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Mapping — The Missing Link in Reducing Risk Under SARA III*

Ute J. Dymon**

Introduction

In 1980, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) was passed.¹ Congress amended it with the Superfund Amendments and Reauthorization Act of 1986 (SARA).² Title III of SARA (SARA III) is entitled, "Emergency Planning and Community Right-To-Know" — the subject of this article. Local communities have since strived to reduce risks by complying with it. SARA III makes communities responsible for their own safety in the event of, e.g., explosions or chemical spills. How effectively have local governments complied? In at least one planning realm with potent possibilities for supporting local emergency managers, achievement is lacking. Most communities need more detailed emergency planning maps, and in the Northeast, comprising Region I of the Environmental Protection Agency (EPA), effective multi-hazard risk maps called for under the Act have yet to be created.

In describing how maps are employed to manage hazards, this paper will consider the role hazard management mapping plays in emergency planning/hazard management under SARA III. It will also address how hazard mapping by local emergency planning committees (LEPCs) has aided hazard identification and other phases of local

* This paper is based on field research conducted in the wake of a gasoline spill in Marlborough, MA. The author thanks Leonard Wallace for insightful comments and suggestions and Paula Hayden for help in preparing the map.

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¹ 42 U.S.C. § 9601 et seq.

² P.L. 99-499, 100 Stat. 1613. See, e.g., U.S. Federal Emergency Management Agency and the Environmental Protection Agency, *Superfund Amendments and Reauthorization Act (SARA)* (1986).

hazard management, the extent to which risk mapping has been accomplished and a case study of how one community coped with an emergency without computer mapping resources. First, however, it may be useful to review Winter's 1993 hazard management map taxonomy³ that regards hazard, risk and emergency as the three major categories.

Hazard maps identify and display the location of hazard zones, areas where there are dangers to humans and their property. Usually these depict "hazard zone geometries" as outlined by Zeigler, Johnson and Brunn.⁴ *Risk* maps require calculation of the conditional probability that a given area will experience a particular hazard or a combination of hazards and portrays the spatial distribution of those risk computations.

The last category, *emergency* maps, comprise three additional types: planning, evacuation and crisis maps. Planning for four aspects of emergency management — mitigation, preparedness, response and recovery — requires pre-event mapping by emergency groups, especially for best use of organizations such as fire, police, public works departments, the Red Cross and public utilities. Evacuation maps are normally produced prior to emergencies and include identifying sensitive populations. They offer a visual plan for moving people in times of danger. Crisis mapping occurs during or immediately after an emergency and encompasses any attempt to map on-the-spot conditions comprising the emergency situation.

Legal and Political Background of Hazard Management Mapping under SARA III

The number of accidents and disasters necessitating evacuation of large numbers of people has increased rapidly over the past decade. In the U.S. during the 1980's, emergency evacuations were required much

³ Nancy L. Winter, Hazard Management Mapping: A Taxonomy, 16 Proc. Appl. Geog. Conf. 173-174 (1993).

⁴ Donald J. Zeigler, James H. Johnson & Stanley D. Brunn, Technological Hazards 14 (1983).

more frequently than in the past⁵ and seem likely to continue to increase.⁶ On-site or in-transit emergencies involving hazardous chemicals have the potential to affect almost any community in the U.S., both rural and urban, and this provides a major challenge to emergency managers. Control of chemicals capable of causing accidents serious enough to require public evacuation is now the responsibility of local governments.

