REMOTE SENSING UTILITY IN A DISASTER STRUCK URBAN ENVIRONMENT

Final Report

October 1, 1973 - September 1, 1976

by

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STATEMENT OF GOALS AND OBJECTIVES

Remote Sensing and Public Health.

The general purpose of this research was to explore and present ways that remote sensing could contribute to solutions of urban public health problems in time of natural disaster. The general objective of this project was to explore potential uses of remote sensing for public health assistance during disaster relief operations which would aid the agencies and organizations involved in relief activities.

The specific objectives changed somewhat during the three year period. Initially, they were (1) to establish a public health/remote sensing team which would be trained to provide assistance to disaster relief managers in time of natural disaster and (2) to develop a manual on remote sensing standing operating procedures for public health assistance during disaster relief operations. It was assumed that a well-defined structure for conducting relief operations existed and that it would be a relatively simple matter to identify the functions and tasks required to manage disaster relief. We planned to identify the needs of user agencies and to suggest ways in which remote sensing could meet these needs.

After completing the literature review and a series of interviews with disaster relief managers (the first year), our initial objectives were revised to conform with the apparent needs of user agencies. Establishing a remote sensing/public health team to be on call to attend disasters was dropped as was the technical manual of standing operating procedures for remote sensing personnel (Appendix A). Instead a guide was written for disaster relief managers. This guide identified six major

public health areas which might be affected by a natural disaster, the functions and tasks associated with each area following a disaster, potential ways remote sensing could aid these functions, and the baseline data which would expedite problem-solving associated with these functions.

We had planned to test the validity of this technology by applying it in a postdisaster situation and comparing it, where possible, to existing methods of gathering information. Such a disaster did not occur in our space and time frame.

Disasters and Public Health.

Disasters interrupt systems necessary to maintain the public health. It is necessary not only to reestablish all the interrupted systems on which the protection of health of a community relies but also to manage the potential and real public health problem during the period of reestablishment. The activities involved in doing this may seem from one perspective to have no relation to health, but from another perspective they are the underpinnings on which the health of a community depends. Two points need to be made clear: (1) Public health activities are broad-spectrum, that is, they are carried out on a societal as well as on an individual level, and (2) the emphasis in public health is on prevention, not cure. Medical care per se or effective treatment of illness, it has been argued, "has little, if any, effect on the health of a community" (Stallones, 1972). In fact, for some diseases successful treatment may even increase the burden of illness in the community. From a community health perspective, medical care or treatment of illness "represents the failures of community health" (Stallones, 1972).

When we consider prevention in relation to natural disasters we do not mean to imply prevention of the event since with most types of natural disaster this is not yet possible. This research emphasizes a preventive approach to the effects of disasters and specifically to post-disaster problems that relate to public health concerns during the emergency phase of relief.

It is generally agreed that there are three phases of relief activities following a natural disaster. The first is the emergency phase during which persons impacted by the disaster are rescued and first aid and other medical care are administered. This phase is followed by the recovery period during which time residents of the community assess their situation and work toward reestablishing a stable way of life. Public health concerns at this time may revolve around treatment of illness which might have occurred as either a result of the disaster, a result of actions taken during the emergency phase, or other factors such as the prevalence of certain disease types predisaster. The final phase deals with restoration and rehabilitation of the community to predisaster conditions and may take from weeks to years depending on the type of disaster and economic resources available to the community.

Concerns of the emergency phase may range from reestablishing transportation routes into an area cut off by a disaster to the identification of environmental factors that foster disease occurrence. In a disaster context, medical care, while remedial, may also come under the umbrella of public health coordination activities. Public health in the context of disaster relief encompasses the total scope of community health, namely, all the community efforts influenced by the medical arts and

sciences, applied to the prevention of disease, protection of life, and the promotion of the well being and efficiency of man, inclusive of the physical, mental, and social aspects.

End Product: Guide for Disaster Relief Managers.

The end product of this research was a guide describing potential applications of remote sensing to public health problems. This guide was written for agency personnel, and it outlined by public health problem the functions and tasks involved in disaster relief management. Evidence exists to show that inappropriate actions on the part of disaster relief managers have frequently contributed to unnecessary mortality, morbidity and inefficient use of resources (Center for Disease Control, 1974). Mismanagement problems are most often caused by a lack of knowledge and/or skill of the work functions required to manage disaster relief. Tasks which can be accomplished or aided by remote sensing were identified. This guide is unique in two respects: (1) It documents functions and tasks which are nowhere clearly outlined and so imparts knowledge to those who cannot rely on experience as well as specifying in diagrammatic form these same tasks for experienced personnel, and (2) It suggests an application of an improved technology for disaster relief managers in solving a serious problem.

