8-2-7 Hazard Mapping

(1) Map Users

The target users of the hazard maps are the staffs in the municipal governments and the offices of the Civil Defense.

(2) Scale of Volcanic Activities and Return Periods

For the Telica-El Hoyo volcanic Complex, existing reference materials, results from field identification and others were used to set assumptions on the scales of eruption.

Lava flow: The maximum scale (apparent volume) among lava flows whose distribution can be identified on the surface at present.

Tephra fall: The actual record of the scale (eruption column height, apparent descent alimentation) in the 1995 eruption of Cerro Negro was the basis of the assumption.

Pyroclastic flow: It is based on the field identification.

Volcanic bomb: The maximum initial velocity was set at a time of eruption from experiences.

(3) The Draft Hazard Map

Figure 8-6 shows the created draft hazard map.

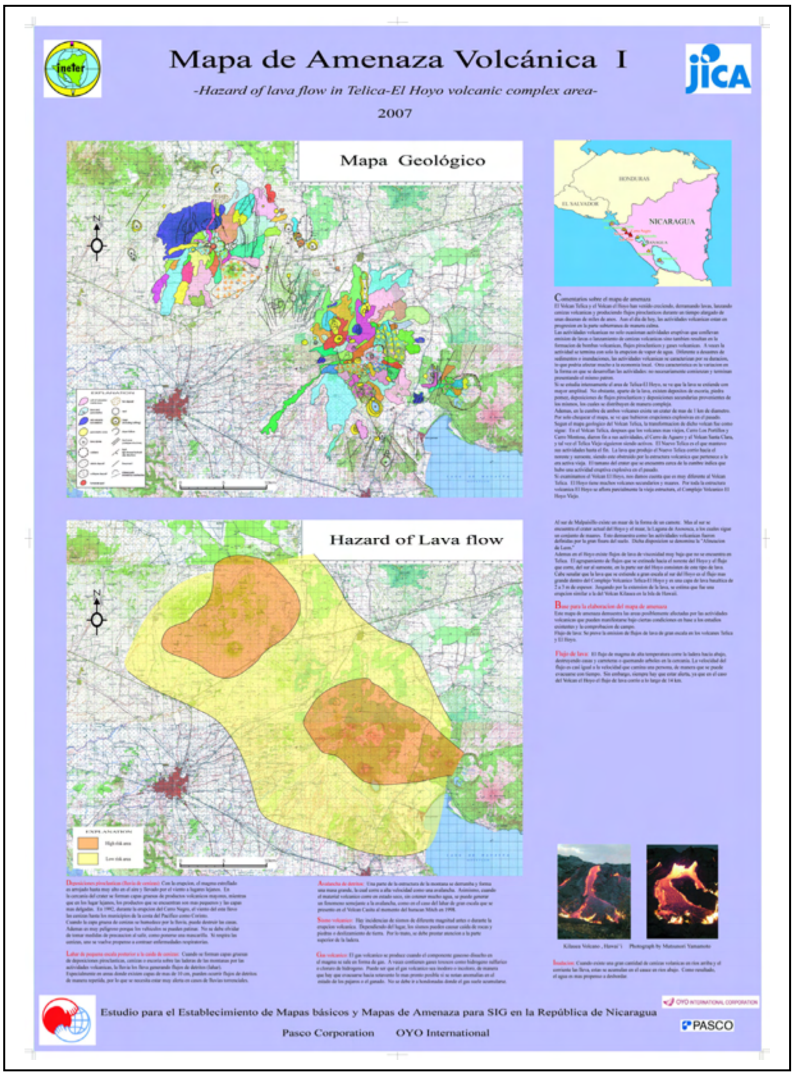

Figure 8-6 Geology (top) and Lava Flow (bottom)

The photographs are Volcano Kilauea (Hawaii's) showing low viscosity basalt lava flows.

8-3 Flood

8-3-1 General

Hazard mapping is summarized in this section. The target area is the Maravila river and its surrounding located in the western part of Nicaragua. Technology transfer was positioned as the major component of the Study.

8-3-2 Characteristics of the Area

The target river is the Maravilla river. The location and general characteristics are indicated in the following chart and the table.

Figure 8-7 Location of the Maravilla River

Figure 8-8 Catchment Areas of the Maravilla River

Catchment area: 64.92 km^2
Length: 29.8 km
Max. Altitude: 800 m

Table 8-2 Daily Rainfall by Return Period

Return Period (year) 1/(1-P)	X
2	159.8
3	182.5
4	196.7
5	207.1
8	227.8
10	237.2
15	253.8
20	265.2
25	274.1
30	281.2
40	292.3
50	300.8
60	307.8
80	318.8
100	327.2
150	342.5
200	353.4
250	361.7
300	368.6
400	379.4
500	387.8

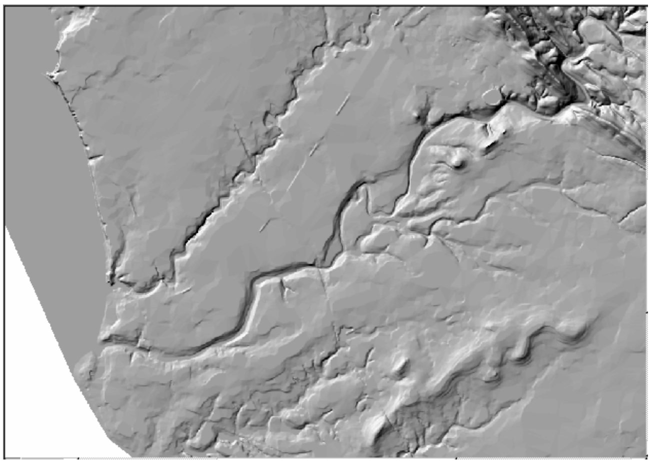

Figure 8-9 Shade Map of the Lower Part of the Maravilla River

The upper region consists of volcanic products of Quarternary Period, and it is presenting the dissection landform of topographic infancy peculiar to the foot volcanic mountain. The upper part of the ridge, which forms a uniform line, presents the landform which inclines gently to the Pacific Ocean side (west side). The trough is deeply covered with the forest and land is less utilized.

