



Technical Memorandum of Public Works Research Institute

No. 1344

Preliminary Report of Investigations on the Relief and
Rehabilitation in the Izu-Ohsima Kinkai Earthquake of 1978

February 1978

Public Works Research Institute
Ministry of Construction



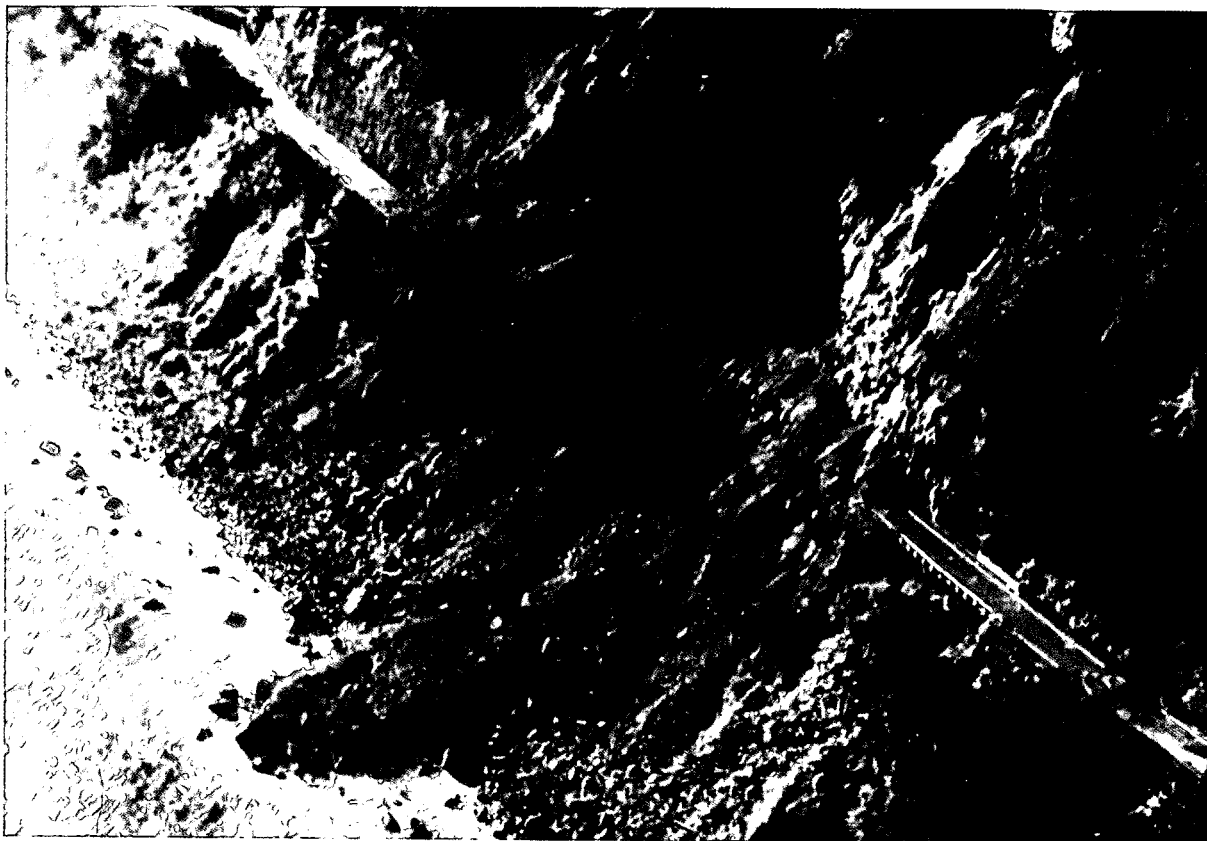


Photo 1. Failure of Ex-national Highway Route 135 Caused by a Landslide in Higashi-izu Town



Photo 2. Sludge Removal from the Mochikoshi River



Photo 3. Flowing Out of Sludge Caused by the Failure of Dykes of its Reservoir



Photo 4. Temporary Countermeasures to Prevent Rock Fall in Shimoda City

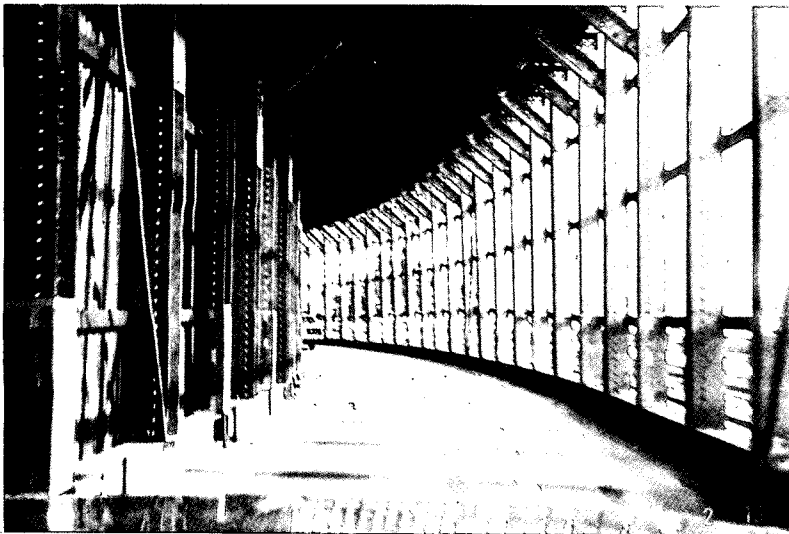


Photo 5. Temporary Structure to Prevent Rock Fall on the Higashi-izu Toll Road



Photo 6. Residential Damage in Shimoda City

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PREFACE

In this decade Izu Peninsula, Shizuoka Prefecture has suffered from three times of earthquakes which brought damage scaled with fifth degree or more in Japan Meteorological Agency's Intensity. Subsequently numerous earthquakes have frequently brought disasters to it historically.¹⁾

Recent developments of earth science concerning seismology, geophysics, geology, etc., have clarified the physical properties of the crustal zone of the earth, consequently followings are recognized on the properties of the Izu Peninsula region.

The peninsula, about 60 km in length of north-south and 30 km in width of east-west originally was an island which upheaved in Pacific Ocean causing a geotectonically compressive movement of Phillipine Sea tectonic plate at an intersection between Sagami and Nankai Troughs and was located in the Fuji volcanic belt zone in geological epoch. It is generally said that the peninsula is covered with igneous rocks owing to the origination itself and had been formed gradually to the present feature with different geological conditions than bows of Japanese islands.

The earthquake made the peninsula learn repeatedly the weakness itself in geological scales. Many investigations have been conducted to survey physical damages to clarify their properties in this earthquake. On the other hand, there has been few of totally systematic investigation and analysis on disasters caused by earthquakes and other natural phenomena upon time depending countermeasures and temporarily organizational systems to minimize disasters.

In this report a field survey conducted after distributions of quationnaires in the period, about a month later the earthquake and its analysis on the responses and systems in and after the earthquake and disaster are described.

February 15th, 1977

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1. An Outline of the Izu-Ohshima Kinkai Earthquake of 1978

1.1 General Information of the Earthquake

After the announcement of Japan Meteorological Agency, the general feature of the earthquake is as follows, (refer Fig. 1-1)

Date and time of the occurrence of the main shock: 1978, January, 14th (Saturday) 12h 24m

Epicenter: $139^{\circ}18'E$, $34^{\circ}48'N$, depth 0 km

Location of the epicenter: Northern part of Ohshima Town, Ohshima island, Tokyo far 26 km in east from Higashi-Izu Town located along the east coast of the central part of the Izu Peninsula.

Magnitude in Richter Scale: $M=7.0$ nominally, containing $\pm\frac{1}{4}$ of errors

Intensity distribution in JMA intensity scale: Shown in Fig. 1-1, but being considered the upmost shall be reached 6.

(note)

Intensity of JMA 5 and 6 corresponding to 8 and 9 in Modified Mercalli Intensity scale respectively.

Focal Mechanism: A right lateral fault developed from the epicenter to almost western direction and lift zone was observed in the northern side.

Severest after-shock: 1978, Jan. 15th 7h 32m a.m., $M=5.7$, the epicenter is estimated as $138^{\circ}54'E$, $34^{\circ}53'N$ and 10 km in depth after Earthquake Research Institute, Tokyo University. (refer Fig. 1-2)

Fore and after shock area: Fore and after shocks are distributed in a belt from Ohshima Island to the western coast of the Izu Peninsula across the middle altitude of the peninsula as shown in Fig. 1-3.

1.2 Fore Shocks

During 36 to 55 minutes past 9 o'clock on 14th, January four times of relatively big shocks, 4th degree of JMA's intensity were observed at Ohshima Meteorological Station after continueing sensible earthquakes from the evening of 13th, January. Immediately after the big shocks of 4th degree the situation was informed by Japan Meteorological Agency to relevant local governments.

In response to the information Shizuoka Prefectural Government distributed it to municipal governments in Shizuoka Prefecture through emergency wireless at 11 o'clock on 14th January with such coments as follows. "By the information of Japan Meteorological Agency, occurrences of earthquakes taking few damage are suspected in the very near future."

1.3 Weather of the Damaged Area before and after the Earthquake

Before and after the earthquake temperature changes and rain falls at Fire Department of Shimoda Municipal Office located in Shimoda City adjacent to the severest damaged area of Kawazu Town and Higashi-Izu Town, are shown in Table 1-1.

In this table, the mean temperature is 8.0 degree in centidegree and the total rainfall is 50.5 mm during full of days in the last January, whose average is on the other hand 7.5 and 66.1 respectively.

1.4 An Outline of the Disaster

In Kawazu Town and Higashi-Izu Town lifeline systems consisting of roads, railways, every kind of buried pipe lines, communication lines, power lines, etc. suffered from damage caused mainly by landslides and surface ruptures. Few of damage occurred in buildings and houses by the causes above and also vibration in these area. Incredibly, damage partially occurred in two of soilfill dykes for stock pile of slime exhausted from a gold mine located at a point far about 40 km from the epicenter of the main shock, along upper stream of Kano River and in Mochikoshi district of Amagi-Yugashima Town in central part of the Izu Peninsula. A part of slime near surface of the stock pile flowed through the break of the dykes via Mochikoshi River of a upper branch of Kano River into main stream of Kano River. (refer Fig. 2--2)

Owing to enlargement of disasters in traffic systems and traffic measures, local industries are suspected in an inactivity as the secondary loss.

As of February 15th, losses of human lives 25, fatally 34 and injury 171 in total were reported.

In the limited district of Shizuoka Prefecture, the amount of the direct losses is estimated as 39.3 billion yen or more, the indirect is under estimating. (refer Table 1--2) Districts other than Shizuoka Prefecture have been estimated as suffering from a very few of damage and losses.

1.5 Occurrences of Historical Earthquakes in the Izu Peninsula, its Geography and Geology

Since seventh century A.D. 14 times of earthquakes bringing damage in the Izu Peninsula and its adjacent area were recorded, 6 times in twentieth century, and 3 times stronger than 5th degree in this decade. On August 18, 1976 Kawazu Town, severest area in this earthquake was attacked by an earthquake as follows,

Magnitude: 5.4 and Maximum Intensity: 5.