HYPOTHESES

The following hypotheses were formulated:

1. Remote sensing technology can supply data faster, more completely, and more accurately than current methods.

2. Using this method of intervention, we can assist reduction of management errors in a disaster caused by information delay.

Testing the difference in quality of data collected at comparable time intervals from current methods and from remote sensing would ideally require that the two collection systems were used simultaneously and then compared. This could have been done if an actual disaster had occurred in the time frame of the current project. A second testing procedure would be to make a retrospective study of the time required for collection of its quality by interviewing persons recently involved in a disaster. This information could be compared to the estimate derived from a simulation whereby remote sensing is used to provide the same data.

Testing the second hypothesis is very difficult and was not undertaken since it is virtually impossible to conduct a controlled exposure validation. This would entail having the same disaster strike two similar communities with equal intensity at the same time and exposing one to remote sensing while using the other as a control community without the use of remote sensing. Additionally, we have no mechanism whereby decision-makers would be limited to utilize data from remote sensing sources. However, we will demonstrate its usefulness by the guide which presents the problems in flow chart form to encourage such utilization.

RESEARCH STEPS

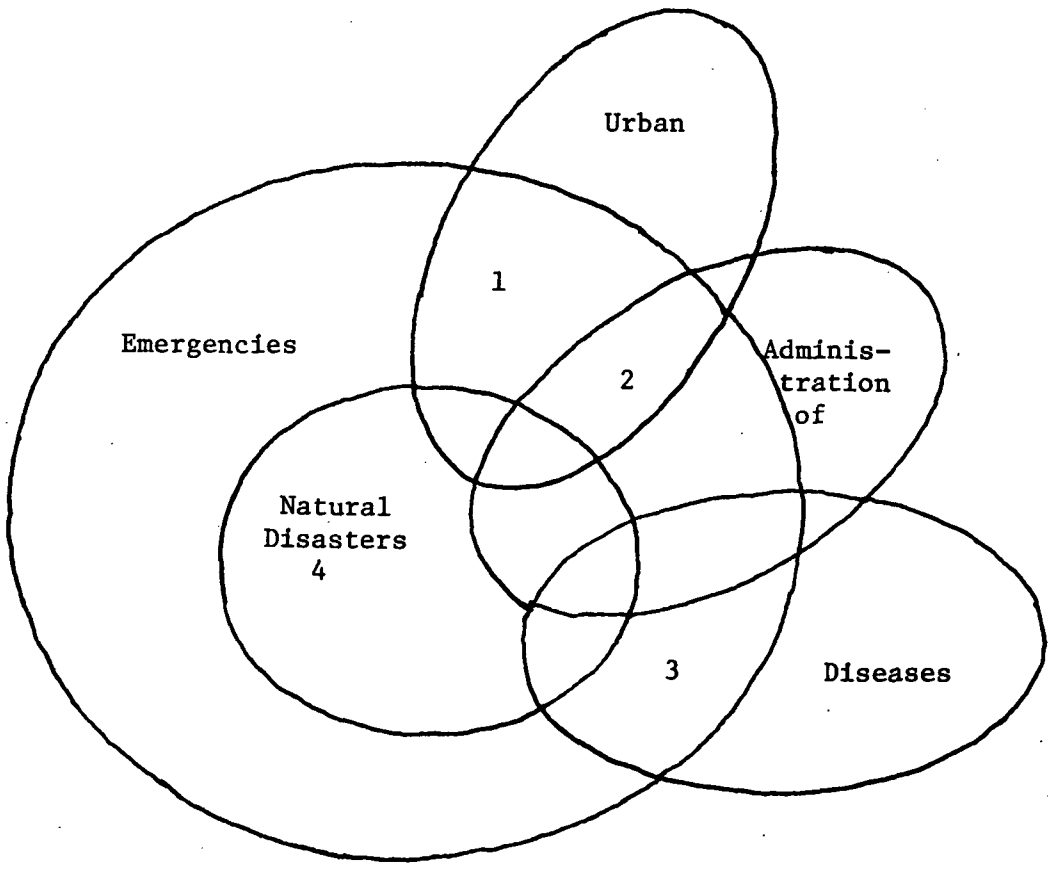
This section details the steps which were taken to complete the research described above.

First Year Steps.

Literature Review.

