	1	$129,628
612	1979, DEC 31	WA	10	STORMS, HIGH TIDES, MUDSLIDES & FLOODS	9	$0
613	1980, FEB 6	HA	9	SEVERE STORMS, HIGH SURF & FLOODS	1	$1,065,524
614	1980, FEB 19	AZ	9	SEVERE STORMS & FLOODING	6	$1,639,322
615	1980, FEB 21	CA	9	SEVERE STORMS, MUDSLIDES & FLOODS	8	$24,837,862
616	1980, APR 9	LA	6	SEVERE STORMS & FLOODING	12	$0
617	1980, APR 16	AR	6	SEVERE STORMS & TORNADOES	5	$0
618	1980, APR 19	MS	4	STORMS FLOOD MUDSLIDE TORNADOES WIND	8	$595,736
619	1980, APR 20	AL	4	SEVERE STORMS, TORNADOES & FLOODS	2	$592,711

620	1980, MAY 15	MO	7	SEVERE STORMS & TORNADOES	1	$0
621	1980, MAY 16	MI	5	SEVERE STORMS & TORNADOES	2	$33,556
622	1980, MAY 21	LA	6	SEVERE STORMS & FLOODING	6	$0
623	1980, MAY 21	WA	10	VOLCANIC ERUPTION (MT ST HELENS)	1	$15,541,372
624	1980, MAY 22	ID	10	VOLCANIC ERUPTION (MT ST HELENS)	8	$54,987
625	1980, JUN 4	NE	7	SEVERE STORMS & TORNADOES	3	$15,657
626	1980, JUL 24	WI	5	SEVERE STORMS & FLOODING	4	$193,278
627	1980, AUG 11	TX	6	HURRICANE ALLEN	12	$1,725,265
628	1980, AUG 15	WV	3	SEVERE STORMS & FLOODING	15	$5,348,583
629	1980, AUG 19	PA	3	SEVERE STORMS & FLOODING	3	$2,717,419
630	1980, AUG 23	OH	5	SEVERE STORMS & FLOODING	7	$1,537,225
631	1980, SEP 8	MI	5	SEVERE STORMS & FLOODING	10	$392,599
632	1980, SEP 26	TX	6	TROPICAL STORM DANIELLE	2	$128,392
633	1980, OCT 2	CA	9	LEVEE BREAK & FLOODING	1	$129,819
635	1980, NOV 27	CA	9	BRUSH & TIMBER FIRES	4	$5,282
636	1981, MAR 17	KY	4	SEWER EXPLOSION	1	$1,583,016
638	1981, APR 10	AL	4	TORNADOES, SEVERE STORMS & FLOODS	1	$44,845
639	1981, MAY 14	AL	4	SEVERE STORMS & FLOODING	1	$222,725
640	1981, MAY 27	MT	8	SEVERE STORMS & FLOODING	10	$2,377,451
641	1981, JUN 15	PA	3	SEVERE STORMS & FLOODING	5	$4,028,171
642	1981, JUN 16	OH	5	SEVERE STORMS, FLOODING & TORNADOES	4	$84,965
643	1981, JUN 30	IL	5	SEVERE STORMS, FLOODING & TORNADOES	4	$410,606
644	1981, JUL 18	KS	7	SEVERE STORMS, FLOODING & TORNADOES	2	$0
645	1981, AUG 28	NV	9	SEVERE STORMS & FLOODING	1	$0
646	1981, SEP 21	TX	6	SEVERE STORMS & FLOODING	1	$516,198
648	1981, OCT 23	TX	6	SEVERE STORMS & FLOODING	9	$1,600,885
649	1981, NOV 4	OK	6	SEVERE STORMS & FLOODING	6	$1,798,930
650	1981, DEC 3	MA	1	URBAN FIRE	1	$13,936
TOTALS						$568,135,711

DISASTER NUMBER	TOTAL FEMA EXPENDITURES	% FEMA TRANSPORT. OF TOTAL EXP.	TOTAL DEAD	CAPITAL OUTLAYS FOR HIGHWAYS BY STATE (000)	MOTOR VEHICLES REGISTERED IN STATE
299	$217,371,932	0.43%	59	$1,183,667	12,367,181
300	$1,834,274	32.57%	0	$291,018	2,163,117
301	$814,713	27.26%	0	$234,219	1,431,732
302	$4,418,862	3.61%	0	$173,904	1,175,836
303	$320,579	0.08%	0	$107,671	1,032,693
304	$7,928,672	0.00%	0	$397,788	4,534,300
305	$234,973	0.00%	0	$255,974	1,859,987
306	$264,155	0.00%	0	$225,850	2,135,635
308	$6,720	80.65%	0	$107,671	1,032,693
309	$217,572	98.73%	0	$243,327	2,002,976
310	$13,664,647	32.47%	0	$354,480	3,737,308
311	$4,943,385	28.19%	0	$784,686	6,890,844
312	$1,283,366	35.77%	4	$741,256	6,023,575
313	$2,056,247	0.64%	0	$639,852	6,984,269
314	$10,000	0.00%	0	$119,972	1,789,483
315	$180,231	0.00%	0	$276,489	1,832,285
316	$644,955	5.12%	0	$1,076,835	12,852,228
317	$100,000	0.00%	0	$167,143	1,887,210
318	$680,163	99.92%	0	$160,648	1,249,152
319	$7,827,310	62.43%	0	$231,084	1,496,115
320	$0	0.00%	0	$601,028	7,315,711
321	$0	0.00%	0	$99,640	1,055,373
322	$2,226,626	31.28%	0	$308,825	2,242,060
323	$6,650,851	6.47%	37	$326,373	873,606
324	$416,380	58.70%	0	$85,462	549,834
325	$7,785,856	5.78%	0	$157,081	2,821,411
326	$1,152,961	12.08%	0	$62,233	536,815
327	$312,970	15.18%	0	$43,473	406,699
328	$2,306,912	20.64%	0	$308,825	2,242,060
329	$2,374,856	79.12%	0	$1,076,835	12,852,228
330	$1,405,233	0.00%	0	$409,878	5,010,537
331	$325,144	84.79%	0	$240,662	2,293,635
332	$659,939	88.90%	0	$343,981	1,967,620

333	$2,836,094	16.69%	0	$601,028	7,315,711
334	$3,135,455	5.19%	0	$308,825	2,242,060
335	$336,239	82.63%	0	$62,110	463,627
336	$24,990,551	29.95%	0	$73,202	462,613
337	$3,865,438	16.26%	0	$427,457	4,835,986
338	$110,457,322	15.20%	0	$889,720	7,006,452
339	$21,114,753	19.95%	0	$309,312	2,602,773
340	$381,657,645	18.75%	0	$591,357	6,311,330
341	$26,336,279	30.29%	0	$249,864	2,130,458
342	$5,028,800	5.78%	0	$1,076,835	12,852,228
343	$510,103	24.42%	0	$177,400	1,301,870
344	$1,715,917	15.60%	0	$326,373	873,606
345	$1,588,263	3.67%	0	$424,957	6,414,345
346	$113,210	62.10%	0	$99,109	695,114
347	$2,172,947	75.61%	0	$300,810	2,368,127
348	$649,419	88.48%	0	$240,463	1,917,075
349	$3,234,956	5.16%	0	$324,373	873,606
350	$4,357,664	44.64%	0	$300,810	2,368,127
351	$1,224,147	7.59%	0	$619,986	5,643,853
352	$524,585	59.71%	0	$225,184	2,359,679
353	$598,842	59.73%	0	$99,109	695,114
354	$1,029,818	59.80%	0	$240,463	1,917,075
355	$180,049	56.86%	0	$591,357	6,311,330
356	$300,000	0.00%	0	$62,233	564,782
357	$200,000	0.00%	0	$157,081	2,821,411
358	$841,534	0.75%	0	$309,312	2,602,773
359	$1,370,161	43.35%	5	$309,312	2,602,773
360	$3,006,790	0.81%	0	$177,400	327,821
361	$567,655	25.82%	0	$99,109	695,114
362	$1,466,593	28.73%	0	$424,951	6,414,345
363	$711,909	5.17%	0	$409,878	5,010,537
364	$5,349,360	45.18%	0	$987,512	13,412,774
365	$651,287	4.88%	0	$581,470	7,815,645
366	$4,790,714	80.90%	0	$227,445	2,466,821
367	$1,382,630	15.30%	0	$891,388	7,319,493
368	$8,822,980	42.80%	0	$170,301	1,312,445
369	$2,145,941	62.24%	0	$202,109	2,353,629
370	$1,377,638	37.99%	0	$280,214	3,170,412
371	$1,650,737	11.41%	0	$428,649	5,239,792

372	$19,664,209	30.75%	0	$255,394	2,727,908
373	$20,769,334	15.01%	0	$539,045	5,951,948
374	$15,418,286	22.08%	0	$287,127	2,057,279
375	$5,113,135	32.73%	0	$104,173	1,185,423
376	$3,241,315	39.30%	0	$228,217	2,472,201
377	$1,916,371	42.23%	0	$440,621	6,644,610
378	$2,242,693	62.12%	0	$130,218	1,777,799
379	$710,636	15.15%	0	$133,957	1,802,567
380	$1,667,281	63.52%	0	$71,017	695,114
381	$473,844	20.16%	0	$305,234	2,090,748
382	$1,325,420	53.67%	0	$227,445	2,466,821
383	$1,590,684	61.78%	0	$65,932	477,780
384	$1,124,442	20.58%	0	$57,342	596,345
385	$5,873,795	43.77%	0	$133,957	1,802,567
386	$1,963,383	43.22%	1	$232,959	1,978,631
387	$984,982	90.60%	0	$487,078	5,347,245
388	$4,236,653	0.05%	0	$202,109	2,353,629
389	$1,596,458	0.43%	0	$104,173	1,185,423
390	$1,968,650	85.88%	0	$440,621	6,644,610
391	$294,293	0.00%	0	$280,214	3,170,412
392	$2,016,083	65.80%	0	$160,054	1,984,145
393	$1,355,042	91.28%	0	$581,470	7,815,645
394	$396,066	60.62%	0	$256,884	3,445,377
395	$2,036,122	87.45%	0	$227,445	2,466,821
396	$1,176,955	23.09%	0	$133,957	1,802,567
397	$15,549,674	73.17%	0	$43,004	274,563
398	$2,205,927	61.77%	0	$581,470	7,815,645
399	$4,403,520	71.40%	0	$52,160	462,140
400	$5,193,907	80.63%	0	$635,786	6,674,740
401	$3,760,962	68.80%	0	$891,388	7,319,493
402	$4,795,698	51.54%	0	$401,165	4,073,749
403	$4,582,234	54.91%	0	$130,218	1,777,799
404	$4,464,805	16.11%	0	$160,054	1,984,145
405	$1,642,657	1.53%	0	$188,672	2,951,795
406	$2,114,761	77.52%	0	$112,235	1,096,840
407	$1,990,610	74.22%	0	$255,394	2,727,908
408	$1,637,488	0.00%	0	$104,173	1,185,423
409	$654,438	52.17%	0	$160,054	1,984,145
410	$2,012,763	67.35%	0	$57,504	637,155

411	$326,390	71.01%	0	$48,679	490,303
412	$7,304,432	77.11%	3	$993,339	13,684,399
413	$5,255,498	53.15%	0	$189,664	1,579,736
414	$2,677,545	70.33%	0	$254,850	2,444,446
415	$3,345,511	64.68%	0	$78,536	633,103
416	$321,529	8.87%	0	$245,402	935,397
417	$1,189,585	55.99%	0	$83,697	585,330
418	$1,878,655	37.62%	0	$356,981	2,134,526
419	$470,896	27.93%	0	$182,213	2,040,649
420	$15,712,306	0.81%	0	$164,250	2,164,060
421	$22,417,351	2.17%	25	$448,509	6,965,481
422	$8,131,945	1.13%	0	$231,959	2,409,753
423	$13,266,172	2.27%	0	$253,482	3,268,516
424	$4,906,272	7.14%	0	$267,142	2,568,381
425	$556,522	12.62%	0	$364,274	3,243,807
426	$25,628	0.00%	0	$245,402	935,397
427	$257,486	0.19%	0	$631,567	6,174,102
428	$283,737	0.00%	0	$246,005	3,569,769
429	$142,359	0.94%	0	$527,104	5,400,904
430	$4,315,652	25.42%	0	$212,877	1,341,245
431	$360,263	0.18%	0	$232,763	2,577,566
432	$2,923,740	96.15%	0	$993,339	13,684,399
433	$76,546	0.00%	0	$73,698	485,305
434	$1,897,182	52.24%	0	$75,039	526,574
435	$451,597	19.16%	0	$195,196	1,245,543
436	$1,278,151	16.32%	0	$448,509	6,965,481
437	$2,894,951	42.52%	0	$195,196	1,245,543
438	$8,926,208	38.76%	0	$631,567	6,174,102
439	$3,228,146	58.14%	3	$303,644	2,809,846
440	$1,917,141	44.13%	0	$332,117	2,532,219
441	$4,189,164	26.15%	0	$182,213	2,040,649
442	$379,068	0.11%	0	$164,250	1,785,327
443	$2,996,777	44.96%	0	$293,469	2,033,686
444	$520,686	0.00%	0	$131,279	1,245,543
445	$883,413	22.45%	0	$448,509	6,965,481
446	$854,430	58.93%	0	$332,117	2,532,219
447	$2,009,745	27.04%	0	$831,100	7,457,802
448	$4,560,004	11.59%	0	$356,981	2,134,526
450	$360,497	0.89%	0	$356,981	2,134,526

452	$3,148,853	3.75%	0	$131,279	1,245,543
453	$2,262,157	54.07%	0	$182,213	2,040,699
454	$2,163,990	34.71%	0	$706,779	8,053,269
456	$715,223	0.74%	0	$266,326	1,341,245
457	$529,779	21.81%	0	$878,825	8,396,489
458	$1,874,106	36.94%	0	$243,571	2,492,785
459	$6,694,359	82.37%	0	$366,520	2,727,133
460	$1,433,428	0.00%	0	$380,703	3,210,973
461	$2,038,869	64.89%	0	$305,977	2,245,138
462	$336,732	0.88%	0	$878,825	8,396,489
463	$533,039	11.32%	0	$247,352	1,283,331
464	$1,496,619	67.25%	0	$243,571	2,492,785
465	$5,275,637	26.40%	0	$503,980	5,545,460
466	$390,885	1.16%	0	$307,421	2,809,846
467	$3,494,266	1.45%	3	$178,994	1,165,040
468	$2,289,803	54.17%	0	$305,977	2,245,138
469	$1,715,592	44.69%	0	$90,973	550,827
470	$4,726,681	32.64%	0	$424,055	2,187,521
471	$418,465	77.30%	0	$247,352	1,283,331
472	$3,613,923	37.77%	0	$104,571	611,487
473	$194,219	82.80%	0	$322,698	2,524,517
474	$1,291,496	46.52%	0	$167,611	2,112,733
475	$5,649,059	35.51%	0	$90,973	550,827
476	$4,393,279	34.31%	0	$322,698	2,524,517
477	$7,841,857	23.07%	6	$247,267	4,154,542
478	$350,754	0.38%	3	$658,347	6,343,875
479	$1,448,181	63.59%	0	$567,168	5,395,372
480	$5,033,130	14.13%	0	$487,512	7,178,933
481	$5,436,131	6.85%	2	$256,953	966,009
482	$699,878	61.29%	0	$307,366	2,590,709
484	$6,670,508	5.07%	0	$567,168	5,395,372
485	$32,914,314	51.17%	0	$798,471	7,659,305
486	$733,458	36.65%	0	$503,980	5,545,460
487	$7,166,514	31.07%	3	$698,793	7,591,358
488	$5,907,259	4.51%	0	$243,571	2,492,785
489	$2,420,897	45.57%	0	$289,300	2,422,724
490	$831,769	1.50%	2	$94,003	462,011
491	$355,941	0.51%	0	$167,611	2,112,733
492	$7,296,285	24.87%	0	$261,488	2,539,764

493	$7,734,627	0.01%	1	$197,760	1,283,331
494	$10,474,315	2.94%	0	$551,494	7,650,669
495	$10,173,448	2.05%	5	$469,884	5,701,372
496	$6,257,481	0.19%	0	$298,363	2,648,897
497	$353,097	0.10%	0	$156,386	2,214,092
498	$532,532	1.23%	0	$171,606	1,349,047
499	$1,183,170	6.47%	0	$266,653	1,446,036
500	$17,908,181	0.00%	0	$143,815	1,199,311
501	$4,198,804	43.13%	0	$99,360	563,391
504	$943,165	3.92%	0	$156,386	2,214,092
505	$43,518,660	8.15%	0	$95,620	681,587
507	$681,191	59.68%	0	$358,617	3,332,202
509	$1,404,382	0.19%	0	$934,777	6,676,583
510	$8,812,524	0.58%	0	$647,148	8,969,754
511	$1,574,074	60.99%	0	$80,514	541,663
512	$1,309,395	85.14%	0	$99,360	7,650,669
513	$3,334,057	62.56%	0	$757,910	8,127,455
514	$2,168,398	52.03%	1	$221,462	1,873,574
515	$2,798,125	53.00%	1	$551,494	7,650,669
516	$722,626	27.90%	0	$307,880	2,941,091
517	$13,273,330	27.35%	50	$207,776	2,027,288
518	$9,619,218	63.91%	0	$42,220	304,929
519	$4,070,741	3.11%	0	$227,588	4,257,205
520	$8,254,178	3.66%	1	$551,494	7,650,661
521	$9,209,415	21.64%	3	$978,065	14,315,843
522	$1,786,084	66.82%	0	$335,044	2,505,062
523	$7,075,716	58.58%	0	$757,910	8,127,455
524	$1,800,000	0.00%	0	$546,684	2,587,158
525	$1,690,000	0.00%	0	$426,682	3,256,758
526	$20,820,000	0.00%	0	$498,575	6,096,249
527	$44,509,511	9.24%	12	$494,653	7,730,292
528	$501,615	0.00%	0	$176,738	4,407,354
529	$75,809,806	5.42%	0	$329,306	2,449,718
530	$31,956,509	33.44%	7	$426,682	3,256,758
531	$48,867,620	12.71%	2	$244,562	1,136,388
532	$2,162,718	37.23%	26	$282,589	2,673,557
533	$2,860,077	81.87%	0	$297,236	2,962,958
534	$2,345,943	11.68%	3	$382,795	2,421,541
535	$1,509,735	1.94%	3	$287,822	3,052,690

536	$589,500	0.00%	0	$364,778	3,496,304
537	$136,834,694	13.60%	0	$546,684	6,476,892
538	$17,066,178	7.26%	26	$287,795	3,052,690
539	$4,964,399	30.40%	6	$206,557	1,892,796
540	$1,726,376	73.46%	0	$256,644	1,554,194
541	$2,463,989	8.38%	37	$364,778	3,496,304
542	$22,073,881	55.90%	11	$331,093	4,079,328
543	$4,359,327	31.22%	0	$426,682	3,256,158
544	$3,899,127	43.50%	1	$297,236	2,962,958
545	$4,613,762	27.82%	5	$296,614	2,894,880
546	$39,660,857	3.55%	0	$144,406	2,698,592
547	$100,162,344	19.52%	11	$958,384	15,576,901
548	$245,297	0.00%	0	$17,023	654,923
549	$456,157	6.87%	3	$63,185	649,833
550	$2,295,837	33.23%	0	$78,909	707,961
551	$13,515,711	15.20%	3	$303,879	1,664,968
552	$5,169,358	59.75%	0	$171,302	1,221,624
553	$1,929,048	9.15%	0	$225,611	3,738,525
554	$3,690,143	66.12%	0	$97,296	599,135
555	$2,306,190	56.08%	2	$525,355	2,914,894
556	$7,162,932	5.77%	0	$415,674	2,564,893
557	$1,717,566	67.73%	0	$97,599	406,189
558	$6,279,762	39.53%	0	$130,854	826,496
559	$6,809,116	58.92%	2	$277,340	2,776,322
560	$11,487,882	28.84%	4	$525,355	2,914,894
561	$12,804,863	23.61%	0	$948,601	10,151,544
563	$446,861	63.65%	1	$347,144	2,776,477
564	$2,190,959	15.66%	0	$203,557	1,458,544
565	$1,583,895	12.46%	0	$415,674	2,564,893
566	$2,073,920	0.15%	0	$958,384	15,576,901
567	$1,622,651	0.79%	3	$415,674	2,564,893
568	$12,035,008	14.26%	2	$424,303	2,543,890
569	$5,957,804	4.90%	0	$264,864	1,172,111
570	$25,149,814	8.20%	0	$303,879	1,664,968
571	$2,703,920	35.31%	0	$111,384	1,030,853
573	$1,390,067	71.06%	0	$94,429	560,345
574	$1,423,290	7.51%	0	$348,359	1,510,825
575	$35,379,793	0.34%	50	$1,117,301	10,000,946
576	$1,003,038	1.55%	0	$219,206	2,592,077

577	$32,533,457	21.00%	4	$255,611	1,485,410
578	$5,918,574	29.62%	2	$337,830	2,840,715
579	$6,507,934	29.55%	0	$374,387	3,242,142
580	$4,963,392	38.99%	0	$1,117,301	10,000,946
581	$20,923,352	63.55%	1	$139,367	616,493
582	$5,498,461	54.09%	0	$542,148	3,025,537
583	$14,369,428	34.24%	0	$914,923	7,283,506
584	$2,242,961	0.00%	0	$465,351	2,678,469
585	$5,258,282	76.06%	0	$422,522	2,995,304
586	$1,777,403	0.00%	0	$638,427	7,298,962
587	$166,193	0.00%	0	$1,117,301	10,000,946
588	$1,390,062	7.84%	0	$298,586	1,979,092
589	$3,633,794	46.11%	0	$111,384	1,030,853
590	$1,074,529	2.14%	0	$414,320	2,351,431
591	$716,542	0.92%	0	$124,431	457,406
592	$2,382,173	34.16%	3	$532,321	2,605,497
593	$3,941,042	61.53%	2	$518,512	3,510,162
594	$3,349,178	12.42%	0	$1,091,251	16,261,297
595	$8,847,586	27.21%	0	$1,117,301	10,000,946
596	$2,582,815	58.75%	2	$313,085	3,788,823
598	$198,122,678	1.52%	0	$337,830	2,840,715
599	$37,418,215	0.53%	0	$255,611	1,485,410
600	$5,212,770	4.02%	0	$638,427	7,298,962
601	$11,702,472	13.35%	1	$384,905	2,767,461
603	$2,935,901	0.00%	4	$1,117,301	10,000,946
604	$1,056,800	0.00%	0	$465,351	2,678,469
605	$250,440	0.00%	0	$411,553	4,446,565
606	$557,579	0.00%	0	$518,512	3,510,162
607	$575,522	0.00%	0	$638,427	7,298,962
608	$594,267	0.00%	1	$136,540	2,206,202
609	$8,156,155	1.59%	0	$1,091,251	16,261,297
612	$222,415	0.00%	0	$514,770	3,131,151
613	$2,623,950	40.61%	0	$85,381	569,802
614	$12,406,812	13.21%	3	$415,022	1,916,753
615	$120,471,708	20.62%	0	$1,288,474	16,873,117
616	$2,224,100	0.00%	0	$570,058	2,779,457
617	$278,600	0.00%	0	$294,978	1,573,718
618	$4,069,886	14.64%	0	$330,865	1,576,774
619	$4,169,666	14.21%	0	$346,444	2,938,108

620	$201,111	0.00%	0	$317,297	3,271,286
621	$751,435	4.47%	0	$566,721	6,488,070
622	$2,257,661	0.00%	0	$570,058	2,779,457
623	$45,572,571	34.10%	0	$588,518	3,225,262
624	$2,422,100	2.27%	0	$115,129	834,068
625	$5,370,023	0.29%	0	$208,046	1,254,095
626	$3,607,486	5.36%	0	$395,982	2,940,911
627	$33,880,387	5.09%	0	$1,801,932	10,474,816
628	$8,357,108	64.00%	0	$397,163	1,319,915
629	$4,435,559	61.26%	0	$588,321	6,925,855
630	$3,525,853	43.60%	0	$557,984	7,771,236
631	$11,486,905	3.42%	0	$566,721	6,488,010
632	$696,338	18.44%	0	$1,801,932	10,474,816
633	$5,309,802	2.44%	0	$1,288,474	16,873,117
635	$10,563,673	0.05%	0	$1,288,474	16,873,117
636	$17,344,653	9.13%	0	$406,448	2,593,447
638	$726,862	6.17%	0	$373,302	3,011,290
639	$3,887,699	5.73%	0	$373,302	3,011,290
640	$5,482,231	43.37%	0	$200,177	736,152
641	$5,028,221	80.11%	0	$702,307	7,009,902
642	$1,379,118	6.16%	0	$501,759	7,737,264
643	$2,469,686	16.63%	0	$921,915	7,597,068
644	$1,948,500	0.00%	0	$921,915	2,023,408
645	$214,089	0.00%	0	$295,850	697,178
646	$965,248	53.48%	0	$1,061,006	11,123,150
648	$4,453,213	35.95%	0	$1,601,006	11,123,150
649	$2,349,904	76.55%	0	$288,435	2,614,381
650	$2,440,957	0.57%	0	$295,491	2,851,581
	$3,001,866,271		461	$129,956,785	1,261,596,335

FEMA Data: The Screening Problem

In order to better manage information resulting from the disaster assistance program an automated data system was developed, the Disaster Management Information System (DMIS). The DMIS automates information on project financing, disbursements, obligations, applications, and other project management data. However, in collecting data from FEMA headquarters office a number of limitations in data were identified.

Data was collected from both headquarters and the region four FEMA office. The DMIS was the primary source of information and six documents (printouts) were available from headquarters in Washington, D. C. These are:

Document Number One: DSR Summary Report
Contains two pieces of information: Road system damage and the number of deaths.

Document Number Two: DMIS 1.1 Disaster Declarations
Printout which identifies the disaster number, the date of declaration, the state, the type of disaster, and the date the case was closed.

Document Number Three: DMIS 1.4 County Designations
Identifies the Date of declaration, date the disaster occurred, the type of disaster and the counties involved.

