3-5. Internet GIS

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

The objective of the Geographical Information System (GIS) is to make full use (data input, analyzing, storing, updating and output) of spatial data beyond the limits of ordinary paper maps. The term “spatial data” here refers to the data that involves distribution, location, configuration and attribution of natural topography such as elevation, rivers, human activity and social situation such as railroads, roads and streets, buildings, land use, vegetation and population. 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 users to make decisions and to assess the influence of the environment and disasters. Development of a GIS normally requires the 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 users 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 uneven spreading of the Internet has caused a problem called "digital divide". The member countries of ADRC show varying degrees of Internet availability and activity. However, recent development for faster communication at a lower cost enables more regions and countries 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. Development of "VENTEN (Vehicle through Electronic Network of disasTer gEographical informatioN)"

3-5-2-1. Background of development of "VENTEN"

The improved reliability (accuracy and resolution) of information extracted from satellite images with the progress of image processing technology in recent years enables us to extract various kinds of information via remote sensing 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 management activities. This is due to the focus on technological breakthroughs by satellite imaging providers, which resulted in the lack of enthusiastic participation by those who are involved in the actual disaster management activities in this area. It is also due to the difficulty in using the information. Only extracting from satellite images is not enough. The information is not useful unless it related to general geographical information such as topography and natural conditions, social information such as population, structures, and infrastructures. With the introduction of the geographical information system (GIS), which is the platform for analysis by overlaying 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 International 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:

- Conclusion 1: All member countries recognized the value of GIS and remote sensing, and the advantages in information management.
- Conclusion 2: Future issues are to acquire real-time satellite images, satellite data at lower costs, technological support for introducing GIS and remote sensing, and technologies for extracting disaster reduction information.

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

In order to resolve these problems, the ADRC developed VENTEN (Vehicle through Electronic Network of disasTer gEographical informatioN), an Internet Geographical

Information System for disaster reduction that can be accessed by anyone, anywhere, using the rapidly expanding Internet.

The basic framework of this system was developed as part of the project called “Research and Development of the Disaster Information Network System in Asian Region” funded by the Japan Science and Technology Corporation (September 1998 – September 2001).

3-5-2-2. Overview of “Research and Development of the Disaster Information Network System in Asian Region”

Awarded funding from the Japan Science and Technology Corporation (segment: environment and safety) , ADRC conducted a 3-year project - “Research and Development of the Disaster Information Network System in Asian Region” - from September 1998 to September 2001. The “VENTEN” (Vehicle through Electronic Network of disasTer gEographical informatioN) is the internet-based disaster information GIS developed as part of the project.

The two main achievements of the project include:

- Development of VENTEN – an internet GIS platform on Disaster Management Information, and
- Development of the database on disaster management information

The issues that require further development include:

- Enhancement of the database
- Development of satellite communication technology
- Real time communication of disaster information

Study papers on this project have been formulated into the “Research and Development of the Disaster Information Network System in Asian Region – VENTEN System Final Report” (ISBN 4-901614-01-0).

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

The goal of the development of VENTEN is to provide both a system and the data (including the results of analysis). This system can be used with a computer connected to the Internet and equipped with a WWW browser.

Although various organizations were already providing, free or at cost, not only basic geographic data such as topography and natural environment but also GIS data, to view and analyze the data, it was necessary to convert the format to a compatible one with the GIS software in use. To resolve the problem, VENTEN is developed with various GIS data converted into the VENTEN format. The GIS data are managed as part of the system.

Fig. 3-5-2-1 shows the overview of VENTEN. Data (such as aerial photograph information) provided by various space development agencies, research institutes and organizations are the original primary data (on the left). In order to extract useful information for disaster management from these primary data, image processing and overlay of data are required in VENTEN. The results of the above operation are sent to end-users. Researchers can also browse, analyze information, and add their results to VENTEN. The VENTEN system has a database and analysis utilities for remote sensing data of disaster and serves