Approximately the first three months of the investigation were devoted to reviewing the literature. A comprehensive literature search and review of two topic areas, disasters and remote sensing of the environment, was carried out. A list of indices and abstracts which were searched in connection with the project appears in Appendix B. A bibliography containing 167 documents examined and used is included in Appendix C. In addition, a computer search was made through the National Library of Medicine (NLM/MEDLINE). Diagram 1 portrays the four areas of literature that were cross-referenced in the search. Table 1 shows the number of references retrieved from each area and the approximate number which were relevant to this project.

DIAGRAM 1



The types and extent of past disasters were examined in order to determine the public health and medical problems related to various types of disasters. It was found that while most publications in the disaster

TABLE 1

REFERENCES RETRIEVED FROM MEDLINE

SEARCH BY TOPIC AREA

	Number cited	Number Applicable
Administration of Natural Disasters	278	15
Diseases and Natural Disasters	81	8
Natural Disaster Articles	300	35
Urban Population and Natural Disasters	51	1

literature emphasized the need to be aware of possible public health problems, few publications enumerated the problems which developed or might develop. In fact only four studies were epidemiological follow-up studies of a disaster (Gilbert et al, 1973; Manos, 1958; Saha, 1972; and Sommer and Wiley, 1972). The literature search then focused on the environmental disruptions most likely to occur in disasters with emphasis on those which had visible physical surrogates. The damage characteristics which might be surrogates for public health problems were identified. The public health implications of these environmental disruptions were then analyzed in terms of the community as a whole and in terms of specific disease outcomes which might result. Diseases were described according to their mode of occurrence, area of endemicity, and control and prevention.

It was also found that the work functions required to effectively manage disaster relief were nowhere clearly outlined. This situation proved to be an unanticipated obstacle since we had assumed that the tasks to be performed in relief operations were already specified. Disaster mismanagement caused by lack of knowledge and/or skill has contributed to unnecessary mortality, morbidity, injury and inefficient use of resources. Before a plan for effective disaster relief management could be devised, the public health functions which needed to be performed in disaster relief had to be delineated.

The staff also searched for literature concerning the application of remote sensing to disasters. Only three studies examined the potential utility of remote sensing in disasters (Rapid City Flood, 1973; Garafalo and Wobber, 1974; Wobber, 1971). None of these studies suggested a framework within which remote sensing could be integrated with disaster relief management functions.

Interviewing.

Disaster-responding agencies in the state of Texas were identified at all levels of government and contact was established between them and the project staff. Prior to interviewing people in the agencies, a letter and two lists of questions were sent to them. (See Appendix D for the letter and questions.) It was hoped that this procedure would facilitate discussion since most agency personnel had not considered the idea of using remote sensing technology in disaster relief activities. The major difficulty in conducting these interviews was the unexpected one already mentioned, i.e., the absence of an explicit specification of disaster relief work functions.

It was possible, then, to talk only in generalities about how relief activities are carried out. These interviews served, however, to acquaint directors and personnel in Texas agencies with this project and to acquire cooperation in developing this application of remote sensing.

Included among the agencies contacted were the Federal Disaster Assistance Administration (FDAA), State of Texas Emergency Operating Center (EOC), Galveston EOC, Houston EOC and the Regional Red Cross.

Flow Diagraming.

As mentioned, disaster plans have been organized around functions that have not been made explicit. SOPs when available usually detail tasks by agencies rather than by functions to be accomplished. This approach leads to fragmentation and duplication of effort since restoring certain systems following a disaster may cross-cut several agencies. For example, checking and restoring the water system and supplying water may involve the Division of Engineering Services which is responsible for checking and repairing the system, the Health Department which is required to test for contamination and the Red Cross which is charged with distributing water to areas where the supply has been cut off. A more holistic approach to disaster relief management would be to diagram work functions across agency boundaries, and this was the approach adopted.

Disaster relief activities were divided into six general areas of public health concern: medical services, water, liquid waste disposal, shelter, food, and transportation. Flow diagrams of the major disaster relief decisions and inputs were made to facilitate discussions with interviewees. It was observed in early interviews that their lack of experience and knowledge regarding their disaster relief functions led to a defensive stance and

hindered information-gathering. The use of the flow diagrams put the burden of presentation on the research staff while the interviewees took the role of experts to criticize or comment on the diagrams. These diagrams elaborated within functions the decisions and tasks required to manage relief activities. Problem-solving contingencies were elaborated within a decision-making framework identifying what has to be done to "solve" a disaster problem. Sixteen interviews were conducted with agency personnel who are responsible for managing relief activities in Houston and in Galveston to verify the accuracy of the diagrams. Revisions were made following suggestions of disaster relief managers.

