

# THE INTEGRATED INFORMATION SYSTEM FOR NATURAL DISASTER MITIGATION

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## ABSTRACT

*Supported by the World Bank, the Integrated Information System for Natural Disaster Mitigation (ISNDM), including the operational service system and network telecommunication system, has been in development for three years in the Center of Disaster Reduction, Chinese Academy of Sciences, based on the platform of the GIS software Arcview. It has five main modules: disaster background information, socio- economic information, disaster-induced factors database, disaster scenarios database, and disaster assessment. ISNDM has several significant functions, which include information collection, information processing, data storage, and information distribution. It is a simple but comprehensive demonstration system for our national center for natural disaster reduction.*

**Keywords:** Information system, GIS, Disaster, Database, Assessment

## 1 INTRODUCTION

When natural disaster occurs, it is very important to capture information about the disaster in a timely manner. Why major natural disasters on the earth in the past have brought enormous damage and huge numbers of casualties relates to the same fact, that abnormal messages had not received enough attention and been properly collected in time before the misfortune happened. The tropical cyclone in 1970 cost 300,000 lives in Bangladesh; another tropical cyclone in 1991 resulted in 139,000 Bangladeshi deaths. Those who did not have any warnings of the calamities' approach were submerged in the stormy surge and flood. The huge tsunami that happened on November 23, 2004 in the Indian Ocean caused 300,000 deaths, and the main reason for such a high death toll is also the same, that people did not receive any information about the approach of the tsunami. There were no warnings, so people had no chance to prepare for the catastrophe.

Nature, however, is not too foul to mankind. In fact, many signals from the environment preview disasters,

warning people to protect themselves from earthquakes, floods, tropical cyclones, volcanic eruptions, etc. The key is that we have to catch and interpret the warnings from nature by advanced modern science and technology in time and do sound preparedness in order to reduce the damages and avoid massive casualties. For instance, the nephogram from a space satellite can help us find and locate tropical storms. Actually, there is a great amount of information we can obtain from such observations; how to precisely understand it efficiently is a very important issue today. Generally, we collect the information, and then we must process it, analyze it, and abstract the useful signals that can help us judge when, where, how intense, and with what influence on us the disaster will be. The next important step is to decide what effective actions we should take to prevent the would-be suffering the most. This is difficult work. We have to do much research and develop an advanced information system to deal with difficult tasks, from processing a great number of historic and present data, to analyzing and assessing past events, probing the development mechanism of disasters, and determining which elements induce the hazards or aggravate the disaster. A comprehensive information system is very useful for research, assessment, forecasting, early warning, and decision-making in modern natural disaster mitigation.

An integrated information system for natural disaster reduction has been developed in the Center of Disaster Reduction, Chinese Academy of Sciences. There have been successively three versions of the information system produced since the beginning of the 1990s. The first version was a visual one created in Turbo C language based on the geographical information system (GIS) developed by experts in the Center of Disaster Reduction, Chinese Academy Of Sciences (Wang, 1998, 1999; Liang, 1999). Through this version, we studied the processes of typhoons and heavy-rain disasters in detail. Based on this information system, we realized for the first time the benefits of tracking and monitoring disasters in China in real-time and began to do disaster prediction and disaster assessment. Afterwards, this version operated for several years and was evaluated highly by internal and international experts. Supported by the World Bank, the newest version, the Integrated Information System for Natural Disaster Mitigation (ISNDM), has been developed over the past three years in the Center of Disaster Reduction, Chinese Academy of Sciences on the platform of the GIS software Arcview. It is a simple but comprehensive demonstration system for our national center for natural disaster reduction.

## **2 THE STRUCTURE AND TECHNICAL FEATURES OF ISNDM**

The Integrated Information System for Natural Disaster Mitigation (ISNDM), including the operational service system and network telecommunication system, has been developed on the platform of the GIS software Arcview. The information has five main parts: disaster background information, socio-economic information, disaster-induced factors database, disaster scenarios database, and disaster assessment information. This section will summarize the structure and technical features of ISNDM.