(note: refer Appendix I)

As mentioned before the Izu Peninsula is covered with igneous rocks, and steep slopes of grounds with airslaked soils developing along coasts and rivers. Therefore the whole of the peninsula is very sensitive in chemical and physical reactions exposed with atmospheric, hydraulic and geomechanic effects, especially, heavy rain falls, which have frequently brought disasters. (refer Fig. 1--4 and 1--5)

Table 1-1. Weather Condition before and after the Main Shock
(after Shimoda Municipal Government)

Date	Weather	Temperature in atmosphere (Centidegree)			Rain fall mm/day
		Max.	Min.	Mean	
Jan. 1	☉	20.5	14.0	15.1	1.0
2	☉ ☉	14.5	11.0	9.8	4.0
3	● ☉	12.0	7.0	7.3	8.5
4	☉	12.5	5.5	7.5	0
5	☉	11.0	5.5	7.3	0
6	☉	13.5	6.5	9.8	0
7	☉	15.5	5.5	9.5	0
8	● ☉	13.5	7.0	9.2	1.0
9	☉	14.5	6.0	10.3	0
10	☉	10.5	2.0	5.9	0
11	☉	13.5	2.0	6.5	0
12	☉	15.5	7.0	10.3	0
13	☉	13.5	7.0	9.2	6.0
14	●	14.5	9.0	9.3	7.5
15	☉	17.5	7.0	12.3	1.0
16	☉	14.5	6.0	8.8	0
17	☉	9.5	6.0	6.9	0
18	●	13.0	6.0	6.8	1.0
19	☉	12.0	8.0	7.8	0
20	☉	13.0	3.0	7.1	0
21	☉	13.0	5.5	7.1	4.0
22	☉	9.5	2.0	4.5	0
23	☉	12.0	0	5.1	0
24	☉	12.5	1.8	6.8	7.0
25	☉	11.0	2.0	5.9	0
26	☉ ●	12.5	4.0	6.8	5.5
27	☉	15.0	6.0	9.8	0.5
28	☉	12.5	6.0	9.3	1.0
29	☉	8.0	4.0	4.9	0
30	● ☉	11.5	2.0	5.8	2.5
31	☉	10.0	3.0	5.4	0
—	—	—	—	Average 8.0°C	Total 50.5 mm

Note: Weather: ☉ fine, ☉ cloud, ● rainy

Table 1-2. Damage and Losses
(as of Feb. 15, 1978, Shizuoka Prefecture)

Classification	Evaluated Loss (in 1,000 yen)	Note
Direct Damage	38,709,501	
Buildings and Houses	5,838,400	
Agriculture and Fishery	6,892,490	
Facility for Education	494,838	
Facility for Welfare and Sanitary	972,783	
Industrial Facility	8,407,582	
Public Works	14,375,408	
Facility for Electricity	228,000	Not Official
Railroad	1,500,000	Not Official
Indirect Damage	Unidentified	Delay of Resumption, etc.
Total	38,709,501	

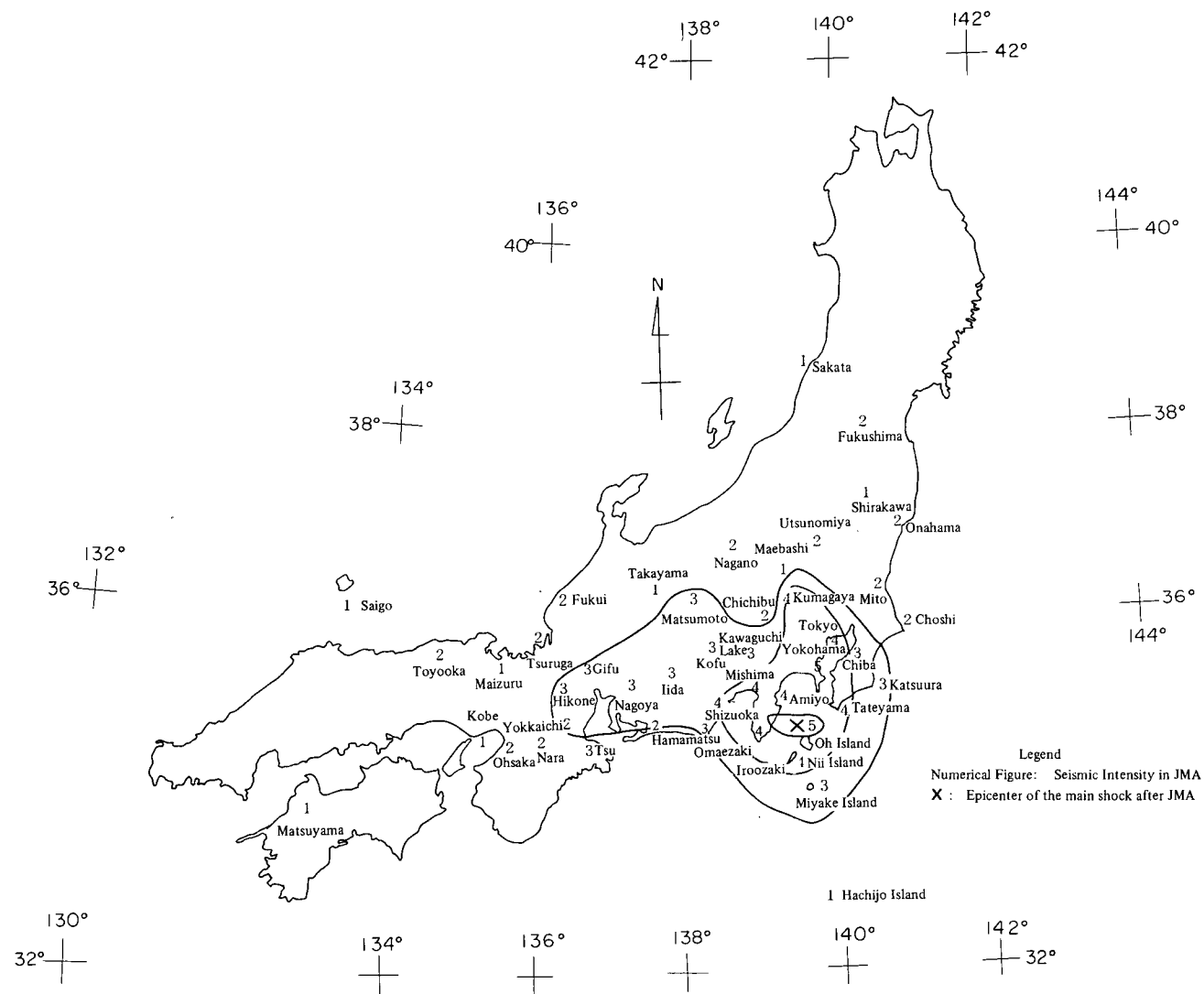


Fig. 1-1 Intensity Distribution Map of the Izu-Ohshima Kinkai Earthquake of 1978

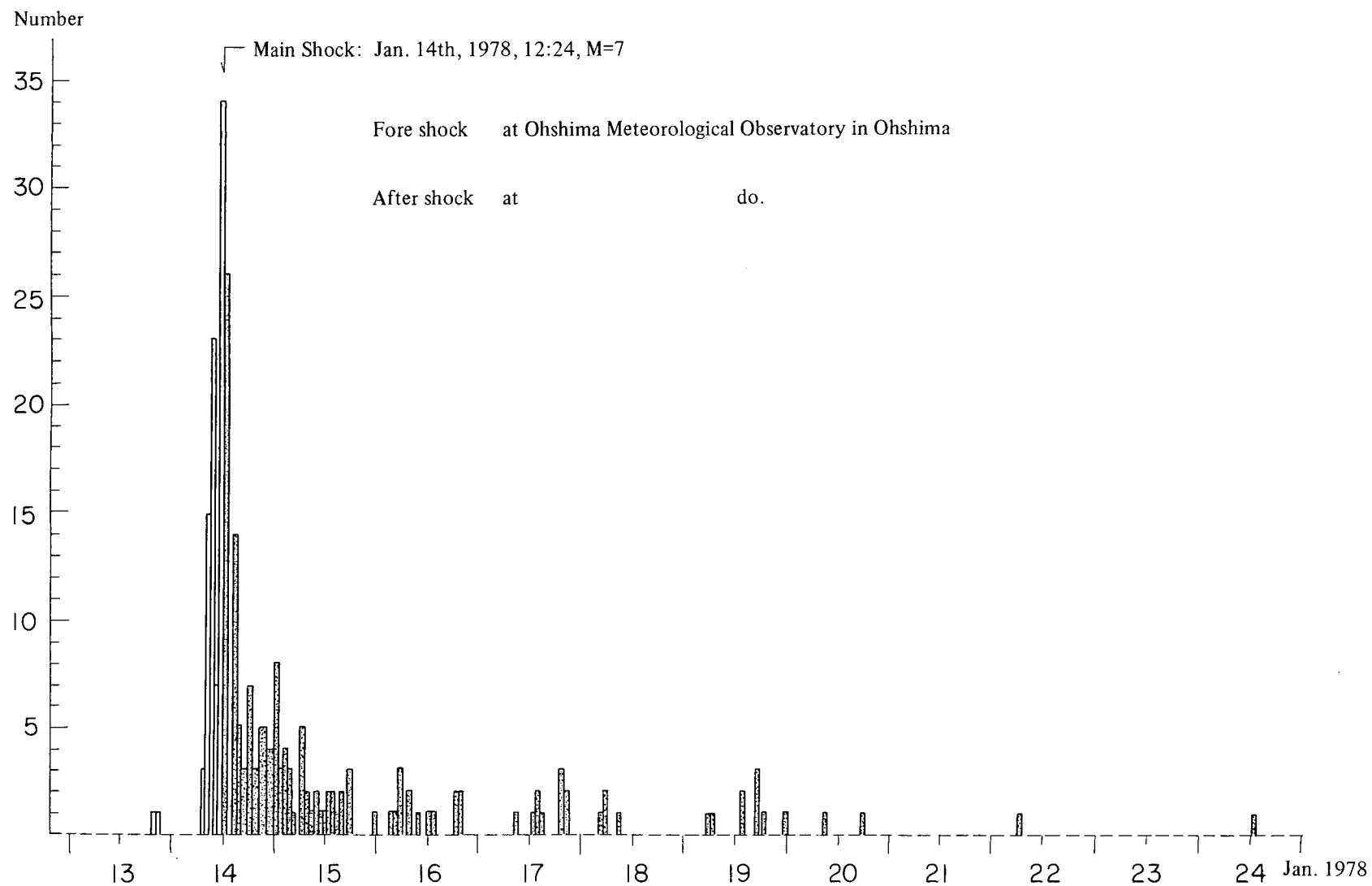
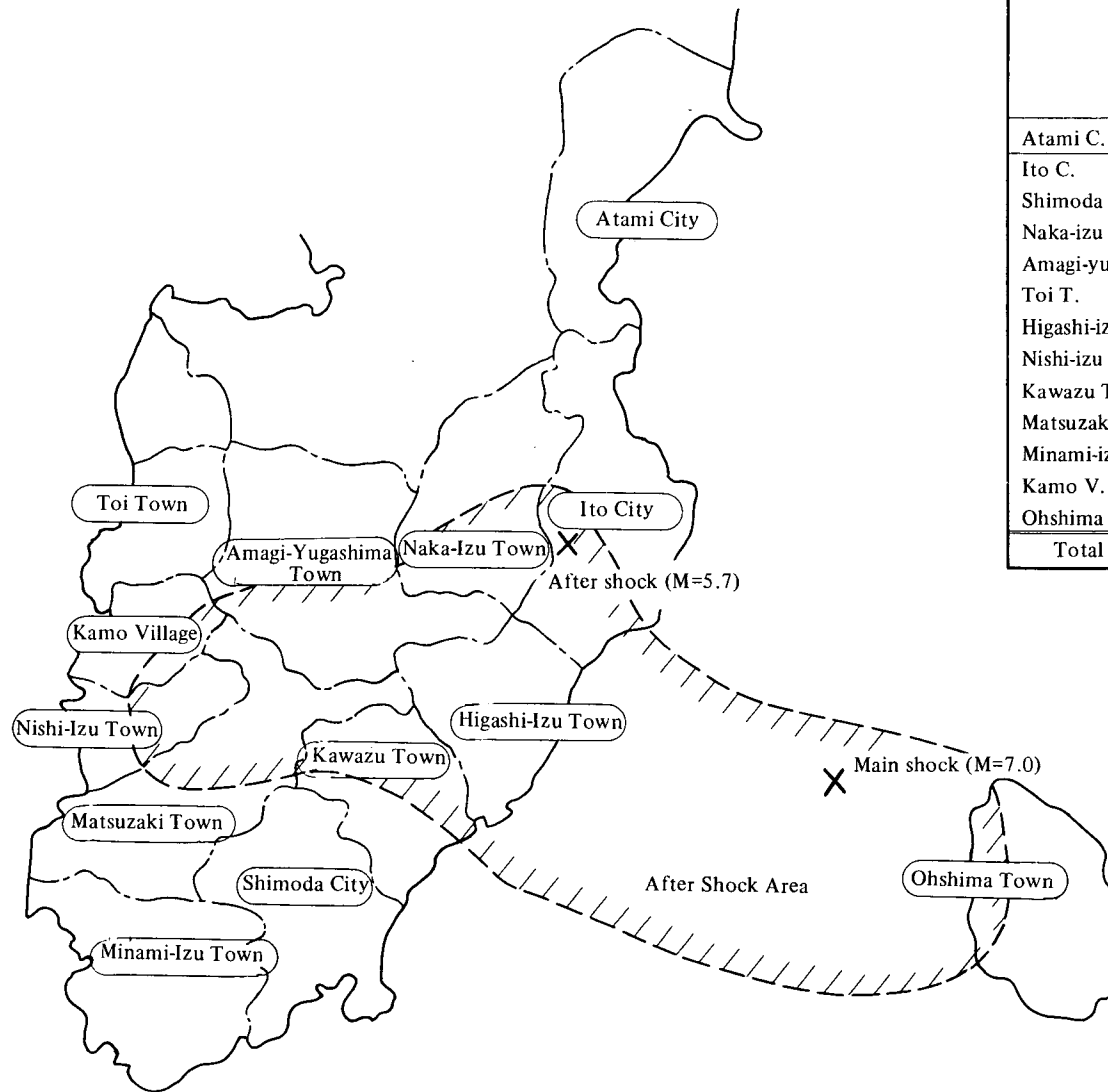


