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FEDERAL EMERGENCY MANAGEMENT AGENCY

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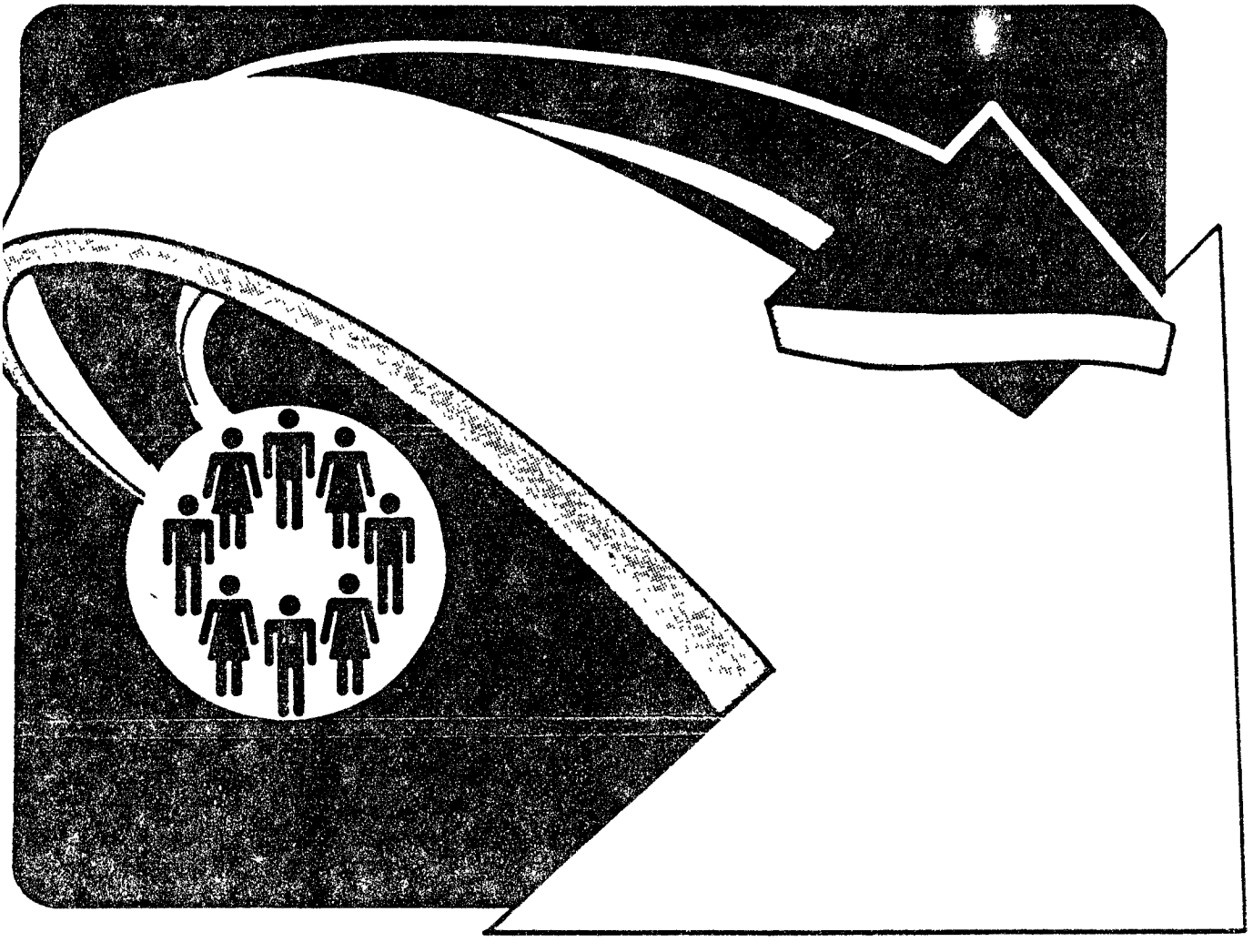
Evacuation: An Assessment of Planning and Research



FEDERAL EMERGENCY MANAGEMENT AGENCY

EXECUTIVE SUMMARY

EVACUATION. AN ASSESSMENT OF PLANNING AND RESEARCH

The purpose of this research was to assess issues and criticism of evacuation planning for all hazards under an integrated emergency management concept, and to review research that addresses those issues. The work identifies gaps in knowledge about evacuation planning issues and the research that could address these gaps.