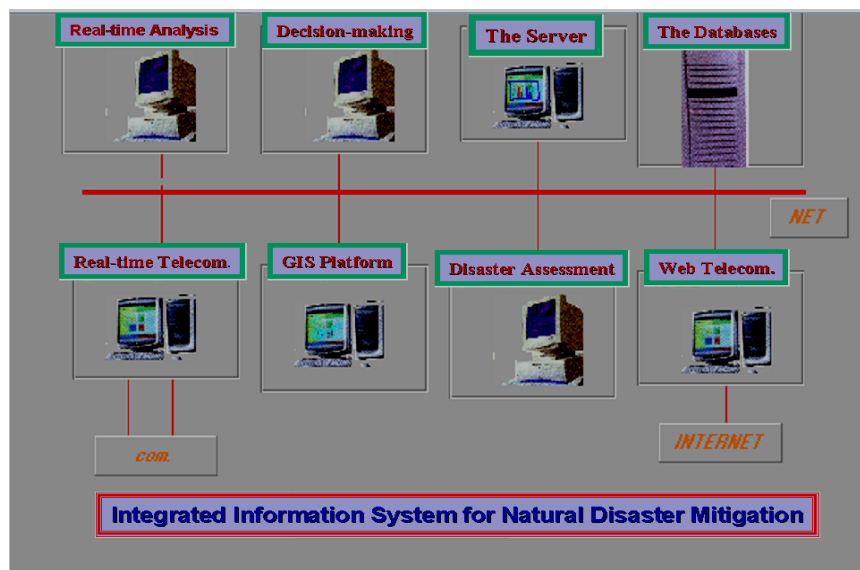
### **2.1 The structure of ISNDM**

Figure 1 shows the main structure of ISNDM. There are eight parts to the system, each having its own special function but also having close relations with all others. The eight modules and their purposes are as follows.

- (1) The Server is in charge of control and management of the whole system.
- (2) The Storage stores all the databases; it is the core of the system and serves the whole system as a data receiver and information provider.
- (3) The GIS Platform is the information processing and integration platform.
- (4) The Disaster Assessment Module carries out disaster risk analyses and assesses disaster scenarios

dynamically.

- (5) The Real-time Analysis Module deals with real-time information to preprocess raw data, to exam the rationality of the data, and to produce metadata for the databases; it also provides some preliminary analyses for a disaster.
- (6) The Real-time Telecommunication Module functions as a real-time information collector and transmitter.
- (7) The Decision-making Supporting Module acts as an adviser for decision-makers involved in natural disaster reduction.
- (8) The Web Telecommunication Module behaves as an operator between Intranet and Internet. It distributes analyzed data and disaster assessment results selected by the system administrator(s) and transmits back relevant information or remote instructions to the users from Internet to Intranet, etc.



**Figure 1.** The structure of the integrated System for Natural Disaster Mitigation (ISNDM)

The ISNDM is installed on Microsoft Windows 2000 or XP and uses man-machine interaction through windows and menus. The telecommunication protocol of ISNDM is the worldwide popular network protocol TCP/IP. The data can be conveniently exchanged and shared among workstations and servers. Every module has hard and software compatible with other modules but has independence that allows its own flexible design according to its special function in ISNDM.

## 2.2 The features of ISNDM

The major features of ISNDM are as follows.

- (1) ISNDM uses an alternation technology based on a matrix clustering analysis method to exchange and transmit the information. It allows 64 ports maximum to receive or send out disaster data simultaneously.
- (2) ISNDM applies a technique of self-adapting for objects in dealing with the different kinds of data, so the flow of data through the system can be automatically simplified and processed in an optimum way as quickly as possible with occupancy of a small amount of disk space.
- (3) With application of the network technique of Intranet, information can be efficiently exchanged between inside and outside ISNDM.
- (4) ISNDM is based on the software Arcview, so the GIS platform can produce visualization of the various reproduced disaster data in 2D or 3D to meet requests.

- (5) The information in ISNDM is controlled by an advanced distributed database management system shared by clients and servers.

### 3 FUNCTIONS OF ISNDM

ISNDM has the following significant functionality including information collection, information processing, data storage, and information distribution.