Document Number Four: DMIS 2.5 Amounts Approved List
Summarizes the amounts approved by work category.

Document Number Five: DMIS D.1 DSR Summary

Identifies the federal agencies involved, number of DSR's and eligible surveys.

Document Number Six: DMIS Report R.5 Public Assistance Summary: Identifies the current estimate of eligible assistance, DSR workload, and project applications and supplements.

Information was collected from the region four office in Atlanta, Georgia. Individual files were evaluated and the following data collected: date and type of disaster; counties affected; damage to property and facilities; deaths and injuries; estimate of resulting unemployment; transportation damage; number of evacuees and estimates of damage. Thus there is a great deal more information available at the regional level where we have access to individual files. This capability does not exist at the federal level. However, the kind of information available at the regional level is more appropriate to the development of impact scenarios for the transportation system.

FHWA's Emergency-Relief Program allocates monies to repair damage to highways on the Federal-aid system and other roads on federal lands. Damage must be the result of a natural disaster or catastrophic failure. Approximately $100 million is appropriated annually from the Highway Trust Fund for the program which intended to supplement activities the State Highway Agencies typically performs. State Highway Agencies (SHA) make application to FHWA after the disaster through a Notice Of Intent (NOI). FHWA has a division office in each state and it transmits information

to the headquarters office. Field engineers from headquarters, and representatives from the SHA and local government conduct a preliminary field survey. Once FHWA receives the NOI it authorizes the state to begin work which is compensated for later through the Emergency Relief program. The SHA actually makes application to FHWA for relief funds. The application must include information on the governor's proclamation; the disaster and the affected area; estimates of repair cost; and identification of the type of damage done.

It is required that program data for Emergency Relief projects be kept to a minimum focusing on collection of information basic to a determination of eligibility. The FHWA headquarters office obligates funds for each disaster based on current needs. The program operates on a pay-as-you-go basis therefore funds are dispensed as work is completed.

FHWA Data: The Screening Problem

The following data was available on computer printouts and was collected from FHWA headquarters office. This included about five documents. These are:

Document Number One: Emergency Relief by Flood Year Includes information on type of appropriation: total cost estimate for each disaster ; total obligation (actual expenditure) and the number of disasters for each state.

Document Number Two: Historical Data

Estimates of disaster cost for the state, federal government and total cost. Information on emergency relief obligations by state,and the federal government.

Document Number Three: Summary Data

Includes the number of disasters occurring in a specific year and their estimated cost. The amount of money actually obligated in a particular year and the amount congress authorized FHWA to spend.

Document Number Four: Fiscal Year Approvals

Contains brief descriptions of the disaster and the state it occurred in. Identifies the amount of money estimated for the disaster.

Document Number Five: Allocation Data

Information on the amount of money allocated for each state for each year 1971-1981.These are not expenditures.

In addition to the information listed in the five documents data was collected from the disaster files kept in headquarters. From these files, governor's letters, and additional letters written to or by FHWA information was collected on the type of disaster, the incident period, the counties involved, the lives lost, revised disaster figures, and initial estimates of disaster cost. Extensive miscellaneous notes were recorded for each file. Table 3 lists information on all FWHA disasters by state and other relevant information. In all there were 158 disasters receiving FWHA allocations between 1971 and 1981. A more extensive analysis of these disasters is given in the empirical section below.

TABLE 3 : LIST OF FHWA DISASTERS BY STATE, DATE AND TYPE, 1971-1981

DATE	DISASTER TYPE	PROCLAMATION DATE BY GOVERNOR
1973, Mar. 14	Floods and Tornadoes	1973, March 28 (Incl)
1975, Feb 15-28, and April 9-14	Floods and Storms	1975, Mar 25 & April 23 (not incl)
1975, Sep 23-24	Hurricane Eloise	
1977, April 4-6	Heavy Rains and Tornado	1977, April 14 (incl)
1978, Jan 24-27	Heavy Rains	1978, Feb 16 (not incl)
1979, March 4	Sinkhole	Included but date cut-off
1979, March 3-4	Floods, Rains and winds	1979, April 19 (incl)
1979, April 12-14	Floods and heavy rains	1979, June 1 (incl)
1979, Sept 12-14	Hurricane Frederic	
1980, April 12-13	Floods and heavy rains	1980, June 10 (Not incl)
1971, Aug 8	Floods	1971, Aug 13 (incl)
1973, Oct 27	Floods (catastrophic)	1973, Oct 30 (not incl)
1974, Nov 10-11	Floods and storms	1974, Nov 12 (incl)
1978, Nov 7-10	Storm and Tidal action	1978, Nov 24 (incl)
1981, Aug 7-8	Floods (catastrophic)	1981, Aug 17 (not incl)
1972, Oct 18-29	Floods and Rains	1972, Nov 16 (Incl)
1977, Oct 6-11	Storms	
1978, Feb 27-March 26	Storms	
1978-1979 Winter	Storms	
1980, Feb 13-22	Floods and Heavy Rains	1980, Feb 15 (not incl)
1973, April-May	Floods and Heavy Rains	
1974, June	Ouachita Nat'l Forest Disaster	
1971, Feb 9	Earthquake	1971, Feb 11 (incl)
1972, Jan 21-March	Floods, Excessive Rains	1972, April 11 (Incl)
1974, Jan 14 - April 1	Storms	1974, Jan 31 (not incl)
1976, Sept 10	Tropical Storm Kathleen	
1978, Jan 13-20	High tides and heavy seas	
1978, Jan & March *	Storms	
1980, March 16	Landslide	1980, April 21 (not incl)
1980, Jan-March	Storms	1980, Feb 7, 19 and 21 (3 procl's)
1980, Nov 8	Earthquake	1980, Nov 21 (not incl)
1981, Jan 18-22	High Winds, Tides and Heavy Seas	1981, March 9 (not incl)
1981, Dec 19 - 1982, Jan 8	Floods and storms	1982, Jan 5, 9, 12, 15 *
1973, May 6	Floods, Severe	1973, May 21 (incl)

1976, July 31	Flood: Big Thompson Canyon	
1972, June 18-23	Hurricane Agnes, high tides	1972, June 22 (not incl)
1973, April 1-7	Flash Floods and rains	1973, July 5 (incl)
1975, July 28-Aug 6	Storms	1975, Aug 22 (exec order not incl)
1975, July 28	Hurricane Eloise	1975, Oct 7 (amended proc incl)
1979, Feb 24- Mar 4	Floods, heavy rainfall	1979, March 7 (incl)
1979, Sept 12	Hurricane Frederick	
1973, March 14-19	Floods and Heavy Rains	1973 April 26 (not incl)
1975 Nov 29	Earthquake and Tsunami	1975 Dec 4 (not incl)
1974, Jan	Floods	
1980, Dec	Floods	
1973, March-May	Floods	1973, April 13 (not incl)
1974, May-June	Floods	
1979, March	Floods	1979, March 9 (incl)
1977, Aug 6	Flash flooding	1977, Aug 11 (not incl)
1979, July, (mid)	Floods	1979, July 26 (incl)
1972, July 11 - Aug 1	Floods	1972, Sept 26 (not incl)
1973, April	Floods and Storms	1973, June 11 (incl)
1974, April 19-22	Floods and Storms	1974, April 30 (not incl)
?	Heavy rains/landslide	
1977, April	Flood	
1979, July (mid)	Floods	1979, July 16 (not incl)
1973, April	Floods	1973, April 30 (incl)
1973, Dec 16	Floods and heavy rains	1974, Feb 6 (not incl)
1976, Feb 1-2	Floods, hurricane force winds	-
1978, Feb 6-8	Coastal Floods, blizzard	
1972, June 21-22	Tropical storm Agnes	1972, June 26 (incl)
1975, Sept 22-26	Floods and heavy rains	1975, Oct 4 (Pres. decl)
1976, Oct 8-10	Floods and severe storms	1976, Oct 12 (letter to Pres)
1979, Sept 5-6		? included, no date
1978, Feb 6-7	Coastal Storm, Blizzard	
1972, Aug 16	Heavy rains	1972, Sept 30 (incl)
1973, March 16-18	Floods along lakeshore, heavy winds	1973, March 17 Amended procl (incl)
1974, April 18-19	Heavy rains, high winds	1974, April 20 (not incl)
1975, Aug 21-Sept 5	Heavy rains	
1972, July 21-23	Floods and storms	1972, July 26 (incl)
1972, Aug 15-22	Floods	1972, Aug 25 (not incl)
1972, Sept 20	Floods	1972, Sept 28 (not incl)
1975, June 28-July 23	Floods and heavy rains	1975, July 28 (incl)

1977, Sept 23-25	Floods and heavy rains	1977, Sept 26 (incl)
1978, June 25-July 8	Floods and heavy rains	1978, July 7 request for pres decl
1971, Dec 5-7	Floods	
1973, March 14-May	Floods	1973, March 20 & April 16 (not inc)
1974, April	Floods	
1976, March 12	Landslide	1976, March 26 (incl)
1975, Aug 1 (?)	Landslide	
1977, Nov 21	Heavy rains	1977, Nov 22 (incl)
1979, April 8	Floods and heavy rains	1979, April 13 (not incl)
1979, Sept	*Hurricane Frederic*	1979, Sept 12 (not incl)
1973, March-May	Floods	1973, June 6 (not incl)
1975 June	Floods from rains & melt-off	1975 June 19 & 21 (not incl)
1978, May (mid)	Floods	
1981, May	Floods	1981, May 26 (not incl)
1971, Feb 17-19	Floods	
1973, Sept 25-Oct 15	Floods and storms	1973, Nov 14 ? (not incl)
1975, May 6	Tornado	1975, June 24 (not incl)
1978, March 13-27	Floods, heavy rains & snowmelt	1978, March 15 (incl)
1973, June 27-July 5	Floods	
1973, Aug 1-3	Floods	1973, Aug 3 (not incl)
1975, July 13-22	Floods	1975, Aug 3 (not incl)
1979, May 7	Fire, bridge	
1972, June	Hurricane Agnes	
	Hurricane Eloise	
1976, June 18-19, July 11-12	Floods and heavy rains	1976, June 29 & July 21 (Pres)
1973, May 27-28	Floods and storms	1973, May 31 (not incl)
1975, Feb	Bridge collapse (catastrophic)	1975, Feb 24 (not incl)
1977, Nov	Floods and storms	1977, Dec 9 & 14 (letters to Pres)
1974, April and May	Storms	
1975, Spring	Floods	1975, June 26 (not incl)
1975, Summer	Floods	1975, Aug 11 (not incl)
1976 Floods		
1978, March (mid)	Floods and ice jams	
1979, April	Floods	1979, April 26 (Pres decl)
1974, April 3	Tornado (?)	
1975, Aug 24-31	Floods and rains	1975, Oct 2 (incl)
1980, Aug 11	Floods and heavy rains	1980, Aug 19 & Sept 16 (not incl)
1971, Dec 9	Floods and storms	
1973, April (early)	Floods and heavy rains	1973, April 24 (not incl)

1973, Oct 10-13	Floods	1973, Oct 17 (not incl)
1974	Bridge failure -catastrophic	
1972, Jan 11-24	Floods	
1974, Jan 14 -	Floods and severe storms	1974, Jan 15 & 21 (not incl)
1980, Dec 25	Flash flooding, mud slides	1980, Dec 30 (not incl)
1971, Sept 11-14	Floods and heavy rains	1971, Sept 14 & 16 (not incl)
1972, June 18-23	Hurricane Agnes - Floods	1972, June 22 (not incl)
1973, June 28-July 4	Floods	
1975, Sept 22-27	Hurricane Eloise - Floods	
1976, June 8-10	Floods, heavy rains & winds	1976, June 25 (incl)
1976, Oct 8-22	Floods and storms	1976, Oct 20 Pres decl (incl)
1977, July 19-20	Floods	1977, July 20 (not incl)
1980, Aug 14-15	Floods and storms	1980, Aug 15 (not incl)
1981, June 8-9	Floods and storms	1981, June 10 (incl)
1978, Feb 6-7	Coastal Flooding, Blizzard	1978, Feb 13, (not incl)
1972, June 9-10	Floods	1972, June 19 (not incl)
1976, June	Storms	
1972, April 12	Floods and storms	
1973, March 16-18	Floods	1973, March 23 (not incl)
1975, March 11-16	Floods	1975, April 22 (not incl)
1977, April 4-7	Storms, heavy rains	1977, April 8 -letter to Pres
1978, Aug (early)	Floods and heavy rains	1978, Aug 2 telegram to Pres
1980, Aug 8 -	Hurricane Allen	1980, Aug 8 (not incl)
1973, June 30	Floods	1973, Aug 8 (not incl)
1976, July 11 & Aug 9-19	Floods and storms	1976, July 29 (incl)
1972, June 20-23	Floods	
1972, Oct 5-6	Floods and storms	1972, Oct 9 (incl)
1979 July (mid)	Floods	1979, July 17 (not incl)
1971, Jan 9-Feb 1	Heavy rains, snowmelt & slides	1971, Feb 4 (incl)
1974, Jan	Storms	
1975, Nov 30-Dec 8	Storms	
1976, Aug 6	Flash floods and storms	
1977, Dec 1-17	Floods and storms	1977, Dec 2 (incl)
1979, Feb 13	Heavy winds	
1980, Dec 24-27	Floods and heavy rains	1980, Dec 31 & 1981, Jan 16(not in)
1972, Aug 18-19	Floods	1972, Aug 21 (not incl)
1972, Feb (late)	Floods	1972, Feb 26 (not incl)
1974, Jan 9-12	Floods	1974, Jan 16 (not incl)
1975, Aug	Floods and heavy rains	1975, Sept 1 (incl)

1977, April	Floods	
1977, Aug 12-15	Floods, severe storms & landslides	1977, Aug 24 (not incl)
1978, Dec 7-12	Floods and heavy rains	1978, Dec 18 (not incl)
1980, Aug 9-21	Floods and heavy rains	1980, Aug 21 (not incl)
1972, Aug-Sept	Floods	1980, Aug 31 (not incl)
1973, April 21	Floods and storms	1973, May 4 (not incl)
1975, Aug 23 & Sept 11	Floods and storms	1975, Sept 8 (not incl)
1978, June 25-July 6	Floods	

STATE	DATE	FHWA APPROVAL DATE FOR EMERGENCY RELIEF	NUMBER OF COUNTIES APPROVED APPROVED FOR EMERGENCY RELIEF	LEVEL OF FUNDING RECEIVED FROM FHWA
Al	1973, Mar. 14		24 in procl	
Al	1975, Feb 15-28, and April 9-14	1975, June 18	13	100%
Al	1975, Sep 23-24	1976, June 12		100%
Al	1977, April 4-6	1977, June 8	1 (9 in procl)	100%
Al	1978, Jan 24-27	1978, March 16	11	100%
Al	1979, March 4	1979, March 23 (regional) Fed ?	1	100% Requested
Al	1979, March 3-4	1979, June 8	4 (16 in procl)	100%
Al	1979, April 12-14	1979, July 5	18	100%
Al	1979, Sept 12-14	1979, Oct 5	2	100%
Al	1980, April 12-13	1980, June 18	1	100%
Ak	1971, Aug 8	1972, Feb 4	3 Boroughs	
Ak	1973, Oct 27	1973, Nov 9		
Ak	1974, Nov 10-11	1974, Dec 31		
Ak	1978, Nov 7-10	1979, Oct 12		100%
Ak	1981, Aug 7-8	1981, Sept 29		100%
Az	1972, Oct 18-29	1972, Dec 27		100%
Az	1977, Oct 6-11	1978, Jan 11		70%
Az	1978, Feb 27-March 26	1978, March 26	5	100%
Az	1978-1979 Winter	1979, May 14	7	
Az	1980, Feb 13-22		3	100%
Ar	1973, April-May	1973, July 13		
Ar	1974, June			
Ca	1971, Feb 9	1971, Feb 22	1	100%
Ca	1972, Jan 21-March	1972, June 10	3 in procl	
Ca	1974, Jan 14 - April 1	1974, May 7 and Dec 6 *	6	100%
Ca	1976, Sept 10	1976, Dec 22	6	100%
Ca	1978, Jan 13-20	1978, May 10	2	100%
Ca	1978, Jan & March *	? (Sept 15, 1978 for BLM Roads)		80%/20% Recommended
Ca	1980, March 16	1980, Aug 29	1	100%
Ca	1980, Jan-March	1980, Aug 20	7	100%
Ca	1980, Nov 8	1981, Feb 2	1	100%
Ca	1981, Jan 18-22	1981, March 29	1	100%
Ca	1981, Dec 19 - 1982, Jan 8	1982, March 16	7	100%
Co	1973, May 6			100%

Co	1976, July 31			100%
Fl	1972, June 18-23	1972, Sept 7	6	100%
Fl	1973, April 1-7		8	
Fl	1975, July 28-Aug 6	1975, Oct 20	8 in procl	100% requested.
Fl	1975, July 28	1976, Feb 23	5 (10 in procl)	70% normal
Fl	1979, Feb 24- Mar 4		2	100% requested
Fl	1979, Sept 12	1979, Oct 22	2	100%
Ga	1973, March 14-19	1973, June 16	4	100%
Ha	1975 Nov 29			100% requested
Id	1974, Jan			
Id	1980, Dec	1981, April 27 (?)		
Il	1973, March-May	1973, May 24	37	100%
Il	1974, May-June		50	100% requested
Il	1979, March	1979, July 30	19	100%
In	1977, Aug 6	1977, Sept 6	1	
In	1979, July, (mid)	1979, Oct 9	5	100%
Ia	1972, July 11 - Aug 1	1972 Dec 45	1 (4 requested)	100%
Ia	1973, April	1973, July 30	9	100%
Ks	1974, April 19-22	1974, July 13	1 (5 requested)	70% (100% requested)
Ky	?	1973, Aug 31		
Ky	1977, April			
Ky	1979, July (mid)	1979, Sept 24	1	100%
La	1973, April	1973, Aug 27		100%
Me	1973, Dec 16	1974, April 8		100%
Me	1976, Feb 1-2		1	100%
Me	1978, Feb 6-8	1978, April 24	4 (?)	100%
Md	1972, June 21-22	1972, July 18	11	100%
Md	1975, Sept 22-26		10 in procl	100% requested
Md	1976, Oct 8-10	1977, Feb 3	1	100%
Md	1979, Sept 5-6		5 in procl	
Ma	1978, Feb 6-7	1978, June 1		100%
Mi	1972, Aug 16	1972, Nov 24	1	100%
Mi	1973, March 16-18	1973, Aug 29	4 (17 in procl)	
Mi	1974, April 18-19	1975, April 14	10	100%
Mi	1975, Aug 21-Sept 5	DENIED: 1976, Feb 13	10	
Mn	1972, July 21-23	1972, Aug 30		100%
Mn	1972, Aug 15-22	1972, Oct 26		100%
Mn	1972, Sept 20	1972, Nov 22		100%
Mn	1975, June 28-July 23	1975, Dec 3	10 (14 in procl)	70%

Mn	1977, Sept 23-25	1977, Nov 9	2	100%
Mn	1978, June 25-July 8	1978, Oct 5	13 (18 requested)	100%
Ms	1971, Dec 5-7	1972, Aug 31 (initial program)		100%
Ms	1973, March 14-May	1973, June 26		100%
Ms	1974, April			
Ms	1976, March 12	1976, June 11	2	100%
Ms	1975, Aug 1 (?)		1	70%
Ms	1977, Nov 21	1978 Feb 8	1	100%
Ms	1979, April 8	1979, July 30	18	100%
Ms	1979, Sept	1980, Jan 10	3	100%
Mo	1973, March-May	1973, July 31		100%
Mt	1975 June	1975 Aug 8	10 (17 requested)	
Mt	1978, May (mid)	1978, June 28		
Mt	1981, May			100%
Ne	1971, Feb 17-19	1971, April 29		
Ne	1973, Sept 25-Oct 15	1974, Jan 8	9	100%
Ne	1975, May 6	1975, July 2	? 2 cities	100%
Ne	1978, March 13-27	1978, May 17		100%
NH	1973, June 27-July 5			
NJ	1973, Aug 1-3	1973, Sept 19		100%
NJ	1975, July 13-22		6 (7 requested)	70% normal Fed share
NJ	1979, May 7	1979, July 11		
NY	1972, June			
NY		1976, Feb 5	5	70% fed share
NY	1976, June 18-19, July 11-12	1976, Oct 12	6	100%
NC	1973, May 27-28	? incl but no date	22 (but only 9 in procl)	100%
NC	1975, Feb	1975, April 14		100% requested but denied
NC	1977, Nov	1977, Dec 16	14	100%
ND	1974, April and May	1974, Aug 26	10	
ND	1975, Spring	1975, Aug 25	9	
ND	1975, Summer	1975, Oct 29	7 (10 in procl)	
ND	1976 Floods			
ND	1978, March (mid)	1978, July 11		100%
ND	1979, April	1979, June 26	17 (30 requested)	100%
Oh	1974, April 3			
Oh	1975, Aug 24-31	1975, Dec 10	3	70% normal
Oh	1980, Aug 11	1980, Oct 17	1	100%
Ok	1971, Dec 9		10 requested	100% requested
Ok	1973, April (early)	1973, June 26? (not legible)	1	100%

Ok	1973, Oct 10-13	1973 Nov 12	5	100%
Ok	1974		1	
Or	1972, Jan 11-24	1972, April 14		
Or	1974, Jan 14 -	1974, April 8	23	100%
Or	1980, Dec 25	1981, Feb 2		100%
Pa	1971, Sept 11-14	1971, Nov 3	4 (6 requested)	100% requested; denied
Pa	1972, June 18-23	1972, July 14		100%
Pa	1973, June 28-July 4	1973, Oct 25	4 (5 requested)	70%
Pa	1975, Sept 22-27	1975, Nov 19	?	70%
Pa	1976, June 8-10	1976, Sept 8	1	100%
Pa	1976, Oct 8-22	1977, Feb 3	7	100%
Pa	1977, July 19-20	1977, Aug 9	3 (6 requested)	
Pa	1980, Aug 14-15	1980, Sept 30	2 (3 requested)	100%
Pa	1981, June 8-9	1981, Aug 5	4	100%
RI	1978, Feb 6-7	1978, Aug 29		100%
SD	1972, June 9-10		4 in request	100% requested
SD	1976, June	1976, Oct 4		100%
Tn	1972, April 12	1972, Aug 22	1	100%
Tn	1973, March 16-18	1973, May 1		100%
Tn	1975, March 11-16	1975, June 5	19	100%
Tn	1977, April 4-7	1977, July 5	6 (9 requested)	100%
Tx	1978, Aug (early)	1978, Oct 17	8	100%
Tx	1980, Aug 8 -	1980, Oct 6	2 (3 requested)	100% requested)
Vt	1973, June 30	1973, Aug 31		100%
Vt	1976, July 11 & Aug 9-19	1976, Oct 26	9	100%
Va	1972, June 20-23		63 in procl	
Va	1972, Oct 5-6		37 in procl	
Va	1979 July (mid)	1979, Sept 24	1	100%
Wa	1971, Jan 9-Feb 1	1971, June 25	12 in procl	100% requested
Wa	1974, Jan			
Wa	1975, Nov 30-Dec 8	1976, April 5		70% normal
Wa	1976, Aug 6	1976, Oct 19	3 in procl	100%
Wa	1977, Dec 1-17		9 requested	
Wa	1979, Feb 13			100%
Wa	1980, Dec 24-27	1981, March 9	6	100%
WV	1972, Aug 18-19		4 requested	100% requested
WV	1972, Feb (late)	1972, March 3		100%
WV	1974, Jan 9-12	1974, April 16		
WV	1975, Aug	1975, Oct 23	2	70%

WV	1977, April			100%
WV	1977, Aug 12-15	1977, Oct 7	2	100%
WV	1978, Dec 7-12	1979, March 6	5 (6 requested)	100%
WV	1980, Aug 9-21	1980, Oct 10	10	100%
Wi	1972, Aug-Sept		4 requested	100% requested
Wi	1973, April 21	1973, Aug 6	4	100%
Wi	1975, Aug 23 & Sept 11	1975, Nov 10	4	70% normal
Wi	1978, June 25-July 6		16 in procl	100% requested

STATE	DATE	ESTIMATED COST OF REPAIRING DISASTER DAMAGE	INITIAL ALLOCATION APPROVED BY FHWA FOR DISASTER RELIEF
Al	1973, Mar. 14	$195,000 for Forest highways	$200,000 for Forest highways
Al	1975, Feb 15-28, and April 9-14		$500,000
Al	1975, Sep 23-24		$250,000
Al	1977, April 4-6	$660,160	$500,000
Al	1978, Jan 24-27	$750,000	$500,000
Al	1979, March 4	$750,000	
Al	1979, March 3-4	$251,402	
Al	1979, April 12-14	$6,000,000	
Al	1979, Sept 12-14	$42,800,000	
Al	1980, April 12-13	$225,000	
Ak	1971, Aug 8	$595,000	
Ak	1973, Oct 27		
Ak	1974, Nov 10-11	$3,395,000	
Ak	1978, Nov 7-10		
Ak	1981, Aug 7-8	$473,130	
Az	1972, Oct 18-29	$497,500: State Highway Engineer estimate	
Az	1977, Oct 6-11	$1,200,000	
Az	1978, Feb 27-March 26	$17,000,000	$3,000,000
Az	1978-1979 Winter	$9,000,000	
Az	1980, Feb 13-22	$17,700,000	
Ar	1973, April-May		$1,500,000
Ar	1974, June		
Ca	1971, Feb 9	$30,000,000	$1,331,000
Ca	1972, Jan 21-March	$1,720,000	
Ca	1974, Jan 14 - April 1	$9,044,704	$5,450,000 for 098; $65,000 for 099
Ca	1976, Sept 10	$8,768,000	$8,770,000
Ca	1978, Jan 13-20		$1,700,000
Ca	1978, Jan & March *	$33,800,000 for Soutern Cal.	
Ca	1980, March 16	$1,100,000	
Ca	1980, Jan-March	$32,100,000	
Ca	1980, Nov 8	$1,500,000	
Ca	1981, Jan 18-22	$1,100,000	
Ca	1981, Dec 19 - 1982, Jan 8	$29,300,000	
Co	1973, May 6	$2,230,000	$2,500,000