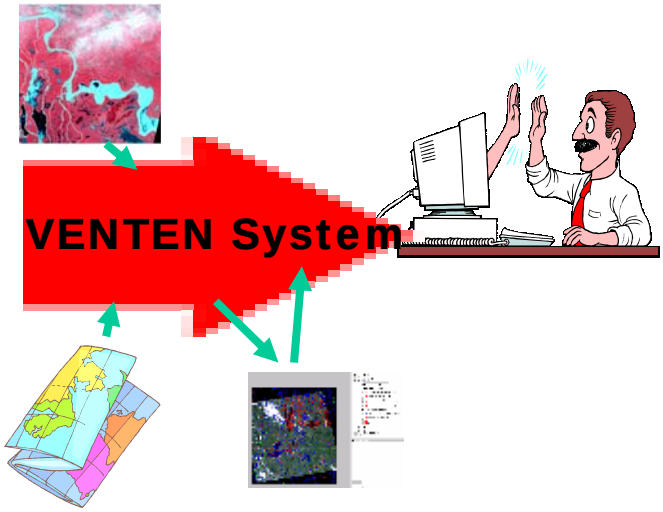


Fig. 3-5-2-1 Placement of VENTEN

persons in charge of disaster management as an information tool. This enables it to make full use of remote sensing data of disaster management in evaluating vulnerability, the preparation of disaster reduction plans and the support of search and rescue, or early warning activities.

3-5-2-4. Overview of "VENTEN"

1) Structure

VENTEN system consists of the Web server, GIS server and database server. Fig. 3-5-2-2 shows the information processing flow in VENTEN. First of all the request from users are accepted by the Web server. The Web server specifies the necessary information including what kind of geographical data and the extent of area (possible to specify multiple geographical data) to the GIS server. The GIS server, referring to the data server if necessary, extracts the subject from the geographical data and then uploads the data to the Web server in a form of a raster data (image data). 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 a hypertext file including the raster image data provided by the GIS server. The system is built with an aim that even first-time users can use it easily. Jumping from the main page to the online manual, tutorials and database are available (Fig. 3-5-2-3). Visualized information of the vegetation index (NDVI: Normalized Difference Vegetation Index) and land elevation are also displayed. Fig. 3-5-2-4 shows the home page of the VENTEN system.

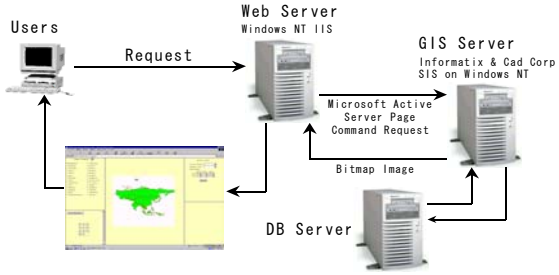


Fig. 3-5-2-2 Process flow of VENTEN

Fig. 3-5-2-3 Top Page of VENTEN

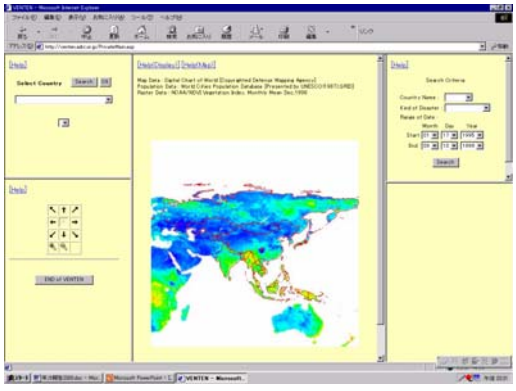


Fig. 3-5-2-4 Start Page of VENTEN

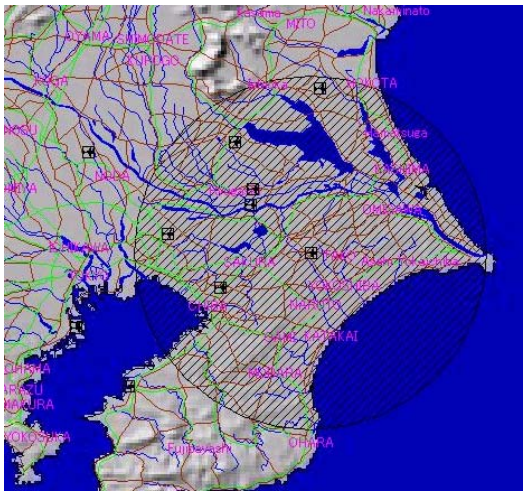
There are several type of Internet GIS. One of them can be used by downloading some application programs. Another system based on the image maps is used as just a viewer of geographical information. The method adopted by VENTEN can be positioned between those two systems in terms of functions. In other 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 responses caused by different network environments of the client machines at the time of operation, and of copyright for the 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, calculation on the server-side takes a longer time. The differences in network environment between VENTEN and end-users

do not have a heavy load when sending data. A server does most data processing and all that the client should do is display the data received. It is also easy to persuade data providers to join in this system because vector data, which are very close to the original information, in amount, are not given to users. The users will get only the raster data, which have been processed using the original vector data.