From the mid-stream regions to the lower stream, a Tertiary deposit (Eocene - Miocene) is distributed, and a cuesta landform is present.

The down-stream region presents a gently-sloped-hilly-terrain form; each river flows to the east carving through a plateau. Most of the hilly terrain of a down-stream region is a cane field. When the cane grows high, it is difficult to interpret micro topography. The built-up area in Masachapa is located at the mouth-of-a-river, and residential units along the river densely occupied the area.

The topography and the outline of land use were shown using the section and ortho-photograph which were created from the topographic model (explained in the latter part of this section) created using 1/5,000 topographic maps as an alternative approach to the aerial-photograph interpretation.

8-3-3 Flood Simulation

(1) Designed Rainfall and Hydrology Analysis

The return period of design rainfall considered the following situations in Nicaragua suggested by the counterpart, and four cases 25 years, 50 years, 100 years, and 200 were selected.

The hydrology observatory used for the analysis was set to the 680032 Julio Buitrago for its availability of rainfall by hour. Daily rainfall by return period was calculated using the lognormal probability paper by the Thomas plotting method.

Table 8-3 Hydrograph

return period / hour	25	50	100	200
1	152.0	167.2	182.1	197.0
2	152.0	167.2	182.1	197.0
3	152.0	167.2	182.1	197.0
4	454.4	499.7	544.4	588.7
5	454.4	499.7	544.4	588.7
6	454.4	499.7	544.4	588.7
7	297.0	326.7	355.9	384.9
8	297.0	326.7	355.9	384.9
9	297.0	326.7	355.9	384.9
10	27.9	30.7	33.5	36.2
11	27.9	30.7	33.5	36.2
12	27.9	30.7	33.5	36.2
13	4.9	5.4	5.9	6.4
14	4.9	5.4	5.9	6.4
15	4.9	5.4	5.9	6.4
16	3.3	3.6	3.9	4.3
17	3.3	3.6	3.9	4.3
18	3.3	3.6	3.9	4.3
19	1.6	1.8	2.0	2.1
20	1.6	1.8	2.0	2.1
21	1.6	1.8	2.0	2.1
22	188.2	206.9	225.5	243.8
23	188.2	206.9	225.5	243.8
24	188.2	206.9	225.5	243.8

The hyetograph was designed using the rainfall pattern from 5:00 am on September 29, 2000 to 4:00 am on September 30, 2000 as the basis. It was determined by extending the hourly rainfall data by the ratio of actual daily rainfall and the planned scale. For the rainfall runoff conversion, the rational formula was used.

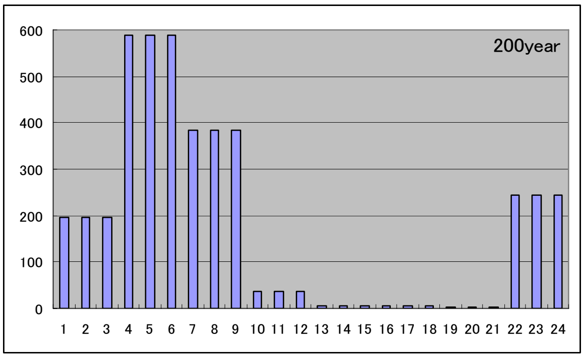

Figure 8-10 Return Period 200 Years

(2) Topographic Model

The topographic-map data used for creation of a landform model are the 1/5,000 topographic map of the seashore part under the possession of the Bureau of Tourism (El Instituto Nicaraguense De Turismo, INTUR). The contour line data were used to create TIN, and from the TIN, DEM with a mesh size of five meters was created. From the DEM with a five meter grid size, a topographic model with a mesh size of 25 meters was created, and the data files for the program was produced. The direction and topographic characteristic of the river were considered to set up the origin and the area in order to conduct efficient calculation possible in making the topographic model. The series of work was conducted using the mesh-generating tool of GIS.

(3) Simulation Result

The method of simulation was decided to be the unsteady varied flow calculation. The simulation program, which was originally developed based on a commercially available program introduced in related books, used this time added improvement based on application in Japan. The language is FORTRAN77. The compiler adopted WATCOM FORTRAN in consideration of its flexibility and availability. The calculation cases are four cases of hydrograph (25 years, 50 years, 100 years, 200 years). All other conditions, such as topographic model and inflow point, are the same.

(4) Results of the Calculation

The results of the calculation showed that even a heavy rain in recurrence-interval 200 did not overflow largely. The flood flow was restricted around the channel. This was because the topography of the Maravilla river has a deep trough landform.

As for these calculation results, per-hour changes in depth of water, flow direction, flow velocity, and others were outputted to a file. The maximum depths of water were taken into GIS, and they were expressed onto ortho-photographs etc. The result, which used as the maximum depth of water, is shown in Figure 8-11.

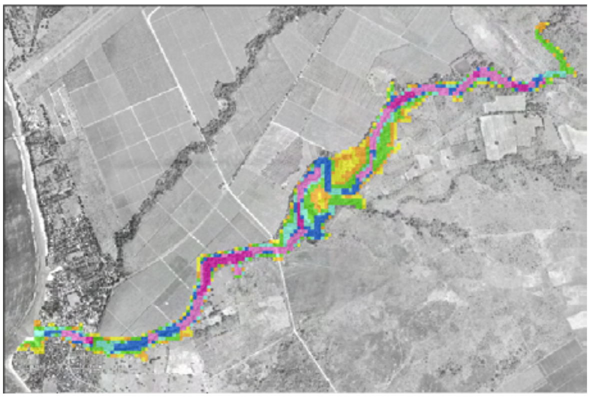

Figure 8-11 Hydrograph: Return Period 200 Years

8-3-4 Flood Hazard Mapping

The Study Team and the counterpart had series of discussions and explanation sessions over the draft hazard maps and finalized the draft.