Co	1976, July 31	$17,742,602(Fed aid roads) $404,449 (Nat forests)	
Fl	1972, June 18-23	$1,300,000	$471,802
Fl	1973, April 1-7		
Fl	1975, July 28-Aug 6	$124,000 fed aid rds, $46,000 forest, $903,000-off	$86,000 ?
Fl	1975, July 28	$455,000	
Fl	1979, Feb 24- Mar 4	$107,350	
Fl	1979, Sept 12	$293,000	
Ga	1973, March 14-19	$192,866	
Ha	1975 Nov 29		
Id	1974, Jan	$7,998,000 for Nat forests	
Id	1980, Dec	$922,106 for forests	
Il	1973, March-May		$1,500,000
Il	1974, May-June		
Il	1979, March	$159,000	
In	1977, Aug 6	$120,500- bridge & culvert, $433,150 other damage	$120,000
In	1979, July, (mid)	$360,000	
Ia	1972, July 11 - Aug 1	$190,326 (31,389 for emrg work, 158,937 for perm)	
Ia	1973, April	$827,750 (windshield est from OEP)	$180,000
Ks	1974, April 19-22		$203,000 (state requested $350,000)
Ky	?	$5,000,000 (1 mil for road, 4 mil for relocation	
Ky	1977, April		
Ky	1979, July (mid)	$700,000	
La	1973, April		$1,611,650 request (not clear)
Me	1973, Dec 16	$635,000 (7 sites)	$300,000
Me	1976, Feb 1-2	$260,000	
Me	1978, Feb 6-8	$31,000 for Fed aid roads, $780,000 state-wide	$31,000
Md	1972, June 21-22	$19,755,000 -Fed aid, $13,965,000 -off system	
Md	1975, Sept 22-26	$1,179,450 for 9 counties *	
Md	1976, Oct 8-10	$136,800	$140,000
Md	1979, Sept 5-6	$5,192,472 *	
Ma	1978, Feb 6-7	$2,100,000	$1,000,000
Mi	1972, Aug 16	$122,255 for 10 projects	
Mi	1973, March 16-18	$1,000,000	
Mi	1974, April 18-19		$850,000
Mi	1975, Aug 21-Sept 5	$139,683	
Mn	1972, July 21-23		$1,000,000
Mn	1972, Aug 15-22		
Mn	1972, Sept 20		
Mn	1975, June 28-July 23	$477,869	$335,000

Mn	1977, Sept 23-25	$1,279,428	$750,000
Mn	1978, June 25-July 8	$5,253,300	
Ms	1971, Dec 5-7		$10,000 Prog 1, $200,000 -Prog 3
Ms	1973, March 14-May		$5,000,000
Ms	1974, April		
Ms	1976, March 12		
Ms	1975, Aug 1 (?)		
Ms	1977, Nov 21	$1,941,000 for replacement; $1,147,000 for repair	$100,000
Ms	1979, April 8	$1,600,000	
Ms	1979, Sept	$836,000	
Mo	1973, March-May		$1,000,000
Mt	1975 June	$2,600,000	
Mt	1978, May (mid)	$268,000	$268,000
Mt	1981, May	$2,250,000	
Ne	1971, Feb 17-19		$107,500 (?)
Ne	1973, Sept 25-Oct 15	$1,129,000 -secondary rds + $5,000 flagging costs	
Ne	1975, May 6	$225,000	$55,000
Ne	1978, March 13-27	$2,800,000	$1,100,000
NH	1973, June 27-July 5		$1,600,000 for Stage II
NJ	1973, Aug 1-3		$1,025,300
NJ	1975, July 13-22	$1,094,695	$750,000
NJ	1979, May 7	$1,000,000	
NY	1972, June		$32,500,000 as of March 7, 1973
NY		$1,500,000	$1,050,000
NY	1976, June 18-19, July 11-12	$2,990,900	$500,000
NC	1973, May 27-28	$450,000 for 9 counties	$450,000
NC	1975, Feb		$606,900
NC	1977, Nov	$4,000,000	$2,000,000
ND	1974, April and May		$255,000
ND	1975, Spring	$310,000	$220,000
ND	1975, Summer		$1,150,000
ND	1976 Floods		
ND	1978, March (mid)		$282,000
ND	1979, April	$2,350,000	
Oh	1974, April 3		
Oh	1975, Aug 24-31		$296,000
Oh	1980, Aug 11	$450,000	
Ok	1971, Dec 9		
Ok	1973, April (early)	$200,000	$200,000

Ck	1973, Oct 10-13		$1,904,000
Ck	1974		
Or	1972, Jan 11-24		
Or	1974, Jan 14 -	$26,000,000	
Or	1980, Dec 25	$12,700,000	
Pa	1971, Sept 11-14	$250,000	
Pa	1972, June 18-23	$108,520,000 by FHWA	$10,000,000 requested.
Pa	1973, June 28-July 4		$550,000
Pa	1975, Sept 22-27	$7,000,000 on Fed aid system	
Pa	1976, June 8-10	$23,000,000	
Pa	1976, Oct 8-22	$949,000	$950,000
Pa	1977, July 19-20	$23,000,000 ?	$25,000,000 ?
Pa	1980, Aug 14-15	$4,200,000	
Pa	1981, June 8-9	$3,000,000	
RI	1978, Feb 6-7	$290,000	$40,000 for prel studies
SD	1972, June 9-10	$11,248,613 (state est)	
SD	1976, June	$2,656,140	$2,000,000
Tn	1972, April 12	$481,000	
Tn	1973, March 16-18		$2,000,000
Tn	1975, March 11-16	$2,000,000 for 24 counties	
Tn	1977, April 4-7	$2,230,000	
Tx	1978, Aug (early)	$3,455,000	
Tx	1980, Aug 8 -	$1,965,000	
Vt	1973, June 30		$2,600,000
Vt	1976, July 11 & Aug 9-19	$1,470,000	$1,470,000
Va	1972, June 20-23	$10,690,000	
Va	1972, Oct 5-6	$1,591,000 for counties, $551,000 for cities *	
Va	1979 July (mid)	$500,000	
Wa	1971, Jan 9-Feb 1	Over $2,500,000	
Wa	1974, Jan		
Wa	1975, Nov 30-Dec 8	$4,061,998	
Wa	1976, Aug 6	$1,654,210	$1,655,000
Wa	1977, Dec 1-17	$4,500,000 for FY 78	
Wa	1979, Feb 13		$151,219,191 oblig in Mar 1983
Wa	1980, Dec 24-27	$6,712,500	
WV	1972, Aug 18-19	$798,945	$1,571,185 (4 seperate alloc's)
WV	1972, Feb (late)		
WV	1974, Jan 9-12	$540,000	$378,000
WV	1975, Aug	$534,078	

WV	1977, April	$2,100,000	$750,000
WV	1977, Aug 12-15	$292,000	$292,000
WV	1978, Dec 7-12	$2.087,103	
WV	1980, Aug 9-21	$5,199,750	
Wi	1972, Aug-Sept	$78,548	
Wi	1973, April 21		$285,000
Wi	1975, Aug 23 & Sept 11	$354,300 by state	
Wi	1978, June 25-July 6	$1,553,000	$1,600,000 requested

ST MISCELANEOUS NOTES FOUND IN FILES

Al Letter of approval only for forest highway funding; according to gov procl, $20 million damage to public property, $8 million to private property
Al $639,000 to repair slides in Conecuh County questioned.
Al Subsequent allocation of $300,000 made on Feb 22, 1977
Al
Al Road washout damage; Included: preliminary cost summary- state fed aid damage=$198,117; county fed-aid damage=$883,845 (No cited source).
Al Road damage to interstate; No FHWA Reply included in file.
Al
Al 27 counties in request. Incl: Listing of damage costs by county.
Al Dauphin Island Bridge destroyed. Sierra Club attempted to intervene and stop construction, but failed. Contract amount for $32,726,330.
Al Culvert damage due to collapse of earth dam upstream
Ak State didn't request 100%, thus didn't receive it. They were allowed to resubmit for 100% funding though.
Ak Bridge destroyed due to failure of dam.
Ak Additional allocation of $700,000 made on June 8, 1975
Ak
Ak
Az Est for Tonto Forest: $250,000 By Az Division, $398,000 By Forest Service.
Az Fed share = $840,000
Az One bridge construction site not approved.
Az
Az All 1980 ER funds were obligated. Work deferred until Oct 1980.
Ar
Ar File just contains additional approval letters.
Ca Presidentially declared. Incl: detailed report on effects of earthquake. At least 8 ER programs.
Ca Fed funds: $1,138,000; ER: $780,000; Public Law 606: $358,000
Ca NPS, BLM and BIA also involved; Jan storm damage appr May 7, March storms app. Dec 6. Allocation increased to $1,221,000 on Dec 6, 1974.
Ca
Ca
Ca Est. COR For BLM Roads- North = $120,000; South = $40,000; North Cal had Jan Storms, South Cal had Feb-March storms
Ca
Ca Incl: Breakdown of Est. COR by county. Est FEMA Cat C expenditures = $50 million.
Ca Earthquake estimated at 7.0 on Richter
Ca Road damage and destruction of supporting seawall. 360 LF of seawall destroyed.
Ca At time, 25 dead, 12 missing, $100 million damage. Pres declared Jan 7,n 1982. Additional 2 counties & $5 million approved on July 28, 1982.
Co Additional request on 8/16/73 for $712,800 to repair damage in national forests.

Co 10 inches of rain in 90 minute period. Two supplemental approvals; $38,854 on 11/1/76 and $4,344,000 on 3/15/79. At least 55 people killed.
Fl Amended procl in Aug 1972 (incl)
Fl Stage 2 of funding (Oct. 23, 1973) was $360,414
Fl * can't tell if this is for this disaster or Hurricane Eloise
Fl
Fl
Fl Additional $56,600 approved? Confusion about this.
Ga
Ha Damage occurred in Hawaii Volcanoes Nat. Park; incl - substantial info from Hawaiian Volcano Observatory Monthly Report.
Id 7 National forests affected; incl - detailed listing of Kootenai Forest damage. Additional $4,000,000 approved on Aug 26, 1974.
Id Damage in Idaho Panhandle Nat. Forest. The Idaho BLM also received $49,000 ERFO funds. Case considered closed as of Jan 10, 1984.
Il Incl: newspaper article
Il An additional $1.5 million approved Sept. 11, 1974
Il Incl: letter to Pres on April 28, 1979.
In Originally was denied.
In
Ia Incl: weather summary & subsequent approval letters.
Ia Incl: detailed damage report by Iowa FHWA division
Ks Up to six inches of rain fell.
Ky State wanted to relocate road in new ROW, not eligible though. Long time span. Letters from 1973 to 1982.
Ky File just consists of a letter requesting an additional ER of $1 million - dated 1977, Dec 1.
Ky
La An additional $525,000 approved Nov 14, 1973. Dollar figures questionable because of incomplete documents.
Me An additional request for $199,600 requested.
Me Includes itemized listing of road damage by political units. Total damage = $463,200.
Me Incl: Newspaper article
Md Info on Hartford County Fed aid roads: 62 bridges destroyed, 449 roads damaged. Off-system roads: 47 bridges destroyed, 561 roads damaged.
Md * = incomplete document
Md Two bridges & roads destroyed, 122 homes destroyed, 367 people evacuated. Prel estimates: Public damage -$601,000: Private $4,354,000: Ag: $135,000
Md * Damage listing for Tripical Storm David, which may be this. Est COR for 3 counties & Baltimore.
Ma Allocation increased to $2,332,000 on June 23, 1978. Designated disaster by Pres. Over 29 inches of snow fell.
Mi
Mi FHWA approved 1 add'tl county on Jan 3, 1974. Confusion about # of counties & amount approved.
Mi Two addt'l counties & $50,000 added on Sept 3, 1975 approval.
Mi Damage was minor. Culvert, shoylder & slope wash-outs.
Mn
Mn
Mn St Louis River & Lake Superior watershed floods.
Mn Approval took long because of abundant raw data included in submission w/o interpretive comments.

Mn Incl: Flood stage data
Mn 16 requested counties in southeast & southcentral Mn, 2 in northwest Mn (tornado).
Ms Program 2 approved Oct 11, 1972; Program 3 approved Feb 6, 1973
Ms
Ms Additional allocation of $11,500,000 on July 28, 1975 for Homochitto Bridge.
Ms Additional procl for another county on May 20, 1976; Approval came on Aug 6, 1976. $2,000,000 allocated on Aug 31, 1976.
Ms Funding increased to 100% on June 29, 1976. Bridge failure damage.
Ms Bridge collapsed. Approval was granted for replacement.
Ms Additional approval increased counties to 30 & Est COR to $4,300,000 (Oct 2, 1979)
Ms
Mo
Mt Incl: river & creekflow rates. off-system damage $2,800,000. Severe damage also occurred to BIA and park roads.
Mt
Mt Senator sent letter requesting 100% funding.
Ne Incl: Letters asking for a total of $500,000 in March & April 1974. Both were approved.
Ne Off-system damage $1,804,000
Ne Damage on Interstate, Primary, Urban & Type II fed aid roads.
Ne
NH Stage I funding = ?
NJ Incl: Additional approval letter
NJ
NJ
NY Extensive info: 24 dead, $100,000,000 prop. damage, ground water aturation chart & chemical concentration charts (source -Water Resources)
NY Additional $1,325,000 approved Nov 24, 1976
NY Region recommended 70/5 funding; State committed themselves to $550,000 of the cost.
NC Greater than 100 yr flood.
NC
NC In addition, $2,191,324 damage in Nat Forests. Incl: subsequent approval letters.
ND
ND Some question about eligibility
ND
ND Incl: only letter about additional approvals - $200,000 on May 5, 1977 & $36,000 on June 18, 1978.
ND
ND Sept 27, 1979, Est. COR increased to $2,630,000 & 3 additional counties approved. State est for 30 counties = $2,900,000.
Oh Incl: just one letter approving additional $200,000. Tornado just written in at top of letter.
Oh Presidentially declared on Sept 11, 1975
Oh
Ok No approval letter. Damage in which no reimbursement will be received exceeds $1,500,000.
Ok Bridge collapsed. Incl: letter requesting add'l $53,150

Ck

Ck Incl: just letters about additional $350,000 being approved. Approval on Jan 5, 1976.

Or Approval is for Dept of Interior road damage.

Or BLM, BIA & Forest Service roads also damaged. Incl: Breakdown of damage by highway system.

Or Incl: Descriptive account of the events. Four roads damaged, one person dead.

Pa

Pa St. estimate: $164,200,000 Fed sys road damage, $501,700,000 total road damage. FHWA estimates lower. Extensive info on total cost. 48 dead.

Pa Funding increased to 100% on Feb 22, 1974

Pa $17,500,000 damage to total rd system. Funding increased to 100% -Dec 1, 1976. 4 addit'l counties approved Mar 18, 1976.

Pa Extensive railroad damage also occurred.

Pa

Pa Pres deco on July 21, 1977. Additional Approval of $243,500 & 2 counties on Nov 17, 1977. Damage broken down by county in file. 500 yr flood

Pa Pres decl on Aug 19, 1980

Pa

RI Seawall damage occurred.

SD No approval letter in file. Incl: daily account of activities after flood.

SD

Tn Apparently denied at first, later approved. One person dead. Over $76,000 spent by state for debris removal.

Tn 100 yr flood

Tn Additional allocation of $190,000 for an additional county approved on Aug 22, 1975.

Tn Incl: letter to Pres w/ extensive info: 2 dead, 16 injured, total damage = $20,953,003.

Tx Incl: newspaper article, 23 dead

Tx Total Est COR increased to $2,200,000 on Oct 24, 1980 by FHWA.

Vt Additional $500,000 approved Nov 13, 1973.

Vt 44 families forced to evacuate, 51 homes isolated by destroyed roads.

Va 4 major bridges damaged. Est COR broken down by road classification.

Va * state estimate, FHWA estimate much lower. Total damage - $2,000,000 to pub prop, $17,000,000 to private prop.

Va

Wa Incl: additional approval letter for $20,000 on July 6, 1972.

Wa Just consists of one letter approving additional $3,345,000 on Sept 30, 1984.

Wa Fed share of Est COR = $2,925,000. Nat Park Service & BIA also involved.

Wa Greater than a 100 yr flood.

Wa $8,881,000 Est COR for Forest Service, BIA also involved. At least 4 dead. Incl: newspaper article & breakdown of road damage by county.

Wa Hood Canal Bridge damaged. File consists of audit of project costs.

Wa Also damage to BLM & Park Service roads. Off-system damage = $1,157,000

WV Revised est COR = $1,570,861 on Nov 20, 1973.

WV Program Item 1 - $1,964,545. Additional $11,225,000 approved Aug 25, 1972.

WV Initial alloc = 70% of Est COR.

WV 5-7 inch rains in 24 hr period.

WV Additional allocations totaling $1,850,000 on July 22, 1977 & Feb 8, 1978.
WV Also Presidentially declared.
WV Off-system damage $2,822,739
WV
Wi
Wi Only part of request approved. Rest was still under investigation.
Wi $306,000 of Est COR for Aug-Sept storms, rest for July storm. Presidentially declared Sept 15, 1975.
Wi Presidentially declared

The kind of analysis undertaken is very much a function of the kind of data available. One strategy employed in this study is to examine other sources as well as collecting any relevant information kept in FHWA headquarters files. A number of general observations may be made. It is very likely that some of the financial data is not totally accurate. In some instances it was not possible to locate files at FHWA headquarters for each disaster and where they existed they were in various states of completion. For older files materials appeared to have not been replaced or to never have been generated. This made it difficult to compare information across years. A major issue was transferring data from the files to forms so it could be transported to Georgia Tech and placed on the computer. A number of quality checks were implemented to assure accuracy.

From reviewing the letter files it was determined that a change in funding occurred. Prior to 1973 program approvals occurred in stages with itemized projects listed in each stage while after 1973 lump sum funding appears to occur. Therefore it was necessary to use lump sum funding for consistency. The most consistent and best source of information were the approval letters sent out by FHWA however some files did not contain these. While some of the letters found in these files referenced the FHWA Disaster Code Number some did not. It would be helpful if all files referenced this number. Otherwise it is impossible to conduct detailed scenarios of damage done to the transportation system.

Probing Other Data Source

Additional data were explored in order to check the quality and extent of the national FHWA and FEMA data bases and to identify other sources of information on damage to the transportation infrastructure. The purpose of this is to identify and locate new and complementary sources.

The Corps of Engineers were contacted and they shared maps outlining corps projects and district boundaries. Once specific projects are identified it is possible to get general information outlining the impact of natural disasters on these specific project areas. For more detailed information we were referred to FEMA regional offices. But the information at such offices focuses on flood disasters only and gives great detail only on damages and repairs for specific projects. The National research Council was contacted and several reports published by them were used in this study. Additional documents are available from the National Technical Information Service in Springfield, Virginia.

The national Oceanic and Atmospheric Administration (NOAA) publishes very helpful information on earthquakes.For example the damage survey tables contained in publications like Tornado Outbreak (NOAA, 1974) provide measures for assessing earthquake impact.

The New York Times Index was searched for data on natural disasters and was found to be a relatively good source for information on the three earthquakes occurring between 1971 and

1981. Although its impact data is not recorded on a sufficiently consistent basis, it is very helpful in identifying other agencies and sources involved in specific disasters.

The Eastern Operations Headquarters of the American Red Cross was contacted and this proved to be the most consistent and substantial source of information on impact of natural disasters. The sources of its information are the Red Cross Chapter reports (903's). We collected information from its headquarters for disasters occurring in region four. A list of all disasters occurring between 1971 and 1981 was sent this to headquarters and in turn it sent to us copies of as many 903 forms as could be located. These forms contain information on the disaster relief provided by the Red Cross and on the damage done. This information was the basis on which it was possible to do more detailed analysis for region IV. A more extensive discussion occurs in section three of this report.

Several railroad companies were contacted but they were unwilling to share information on damage to facilities or cost of such damage.

Empirical Analysis of the Impact on Transportation Lifelines

The analysis of disasters below includes only those occurrences where both FEMA and FHWA obligations were involved. Disasters are classified into eight categories: earthquakes; floods, severe storms; floods, landslides; floods, snowmelts;

tornadoes; hurricanes; typhoons, tropical storms; and other disasters such as dam collapse. Table 4 records each individual disaster by type occurring between 1971 and 1981. In all there were 108 such disasters. The table also includes other relevant information such as the disaster type, incidence period, counties that impacted, Category C damage expenditures, total Fema expenditures and the number of deaths resulting from the disaster.

Table 5 is a summary of FEMA and FHWA disaster expenditures by program. FEMA total expenditures were close to $2,000,000,000 over the ten year period. FEMA transportation expenditures are less than 20 percent of total or $366 million. Expenditures under FHWA 098 (emergency relief on federal aid highways) is approximately five times FHWA 099 expenditures (for other federal roads). These were $479 million and $90 million respectively while total transportation expenditures were $936 million.

Table 6 lists disasters that have impacted transportation systems. Over the ten year period Region 4 recorded the largest number of natural disasters followed by regions 3, 5, and 8 respectively. Regions 1, 10, and 6 each experienced nine disasters while regions 7, 2, and 9 had the fewest. Floods are the most frequently occurring disaster with the largest number concentrated in regions 3 and 4, see also Figure 5. Additionally floods occur with a very high frequency across all regions, when look at as a percent of all disasters.

TABLE 4 : LIST OF NATURAL DISASTERS BY NUMBER, DATE AND OTHER RELEVANT INFORMATION
(DISASTERS WITH FEMA AND FHWA EXPENDITURES, 1971 TO 1981)

DISASTER NUMBER	DECLARATION DATE	STATE	REGION	DISASTER TYPE	INCIDENCE PERIOD
299	1971, FEB 9	CA	9	EARTHQUAKE	1971, FEB 9
303	1971, FEB 23	NE	7	FLOODS	1971, FEB 18-MAR 16
312	1971, SEP 18	PA	3	FLOODS	1971, SEP 11-OCT 11
317	1972, JAN 14	OK	6	FLOODS, SEVERE STORMS	1971, DEC 9-DEC 15
318	1972, JAN 19	MS	4	FLOODS, HEAVY RAINS	1971, DEC 3-10
319	1972, JAN 21	OR	10	FLOODS, SEVERE STORMS	1972, JAN 11-24
323	1972, FEB 27	WV	3	FLOODS	1972, FEB 24-26
329	1972, APR 5	CA	9	FLOODS, SEVERE STORMS	1972, JAN 20-MAR 15
331	1972, MAY 15	TN	4	FLOODS, HEAVY RAINS	1972, APR 12-14
336	1972, JUN 10	SD	8	FLOODS, HEAVY RAINS	1972, JUN 9-10
338	1972, JUN 23	NY	2	TROPICAL STORM AGNES	1972, JUN 18-JUL 3
339	1972, JUN 23	VA	3	TROPICAL STORM AGNES	1972, JUN 21-25
340	1972, JUN 23	PA	3	TROPICAL STORM AGNES	1972, JUN 21-JUL 4
341	1972, JUN 23	MD	3	TROPICAL STORM AGNES	1972, JUN 21-JUL 4
352	1972, SEP 10	WI	5	FLOODS, HEAVY RAINS	1972, AUG 15-21
359	1972, OCT 10	VA	3	FLOODS, SEVERE STORMS	1972, OCT 5-10
366	1973, MAR 21 & MAY 11	TN	4	FLOODS & SEVERE STORMS	1973, MAR 14-MAY 8
368	1973, MAR 27	MS	4	FLOODS, TORNADOES, HEAVY RAINS	1973, MAR 14-JUN 10
369	1973, MAR 27	AL	4	FLOODS, TORNADOES	1973, MAR 14-23
370	1973, APR 4	GA	4	FLOODS, TORNADOES	1973, MAR 16-31
371	1973, APR 12	MI	5	FLOODS, SEVERE STORMS	1973, MAR 16-APR 10
372	1973, APR 19	MO	7	FLOODS, TORNADOES, HEAVY RAINS	1973, MAR 6-APR 22
373	1973, APR 26	IL	5	FLOODS, SEVERE STORMS	1973, MAR 1-MAY 31
374	1973, APR 27	LA	6	FLOODS, SEVERE STORMS	1973, MAR 24-MAY 24
375	1973, APR 27 & MAY 29	AR	6	FLOODS, SEVERE STORMS	1973, APR 1-MAY 27
376	1973, APR 27	WI	5	FLOODS, SEVERE STORMS	1973, MAR 7-APR 22
386	1973, MAY 23	IA	7	FLOODS, SEVERE STORMS	1973, MAR 13-MAY 3
392	1973, JUN 13	OK	6	FLOODS, TORNADOES, SEVERE STORMS	1973, APR 1-MAY 7
394	1973, JUN 25	NC	4	FLOODS, SEVERE STORMS	1973, MAY 27-28
397	1973, JUL 6	VT	1	FLOODS, LANDSLIDES, STORMS	1973, JUN 26-JUL 6
399	1973, JUL 11	NH	1	FLOODS, SEVERE STORMS	1973, JUN 26-JUL 6