2) Functions

VENTEN has GIS standard functions of "drawing a map in any scale", "buffering", "overlaying" and "searching by location and attribute". Fig. 3-5-2-5 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 in Japan as its center. The city names and their population in that area are displayed as below. The shortest route analysis function helps determine the shortest route for evacuation or 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 selected with bold line (Figure 3-5-2-6). This function is not only useful for searching the shortest route but also for searching routes to avoid a damaged area by combination with the buffering function.

As described above, VENTEN provides the raster data (image data) 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	125069
Yachiyo	142402
Abiko	113239
Tsuchuira	119956
TOTAL	1387193
	1387193

Fig. 3-5-2-5 Designation of a 50 km range from Narita Airport as Buffer on VENTEN (top) and Results of the Calculation of Population in the Buffer Area (bottom)

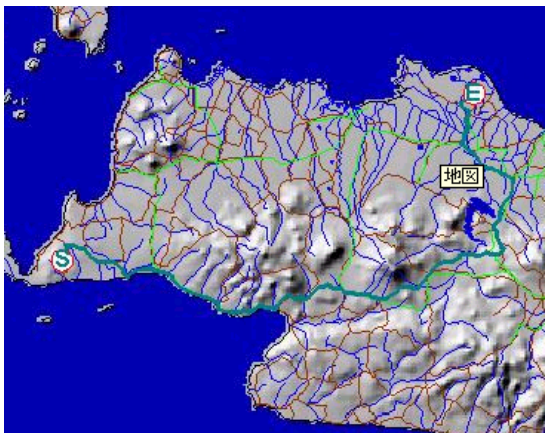


Fig. 3-5-2-6 Result of the Shortest Route Analysis

3) Data

VENTEN gathers data for the member countries of ADRC (24 countries as of the end of March, 2003). Collecting two types of information; one is the basic geographical information (e.g. topography and natural conditions), the other is geographical information for disaster management. In 2002, basic geographical information of Asian region including not only member countries but other Asian countries has been also integrated into VENTEN, thus eliminating the blank of basic geographical information of natural disasters occurring at the border areas between countries (see Fig. 3-5-2-7).

① Basic geographical information

A menu box is provided at the lower right section of the VENTEN screen to choose Show or Hide basic geographical data.

Fig. 3-5-2-8 and tables 3-5-2-1 and 3-5-2-2 indicate the basic geographical data integrated into the system to date.

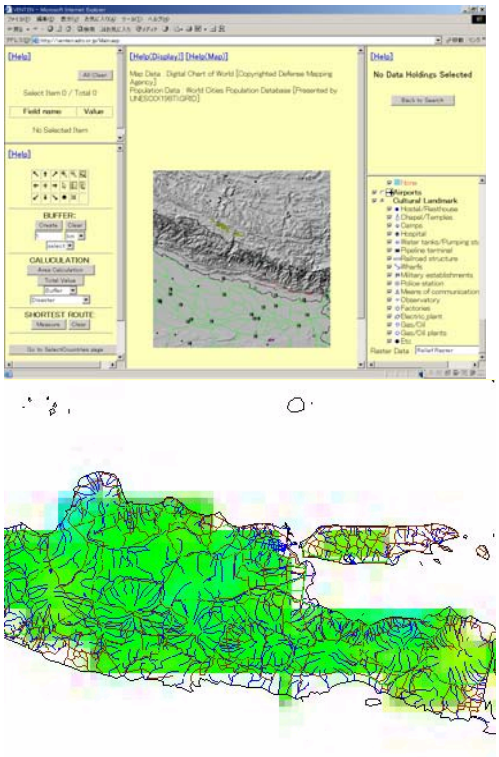


Fig. 3-5-2-7 Map of basic Geographical Information (top) and Maps including Satellite Data of NOAA Vegetation Indices (bottom)