In the course of this research, over 300 documents were reviewed and abstracted, and key findings were summarized. Issues were identified by review of hearings, litigations, critiques, and discussions with planners and experts. A comparison of the research findings with the issues leads to the conclusions presented in this executive summary.

ES 1. PROGRESS IN EVACUATION PLANNING: 1975-1985

Over the past decade, evacuation planning has become more sophisticated and advanced. Progress has been made in at least four major ways. First, evacuation planning for some hazards has integrated physical risk studies with quantitative evacuation traffic modeling and behavioral research to produce comprehensive planning guidance. The best examples of this approach are found in hurricane evacuation planning and nuclear power plant evacuation planning. For the former, extensive modeling of hurricane storm surge defines the maximum levels of water inundation. Vulnerability studies identify populations at risk, and behavioral studies are used to estimate evacuation departures and destination. Combined with a quantitative evacuation time estimate, local emergency planners know when they must make an evacuation decision and which areas to evacuate. This type of approach is less well developed for other hazards, although FEMA is moving in the direction of initiating similar programs for some other hazard types. Second, the adoption of an integrated or generic emergency management approach has and will further bolster the expediency of evacuation planning. Given the integrated scientific approach being pursued, integrated planning will eliminate many overlapping planning tasks. Furthermore, it will encourage more flexible emergency evacuation capabilities that will apply to most conceivable contingencies.

Third, over the past 10 years, most aspects of evacuation logistics have been defined and researched and, as a result, are well understood. Withstanding the issues raised in the subsequent section, the knowledge of how to move small or moderately large numbers of people is fairly well developed. This does not mean this knowledge has been implemented or adopted in all evacuation plans, or that some hazard-specific uncertainties have been eliminated. Overall, however, we know the resource

requirements needed to evacuate most populations from threatened areas in a reasonable length of time.

Finally, there are indications that the local implementation of evacuation procedures has improved. Each year thousands of people are successfully evacuated from floods and hazardous-material accidents. Evacuation rates from high risk coastal areas preceding hurricanes are very high, and deaths from hurricane surge have been significantly reduced. Many specific success stories could be cited.

Some issues concerning evacuation planning still, however, remain unresolved. The fact is that people who could have evacuated to safety continue to die in disasters. The next section defines and discusses these issues.

ES 2. UNRESOLVED ISSUES IN EVACUATION PLANNING

Our research has identified ten major issues in evacuation planning that cut across hazards. These are issues that can be completely or partially resolved through additional research. Additional hazard-specific issues also exist and are addressed in the accompanying report. Each issue is now discussed and general research needs are identified.

ES 2.1 PLANNING FOR LARGE SCALE EVACUATIONS

Several issues regarding the planning needs for and feasibility of evacuating large urban areas are still unresolved. Large-scale evacuation concepts have been primarily derived from the now abandoned crisis relocation planning and from hurricane evacuation planning. Under the integrated planning concept large-scale evacuations are applicable for many hazardous situations in heavily populated areas. For example, an earthquake prediction could lead to large population movements, as could a nuclear transport accident or a terrorist-placed nuclear weapon.

Uncertainty stems from questions regarding extrapolation of the well-defined logistics of evacuation of small populations to massive ones. For example the logistics of reverse traffic flow after a sporting event are understood; however, it is unclear whether they could apply to evacuation routes out of Dade County, Florida, following a hurricane evacuation decision. The Federal Emergency Management Agency (FEMA) has made significant progress toward providing planning guidance on large-scale evacuation although some of the principles remain untested and perhaps are untestable.