400	1973, JUL 17	PA	3	FLOODS, SEVERE STORMS	1973, JUN 27-JUL 4
401	1973, JUL 20	NY	2	FLOODS, SEVERE STORMS	1973, JUN 28-JUL 5
402	1973, AUG 7	NJ	2	FLOODS, SEVERE STORMS	1973, AUG 1-3
404	1973, OCT 13	OK	6	FLOODS, SEVERE STORMS	1973, OCT 10-14
405	1973, OCT 16	MA	1	FIRE (CITY OF CHELSEA)	1973, OCT 14-15
406	1973, OCT 20	NE	7	FLOODS, SEVERE STORMS	1973, SEP 25-OCT 15
408	1973, NOV 7	AK	10	FLOODS, HEAVY RAINS	1973, OCT 25-29
410	1974, JAN 18	ME	1	FLOODS, SEVERE STORMS	1973, DEC 16-28
413	1974, JAN 25	OR	10	FLOODS, SNOWMELT, SEVERE STORMS	1974, JAN 14-21
414	1974, JAN 25	WA	10	FLOODS, SNOWMELT, SEVERE STORMS	1974, JAN 13-20
415	1974, JAN 25	ID	10	FLOODS, SNOWMELT, SEVERE STORMS	1974, JAN 13-20
416	1974, JAN 29	WV	3	FLOODS, SEVERE STORMS	1974, JAN 10-11
417	1974, JAN 29	MT	8	FLOODS, LANDSLIDES, SEVERE STORMS	1974, JAN 15-19
421	1974, APR 4	OH	5	TORNADOES	1974, APR 1-4
430	1974, APR 18	MS	4	FLOODS, HEAVY RAINS	1974, APR 12-20
434	1974, MAY 14	ND	8	FLOODS, SNOWMELT, HEAVY RAINS	1974, APR 14-JUN 7
435	1974, MAY 31 & JUN 8	AR	6	FLOODS, SEVERE STROMS	1974, MAY 14-JUN 10
438	1974, JUN 10	IL	5	FLOODS, SEVERE STORMS	1974, MAY 17-JUN 30
452	1974, NOV 14	AK	10	FLOODS, SEVERE STORMS	1974, NOV 11-14
459	1975, MAR 22	TN	4	FLOODS, SEVERE STORMS	1975, MAR 11-APR 13
464	1975, APR 23 & MAR 14	AL	4	FLOODS, SEVERE STORMS	1975, JAN 10-APR 14
465	1975, APR 26	MI	5	FLOODS, WINDS, SEVERE STORMS	1975, APR 18-30
467	1975, MAY 7	NE	7	TORNADOES, SEVERE STORMS	1975, MAY 6
472	1975, JUN 28	MT	8	FLOODS, SNOWMELT, SEVERE STORMS	1975, JUN 19-24
476	1975, JUL 17	MN	5	FLOODS, TORNADOES, SEVERE STORMS	1975, JUN 28-JUL 21
477	1975, JUL 23	NJ	2	FLOODS, WINDS, HAIL, RAINS	1975, JUL 13-22
479	1975, AUG 22	FL	4	FLOODS	1975, JULY 28-AUG 18
481	1975, SEP 12	WV	3	FLOODS, HEAVY RAINS	1975, AUG 31-SEP 1
482	1975, SEP 15	WI	5	FLOODS (FLASH), TORNADOES, RAINS	1975, AUG 21-SEP 11
485	1975, SEP 26	PA	3	FLOODS, HEAVY RAINS, SEVERE STORMS	1975, SEP 22-30
487	1975, OCT 2	NY	2	FLOODS, RAINS, LANDSLIDES, STORMS	1975, SEP 22-27
488	1975, OCT 2	AL	4	FLOODS, TORNADOES, SEVERE STORMS	1975, SEP 22-25
489	1975, OCT 4	MD	3	FLOODS, HEAVY RAINS	1975, SEP 22-26
490	1975, DEC 7	HA	9	EARTHQUAKES, SEISMIC WAVES, VOLCANOES	1975, NOV 29-DEC 12
492	1975, DEC 13	WA	10	FLOODS, SEVERE STORMS	1975, NOV 30-DEC 8
499	1976, APR 1	MS	4	FLOODS, TORNADOES, SEVERE STORMS	1976, MAR 26
501	1976, APR 16	ND	8	FLOODS	1976, MAR 18-28
505	1976, JUN 6	ID	10	FLOODS CAUSED BY DAM COLLAPSE	1976, JUN 5
511	1976, JUN 25	SD	8	FLOODS (FLASH), MUDSLIDES	1976, JUN 14-18

513	1976, JUL 7	PA	3	FLOODS (FLASH), HIGH WINDS	1976, JUN 15-22
517	1976, AUG 2	CO	8	FLOODS (FLASH), SEVERE STORMS	1976, JUL 31-AUG 3
518	1976, AUG 5	VT	1	FLOODS, WINDS, STORMS	1976, JUL 11-AUG 12
521	1976, SEP 21	CA	9	TROPICAL STORM KATHLEEN FLOODS	1976, SEP 9-25
522	1976, OCT 14	MD	3	FLOODS, SEVERE STORMS	1976, OCT 8-9
523	1976, OCT 20	PA	3	FLOODS, SEVERE STORMS	1976, OCT 8-10
529	1977, APR 6	KY	4	FLOODS, SEVERE STORMS	1977, APR 4-8
531	1977, APR 7	WV	3	FLOODS, SEVERE STORMS	1977, APR 3-7
532	1977, APR 9	AL	4	FLOODS, SEVERE STORMS	1977, APR 4-7
533	1977, APR 29	TN	4	FLOODS, SEVERE STORMS	1977, APR 4-7
534	1977, MAY 2	LA	6	FLOODS, SEVERE STORMS	1977, APR 20-27
537	1977, JUL 21	PA	3	FLOODS, SEVERE STORMS	1977, JUL 19-22
541	1977, NOV 7	GA	4	FLOODS CAUSED BY DAM COLLAPSE	1977, NOV 6
542	1977, NOV 9	NC	4	FLOODS, SEVERE STORMS	1977, NOV 4-6
545	1977, DEC 10	WA	10	FLOODS, MUDSLIDES, SEVERE STORMS	1977, DEC 1-17
546	1978, FEB 10	MA	1	COASTAL FLOODS, SNOW, ICE, STORMS	1978, FEB 6-8
548	1978, FEB 16	RI	1	SNOW, ICE	1978, FEB 6-7
549	1978, FEB 16	NH	1	COASTAL FLOODS, TIDAL SURGE & WINDS	1978, FEB 6-7
550	1978, FEB 17	ME	1	COASTAL FLOODS, TIDAL SURGE & WINDS	1978, FEB 6-7
552	1978, MAR 24	NE	7	FLOODS, ICE JAMS, SNOWMELT, STORMS	1978, MAR 13-27
554	1978, APR 17	ND	8	FLOODS, ICE JAMS, SNOWMELT, STORMS	1978, MAR 11-MAY 6
558	1978, MAY 29	MT	8	FLOODS, SEVERE STORMS	1978, MAY 16-23
559	1978, JUL 7	WI	5	FLOODS, TORNADOES, HAIL, STORMS	1978, JUN 25-JUL 6
560	1978, JUL 8	MN	5	FLOODS, TORNADOES, HAIL, STORMS	1978, JUN 25-JUL 7
561	1978, AUG 8	TX	6	FLOODS, SEVERE STORMS	1978, AUG 1-7
577	1979, APR 16	MS	4	FLOODS, TORNADOES, SEVERE STORMS	1979, APR 8-MAY 3
581	1979, APR 26	ND	8	FLOODS, SNOWMELT, SEVERE STORMS	1979, APR 11-JUN 6
583	1979, APR 30	IL	5	FLOODS, SEVERE STORMS	1979, MAR 1-JUN 1
592	1979, JUL 19	KY	4	FLOODS (FLASH), SEVERE STORMS	1979, JUL 15-
593	1979, JUL 20	VA	3	FLOODS (FLASH), SEVERE STORMS	1979, JUL 15-16
598	1979, SEP 13	AL	4	HURRICANE FREDERIC	1979, SEP 12-13
599	1979, SEP 13	MS	4	HURRICANE FREDERIC	1979, SEP 12-13
600	1979, SEP 13	FL	4	HURRICANE FREDERIC	1979, SEP 12-13
614	1980, FEB 19	AZ	9	FLOODS, SEVERE STORMS	1980, FEB 13-22
627	1980, AUG 11	TX	6	HURRICANE ALLEN	1980, AUG 10-20
628	1980, AUG 15	WV	3	FLOODS, SEVERE STORMS	1980, AUG 4-22
629	1980, AUG 19	PA	3	FLOODS, SEVERE STORMS	1980, AUG 14-15
641	1981, JUN 15	PA	3	FLOODS, SEVERE STORMS	1981, JUN 8-15

DISASTER NUMBER	NUMBER OF COUNTIES IMPACTED	FEMA TRANSPORTATION DAMAGE EXPENDITURES	FEMA TOTAL DAMAGE EXPENDITURES	DEAD	DISASTER NUMBER	FHWA 098 EXPENDITURES
299	1	$939,228	$217,371,932	59	299	$19,258,463
303	19	$259	$320,579	0	303	$2,835,276
312	7	$459,019	$1,283,366	4	312	$171,360
317	12	$0	$100,000	0	317	$769,766
318	9	$679,594	$680,163	0	318	$1,208,824
319	10	$4,886,669	$7,827,310	0	319	$1,406,141
323	7	$430,287	$6,650,851	37	323	$26,530,927
329	2	$1,879,091	$2,374,856	0	329	$431,295
331	4	$275,694	$325,144	0	331	$279,980
336	4	$7,484,684	$24,990,551	0	336	$7,846,816
338	26	$16,786,539	$110,457,322	0	338	$31,692,727
339	106	$4,212,985	$21,114,753	0	339	$12,943,196
340	67	$71,544,268	$381,657,645	0	340	$57,683,525
341	23	$7,976,684	$26,336,279	0	341	$30,491,711
352	4	$313,245	$524,585	0	352	$63,550
359	31	$593,986	$1,370,161	5	359	$562,932
366	47	$4,587,021	$6,116,134	0	366	$4,155,867
368	52	$3,775,901	$8,822,980	0	368	$5,358,187
369	28	$1,335,607	$2,145,941	0	369	$1,782,551
370	14	$523,351	$1,377,638	0	370	$252,411
371	14	$188,425	$1,650,737	0	371	$1,410,815
372	94	$6,046,872	$19,664,209	0	372	$1,262,044
373	52	$3,118,325	$20,769,334	0	373	$3,921,019
374	38	$3,404,437	$15,418,286	0	374	$1,848,510
375	43	$1,680,477	$6,709,593	0	375	$1,833,632
376	34	$1,273,829	$3,241,315	0	376	$699,899
386	26	$848,486	$1,963,383	1	386	$671,486
392	31	$1,326,577	$2,016,083	0	392	$1,089,821
394	9	$240,084	$396,066	0	394	$285,905
397	14	$11,377,880	$15,549,674	0	397	$2,535,262
399	10	$3,143,970	$4,403,520	0	399	$1,969,586

400	10	$4,188,051	$5,193,907	0	400	$498,103
401	6	$2,587,515	$3,760,962	0	401	$2,033,500
402	4	$2,471,649	$4,795,698	0	402	$40,236
404	5	$719,185	$4,464,805	0	404	$1,743,904
405	1	$25,170	$1,642,657	0	405	$89,193
406	15	$1,639,342	$2,114,761	0	406	$1,503,038
408	1	$0	$1,637,488	0	408	$350,675
410	12	$1,355,572	$2,012,763	0	410	$282,296
413	19	$2,793,398	$5,255,498	0	413	$3,949,294
414	13	$1,883,130	$2,677,545	0	414	$3,582,275
415	9	$2,163,893	$3,345,511	0	415	$7,323,038
416	5	$28,530	$321,529	0	416	$1,812,803
417	7	$666,094	$1,189,585	0	417	
421	14	$485,428	$22,417,351	25	421	$415,135
430	30	$1,096,992	$4,315,652	0	430	$11,464,258
434	18	$991,170	$1,897,182	0	434	$277,184
435	1	$1,317,591	$3,346,548	0	435	$596,162
438	47	$3,459,799	$8,926,208	0	438	$2,694,047
452	1	$118,027	$3,148,853	0	452	$3,854,093
459	46	$5,514,297	$6,694,359	0	459	$1,459,531
464	8	$1,698,771	$3,370,725	0	464	$2,988,802
465	17	$1,392,761	$5,275,637	0	465	$467,696
467	3	$50,758	$3,494,266	3	467	$50,689
472	14	$1,364,859	$3,613,923	0	472	$1,670,475
476	17	$1,507,493	$4,393,279	0	476	$429,922
477	13	$1,809,008	$7,841,857	6	477	$1,075,294
479	8	$920,954	$1,448,181	0	479	$461,055
481	2	$372,343	$5,436,131	2	481	$535,784
482	4	$428,953	$699,878	0	482	$246,655
485	30	$16,843,664	$32,914,314	0	485	$9,605,728
487	16	$2,226,912	$7,166,514	3	487	$6,105,132
488	15	$266,335	$5,907,259	0	488	$237,318
489	16	$1,103,219	$2,420,897	0	489	$1,609,418
490	1	$12,511	$831,769	2	490	$2,519,715
492	12	$1,814,539	$7,296,285	0	492	$2,714,314
499	4	$76,587	$1,183,170	0	499	$5,671,056
501	9	$1,810,849	$4,198,804	0	501	$769,530
505	5	$3,547,817	$43,518,660	0	505	$12,281,989
511	4	$960,065	$1,574,074	0	511	$979,998

513	2	$2,085,632	$3,334,057	0	513	$672,330
517	4	$3,630,821	$13,273,330	50	517	$2,496,447
518	12	$6,147,905	$9,619,218	0	518	$1,142,658
521	3	$1,992,713	$9,209,415	3	521	$6,116,279
522	2	$1,193,422	$1,786,084	0	522	$136,524
523	21	$4,144,704	$7,075,716	0	523	$1,378,666
529	15	$4,109,422	$75,809,806	0	529	$211,301
531	11	$6,209,734	$48,867,620	2	531	$3,690,327
532	9	$805,090	$2,162,718	26	532	$715,623
533	6	$2,341,553	$2,860,077	0	533	$2,216,701
534	8	$273,986	$2,345,943	3	534	$601,831
537	8	$18,615,244	$136,834,694	0	537	$28,559,688
541	1	$206,442	$2,463,989	37	541	$41,923
542	16	$12,340,280	$22,073,881	11	542	$4,437,013
545	19	$1,283,640	$4,613,762	5	545	$10,019,832
546	8	$1,408,618	$39,660,857	0	546	$1,914,264
548	5	$0	$245,297	0	548	$98,111
549	1	$31,354	$456,157	3	549	$1,716,380
550	4	$762,891	$2,295,837	0	550	$31,000
552	21	$3,088,438	$5,169,358	0	552	$1,989,257
554	25	$2,439,860	$3,690,143	0	554	$727,607
558	7	$2,482,578	$6,279,762	0	558	$118,035
559	16	$4,011,732	$6,809,116	2	559	$1,669,135
560	17	$3,312,945	$11,487,882	4	560	$2,458,221
561	8	$3,022,702	$12,804,863	0	561	$2,773,577
577	38	$6,830,723	$32,533,457	4	577	
581	42	$13,296,341	$20,923,352	1	581	$4,164,796
583	29	$4,920,580	$14,369,428	0	583	$926,882
592	1	$813,653	$2,382,173	3	592	$886,132
593	1	$2,425,090	$3,941,042	2	593	$524,454
598	11	$3,004,081	$198,122,678	0	598	$52,347,742
599	16	$198,684	$37,418,215	0	599	$6,018,632
600	5	$209,389	$5,212,770	0	600	$190,666
614	6	$1,639,322	$12,406,812	3	614	$2,615,924
627	12	$1,725,265	$33,880,387	0	627	$1,838,592
628	15	$5,348,583	$8,357,108	0	628	$6,564,030
629	3	$2,717,419	$4,435,559	0	629	$7,237,967
641	5	$4,028,171	$5,028,221	0	641	$2,758,610

FHWA 099 EXPENDITURES	TOTAL ROAD EXPENDITURES FEMA TRANSPORTATION + FWHA 098 + FWHA 099
$33,541	$20,231,232
	$2,835,535
	$630,379
	$769,766
	$1,888,418
$2,038,754	$8,331,564
	$26,961,214
$11,603,329	$13,913,715
$1,045,831	$1,601,505
$3,245,761	$18,577,261
$187,453	$48,666,719
$1,219,690	$18,375,871
	$129,227,793
	$38,468,395
	$376,795
$57,745	$1,214,662
$1,634,922	$10,377,810
$252,892	$9,386,980
$748,759	$3,866,917
	$775,762
	$1,599,240
	$7,308,916
	$7,039,344
	$5,252,947
	$3,514,109
	$1,973,728
	$1,519,972
	$2,416,398
$195,931	$721,920
$159,621	$14,072,763
$840,231	$5,953,787

	$4,686,154
	$4,621,015
	$2,511,885
	$2,463,089
	$114,363
	$3,142,380
	$350,675
	$1,637,868
$8,814,459	$15,557,151
$7,230,530	$12,695,934
$9,808,093	$19,295,025
	$1,841,333
$1,499,353	$2,165,447
	$900,563
	$12,561,250
	$1,268,354
	$1,913,753
	$6,153,846
	$3,972,120
$209,801	$7,183,629
	$4,687,573
	$1,860,457
	$101,447
$5,272,031	$8,307,365
	$1,937,415
	$2,884,302
	$1,382,009
	$908,127
	$675,608
	$26,449,392
	$8,332,044
	$503,653
	$2,712,637
$337,389	$2,869,615
$4,969,471	$9,498,324
	$5,747,643
	$2,580,379
	$15,829,806
$760,361	$2,700,424

	$2,757,962
$21,216,178	$27,343,446
$122,465	$7,413,028
$45,931	$8,154,923
	$1,329,946
	$5,523,370
	$4,320,723
	$9,900,061
	$1,520,713
	$4,558,254
	$875,817
	$47,174,932
	$248,365
	$16,777,293
$3,840,771	$15,144,243
	$3,322,882
	$98,111
	$1,747,734
	$793,891
	$5,077,695
	$3,167,467
$446,712	$3,047,324
	$5,680,867
	$5,771,166
	$5,796,279
$4,406	$6,835,129
	$17,461,137
	$5,847,462
	$1,699,785
	$2,949,544
	$55,351,823
	$6,217,316
$648,809	$1,048,864
$2,175,926	$6,431,172
	$3,563,857
$248	$11,912,861
	$9,955,386
	$6,786,781

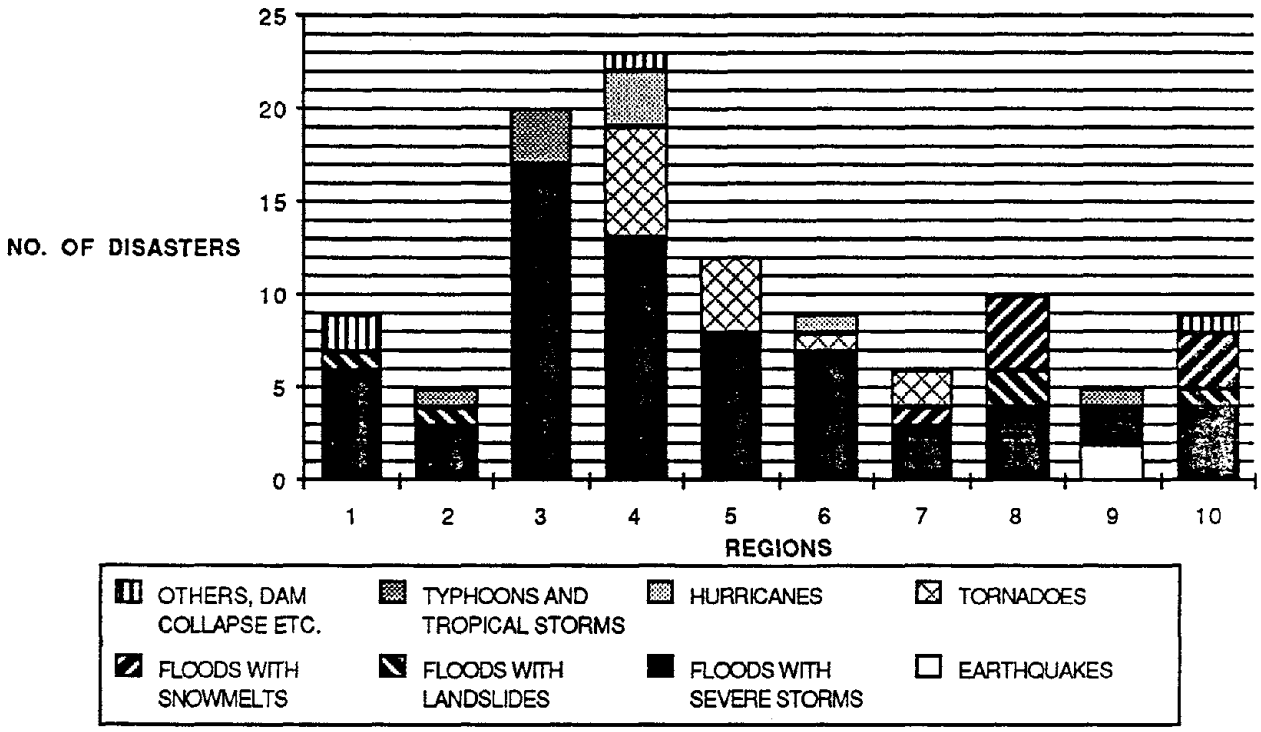
TABLE 5: SUMMARY OF FEMA & FHWA DISASTER EXPENDITURES, 1971-1981

DISASTER CATEGORY	FEMA TRANSPORTATION DAMAGE EXPENDITURES	FEMA TOTAL DAMAGE EXPENDITURES	FHWA 098 EXPENDITURES	FHWA 099 EXPENDITURES	TOTAL ROAD EXPENDITURES FEMA TRANSPORTATION + FWHA 098 + FWHA 099
EARTHQUAKES	$951,739	$218,203,701	$21,778,178	$370,930	$23,100,848
FLOODS, SEVERE STORMS	$179,677,947	$667,213,139	$182,036,873	$49,803,303	$411,518,124
FLOODS, LANDSLIDES	$16,514,591	$30,093,609	$19,640,224	$6,260,105	$42,414,920
FLOODS, SNOWMELTS	$28,021,089	$46,572,512	$23,683,926	$31,125,113	$82,830,128
TORONADOES	$29,550,309	$122,252,631	$20,676,490	$1,006,057	$51,232,856
HURRICANES	$5,137,419	$274,634,050	$60,395,632	$648,809	$66,181,860
TYPHOONS,TROP. STORMS	$102,513,189	$548,775,414	$138,927,439	$1,453,074	$242,893,702
OTHER, DAM COLLAPSE	$3,779,429	$47,870,603	$12,511,216	$0	$16,290,645
TOTAL EXPENDITURES	$366,145,712	$1,955,615,659	$479,649,979	$90,667,392	$936,463,083

TABLE 6: NUMBER OF FEMA AND FHWA DISASTERS BY TYPE AND REGION, 1971-1981

TYPE OF DISASTER	REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6	REGION 7	REGION 8	REGION 9	REGION 10	TOTALS
EARTHQUAKES	0	0	0	0	0	0	0	0	2	0	2
FLOODS WITH SEVERE STORMS	6	3	17	13	8	7	3	4	2	4	67
FLOODS WITH LANDSLIDES	1	1	0	0	0	0	0	2	0	1	5
FLOODS WITH SNOWMELTS	0	0	0	0	0	0	1	4	0	3	8
TORNADOES	0	0	0	6	4	1	2	0	0	0	13
HURRICANES	0	0	0	3	0	1	0	0	0	0	4
TYPHOONS AND TROPICAL STORMS	0	1	3	0	0	0	0	0	1	0	5
OTHERS, DAM COLLAPSE ETC.	2	0	0	1	0	0	0	0	0	1	4
TOTALS	9	5	20	23	12	9	6	10	5	9	108

FIGURE 5 : FEMA & FHWA DISASTER TYPES BY REGION, 1971-198



Approximately $3.8 billion was spent on emergency relief programs in total by FHWA and FEMA. Figure 6 gives the distribution of these expenditures by type. Floods, severe storms accounts for the largest expenditure or 39.17% of the total. Typhoons, tropical storms is the second highest expenditure category accounting for 27.19% and is followed by hurricanes at 10.7%. The fourth largest expenditure category is earthquakes which is followed by tornadoes, flood snowmelt, floods landslides, and other types respectively. Of the $3.8 billion in disaster expenditures, transportation damage accounts for $936 million or 25 percent of all money spent.

The regional allocation of these expenditures is given in Table 7 and Figure 7. According to Figure 7, region 3 received 37.35 percent of all transportation disaster expenditures from 1971-1981. Region 4 received the second highest amount, 17.01 percent followed by region 10 with 10.75 percent, region 8, 9.25 percent, region 2, 7.16 percent and regions 9, 5, 1, and 2 in respective order. The three regions with the greatest number of transportation related disasters occurrences were 4, 3, and 5 which combined accounted for 51 percent of all disasters and received 58.6 percent of all disaster assistance.

Figure 8 shows the proportion of each $100.00 allocated by region by region for disaster assistance of type 098, 099 and FEMA. All regions received some amount of FEMA expenditures per $100.00 allocated. This varied from a high of $70.00 per $100.00 in region 1 to a low of only $11.00 per $100.00 in region 9.

