3-5. Internet GIS

3-5-1. Objectives of Internet GIS for Disaster Reduction Management

The objective of Geographical Information System (GIS) is to make full use (data input, analyzing, storing, and output) of spatial data beyond the limits of ordinary paper maps. The spatial data, in this case, means not only surface data such as elevation or land use but also data for managing locations, shapes, and attributes of administrative borders, buildings, roads, railways, rivers, etc. Use of GIS utilities such as visualization by arbitrary overlay of spatial data, extraction of areas of influence, and selection of the shortest path facilitates for users to make decision and to assess the influence of environment and disasters. Implementation of a GIS normally requires introduction of software and hardware, however an advantage of GIS constructed on the Internet is that a system that allows analyzing, displaying, and acquiring data through the Internet can be developed without having to install any special GIS software on the user side. This is very important in handling disaster information as it leads to suppressed investment on equipment and promote information sharing easily.

In recent years, the unevenly spreading the Internet has caused a problem called "digital divide". The member countries of ADRC show varying degrees of Internet availability and activity. However, some regions and countries are going to use the satellite communication technology to access the Internet, we expect for the Internet GIS as a disaster risk management system in an emergency more eagerly than ever.

3-5-2. Overview of "Development of Disaster Information Network System in the Asian Region"

ADRC, with financial assistance from the Japan Science and Technology Corporation, conducted the project "Development of Disaster Information Network System in the Asian Region" over a period of three years from September 1998 until September 2001. As a part of this activity, "VENTEN (Vehicle through Electric Network of disasTer gEographical informatioN)", the Internet GIS with disaster reduction management information, was developed. The outline of the entire project is as follows:

1) Project name

"Development of Disaster Information Network System in the Asian Region"

2) Field of assistance

Calculation Science Technology Applied-Specific Research and Development Promotion Project (specific field: Environment and Safety)

3) Research representative

Yujiro Ogawa (ADRC)

4) Administrator of research

Bambang Rudyanto (ADRC, from April, 2000 until September, 2001)
Hirotaka Suzuki (ADRC, from October, 1998 until March, 2000)

5) Project duration period

From September, 1998 until September, 2001

6) Major subjects of project

- Construction of a platform for sharing disaster reduction information via Internet GIS (VENTEN system)
- Construction of a search engine of disaster reduction information
- Geographical information database for disaster reduction (map of Asia, populations, NOAA satellite images, active faults, tsunami (historic data))

・Construction of information partnerships based on remote sensing analysis

7) Summary of project results

The major results from the project can be summed up in the following two points:

・Construction of the disaster reduction information platform, "VENTEN", for Internet GIS

・Construction of the disaster reduction information database

The following can be pointed out as the remaining problem for future research:

・Expansion and enrichment of the database

・Development of technology to use satellite data

・Interactive communication of real-time disaster reduction information

The Papers that resulted from this research project were published as the "Final Report of Development of Disaster Information Network System in the Asian Region: 'VENTEN' System" (ISBN 4-901614-01-0).

3-5-3. Development of "VENTEN (Vehicle through Electric Network of disasTer gEographical informatioN)"

3-5-3-1. Background of development of "VENTEN"

The improved reliability of information extracted from satellite images with the progress of image processing technology in recent years enables us to extract various kind of information via remote sensing at anytime and anyplace and also to apply the information to disaster management. At this point, no available system can be linked directly to the reduction of disasters and operate in conjunction with disaster reduction activities. This is due to the focus on technological breakthroughs by satellite image providers, which resulted in the lack of enthusiastic participation by those who are involved in the actual disaster reduction activities in this area. It is also due to the difficulty in using the information only extracted from satellite images in actual operations and the information is not useful unless in connection with general geographical information such as topography and natural conditions, and social information such as population, structures, and infrastructures. In the introduction of the geographical information system (GIS), which is the platform for analysis by overlay of this geographical information, high costs and skill are required and poses enormous hurdles in the ability to use satellite information for disaster reduction.

At the first ADRC Expert Meeting, held February 16 to 18, 1999, a workshop entitled “Utilization of Technologies” was organized to discuss the use of GIS and remote sensing for disaster reduction. The following conclusions were reached:

□ All member countries recognized the value of GIS and remote sensing, and their advantages in information management.

□ Future problems are acquiring real-time satellite images, acquiring satellite data at lower costs, technological support for introducing GIS and remote sensing, and acquiring technologies for extracting disaster reduction information.

Despite the high interest shown in GIS and remote sensing by the disaster reduction departments in each country, high costs and the necessary skills pose obstacles in the application of these technologies.

In order to resolve these problems, the ADRC developed VENTEN (Vehicle through Electric Network of disasTer gEographical informatioN), a Internet Geographical Information System for disaster reduction that can be accessed by anyone, anywhere, using the rapidly expanding the Internet.