Second, under an integrated approach, it is unclear what special planning elements for large-scale evacuation will be adopted by large cities. Furthermore, there is a need to ensure consistency in planning guidance coming from FEMA regarding large-scale evacuation. Conceptually

evacuating Miami for a hurricane is not greatly different than evacuation for other possible causes.

Finally, we are of the opinion that large-scale evacuation planning may have implementation problems; however, these problems do not warrant abandonment of planning or even plan implementation. Emergency management is not a zero-risk process; it is a design to prevent loss of life and property. Continued efforts at refining abilities to move large populations and estimating the effectiveness of evacuations are warranted.

ES 2.2 SPECIAL EVACUATION PLANNING NEEDS FOR FAST MOVING EVENTS

Evacuation has routinely been cast as a solution to lost lives and moveable property when enough time exists for its successful implementation. Available time between the detection of a disaster's impending impact and its striking an endangered population, however, can be and has been short. Little is known about the special planning needs for fast-moving events that could help implement fast evacuations. Research to develop and integrate needed knowledge on special evacuation planning needs for fast moving events cuts across a range of physical, technological, and social sciences. For example, we lack physical studies of risk for some hazards on which planning must be based. Additionally, it is not known what special emergency information requirements are needed for a population that must move quickly, or if even special information schemes could encourage quick response. Hazard-specific studies are in order to determine differences in quick response evacuations and to identify alternative fast evacuation strategies; for example, climbing canyon cliffs to escape mountain flash floods. Finally, technical and physical knowledge about risk must be integrated with social science knowledge about quick response to provide a basis for drafting special planning needs and technical assistance for fast-moving events.

ES 2.3 EVACUATION PLANNING FOR CONCURRENT HAZARDOUS EVENTS

Integrated emergency management cannot ignore concurrent hazards that can strike communities at the same time. Recent history catalogues many examples. The 1971 San Fernando Earthquake, for example, saw the need for a large evacuation of people at risk because of a potential dam failure. Additionally, a severe storm in California recently was the cause of a spill of hazardous material and precipitated an evacuation during the storm. Insufficient knowledge exists to catalogue and identify unique problems created by concurrent hazardous events on which to mount sound preparedness plans. Comprehensive investigations of concurrent hazards are in order, and these should carefully distinguish between two classes of concurrent events. First, concurrent hazards can be linked; one event may cause another, and these are not uncommon. These may occur simultaneously, or with one subsequent to the other. Second, concurrent hazards may be independent of each other, and these are uncommon with, more often than not, low statistical odds. A basis must be developed to distinguish between these types, identify which concurrent hazards are

realistically planned for, and identify unique planning problems for concurrent hazards and how to take them into account in the general planning process.

ES 2.4 HUMAN BEHAVIOR IN EVACUATIONS

The key to a successful evacuation is getting the people who are at risk to move to an area that is safe. Consequently, the bottom-line in evacuations is understanding, planning on the basis of, and implementing the lessons available from the social sciences about public response to evacuation advisements, orders, and public risk information in emergencies. Knowledge about public evacuation behavior is broad; however, it is the result of a piecemeal effort that pulled together the findings of divergent pieces of research involving varied hazards and using somewhat different research designs, methods, approaches, and models. Consequently, we have no systematic evidence to suggest, for example, that differences in hazards make a difference in public response on which to fine-tune evacuation planning. What is needed is a cross-hazard investigation of public evacuation behavior using state-of-the-art research designs, methods, and theoretical models to reveal the commonalities and differences in public evacuation behavior. Such a cross-hazards investigation would facilitate more accurate evacuation planning.