FIGURE 6 : SUMMARY OF FEMA AND FWHA DISASTER EXPENDITURES BY TYPE, 1971-1981 (TOTAL=$3.804 BILLION)

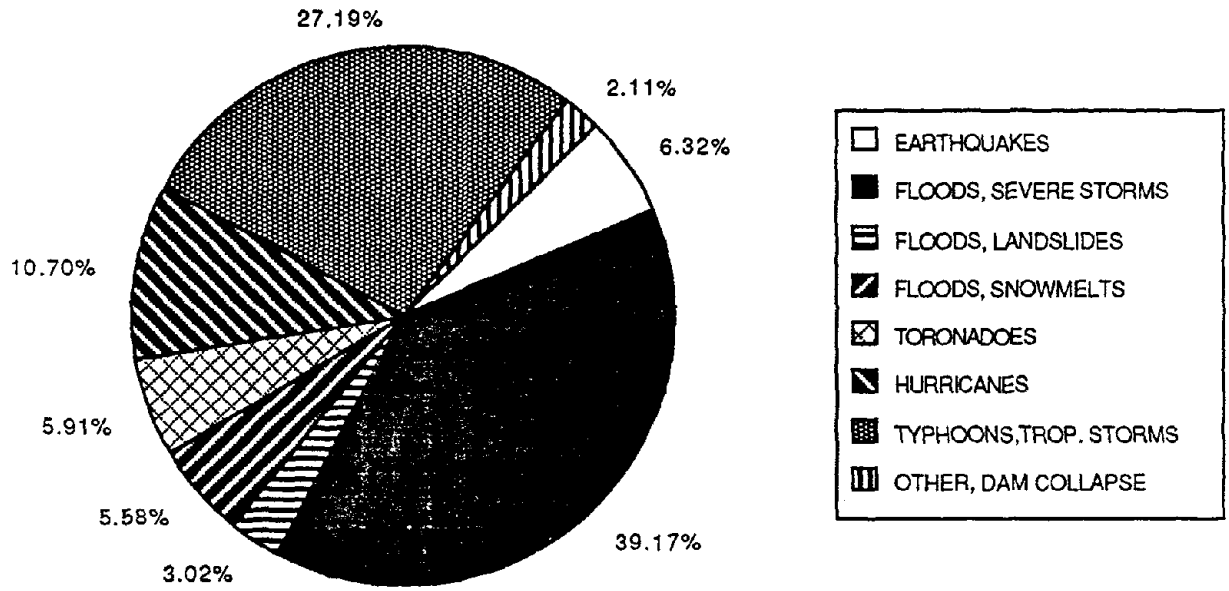


TABLE 7 : DISASTER EXPENDITURES BY REGION AND AGENCY, 1971-1981

REGIONS	FEMA TOTAL DAMAGE EXPENDITURES	FEMA TRANSPORTATION DAMAGE EXPENDITURES	FHWA 098 EXPENDITURES	FHWA 099 EXPENDITURES	TOTAL TRANSPORTATION EXPENDITURES (FEMA + 098 + 099)
REGION 1	$75,885,980	$24,253,360	$9,778,750	$1,122,317	$35,154,427
REGION 2	$134,022,353	$25,881,623	$40,946,889	$187,453	$67,015,965
REGION 3	$704,359,934	$154,521,035	$193,968,084	$1,277,682	$349,766,802
REGION 4	$423,823,176	$51,850,505	$102,671,477	$4,741,351	$159,263,333
REGION 5	$100,564,750	$24,413,515	$15,402,976	$0	$39,816,491
REGION 6	$81,086,508	$13,470,220	$13,095,795	$0	$26,566,015
REGION 7	$32,726,556	$11,674,155	$8,311,791	$0	$19,985,946
REGION 8	$81,630,706	$35,127,321	$19,050,888	$32,440,394	$86,618,604
REGION 9	$242,194,784	$6,462,865	$30,941,676	$14,196,117	$51,600,658
REGION 10	$79,320,912	$18,491,113	$45,481,653	$36,702,078	$100,674,844

FIGURE 7: PERCENT DISTRIBUTION OF TRANSPORTATION DISASTER EXPENDITURES BY REGION, 1971-1981

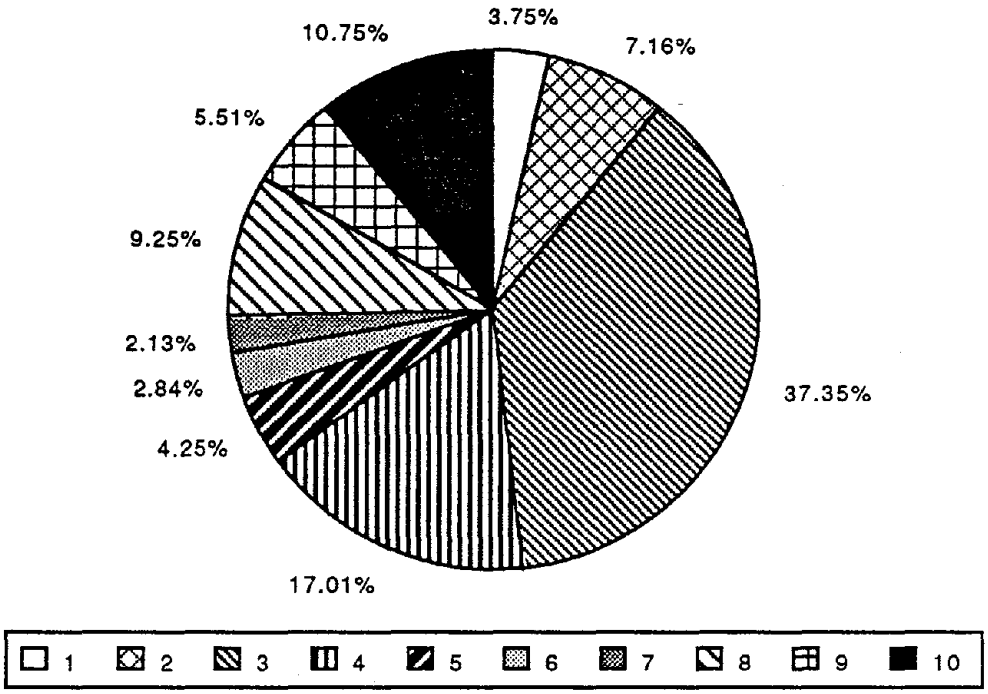
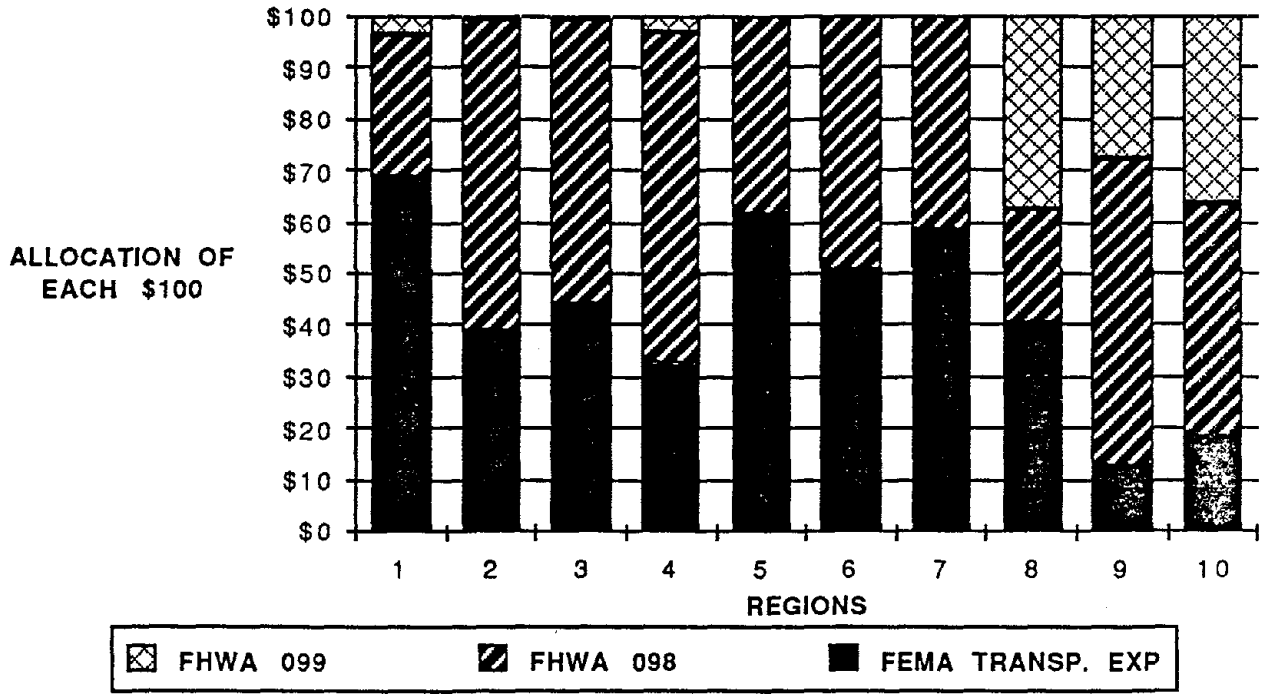


FIGURE 8: ALLOCATION OF EACH $100 OF TRANSPORTATION RELATED DISASTER ASSISTANCE BY REGION, 1971-1981



Likewise all regions received 098 allocations per $100.00 varying from a high of $68.00 in region 4 to $11.00 in region 8. Finally only five regions received 099 allocations, regions 1, 4, 8 and 10.

Figure 9 charts total FEMA expenditures between 1971 and 1981 and the relative proportion allocated to transportation damage. The abnormally large allocation in 1972 reflects the damage caused by Tropical Storm Agnes between June 18, 1972 and July 4, 1972. Figure 10 provides similar information for FEMA and FHWA expenditures.

The information obtained up to this point was used to develop regression models that estimate the impact of types of disasters on transportation lifelines. The dependent variable in the models is the logarithm of the sum of expenditures in Category C FEMA, 098 FHWA and 099 FHWA. Category C expenditures consists of FEMA funds spent for any construction feature within the public Right of Way that is essential in making the road or street functional. Only facilities regularly maintained and kept in repair are eligible for disaster assistance when damaged or destroyed.

FHWA 098 expenditures consists of FHWA appropriations for emergency relief on federal aid highways while FHWA 099 expenditures consist of appropriations for emergency relief on other federal roads such as national park service roads. Total road expenditures equals FEMA transportation expenditures plus FHWA 098 plus FHWA 099 and constitute the dependent variable.

FIGURE 9 : FEMA EXPENDITURES OVER TIME, 1971-1981 (WHERE FWHA EXPENDITURES WERE ALLOCATED ALSO)

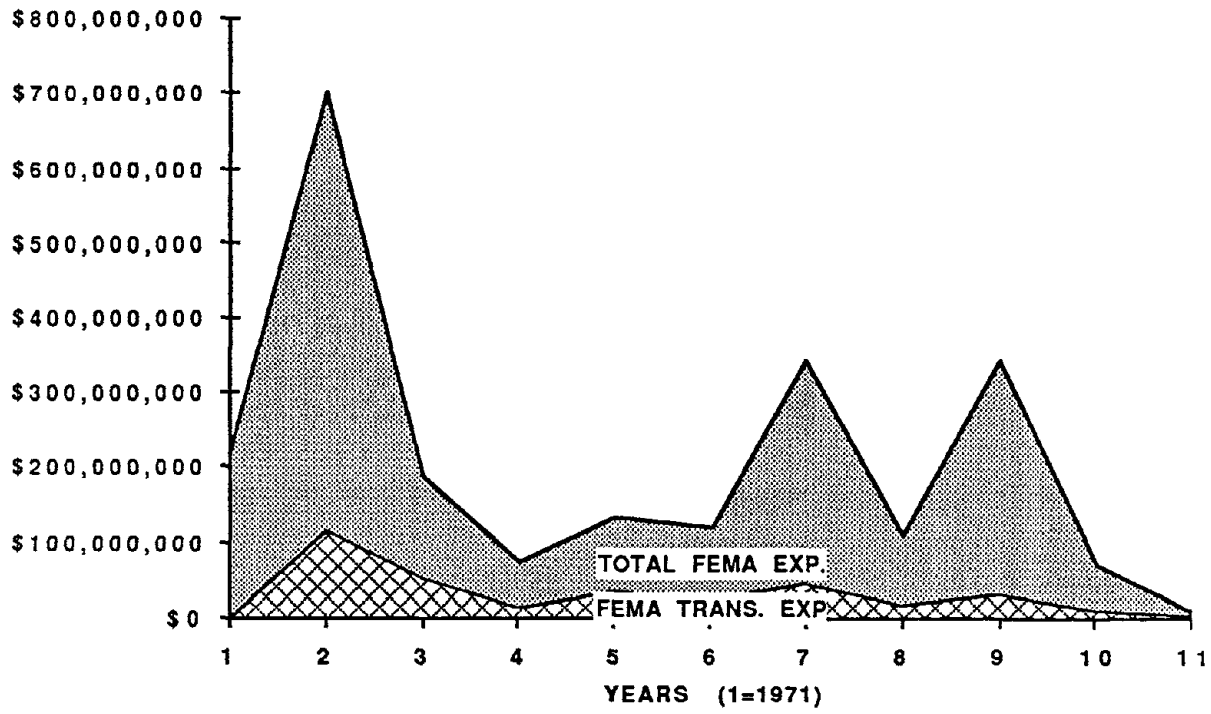
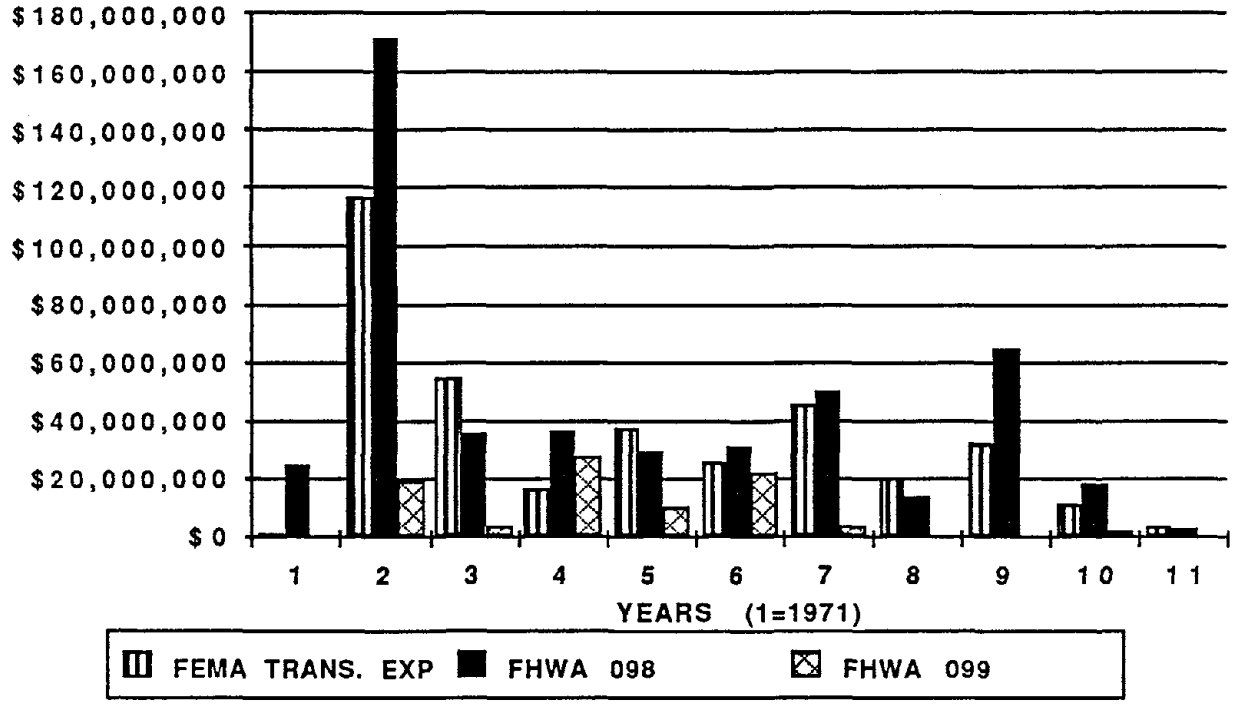


FIGURE 10: TYPES OF EXPENDITURES OVER TIME, 1971-1981



We use total government transportation expenditures as a proxy for the total amount of damage accruing to the transportation system from a natural disaster. Our reasoning in doing this is that even though federal expenditures may not include all damage costs, we believe the relation between federal expenditures and all actual costs will remain constant over time. The model is as follows:

$$\text{Ln(X) of Totrdexp} = \text{Constant} + a_1(\text{Counties}) + a_2[\text{Ln(X) of Capout}] + a_3[\text{Ln(X) of Vehreg}] + a_4(\text{Type1}) + a_5(\text{Type2}) + a_6(\text{Type3}) + a_7(\text{Type4}) + a_8(\text{Type6}) + a_9(\text{Type7}) + a_{10}(\text{Type8}) + a_{11}(\text{Reg1}) + a_{12}(\text{Reg2}) + a_{13}(\text{Reg3}) + a^1_4(\text{Reg5}) + a_{15}(\text{Reg6}) + \ldots\ldots\ldots\ldots + a_{20}(\text{Reg10}) + e^i$$

The independent variables are :1. The number of counties impacted by the disaster; 2. The log of total capital outlay for highways by all units of government. Data is recorded at the state level for the year of the disaster occurrence and measured in thousands of dollars; 3. The log of motor vehicles registered in the state. Note that variables 2 and 3 are included in order to derive a measure of the extensiveness of the transportation infrastructure. 4. Dummy variables are included in the model for disaster type with type 5 (tornadoes) as the reference. Dummy variables are included for regions with region 4 as the reference.

Three regression models were run, see Table 8. Model 1 contained 10 explanatory variables and excluded controls for region. Model 2 contains 12 explanatory variables and excluded

controls for disaster type. The final model, whose results we discuss here, had the best fit and controlled for both disaster type and regions. It contains 19 explanatory variables.

The results given in Table 8 under model 3 are based on pooling observations on disasters occurring in each state across the range 1971-1981. The level of significance of the included variable coefficients is given in the last column of the table. The number of counties impacted and log of capital outlays are significant at better than the .05 level and both have the expected sign. Also the change in transportation disaster expenditures for disasters occurring in region 10 as opposed to region 4 is statistically significant. The adjusted r-squared for model 3 is .35 and is higher than the same value in model 1, .306 and model 2, .319.

The F statistic indicates that the regression equation is statistically significant at better that the .05 level and the standard error of the regression in model 3 is also the lowest at 1.073. Although the adjuster r-squared is .35, perhaps a better measure of the goodness of fit of the model is the small size of its standard error relative to the mean value of the dependent variable. A desired value for this is 15% or less while our value is 6.6%. The positive signs on all but vehicle registration correspond to expectations. That is we would expect a positive impact on the percent change in total transportation disaster expenditures as the percent change in the number of counties impacted and capital outlay on highways increases.

The negative sign for the log of vehicle registration is unexpected but statistically insignificant. Alternative model specifications were tried to correct this sign but each produced similar results. Yet we continue to include this variable because it represents a good proxy for the extensiveness of the states transportation network.

The coefficient for counties indicates that if a disaster impacts one additional county there will be a 2.8% increase in transportation expenditures. The coefficient of the log of capital outlays indicates that if capital outlays increase by 1% the total expenditures on transportation related damage will increase by .93 of one percent. Capital outlays were included as a proxy for the level of development of the transportation infrastructure. The log of vehicles registered indicates that a 1% increase in the number of vehicles registered will cause a .59 percent decrease in transportation damage. As mentioned earlier, we had expected this coefficient to be positive.

The dummy variables for disaster type are referenced to the impact of tornadoes. All types of disasters except type 8 cause a greater impact on disaster expenditures than do tornadoes.

TABLE 8 : MODEL 3

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

DF:	R:	R-squared:	Adj. R-squared:	Std. Error:
107	.682	.466	.35	1.073

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	19	88.3	4.647	4.037
RESIDUAL	88	101.299	1.151	p = .0001
TOTAL	107	189.598		

No Residual Statistics Computed

1

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
INTERCEPT	11.248				
counties	.028	.007	.377	3.959	.0002
ln(x) of capout	.928	.409	.576	2.268	.0258
ln(x) of vehreg	-.589	.324	-.401	1.818	.0724
type1	.688	1.068	.07	.645	.5209
type2	.337	.363	.123	.929	.3557
type3	.617	.647	.098	.953	.3432

2

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
type4	.508	.589	.1	.863	.3906
type6	.849	.665	.121	1.276	.2054
type7	1.293	.684	.205	1.89	.062
type8	-1.212	.693	-.173	1.75	.0836
REG1	.499	.564	.104	.884	.3792
REG2	.416	.589	.066	.707	.4815
REG3	.223	.38	.065	.588	.5578

3

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
REG5	-.467	.409	-.107	1.141	.257
REG6	-.373	.424	-.078	.88	.3815
REG7	-.677	.516	-.117	1.313	.1928
REG8	.554	.532	.121	1.042	.3001
REG9	.737	.745	.117	.989	.3255
REG10	1.295	.492	.27	2.63	.0101

4

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
INTERCEPT					
counties	.014	.043	.014	.043	15.675
ln(x) of capout	.115	1.741	.115	1.741	5.142
ln(x) of vehreg	-1.233	.055	-1.233	.055	3.306
type1	-1.434	2.811	-1.434	2.811	.415
type2	-.384	1.058	-.384	1.058	.862
type3	-.67	1.903	-.67	1.903	.908

5

Multiple Regression Y1:ln(x) of totrdexp 19 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
type4	-.662	1.678	-.662	1.678	.744
type6	-.473	2.171	-.473	2.171	1.628
type7	-.066	2.652	-.066	2.652	3.574
type8	-2.59	.165	-2.59	.165	3.062
REG1	-.623	1.62	-.623	1.62	.781
REG2	-.754	1.586	-.754	1.586	.5
REG3	-.531	.978	-.531	.978	.346

6

Multiple Regression Y_1:ln(x) of totrdexp 19 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
REG5	-1.28	.346	-1.28	.346	1.302
REG6	-1.214	.469	-1.214	.469	.774
REG7	-1.703	.348	-1.703	.348	1.723
REG8	-.503	1.611	-.503	1.611	1.086
REG9	-.744	2.218	-.744	2.218	.978
REG10	.316	2.273	.316	2.273	6.919

7

TABLE 8 : MODEL 1

Multiple Regression Y_1:ln(x) of totrdexp 10 X variables

DF:	R:	R-squared:	Adj. R-squared:	Std. Error:
107	.609	.371	.306	1.109

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	10	70.259	7.026	5.711
RESIDUAL	97	119.339	1.23	p = .0001
TOTAL	107	189.598		

No Residual Statistics Computed

1

Multiple Regression Y_1:ln(x) of totrdexp 10 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
INTERCEPT	12.295				
counties	.02	.007	.269	2.936	.0042
ln(x) of capout	.877	.341	.544	2.569	.0117
ln(x) of vehreg	-.622	.307	-.423	2.028	.0453
type1	1.51	.863	.154	1.75	.0833
type2	.644	.348	.236	1.85	.0673
type3	1.387	.599	.22	2.317	.0226

2

Multiple Regression Y_1:ln(x) of totrdexp 10 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
type4	1.344	.516	.266	2.607	.0106
type6	.966	.654	.138	1.478	.1428
type7	2.147	.607	.34	3.539	.0006
type8	-.614	.686	-.088	.896	.3727

3

Multiple Regression Y_1:ln(x) of totrdexp 10 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
INTERCEPT					
counties	.007	.034	.007	.034	8.621
ln(x) of capout	.199	1.554	.199	1.554	6.597
ln(x) of vehreg	-1.23	-.013	-1.23	-.013	4.111
type1	-.203	3.223	-.203	3.223	3.061
type2	-.047	1.336	-.047	1.336	3.424
type3	.199	2.576	.199	2.576	5.367

4

Multiple Regression Y_1:ln(x) of totrdexp 10 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
type4	.321	2.368	.321	2.368	6.796
type6	-.332	2.265	-.332	2.265	2.183
type7	.943	3.351	.943	3.351	12.525
type8	-1.976	.747	-1.976	.747	.802

5

TABLE 8 : MODEL 2

Multiple Regression Y_1:ln(x) of totrdexp 12 X variables

DF:	R:	R-squared:	Adj. R-squared:	Std. Error:
107	.629	.396	.319	1.098

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	12	75.029	6.252	5.185
RESIDUAL	95	114.569	1.206	p = .0001
TOTAL	107	189.598		

No Residual Statistics Computed

1

Multiple Regression Y_1:ln(x) of totrdexp 12 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
INTERCEPT	10.421				
counties	.034	.006	.454	5.35	.0001
ln(x) of capout	1.214	.396	.754	3.066	.0028
ln(x) of vehreg	-.767	.318	-.523	2.413	.0177
REG1	.551	.556	.115	.99	.3246
REG2	.732	.557	.116	1.314	.192
REG3	.369	.348	.108	1.058	.2927

2

Multiple Regression Y_1:ln(x) of totrdexp 12 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
REG5	-.553	.407	-.126	1.358	.1778
REG6	-.267	.429	-.056	.623	.5348
REG7	-.692	.52	-.12	1.33	.1868
REG8	.843	.472	.184	1.786	.0772
REG9	1.163	.562	.184	2.071	.0411
REG10	1.401	.448	.292	3.125	.0024

3

Multiple Regression Y_1:ln(x) of totrdexp 12 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
INTERCEPT					
counties	.021	.047	.021	.047	28.624
ln(x) of capout	.428	2.001	.428	2.001	9.402
ln(x) of vehreg	-1.398	-.136	-1.398	-.136	5.825
REG1	-.553	1.655	-.553	1.655	.981
REG2	-.374	1.839	-.374	1.839	1.727
REG3	-.323	1.06	-.323	1.06	1.12

4

Multiple Regression Y_1:ln(x) of totrdexp 12 X variables

Confidence Intervals and Partial F Table

Parameter:	95% Lower:	95% Upper:	95% Lower:	95% Upper:	Partial F:
REG5	-1.361	.255	-1.361	.255	1.843
REG6	-1.12	.585	-1.12	.585	.388
REG7	-1.725	.341	-1.725	.341	1.768
REG8	-.094	1.78	-.094	1.78	3.191
REG9	.048	2.278	.048	2.278	4.287
REG10	.511	2.291	.511	2.291	9.765

5

However none proved statistically significant. The types are: 1. Earthquakes, 2. Floods severe storms, 3. Floods landslides, 4. Floods snowmelts, 5. Tornadoes, 6. Hurricanes, 7. Typhoons, and 8. Others. The results indicate that the impact of all disaster types on the transportation system is similar.

Regional impacts were referenced to region 4. The results indicate that only region 9 disasters have impacts that are significantly different than those of region 4.

III. THE REGION IV DATA BASE

Region four encompasses the southeastern states: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee. An organizational chart for region four is presented in Figure 11. The mission of FEMA's Region IV includes the following:

1. Development and implementation of a comprehensive emergency management program.
2. Support of FEMA's national program and objectives.
3. Development and maintenance of emergency capabilities at regional, state, and local government levels.
4. Provision of leadership and guidance in emergency management program development within Region IV.
5. To assist the FEMA National Director in developing overall policy and provide information about Region IV progress.

6. Evaluation, administration and maintenance of emergency operations capability within Region IV.
7. Provision of support staff to other federal agencies in accordance with FEMA guidelines.
8. Provision of guidance and supervision of the Regional Accomplishment of these goals requires great coordination and responsiveness to issues affecting preparedness at all levels of government in Region IV.