- (1) Information Collection: ISNDM can receive real-time disaster information from ministries, provinces, and cities through its input ports.
- (2) Information Processing: Large amounts of information from various sources, such as regular ground-observing systems, satellite images, etc., can be processed quickly and then be superimposed with socio-economic information and visualized on a GIS platform to assess disasters dynamically.
- (3) Information Storage: Real-time information is kept in the Real-time Database for the first day after its arrival. The data is transferred to the Historic Database in the second day for further use in the future. The Real-time Database is usually updated daily. A great amount of important data, such as geographical information, district subdivision and socio-economic data, historic disaster data in different categories, recreated data and images, etc., are stored in the Historic Database.
- (4) Information Distribution: Disaster information can be distributed by FTP through the special network to the users and publicized on the Internet.

The following pictures demonstrate some of the functions of ISNDM. Figure 2 shows the socio-economic information in Historic databases. It is the yearly averaged crop yield of the Fujian Province in China. Figure 3 shows the typhoon tracks passing through the spot ((115.78°N, 17.30°E) from 1949 to 1994. Figure 4 is the 3D simulation function of the flood which occurred in Poyang Lake in China in 1998. Figure 5 is the landslide disaster distribution in China. These pictures are just some of the overall system functions, and this system actually does many additional disaster assessments and disaster monitoring. Some modules will be improved and the functions will be enlarged and enhanced.

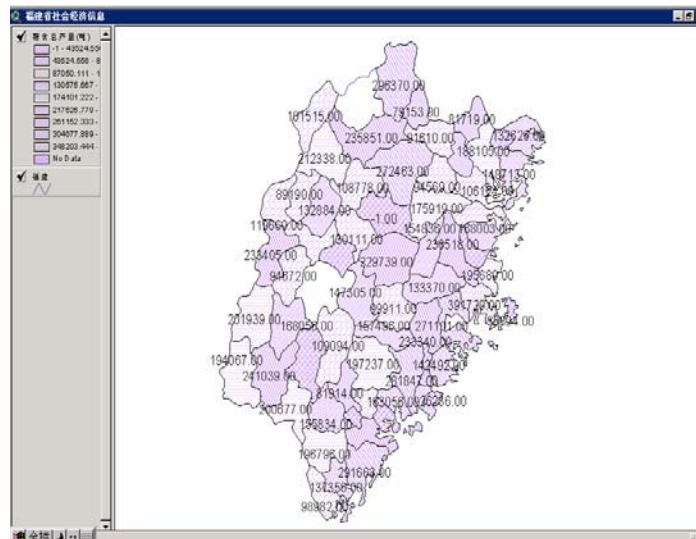


Figure 2. The yearly average crop yield of Fujian Province of China

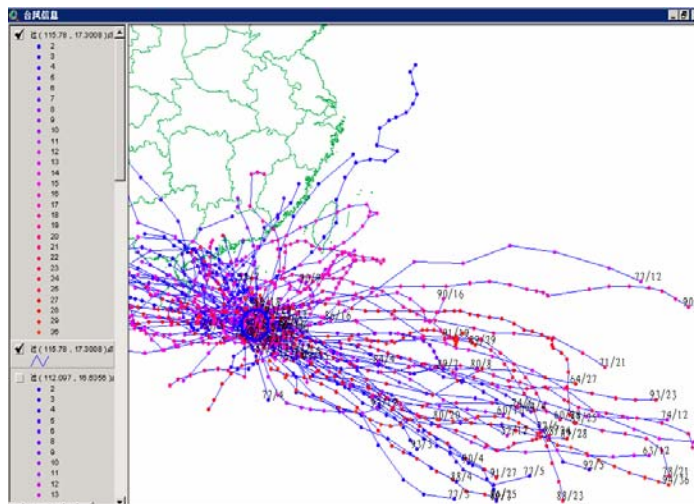


Figure 3. The historic typhoon tracks which passed through the point (115.78°N, 17.30°E).

