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THE GLOBAL EMERGENCY OBSERVATION AND WARNING SYSTEMS

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INTRODUCTION

The impact of natural hazards on humanity is an ever-increasing problem, especially as the population increases and migrates to vast urban centers. Causing more that US $100B worth of damage and claiming more than 150,000 lives annually, natural disasters have caught the attention of public officials, as well as disaster management, relief, and humanitarian organizations worldwide. There is a significant thrust in the United States Government, the United Nations, and governments around the world to focus efforts on mitigating the deleterious effects of natural hazards on the human population and supporting infrastructure.

Fortunately, the technology exists today to make a significant impact on the effects of natural disasters. Indeed, no technological breakthroughs are required to implement a global system capable of performing the functions required to provide sufficient information for prevention, preparedness, warning, and relief from natural disaster effects. One such system that has been proposed would combine the elements of remote sensing, data processing, information distribution, and communications support on a global scale for natural disaster mitigation. The concept is called the Global Emergency Observation and Warning (GEOWARN) system.

ORIGIN OF THE GEOWARN CONCEPT

The GEOWARN Concept was originally developed at the 1993 Summer Session of the International Space University (ISU) hosted in Huntsville, Alabama, USA. During the ten weeks of intensive interdisciplinary space studies, the international student body, comprising 100 students from 30 countries, engaged in the development of two student design projects. GEOWARN was one of the design projects and was supported by 38 students from 16 countries in America, Europe, Africa, and Asia.

The primary motivation for the GEOWARN project is a clear need for such a system to provide warning and relief support to those countries and regions of the world that currently do not enjoy these services. Furthermore, the United Nations (UN) has declared the decade of the 1990's to be the International Decade for Natural Disaster Reduction (IDNDR, or the Decade). The time is clearly appropriate to consider the development of a GEOWARN concept, which would support the third main objective of the Decade: ready access to global, regional, national and local warning systems and broad dissemination of warnings.

A PROMISING CONCEPT FOR GLOBAL WARNING AND RELIEF

Based upon an extensive characterization of natural hazards, and an evaluation their impacts on humanity, the ISU student design team developed a set of functional and technical requirements for a global warning and relief system. Figure 1 shows the economic

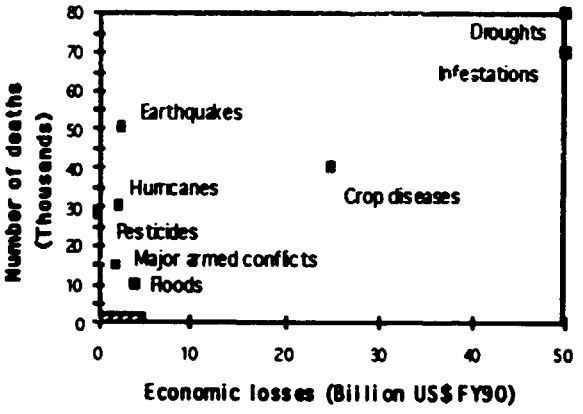

Figure 1. Disaster Impacts.

and human impacts of natural disasters. The economic losses and number of deaths due to specific types of disasters were assessed. The ISU team identified eight types of natural disasters have the most pronounced effects on humanity. These primary disasters are identified in the figure. All other types of disasters would be plotted inside the shaded area in the lower left corner of the graph. Armed conflicts and the improper use of pesticides were eliminated from the scope of GEOWARN since they are political problems rather than natural disasters. It was assumed that the remaining six primary disasters would drive the requirements for the GEOWARN system, and that if the GEOWARN system satisfied those requirements for the six primary disasters then it would be able to satisfy the requirements for virtually all other natural disasters. The requirements were determined for the remote sensing, communications and data management elements of the system. From these requirements, a suitable architecture was derived. The architectural elements for realization of the proposed concept include space-based and airborne remote sensing platforms, ground-based sensors, high speed communications links for sensed data and processed information, advanced data processing capabilities including state-of the-art geographical information systems, and an extensive archive containing information relevant to each affected area, the primary hazards therein, disaster management resources, and pertinent rules and regulations for disaster management.