The quality of emergency preparedness is a critical factor and, this is particularly true in Region IV which has less than 20 percent of the nations population; 10 percent of its land mass; and more than 55 percent of all major disaster declarations. Flooding is the most frequently occurring followed by tornadoes (FEMA, 1979-1980) although hurricanes are the most devastating. Seismic activity occurs along the Kentucky, Mississippi, Tennessee and South Carolina fault lines.

When natural disasters occur the Disaster Response And Recovery Division coordinates federal relief. In addition, its staff provides on-going technical assistance to governments to increase the survivability of public buildings and facilities undergoing restoration. It also responds to man-made emergencies such as chemical spills. Figure 12 lists some of the coordination activities undertaken by the Disaster Response And Recovery Division.

FIGURE 11 : REGION IV ORGANIZATIONAL CHART

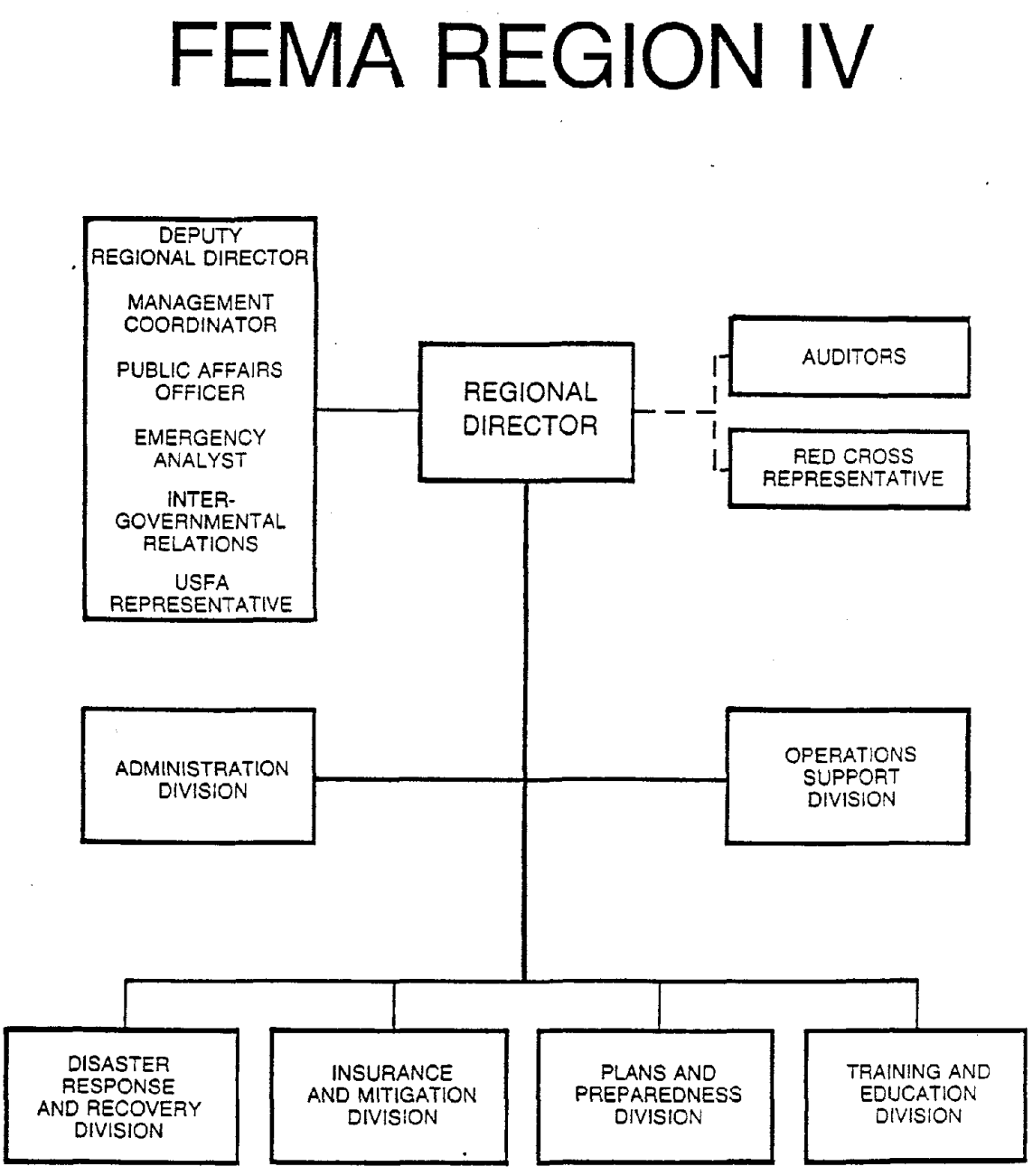


Figure 12

FUNCTIONS OF THE RESPONSE AND RECOVERY DIVISION

Temporary housing for victims	Quick-fix repairs
Assistance with mortgage or rental payments	Disaster unemployment assistance and job placement
Low interest loans	Agricultural assistance
Distributing food coupons	$5000 family and individual grants
Legal Services	Consumer Counseling
Crises/Mental Health Counseling	Social Security Assistance
Veterans Assistance	Clearance of Debris
Repair/replacement of roads, streets,bridges and water control facilities	Repair/replacement of public buildings and recreational facilities
Repair/replacement of private nonprofit facilities	Community loans
Repairs and operating assistance to public schools	

Source: FEMA REGION IV Highlights Of Activities 1979-1980
Federal Emergency Management Agency

There is need to better anticipate the impacts of various disasters in order to better prepare for the negative affects they have.

Region IV: Developing The Data Base

The ability to identify regional impact of natural disasters is dependent on the data base linking disasters to impacts. As

has been discussed the data to do detailed impact analysis of the transportation system is not available. As a result it was necessary to explore other sources of impact data. The most substantial source was the American Red Cross. When a disaster occurs the Red Cross is concerned with immediate relief (providing immediate shelter, clothes, food etc.).

Once involved the Red Cross assesses damage and completes a Chapter Disaster Relief Report on a county basis. This contains information on the number dead, missing, homes destroyed, injured, etc. Red Cross expenditures are also recorded. Relief reports are revised as numbers change until a final report is issued.

Mr. Ben L. Evans, Director of Disaster Services with the Eastern Operations Headquarters was contacted in Alexandria, Virginia. Disaster Relief Reports are located at the three regional Red Cross headquarters. Several problems were associated with the data collected from regional headquarters:

A. There were numerous reports for which it was not possible to locate relief reports. In some instances counties are declared disaster areas due to public works damage and no families are affected. The Red Cross would then have no involvement. This fact might explain the lack of reports for some counties located in presidentially declared disaster areas.
B. All Red Cross records are filed by chapter name. It is

possible for one chapter to have jurisdiction for neighboring counties without being identified in the chapter name. Therefore, where we only had county names it was not always possible to identify the chapter and therefore these reports were not collected.

C. Red Cross records utilize the date of the disaster and not the declaration date.

Nonetheless, the disaster relief reports are the most consistent and helpful source of impact data by which to gauge disaster intensity. The kind of data collected by the Red Cross provides more of an opportunity to support the development of regional impact models particularly when coupled with data available at the national level.

Table 9 lists all FEMA disasters occurring in region 4. There is a total of 62 such disasters. Total expenditures for transportation damage from 1971-1981 in region 4 was $72,437,240. The column labeled % FEMA Transport. Of Total Expenditure gives the percent transportation was of total FEMA expenditures. For example, disasters number 318, 387, 332, 395, 331, 459, and 533 respectively were occurrences where transportation expenditures were the highest percent of total FEMA expenditures. Following is a list of the kinds of disasters included:

1. 318 Heavy rains & flooding
2. 387 Severe storms & flooding
3. 332 Heavy rains & flooding

4. 395 Severe storms & flooding

5. 331 Heavy rains & flooding

6. 459 Severe storms & flooding

7. 533 Severe storms & flooding

Thus, in the above instance we might conclude that flooding results in a much larger percentage of expenditures allocated to road damage. In this way it is possible to discuss road damage within the context of specific types of disasters.

Table 10 summarizes FEMA data for region 4. Figure 13 is a graphic summary of transportation damage as a percent of total FEMA damage. Tennessee received the highest allocation of FEMA transportation damage expenditures $20.5 million, followed by Mississippi, North Carolina and Kentucky. Tennessee also experienced the largest deaths resulting from disasters. Alabama on the other hand received the highest total FEMA allocation $239.2 million followed by Kentucky. Additionally, Tennessee was the state where road damage was the highest percent of total expenditures, 63.49 followed by North Carolina with 54.69 percent. Total FEMA transportation damage expenditures were greatest in Tennessee, Mississippi and North Carolina respectively. The states with the greatest number of deaths resulting from disasters over the ten year time period were Tennessee, Mississippi, Alabama, Kentucky, Florida, Georgia, and North Carolina respectively.

Detailed information on the 23 region 4 disasters involving both FEMA and FHWA expenditures are listed in Table 11 while

Table 12 summarizes data in Table 11 by state. It indicates that total transportation expenditures for FHWA were $107,412,828.00, and $51,850,505.00 for FEMA. Table 13 lists detailed information on FHWA allocations for region 4 disasters while Table 14 contains Region 4 Red Cross data in addition to FEMA data. A comparison of the data under the FEMA columns with that under Red Cross columns indicates Red Cross data is much more detailed than is FEMA data. For example Red Cross gives detailed information on deaths, injuries, damage to dwellings and businesses destroyed.

TABLE 9: ALL REGION 4 FEMA DISASTERS BY DISASTER NUMBER AND OTHER INFORMATION
1971-1981

DISASTER NUMBER	DECLARATION DATE	STATE	REGION	DISASTER TYPE	NO. COUNTIES IMPACTED	FEMA TRANSPORT. DAMAGE EXPEND.
369	1973, MAR 27	AL	4	SEVERE FLOODING & TORNADOES	28	$1,335,607
388	1973, MAY 29	AL	4	SEVERE STORMS & FLOODING	12	$2,100
422	1974, APR 4	AL	4	TORNADOES	20	$91,564
458	1975, MAR 14	AL	4	SEVERE STORMS & FLOODING	23	$692,358
464	1975, APR 23	AL	4	SEVERE STORMS & FLOODING	8	$1,006,413
488	1975, OCT 2	AL	4	WINDS, TORNADOES, RAINS & FLOODING	15	$266,335
532	1977, APR 9	AL	4	SEVERE STROMS & FLOODING	9	$805,090
563	1978, AUG 20	AL	4	SEVERE STORMS & FLOODING	1	$284,443
578	1979, APR 18	AL	4	STORMS, WIND & FLOODING	28	$1,752,853
598	1979, SEP 13	AL	4	HURRICANE FREDERIC	11	$3,004,081
619	1980, APR 20	AL	4	SEVERE STORMS, TORNADOES & FLOODS	2	$592,711
638	1981, APR 10	AL	4	TORNADOES, SEVERE STORMS & FLOODS	1	$44,845
639	1981, MAY 14	AL	4	SEVERE STORMS & FLOODING	1	$222,725
304	1971, MAR 15	FL	4	FREEZE	6	$0
337	1972, JUN 23	FL	4	TROPICAL STORM AGNES	14	$628,601
387	1973, MAY 26	FL	4	SEVERE STORMS & FLOODING	13	$892,440
479	1975, AUG 22	FL	4	FLOODING	8	$920,954
484	1975, SEP 26	FL	4	HIGH WINDS, HEAVY RAINS & FLOODS	6	$338,246
526	1977, JAN 31	FL	4	SEVERE WINTER WEATHER	35	$0
586	1979, MAY 15	FL	4	SEVERE STORMS, TORNADOES & FLOODS	4	$0
600	1979, SEP 13	FL	4	HURRICANE FREDERIC	5	$209,389
607	1979, SEP 29	FL	4	SEVERE STORMS & FLOODING	3	$0
370	1973, APR 4	GA	4	SEVERE FLOODING & TORNADOES	14	$523,351
391	1973, JUN 11	GA	4	SEVERE STORMS & TORNADOES	1	$0
425	1974, APR 5	GA	4	TORNADOES	20	$70,258
460	1975, MAR 29	GA	4	TORNADOES, HIGH WINDS & HEAVY RAINS	1	$0
507	1976, JUN 11	GA	4	SEVERE STORMS & FLOODING	8	$406,556
536	1977, JUN 2	GA	4	SHRIMP LOSS FROM COLD WEATHER	6	$0
541	1977, NOV 7	GA	4	DAM COLLAPSE, FLOODING	1	$206,442
305	1971, MAY 10	KY	4	TORNADO	8	$0
332	1972, MAY 15	KY	4	HEAVY RAINS & FLOODING	10	$586,655
381	1973, MAY 11	KY	4	SEVERE STORMS & FLOODING	5	$95,533

420	1974, APR 4	KY	4	TORNADOES	34	$127,246
461	1975, MAR 29	KY	4	SEVERE STORMS & FLOODING	17	$1,323,111
468	1975, MAY 24	KY	4	SEVERE STORMS & FLOODING	4	$1,240,429
529	1977, APR 6	KY	4	SEVERE STROMS & FLOODING	15	$4,109,422
568	1978, DEC 12	KY	4	SEVERE STORMS & FLOODING	37	$1,715,908
592	1979, JUL 19	KY	4	SEVERE STORMS & FLASH FLOODS	1	$813,653
636	1981, MAR 17	KY	4	SEWER EXPLOSION	1	$1,583,016
302	1971, FEB 22	MS	4	STORMS & TORNADOES	23	$159,718
318	1972, JAN 19	MS	4	HEAVY RAINS & FLOODING	9	$679,594
368	1973, MAR 27	MS	4	HEAVY RAINS, FLOODS & TORNADOES	52	$3,775,901
430	1974, APR 18	MS	4	HEAVY RAINS & FLOODING	30	$1,096,992
456	1975, JAN 30	MS	4	TORNADOES	2	$5,300
499	1976, APR 1	MS	4	SEVERE STORMS, TORNADOES & FLOODS	4	$76,587
577	1979, APR 16	MS	4	SEVERE STORMS, TORNADOES & FLOODS	38	$6,830,723
599	1979, SEP 13	MS	4	HURRICANE FREDERIC	16	$198,684
618	1980, APR 19	MS	4	STORMS FLOOD MUDSLIDE TORNADOES WIND	8	$595,736
394	1973, JUN 25	NC	4	SEVERE STORMS & FLOODING	9	$240,084
428	1974, APR 12	NC	4	TORNADOES	6	$0
542	1977, NOV 9	NC	4	SEVERE STORMS & FLOODING	16	$12,340,280
605	1979, SEP 29	NC	4	SEVERE STORMS & FLOODING	1	$0
306	1971, MAY 18	TN	4	TORNADO	3	$0
331	1972, MAY 15	TN	4	HEAVY RAINS & FLOODING	4	$275,694
366	1973, MAR 21	TN	4	HEAVY RAINS & FLOODING	47	$3,875,609
382	1973, MAY 11	TN	4	SEVERE STORMS & FLOODING	6	$711,412
395	1973, JUN 28	TN	4	SEVERE STORMS & FLOODING	12	$1,780,665
424	1974, APR 4	TN	4	TORNADOES	45	$350,319
459	1975, MAR 22	TN	4	SEVERE STORMS & FLOODING	46	$5,514,297
533	1977, APR 29	TN	4	SEVERE STROMS & FLOODING	6	$2,341,553
544	1977, NOV 12	TN	4	SEVERE STORMS & FLOODING	6	$1,696,056
585	1979, MAY 7	TN	4	SEVERE STORMS, TORNADOES & FLOODS	14	$3,999,701
TOTAL					839	$72,437,240

DISASTER NUMBER	TOTAL FEMA EXPENDITURES	% FEMA TRANSPORT. OF TOTAL EXP.	TOTAL DEAD
369	$2,145,941	62.24%	0
388	$4,236,653	0.05%	0
422	$8,131,945	1.13%	0
458	$1,874,106	36.94%	0
464	$1,496,619	67.25%	0
488	$5,907,259	4.51%	0
532	$2,162,718	37.23%	26
563	$446,861	63.65%	1
578	$5,918,574	29.62%	2
598	$198,122,678	1.52%	0
619	$4,169,666	14.21%	0
638	$726,862	6.17%	0
639	$3,887,699	5.73%	0
304	$7,928,672	0.00%	0
337	$3,865,438	16.26%	0
387	$984,982	90.60%	0
479	$1,448,181	63.59%	0
484	$6,670,508	5.07%	0
526	$20,820,000	0.00%	0
586	$1,777,403	0.00%	0
600	$5,212,770	4.02%	0
607	$575,522	0.00%	0
370	$1,377,638	37.99%	0
391	$294,293	0.00%	0
425	$556,522	12.62%	0
460	$1,433,428	0.00%	0
507	$681,191	59.68%	0
536	$589,500	0.00%	0
541	$2,463,989	8.38%	37
305	$234,973	0.00%	0
332	$659,939	88.90%	0
381	$473,844	20.16%	0

420	$15,712,306	0.81%	0
461	$2,038,869	64.89%	0
468	$2,289,803	54.17%	0
529	$75,809,806	5.42%	0
568	$12,035,008	14.26%	2
592	$2,382,173	34.16%	3
636	$17,344,653	9.13%	0
302	$4,418,862	3.61%	0
318	$680,163	99.92%	0
368	$8,822,980	42.80%	0
430	$4,315,652	25.42%	0
456	$715,223	0.74%	0
499	$1,183,170	6.47%	0
577	$32,533,457	21.00%	4
599	$37,418,215	0.53%	0
618	$4,069,886	14.64%	0
394	$396,066	60.62%	0
428	$283,737	0.00%	0
542	$22,073,881	55.90%	11
605	$250,440	0.00%	0
306	$264,155	0.00%	0
331	$325,144	84.79%	0
366	$4,790,714	80.90%	0
382	$1,325,420	53.67%	0
395	$2,036,122	87.45%	0
424	$4,906,272	7.14%	0
459	$6,694,359	82.37%	0
533	$2,860,077	81.87%	0
544	$3,899,127	43.50%	1
585	$5,258,282	76.06%	0
	$574,410,396		87

TABLE 10: SUMMARY DATA ON REGION 4, ALL FEMA EXPENDITURES
1971-1981

STATE	NO. COUNTIES IMPACTED	TOTAL DEAD	FEMA TRANSPORT. DAMAGE EXPEND.	TOTAL FEMA EXPENDITURES
AL	159	159	$10,101,125	$239,227,581
FL	94	94	$2,989,630	$49,283,476
GA	51	51	$1,206,607	$7,396,561
KY	132	132	$11,594,973	$128,981,374
MS	182	182	$13,419,235	$94,157,608
NC	32	32	$12,580,364	$23,004,124
TN	189	189	$20,545,306	$32,359,672

FIGURE 13: TRANSPORTATION DAMAGE AS A PERCENT OF REGION FOUR TOTAL FEMA DAMAGE, 1971-1981

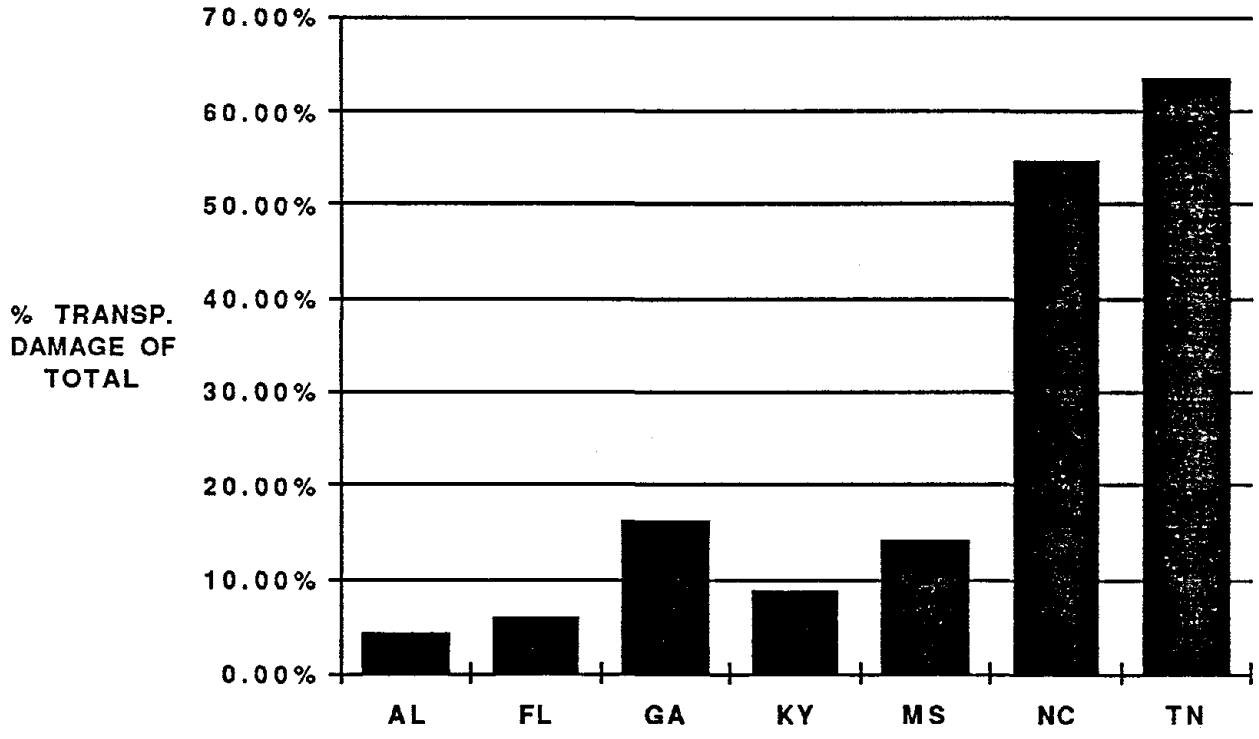


TABLE 11: REGION 4 NATURAL DISASTERS BY NUMBER, DATE AND OTHER RELEVANT INFORMATION
(DISASTERS WITH FEMA AND FHWA EXPENDITURES, 1971 TO 1981)

DISASTER NUMBER	DECLARATION DATE	STATE	REGION	DISASTER TYPE	INCIDENCE PERIOD
369	1973, MAR 27	AL	4	FLOODS, TORNADOES	1973, MAR 14-23
464	1975, APR 23 & MAR 14	AL	4	FLOODS, SEVERE STORMS	1975, JAN 10-APR 14
488	1975, OCT 2	AL	4	FLOODS, TORNADOES, SEVERE STORMS	1975, SEP 22-25
532	1977, APR 9	AL	4	FLOODS, SEVERE STORMS	1977, APR 4-7
598	1979, SEP 13	AL	4	HURRICANE FREDERIC	1979, SEP 12-13
479	1975, AUG 22	FL	4	FLOODS	1975, JULY 28-AUG 18
600	1979, SEP 13	FL	4	HURRICANE FREDERIC	1979, SEP 12-13
370	1973, APR 4	GA	4	FLOODS, TORNADOES	1973, MAR 16-31
541	1977, NOV 7	GA	4	FLOODS CAUSED BY DAM COLLAPSE	1977, NOV 6
529	1977, APR 6	KY	4	FLOODS, SEVERE STORMS	1977, APR 4-8
592	1979, JUL 19	KY	4	FLOODS (FLASH), SEVERE STORMS	1979, JUL 15-
318	1972, JAN 19	MS	4	FLOODS, HEAVY RAINS	1971, DEC 3-10
368	1973, MAR 27	MS	4	FLOODS, TORNADOES, HEAVY RAINS	1973, MAR 14-JUN 10
430	1974, APR 18	MS	4	FLOODS, HEAVY RAINS	1974, APR 12-20
499	1976, APR 1	MS	4	FLOODS, TORNADOES, SEVERE STORMS	1976, MAR 26
577	1979, APR 16	MS	4	FLOODS, TORNADOES, SEVERE STORMS	1979, APR 8-MAY 3
599	1979, SEP 13	MS	4	HURRICANE FREDERIC	1979, SEP 12-13
394	1973, JUN 25	NC	4	FLOODS, SEVERE STORMS	1973, MAY 27-28
542	1977, NOV 9	NC	4	FLOODS, SEVERE STORMS	1977, NOV 4-6
331	1972, MAY 15	TN	4	FLOODS, HEAVY RAINS	1972, APR 12-14
366	1973, MAR 21 & MAY 11	TN	4	FLOODS & SEVERE STORMS	1973, MAR 14-MAY 8
459	1975, MAR 22	TN	4	FLOODS, SEVERE STORMS	1975, MAR 11-APR 13
533	1977, APR 29	TN	4	FLOODS, SEVERE STORMS	1977, APR 4-7

DISASTER NUMBER	NUMBER OF COUNTIES IMPACTED	FEMA TRANSPORTATION DAMAGE EXPENDITURES	FEMA TOTAL DAMAGE EXPENDITURES	DEAD	DISASTER NUMBER	FHWA 098 EXPENDITURES
369	28	$1,335,607	$2,145,941	0	369	$1,782,551
464	8	$1,698,771	$3,370,725	0	464	$2,988,802
488	15	$266,335	$5,907,259	0	488	$237,318
532	9	$805,090	$2,162,718	26	532	$715,623
598	11	$3,004,081	$198,122,678	0	598	$52,347,742
479	8	$920,954	$1,448,181	0	479	$461,055
600	5	$209,389	$5,212,770	0	600	$190,666
370	14	$523,351	$1,377,638	0	370	$252,411
541	1	$206,442	$2,463,989	37	541	$41,923
529	15	$4,109,422	$75,809,806	0	529	$211,301
592	1	$813,653	$2,382,173	3	592	$886,132
318	9	$679,594	$680,163	0	318	$1,208,824
368	52	$3,775,901	$8,822,980	0	368	$5,358,187
430	30	$1,096,992	$4,315,652	0	430	$11,464,258
499	4	$76,587	$1,183,170	0	499	$5,671,056
577	38	$6,830,723	$32,533,457	4	577	
599	16	$198,684	$37,418,215	0	599	$6,018,632
394	9	$240,084	$396,066	0	394	$285,905
542	16	$12,340,280	$22,073,881	11	542	$4,437,013
331	4	$275,694	$325,144	0	331	$279,980
366	47	$4,587,021	$6,116,134	0	366	$4,155,867
459	46	$5,514,297	$6,694,359	0	459	$1,459,531
533	6	$2,341,553	$2,860,077	0	533	$2,216,701