3-5-3-2. Goal for the development of "VENTEN"

The goals in the development of VENTEN were to provide both a system and data. This

system can be used with a PC connected to the Internet and installed a browser for WWW.

Many international organizations and so on provide basic geographical information such as topography and natural conditions. In order to browse and analysis this information, it is necessary to convert the data format according to that used by GIS. Thus in developing VENTEN, various kind of geographical information was gathered and converted to a format which can be used easily on the VENTEN and provided together with the system.

Fig. 3-5-3-1 shows the placement of VENTEN. On the left, various space development agencies, research institutes and organizations to produce such as aerial photograph information, which provide the original primary data. In order to extract useful information for disaster reduction from this primary data, numerous image processing and overlays are required, as are the means to send this information to the persons handling the actual disaster reduction work. Disaster reduction researchers can also browse, analyze information, and add their results to VENTEN. The VENTEN system has database and analysis utilities for remote sensing information of disaster reduction management and serves as the information transmission route to persons working on disaster reduction. This enables to make full use of remote sensing information of disaster reduction in actual activities to reduce damage, the preparation of disaster reduction plans and the support of rescue activities.

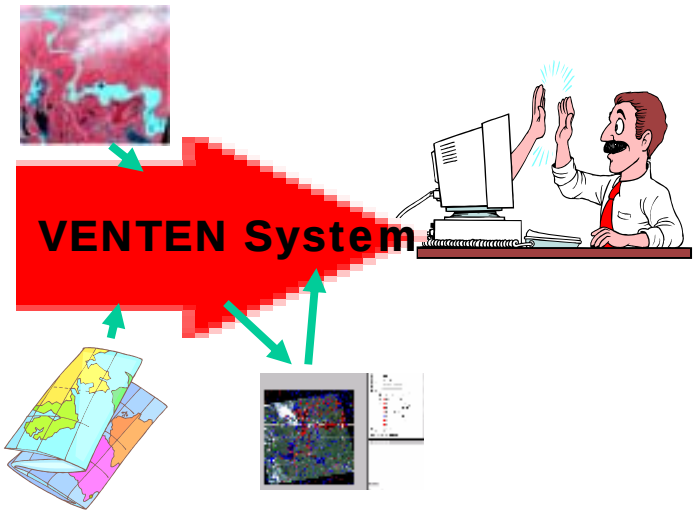


Fig. 3-5-3-1 Placement of VENTEN

3-5-3-3. Overview of "VENTEN"

1)Structure

VENTEN system consists of the Web server, GIS server and database server. Fig. 3-5-3-2 shows the information processing flow in VENTEN. First of all the request from users are accepted by the Web server. The Web server specifies necessary information including what kind of geographical data and what part of an area are needed (possible to specify multiple geographical data), for the GIS server. The GIS server, referring to the data server if necessary, extracts the subject from the geographical data those accumulated within it and then upload data to the Web server in a form of a raster data image. The Web server arranges a country selection menu, disaster information selection menu, show/hide selection button, scale and area management button to be displayed besides the geographical data. Then it sends users as a hypertext file including the raster image data provided by the GIS server.

The system is built with aiming that even first-time users can use easily, so jumping from the main page to the online manual, tutorials and database are available (Fig. 3-5-3-3). To display NOAA satellite images and contour images of land elevation are also available. Fig. 3-5-3-4 shows the home page of the VENTEN system.

There are a couple of systems for Internet

Fig. 3-5-3-2 Processing Flow of VENTEN

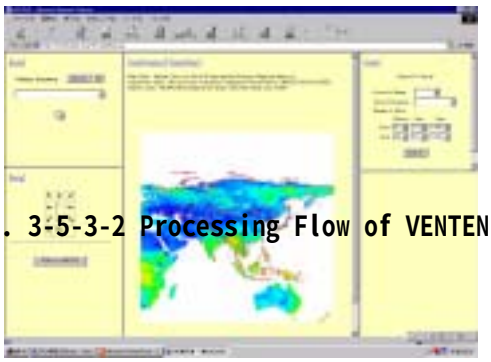


Fig. 3-5-3-4 VENTEN System Initial Screen

based GIS. One of them can be used by downloading an application program. Another system based on the image maps is used as just a viewer of geographical information. The method adopted by VENTEN can be positioned between those two systems in terms of functions. In other words, users can handle the vector data on VENTEN, but obtain only the raster data based on the vector data. Although it restricts users to obtain data, this system solves the problems of difference in response caused by different network environments of client machine at the time of operation, and of copyright for data. For Internet GIS, traffic load on the network sending data is problematic. However, since this system only sends fixed scale images of 470 x 470 pixels to be displayed at the center of the VENTEN screen, calculations on the server-side take longer time and differences in network environment between VENTEN and end users do not have a significant load of sending data. Most data processing is done by a server machine and all the client machine should do is display the data it receives, so that difference of performance in various client machines does not show significant influence. It is easy to persuade many data providers to join in this system because vector data, which is very close to the original information in its amount, is not given to users. The users will finally get only the raster data, but they can treat it as if they could directly access the vector data.