Rather than invest scarce resources in the development of new infrastructure to support the development of a global warning and relief system, it was proposed that the GEOWARN be implemented incrementally, capitalizing on existing remote sensing platforms, computing and data centers, and communications capabilities. This implementation strategy is similar to that of the International Emergency Readiness and Response Information System (IERRIS) which has been proposed under the UN IDNDR initiative. The ISU study concluded that to fulfill the technical requirements derived, a modicum of new space-based remote sensing platforms are required to compliment existing satellite observation systems. It was also proposed that aircraft-mounted remote sensing capabilities be exploited to allow quick response times and eliminate the possibility that a space-based remote sensing platform may not be in the proper position to make the required observations in a timely fashion. Realizing that technology is not the total solution to the problem, consideration is also given to relevant international issues, social issues, and the organizational structure of a GEOWARN system.

THE NASA MSFC GEOWARN FEASIBILITY STUDY

A review of the proposed GEOWARN system as put forth by the ISU student design team revealed that a great potential exists for the realization of the concept. In an unfunded concept feasibility study begun in November, 1993, the Program Development Office of the Marshall Space Flight Center (MSFC) undertook to examine in detail the work done during the ISU '93 Summer Session. A team of fifteen engineers and scientists, which included a student from the ISU GEOWARN design team, dissected the proposed design and evaluated the merit of the concept. The goals of the feasibility study include: 1) assessment of the technical, programmatic, and implementation aspects of GEOWARN; 2) identification of remote sensing, communication and data processing requirements; and 3) identification space based, airborne, and ground based GEOWARN elements.

The primary focus of the feasibility study has been on the technical issues associated with actual implementation of a global warning and relief system. A significant conclusion of the evaluation is that there are absolutely no technical impediments to realizing a system that could attain the goals of the GEOWARN concept. Indeed, a plethora of potential system elements have been identified during the course of the study that meet the operational requirements. These elements include a host of remote sensing satellites, ground receiving stations, data processing centers, satellite communications systems, simulations and models of weather and other natural phenomena, detailed geographical information systems, and user interfaces designed specifically for emergency management officials. The Marshall study differed from the ISU study in some aspects on the remote sensing requirements. It was concluded that a significant disaster warning and relief capability could be achieved through the use of existing and planned remote sensing satellites, there is no strong requirement for additional satellites to support the GEOWARN system. Agencies throughout the