FHWA 099 EXPENDITURES	TOTAL ROAD EXPENDITURES FEMA TRANSPORTATION + FWHA 098 + FWHA 099
$748,759	$3,866,917
	$4,687,573
	$503,653
	$1,520,713
	$55,351,823
	$1,382,009
$648,809	$1,048,864
	$775,762
	$248,365
	$4,320,723
	$1,699,785
	$1,888,418
$252,892	$9,386,980
	$12,561,250
	$5,747,643
$4,406	$6,835,129
	$6,217,316
$195,931	$721,920
	$16,777,293
$1,045,831	$1,601,505
$1,634,922	$10,377,810
$209,801	$7,183,629
	$4,558,254

TABLE 12 :SUMMARY OF FEMA AND FHWA DISASTERS, REGION 4

STATE	NUMBER OF COUNTIES IMPACTED	FEMA TRANSPORTATION DAMAGE EXPENDITURES	FEMA TOTAL DAMAGE EXPENDITURES	DEAD	FHWA 098 EXPENDITURES
AL	71	7109884	211709321	26	58072035.72
FL	13	1130343	6660951	0	651721
GA	15	729793	3841627	37	294334.61
KY	16	4923075	78191979	3	1097432.15
MS	149	12658481	84953637	4	29720957
NC	25	12580364	22469947	11	4722918
TN	103	12718565	15995714	0	8112079
TOTAL	392	51850505	423823176	81	102671477

FHWA 099 EXPENDITURES	TOTAL ROAD EXPENDITURES FEMA TRANSPORTATION + FWHA 098 + FWHA 099
748758.81	65930678.53
648809.4	2430873.4
0	1024127.61
0	6020507.15
257298.17	42636736.17
195931.08	17499213.08
2890553.46	23721197.46
4741351	159263333

TABLE 13 : LIST OF FHWA REGION 4 DISASTERS BY STATE, DATE AND TYPE, 1971-1981

STATE	DATE	DISASTER TYPE	PROCLAMATION DATE BY GOVERNOR
Al	1973, Mar. 14	Floods and Tornadoes	1973, March 28 (Incl)
Al	1975, Feb 15-28, and April 9-14	Floods and Storms	1975, Mar 25 & April 23 (not incl)
Al	1975, Sep 23-24	Hurricane Eloise	
Al	1977, April 4-6	Heavy Rains and Tornado	1977, April 14 (incl)
Al	1978, Jan 24-27	Heavy Rains	1978, Feb 16 (not incl)
Al	1979, March 4	Sinkhole	Included but date cut-off
Al	1979, March 3-4	Floods, Rains and winds	1979, April 19 (incl)
Al	1979, April 12-14	Floods and heavy rains	1979, June 1 (incl)
Al	1979, Sept 12-14	Hurricane Frederic	
Al	1980, April 12-13	Floods and heavy rains	1980, June 10 (Not incl)
Fl	1972, June 18-23	Hurricane Agnes, high tides	1972, June 22 (not incl)
Fl	1973, April 1-7	Flash Floods and rains	1973, July 5 (incl)
Fl	1975, July 28-Aug 6	Storms	1975, Aug 22 (exec order not incl)
Fl	1975, July 28	Hurricane Eloise	1975, Oct 7 (amended proc incl)
Fl	1979, Feb 24- Mar 4	Floods, heavy rainfall	1979, March 7 (incl)
Fl	1979, Sept 12	Hurricane Frederick	
Ga	1973, March 14-19	Floods and Heavy Rains	1973 April 26 (not incl)
Ky	?	Heavy rains/landslide	
Ky	1977, April	Flood	
Ky	1979, July (mid)	Floods	1979, July 16 (not incl)
Ms	1971, Dec 5-7	Floods	
Ms	1973, March 14-May	Floods	1973, March 20 & April 16 (not inc)
Ms	1974, April	Floods	
Ms	1976, March 12	Landslide	1976, March 26 (incl)
Ms	1975, Aug 1 (?)	Landslide	
Ms	1977, Nov 21	Heavy rains	1977, Nov 22 (incl)
Ms	1979, April 8	Floods and heavy rains	1979, April 13 (not incl)
Ms	1979, Sept	Hurricane Frederic	1979, Sept 12 (not incl)
NC	1973, May 27-28	Floods and storms	1973, May 31 (not incl)
NC	1975, Feb	Bridge collapse (catastrophic)	1975, Feb 24 (not incl)
NC	1977, Nov	Floods and storms	1977, Dec 9 & 14 (letters to Pres)
Tn	1972, April 12	Floods and storms	
Tn	1973, March 16-18	Floods	1973, March 23 (not incl)
Tn	1975, March 11-16	Floods	1975, April 22 (not incl)
Tn	1977, April 4-7	Storms, heavy rains	1977, April 8 -letter to Pres

STATE	DATE	FHWA APPROVAL DATE FOR EMERGENCY RELIEF	NUMBER OF COUNTIES APPROVED APPROVED FOR EMERGENCY RELIEF	LEVEL OF FUNDING RECEIVED FROM FHWA
Al	1973, Mar. 14		24 in procl	
Al	1975, Feb 15-28, and April 9-14	1975, June 18	13	100%
Al	1975, Sep 23-24	1976, June 12		100%
Al	1977, April 4-6	1977, June 8	1 (9 in procl)	100%
Al	1978, Jan 24-27	1978, March 16	11	100%
Al	1979, March 4	1979, March 23 (regional) Fed ?	1	100% Requested
Al	1979, March 3-4	1979, June 8	4 (16 in procl)	100%
Al	1979, April 12-14	1979, July 5	18	100%
Al	1979, Sept 12-14	1979, Oct 5	2	100%
Al	1980, April 12-13	1980, June 18	1	100%
Fl	1972, June 18-23	1972, Sept 7	6	100%
Fl	1973, April 1-7		8	
Fl	1975, July 28-Aug 6	1975, Oct 20	8 in procl	100% requested.
Fl	1975, July 28	1976, Feb 23	5 (10 in procl)	70% normal
Fl	1979, Feb 24- Mar 4		2	100% requested
Fl	1979, Sept 12	1979, Oct 22	2	100%
Ga	1973, March 14-19	1973, June 16	4	100%
Ky	?	1973, Aug 31		
Ky	1977, April			
Ky	1979, July (mid)	1979, Sept 24	1	100%
Ms	1971, Dec 5-7	1972, Aug 31 (initial program)		100%
Ms	1973, March 14-May	1973, June 26		100%
Ms	1974, April			
Ms	1976, March 12	1976, June 11	2	100%
Ms	1975, Aug 1 (?)		1	70%
Ms	1977, Nov 21	1978 Feb 8	1	100%
Ms	1979, April 8	1979, July 30	18	100%
Ms	1979, Sept	1980, Jan 10	3	100%
NC	1973, May 27-28	? incl but no date	22 (but only 9 in procl)	100%
NC	1975, Feb	1975, April 14		100% requested but denied
NC	1977, Nov	1977, Dec 16	14	100%
Tn	1972, April 12	1972, Aug 22	1	100%
Tn	1973, March 16-18	1973, May 1		100%
Tn	1975, March 11-16	1975, June 5	19	100%
Tn	1977, April 4-7	1977, July 5	6 (9 requested)	100%

STATE	DATE	ESTIMATED COST OF REPAIRING DISASTER DAMAGE	INITIAL ALLOCATION APPROVED BY FHWA FOR DISASTER RELIEF
Al	1973, Mar. 14	$195,000 for Forest highways	$200,000 for Forest highways
Al	1975, Feb 15-28, and April 9-14		$500,000
Al	1975, Sep 23-24		$250,000
Al	1977, April 4-6	$660,160	$500,000
Al	1978, Jan 24-27	$750,000	$500,000
Al	1979, March 4	$750,000	
Al	1979, March 3-4	$251,402	
Al	1979, April 12-14	$6,000,000	
Al	1979, Sept 12-14	$42,800,000	
Al	1980, April 12-13	$225,000	
Fl	1972, June 18-23	$1,300,000	$471,802
Fl	1973, April 1-7		
Fl	1975, July 28-Aug 6	$124,000 fed aid rds, $46,000 forest, $903,000-off	$86,000 ?
Fl	1975, July 28	$455,000	
Fl	1979, Feb 24- Mar 4	$107,350	
Fl	1979, Sept 12	$293,000	
Ga	1973, March 14-19	$192,866	
Ky	?	$5,000,000 (1 mil for road, 4 mil for relocation	
Ky	1977, April		
Ky	1979, July (mid)	$700,000	
Ms	1971, Dec 5-7		$10,000 Prog 1, $200,000 -Prog 3
Ms	1973, March 14-May		$5,000,000
Ms	1974, April		
Ms	1976, March 12		
Ms	1975, Aug 1 (?)		
Ms	1977, Nov 21	$1,941,000 for replacement; $1,147,000 for repair	$100,000
Ms	1979, April 8	$1,600,000	
Ms	1979, Sept	$836,000	
NC	1973, May 27-28	$450,000 for 9 counties	$450,000
NC	1975, Feb		$606,900
NC	1977, Nov	$4,000,000	$2,000,000
Tn	1972, April 12	$481,000	
Tn	1973, March 16-18		$2,000,000
Tn	1975, March 11-16	$2,000,000 for 24 counties	
Tn	1977, April 4-7	$2,230,000	

ST	MISCELANEOUS NOTES FOUND IN FILES
Al	Letter of approval only for forest highway funding; according to gov procl, $20 million damage to public property, $8 million to private property
Al	$639,000 to repair slides in Conecuh County questioned.
Al	Subsequent allocation of $300,000 made on Feb 22, 1977
Al	
Al	Road washout damage; Included: preliminary cost summary- state fed aid damage=$198,117; county fed-aid damage=$883,845 (No cited source).
Al	Road damage to interstate; No FHWA Reply included in file.
Al	
Al	27 counties in request. Incl: Listing of damage costs by county.
Al	Dauphin Island Bridge destroyed. Sierra Club attempted to intervene and stop construction, but failed. Contract amount for $32,726,330.
Al	Culvert damage due to collapse of earth dam upstream
Fl	Amended procl in Aug 1972 (incl)
Fl	Stage 2 of funding (Oct. 23, 1973) was $360,414
Fl	* can't tell if this is for this disaster or Hurricane Eloise
Fl	
Fl	
Fl	Additional $56,600 approved? Confusion about this.
Ga	
Ky	State wanted to relocate road in new ROW, not eligible though. Long time span. Letters from 1973 to 1982.
Ky	File just consists of a letter requesting an additional ER of $1 million - dated 1977, Dec 1.
Ky	
Ms	Program 2 approved Oct 11, 1972; Program 3 approved Feb 6, 1973
Ms	
Ms	Additional allocation of $11,500,000 on July 28, 1975 for Homochitto Bridge.
Ms	Additional procl for another county on May 20, 1976; Approval came on Aug 6, 1976. $2,000,000 allocated on Aug 31, 1976.
Ms	Funding increased to 100% on June 29, 1976. Bridge failure damage.
Ms	Bridge collapsed. Approval was granted for replacement.
Ms	Additional approval increased counties to 30 & Est COR to $4,300,000 (Oct 2, 1979)
Ms	
NC	Greater than 100 yr flood.
NC	
NC	In addition, $2,191,324 damage in Nat Forests. Incl: subsequent approval letters.
Tn	Apparently denied at first, later approved. One person dead. Over $76,000 spent by state for debris removal.
Tn	100 yr flood
Tn	Additional allocation of $190,000 for an additional county approved on Aug 22, 1975.
Tn	Incl: letter to Pres w/ extensive info: 2 dead, 16 injured, total damage = $20,953,003.

TABLE 14: RED CROSS DATA AS COMPARED TO FEMA DATA FOR REGION 4

FEMA DATA						
DISASTER NUMBER	STATE	REGION	DECLARATION DATE	DISASTER TYPE	INCIDENCE PERIOD	STATUS (O OR C)
420	KY	4	1974, APR 4	TORNADOES	1974, APR 1-4	C
458	AL	4	1975, MAR 14	SEVERE STORMS & FLOODING	1975, JAN 10-FEB 28	C
461	KY	4	1975, MAR 29	SEVERE STORMS & FLOODING	1975, MAR 10-APR 10	C
532	AL	4	1977, APR 9	SEVERE STROMS & FLOODING	1977, APR 4-7	C
544	TN	4	1977, NOV 12	SEVERE STORMS & FLOODING	1977, NOV 5-7	C
568	KY	4	1978, DEC 12	SEVERE STORMS & FLOODING	1978, DEC 7-19	O
577	MS	4	1979, APR 16	SEVERE STORMS, TORNADOES & FLOODS	1979, APR 8-MAY 3	O
578	AL	4	1979, APR 18	STORMS, WIND & FLOODING	1979, APR 11-22	O
585	TN	4	1979, MAY 7	SEVERE STORMS, TORNADOES & FLOODS	1979, MAY 3-5	O
592	KY	4	1979, JUL 19	SEVERE STORMS & FLASH FLOODS	1979, JUL 15-	O
598	AL	4	1979, SEP 13	HURRICANE FREDERIC	1979, SEP 12-13	O
599	MS	4	1979, SEP 13	HURRICANE FREDERIC	1979, SEP 12-13	O
600	FL	4	1979, SEP 13	HURRICANE FREDERIC	1979, SEP 12-13	O
618	MS	4	1980, APR 19	STORMS FLOOD MUDSLIDE TORNADOES WIND	1980, MAR 28-APR 20	O
619	AL	4	1980, APR 20	SEVERE STORMS, TORNADOES & FLOODS	1980, APR 12-13	O

					RED CROSS DATA			
NO COUNTIES	CATEGORY C DAMAGE	TOTAL DAMAGE	CATEGORY C AS % OF TOTAL	NUMBER DEAD	DISASTER NUMBER	RED CROSS DEAD	INJURIES	DWELLINGS DESTROYED
34	$127,246	$15,712,306	0.81%	0	420	66	1,076	2,011
23	$692,358	$1,874,106	36.94%	0	458	0	0	0
17	$1,323,111	$2,038,869	64.89%	0	461	3	0	0
9	$805,090	$2,162,718	37.23%	26	532	1	4	8
6	$1,696,056	$3,899,127	43.50%	1	544	0	0	10
37	$1,715,908	$12,035,008	14.26%	2	568	0	0	0
38	$6,830,723	$32,533,457	21.00%	4	577	4	947	32
28	$1,752,853	$5,918,574	29.62%	2	578	7	9	35
14	$3,999,701	$5,258,282	76.06%	0	585	0	5	8
1	$813,653	$2,382,173	34.16%	3	592	1	59	50
11	$3,004,081	$198,122,678	1.52%	0	598	10	3,483	1,659
16	$198,684	$37,418,215	0.53%	0	599	2	720	66
5	$209,389	$5,212,770	4.02%	0	600	0	19	0
8	$595,736	$4,069,886	14.64%		618	0	0	0
2	$592,711	$4,169,666	14.21%	0	619	3	14	10

RED CROSS DATA					
MOBILE HOMES DESTROYED	APT UNITS DESTROYED	SMALL BUSINESSES DESTROYED	DWELLINGS REBUILT	GRAND TOTAL	PERCENT RED CROSS COUNTIES
326	-	195	0	$849,100	68%
0	0	0	0	$269	4%
10	25	42		$118,820	63%
7	0	0	0	$20,599	9%
5	0	0	0	$76,736	100%
0	0	-	-	$9,438	3%
63	0	357	0	$2,145,957	66%
91	25	93	0	$581,835	61%
9	0	-	-	$21,766	57%
58	0	-	-	$144,778	100%
4,021	40	-	-	$3,618,311	9%
187	4	-	-	$1,361,535	50%
0	0	-	-	$43,956	80%
0	0	-	-	$12,838	25%
0	1	-	-	$77,746	100%

IV. EARTHQUAKES: SELECTED CASE STUDIES

Earthquakes are particularly threatening due to their ability to initiate activity on the part of other natural hazards. Although they are typically of short duration they can be devastating thus, there is tremendous need to better identify areas of seismic activity and predict potential effect associated with earthquakes.

Older structures are particularly susceptible to earthquake damage and are prime hazards although some modern structures do not meet seismic safety standards. Determination of appropriate levels of construction to resist earthquakes is a critical issue in lifeline engineering. The ability to identify these is of vital importance to decision makers and planners.

Within the context of urban areas lifelines represent a substantial portion of economic investment susceptible to damage in the event of an earthquake. Such damage may have a profound impact on public well-being. It potentially may result in:

A. Disruption and damage to the transportation system thereby limiting the community's ability to respond and survive.

B. Dangers posed by ruptured utility lines (fires etc.).

C. Isolation and inability to communicate.

Needless to say, the cost of repair is prohibitive. And even partial damage means the lifeline may not be able to perform as a system or network.

Transportation Lifeline Performance During Earthquakes

There are a number of ways in which the transportation system can be interrupted during an earthquake. During the Miyagiken-oki Earthquake on June 12, 1978 in Japan the automatic control of traffic lights was curtailed. This occurred during the rush hour and resulted in massive traffic jams. Travel on major roads was restricted to national highways and the Tohoku Expressway. Table 15 contain information on travel restrictions on national highways and roads administered by Miyagi Prefectural Government. Rail service was suspended for a minimum of two days to up to three and one-half weeks in other instances. Service at the Sendai Airport was temporarily suspended (Kuribayashi et. al. , 1979). Figure 14 is a map of the transportation network in Miyagi Prefecture.

September 19, 1985 an earthquake of 8.1 magnitude struck Mexico. The ground motions associated with the 1985 earthquake were possibly the largest to be felt in Mexico City. Despite the great intensity transportation lifelines

The critical role played by transportation lifelines was dramatically illustrated after the Tangshan earthquake on July 28, 1976. Disaster relief was severely hampered and external traffic facilities were destroyed. Cracks developed in the pavement between older and more recently filled roadbeds. River banks adjacent to roads slid or settled unevenly. Bridges were destroyed this included; droppage of lateral beams, collapse of

TABLE 15 : TRAVEL RESTRICTIONS

Number of the Route	Damaged Sites (Kilometer Post)	States of the Damage	Restriction	Period of the Restriction	
				Beginning of the Restriction	End of the Restriction
4	Tamachi, Shiroishi City (304.5km)	Sinking of the road surface by the bursting of a water pipe	One-side restriction	23:00, June 12	1:30, June 13
"	Tomiya Town, Kurokawa County (371.7km)	Upheaval of the road surface h=20.40cm	"	17:20, June 12	8:00, June 13
6	Kashima Town, Soma County (283.4km)	Sinking of the road surface near an abutment h=10cm	"	18:00, June 12	19:00, June 12
45	Naruse Town, Monou County (Ono Bridge) (38.0km)	Movement of the girder	Traffic suspension	19:00, June 12	18:00, June 17 Traffic restriction of vehicles loaded more than 1 ton continued.
"	Naruse Town, Monou County (38.2km)	Landslide V=400m^3	One-side restriction	19:00, June 12	13:00, June 16
"	Kanan Town, Monou County (Tenno Bridge) (58.3km)	Cracks in the pier	Traffic restriction of vehicles loaded more than 1 ton	18:00, June 20	
"	Oofunato, Oofunato City (165.5km)	Cracks in the road surface 70m	"	13:00, June 13	19:30, June 16
"	Sanriku Town, Kesen County (180.6km)	Cracks in the road surface 10m.	"	19:05, June 12	17:00, June 15

TABLE 15 : (CONTINUED)

Number of the Route	Damaged Sites (Kilometer Post)	States of the Damage	Restriction	Period of the Restriction	
				Beginning of the Restriction	End of the Restriction
45	Sanriku Town, Kesen County (183.6km)	Cracks in the road surface 50m	Traffic restriction of vehicles loaded more than 1 ton	19:05, June 12	17:00, June 15
"	Sanriku Town, Kesen County (184.3km)	Cracks in the road surface 32m	"	17:51, June 12	17:00, June 15
"	Noda Village, Kunohe County (336.7km)	Landslide L=10m V=100m^3	"	18:20, June 12	17:00, June 14
48	Miyagi Town, Miyagi County (30.5km)	Falling down of a tree	"	17:30, June 12	19:50, June 12
108	Kanan Town, Monou County (5.8km)	Depression of the road L=6m h=70cm	Traffic suspension	18:00, June 12	16:25, June 13
"	Furukawa City (35.5km)	Leakage of gas	"	17:30, June 12	19:50, June 12

Source: Public Works Research Institute, Functional Damage and Rehabilitation of Lifelines in the Miyagiken-Uki Earthquake of 1978, August 1979.

TABLE 15 : (CONTINUED)

Traffic Control on the Roads Administrated by Miyagi Prefectural Government from June 12 till July 10.

	Date and Time / Restriction	18:00, June 12	17:00, June 13	17:00, June 14	17:00, June 15	17:00, June 16	17:00, June 17	17:00, June 18	8:00, June 19	~	10:00, July 10	Note
Road	Traffic suspension	16	10	8	8	8	8	8	10		5	
	Traffic restriction of large-sized vehicles	1	2	2	1	0	2	2	2		1	Time restriction from July 7 except for on Sunday
	One-side restriction	12	9	7	7	8	7	7	7		0	
	Speed restriction	2	0	0	0	0	0	0	0		0	
	Total	31	21	17	16	16	17	17	19		6	
Bridge	Traffic suspension	5	3	4	4	4	5	5	5		0	
	Traffic restriction of large-sized vehicles	2	1	1	1	2	2	2	2		3	Traffic suspension of vehicles at Kinno Bridge, Eai Bridge and Komazuka Bridge
	One-side restriction	3	3	3	3	3	3	3	3		3	Traffic suspension of vehicles loaded more than 1 ton
	Speed restriction	2	4	4	3	4	3	3	3		0	
	Total	12	11	12	11	13	13	13	13		6	

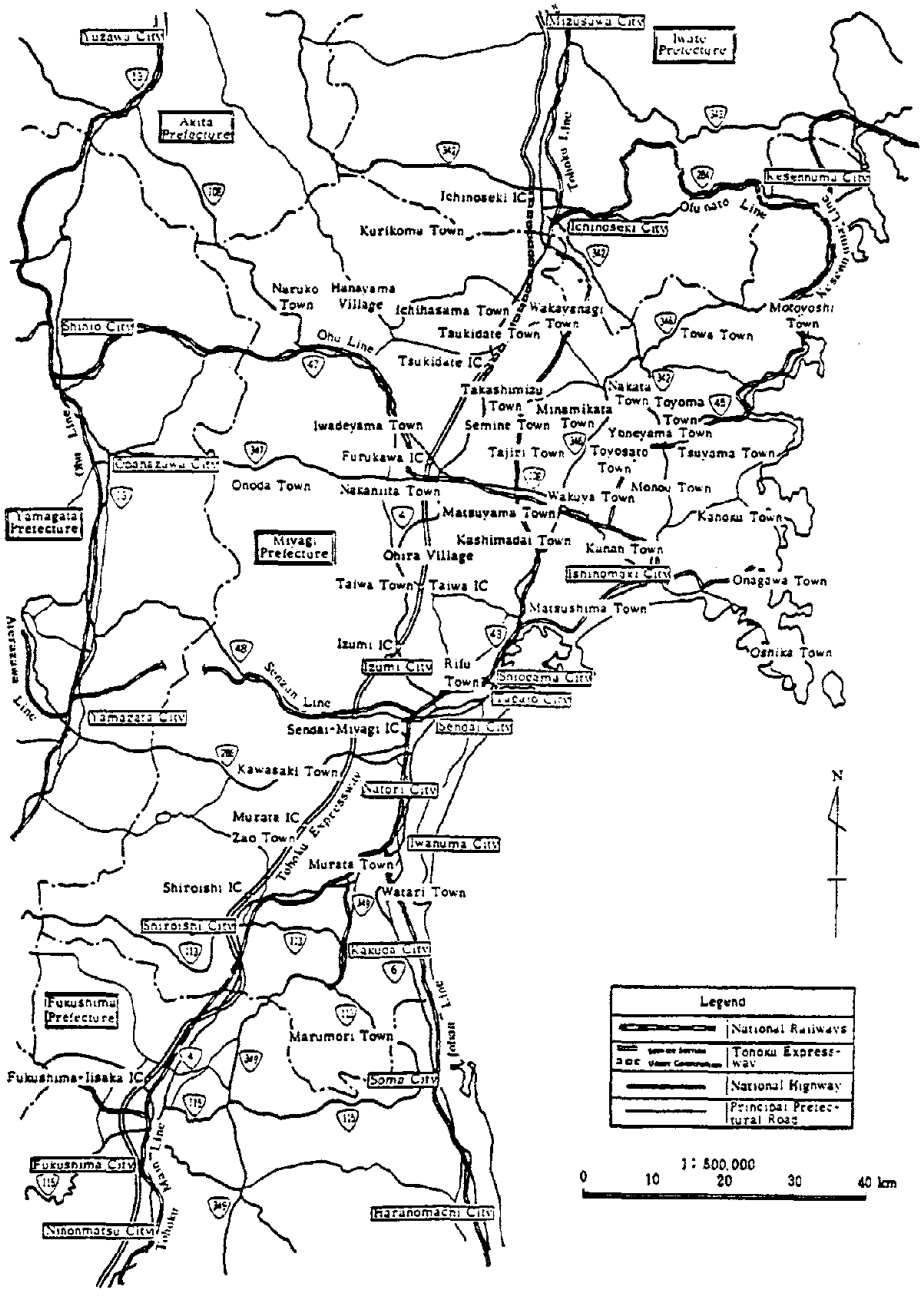
TABLE 15 : (CONTINUED)

(Table 1-2 continued)

	Date and Time / Restriction	18:00, June 12	17:00, June 13	17:00, June 14	17:00, June 15	17:00, June 16	17:00, June 17	17:00, June 18	8:00, June 19	~	10:00, July 10	Note
Total	Traffic Suspension	21	13	12	12	12	13	13	15		5	
	Traffic restriction of large-sized vehicles	3	3	3	2	2	4	4	4		4	
	One-side restriction	15	12	10	10	11	10	10	10		3	
	Speed restriction	4	4	4	3	4	3	3	3		0	
	Total	43	32	29	27	29	30	30	32		12	

Source: Public Works Research Institute, Functional Damage and Rehabilitation of Lifelines in the Miyagiken-Uki Earthquake of 1978, August 1979.