ES 2.5 ACCURACY OF EVACUATION TIME ESTIMATES

Currently, evacuation time estimates are derived from a number of different models and modeling procedures. These estimates are used to meet regulatory requirements, to prepare plans, to understand the timing of evacuation decisions, and to determine the effectiveness of evacuation as a protective action strategy. Evacuation time models' accuracy has been challenged in hearings regarding nuclear power plant licensing, in critiques of large-scale evacuation planning, and to a lessor degree in development of hurricane response plans. The major issues regarding these models are threefold.

First, different models are used for different hazards and for different geographical regions. These differences are not based on special geographical features or on different hazard characteristics, but on different researchers or contractors. A more systematic and coordinated approach under an integrated framework would be desirable.

Second, the assumptions made by various models and the variables they include and exclude are largely unarticulated across model type. It would be useful to understand the possible biases and sources of potential errors created by model assumption and structure.

Third, current models lack validity, that is, a comparison of their predictions with real-life experience. To our knowledge, no attempt has been made to compare model results with actual times derived from an

emergency evacuation. As a result, the errors in the evacuation time estimates are largely unknown.

ES 2.6 REENTRY AFTER EVACUATION

Evacuation is too often viewed as a singular act--movement of people out of an endangered area to one of safety. It is actually a process that includes other decisions and moves. Reentry of the evacuated population into the evacuated area is an issue faced in every evacuation; there are few permanent evacuations. Reentry is not a straightforward affair, and it can be riddled with problems and risks. For example, the recent evacuation of communities in the Carolinas because of Hurricane Diane saw some towns reinhabited prior to landfall of the hurricane. The Three Mile Island evacuation was somewhat confused over when reentry would be appropriate (e.g., when risk was over). The reentry of Livingston, Louisiana, after the Illinois Central Gulf Railroad derailment and hazardous waste fires was on-again/off-again for several weeks. The gaps in plans over reentry are obvious and great, as are behavioral studies to investigate issues and problems of reentry on which a planning effort could be based. It is not clear why or how plans should address reentry, nor how or what guidance should be given to those who develop evacuation plans. Integrated emergency management must address reentry systematically; to continue to slight this issue would be to ignore how best to keep evacuees who are safe from subjecting themselves to the risk they have just avoided.

ES 2.7 SPECIAL POPULATIONS PLANNING NEEDS

Special populations are groups of people whose needs may not be met by general evacuation planning. These populations may be concentrated in prisons, hospitals, schools, nursing homes, and other institutional populations, or dispersed such as nonambulatory, deaf, mentally retarded, or foreigners. Some populations can possess characteristics of both, for example, tourists. Some research has been conducted on the problems of evacuating special populations, and more is currently underway. This knowledge, however, is somewhat dispersed and may not be readily accessible to evacuation planners--it should be identified and consolidated. In addition, ways in which it can be presented and adopted into evacuation plans should be explored. Existing research may not address all logistical issues of moving special populations. Practical planning guides for evacuation resource need and plan implementation would be beneficial to local planners.

ES 2.8 LIABILITY FOR EVACUATION

There is widespread concern among emergency managers about their liabilities when ordering of an evacuation. Their concerns include liability for damages incurred if no disaster occurs, liability for damages if no evacuation is ordered, or liability for damages if the

evacuation order is late or covers an inappropriate area. The problem associated with such concerns is not who eventually would win litigation of such claims but rather if these concerns might interfere with making sound evacuation decisions based on technical criteria and experience.

If liability or perceptions of liability act as a constraint to evacuation or affect evacuation decisions, then it would be desirable to take actions to remove those constraints. This would involve improving the understanding about how emergency managers make evacuation decisions in general and, specifically, how liability affects decisions. Second, this would involve additional work on the grounds for liability and actions that could remove liability without threatening the rights of the public.

ES 2.9 UNCERTAINTIES IN DECISION-MAKING

Deciding when and where to evacuate in the face of an impending disaster is a thorny issue for most hazard situations. Usually there are some uncertainties involved. For nuclear accidents, source terms may be incorrectly estimated and winds may shift. For hurricanes, the 24-hour forecast error is plus or minus 100-125 miles. Such uncertainties create several planning or decision dilemmas for planners and officials.