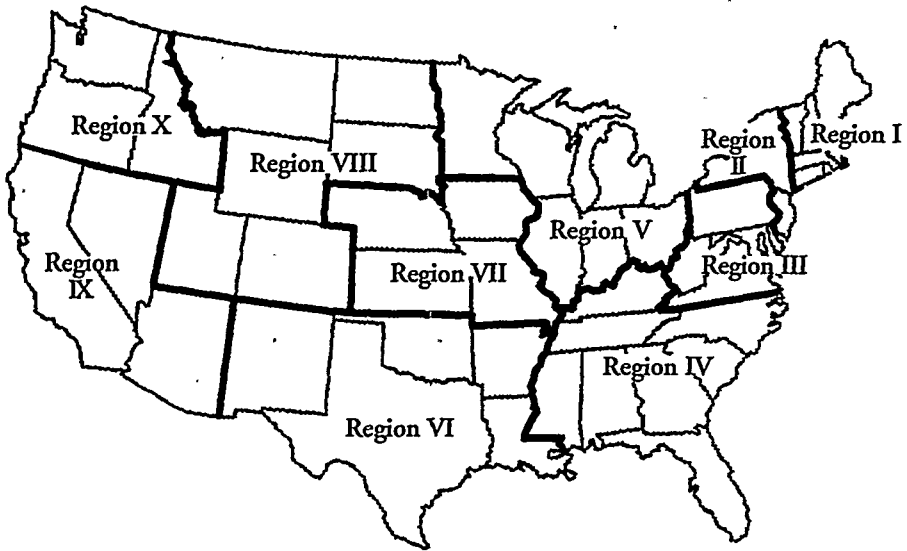
Since 1986, when Congress passed SARA III, each state is obligated to form an emergency response commission whose task it is to designate emergency planning districts for the preparation and implementation of emergency response plans. Each district then establishes an LEPC with broad duties including public distribution of a local emergency plan. Members of an LEPC are broadly representative, including elected State and local officials; local law enforcement, civil defense, firefighting and first aid personnel; health, environmental, hospital and transportation agencies; broadcast and print media representatives; community groups and owners and operators of facilities subject to regulation.

Nationally, 4,000 LEPCs now exist within ten larger U.S. emergency management regions as designated by both the EPA and the Federal Emergency Management Agency (FEMA).⁷ The map reproduced below depicts these Emergency Management Regions. Because of the historic U.S. pattern of political jurisdictions, roughly one-fourth of the LEPCs are in New England (part of Region I) and are town-or community-based. Elsewhere, counties or regions, normally much larger in geographic area, are the basis for emergency planning districts.

⁵ John H. Sorenson & Barbara M. Vogt, *Emergency Planning for Nuclear Accidents: Contentions and Issues*, Symposium: Nuclear Radiation and Public Health Practices and Policies in the Post-Chernobyl World (Oak Ridge National Laboratory 1987).

⁶ Ute J. Dymon & Nancy L. Winter, *Evacuation Mapping: The Utility of Guidelines*, 17(1) *Disasters* 12 (1993).

⁷ Personal interview with Leonard Wallace, Director, EPA Region I, Lexington, MA (1993).

Emergency Management Regions⁸*Emergency Planning Maps*

Two major forms of emergency planning maps are vital to effective functioning of any LEPC. The first uses risk assessment in pre-emergency planning to inform emergency managers of high risk areas in their communities, based upon both natural and technological hazards. The second facilitates response during or after an extreme event. Under the constraints of an emergency, when decision makers lack time to read lengthy text, well-designed maps provide a quick and comprehensive view of the situation.

Such maps offer a view of a disaster's spatial impact and allow speedy notification of all affected utilities and institutions. They also help emergency managers control the cause of a crisis while supervising public safety through evacuation. Finally, during an emergency, maps

⁸ Adapted from 55 F.R. 8823 (1990). Alaska and Hawaii are omitted because of space limitations; they are in Regions X and IX, respectively. [Ed.]

also serve as key devices for answering media questions and/or informing the public.⁹ The key advantage of both risk maps and response maps is that they can be prepared before an emergency. Still, in many communities, map resources are often scarce or non-existent, leaving such communities ill-prepared to deal with emergencies.¹⁰

Although SARA III does not explicitly refer to maps, instructions for mapping are incorporated by reference to the National Contingency Plan established under CERCLA § 105¹¹ that directs guidance documents for preparation and implementation of emergency plans to be published. Specific suggestions for map production by LEPCs are detailed in such guidance documents from the FEMA and EPA.

FEMA Directives for SARA Title III Mapping

FEMA describes the major role and development of LEPCs as:

Comprehensive Emergency Response Plans drawn up by each local emergency planning committee must be reviewed at least once a year and must contain evacuation plans, including provisions for a precautionary evacuation and alternative traffic routes.

These comprehensive plans have come to be known as “EOPs” or “emergency operations plans”. By September, 1988, 12 different Federal Government publications focusing on preparedness and response planning considerations described differing planning criteria for EOPs.

FEMA's Basic Plan for an EOP

To support the Integrated Emergency Management System (IEMS)¹² approach to multihazard emergency operations planning,

⁹ National Research Council, *Improving Risk Communication*, 7 (1989). See also, J. Sorenson & D. Mileti, *Risk Communication in Emergencies in Communicating Risks to the Public* 368 (Roger J. Kasperson & Pieter Jan M. Stallen eds. 1991) (describes risk communication difficulties during an emergency and offers an emergency risk communication model).