FIGURE 14 : TRANSPORTATION NETWORK, THE MIYAGI PREFECTURE



longitudinal beams, and significant displacement of piers. Roads in the city suffered much lighter damage than external ones. Collapsed buildings stopped traffic and further damaged the roads.

For the railroad there was damage to the track coupled with the derailment and overturning of both passenger and freight trains. This resulted in more damage to the roadway. Bridges over which the railroad traveled were not as severely damaged as other bridges. Passenger depots and communications were damaged extensively (Xunchu,1981). Following the earthquake the amount of traffic was significantly reduced. Also disaster relief vehicles had to use alternative routes that were much less efficient.

The airport was operational by July 29. By August 5,all external facilities had been temporarily repaired
and were open to traffic and the railroad re-opened on August 10. There are a number of implications to be drawn from this experience:

1. Transportation lifelines must have the capability to meet the demands placed upon it after the earthquake. This implies that a great amount of redundancy must exist or specific plans made to accommodate emergencies.
2. Highways connecting railroad facilities, freight terminals, airports, etc. must be accessible and operative. The design implications must be addressed.
3. Traffic control capability must be extensive.
4. Plans should be made for emergency repair of major

transportation facilities.

5. Distribution capability must exist for food, drugs etc.

6. Inspection of transportation facilities regularly so we can evaluate their vulnerability and examine the possibility of retrofitting.

James D. Cooper in " MITIGATION OF EARTHQUAKE DAMAGE ON HIGHWAY SYSTEMS" outlines the likely damage to highways resulting from a major eastern earthquake. Most research has focused on improving the seismic safety of bridges connecting highway systems. Data on lifeline failure has generally been collected in post-earthquake site visitations. Again, roadway cracking, road closure, and sliding slopes/embankments are likely occurrences although system redundancy will alleviate stress on the transportation system. Bridges would probably experience collapsed spans, column or pier movement, joint movement and column or foundation failure. The failure of bridges in past earthquakes suggest the need for an aggressive program of inspection and improvement to those structures susceptible to the great damage or the closure of those where costs are prohibitive. No matter the approach taken what is desirable is the increased seismic safety of the transportation network.

On September 19, 1985 an earthquake of magnitude 8.1 struck Mexico. The ground motions associated with the earthquake were probably among the strongest ever felt in Mexico City. Despite the intensity, transportation lifelines performed extremely well.

Streets experienced only minor damage and the METRO was fully operational although it was shut down for inspection immediately afterward to assure passenger safety. METRO was designed so it encompassed a number of seismic considerations. Airports were also operational and did not sustain much damage. Thus, there is opportunity to study good performance of transportation lifelines during an earthquake of significant magnitude.

One of the more extensive analysis of transportation lifeline performance (Kawashima et. al., 1985) was detailed in the joint U.S.-Japan Workshop on Urban Earthquake Hazards Reduction.In addition to examining the affects on the transportation system in the Nihonkai-chubu earthquake in 1983 the performance in three other earthquakes are examined. The Nihonkai-chubu earthquake ocurred in Japan and had a magnitude of 7.7. There was heavy loss of life (104 persons) and extensive liquefaction.

There was great interruption of traffic flow on highways in approximately 45 places however restoration was prompt. Ports and harbors were damaged extensively and railroads were damaged in approximately 693 places on 12 lines. However, railroad restoration was accomplished in about three weeks. Table 16 compares four earthquakes affecting the Tohhoku Region within the last twenty-five years. They are the:

Nigata occurring in 1964 with a magnitude of 7.5

Tokachi-oki occurring in 1968 with a magnitude of 7.9

Miyagi-ken-oki occurring in 1978 with a magnitude of 7.4

TABLE 16:

Comparison of Damage From Four Earthquakes in the Tohhoku Region

		Niigata Earthquake		Takachi-oki Earthquake		Miyagi-ken-oki Earthquake		Nihonkai-chubu Earthquake	
Date of Occurence		June 16, 1964, pm 1:02		May 16, 1968, am 9:49		June 12, 1978, pm 5:14		May 26, 1983, pm 0:00	
Magnitude of Earthquake and Max. JMA Intensity		M=7.5 , V(JMA)		M=7.9 , V(JMA)		M=7.4 , V(JMA)		M=7.7 , V(JMA)	
Major cities Affected by Earthquake (Population)		Niigata City (0.45 Million)		Aomori City (0.29 Million) Hachinobe City (0.24 Million)		Sendai City (0.66 Million)		Akita City (0.29 Million) Noshiro City (0.06 Million)	
Damage Features		Extensive liquefaction developed in Niigata City and its vicinity; caused severe damage to highway bridges, embedded line-structures, embankments et al. Invasion of tsunami into low-land made restoration extremely elongated.		Damage of soil structure was predominant because of saturation by rainfall which continued for several days before earthquake.		Ground acceleration was rather severe (about 0.4G) at Sendai City. Importance of preventing damage to lifeline facilities, including highway bridges, was widely recognized after this earthquake.		Extensive liquefaction developed and many soilstructures were damaged. Structures in which seismic effect was considered in design suffered little damage.	
Number of Persons Dead and Injured		28 , 418		58 , 811		28 , 335		104 , 324	
Number of Completely Collapsed Residential Houses		3,456		1,023		1,383		1,584	
Damage to Civil Engineering Structures (Million Yen)	Highway	9,498	(2.2%)	8,222	(5.7%)	6,714	(2.1%)	13,806	(8.4%)
	Bridges	5,969	(1.4%)	1,388	(1.0%)	7,665	(2.3%)	1,858	(1.1%)
	Hydraulic Structures	16,222	(3.8%)	5,805	(4.0%)	15,294	(4.7%)	48,469	(29.5%)
	Civil Engineering Structures	61,605	(14.2%)	24,246	(16.7%)	31,802	(9.7%)	79,947	(48.7%)
Total Damage (Million Yen)		432,586	(100%)	145,098	(100%)	326,428	(100%)	164,172	(100%)

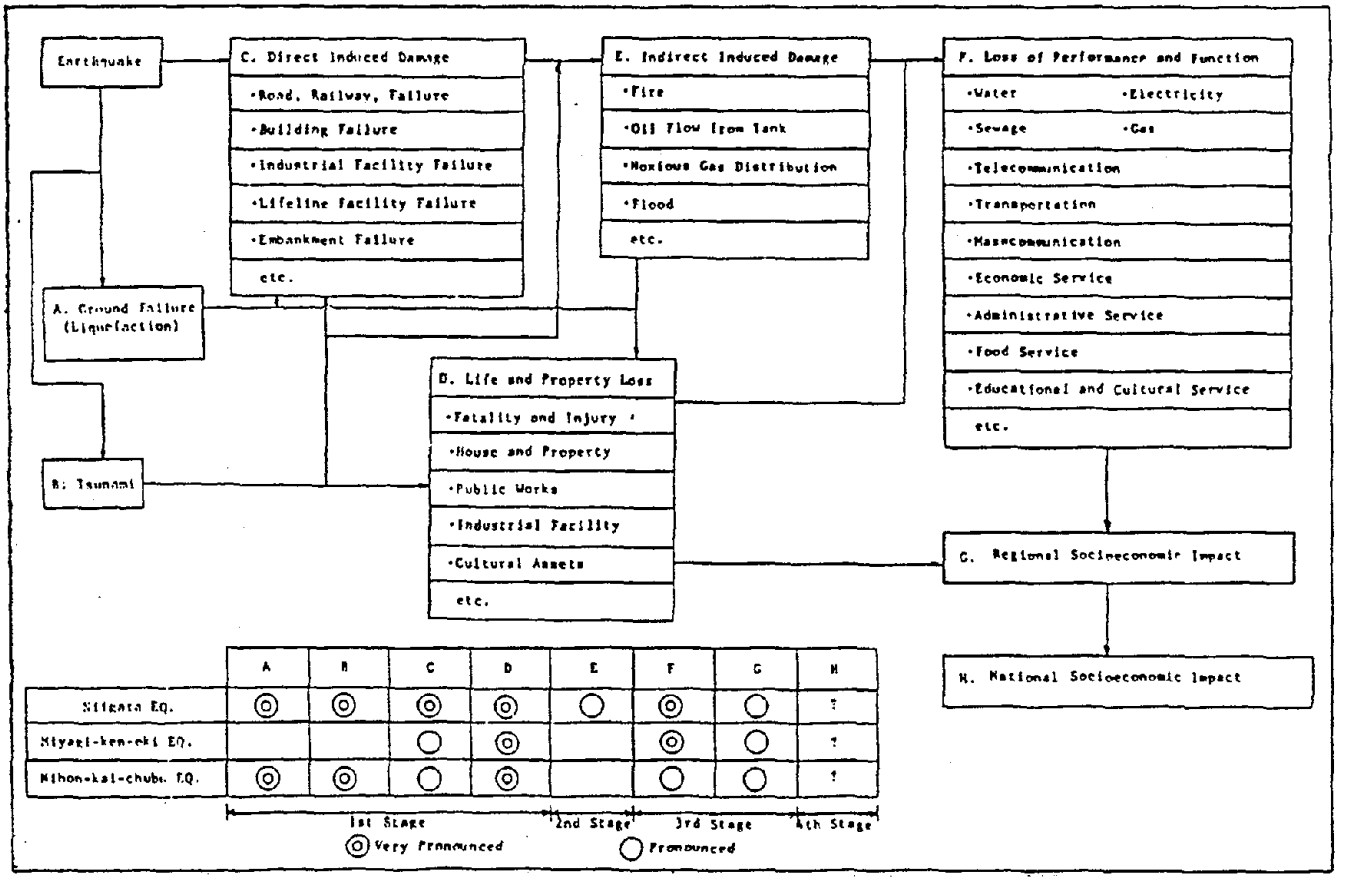
Source: Earthquake Engineering Research Institute, Proceedings--U.S.-Japan Workshops on Urban Earthquake Hazards Reduction, July 1985.

Nihonkai-chubu occurring in 1983 with a magnitude of 7.7 Damage to civil engineering structures varies from approximately ten percent to about fifty percent. Kawashima et. al. developed a description of the damage pattern earthquakes follow (See Figure 15). They suggest damage occurs in the four stages identified in the figure.

Earthquakes: San Fernando, Hilo, and El Centro

The three earthquakes named above occurred during the 1971-1981 time period. The San Fernando earthquake occurred in San Fernando, California in February, 1971. The Hilo occurred in Hilo, Hawaii in April, 1973 and the El Centro in El Centro, California in October, 1979. A major issue in examining the impact on transportation lifelines is identifying sources of data. There is not good information available on the impact of lifelines during these occurrences. As a result, many additional sources were sought in an attempt to expand the information base relative to these three disasters. The New York Times Index was reviewed, as were earthquake journals, and data was collected from FHWA and FEMA offices. In addition an extensive library search was undertaken. The result of this effort forms the basis for the following analysis. As is often the case with research of this kind we raise many more issues than we have the capability to answer or resolve.

FIGURE 15 : EARTHQUAKE DAMAGE PATTERN



The San Fernando Earthquake

The information contained in this section was collected from a review of articles identified in the New York Times Index which lists articles carried in the New York Times. There was a great deal of information that focused on impact with a very good descriptive account of the disaster.

The earthquake struck at 6 A.M. on February 9, 1971 in San Fernando, California. It had a magnitude of 6.5 on the Richter Scale and lasted for approximately one minute. Aftershocks occurred on February 15 all with magnitudes less than four. The quakes epicenter was near Newhall about 40 miles north of Los Angeles. Sixty-two people died in the disaster and tremendous damage was done. Dams, runways, highways, freeways, and bridges were badly damaged. Five major highways had to be closed this included interstates 5, 405, 210, 14, and 2. In one instance the freeway buckled and slabs tilted more than five feet above the roadbed. A number of overpasses collapsed killing people and disrupting traffic. Traffic jams were crippling and thousands of people were evacuated. Preliminary estimates set the total loss at one billion dollars. A summary of information contained in articles carried in the New York Times are located in Appendix II. One difficulty in consulting newspapers is that coverage is not ongoing and as statistics/information changes this is not reported. For example the last newspaper account listed 62 casualties while numerous sources written since then list 64 casualties.

FEMA

FEMA records indicate a total commitment of $217,371,928 for all work categories. These include:

Work Category	Description	Amount
A	Debris Clearance	$1,519,674
B	Protective Measures	$3,179,430
C	Road Systems	$939,228
D	Water Control Facilities	$1,363,719
E	Public Buildings and Equipment	$112,500,000
F	Public Utilities	$67,292,238
G	Facilities Under Construction	$213,038
H	Private Nonprofit Facilities	$348,479
I	Other damages	$265,135
IFG	Individual Family Grants	0
	Agencies Other Agencies Expenditures	$29,744,300

Road systems are $939,228.00 or .43 percent of the total amount.

FHWA

In his declaration of emergency then governor Ronald Reagen said, " The County of Los Angeles and cities located herein and the state have suffered serious damage to their road systems and have sustained loss of bridges, drainage structures, roadbeds, and road surfaces on the Federal-aid interstate, primary and

secondary systems"(FHWA, 1971). The declaration continued to summarize in general the devastation to the transportation system. It is interesting to note this particular lifeline and the damage it sustained formed the basis of the proclamation. A special report written immediately following the earthquake described impacts in a fairly detailed manner. Of course the obvious problem is that the impacts were in many instances still unfolding. Also, documents like this one are not mandatory therefore their availability is not assured. The estimate of damage to the Federal-Aid System was $30,000,000. The actual obligations shown on FHWA records is $19,292,004.47. Substantially less than the initial estimate.

The Hilo Earthquake

The Hilo earthquake struck on April 26, 1973 in Hawaii at 10:30 A.M. Its epicenter was under the Kilauea crater located approximately 30 miles from the City of Hilo. Several buildings swayed and landslides occurred. One building was flattened, more than 100 homes were damaged and eleven persons were injured. Power lines, telephone lines and water pipes were damaged. The initial estimate of damage was one million dollars.

FEMA

FEMA records indicate a total commitment of $1,536,683

for all work categories. These include:

Work Category	Description	Amount
A	Debris Clearance	$44,569
B	Protective Measures	$2,624
C	Road Systems	$928,751
D	Water Control Facilities	0
E	Public Buildings and Equipment	$412,103
F	Public Utilities	$136,662
G	Facilities Under Construction	0
H	Private Nonprofit Facilities	$1,125
I	Other damages	$1,350
IFG	Individual Family Grants	0
Agencies	Other Agencies Expenditures	$9,499

Road systems are $928,751 or 60.0 percent of the total amount. There is no record of FHWA expenditures in the Hilo earthquake.

The El Centro Earthquake

The El Centro earthquake struck on October 15, 1979 shaking southern California and northern Mexico. It had a magnitude of 6.4 with an epicenter located 14 miles east of Calexico. Damage was largely contained in the Imperial Valley. There was extensive damage to public utilities, buildings, and roads. Several

aftershocks occurred on the same day and approximately 18 shocks were felt within the 18 hour period following the main shock. There was extensive property damage on both sides of the border. The canal supplying water to Imperial Valley was damaged and had to be drained in order to be repaired. The initial estimate of damage was $20,000,000.

FEMA

FEMA records indicate a total of $8,219,811 for all work categories. These include:

Work Category	Description	Amount
A	Debris Clearance	$11,786
B	Protective Measures	$171,800
C	Road Systems	$129,628
D	Water Control Facilities	$325,365
E	Public Buildings and Equipment	$6,065,261
F	Public Utilities	$993,017
G	Facilities Under Construction	$5,558
H	Private Nonprofit Facilities	0
I	Other damages	$56,196
IFG	Individual Family Grants	$300,000
Agencies	Other Agencies Expenditures	$161,200

Road systems are $129,628 or 2 percent of the total amount.

FHWA

The total cost according to FHWA records was $37,493,325.48.

V. STUDY IMPLICATIONS AND CONCLUSIONS

The major objectives of the study were accomplished. These are: To prepare a national transportation damage data base that can be used to shed light on policy issues; To conduct preliminary analysis on the data base; To identify data and knowledge gaps in the area of transportation damage impacts; To identify what kinds of research issues should follow from the study; and To identify the general vulnerability (damage) to transportation systems resulting from natural disasters. The concept of deriving a general vulnerability of our transportation systems is a unique departure from standard practice. In this regards, our results confirm the general lack of information on natural disasters and their impacts on transportation system. There is a distinct need to extend the knowledge base. We must identify the kinds of disasters likely to occur at specific locations, their characteristics and consequences, and the vulnerabilities transportation lifelines at specific regions. This study is distinctive in that it generates a national data base that allows the creation of measures of general vulnerability.

Data is available on all natural disasters that have impacted transportation lifelines. In this regard our sample actually turns out to be a census. However the amount and quality of data available on each disaster varies significantly. As a result only a few variable are available across the entire

population of disasters. This limits the general analysis to a relatively small number of categories such as types of disasters, damage expenditures by FHWA and FEMA, location and date of occurrences number of deaths, number of counties impacted, etc. Conspicuously absent is information on the economic impact of transportation damage, characteristics of the transportation network relative to the damage it experiences, data on private sector damage/costs, injuries and transportation system performance during disasters. In many ways the structure of the Damage Survey Report contributes to this limitation because of the information it contains. On the other hand data contained in the DMIS permits a much more detailed analysis of disaster impacts. At the regional level there is more data available in file folders. However the inconsistency of its quality does not allow it to be used for general analysis.

Over the ten year period examines, region 4 recorded the largest number of natural disasters followed by regions 3, 5, and 8 respectively. Floods have the greatest impact on the transportation system, accounting for almost 40% of FEMA and FHWA disaster expenditures. They occur most often in regions 3 and 4.

Attempts to model the impact of disasters on transportation damage turned out to be moderately successful. When variables such as disaster type, region, size of the impacted area, and measures of the extensiveness on transportation infrastructure are controlled we are able to explain 35% of the variance in damage related expenditures. However when this variance is

compared to the mean value of disaster expenditures it was found to be particularly small. Overall however the results indicate that either other important factors are missing from our model or that it is difficult to model disaster damage with high degrees of accuracy. In general our results found no significant difference in the impact of disaster types on transportation damage expenditures.

Region 4 has less than 20% of the nation's population but experience more than 55% of all natural disasters. During a special study of this region the American Red Cross was to have the most substantial data available on natural disaster impacts. Its data includes more detailed information on injuries, dwellings destroyed, more accurate counts of deaths, businesses homes, and apartments destroyed and dwellings rebuilt. Although richer in content, the absence of its general availability and small sample size means that it can not be used to analyze general impacts.

Because the number of earthquakes occurring in the U.S. between 1971 and 1981 were very limited, we drew upon the experiences of locations outside of the country to gather information on impact damage to transportation lifelines. Systems experienced damage and disruptions in a number of ways including: massive traffic jams, disruption of rail service, loss of mobility, destruction of the roadway system including bridges, flooding and sinking of roads, upheaval of the road surface, damage to passenger and freight trains, damage to piers and

drainage structures and disruption of emergency service and food distribution. finally our research suggests the following points:

1. More research is needed in assessing the general vulnerability of selected facilities and vulnerability at the regional level. One way of summarizing this information could be through the development of vulnerability maps.

2. Once general vulnerability is determined it is appropriate to develop more refined measures of system vulnerability. This will allow a more precise implementation of mitigation procedures.

3. Policies must reflect anticipated disaster impacts.

4. There is a need for greater cooperation with respect to data collection between FEMA and FHWA to document transportation system damage.

5. Information collection from private agencies must be undertaken to document damage.Since anonymity is important to businesses, the government is the most appropriate agency to facilitate this.

6. Given the frequency of flood damage to roadways, reconstruction should be allowed so as to enhance the quality and standard of the damaged facility.

7. As depositories, regional offices should become more active and better organized.

8. Better initial estimates of damage should be an agency goal as there currently exists great variance between initial damage estimates and actual expenditures.

9. Red Cross Chapter Reports are examples good examples of detailed impact data and can complement FEMA and FHWA sources quite well. Much more attention should be given to exploiting these sources.

10. Planning for disasters in high frequency areas such as Region 4 could be greatly facilitated through the development of vulnerability maps.

11. The fact that transportation damage accounts for 25% of all disaster expenditures means that much more attention and policies should be oriented to this direction.

12. Since our empirical research did not find any significant differences in damage caused by various types of disasters (other things equal) a major consideration then is determining the frequency of occurrence of various types.

13. The overwhelming impact of floods means that much more attention and research should be directed here. Reconstruction of damaged lifelines should be done at a level which improves the quality and standard of construction.

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APPENDIX I

OFFICIAL TWO LETTER STATE ABBREVIATIONS

REGION I

Connecticut	CT
Maine	ME
Massachusetts	MA
New Hampshire	NH
Rhode Island	RI
Vermont	VT

REGION II

New Jersey	NJ
New York	NY
Puerto Rico	PR
Virgin Islands	VI

REGION III

Delaware	DE
District of Columbia	DC
Maryland	MD
Pennsylvania	PA
Virginia	VA
West Virginia	WV

REGION IV

Alabama	AL
Canal Zone	CZ
Florida	FL
Georgia	GA
Kentucky	KY
Mississippi	MS
North Carolina	NC
South Carolina	SC
Tennessee	TN

REGION V

Illinois	IL
Indiana	IN
Michigan	MI
Minnesota	MN
Ohio	OH
Wisconsin	WI

REGION VI

Arkansas	AR
Louisiana	LA
New Mexico	NM
Oklahoma	OK
Texas	TX

REGION VII

Iowa	IA
Kansas	KS
Missouri	MO
Nebraska	NE

REGION VIII

Colorado	CO
Montana	MT
North Dakota	ND
South Dakota	SD
Utah	UT
Wyoming	WY

REGION IX

Arizona	AZ
California	CA
Guam	GU
Hawaii	HI
Northern Mariana Islands	MR
Nevada	NV
Trust Territory	TT

REGION X

Alaska	AK
Idaho	ID
Oregon	OR
Washington	WA

APPENDIX II

COMMENTS FROM NEW YORK TIMES ARTICLES

NYT

ARTICLE DATE: 2/10/71
QUAKE INSURANCE IS CARRIED BY FEW, COVERAGE IS COSTLY

Few people have earthquake insurance because it costs twice as much as other insurances and has a substantial deductible, usually 5%. NYT

ARTICLE DATE: 2/11/71
DEATHS RISE TO 51 IN QUAKE ON COAST, CLEANUP STARTED

Death toll increased on 51

10 still buried at Sylmar VA Hospital

80,000 people being asked to stay away from their homes as a precautionary measure due to a weakened dam at the Van Norman Lake Resevoir

Aftershocks reaching as high as 5 on Richter scale

Gas main rupture and exploded injuring 6 people in a Westwood Restaurant

Difficulty in compiling statistical estimates

Property damage is expected to exceed 1 million

675 privately owned homes suffered major structural damage, 199 declared unsafe for occupancy

17,000 residents in town of San Fernando were w/o water

Golden State and San Diego Freeways still blocked by torn pavement and falling debris from falling overpasses

At least 7 school buildings that didn't meet building code standards received damage NYT

ARTICLE DATE: 2/11/71
MOST ARE PATIENT, OTHERS ANNOYED

This article dealt with the 80,000 people evacuated from the Van Norman Lake Resevoir area

Strict patrol had to be maintained to keep looters away

Entrance to unsafe area was allowed on a limited basis--emergencies only

Schools closed

Contamination of water

Damage to water mains

A 70 year old man brought from a nursing home located in the off limits area suffered a heart attack during one of the after shocks NYT

ARTICLE DATE: 2/11/71
HEAVY VOLUME OF CALLS SNARLS PHONE CIRCUITS TO LOS ANGELES

Concerned relatives calling Los Angeles overloaded telephone circuits.

Delays of two hours or more before people could get through

LA operations usually handles 95,000 calls - it had to handle 800,000. This means that they handled a volume, 8.5 times more than normal

An additional 300 operators were brought in on an emergency basis

Red Cross had to handle a bag percentage of the volume of calls through its emergency teletype communications system - even this system was overloaded NYT

ARTICLE DATE: 2/12/71

THREAT OF FLOODING EASES IN CALIFORNIA; 57 NOW DEAD IN QUAKE

People found it difficult to return to normal patterns of life

Rescue crews generally had to search for bodies believed to be buried under the debris

Fresh water still unavailable

Major freeways still blocked

Prediction of traffic jam for outgoing traffic onthe weekend

Workmen had to pumpwater out of cracked dam

Overcrowding in evacuation camps

Confusion among non-english speaking residents as they did not know that was going on

Difficulty anticipated in future selling of houses in the affected areas because of skepticism in buying a house in the earthquake-prone area NYT

ARTICLE DATE: 2/13/71

80,000 ARE PERMITTED TO RETURN TO THEIR HOMES IN LOS ANGELES

Water had to be pumped out from the dam for four days to bring it to the safety level

Several people were killed, buried by the debris

Some persons still missing

The earthquake created fissures in the dam

Water supply still inadequate (broken main)

Families still camped out

At least a year before damage to Golden State and Foodhill freeways could be repaved (crumpled pavings and collapsed overpasses)

Schools suffered serious structural damageNYT

ARTICLE DATE; 2/14/71

QUAKE-DAMAGED MISSION ON COAST NEEDS EXTNSIVE REPAIRING

Damage to historic buildings of great value--mostly cracks in walls

Damage to statues and other artifacts

ARTICLE DATE: 12/16/71

LOS ANGELES AREA HIT BY MINOR QUAKES

After shocks were felt on February 15th

Three aftershocks recorded measuring 3.9, 3.7, and 3.5 on the Richter scale

Several homes were declared unsafe

Evacuation camps set up in schools

Still no water, gas or telephone or sanitation facilities

Death toll up to 62

This article cites the # evacuated from the Van Norman Lakes Area was 120,000

Nearly 200 homes have been declared unsafe in the communities of Sylmar, Sunland and Tujunga