These diagrams are linear, that is, various tasks are ordered sequentially according to priorities. However, relief activities for the most part have a web-like structure in which many things go on concurrently. Therefore it must be kept in mind that the starting point for all of the diagrams is either predisaster planning or immediately postdisaster. In addition, tasks on some of the diagrams may go on simultaneously. For example, repair of the water facilities may go on concurrently with distribution of water. How remote sensing can aid these work functions will be discussed in the following section.

Remote Sensing.

Based on the literature review a list of environmental disruptions which might serve as surrogates for health problems was developed. This list was checked by a number of photo interpreters to verify which items could be detected from aerial photography at given scales and film types (Table 2). Additions were made to the list based on a photographic analysis of two previous disasters--the Celia hurricane and the Managua earthquake.

TABLE 2

LIST OF SURROGATES

Utilities
- broken water mains
- broken sewer lines
- downed power/phone lines (oblique only)
- contaminated reservoirs/wells
- disrupted traffic signals
- power plant damage
- water supply station damage (pump)
- natural gas supplies (plant)

Streets
- obstructed by trees/poles
- obstructed by structural debris
- collapsed bridges
- disrupted road surface
- collapsed elevated roadways
- road washout

Structural Damage
- roofs off
- trees/poles fallen on structures
- structure off foundation
- foundation settled
- concrete embankments disrupted
- mobile homes displaced
- fallen towers, steeples, a.c. units, stacks
- fallen radio/tv towers
- fallen advertising display
- damage to oil tanks, industry
- garages/out buildings damaged

Vegetation
- stripped, branches down
- silt covered, trampled
- uprooted

Miscellaneous
- boats/commercial vessels displaced/beached
- small, local landslides
- passenger vehicles overturned
- roadroad tracks blocked or damaged
- fallen fences
- large animal carcasses

(Appendix D also contains a list of questions asked of remote sensing personnel.)

Using the flow diagrams discussed in the previous section, the specific observations needed to accomplish tasks within the six functions were listed. Several photo interpreters reviewed these observations to confirm if they could be made using remote sensing. Many of the items overlap with the environmental disruptions identified as part of the literature review.

Attention was also given to outlining remote sensing systems which would be adaptable to disaster situations. Camera systems, film and filter combinations, aircraft, scales of photography and other variables were examined. Although primary emphasis was given to aerial photography, alternatives to photography which also may be defined as remote sensing were considered such as videotape systems and a trained observer/recorder in low altitude aircraft. The selection of a remote sensing system will depend to a large extent on the resources of the community wishing to implement this plan.

Procedure Used to Develop Guide.

A. First draft of guide
    1. Preparation
        a. Literature review
        b. Interviewing
    2. Flow diagramming of functions
        a. Decision-making tasks
        b. Remote sensing tasks
    3. Verification of diagrams with disaster relief managers

4. Write up of discussions on cross-cutting agency functions and how diagrams may be used to synchronize them

B. Review and Evaluation

1. Agency review

2. Consultant review

Second Year Steps.

Iterations of the guide.

Following the literature review and interviews with knowledgeables in the field of disaster relief management, the staff drafted a guide. This guide was reviewed internally and was redrafted four times before being sent out for external review. This process of writing and rewriting lasted approximately six months (January-June, 1975).

Our primary concerns in writing the guide were that it be written in an understandable manner, that it be kept general so as not to preclude individual adaptations, and that the applications we described were feasible and could be implemented with a reasonable amount of planning.

Preplanning for natural disasters is a subject which is much discussed and encouraged by EOC directors but which lacks implementation in most communities. This guide strongly emphasizes preplanning and includes charts and tables of recommended baseline data for the six public health problem areas. These tables can serve as guidelines for communities wishing to compile such data.

The main functions which need to be performed in a natural disaster to maintain or restore the public health were examined, and the ability to use remote sensing data to fulfill these functions was described. Technical

information on remote sensing systems which would be adaptable to natural disasters was written up as an appendix to the guide.

Review of Guide.

The guide was assessed by review for clarity and for impressions of feasibility. A draft copy of the guide was mailed out to 35 disaster relief managers, consultants, and remote sensing specialists for their comments, and follow-up interviews were conducted by the staff. Where personal interviews were not possible due to distance or other factors, written feedback was solicited. Three months were spent interviewing disaster relief managers (June-August, 1975). (See Appendix E for a list of reviewers.)

Response to the guide was for the most part favorable. The clarity and readability of the guide were affirmed as was the feasibility of the concept. The need for preplanning was asserted, but a major obstacle to this end was identified in the lack of resources, i.e., limited personnel to assign the task of accumulating predisaster data.