(1) Characteristics

The hazard maps are defined as the maps, which indicate information relevant to the inundation estimation areas so that disaster prevention persons in charge utilize for disaster measures. The target users are the staffs in the central government and the disaster prevention person in charge in local governments. Departments, such as the police and fire, are also included and disaster prevention persons in charge do not necessarily have the knowledge of hydrology or river engineering. Therefore, we decided to consider exclusion of the technical description to make the contents more intelligible. Moreover, materials, which were devised, were to be produced so that the contents would be well known to the local residents.

(2) Contents and Expression

The specifications of the map based on the concept described are explained as follows.

1) Format

Two types were produced.

Type G (A1 size): A large size map is necessary because many people need to share the information that covers wide areas for disaster prevention activities.

Type P (letter size): It is a common document size in Nicaragua to be delivered to local residents. The letter size was selected for easy production using photo-copiers and printers of personal computers.

2) Expression of Flood Assumption Zone

Although the calculation result of a flood assumption zone was outputted for four kinds of every plan scales, what is expressed on a map presupposed that it is restricted to one case of a 200-year scale which shows the greatest range and the greatest depth of water. The classification of the depth of water reflects the housing structure in Nicaragua; Four categories, 0 to 0.5 m, 0.5 to 1.0 m, 1.0 to 3.0 m and over 3.0 m were selected.

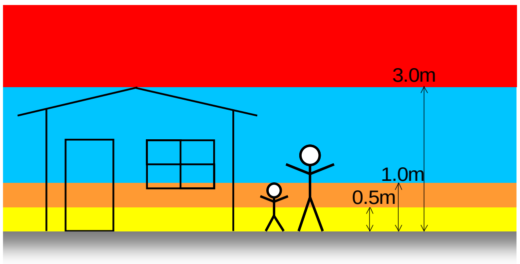

Figure 8-12 Image of Water Depth

3) Base Map

The base map, which displays an inundation hazard zone, was created by overlaying the ortho-photographs with a transparency rate of 50% taken in the Study onto the hill shade map. The hill shade map was created from the contour lines of the topographic maps used for creating the topographic model. The scale was set at 1/7,000 to maximize the expression of the flooded areas while the contents were fitted in the map size within the boundary.

4) Explanation

The purpose, users, conditions were described as an explanation of the map. The Study Team prepared a draft. The counterpart prepared the final version in Spanish after repeated discussions.

5) Others

For non-professionals, illustrations of water depths and intensity of heavy rains were included in the hazard map.

8-3-5 The Draft Hazard Map

The hazard maps as the last result were produced using GIS (ArcGIS) so that the staffs in the counterpart agency would be able to make changes and to the outputs by themselves. We decided to produce 50 copies of Type G from the plotter and Type P from the printer each.　The Study Team decided to provide GIS data, the map laying-out data, and files in the pdf file format.

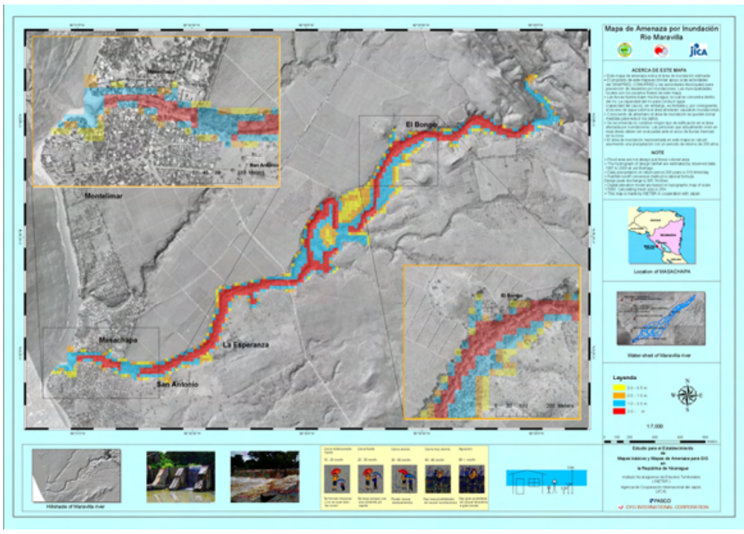

Figure 8-13　Draft Hazard Map (Type G)

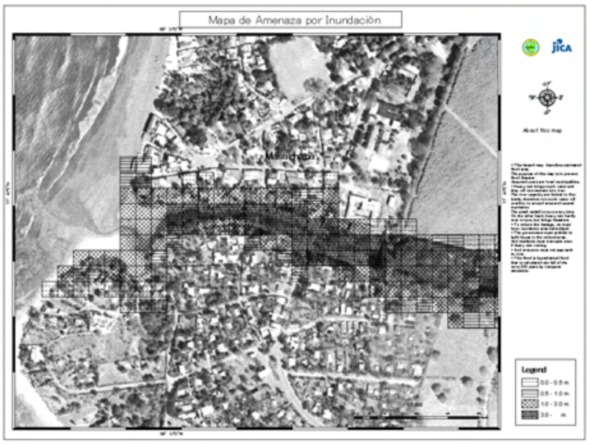

Figure 8-14　Draft Hazard Map (Type P)

8-4 Tsunami

Based on collected data, topography model, scenario Tsunami is defined. Simulation is made and is checked with observed data to use if the methodology and input parameter can reproduce the past event. Simulation can be made for other cases, and calculated result will be used to demonstrate the estimated inundation area.

8-4-1 Simulation Method

(1) Definition of Scenario Tsunami

Historical data of Tsunami disaster along Pacific coast in Nicaragua is limited. Most of them are recorded after mid-19th century, when population in coastal area began. Among them, the 1992 Nicaragua Tsunami is the worst event, in terms of magnitude and its source area location to the most of the Nicaraguan coast. For this reason, a Tsunami with same magnitude as the 1992 Tsunami is used as the scenario herein (model S8). In addition, same dimension of area is located close to San Juan del Sur to evaluate the worst case for San Juan del Sur. (See Figure 8-15).