Fig. 1-2 Fore and After Shocks



	Loss of Lives		Damage of Dwelling Houses		Affected Households and Sufferers	
	Dead	Injured	Totally Razed	Half Razed	Affected Households	Sufferers
Atami C.	0	0	0	0	0	0
Ito C.	0	4	1	4	3	13
Shimoda C.	0	51	12	24	41	131
Naka-izu T.	0	0	0	0	0	0
Amagi-yugashima T.	5	8	0	0	0	0
Toi T.	0	0	0	0	0	0
Higashi-izu T.	9	109	49	381	440	1,807
Nishi-izu T.	0	2	7	34	41	128
Kawazu T.	11	28	16	56	72	313
Matsuzaki T.	0	2	4	11	15	55
Minami-izu T.	0	1	0	0	0	0
Kamo V.	0	0	0	27	27	108
Ohshima T.	0	0	0	0	214	677
Total	25	205	89	537	853	3,232

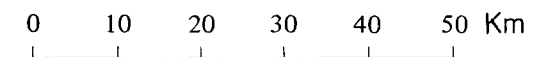


Fig. 1-3 Distribution Map of the Earthquake Damage

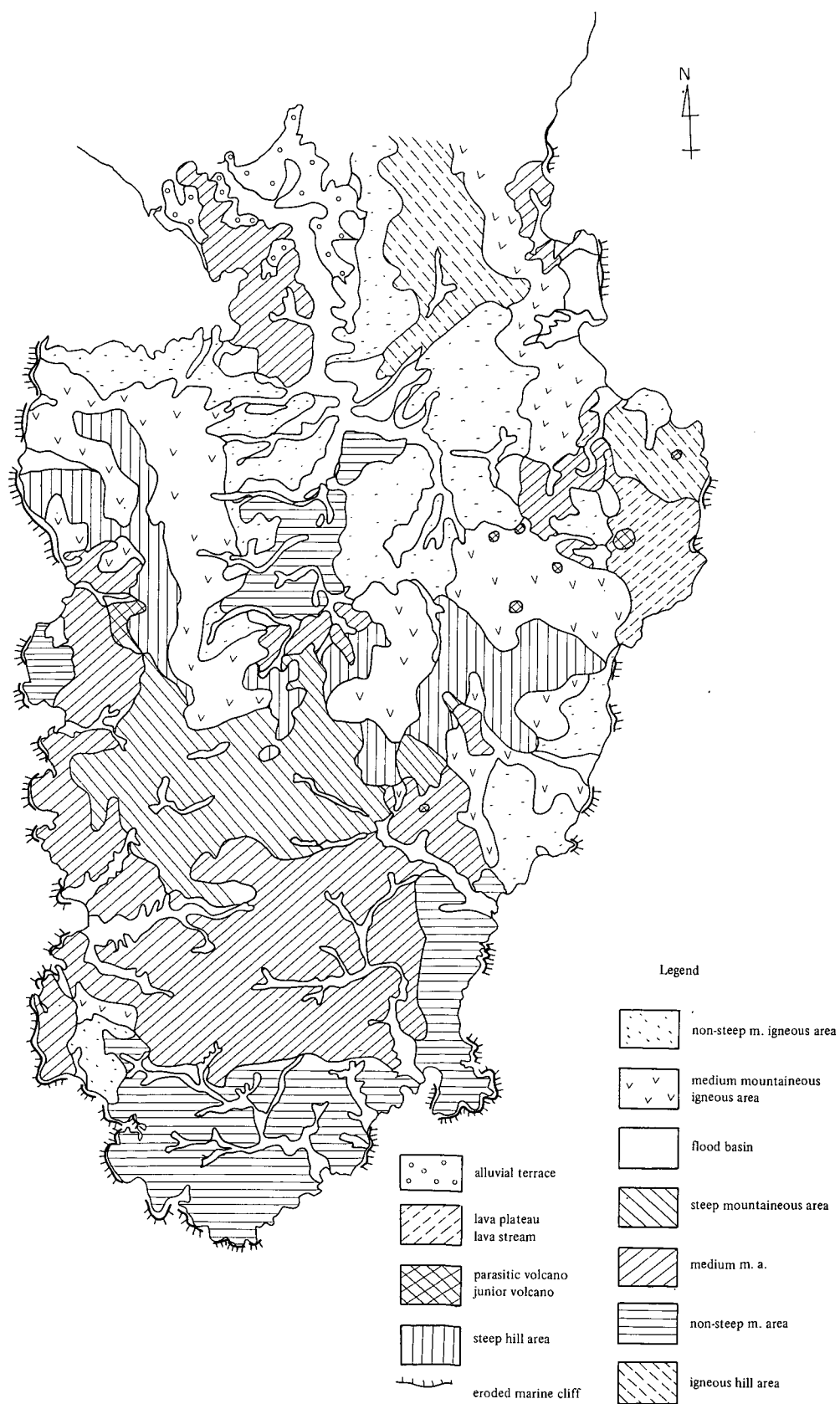


Fig. 1—4 Geographical Feature of Izu Peninsula

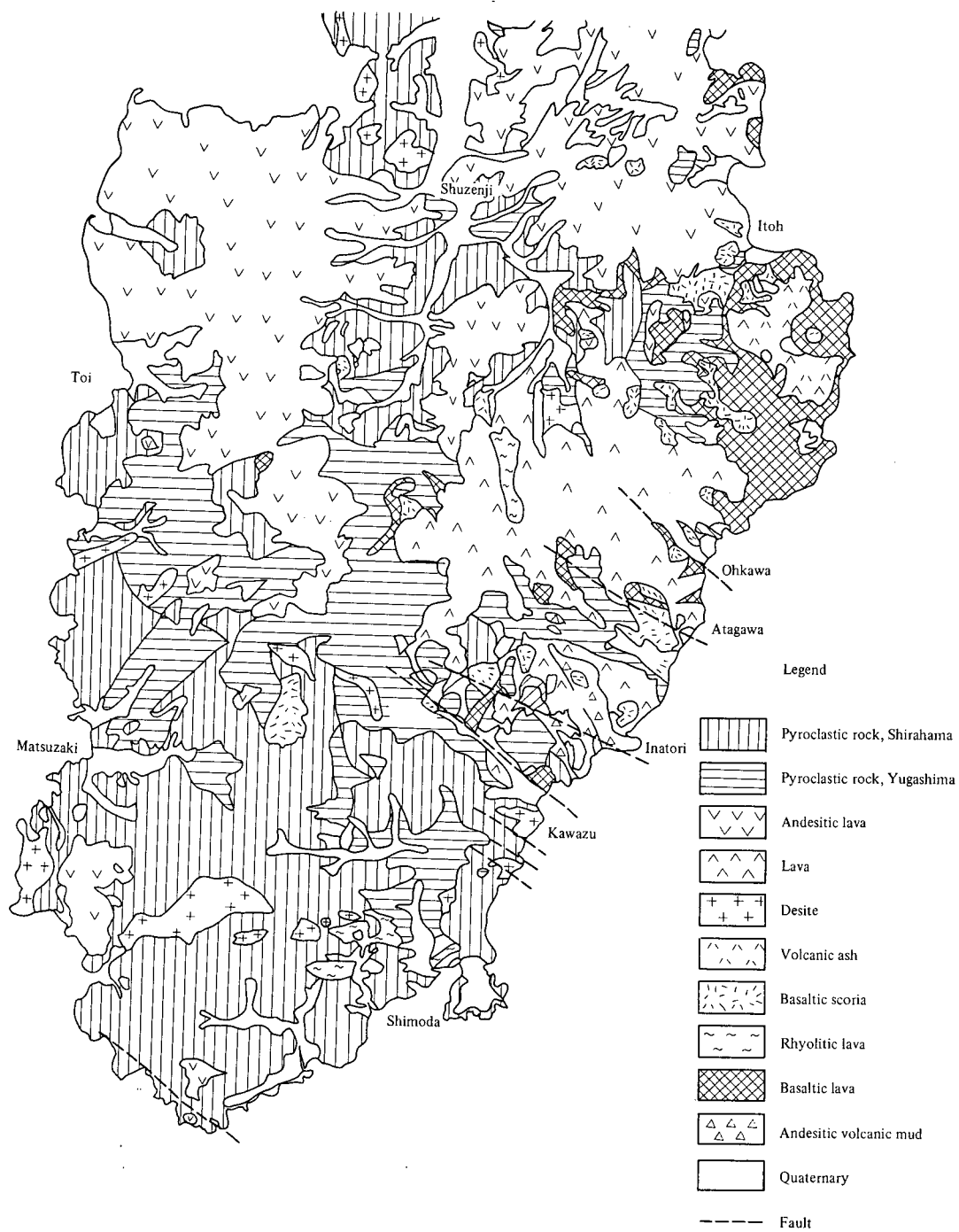


Fig. 1-5 Subsurface Geology of Izu Peninsula

2. Damage and Losses

2.1 General Description

Direct losses of articles due to the earthquake, including costs for resumptions, are at least described in this chapter. The amount of the losses will be slightly changed after assessments to the estimation conducted by upper administrations. In this chapter indirect losses and secondary losses due to a delay of resumptions are described as possible as estimated.