Third Year Steps.

Comments of reviewers pertaining to the organization and content of the guide were analyzed. A major reorganization and rewriting of the guide was made in accordance with suggestions for change made by reviewers (September-December, 1975).

A second set of about 30 reviewers were asked to comment on the revised draft of the guide (January-March, 1976). These reviewers included some persons from the first group in addition to others whose names were suggested by initial reviewers. Second-round interviews were conducted in a similar manner to first-round interviews, i.e., personal interview or

written feedback. (See Appendix E for the list of reviewers.)

Comments of reviewers were considered, and the guide was revised into its final form (April-August, 1976). Major reorganization of the format of the second draft was not required. Suggestions of reviewers pertained for the most part to integrating the role of remote sensing into disaster relief management activities. Appendix G is the final version of the guide.

The staff attended two natural disaster simulation exercises as on-site observers during 1976. One exercise was on the county level (Galveston County, Texas) and the other was on the city level (Pasadena, Texas). These exercises were conducted by the directors of the Emergency Operating Centers. These experiences helped to validate the concepts suggested in the guide.

Plans for Distribution.

The guide will be distributed to all reviewers and to each State Emergency Operating Center. A letter will accompany those guides sent to State EOC directors in order to familiarize them with the content of the guide and to suggest potential users within their states (e.g., city and county EOC directors). It is expected that this process will be the most effective and efficient way of reaching potential users of the concepts discussed in the guide since our reviewers were persons in agencies on all levels of government. In addition, other persons who have heard of our research and who have requested information about our project will receive the guide. (See Appendix F for a list of those persons who were not reviewers but requested information about our research.) We expect that additional requests will be received once the guide begins to circulate.

A list of persons and/or agencies receiving the guide in the future will be kept on file.

RECOMMENDATIONS

To enhance the probability that the concepts in the guide will be implemented, it is recommended that training seminars, similar to simulation exercises, be conducted for persons who assume the role of disaster relief managers. These seminars could be funded through a grant or communities could contract for this training through consulting fees.

Possibilities for Future Research.

As imagery from more sophisticated remote sensing systems such as aerial and space satellites is studied, more subtle indicators on such phenomena as population mobility, speed of economic and social recuperation, speed of industrial and business recovery, etc. may be developed (Fritz, 1976). Such indicators would permit the assessment of even more complex phenomena than the kinds of damage assessment discussed in this guide. The development of measures of social psychological phenomena require the coordination of postdisaster ground field studies with satellite and aerial photographic coverage.

Another validation of the usefulness of remote sensing in this area would be to conduct a follow-up epidemiological study correlating the public health problems which actually occurred in a disaster and those predicted from photographic surrogates, taking into account preventive measures. This would involve collecting health data from the local agencies responsible for health care in the community such as the Health Department and various hospitals and from emergency relief organizations such as the Red Cross.

Recommendations could then be made regarding this application of remote sensing technology in meeting the public health needs of a disaster-stricken community. If time and resources permit, a second pilot study on a different type of disaster could be conducted to verify the findings of the first investigation.

Another application of the approach discussed in the guide would be the expansion of these concepts to developing countries. Differences in life-style and the state of predisaster community health make the post-disaster situation in developing countries qualitatively different from that in the United States. The wide range in governmental structures and the lack of warning systems also add to the differences that would be encountered. Thus, the guidelines to be followed and the diseases to be considered would differ considerably depending on the country in which a disaster occurred. For instance, a hurricane in Bangladesh would undoubtedly have a more severe public health effect than one on the Gulf Coast. Consequently, the potential public health benefits for overpopulated developing countries from the adoption of these guidelines for the use of remote sensing cannot be over-emphasized.

There are several other potential uses of remote sensing in disaster-related activities which have not been fully explored. Insurance companies could utilize remote sensing data as an aid to making decisions about claims. It also may be possible after sufficient data is collected, to pinpoint areas of prime susceptibility to disasters such as floods in order to stress the importance of flood insurance. Remote sensing data on the effects of floods also could be used to suggest alternative measures to reduce flood effects or perhaps land use controls or legislative policy change.

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PRESENTATIONS

Marjorie Rush and Sally Vernon
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Marjorie Rush and Sally Vernon
1976 "Potential Uses of Remote Sensing in Disaster Relief Management." Presented at the National Workshop on Natural Hazards, June 30, July 1, 2, 1976, Boulder, Colorado. (Outline only; no formal written text.)

A summary of the concepts and procedures contained in the guide were presented to these groups.