¹⁰ Ute J. Dymon & Nancy L. Winter, *Emergency Mapping in Grass Roots America: A Derailment Evacuation Case Study*, 22(4) *Geoforum* 377 (1991).

¹¹ 42 U.S.C. § 9605.

¹² David McLoughlin, *A Framework for Integrated Emergency Management*, 45 *Pub. Admn. Rev.* (Special Issue, Jan. 1985).

FEMA developed a Guide for the Review of State and Local Emergency Operations Plans (EOPs)¹³ to clarify basic policy. It aimed at improving the quality of EOPs and facilitating the review of such plans. The Basic Plan for an EOP according to FEMA includes: (1) Direction and Control, (2) Communications, (3) Warning, (4) Emergency Support Services (ESS), (5) Radiological Defense, (6) Emergency Public Information, (7) Evacuation and (8) Shelter. Also, in regard to mapping specifically, § 8(c) requires that any EOP “identifies on maps the primary and alternate evacuation routes for the established risk area(s) in the jurisdiction.”

The description of the Basic Plan lists the following as requirements for the Introduction section of an EOP:

A summary of the jurisdiction’s hazard identification process that includes... in section (b) maps which identify high hazard areas/sites and preselected monitoring points for emergencies. These maps show:

1. High risk areas (nuclear attack target areas, floodplains, flashflood areas, earthquake zones)
2. Probable high risk sites (dams, nuclear power plants, hazardous materials production sites, storage and disposal facilities, etc.)
3. Evacuation routes
4. Location of public shelters
5. Location of a primary/alternate EOC and other critical direction and control facilities
6. Major roads, railways, and waterways that are used to transport the extremely hazardous substances (EHS), as defined in Title III of the Superfund Amendments and Reauthorization Act of 1986, that are produced or stored in the jurisdiction.

As categories of map content, these requirements enhance hazard identification (1 and 6), provide public information upon which citizens may base their actions (3 and 4), and facilitate emergency management planning (1, 2, 5 and 6). Items 1 and 2 represent a request for multiple hazard mapping (MHM)¹⁴ which depicts on a single map not only the

¹³ Federal Emergency Management Agency, Guide for the Review of State and Local Emergency Operations Plans (1988).

technological hazards in a given area but also the magnitude, frequency, and area of effect of varying natural hazards.¹⁵

Community Risk Assessment

Data collected for mapping in a given community must be analyzed and characterized through risk assessment. This process creates the basis for sophisticated multihazard mapping to identify areas of highest risk within the emergency planning district. This comprehensive view of risk is inherent in the FEMA map content lists detailed above. Designing an EOP that adheres to FEMA guidelines requires an LEPC to mesh data about natural hazards such as floods, earthquakes and hurricanes with data about an almost infinite list of possible technological hazards including on-site chemical releases and explosions, in-transit chemical emergencies, nuclear incidents, air and train crashes and dam failures. Thus, assessing local risks is the key to design and production of viable maps. Yet, in EPA Region I, an adequate multihazard risk assessment of an emergency planning district has yet to be accomplished by an LEPC.

Community Compliance in Region I

Under SARA III, each LEPC is required to file an EOP for state approval, but each LEPC also has the right to submit its emergency plan for federal review. Fifteen federal agencies¹⁶ constitute the National Response Team (NRT) and the regional representatives of these agencies review the plan. The submitting LEPC then receives a 100 page report from the NRT citing the inadequacies and adequacies in its plan. In the eight years since SARA III was promulgated, only ten of approximately 1,000 LEPCs in Region I have submitted EOPs for

¹⁴ Department of Regional Development and Environment Executive Secretariat for Economic and Social Affairs, Organization of American States, *Primer on Natural Hazard Management in Integrated Regional Development Planning* (1991) (Hazardous natural phenomena include extreme geophysical threats that are geologic, seismic, atmospheric and hydrologic.).

¹⁵ See Figure 6-1, *id.*, at. 6-5.