2.2 Buildings and Houses

The most part of damage in buildings and houses was brought by land slides and surface ruptures and a few of damage occurred due to ground motions. On reduction of values of articles in buildings and houses the number and value of them can not be exactly presented, however the value of the article is estimated as one third of the value of a house or three million yen for a house.

Damage and losses are shown in Table 2-1.

2.3 Agriculture and Fishery

Damage and losses on agricultural products, farm yards, forests, fishing ports, water sources for agriculture, water ways, roads for agriculture, refining plants for fruits and vegetables are shown in Table 2-2.

2.4 Facilities for Education

Damage and losses on schools, play grounds, etc. are shown in Table 2-3.

2.5 Facilities for Welfare and Sanitary

Damage and losses on hospitals, medical stations, relief facilities and water supply systems are shown in Table 2-4.

2.6 Industries

Principal industries in the severest damaged area are recognized as tourism industries except agricultures as stated in 2.3.

The damage and losses concerning two dykes of Mochikoshi Gold Mine, Chyugai Mining Co. Ltd. have not been clear yet, then round numbers and losses are described here.

Damage and losses on industries are shown in Table 2-5.

2.7 Roads

As shown in Fig. 2-1 to 2-4 various damage caused by slidings of embankments, slope failures, surface ruptures and faults occurred on and along the roads listed belows,

National highway 135,

Higashi-Izu toll road,

Principal Prefectural Road: Shyuzenji-Shimoda line, and Municipal roads.

Damage and losses concerning roads are shown in Table 2-6.

2.8 Water Quality of Rivers

It has not been yet encountered that quantitative damage caused by the failure of two dykes of Mochikoshi Gold Mine shown in Fig. 2-5. Effects of polluted water by sodium cyanide contained in slime flowed out from breaks of the dykes are worried to water quality and bionomic systems in rivers and marine sites.

The effect to water quality is shown in Table 2-7.

2.9 Facilities for Flood Control and Preservation of Mountaineous Areas

There is no damage in facilities for flood control and preservation of mountaineous areas except ruptures of natural slopes being described in section "2.7 Roads" and "2.10 Railways."

2.10 Railways

Great damage occurred in railway facilities along a line between Higashi-Izu and Kawazu railroad stations on the line operated by Izu Kyuko Railroad Co. Ltd., from Shimoda to Tokyo directly connected with Japanese National Railways.

The damage and loss are shown in Table 2-8.

2.11 Communication Systems

There is not any substancial damage in telephone systems except cutting of an aerial wire caused by falling rocks in Kawazu Town. However, during about a half of a day after the main shock in all districts of the Izu Peninsula telephone calls were not available to automatically operate in fail-safe systems to protect from total failures by extra ordinary increases of calls including apparent calls from signals through wrong telephone sets with unfastened receivers caused by shaking.

2.12 Power and Energy Systems

On electrical power systems minor damage occurred in two power plant, two transformer stations, two channels and 24 towers for transmission lines as shown in Table 2-9.

In the severest damaged area there are liquid petroleum gas cylinders for domestic use, areal gas supply service, and kerosene storages for vehicles, ships and machinery. Their damage was very slight.

2.13 Other Facilities

Slight damage occurred in facilities for the public peace, police and fire stations, therefore, their activities were not disturbed fatally.

2.14 Indirect Losses due to Delays of Resumptions

Indirect losses due to delays of resumptions of various industries have not been yet evaluated, but the losses would be supposed in tourism industries, agriculture concerning flowers, fruits and vegetables, and transportation industries. In the fatal case the resumption of the blockaded line in Izu Kyuko Railroad Co. Ltd. will delay to coming June.

The articles concerning the indirect losses, up-to-date are listed in table 2-11.

For reference losses due to this earthquake are listed in comparison with ones due to the Niigata Earthquake of 1964 in Table 2-11.

Table 2-1. Damage and Losses in Buildings and Houses

(Damaged buildings and houses in Shizuoka Pref.)

Classification \ Location			Higashiizu T.	Amagi-yugashima T.	Kawazu T.	Shimoda C.	Nishiizu T.	Matsuzaki T.	Toi T.	Ito C.	Minamiizu T.	Kamo V.	Atami C.	Nakaizu T.	Total
Dwelling	Totally Razed House	House	49		16	12	7	4		1					89
		Family	49		16	16	7	4		1					93
		Sufferer	180		77	44	23	14		1					339
	Half Razed House	House	381		56	24	34	11		4		27			537
		Family	391		56	25	34	11		2		27			546
		Sufferer	1,627		236	87	105	41		12		108			2,216
	Partially Destroyed House	House	1,739	124	879	77	208	195	100	304	29	114	1	21	3,791
		Family	1,760	124	879	81	252	194	100	306	29	114	1	20	3,860
		Sufferer	7,001	500	3,581	291	959	701	400	1,166	119	392	4	84	15,198
Non-dwelling	Public Building	House	6	2		12	2	1				1			24
	Others	House	145		78	57	120	9	60	45		20			534

(Losses of Three Municipalities, Severely Damaged)

Classification \ Location	Higashi-izu T.	Kawazu T.	Shimoda C.	Total
Dwelling	3,720,600	1,087,300	155,100	4,963,000
Non-dwelling	357,800	475,000	22,600	855,400
Total	4,078,400	1,562,300	177,700	5,818,400

Table 2-2. Damage and Losses in Agriculture and Fishery

Classification	Number of Damage	Loss in thousand yen	Note
Agriculture	20.8 ha, 1,706	4,969,518	Crops, Agricultural land, Facility for agriculture
Forestry	19.9 ha, 101	1,623,972	Forest, Facility for forestry
Fishery	49	299,000	Facility for fishing port
Total	40.7 ha, 1,856	6,892,490	

Table 2-3. Damage and Losses in Facilities for Educations

Classification	Number of Damage	Loss in thousand yen
Kinder Garten	12	24,972
Primary School	22	136,603
Junior High School	13	107,355
Senior High School	11	201,250
Hutte	1	1,030
Public Hall	5	1,918
Gymnastic Facility	1	10,000
Cultural Estate	5	11,610
Library	1	100
Total	71	494,838

Table 2-4. Damage and Losses in Facilities for Welfare and Sanitary

Classification	Number of Damage	Loss in thousand yen
Hospital	61	523,288
Water Supply Services		327,747
Solid Waste Disposal Plant	2	20,885
Hospital for Epidemic	1	200
Others	54	100,663
Total	—	972,783

Table 2-5. Damage and Losses in Industries

Classification	Number of Damage	Loss in thousand yen
Commercial	1,699	2,566,697
Mining and Industry	474	558,773
Tourism and Service	1,053	5,282,112
Total	3,226	8,407,582

Table 2-6. Damage and Losses in Roads

Classification	Number of Damage	Loss in thousand yen
Shizuoka Prefectural Government	283	10,632,771
Shimoda City	31	42,037
Kawazu Town	269	1,165,990
Higashi-izu Town	123	234,000
Prefectural Highway Public Corporation	16	102,000
J.H.P.C.	31	1,700,000
Total	753	13,876,798

Table 2-7 Water Pollution Due to Sodium Cyanide in Kano River

(in PPM)

	Mizunuki Bashi		Endo Bashi		Chitose Bashi		Kurose Bashi	
	Time	Density	Time	Density	Time	Density	Time	Density
Jan. 14					18:50	ND	18:15	ND
Jan. 15					9:45	1.34	9:50	ND
					10:30	ND	10:30	ND
					13:25	1.25	14:20	0.016
Jan. 16					9:40	0.19	10:25	0.13
					13:20	0.14	13:55	0.14
Jan. 17					9:35	ND	10:20	ND
					14:20	ND	15:10	ND
Jan. 18					10:25	153 ND	11:45	61 ND
					14:15	143 ND	15:10	78 ND
Jan. 19					10:30	97 ND	12:00	50 ND
					14:25	76 ND	15:00	56 ND
Jan. 20	8:00	2,230	8:00	153	9:45	100 ND	10:35	43 ND
					14:10	62 ND	14:50	41 ND
Jan. 25	8:00	615	8:00	89.3	9:30	30 ND	10:15	14 ND
					14:05	30 ND	14:40	14 ND
Jan. 30	8:00	666	8:00	46.7	10:00	20 ND	10:35	10 ND
					14:10	15 ND	14:45	13 ND
Feb. 4	9:00	325	9:00	21.0	9:20	22 ND	10:00	7 ND
					13:50	12 ND	14:30	10 ND

Note: upper, suspended solid (SS) lower, density of sodium cyanide (CN⁻¹)

Table 2-8 Damage and Losses in Izu-Kyuko Railroad Co. Ltd.