SIMULATION EXERCISES ATTENDED

Galveston County, Texas, Emergency Operating Center, Dickinson, Texas.
January 29-30, 1976.

Pasadena, Texas, Emergency Operating Center.
March 24-25, 1976.

TRAVEL

Disaster Research Center, Ohio State University.

Date: April 24, 1975

Drs. Russell Dynes and Quarantelli were interviewed in regard to their purposes and procedures in disaster research. They provide experience to persons interested in the sociological aspect of public service reactions to disaster situations. We gained from the visit a bibliography on related works, interview forms and general knowledge regarding disaster research.

American Public Health Association Annual Meetings, Chicago, Illinois.

Date: November 15-20, 1975

Sessions pertinent to project concerns were attended.

California

Date: April 23, 1976

Several remote sensing experts and users were interviewed. They included Dr. Robert Mullens, Community Analysis Bureau, Los Angeles; Lt. Commander Scott M. Ruby, Department of the Navy, Light Photographic Squadron 63, Naval Air Station Miramar, San Diego; Mr. Mike Gialdini, Remote Sensing Institute, University of California, Berkeley; Mr. Jerry Deerwester, Chief Projects Analysis Branch, Ames Research Center, Moffett Field; Ms. Lois Clark McCoy, National Association of Search and Rescue Coordinators, La Jolla, California; Mr. Eric Orme, Disaster Emergency Services, California State Department of Health, Sacramento, California. Each person communicated his or her interest in remote sensing and all agreed to be reviewers of the guide.

Lubbock, Texas

Date: June 21, 1976

A conference on tornadoes and their impacts was attended by over 100 persons in meteorology, engineering and government services. Tornadoes are a common type of disaster in Texas and the midwest. An attempt is being made by researchers to better understand their destructive forces and to create interventions so less damage and injury is sustained by them.

APPENDICES

APPENDIX A

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

REPLY TO
ATTN OF: DE63/2-75/19

Marjorie Rush, Ph.D.
University of Texas School of Public Health
P. O. Box 20186
Houston, TX 77025

Dear Doctor Rush:

I acknowledge receipt of your annual report entitled, "Remote Sensing in a Disaster-Struck Urban Environment." I commend you on a fine report.

Recognizing the real concern for funding, time (grant termination 31 Aug 76), and capabilities, Mr. Vitale and I feel that rather than dilute your efforts, your greatest contribution toward the overall effort would be to have you dedicate your time toward producing one manual. This manual would address the user agencies, describing to them the potential applications of remote sensing data to disaster assessment and relief. The manual addressing the image analyst will be a subject for further funding. It is acknowledged that you will not analyze any realtime data from a natural disaster.

I would appreciate a briefing sometime in March or April at your convenience. Let me know if I can be of further assistance.

Sincerely,

F. T. Satalowich

APPENDIX B

INDICES, ABSTRACTS, AND BIBLIOGRAPHIES

An Annotated Bibliography on Disaster and Disaster Planning
(Disaster Research Center)
Applied Science and Technology Index
Biological Abstracts
Congressional Index Service
Disaster Research Center Publications
DCPA Publications
Engineering Index
Excerpta Medica - Environmental Health and Pollution Control
Excerpta Medica - Public Health, Social Medicine and Hygiene
Government Reports Announcements
Governmentwide Index to Federal Research and Development Reports
Monthly Catalogue - United States Government Publications
N.Y. Times Index
Oceanic Index
Reader's Guide to Periodical Literature
Science Citation Index
Selected Water Resources Abstracts
Water Resources Abstracts
Water Resources Research Catalogue

Indices Of:

American Journal of Epidemiology
American Journal of Public Health
American Journal of Sociology
American Sociological Review
British Journal of Sociology
Contemporary Sociology
Human Organization
Journal of World Meteorological Association
Medical Care Review
Monthly Weather Review
Sociology
Sociology and Social Research
Urban Review
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APPENDIX C

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APPENDIX D

LETTER TO AGENCIES, LISTS OF QUESTIONS

Dear

Thank you for agreeing to meet with us to discuss our project. As I mentioned on the telephone, we are developing potential uses for aerial photography in times of disaster. Specifically we would like to identify ways in which this technology could minimize or alleviate public health problems following a disaster. For example, areas of stagnant or contaminated water which might attract mosquitoes and thus lead to an outbreak of encephalitis could be pinpointed. Preventive steps could be taken against these sources before a problem developed.

The goals of our project are (1) to develop a procedures manual on using aerial photography as an aid to identifying and solving public health problems during a disaster and (2) to recommend skills and roles of a public health/remote sensing team to implement the procedures which would aid disaster-responding agencies.