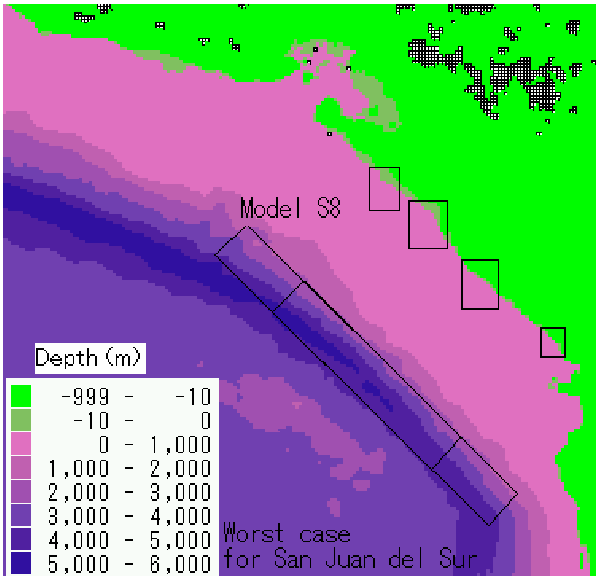

Figure 8-15 Location of Fault Models

(2) Parameter Setting

The source parameter of scenario Tsunami is based on Satake (1995). Displacement and rise time are adjusted, and several models are tested as shown in Table 8-4 to fit the observed inundation data. Water level of the ocean is set as maximum water level here, to consider the worst case, because the 1992 Nicaragua Tsunami occurred at the time of maximum water level as well. As a result, model S8 shows the best fit to the 1992 Tsunami inundation, and regarded as a worst case for Corinto, Puerto Sandino, and Masachapa. For San Juan del Sur, same model closest to San Juan del Sur is regarded as a worst scenario. Time step for calculation is set as two seconds, considering that the velocity of wave in simulation should exceed the velocity of real Tsunami wave.

Table 8-4 Parameter of Tsunami Models

		Model				
		S5	S6	S7	S8	S9
Length (km)		250	250	250	250	250
Width (km)		40	40	40	40	40
Displacement (m)		6	8	8	10	12
Rise Time (seconds)		300	300	300	300	300
Strike (degree)		315	315	315	315	315
Dip (degree)		15	15	15	15	15
Slip Angle (degree)		90	90	90	90	90
Depth of Upper Edge (km)		1	1	1	1	1
Origin of Fault	Latitude	10.0626	10.0626	10.2880	10.2880	10.2880
	Longitude	86.5712	86.5712	86.8073	86.8073	86.8073

(3) Topography Model Development

Simulation program solves the equation of motion by the finite difference method. For this method, topography of the seabed and the land shall be expressed by grid model. Several size of grid shall be applied for the analysis. Calculation shall be conducted using smaller grid one by one toward the land from the offshore.

From a consideration to avoid numerical viscosity term and numerical dissipation term, 2700m square grid system is applied to open sea area including wave source area. Then, 900m, 300m, 100m square grid systems is applied toward the land from the offshore as shown in Figure 8-16 is developed. Since there are various sources of topography data, data with better precision are respected when two types of data overlaps in same area.

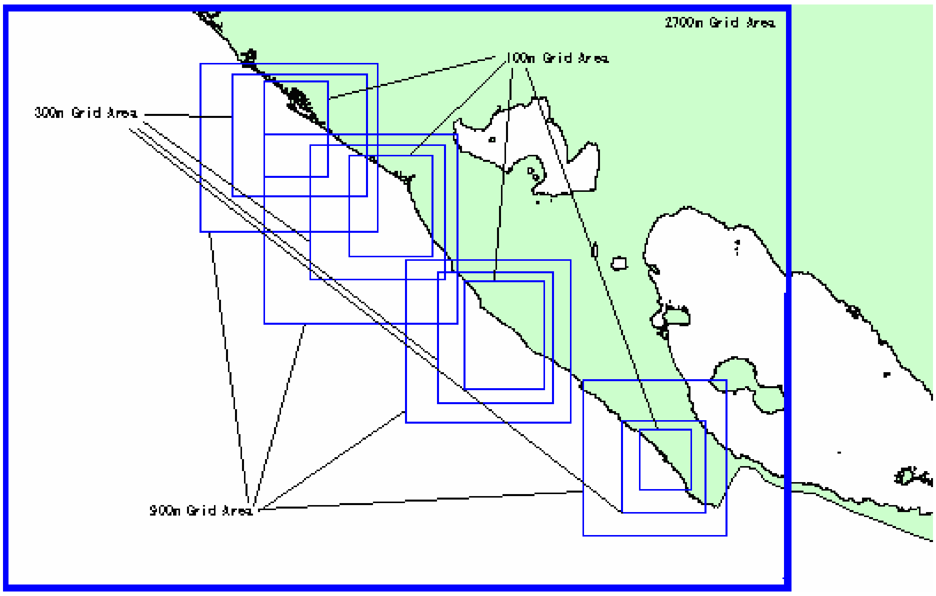

Figure 8-16 Grid System Developed for Analysis

(4) Outputs

The outputs of simulations include time history of water level change at some points along coast, animation of water level change in simulated area, and distribution of maximum inundation in coast area. Maximum inundation depth in 100m grid can be displayed graphically using GIS function, as shown in Figure 8-17 .