¹⁶ For a list of the National Response Team (NRT) agencies, see 55 F. R. 8821 (1990).

federal review. They include: New Bedford and Fall River, Massachusetts; Bristol, East Providence and Providence, Rhode Island; Bow, Nashua and Concord, New Hampshire, the Tri-Town District of Connecticut encompassing East Lyme, Waterford and New London; and Windham County, Vermont, with Brattleboro as its largest municipality. The key cartographic fact is that none of these ten plans encompassed a risk assessment process which produced the pre-emergency risk maps envisioned in the FEMA guidelines. Generally, also, there is a dearth of emergency response mapping on the local level which often results in cases of emergency managers having to make decisions about the physical situation and evacuations without the spatial information maps provide. However, an outstanding example of emergency management highlights the positive results of the emergency mapping inspired by SARA III.

Marlborough's Gasoline Spill

A potentially explosive emergency was managed expeditiously through a combination of creative crisis mapping and response maps hand-produced by an individual inspired by SARA III guidelines. It occurred in Marlborough, Massachusetts, a city of about 31,000 population with a large number of French-Canadian and Portuguese inhabitants. Located sixty miles west of Boston, and part of its high-tech industrial belt, a network of major highways makes the city easily accessible from Boston and Worcester. Marlborough's high-tech labor force commutes from these nearby cities and smaller communities, swelling the population on an average working day to about 130,000.

Fortuitously, the incident occurred on a cold, winter Saturday night. A truck delivering to a downtown gas station experienced a crack in a hose, spilling about 100 gallons of gasoline into the main street storm drain. Shortly after this was reported, pockets of gasoline vapors set off underground explosions causing manhole covers to fly into the air. Fumes seeped into the basements of several houses, causing major explosions and severely damaging many houses.

*The Need for a Crisis Map*¹⁷

Controlling the spill became a major concern and resulted in an unusual form of crisis map concocted on-the-spot to aid in control and response efforts. Following the spill, the delivery truck driver swiftly contacted the Fire Department. According to emergency procedures, the local Fire Chief became the commander-in-chief for emergency plan implementation. After contacting emergency personnel, he ordered evacuation of residences on both sides of the affected storm drain. After consulting the town's hazard maps, he identified the full danger zone and ordered an evacuation of all residents within the area.

There was great uncertainty as to where the actual danger lay because potential underground seepage was complicated by the fact that the main street also contained an abandoned, antiquated former sewer system which led off to no one knew where. No current sewer maps showed the aged drains. To visualize the pattern and extent of the ancient drains, a search had to be conducted in the files of the public works department. No one map showed the old drain system, but a series of maps were found that, when taped together, resulted in an eight foot long crisis map depicting the old underground channels. This crude map enabled emergency decision makers to determine potential sources for further explosions.

The next morning, most evacuees were permitted to return to their homes, but those living in houses affected by explosions or having potential for later explosions had to stay elsewhere for a few days. In spite of the severity of the accident, no major injuries were reported, possibly because the media helped to distribute information to the public.

Hazard Maps and Response Maps

In Marlborough, more serious consequences of the spill were surely averted by the impetus provided by SARA III and the dedication of a town employee who attempted to meet the FEMA guidelines. Marlborough had designated one of its local firefighters as the emergency manager, and he took a major interest in training himself

¹⁷ See Dymon & Winter, *supra* note 10.

and fellow firefighters in most aspects of emergency preparedness. One of his special interests was preparation of an extensive set of emergency planning maps.

Marlborough, like many other LEPCs, had meager resources for emergency planning. Even though the town had a CAMEO computer system for storage of town data and map production, no one was trained to use it. Yet, this did not deter the emergency manager from hand producing a set of perhaps lifesaving hazard and response maps.

Although the response was ad hoc, this is often the essence of an emergency. Usually some aspect of emergency decision making requires handling of unforeseen conditions. However, the combination of available hand-drawn hazard and evacuation maps with a hastily-assembled crisis map gave the commander information needed for decision making.

Hazard maps were drawn in Marlborough, but the real SARA III goal of having a combined natural and technological risk map was not achieved. Following steps in FEMA's risk assessment process under SARA III, the emergency manager sent an extensive questionnaire to all industries, businesses and residences as an appendix to the city census to collect data concerning the location of critical facilities, the storage and transportation of hazardous materials and the location of sensitive populations. Using detailed base maps from the city's engineering department, designed for zoning, utilities and services, he produced hazard maps by coloring in: 1) industries and businesses storing hazardous materials, 2) roadways used to transport hazardous materials and 3) lists of hazardous materials and their effects on humans and the environment.¹⁸

Each site for storage of hazardous materials became a circle with a radius of one mile. Strip-shaped buffer areas depicting routes employed for transportation of hazardous materials also are shown. This was the first step in preparing a risk map for the town. To produce the risk map recommended by FEMA for an EOP, data about the location and

¹⁸ Map quality prevented their being reproduced here.

probability of harm from other potential technological and natural hazards would need to be added.