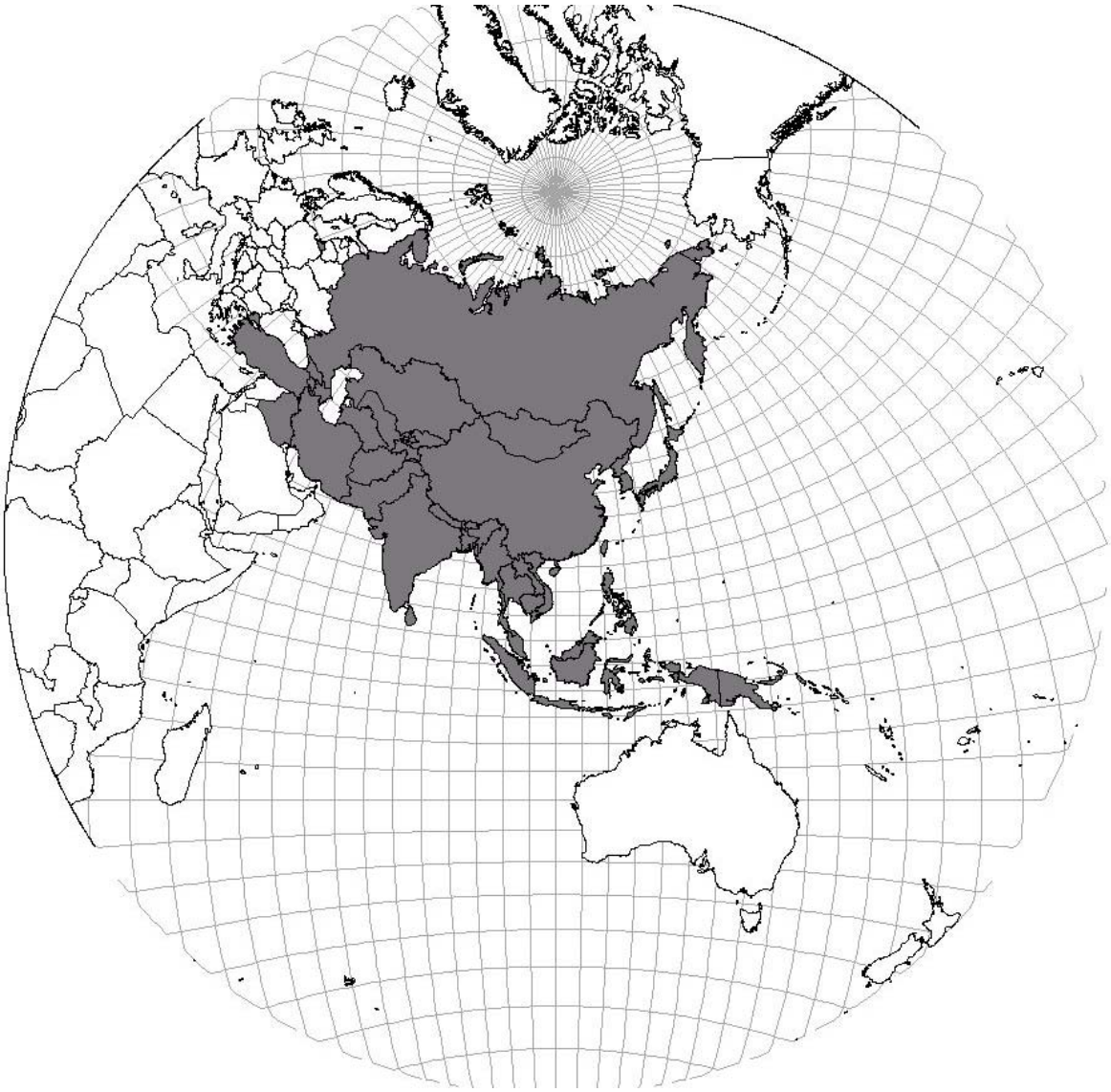


Fig. 3-5-2-8 Basic geographical data integrated into VENTEN (dark area)

Table 3-5-2-1 Basic geographical data (vector data)