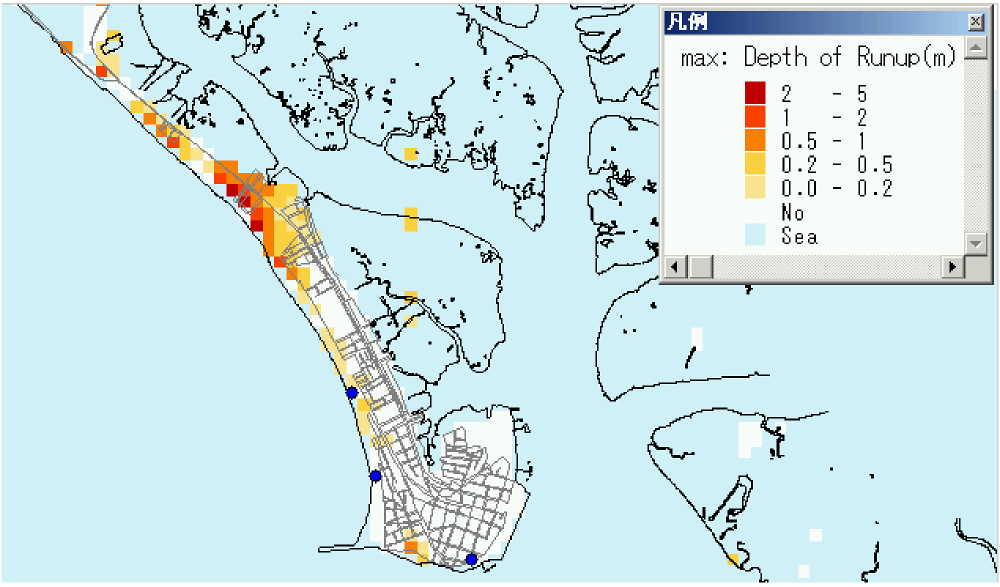

Figure 8-17 An Example of Maximum Inundation Depth

(5) Results and Interpretation

The maximum inundation along the Pacific coast obtained by different models of simulation and observed inundation during the 1992 Nicaragua Tsunami is compared as shown in Figure 8-19. Though exact comparison is difficult due to the limited number of bathymetry data, and due to the lack of information regarding the heterogeneity in fault rupture, over all distribution pattern of simulated inundation along the coast agrees well with observed inundation.

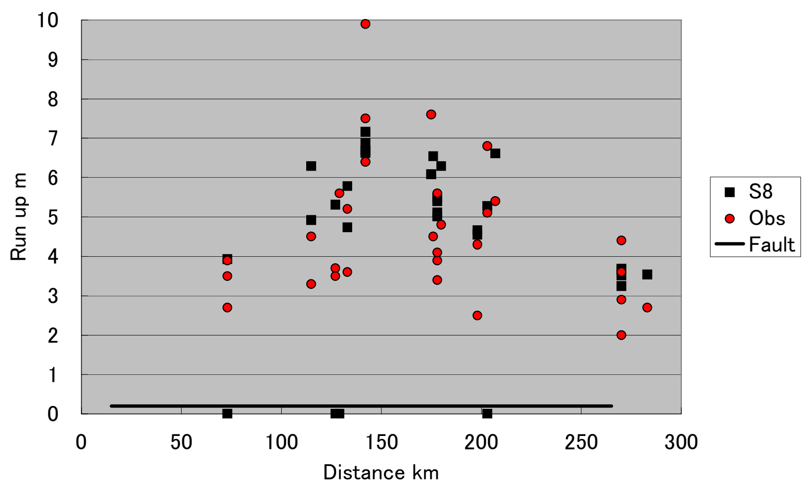

Figure 8-18 Comparison of Observed Data and Simulation Result

8-4-2 Bathymetry Survey in the Shallow Coastal Area in Front of Masachapa and Its Vicinity for the Tsunami Analysis

The preliminary survey was conducted on February 9. The final survey was conducted from February 11 and completed on the day of March 7.

(1) Result of Tide measurement

The measured tide height in Elevation is compared with the predicted tide height at Puerto Sandino after correction, the original data of which have been given based on the Lower Low Water Level at Puntarenas in Costa Rica (e.g., -1.168m). Figure 8-19 shows the comparison of the data obtained on February 11. The tide height at Masachapa is very similar to that of Puerto Sandino: however, the minimum and maximum tide is occurring a little earlier than Pt. Sandino by 10 to 15 minutes. The minimum and maximum tide height at San Juan del Sur is predicted as earlier than that of Pt. Sandino by about one hour and 20 minutes; therefore, the Study team carried out the bathymetry survey in Masachapa offshore area as the additional study item in the second year of the Study.