Another map that aided decision makers in handling evacuations shows single versus multiple housing. Each block displays and lists by individual citizens' names those in need of special care, the physically or mentally impaired, nursing home residents, those in childcare centers and students in private and public schools. Lists attached to these sensitive population maps are color-coded according to special needs so that a decision maker can identify special evacuation requirements for a specific citizens at a glance.

Other important maps produced by the emergency manager include a critical facilities map locating fire stations, police stations, utilities, hospitals, bus stations and care facilities and a map featuring all facilities, such as schools and churches, that could be used for emergency shelter, color coding officially designated emergency shelters. To make them durable for field use, the maps were also laminated, but information could be added to the outer surface of the maps as needed. On the night of the gasoline spill, these maps were available to all emergency personnel in the fire station.

Availability and use of the hazard and response maps made by the Marlborough emergency manager increased the speed of decision making for both evacuations and managing the dangerous physical conditions. They were also handy for explaining the accident and its impact to media representatives who, in turn, informed members of the public who are often unable to comprehend complex technological processes which pose risks in a given situation.¹⁹ Radio and television news alerted the public and provided explanations to improve the understanding of persons affected by it and of their worried friends and relatives.

¹⁹ See M. L. Baughman, *Media Amplification of Risk: Implications for Hazardous Materials Transport*, presented Ann. Mtg. Soc'y Risk Analysis (1991) and NRC, *supra* note 8, at 7.

Summary and Conclusions

During a disaster, emergency managers are under great pressure to make decisions that may affect the lives of thousands of people, often with only a few minutes to analyze a situation and act. The hazard and emergency maps used during the Marlborough gasoline spill clearly provided needed information. While cartographically simple, they served their purposes by enabling prompt and appropriate responses and by helping to inform the public.

Their availability is a credit to an individual who had a keen interest in mapping and a strong commitment to emergency planning and, during the emergency, to a team that created an invaluable crisis map from town archives. Yet, the incident highlights a lack of local focus and funding to implement the CAMEO computer mapping system supported by EPA.

In contrast, as Lindell and Perry report, "despite the critical roles assigned to local governments in emergency management, their performance to date has been spotty."²⁰ Not only do severe budget problems lead communities to give map preparation low priority, but comprehensive emergency management planning is hindered by lack of awareness of hazards and the potential for harm to their communities.

The Marlborough situation highlights the urgent need for full risk mapping as delineated by FEMA. If such maps become available, risks will be more clearly defined and emergencies more readily coped with. Monmonier and Schnell²¹ suggest that the design of effective risk maps requires an understanding of the intended audience and its limitations. They point out that elected officials and the general public require concise, straightforward, simplified presentations. One deterrent to local risk assessments expected by FEMA in the Basic Plan for EOPs is the sophisticated calculations required to complete them.

²⁰ M. K. Lindell & R. W. Perry, *Behavioral Foundations of Community Emergency Planning* 29 (1992).

²¹ See Mark Monmonier & George A. Schnell, *Natural Hazard Mapping: Status and Review in Natural and Technological Disasters: Causes, Effects and Preventive Measures* 441(1992).

Changing environmental laws complicate the process. Under the Oil Pollution Act of 1990,²² each emergency planning district must define what is “environmentally sensitive” and must determine the resources to be protected. The planning process for the new Clean Air Act²³ Title III § 112r²⁴ has just started and involves the need to monitor 112 substances. Proposed regulations for the Clean Air Act go into effect in November, 1994, and within two years, facilities handling covered substances must submit air pollution reports to their LEPCs describing worst case scenarios and possibly even consequence flow charts. No Region I LEPC has yet submitted risk assessment maps, and these new regulations will make this even more difficult.

Local politics may compound the problem. It is possible that preparation and publication of risk maps may cause, e.g., property values to drop in high risk areas. This, too, may hinder required mapping and prolong the unavailability of an important missing link in emergency planning and response.



22 33 U.S.C. § 2701 et seq.

23 42 U.S.C. § 7401 et seq.

24 42 U.S.C. §7412(r).