Number	Damage
1	Subsidence of rail, Inclination of poles
2	Rock fall (50 cm ~ 10 m)
3	Subsidence of rail
4	Subsidence of rail, Inclination of signal and poles
5	Peel off of tunnel lining
6	Subsidence of rail
7 a	Subsidence of rail and platform
7 b	"
7 c	Inclination of signals
7 d	Subsidence of rail and platform, Inclination of poles
7 e	Subsidence of rail and platform
7 f	"
7 g	"
8	Deformation of tunnel lining
9	Subsidence of rail
10	Rock fall, Landslide, Subsidence of rail
11	Deformation of tunnel lining
12	Collapse of rock shed by landslide (10,000 m ³)
13	Collapse of retaining wall
14	Crack in wall
15	"
16	Deformation of tunnel lining, Dislodgement of wall
17	Rock fall (16 m x 6 m x 5 m)
18	Rock fall, Disconnection of cables, Damage of poles
19	Landslide (70 m ³ , 500 m ³)
20	" (50 m ³)
21	Dislodgement of abutment (80 mm)
22	" (60 mm)
23	Landslide (100 m ³)

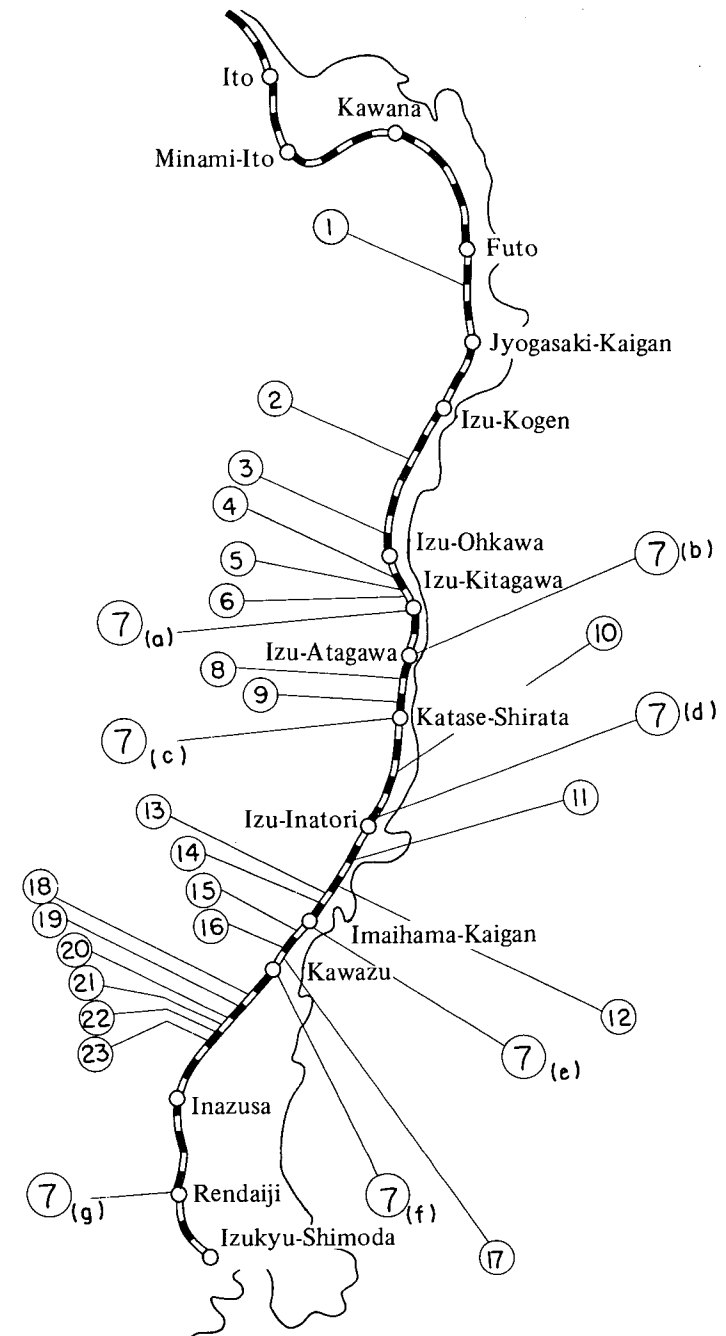


Table 2-9 Damage and Losses in Facilities for Electric Power

Classification	Number of Damage	Loss in thousand yen
Power Plant	2	
Transformer Station	2	
Water Channel	2	
Tower for Transmission Line	Several	
Total		228,000

Table 2-10 Indirect Losses

Classification	Indirect loss	Note
Agriculture		Decrease of agricultural product by damage of agricultural land and agricultural facilities
Industry		
Trade		Decrease of income by interruption of business
Industry		Decrease of product by interruption of work
Tourism		Decrease of income by interruption of work and decrease of tourist
Electric Power		Decrease of income by interruption of power supply
Railroad		Decrease of income by interruption of service

Table 2-11 Damage and Losses in Comparison between the Izu-Ohshima Kinkai Earthquake of 1978 and the Niigata Earthquake of 1964

Eq. \ Classification	Direct Loss (bil. yen)	Indirect Loss (bil. yen)	Indirect/Direct
Izu Ohshima Kinkai	39		
Niigata	130	122	0.94

