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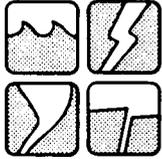
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The Role of Emergency Mapping in Disaster Response

Ute J. Dymon

University of Colorado, Institute of Behavioral Science, Natural Hazards Research and Applications Information Center

Quick Response Research Report #42

1990

THE ROLE OF EMERGENCY MAPPING IN DISASTER RESPONSE

By

Ute J. Dymon
Department of Geology/Geography
University of Massachusetts

QUICK RESPONSE RESEARCH REPORT #42

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The views expressed in this report are those of the authors and not necessarily those of the Natural Hazards Center or the University of Colorado.

FINAL REPORT
Quick Response Research

Ute J. Dymon
Department of Geology/Geography
University of Massachusetts, Amherst, MA 01003

THE ROLE OF EMERGENCY MAPPING IN DISASTER RESPONSE

Maps are a key ingredient in emergency planning for
technological disasters. DeLucia (1979) declares that "maps are
the fundamental media of communication for planning information."
By providing spatial organization of the critical movements in a
hazardous event, maps are indispensable tools necessary:

- to coordinate the efforts of emergency groups and
  services by using a generally accepted model for actions;
- to provide a guide for possible action by the
  public;
- to aid the flow of resources and services before, during
  and after an emergency;
- to serve, especially during the event, as the quickest
  method for locating at a glance all the elements at work
  in a specific geographic area without having to read
  large volumes of information;
- to illuminate for emergency managers and for the public
  the physical constraints of the incident site and the
  most advantageous choice of actions to take; and
- to serve as educational devices or public relations
  tools.

Despite the basic role emergency planning maps can play in
promoting cross-departmental, cross-agency and cross-jurisdic-
tional coordination of emergency response efforts, review of the
cartographic literature revealed few references concerning the
use of emergency maps. With support from the Natural Hazards
Research and Applications Information Center in Boulder,
Colorado, a Quick Response Study investigation of a train
derailment in rural Pennsylvania sought to determine what and how
many maps were available for use during the emergency and how
they were employed. These basic questions shaped the inquiry:

1. What political jurisdictions, government offices,
   and agencies or private organizations were involved
   or responded?
2. What kinds of maps were employed by these actors
   during emergency response efforts?
3. What maps were available for use by the general
   public and what maps were actually used and owned by
   evacuees?

The Emergency Event
   Map use during a train derailment and subsequent explosive

fire was the focus of this research. This technological disaster
struck Craigsville on April 22, 1990, at approximately 9:30 pm
when 29 cars of a 97-car Buffalo and Pittsburgh Railroad train
being pulled by five locomotives derailed on a steep slope in the
town. One derailed car carried 2000 gallons of sodium hydroxide,
a drain cleaner, but twelve of the derailed tankers held more
than 100,000 gallons of crude oil. Over the span of the emergen-
cy, four of these tankers exploded, and the coal in numerous
open-topped cars caught fire. Caustic sodium hydroxide and
particulates from the burning crude oil built a cloud more than a
hundred feet high which was kept close to the ground by a temper-
ature inversion. To prevent further dispersal of this cloud, air
traffic was forbidden in a 5 mile diameter zone around the
accident site. An air advisory was issued warning the elderly,
those with respiratory problems and the young to close windows
and stay indoors. Fourteen fire companies and five ambulance
services under the direction of the Fire Chief of the Wor-
thington-West Franklin Volunteer Fire Company provided emergency
services during the first three days of the crisis. The evacua-
tion of approximately 400 residents in the Craigsville area took
place the night of the derailment. As stubborn fires continued
for two days, threat conditions led to a destructive potential
sufficient to cause: fire damage to four homes, extensive con-
tamination of the local water supply, fish kills downstream along
the Allegheny River, loss of 12,000 trout hatchlings stocked in
Buffalo Creek, a black oil film on structures, health hazards
from fouled air for a week or longer and economic loss to several
local farm businesses. Two firefighters sustained injuries, but
there were no fatalities.

Research Strategy
        Two survey questionnaires administered in interviews with
emergency personnel and evacuees included questions about residen-
cy, educational and career background, map use, map availability
and map needs. Followup telephone calls were made to complete 20
interviews with officials and representatives of volunteer
agencies and thirty interviews with evacuees. Three foci shaped
on-site observations: 1) identifying maps available for use by
emergency personnel in the Command Center and in emergency
vehicles; 2) determining the extent of map use at the derailment
site; and 3) establishing the role of maps in communicating risk
to the media.

Research Findings
        Results revealed that there was no map showing residences
available to guide emergency efforts, and the public was evacuat-
ed without the official decision maker consulting a map. Emer-
gency response personnel complained about a lack of maps of the
appropriate scale and detail for use in the Command Center and in
the office of the Incident Commander, Fire Chief of the Wor-
thington, West Franklin Township, there was not one map on the
walls. A USGS topographical map and a General Highway Map, both
brought to the Command Center by the Pennsylvania Emergency
Management Agency, were referred to, but the impact area was

larger than this one·USGS quadrangle map showed. Because Craigs-
ville is located near the upper corner of a USGS quadrangle,
four USGS topo maps were needed to show all of the land impacted;
therefore, even the topo map emergency responders had available
to use was incomplete. In his role as water systems manager for
Armstrong County, one person used his wetland map of Buffalo
Creek to advise Pennsylvania Department of Environmental Resour-
ces (PADER) on strategies to protect the surface waters of the
area during the night of the derailment.