First, evacuation zones are predetermined; however, it is unclear whether or not worst-case assumptions should be used in delineating evacuation zones. What constitutes a reasonable planning basis needs clearer definition.

Second, as pointed out under liability, we have a poor understanding about how local officials make evacuation decisions. Improving that understanding would help to provide better guidance for decision-making.

Third, prescriptive decision tools are being developed to aid decision-making. It is not clear how these tools will be used, whether they will result in better decisions or even if they will be adopted. An assessment of prescriptive decision tools, including articulation of their biases and limits and investigation of their use, seems warranted. Furthermore, if more tools are developed, across-hazard differences in tool applicability and tool flexibility for multi-hazard use may require investigation.

ES 2.10 ADOPTION OF INTEGRATED EMERGENCY MANAGEMENT SYSTEMS

During the past decade, our knowledge about evacuation principles has grown, along with out ability to plan successfully for the effective implementation of evacuation plans. At the same time, this information has been widely disseminated and shared with state and local users, as well as members of the private sector. The current state of these users' adoption of this evacuation planning information is not fully known. It is not known, for example, the degree to which the cross-hazard emergency

management approach has truly replaced hazard-specific approaches in local and state entities. More importantly, if the approach has had a slow start in some places, the constraints to its adoption have not been clearly identified so that efforts could be made to remove them. Additionally, existing knowledge may not be fully taken advantage of on all fronts where it could be used. For example, we know what and how emergency public information and warnings should be presented to facilitate a public evacuation, but we do not know the extent of full adoption in local evacuation plans. Work must be done to determine how to better assist local and state entities in implementing state-of-the-art evacuation planning and its full adoption in local evacuation plans.

ES 3.0 IMPROVING EXISTING PLANNING USING CURRENT KNOWLEDGE

Several steps can be taken to improve existing evacuation planning, independent of the development of new knowledge. The most significant is the adoption of a systematic method for developing a plan such as the process described in the hurricane program. This involves identifying the nature of threats and their geographical distribution, estimating the time available from detection of the hazard until the point where evacuation is not feasible, calculating how long it will take to evacuate, and developing guidelines to implement an evacuation based on these estimates and other relevant data. The full details of this process are outlined in Chapter Two. This, however, can be implemented as a relatively simple procedure or fairly complex one depending on the seriousness of the threat and available resources or expertise. Even if it is a simple effort, the benefits still can be significant because planning will have led officials to a better understanding of the decision-making process.

The second step to improve the effectiveness of evacuation planning is to advance the application of existing knowledge of state-of-the-art hazard warning and emergency communication systems. Poor or problematic evacuations are often due to the failure to notify the public at risk or to provide good information. Much is known at the present time about how to design good warning systems. This knowledge has not been systematically applied in the development of plans and operating procedures. Better warnings have had a dramatic impact on reducing fatalities from hurricanes; further improvements are still possible, and for a number of other hazards, much could be done to increase citizen compliance with protective action recommendations, including evacuation.

Third, evacuation plans can be improved to better meet the needs of special or institutional populations. Although the technical basis for evacuating special populations still needs improvement, identifying the means and resources needed to evacuate institutions in high risk areas is certainly feasible. This is often done after problems or near misses are experienced. In addition, developing mechanisms for more effective communication with minority or other populations who are reluctant to evacuate is also possible but usually ignored. Improvements can be made but are often not politically salient.

Finally, developing more effective organizations to implement evacuation plans and make evacuation decisions is feasible at all levels of government. This can be done with little or no expenditure of additional resources in many cases but may involve redirecting planning efforts. This will involve, however, the development of new planning guidance and training materials that will incorporate existing knowledge of organizational effectiveness in planning and emergency response.