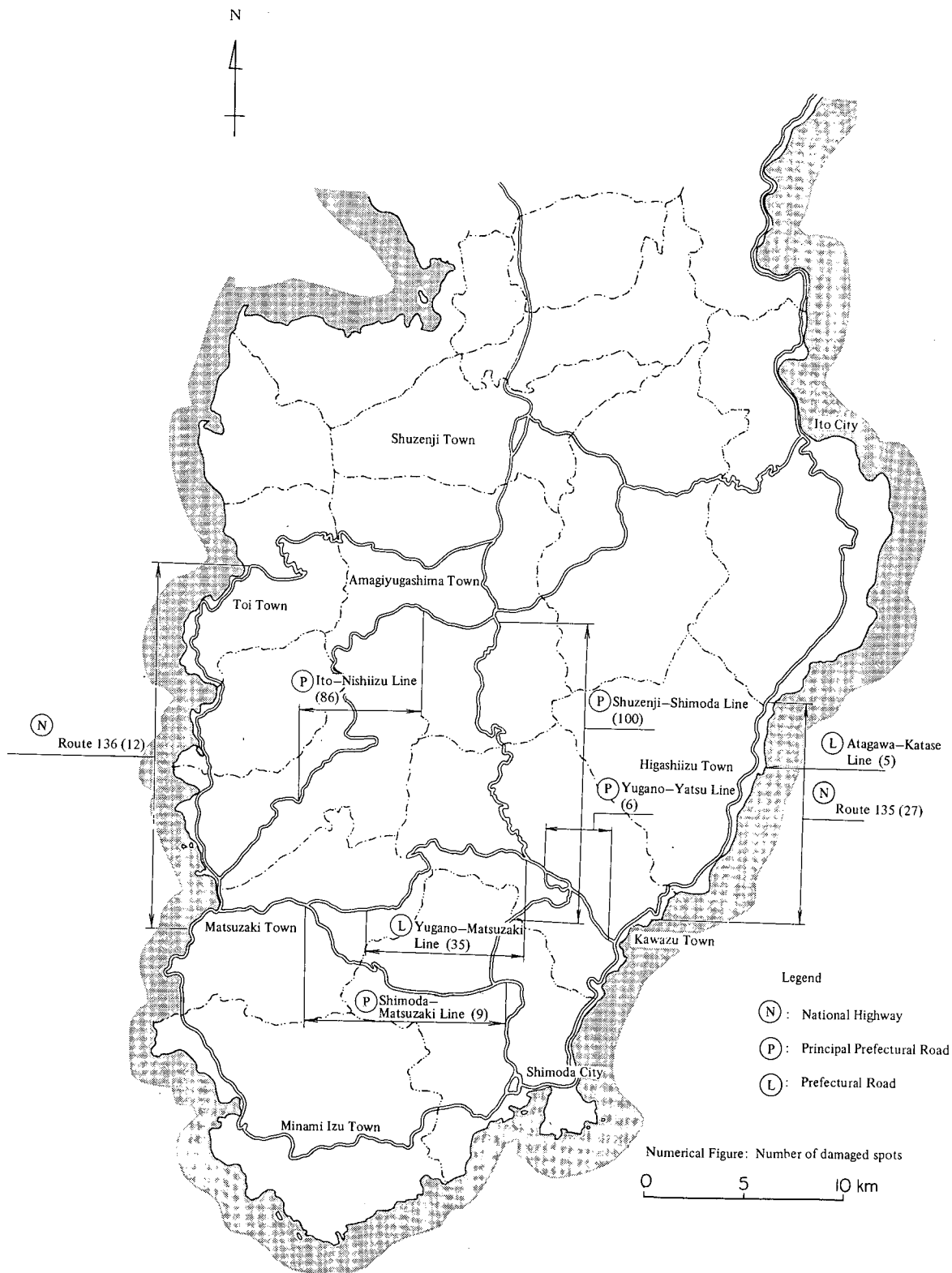


Fig. 2-1 Distribution Map of Damage to Roads

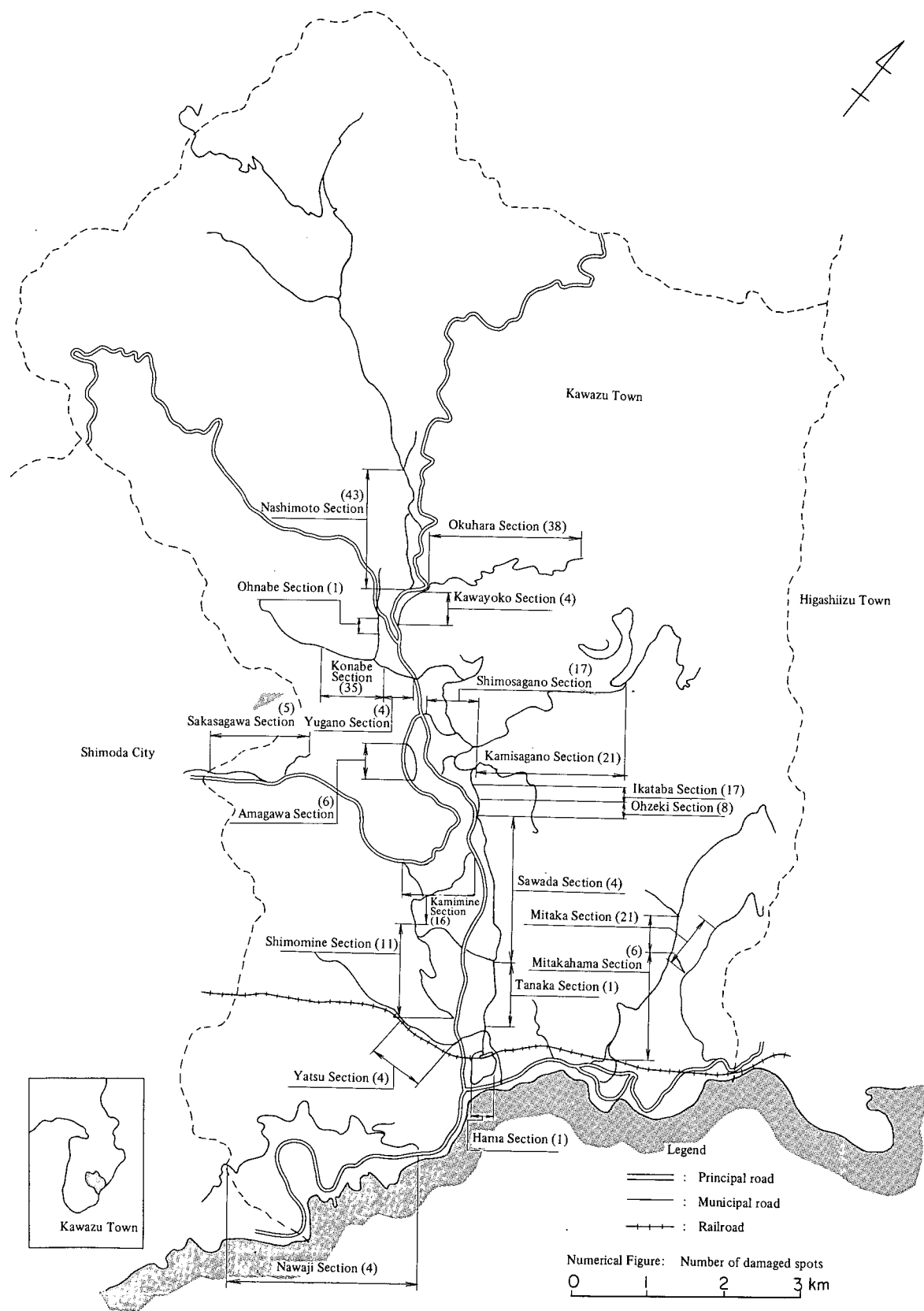


Fig. 2-2 Damage Distribution of Municipal Road in Kawazu Town

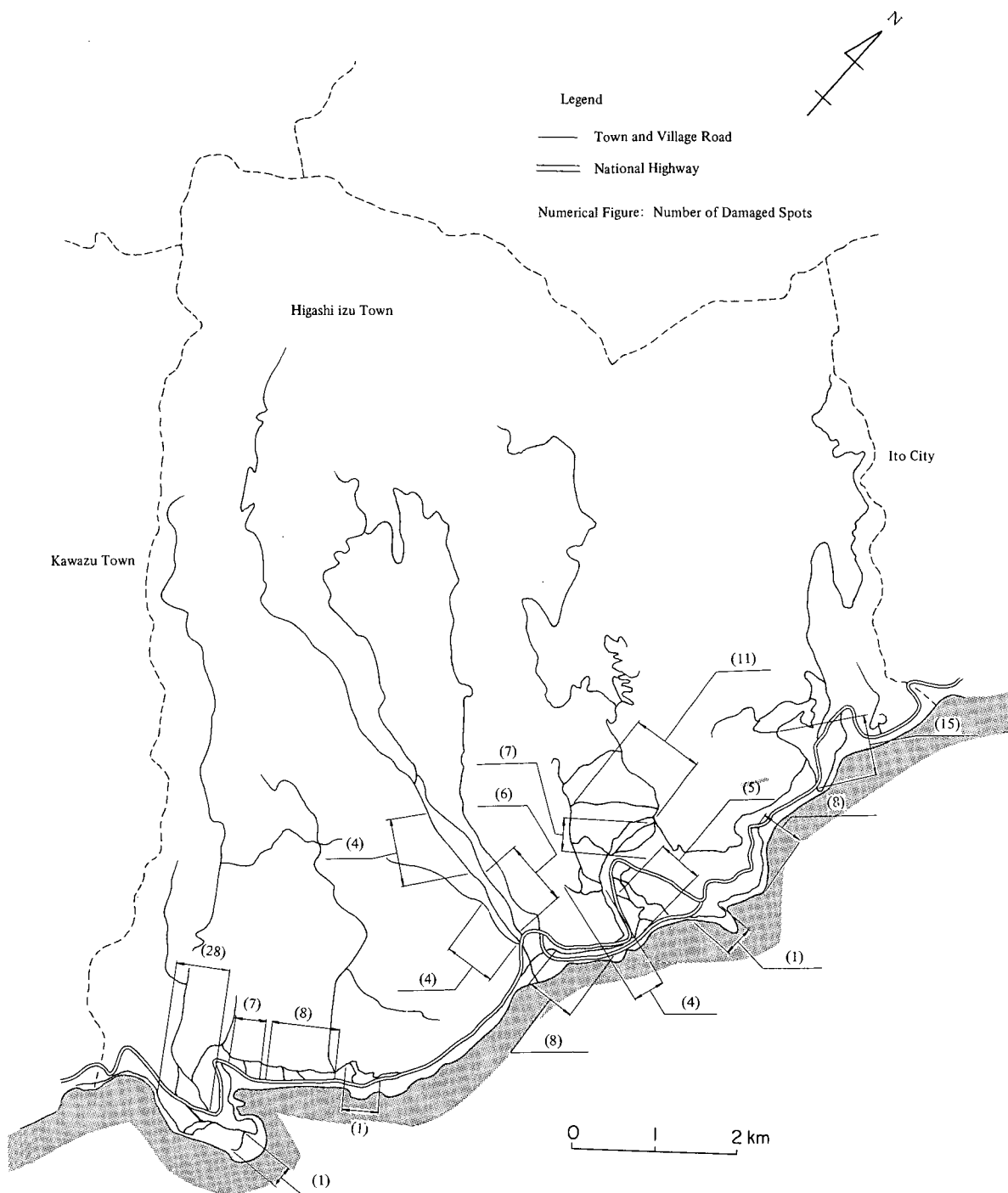


Fig. 2-3 Damage Distribution of Municipal Road in Higashi-izu Town

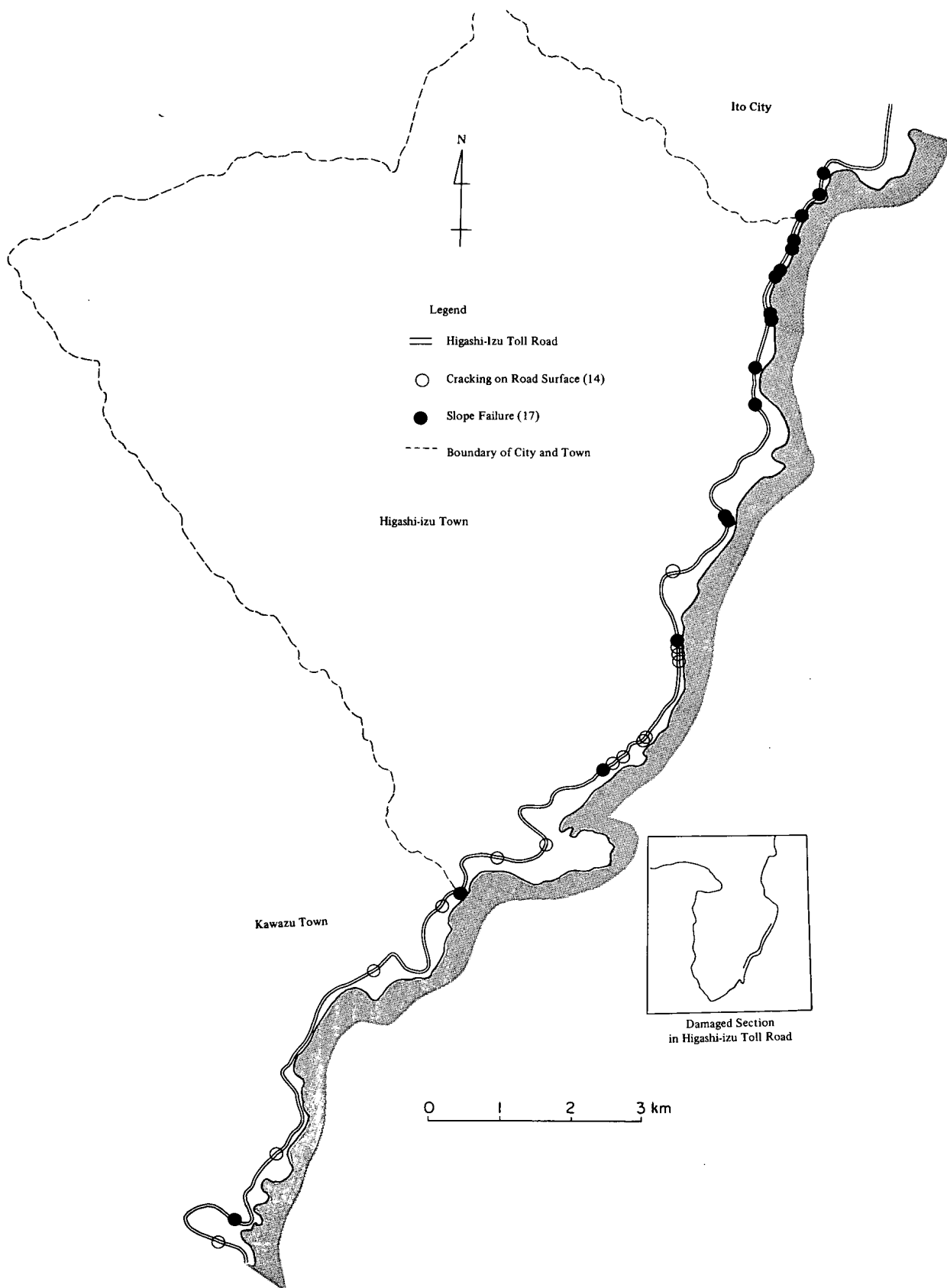


Fig. 2-4 Damage Distribution of the Higashi-izu Toll Road

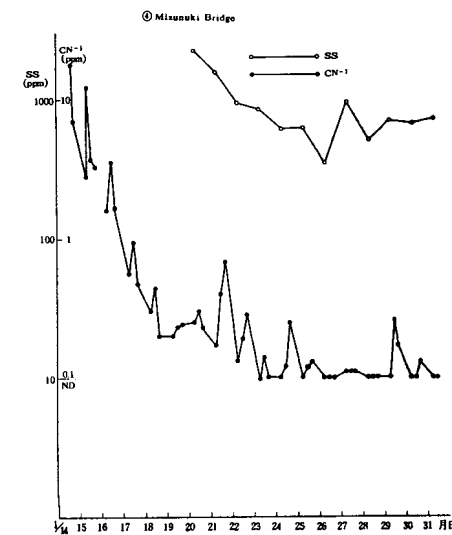
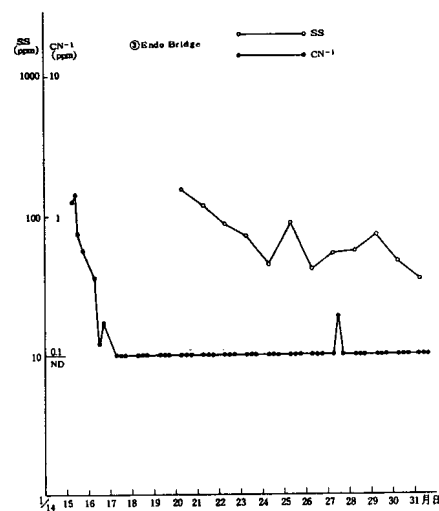
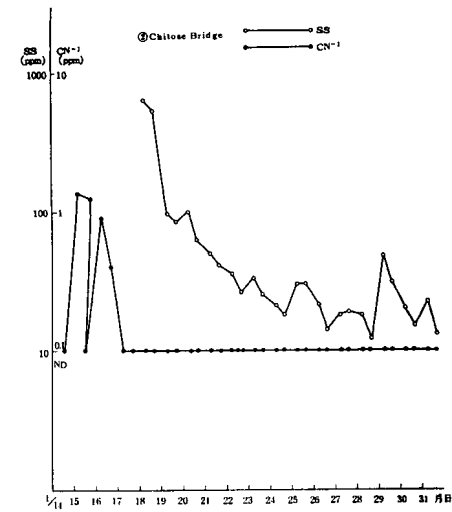
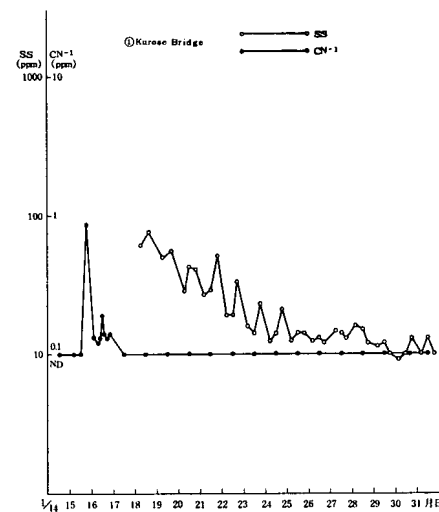
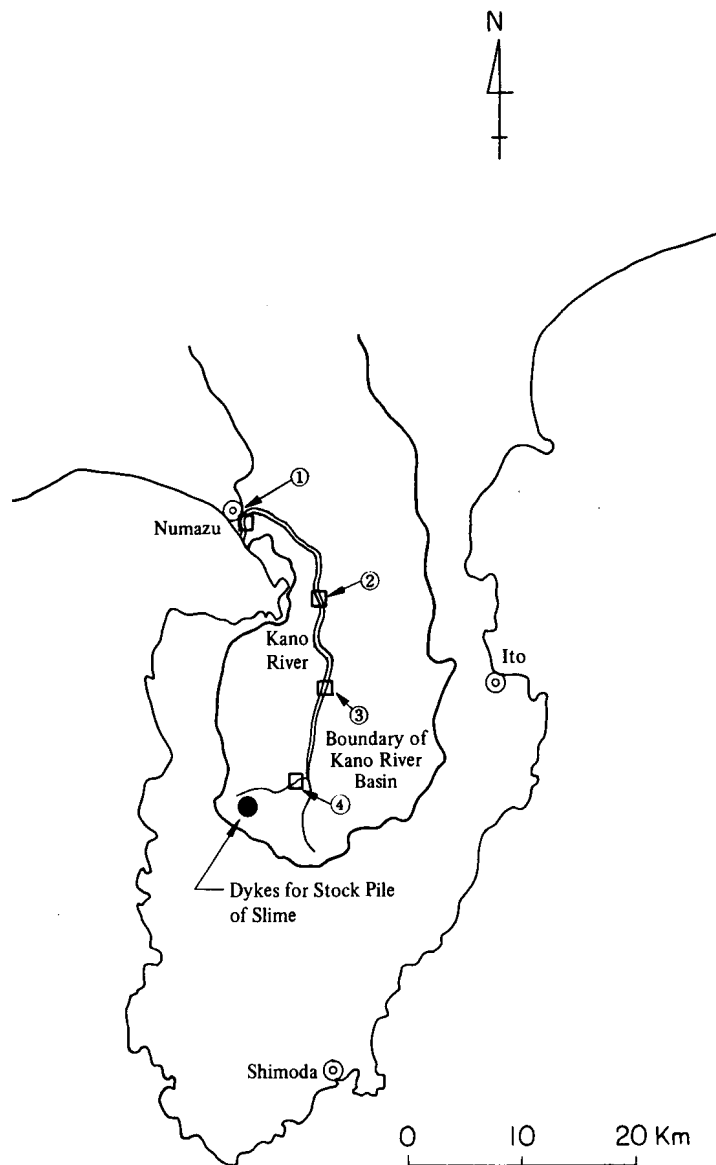


Fig. 2-5 Water Pollution due to Sodium Cyanide in Kano River

3. Countermeasures for the Emergency in and after the Earthquake

3.1 General Description

Main purposes of countermeasures for the emergency immediately after the earthquake are ;

- 1) Rescue of unidentified and injured persons,
- 2) Minimum rehabilitation of living facilities.

Relevant administrative organizations, after the earthquake, put emphasis on

- 1) saving lives burried in landslides,
- 2) restoration of damaged roads and
- 3) maintaining drinking water because of the extensive damage of water pipes.

Fig. 3-1 illustrates the relationship of the events, organizational systems and operations, countermeasures for the emergency, and reconstruction.

3.2 Organizational Systems and their Operations

Shizuoka Prefectural Government Office and municipalities sustained some damage respectively set up the Rescue and Rehabilitation Center as shown in Table 3-1, following the Regional Disaster Prevention Plan of each body. Fig. 3-2 and 3 are the structures of the Center of Shizuoka Prefectural Government Office and Shimoda City Office.

At the same time of the establishment of the prefectural center, Shimoda Branch headed by the Director of Shimoda Tax Office was established in Shimoda. (see Fig. 3-2) Since the severe damage occurred in Kawazu T. and Higashi-izu Town next to Shimoda City, front base of the Branch was organized in Jan. 17 at Kawazu municipal office, exceptionally from the usual structure of Fig. 3-2. The 20 personnels led by an accounting superintendent, next position to the vice governors, were dispatched to Kawazu. They pursued the information collection, rescue and rehabilitation in cooperation with the municipal official.

Collecting the information about the damage, rescue, rehabilitation of damaged facilities overwhelmed the capacity of municipal offices and lower prefectural organizations. Several prefectural officials were dispatched to Izu district to assist the businesses stated above. Three search groups were sent to Prefectural Construction Office in Shimoda. Those who were transmitted to Kawazu Office assisted the municipal proper business in addition to their own as collection of information and its transmission to the headquarter.

Governor of Shizuoka Prefecture demanded the Self Defense Forces (SDF) to dispatch their power. Several corps including 400 men of 34th regiment moved to Izu in January 14. Some of them arrived at the damaged sites at night of the same day. They rescued the unidentified and injured persons, and removed the fallen soil and rocks from slopes beside roads and behind houses. Table 3-2 shows the performances of SDF.

Besides the responses of administrations to the emergency as stated above, fire self defense squads and community systems (private organizations) contributed greatly to the rescue and rehabilitation. Table 3-3 shows the performances of fire self defense squads. They mainly pursued the rescue and dissemination of information.

Table 3-4 shows the list of other organizations related to rescue and rehabilitation.

There had been observed many foreshocks reached 3 to 4 in JMA scale. Each administration had prepared for the main shock. Some of the executives and disaster relevant personnels remained at the offices afternoon of Jan. 14, although it was Saturday and was half day off. Additionally the main shock took place at 12:24, 24 minutes after the business hours. Personnels who were on their way home quickly came back to the office and built up the emergency system.

Prefectural Government Office transmitted the information about the foreshocks, which JMA had issued, to branch offices of prefectural government and municipal offices. Shimoda City Office announced it to the personnel in the building. Kawazu Town Office judged it not such urgent to disseminate immediately, according to the previous earthquake experiences.