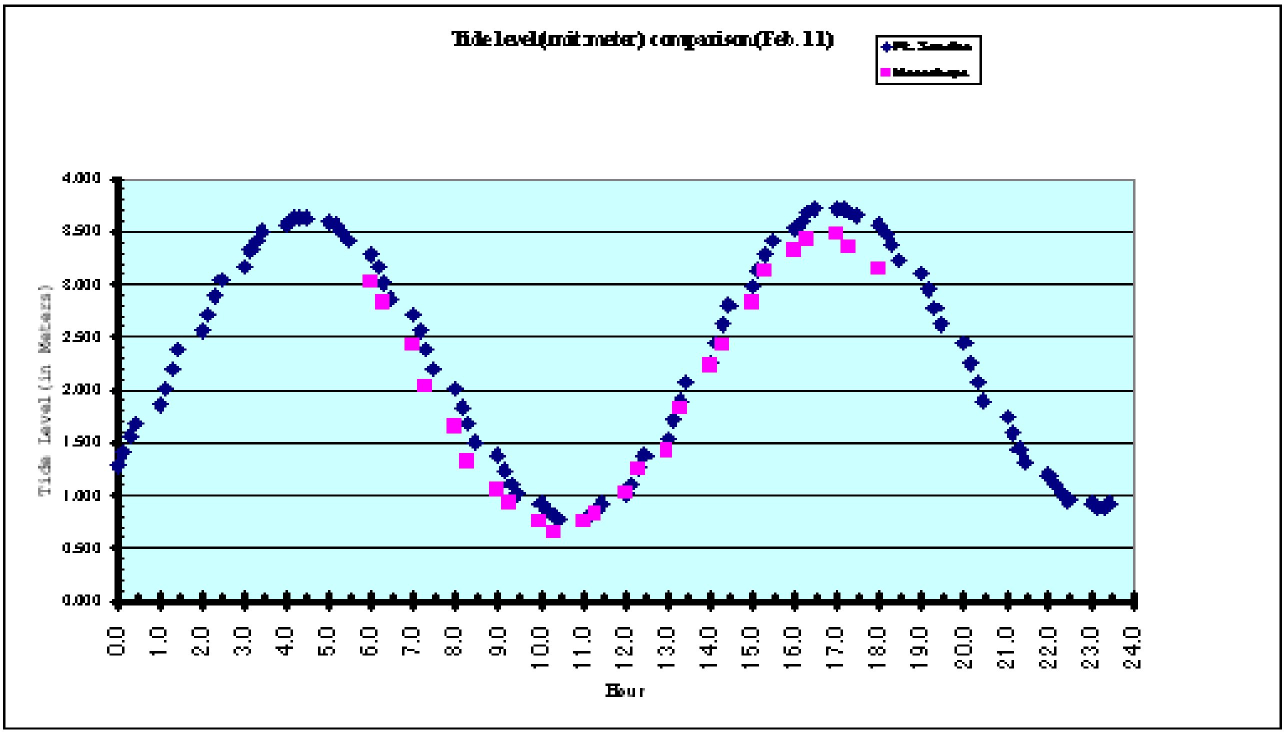

Figure 8-19 Comparison of Tide Height in Masachapa with Predicted One at Pt. Sandino

(2) Final form of surveyed data

The data to be provided by the Counterpart, Hydrografia INETER, is the digital data in the sameformat of XYZ03 (Latitude, Longitude, and Depth elevation) corrected with the Tide elevation data based on the temporal Tide measurement at Masachapa. The area, which was able to sound, was in the number of sounding lines as 50 lines on March 6, 2005, as shown in Figure 8-20.

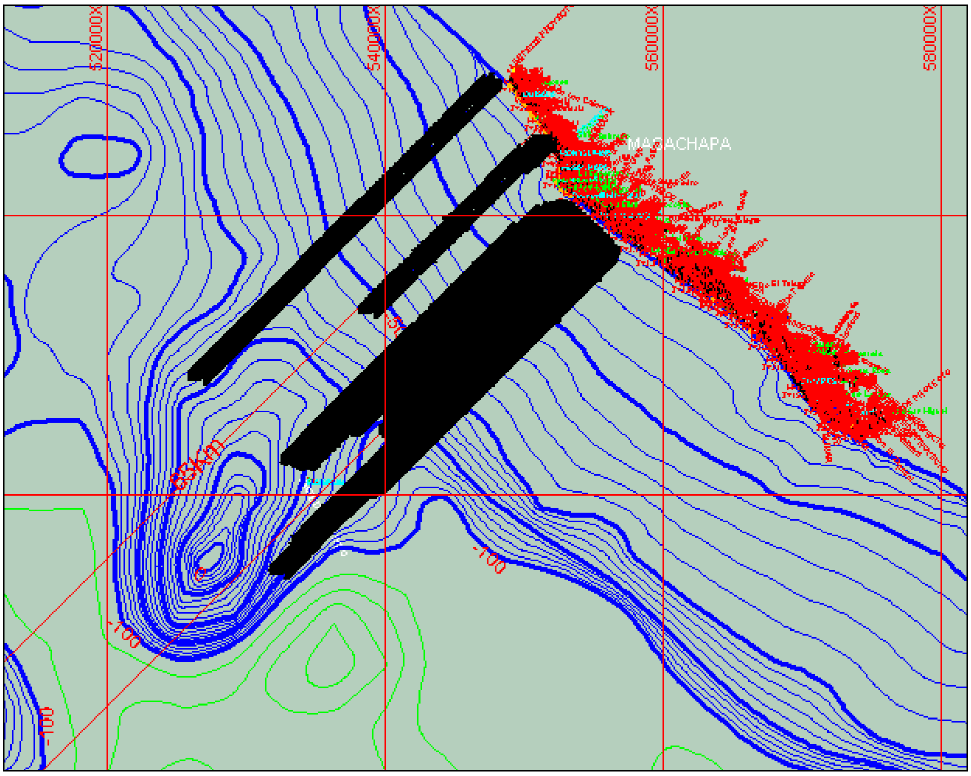

Figure 8-20　The Area which the sounding was completed by March 6, 2005

9 RECOMMENDATIONS

9-1 Recommendations to INETER

9-1-1 Basic Topographic and Geographic Information

- Maintenance of the Geographic Base data with same specifications so that all new geographic data to be produced in the future use the spheroid WGS84 adopted in this project as reference to facilitate their overlying with greater accuracy. Existing information should also be updated using the same reference.
- Extension of the Geographic Basic Data to cover the rest of the Country since this study covers only the Pacific Coast of Nicaragua
- Installation of Original Bench Marks, which do not exist in Nicaragua, since they are crucial to monitor height changes
- Updating Interpretation Keys for consistent field identification among surveyors
- Preparation of a Gazetteer based on an annotated database that should be prepared utilizing the data collected during the field identification process carried out by the project.
- Development of new products and services and their marketing strategies so that the digital maps that INETER can now produce utilizing GIS technology can be easily accessed by the society.
- Establishment of a crustal movement observing system for monitoring earthquake, volcanic and slope stability conditions
- Human Resources Development through the documentation by the trained staff of the acquired skills and technologies so that knowledge can reach other staff members

9-1-2 Hazard Mapping

These recommendations are based on the material included in questionnaires filled by the Japanese experts in charge of the preparation of the hazard maps produced by this project. Four hazards are considered: 1) Seismic hazard, 2) Volcanic hazard, 3) Flood hazard, and 4) Tsunami hazard.