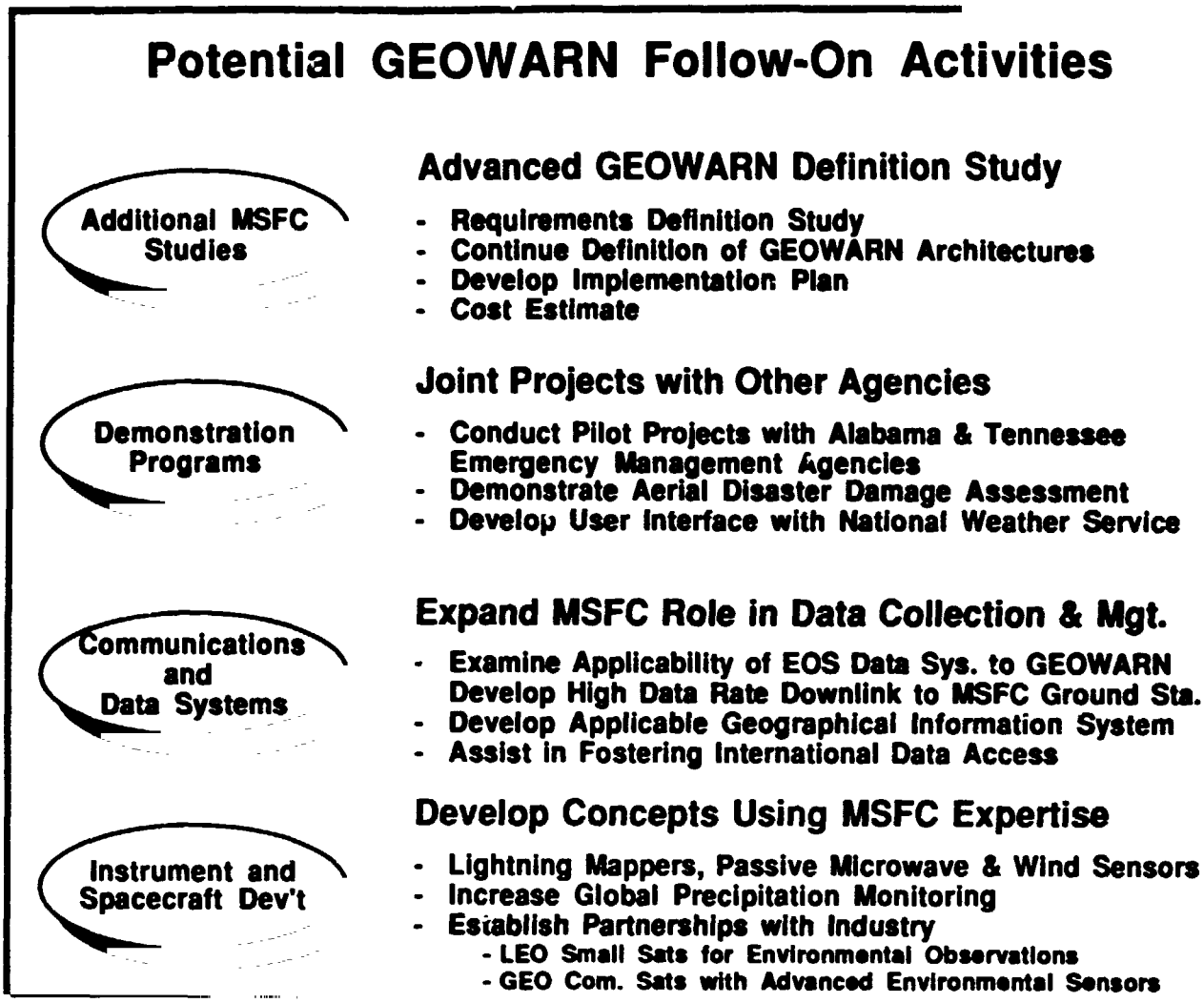

Figure 2. Follow-on Activities.

United States and the world are aggressively pursuing individual projects and programs that could be integrated into a GEOWARN system. These global assets have been catalogued as a part of the study.

FUTURE STUDIES AND DEMONSTRATION PROJECTS

The Marshall Space Flight Center Study has identified many potential roles for NASA in the definition of the GEOWARN system and the development of system components. These roles are summarized in the potential follow-on activities listed in Figure 2. The GEOWARN concept as presented by the ISU has been assessed to be technically feasible, with only minor modifications to the proposed architecture. Prior to specifying the details of a final system configuration, an in-depth technical requirements study is necessary to ensure that all critical parameters are addressed by the system. Such a study was not possible in the limited time available to the ISU team. An advanced requirements study is planned to commence in mid 1994.

To support the planned advanced studies, demonstration projects are also proposed. These are currently planned at a local, state, and regional level and would make use of space and airborne remote sensing data and the Distributed Active Archive Centers of the Earth Sciences Data Information System under development as part of the NASA Mission to Planet Earth. Cooperation among several US Government and

State agencies is planned.

The heart of GEOWARN will be the data processing and information dissemination systems. Existing and planned systems will be utilized to the extent possible. Information systems such as the IERRIS and others both existing and planned should be incorporated as part of the global network. Advances in high speed data processing, geographical information system, relational data base capabilities, and information displays make the realization of the data and information component of the system technically feasible. Communication of the data and information via ground and satellite links is possible at data rates which are more than sufficient to meet the identified needs. Advanced studies will investigate the application of current and planned communications and data systems to aspects of GEOWARN.

Although all of the architectural elements required for full system realization are not in place today, the next decade will see the launch of a number of advanced satellite systems that could be incorporated, in keeping with the incremental development scheme. The potential exists that new satellites may be needed, and future advanced studies towards a GEOWARN final configuration will quantify these needs. Advantage must be taken of all existing and planned space assets prior to proposing the development of new, expensive remote sensing platforms. Airborne remote sensing systems, including private, public, and military assets will be assessed for incorporation into the system architecture, as well. New airborne sensor requirements will be identified.

Efforts to involve international organizations in the studies are ongoing. Interest has been expressed at the European Space Agency, the Canadian Space Agency, and other international organizations, primarily by members and supporters of the ISU student design team. The MSFC study team acknowledges that development of the GEOWARN concept and its eventual realization will require significant inter-agency and international cooperation. It is also realized that the technical solution is only part of the total solution. There are an enormous number of social, political, and legal issues which must be addressed, or the concept will fail. The team requires and actively seeks advice and cooperation of all relevant organizations in effort to achieve the goal of providing global warning and relief for natural disasters.