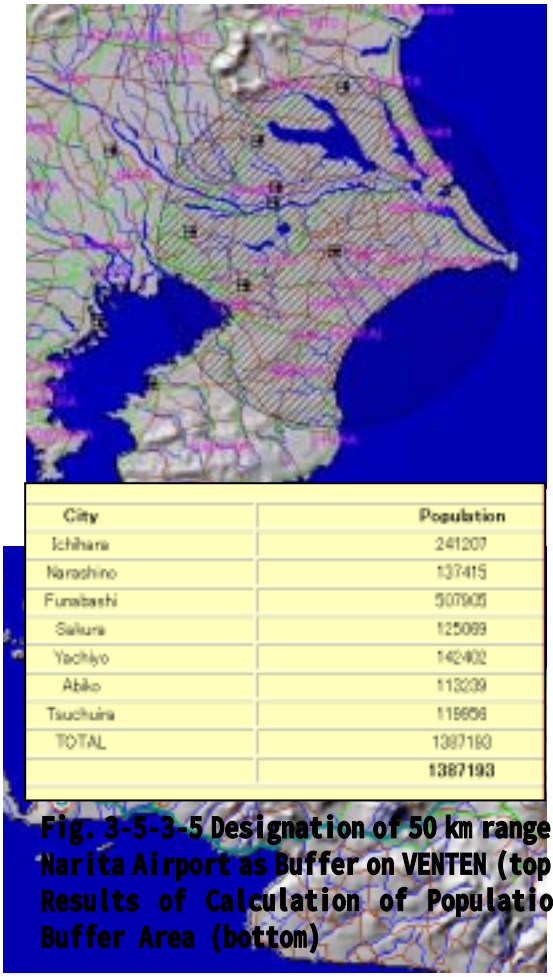
Fig. 3-5-3-3 VENTEN Main Page

2)Functions

VENTEN has GIS standard functions of "drawing a map in any scale", "buffering", "overlaying" and "searching by location and attribute". Fig. 3-5-3-5 shows a buffer area with extracted results of population of cities in the area. The buffer is set to 50 km with Narita International Airport as its center. The city names and their population in that area are displayed as shown.

The shortest route analysis function helps determine the shortest route for evacuation and transportation of supplies. To put it concretely, the source of the supplies is taken as the starting point S and the damaged area as the destination E. Among the many routes displayed, the shortest route is displayed in bold lines (Figure 3-5-3-6). This function is not only useful for searching the shortest route but also for searching routes to avoid the damaged area by the combination of other functions and the buffering function.

As described above, VENTEN provides the raster-formatted images to the end users, but the users can make various requests to process the vector data on the server.



City	Population
Ichihara	241207
Narashino	137415
Funabashi	507905
Sakura	125089
Yachiyo	142402
Abiko	113239
Tsuchiura	119656
TOTAL	1387193
	1387193

Fig. 3-5-3-5 Designation of 50 km range from Narita Airport as Buffer on VENTEN (top) and Results of Calculation of Population in Buffer Area (bottom)

Fig. 3-5-3-6 Results of Analysis of Shortest Route

3)Data

VENTEN gathers data for the 23 member countries of the ADRC. Collecting two types of information; one is the basic geographical information which is useful for not only disaster reduction, particularly topography and natural conditions, the other is geographical information of disaster reduction management on maps. Until now, the following information has been gathered (refer to Fig. 3-5-3-7):

①Basic geographical information

National borders (polygon), water systems (line, polygon), railroads (line), roads (line), airports (point), position of cities (point), city name (character strings), population (numerical value), shaded image based on elevation (raster image), contour map of elevation (raster images) (data source: DCW (Digital Chart of the World), GRID, GTOPO30) and NOAA satellite data of vegetation indices (of two terms, July and December 1998).

②Geographical information of disaster reduction management

The flooded areas of the 1998 Chang Jiang deluge, the affected information of houses around Nishinomiya Station at the 1995 Great Hanshin-Awaji Earthquake, the affected information for each sections at the 1995 Great Hanshin-Awaji Earthquake (by Building Research Institute, Government of Japan) and the active fault distribution map.

A menu on basic geographical information is arranged at the bottom right of the VENTEN screen, to enable user to control on/off of the information as the need arises. The vegetation indices with 16 km resolution (of two terms, July and December 1998) by NOAA satellite data has enabled to get the land use, which is indispensable for disaster risk management. Introduction of data from other satellites such as LANDSAT, SPOT, and ALOS is under consideration.