At present we are focusing on Texas and are attempting to identify agencies and organizations on the various levels of government who respond to disasters. The tasks and functions of these agencies are nowhere extensively discussed in the literature and, more importantly, the experience of the people who deliver disaster relief is not published. Thus, we have found it necessary to meet with people working in this area in order to find applications of aerial photography which are useful.

We thought it might facilitate discussion at our meeting if we first sent you a list of questions we wished to discuss.

Sincerely,

Marjorie Rush
Principal Investigator

APPENDIX D (continued)

HEALTH PROBLEMS: QUESTIONS PROPOSED FOR DISCUSSION

1. What are the major community health problems encountered in disasters you have experienced?

2. Were any of the health problems you experienced due to contaminated or stagnant water?

If so, give specific examples, i.e., type and extent of disease.

3. Were any of the health problems you experienced due to crowding and thus unsanitary conditions of relief shelters?

If so, give specific examples, i.e. type and extent of disease.

4. Were any of the health problems you experienced due to contaminated food supplies?

If so, give specific examples, i.e., type and extent of disease.

5. Were any of the health problems you experienced due to exposure to dead animals and/or humans?

If so, give specific examples, i.e., type and extent of disease.

6. Were any of the health problems you experienced due to a vector problem (i.e., mosquitoes, flies, rats, etc.) aggravated by the respective disaster?

If so, give specific examples, i.e. type and extent of disease.

7. Have snakes ever been a problem in any of the disasters you have experienced?

8. Other than trauma cases, (cuts, fractures, etc.) can you point out any other significant areas where health problems could occur?

9. To what extent are trauma cases prevalent in disasters you have experienced?

10. How can a "disaster team" best intervene to minimize death, disability, and/or suffering?

APPENDIX D (continued)

AGENCY FUNCTIONS: QUESTIONS PROPOSED FOR DISCUSSION

1. What functions does your agency or department perform during a disaster?

2. What are the interrelationships between your agency or department and other levels of government? I.e., What is the "chain of command?"

3. What resources are available to your agency or department? E.g., a written disaster plan, maps of the city sewage, water and gas systems, shelters and manpower. How are volunteers incorporated into relief activities?

4. To what extent do disaster victims use your services?

5. How could the services you are prepared to provide be more widely used?

6. What disasters have you been involved in and what were some major problems you encountered?

7. How could you use aerial photos in your job?

APPENDIX D (continued)

1. Is it possible to roughly estimate the damage to a broad geographic area?
   a. If yes, how is this done? What criteria are used to measure degree of damage?
2. Are the signatures of the type of structure listed in Table 1 sufficiently different to enable their identification?
   a. If yes, do you think any image analyst could identify them? How did you learn?
   b. If no, do you know if anyone could?
3. Can you tell if structures are damaged or undamaged?
   a. If yes, what is needed to identify damaged structures? For example, angle of camera (oblique, vertical), film type, and scale.
4. What are the major steps in the process of photo interpretation?
   a. What criteria are used?
   b. What is the sequence of events?
5. Can the following degree of damage scale be used on the structures in the Table?

   1 - no damage

   2 - slight damage

   3 - medium damage - structure on foundation

   4 - structure off foundation

   5 - structure demolished

   6 - foundation, no building

6. Can the type of construction material be identified? For example, brick, frame, concrete?
7. Would the type of natural disaster--hurricane, earthquake, flood, tornado--affect photo interpretation of damage?
   a. If yes, how?

8. Does density affect photo interpretation?

   a. If yes, how?

9. Is there a more convenient way, from a photo interpreter's point of view, of organizing the information in the Table?

10. Can any basically trained photo interpreter perform the above operations?

    a. If no, what training would be necessary?

    b. Where would you look for a person capable of doing this?

11. Under normal conditions approximately how long would it take to perform the following operations?

    a. Overfly and film the disaster?

    b. Process the film?

    c. Perform photo interpretation?

12. What preplanning is necessary?

13. What equipment is needed to process and analyze the film?

14. What other items would be useful? For example maps of the area or pre-disaster photos.

15. What other requirements need to be considered? For example, space.

16. What is the approximate cost of doing the things listed in question 11?

17. What is the most efficient way in terms of cost of doing the things listed in question 11?

18. To what degree is film an accurate recorder? Is it preferable to using a trained observer in a plane?

19. How much ground truth is recommended? (Validation)

    a. What does this depend on? For example, familiarity with an area by the photo interpreter may lessen the time required for ground truth.