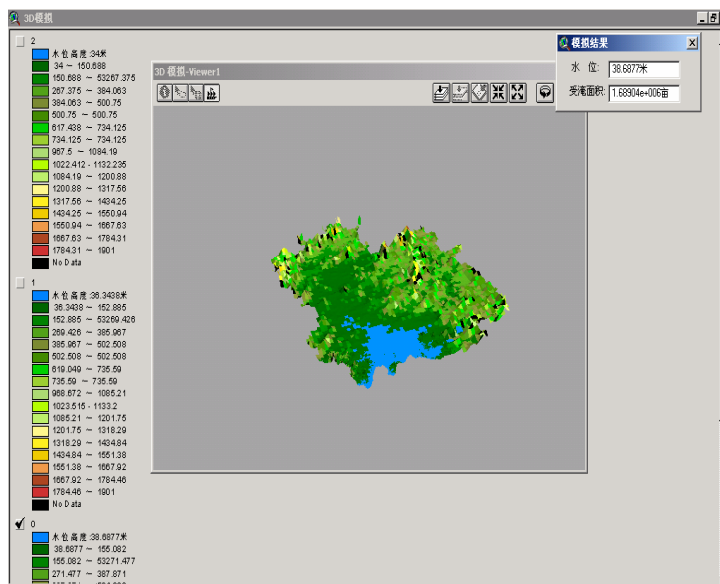


Figure 4. 3D Simulation of the 1998 flood in Poyang Lake in China.

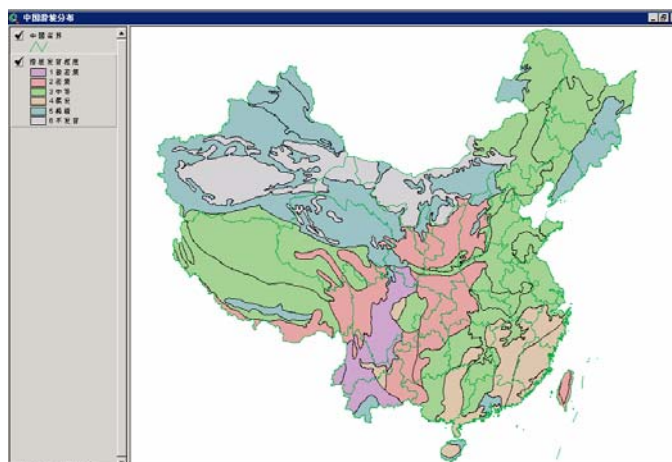


Figure 5. The landslide disaster distribution in China

ISMDM is integrated by large sums of databases of different disaster categories and can process various data and visualize them in graphics or in images in high speed according to what is requested. A module of a support system for decision-making has been designed in ISNDM, but because of lack of relative data, although practical it is really too simple. If data sharing is realistically assured, ISNDM can be applied to daily operations of natural disaster mitigation.

## **4 CONCLUSION**

Mankind has to face natural hazards and bear the suffering from natural disasters. The scientific community believes that although natural disasters are inevitable, human society can use modern science and technology to effectively prepare for them so that the disaster damage can be reduced and a great number of lives can be saved. The modern science and technology system for disaster reduction can play a very important role in collection, processing, and interpretation of disaster information, especially in supporting decision-makers and in distribution of disaster messages quickly to the people who would be affected. It can also be helpful during rescue and reconstruction stages. Scientists in the Center of Disaster Reduction at the Chinese Academy of Sciences have been working on natural disaster data. A key national project of research on heavy-rain and typhoon disasters in 1990-1996 had the involvement of over 300 experts from all over China and finished the first version of the disaster information system (Wang, et al, 1998, 1999). From 1996 to 2006, with support from the UNDP, the Ministry of Human Affairs of China, and the World Bank, we developed two up-to-date versions, including flood simulation (Liang, et al, 1999), numerical simulation on drought in China (Chen, 1997), drought monitoring (Feng, et al, 2004), numerical modeling on heavy-rain and typhoons (Feng, et al, 1999, 2004; Zhang, et al, 2006; Wang, et al, 2006), and information system development. Some of the work is very fundamental but useful for research on natural disaster mitigation. Because this is a multi-disciplinary field, it is certainly a challenge to scientists working in this area. In 2005, we implemented an initiative on natural disaster mitigation supported by the Inter Academy Panel on International Issues, where scientists from the USA, Sweden, Japan, Bangladesh, India, China, and Cuba worked together. Since October 2006 we have a new task group under the Committee on Data for Science and Technology, ICSU (CODATA), to establish a comprehensive science and technology system for global disaster mitigation. Experts from many countries and regions are involved in this task group. Compared to this system, ISNDM is just a very basic one, but the knowledge and experience obtained from ISNDM benefited the development of the comprehensive scientific and technological system for natural disaster mitigation established by the new CODATA task group.

## **5 AKNOWLEGDEMENTS**

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