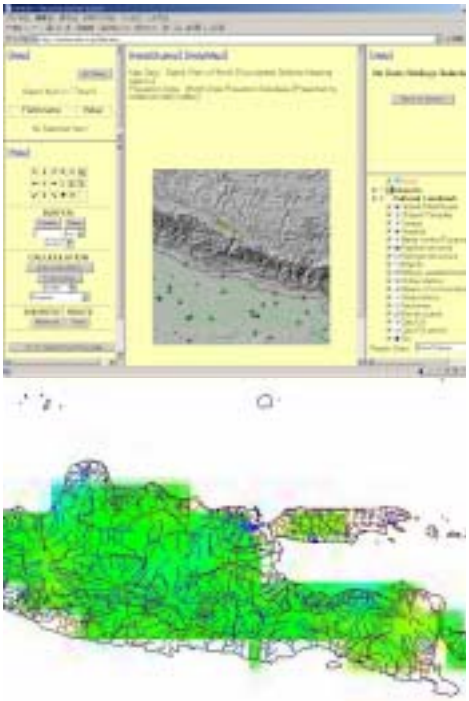


Fig. 3-5-3-7 Map of basic Geographical Information (top) and Maps including Satellite Data of NOAA Vegetation Indices (bottom)

3-5-3-4. Future development plan of "VENTEN"

1)Basic geographical information

Some countries among the 23 member countries of ADRC are now preparing their basic geographical information. Currently, ADRC is gathering such data. Then it will be modified and imported into VENTEN in the early time of the fiscal year 2002. (Refer to Tables 3-5-3-1 to 3.)

Table 3-5-3-1 Countries for Which Basic Geographical Information are preparing

No.	Country	Official Country Name
1	Azerbaidjan	Azerbaidjan Republic
2	Afghanistan	Afghanistan
3	Armenia	Republic of Armenia
4	Iraq	Republic of Iraq
5	Iran	Islamic Republic of Iran
6	Kyrgyz	Kyrgyz Republic
7	Georgia	Georgia
8	Turkey	Republic of Turkey
9	Turkmenistan	Turkmenistan
10	Pakistan	Islamic Republic of Pakistan
11	Bhutan	Kingdom of Bhutan
12	Brunei	Brunei Darussalam

Table 3-5-3-2 List of Basic Geographical Information (Vector Data)

Data Name		Data Structure
Airport Data	AEPOINT	Point
Cultural Facility Data	CLPOINT	Point
River (Polygon) Data	DNAREA	Polygon
River (Line) Data	DNLINE	Line
Land Use Data	LCAREA	Polygon
Coastline Data	POAREA	Polygon
City Name Data	PPPOINT	Point
Road Data	RDLINE	Line
Railway Data	RRLINE	Line
Transportation Facility (Line) Data	TSLINE	Line
Transportation Facility (Point) Data	TSPOINT	Point

Table 3-5-3-3 List of Basic Geographical Information (Raster Data)

Image File Name		Data Structure
Contour Image Data	Dem	Raster (Approx. 10km Resolution)
Shaded Image Data	Relief	Raster (Approx. 10km Resolution)
		Raster (Approx. 1km Resolution)

2)Geographical Information of Disaster Reduction Management

Information of active fault distribution in Asian countries is extremely important in earthquake disaster reduction. However, there are many difficulties to gather and arrange actual data due to the severe natural environment and economic and technical reasons. ADRC, in collaboration with the Disaster Management Planning Hyogo Office of the United Nations Center for Regional Development (UNCRD), is developing a data processing method to identify active faults found on the surface through stereoscopic vision of aerial photographs. This method has an advantage of revealing existence of conspicuous active faults without any geological survey of the subject areas. We are investigating to incorporate these data into VENTEN.

3)Linkage with satellite data suppliers

ADRC is currently conducting researches on construction of a disaster information network utilizing high-speed Internet satellite and mobile technology under cooperation with the National Space Development Agency of Japan (NASDA) and the Communications Research Laboratory (CRL). The purposes of this network are to instantaneously transmit information of disasters occurring in the Asian region to ADRC and to contribute to understanding situations of disaster-affected areas and deployment of international emergency assistance. In addition, it can be used as a real-time examination of images shooting by the crew on site to assess remotely risks concerning the collapse of buildings. Another subject of research is the method for VENTEN to use data from the Advanced Land Observing Satellite（ALOS）that is planned for launch in 2004.

4)User interface and function improvements

Some parts of the current version of VENTEN are yet to be improved to provide more sophisticated user-interface. It is necessary to make clear what points the end-users need improvement through questionnaires and workshops to support the administration of well-planned development.