(1) Earthquake Hazard

Recommendations at the institutional level

- Collection of improved earthquake location data through the upgrading and extension of the seismic observation network.
- Installation of a larger number of continuous-observation (24 hours/day) stations in the strong motion observation system and establishment of a standard processing format.
- Collection of reliable data on the characteristics of past disastrous earthquakes and the associated damage and loss observations. The analysis of this information would allow the formulation of empirical relations to estimate future damage and loss.
- Collection of geophysical and geotechnical data of surface soil layers and underlying engineering bed rock. For this purpose, a suitable number of boring machines and undisturbed soil samplers, as well as physical and mechanical testing apparatus, should be distributed among domestic institutions.
- Establishment of a national program for the acquisition of the necessary data to perform simulations similar to the one performed in this project in other areas of Nicaragua.
- Careful extension of these studies to the rest of the country taking into account that

the information available for other areas is even less complete than the one available for Managua.

- Better allocation of resources on human resources development to improve the rather uneven levels of education, knowledge and ability of the staff within INETER. Currently, the knowledge and technologies brought by international projects are limited to the individuals that were in charge (as counterparts) of these projects.

Recommendations to improve the earthquake hazard map for Managua City

- Development of a database of site-response characteristics derived from strong motion records obtained in the past.
- Development of a reliable database of seismic intensities observed for historical disastrous earthquakes
- Integration and analysis of micro-tremor data to investigate the characteristics of site response in the Managua City area
- Collection and evaluation of all available geologic data on active faults
- Collection and evaluation of available geologic and geophysical data on the geological profile, classification, and physical and dynamic properties of subsurface soil layers and the underlying engineering bedrock.

(2) Volcanic Hazards

- Improvement of interpretation and utilization of aerial photography by raising the capacity of INETER staff in this field and properly equipping this activity.
- Implementation of deeper discussions on the basic concepts and philosophies of hazard mapping necessary to elaborate maps that reflect the local realities.
- Improvement of geological research on volcanoes by developing systematic training programs with emphasis in the practical aspects of volcanic geology.
- Development of the human resources with the capacity of executing field investigations of volcanoes. Training should be provided on both the theory and practice of volcanoes.
- Basic data collection and organization through systematic programs for data acquisition, validation, synthesis and analysis. Deep knowledge of GIS techniques and volcanic geology should be incorporated in the process.
- Increased coordination with the seismic observation section to benefit from each other's interaction.

(3) Flood Hazard

- Development of human resource through the preparation of manuals based on the materials prepared for the project's training seminars, application to other rivers of the methodology utilized in this project, implementation of training programs on hydraulic analysis, especially the two-dimensional analysis of unsteady flow, and increasing the Fortran programming and numerical simulation capabilities of the staff.
- Gathering of hydrological data and establishment a comprehensive, well-organized database.
- Preparation of a "flood catalogue" that collects and organizes valuable information from past disasters.
- Preparation of a master plan with the long-term goal of preparing hazard maps for all the rivers in Nicaragua. The plan should define priorities, funding sources, and a time line that realistically reflects the local resources and capabilities. It must also include an implementation strategy that considers active collaboration with other institutions, local authorities, and the communities
- Establishment and development of a "project team" specialized in the estimation and mapping of flood hazard.

- Establishment of a research program on the particular characteristics of flood hazard in Nicaragua to determine, among other things, suitable methods of hydrological analysis, adequate mesh sizes for the analysis, simulations programs, necessary criteria for parameter selection, contents of studies and maps, users and applications.
- Improvement of flood forecasting procedures to, combining them with hazard mapping methodologies, prevent flood disasters in a more effective way.

(4) Tsunami Hazard

- Closer collaboration between the Department of Geophysical and Hydrological Resources is indispensable.
- Collection of new and better data is needed, especially bathymetry data in the near coast area, which is a key factor for improvement of the simulation models.
- Implementation of field survey training programs so that Nicaraguan staff will be able to do such surveys in future Tsunami events. For the 1992 Tsunami, field survey was done mainly by foreign researchers.
- Development of applications to disaster prevention. For this purpose, cooperation with related institutions should be established since INETER's interest in hazard mapping is rather limited to do simulations.
- Training of more staff since there is no staff currently assigned uniquely to Tsunami study, and the number of trainees was rather limited this time.
- Learning from international experiences since, as major Tsunamis are rare, experiences in other countries provide good opportunities to better understand this phenomenon.

9-1-3 Uses and Development of GIS Technology

- Sharing of Geographic Basic Data among the largest possible number of agencies to significantly increase work's efficiency and, consequently, reduce the initial investment cost.
- Effective Data Distribution and Support for Users through various feasible channels, such as internet, CD-ROM, DVD, and printed maps, to ensure their widespread use as an instrument for decision-making or as a tool for information analysis.
- Provision for SINAPRED of basic information for the before/during/ and after stages of the disaster, assistance for emergency response activities, and maps tailored to the specific needs and conditions of any location within the country.
- In-depth GIS training on system's structural design to ensure the proper design of the system's structure and its systematic implementation.
- Promotion of the interaction among the various INETER departments to reduce the wide variation of GIS capabilities among them and facilitate sharing of experiences, knowledge, and working techniques.
- Development of marketing and distribution strategies for INETER's products to identify all the current and potential users as well their needs and preferences. This will ensure the production of outputs that respond to the market demand and, therefore, are looked after by INETER's clients.
- Proper utilization of the GIS packages through the implementation of the necessary actions to strengthen the institutions, train the personnel, and create formal structures for the efficient use and exchange of information among institutions. This will ensure proper understanding of GIS technology and its applications and will not let this useful tool to remain underutilized.

9-1-4 Georiesgos GIS

The Geographic Information System (GIS) of Georiesgos (Georisks), developed by the

Geophysics Division in cooperation with INETER's other divisions and several local and international organizations, is a technically sound system, the most advanced of its type in Central America, which already includes a significant amount of information on hazards, vulnerability and risk in Nicaragua. Through INETER's LAN, all the computers of the institution have access to this GIS, which also publishes electronic information through the Internet, including interactive maps. The utilization of this existing system is recommended for the following activities:

- Integration of all the results of this project in the Georiesgos GIS and follow up on the development and update of the produced databases and maps. Publication of maps and covertures in the Georiesgos GIS' map server.
- Integration into the Georiesgos GIS of all the geographic information, aerial photography, and DEM produced by the project so that they can readily and efficiently be usable for the development of new hazard, vulnerability, and risk maps and for emergency response activities.
- Integration in the Georiesgos GIS of a database of the at-risk elements and publication of this information in the way of an interactive map on INETER website so that it can reach a wide audience and be utilized, especially, in case of emergencies. Continuous update of this information.
- Utilization, on a regular base, of the Georiesgos GIS by all the INETER divisions, which should have access to all the databases although each division could have its own GIS applications. Training of staff in other divisions on the use of the Georiesgos GIS. Closer collaboration between the Divisions of Geophysics and Cartography/Geodesy is especially recommended to take advantage of the work done in both divisions by the project.
- Utilization of the Georiesgos by SINAPRED and other institutions to optimize resources and save funds and time in the development of disaster prevention programs.