        The Incident Commander directed the evacuation without the
use of one map to show the location of residents. Emergency
response personnel operated solely from their own mental maps of
the area resulting in the application of a system of collective
mental maps.

        The videotape shot by the fire company's photographer and
comments from Craigsville residents point to the dangers of
conducting an evacuation without appropriate residency maps.
Fire company radio communications captured on the official video-
tape reveal that emergency personnel discussed street location
directions at length. If they had been able to reference identi-
cal town maps, less vital time at the peak of the crisis would
have been wasted. Evacuee interviews revealed that there were
indications two isolated and unusual locations of residences
resulted in oversights during evacuation. Had town maps been
available, these homes need not have been overlooked. Finally,
the fact that this derailment emergency and evacuation were
handled successfully was due to the relatively limited area
impacted. Had the cloud been more toxic or the fire area larger,
the lack of maps for evacuation and control of the physical agent
could have had even more critical consequences.

        Evacuee interviews revealed the following: 1) no maps other
than mental maps were used by the public during the evacuation;
2) nearly one-fifth of the people interviewed, all new residents
in the community, said they could see the advantage of having a
map available for use during an evacuation; 3) even if they had
wanted to use one, thirty percent of the interviewees own no maps
at all; and 4) the majority had Pittsburgh and Pennsylvania road
maps both in their homes and in their cars. Already published
maps were not viewed by the evacuees as essential for emergency
evacuations.

        "Crisis mapping," a new genre of mapping for decision making
and risk communication, was found to exist during this emergency.
At least six of the federal and state agencies or companies
operating out of the command center prepared hand drawn site
sketches to facilitate decision making and risk communication
during the emergency. This new type of cartographic tool served
various functions. One taped to the wall of the Command Center
the morning after the event was used to organize water sampling
efforts by the Pennsylvania Department of Environmental Resour-
ces. Another crisis map was faxed overnight by the PEMA staff at

the Command Center to their Harrisburg office to provide the
basis for phone consultations the next day. The most important
crisis map prepared during this incident was a sketch of the
zigzagged, derailed railroad cars drawn on a 17" x 24" poster-
board. The Fire Chief postponed making critical decisions about
controlling potential exlosions on Monday until this crisis map
was available. At a news conference on Tuesday, this same roughly
drawn crisis map provided the chief means for communicating to
the media in a news conference the degree of potential risks
remaining. Crisis maps were produced by the EPA, NSTB and
Buffalo and Pittsburgh Railroad to mitigate and to reconstruct
the accident.

A truism that characterizes this disaster is "the closer you
get to the incident, the fewer the maps that are available." At
the state level in Pennsylvania, a comprehensive computer mapping
system provides detailed emergency maps. Part of this mapping
capability is a one million dollar "TAGAVAN" that can perform
chemical analysis and produce plume maps at the emergency inci-
dent site. Conditions in the Craigsville case prevented use of
this van. Before the derailment, requests went out to each
county in Pennsylvania to submit to the state county data to be
incorporated into the statewide Geographical Information System
(GIS). This mapped data then became available to individual
counties in a form whereby they could add information to produce
updated maps. The skills necessary for use of this GIS by county
and state employees are still being acquired, and updating of the
county data is not yet complete.

Conclusions and Recommendations

In emergency planning, the role of detailed maps in disaster
management has been neglected. In the Craigsville case, emergen-
cy personnel expressed a strong need for blownup topographical
maps and residency maps. By producing crisis maps, they were
able to document the details of spatial relationships and the
changing elements of the emergency to control and mitigate the
consequences of the disaster. In both the response and recovery
periods of this technological disaster, crude crisis maps helped
emergency managers: grasp the geographic facts necessary to deal
with the physical agent, explain risks to the media, document
better records of the history of the incident, and reconstruct
the disaster to establish what lessons were learned. Crisis
mapping is filling a void and should be recognized as a critical
part of emergency management that needs to be integrated more
fully into planning.

More specific recommendations based on insights gained from
this Quick Response research include the following:

1. There is a need for funding to produce local town maps
   which include residences.
2. The important role of crisis maps needs to be
   acknowledged by emergency planners so materials for their

production are taken to the sites of technological
disasters.
3. To improve the effectiveness of crisis maps, guidelines
   for their necessary content and design should be
   developed. This would include standardization of methods
   for showing accurate locations of sampling sites, tracing
   dynamic conditions during the event, portraying
   relationships to other geographical locations and
   phenomena, and indicating directions and scale.
4. By determining the person who is tasked with drawing
   crisis maps, training can be provided.
5. Research is needed to establish whether implementation of
   computer mapping capabilities for crisis mapping in the
   field is warranted.
6. Emergency mapping, especially crisis mapping, deserves
   special attention on the part of cartographers, decision
   makers and emergency managers.

Emphasis was put on the mapping aspects of this incident.
For a more detailed report, including analysis of the social
factors existing in this community through application of Quaran-
telli's model of evacuation, a journal article has been prepared
and will be supplied upon request.