TABLE 1

	YES	NO
1. Structural Damage		
Community facilities		
Hospitals and medical		
Schools		
Churches		
Fire and police stations		
Developed recreational areas		
Civic buildings		
Buildings designated as shelters		
Residential		
Single Family		
Mobile homes (trailers)		
Multi-family 1-3 story		
Multi-family - over 3 story		
Commercial		
Office		
highrise		
other		
Retail outlets		
Motels and hotels		
Industrial		
Large manufacturing		
Light industrial		
Wholesale and warehouse		
Storage tanks		

2. Damage to Transportation Routes

Streets

Obstructed

trees/poles

structural debris

Road washout

Disrupted road surface

Collapsed bridges

Collapsed elevated roadways and subways

Disrupted railroad lines

Airports

Structural damage

Damage to runways

3. Damage to Utilities

Broken water mains

Contaminated resevoirs or wells

Damage to pumping stations

Broken sewer lines

Damaged pumps

Damage to treatment plant

Power plant damage (atomic, regular)

Transformer stations

Downed power/phone lines

4. Areas of Inundation

5. Occurrance of ponded water areas -- Which might constitute a health hazard

Oil Pollution

Chemical contamination

Animal carcusses

6. Accumulated rubble and brush

7. Fire damage

8. Safe or shelter areas

APPENDIX E

LIST OF REVIEWERS

Franklin J. Agardy, Chairman AWWA
Emergency Planning Commission
URS Corp.
San Mateo, California

Dr. Charles Barnes, Manager
Health Applications Office
NASA
Lyndon B. Johnson Spacecraft Center
Houston, Texas

Eddie Barr
EOC Director
Galveston, Texas

Marion P. Bowden, Coordinator
Division of Disaster Emergency Services
Texas Department of Public Safety
Austin, Texas

Col. William Brady
EOC Director
Dickenson, Texas

Jim Becht
University of Texas
School of Public Health
Houston, Texas

John Caswell
Executive Assistant Director
City of Houston
EOC
Houston, Texas

W. L. Collier, Jr.
Baytown, Texas

Dr. Earl Cook
Dean of the College of Geosciences
Texas A & M University
College Station, Texas

W. P. "Bill" Cornelius, Jr.
Director of Planning
Baytown, Texas

Frank Cox, Deputy Coordinator
Division of Disaster Emergency Services
Texas Department of Public Safety
Austin, Texas

Howard Crain
Houston, Texas

Murray McCormick
Houston, Texas

Frank W. Cox
Spring, Texas

Atlee M. Cunningham
Water Superintendent
City Water Department
Corpus Christi, Texas

Mike Criswell
Director of Utilities
Department of Public Works
Galveston, Texas

Jerry Deerwester
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Billie Fife
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James Havens
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Texas

J. Fletcher Hickerson
Director
Civil Defense and Safety
Baytown, Texas

Jeff Hinkley
Urban Planner
Department of Planning and
Environmental Services
Galveston, Texas

Warren J. Holland
Emergency Medical Services
Galveston, Texas

Steve Huffman
Assistant City Manager
Galveston, Texas

Lt. Raymond E. Howard
Groves, Texas

Edward R. Ibert
Director of Public Health
Health Department
Pasadena, Texas

Dr. Wm. Kemmerer
Health Officer
Galveston City/County Health Department
La Marque, Texas

Kay Kutchins, Training Administrator
San Antonio Water Board
San Antonio, Texas

Robert Lansford
Emergency Operations Center
Texas Department of Public Safety
Austin, Texas

T. W. "Bob" Leonard
Safety Engineer
Harris County Civil Defense Director
Houston, Texas

Douglas Matthews
Department of Transportation
Planning and Grants Coordinator
Galveston, Texas

Carroll McClain
Department of Public Health
Galveston, Texas

Rex G. McDonnell
Monsanto
Texas City, Texas

Jack McGraw, Director
Office of Preparedness
Department of Housing and Urban
Development
Federal Disaster Assistance
Administration
Washington, D.C.

Ray McKinney
Health Applications Office
NASA
Lyndon B. Johnson Spacecraft Center
Houston, Texas

Wm. J. "Bill" McLarty, Supervisor
Disaster Health Services
Emergency Medical Services
State of California
Department of Health
Sacramento, California

Colonel James Minish
Incline Village, Nevada

Capt. M. E. Mote
Houston, Texas

Robert H. Mullens II
Office of Mayor
Community Analysis Bureau
Los Angeles, California

Joe Nadon
Department of Transportation
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Eric Orme
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APPENDIX F

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APPENDIX G

COPY OF GUIDE

"Potential Role of Remote Sensing in Disaster Relief Management"