3.3 Refuge and Rescue

The damage brought by the earthquake was mainly caused by landslides. It owes to the steep mountain slope and the weathered igneous rocks. Moreover there existed a possibility of relatively big aftershocks. Damaged area was dotted with the dangerous cliffs and slopes. Issued recommendations to refuge based on the authority of municipality heads are listed in Table 3-5.

Some people in the districts other than those in Table 3-5 evacuated based on their own decision. They had detected the danger of landslide preceding to the recommendation by the municipalities. Moreover the municipalities avoided to spend extra budget to establish refuge places. Table 3-6 shows numbers of evacuees and refuge places. Adding to schools and public halls, private residents were also used for a refuge place.

3.4 Restoration

1) Water Supply Facilities

Water supply facilities consist of municipal and areal water supplies. The scale of the latter is smaller. Water pipes sustained big damage but the filtration plant suffered less damage. Consequently it did not take a long time to restore. As shown in Table 3-7, municipal and areal water supplies were restored by Jan. 26 in Higashi-izu Town and Kawazu Town respectively.

Drinking water shortage was not severe problem during the suspended period of water supply. One reason is each municipality usually prepares water wagons and can supply drinking water if only the water source is survived after the earthquake. The other is water wagon of the Ground Self Defense Force and water boat of Maritime Self Defense Force carried drinking water to disaster-hit area.

The dykes of a sludge reservoir at Mochikoshi gold mine, Chugai Mining Co. Ltd, gave way and a part of sludge with sodium cyanide held there of about 58,500 m³ flowed into the Mochikoshi river and its main river, the Kano river. Izu-nagaoka Town Office halted to take water from the Kano river

when detected sodium cyanide. They have not resume to take water yet as of Feb. 13. They are taking water source from existing wells and narrow streams.

2) Telecommunication Facilities

Damage to telecommunication facilities of Japan Telegraph and Telephone Public Corporation (JTTPC) was not substantial as stated in 2.11. By Jan. 17 most functions had recovered except the 49 circuits in Kami-kawazu, Kawazu Town. Whole circuits had begun the operation by Jan. 25. (Refer Table 3-8)

The demand for the telephone call steeply increased after the earthquake, which caused the difficulty to call from outside of the damaged area. The confused duration went to the end by the day of the main shock. After then telephone network of JTTPC was used as the measures for rescue and rehabilitation of relevant organizations.

3) Electric Power Facilities

The electric power was cut off at about 15,000 residents after the earthquake. Tokyo Electric Power Co. Ltd dispatched 888 personnel from 14th through 16th of Jan. to repair temporarily.

It was finished by 19:15, Jan. 15. Outline of the rehabilitation is in Table 3-8.

4) Gas Supply Facilities

Shimoda City was the only one having areal gas supply service in Izu territory. The gas supply company in Shimoda City examined all gas pipes before resuming the service. Most houses in the area other than Shimoda City were installed with a liquid petroleum gas (LPG) cylinder. The gas company specialists inspected whole cylinders preceding the reopening in Jan. 17.

3.5 Resumption of Traffics and Traffic Control

The skelton of the highway in the Izu Peninsula is consisted of National Highway route 135 and 136 and a Principal Prefectural Road, Shuzenji-Shimoda Line, part of which are toll roads. The railroad network is of Ito Line (JNR, Atami-Ito), Izu-Kyuko Line (Izu-Kyuko Railroad Co. Ltd, Ito-Shimoda) and Izu-Hakone Railroad Line (Mishima-Shuzenji). (See Fig. 3-4)

1) Highways

Most of the damage of highways was generated by landslides from artificially cut and native slopes and at embankments on steep slopes. The damaged sites were too concentrated in the mountaineous area to perform the rehabilitation works all at once. The works were started from both sides of the damaged route and went forward to the middle.