File name	Description	Data structure
AEPOINT	Airports	Point
CLPOINT	Cultural facilities	Point
DNAREA	Rivers(polygon)	Polygon
DNLINE	Rivers (line)	Line
LCAREA	Land coverage	Polygon
POAREA	Seashore lines	Polygon
PPPOINT	City names	Point
RDLINE	Roads and streets	Line
RRLINE	Railroads	Line
TSLINE	Transportation facilities (line)	Line
TSPOINT	Transportation facilities (point)	Point

Table. 3-5-2-2 Basic geographical data (image data)

Image file name	Description	Data structure
Relief	Shadow image data	Raster (approx.10km resolution)
	(Changed according to the scale)	Raster (approx.1km resolution)
DEM	Elevation image data	Raster (approx.10km resolution)
Vegetation July, 1998	Vegetation index image data (Summer)	Raster (approx.15km resolution)
Vegetation Dec., 1998	Vegetation index image data (Winter)	Raster (approx.15km resolution)

② Geographical data for disaster management

- □ Damages to housing around Nishinomiya station by the Great Hanshin-Awaji Earthquake in 1995
- □ Damages to housing in each district of the city analyzed on the basis of survey results of the Great Hanshin-Awaji Earthquake in 1995 (by Building Research Institute, Ministry of Construction, Japan)
- □ Flood in Chang Jiang in 1998
- □ Distribution of active faults (Japan, Eastern area of Nepal, and Sakhalin (Russia))

3-5-2-5. Future development plan of "VENTEN"

1) Basic geographical information

The scale of geographical data currently integrated into VENTEN is mainly 1:1,000,000.

On the other hand, the scales most frequently used for the basic national land maps are 1:50,000～25,000, and maps at scales of 1:5,000～2,500 would be desired for city planning

including disaster management planning (disaster preparedness and emergency response). Today, however, it is impossible to integrate map data of these scales into the VENTEN system because such detailed digital map data are not available in many Asian countries. If the development, updating and distribution of high-resolution GIS data via satellite observation become possible in near future, the integration of those achievements in the VENTEN system must be taken into account. ADRC will continue to update geographical data as far as possible.

2) Geographical Information for Disaster Management

Information of active fault distribution in Asian countries is extremely important in earthquake disaster reduction. However, there are many difficulties associated with the collection and arrangement of actual data due to the severe natural environment or economic and technical reasons. In collaboration with researchers of active faults in Japan, ADRC is currently promoting a data process technology project to reveal the distribution of active faults exposed on the surface through the stereoscopic vision processing of aerial photographs in some member countries experiencing severe earthquake disasters. This method has an advantage of revealing the existence of possible active faults without any on-site geological inspection. In addition, the survey of topography from a wider view enables detection of active faults that might be missed by a field survey, not being influenced by local disturbances. We are investigating the incorporation of these data into VENTEN.

GIS data should be accumulated not only for earthquakes but also for other natural disasters such as tidal waves, floods, volcanoes, landslides and droughts. ADRC will take into account the integration of databases created by external organizations in accumulating the data.

It is also important to incorporate disaster reduction, damage information, such as hazard maps, early warning and result of damage as GIS data and make them available on VENTEN. Various maps are available today, but useable GIS data are still limited. ADRC plans to include hazard map information in VENTEN.

3) Linkage with satellite data suppliers

ADRC is currently conducting researches on construction of a disaster information network utilizing high-speed Internet satellite (WINDS:Wideband InterNetworking engineering test and Demonstration Satellite), remote sensing and mobile technology under cooperation with the National Space Development Agency of Japan (NASDA), the Communications Research Laboratory (CRL) and Diamond Air Service Inc. (DAS). The purpose of this project is to enable real time transmission of image data from high resolution camera equipped on an aircraft to the headquarters when a severe disaster occurs. If information is made available on ADRC's website, it contributes to the prompt sharing of disaster information and to the emergency response activities.

In addition, it can be used as a real-time examination of images shot by the crew on site to assess damage. This system must be linked with GIS, and how to incorporate the technology into VENTEN requires further researches.

The launch of WINDS is planned for 2005. 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. A contribution to the Global Map project is one of the aims of ALOS, and success of ALOS will sure be a great help in sharing high-resolution geographical data at the global level.

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. Help information, user manuals and tutorials must be improved. It is also necessary to identify the needs of end-users through questionnaires and workshops.