9-2 Recommendations to other institutions and the National System

9-2-1 Uses of Hazard Maps

The recommendations presented here are the result of the analysis of more than 350 questionnaires completed by representatives of more than 50 organizations from the public, private and civil society sectors of Nicaragua. The uses of hazard maps are recommended in two major aspects: 1) Application of the results for risk reduction activities; and 2) Information dissemination measures.

(1) Application of the results for risk reduction activities

- Incorporation of Census Data to Hazard Maps to delineate emergency response drills, design early warning systems, and determine safe and evacuation areas.
- Development of Community-Based Disaster Management Plans adopting user-friendly versions of the project's maps to educate and raise awareness about the existing risk among the community and its leaders and to prepare appropriate contingency plans for cities and organizations and for the revision of the existing ones.
- Development of Regional Plans through the incorporation of these results in the corresponding regulatory and legislation instruments for disaster risk control. Land use and urban planning regulations should also be revised utilizing the new information produced by the project.
- Formulation of a Comprehensive Disaster Prevention Policy by utilizing these re-

sults to update existing and create new disaster reduction policies and regulations.

(2) Information Dissemination Measures

- Local authorities and local emergency committees should disseminate these results working in collaboration with community leaders.
- Collaboration with the media should be developed through the implementation of training programs that would allow professional communicators to transmit effectively accurate information to the community.
- Preparation of a Brochure for General Public that properly explains to the community the project findings and results and is widely distributed in, especially, public places.
- Dissemination of resulting hazard maps at public places such as community centers, libraries, schools, churches, hospitals, public buildings. Also, implementation of regular seminars and workshops for the community and local institutions.
- Dissemination of information among institutions and professionals through its incorporation in the education of new professionals in the Universities and the implementation of seminars for professional associations (engineers, architects, urban planners), universities, chamber of construction and other related institutions.
- Total Coordination of Publicity and Promotion Activities through the updating of INETER's distribution mechanisms to inform the potential users and facilitate the access of these results by all related organizations.

9-2-2 Strengthening Disaster Prevention

A series of discussions and interview sessions with local authorities and stakeholders regarding disaster prevention produced recommendations in the following major themes: 1) Institutionalization of risk reduction: 2) Future activities to be undertaken; and 3) Community involvement and participation.

(1) Institutionalization of risk reduction

- Revision of the legal framework in order to decentralize risk reduction activities and reduce the current strong dependency on centralized decisions.
- Better coordination of the projects and activities implemented through foreign assistance to increase their impact and efficiency and optimize the use of the resources made available by the international community.
- Better communication and collaborative work between SINAPRED and the technical institutions such as INETER, universities and research centers. Also, interaction with end users, such as local authorities and community leaders, should be improved.
- Creation of a disaster reduction information center that compiles, organizes and makes all the existing and newly produced information available to all the potential users.
- Incorporation of local capacity building at the center of any new program, domestic or international, on disaster risk reduction. The empowerment of local governments, for example, will facilitate the decentralization process.
- Development of financial stability of risk reduction initiatives through the active incorporation of the private sector and its valuable financial and technological resources, establishment of a municipal fund for disaster risk reduction purposes, and better definition of the role of the insurance sector.
- Enhancement of the local authorities' role in informing the communities about existing risk and means to reduce it.
- Better coordination of the individual efforts already made by organizations in both the public and private sectors.

- Development of programs and mechanisms to incorporate the active participation of all the sectors (public, private, civil society) of the community in risk reduction activities.
- Performance of a systematic evaluation of the current state of risk management in Nicaragua to identify what has been achieved and what is lacking. The results of this evaluation should be used to define actions to be taken to construct on what has already been achieved.
- Development of financial and technical programs to guarantee maintenance and operation of the equipment donated by international-assistance projects after the conclusion of those projects.

(2) Future activities to be undertaken

- Improvement of the quality of available data by implementing programs to systematically collect new information and perform the required analyses to validate their quality and usefulness.
- Preparation of appropriate disaster risk reduction and contingency plans for cities and organizations and revision of the existing ones.
- Development of tools and mechanisms to monitor progress of risk management activities in order to perform periodic evaluations of the process and make the necessary corrections.
- Implementation of special programs in collaboration with construction companies, professional associations, and Chamber of Construction to train the professionals on effective risk reduction techniques and proper construction practices.
- Establishment of training programs for local authorities, who are the end users of the results and information produced by risk reduction studies.
- Utilization of the experience and technology learned from projects like this one to continue the work covering all the national territory.
- Coordination with other institutions in the region that are doing similar studies in neighboring countries to increase the completeness and impact of these studies.

(3) Community incorporation in risk reduction activities

- Incorporation of all the sectors of the society as active actors in the implementation of risk reduction activities.
- Utilization of the results of this and other similar studies to implement systematic programs of regular disaster drills with the communities.
- Incorporation of risk reduction in the school programs through the Ministry of Education.
- Implementation of awareness raising programs to inform the community about the existing risk and of feasible measures to reduce it.
- Incorporation of risk reduction in mainstream community life through the establishment of special dates to remember the importance of disaster preparation. In Corinto, for example, the establishment of the "Tsunami Day" on September 1, aniversary of the 1992 Tsunami, could increase community awareness on the existing risk and the importance of reducing it.