Table 3-9 shows the traffic control. The numbers in the table correspond to those in Fig. 3-4. The site indicated by X is still out of service as of Feb. 12. Out of the major highways Route 136 firstly reopened at 12:00, Jan. 16. As for the route on the east coast, both the Higashi-izu Toll Road and ex-national highway route 135 administrated by Japan Highway Public Corporation (JHPC) and Prefectural Construction Office respectively run in parallel. (Fig. 3-5) Both administrators negotiated the priority of the route to be firstly restored and determined either route site by site in accordance

with the damage circumstances. Drawing an example of the site like Fig. 3-6 the priority was given to the Toll Road even though the restoration of the ex-national highway was obliged to be delayed. In the result the resumption of the ex-national highway is still suspended as of Feb. 12 because of the heavy damage as shown in Photo-1. The Higashi-izu Toll Road was out of service from 14th through 16th of January. It opened from 17th through 29th exclusively to the emergency vehicles only in the daytime (7:00 ~ 19:00). It became shut again from Jan. 30 through Feb. 9 because of the rehabilitation works. Since Feb. 10 it has resumed with some one lane sections. Principal Prefectural Road, Shuzenji-Shimoda Line sustained an extensive damage, where a tourist bus was buried in a landslide and three passengers were dead. Prefectural Construction Office and SDF have made a great effort to restore the road, but it is still out of service as of Feb. 12.

There were little confusion and shortage of daily goods in the damaged area, although two of the major highways were blocked. Because the other major highway, route 136 was reopened relatively soon and was used for the major line of transportation.

Some gardening agriculture of fruits was affected by the traffic control causing the increase of transportation costs.

2) Railroad

Most damage of railroad facilities was of Izu-kyuko Railroad Co. Ltd. The line was stopped after the earthquake and reopened as :

Ito ~ Izu-kogen	12:30, Jan. 15
Izu-kogen ~ Katase-shirata	12:20, Jan. 17
Katase-shirata ~ Inatori	6:55, Jan. 30
Kawazu ~ Shimoda	6:30, Jan. 31

The section between Inatori and Kawazu is still blocked by the tunnel whose lining was crushed due to the active fault. Inatori and Kawazu are connected by bus service so far.

The facilities of Japanese National Railroad (JNR) suffered no damage. However, according to its own regulation of operation, JNR stopped the services and examined the facilities. The resumed time of each line was as below :

New Tokaido Line (superexpress)	16:55, Jan. 14
Tokaido Line	15:15, Jan. 14
Ito Line	15:00, Jan. 14
Minobu Line	12:40, Jan. 14
Futamata Line	14:50, Jan. 14

3.6 Collection and Transmission of Information

Collecting information on the damage itself and the demand of goods and machinery for rehabilitation is the substantial problem in the very beginning of the emergency. Most of the information on the damage of dwellings, water supply, electric power and telecommunication facilities was gathered by midnight of Jan. 14 by

the relevant administrations and public organizations. Though Kawazu Town Office, the most heavily damaged area, could not finish to collect the data by then, and continued it on the next day.

For example, Shimoda City Office dispatched 38 personnels immediately after the earthquake to investigate the damage. They collected up the number and scale of the damage in a few hours and transmitted them to the headquarter of Prefectural Government Office. Detailed investigation was continued from 15th through 18th of January.

The personnels of Kawazu Town Office were dispatched to the damaged district in the town and evaluated damage and losses, but could not finish within the first day. Much information were brought by community chiefs and members of fire self defense squad. Kawazu Town is divided into 23 communities, and daily information has been transmitted by using the community system. In case of the earthquake a community chief voluntarily gathered the information of damage in the community and reported it to the Town Office. Forty municipal officials of Town Office belonged to the fire self defense squad and some of them took a leadership among its members to collect the information.

Community systems were well organized and each citizen knew his duty to cope with natural disaster. It contributed effectively to the collection of information.

Collecting the information on the damage of roads was difficult, because the traffic route itself was blocked everywhere. Especially as for Principal Prefectural Road, Shuzenji-Shimoda Line, entering by an automobile was impossible. The searching personnels of Prefectural Construction Office investigated the damaged sites on foot. It took 3 days to grasp the outline of the damage and more 3 days for detailed investigation.

Three personnels of the Prefectural Government Office flew by a helicopter of SDF over the damaged territory in the afternoon of Jan. 14. However they only recognized the damaged sites and could not grasp the detail, because the pilot was not accustomed to the highway routes and the altitude was relatively high.

Some information on the damage of highways was brought by the road monitors along them whom the road administrator had entrusted to collect the information of accidents and damage. The incident that a tourist bus was buried in the landslide in Nashimoto, Kawazu Town was informed to Prefectural Construction Office by one of the monitors resided beside the Principal Prefectural Road, Shuzenji-Shimoda Line.

Telephone network of JTTPC was also the principal measures for communication in the emergency. However for a few hours after the earthquake the demand for telephone call exceeded the capacity and made it difficult. During the period emergency wireless, eleven circuits of those had been installed in Shizuoka Prefecture, was utilized to communicate between Prefectural Government Office and municipal offices. Prefectural Government has planned to increase the circuits to 35 by October, 1978.

An exclusive circuit was installed temporarily between Prefectural Construction Office and Shimoda Branch in Shimoda Tax Office after the earthquake.

3.7 Other Measures for the Emergency

The collapsed dykes caused the sludge flow in the Mochikoshi and Kano Rivers. Chugai Mining Co. Ltd, owner of the dykes, and the administrators of the rivers both took emergency measures as follows :

1) Temporary rehabilitation of dykes

They repaired the dykes temporarily by driving double steel sheetpiles.

2) Removal of sludge from the Mochikoshi River

They removed the sludge settled on the riverbed and threw away to the abandoned mines. It was scheduled to be finished by Feb. 20 (Refer Photo-2)

Most residents except in Shimoda City were installed with LPG cylinder. The personnels of the LPG supply company examined the whole equipment in Kawazu Town and repaired if necessary. The service was resumed after all examination was over.

Table 3-1 Established Date of Rescue and Rehabilitation Center in each Administration

Administration	Established Date of Rescue and Rehabilitation Center
Shizuoka Prefectural Government Office	January 14, 14 : 10
Shimoda Office, do	January 14, 14 : 10
Kawazu Office, do	January 17,
Higashi-izu Town Office	January 14, 13 : 10
Matsuzaki Town Office	January 14, 12 : 45
Kawazu Town Office	January 14, 14 : 10
Shimoda City Office	January 14, 14 : 50

Table 3-2 Dispatched Self Defense Forces to Damaged Area

Destination	Ground, Maritime, Air	Period	Man-days	Vehicle-days
National Highway Route 136 (Restoration of the Highway)	Ground	Jan.14	680	Tractor Shovel (2) Bulldozer (7) Dump Truck (3) Power Shovel (7)
Amagi-yugashima Town (Restoration of the Highway)	Ground	Jan.18~22	743	(49)
Mitakairiya, Kawazu Town (Searching the Missings)	Ground	Jan.15~29	11,364	Tractor Shovel (10) Trailer (18) Bulldozer (77) Bulldozer for Soft Ground (48) Dump Truck (23) Power Shovel (93) Wrecker (40) Drugshovel (131) Others (535) Oil Pressure Shovel (2) Drain Pump Fire Engine
Nashimoto, Kawazu Town Onabe, Kawazu Town (Rescue for the Bus Accident)	Ground	Jan.15~17	2,344	Wrecker (6) Water Trailer (39) Food Supply Car (21) Ambulance Others (416)
Yugano, Kawazu Town	Ground	Jan.18	50	Dump Truck (3) Power Shovel (2) Others (1)
Numanokawa, Kawazu Town (Watching the Waterlevel of a Stream)	Ground	Jan.20~21	40	Chain Saw Others (4)
Kawazu Town (Water Supply)	Ground	Jan.18~22	139	Water Wagon (22) Filtration Equipment
Kawazu Town (Information Exchange)	Ground	Jan.26~29	490	Aircraft (5)
Mochikoshi, Amagi-yugashima Town (Rehabilitation of the Dyke)	Ground	Jan.15~18	305	Helicopter (60) Bulldozer (8) Trailer (6) Power Shovel (4) Dump Truck (8) Others (14)
Naramoto, Higashi-izu Town (Restoration of the Highway Rescue at a Destroyed Hotel)	Ground	Jan.15~19	1,078	Power Shovel (13) Bulldozer (40) Wrecker (9) Tractor Shovel (4) Dump Truck (64) Air Compressor (9)
Inatori-ko, Higashi-izu Town (Water Supply)	Maritime	Jan.14~24	2,349	Guardboat (4) Troopship (13) Special Ship (2)
Izu Territory (Transportation, Survey)	Air	Jan.14~15	8	Aircraft (2)

Table 3-3 Fire Self Defense Squad Performance

	Jan. 14		Jan. 15		Jan. 16		Jan. 17	
	Per- sons	Performance	Per- sons	Performance	Per- sons	Performance	Per- sons	Performance
Shimoda C.	530	Dissemination of Tsunami Alarm Survey of Damaged Area	184	Rehabilitation	20	Rehabilitation		
Higashi-izu T.	480	Rescue at Takami Hotel Dormitory Rescue at Landslide Site of Higashi- izu Toll Road Rehabilitation Rescue at the Collapsed Building	480	Rehabilitation Water Supply	320	Rehabilitation Water supply	296	Rehabilitation Soil Removal from Road Repair Water Pipe Investigation of Drinking Water
Kawazu T.	330	Rescue at Landslide Site	392	Rescue at Landslide Site	330	Rescue at Landslide Site Rehabilitation	184	Rescue at Landslide Site
Minami-izu T.	200	Dissemination of Tsunami Alarm Watching Tidal Level	45	Reinforcement to Kawazu T.	45	Reinforcement to Kawazu T.	15	Reinforcement to Kawazu T.
Matsuzaki T.	360	Survey of Damaged Area Rehabilitation	360	Survey of Damaged Area Rehabilitation	10	Survey of Damaged Area Rehabilitation		
Nishi-izu T.			81	Clearing Up the Damaged Area				
Kamo V.			60	Survey of Damaged Area Investigation of Danger- ous Site				
Total	1,900		1,602		725		495	

(Table 3-3 continued)

Jan. 18		Jan. 19		Jan. 20		Jan. 21	
Per- sons	Performance	Per- sons	Performance	Per- sons	Performance	Per- sons	Performance
5	Dissemination of Recommendation of Refuge						
270	Traffic Control Soil Removal from Road Assistance for the Removal of Evacuees Investigation of Drinking Water	38	Water Supply	38	Water Supply	57	Water Supply Rehabilitation Patrol
68	Rescue at Landslide Site	83	Rescue at Landslide Site	90	Rescue at Landslide Site	109	Rescue Draining
16	Patrol						
359				128		166	

Table 3-4 Man-days Pursued for Rescue and Rehabilitation of Organizations

Organization \ Item		Period	Man-days	Vehicle-days
Police		Jan. 14	11,551	2,341
Fire Defense	Fire Fighting Squad	Jan. 14 ~ Jan. 30	8,069	—
	Local Public Official	Jan. 14 ~ Jan. 20	471	—
Self Defense Forces	Ground	Jan. 14 ~ Jan. 30	23,065	4,268
	Maritime	Jan. 14 ~ Jan. 24	2,315	23
	Air	Jan. 14 ~ Jan. 15	8	2
Maritime Safety Division		Jan. 15	—	2
JTTPC		Jan. 14 ~ Jan. 18	1,180	303
Tokyo Electric Power Co.		Jan. 14 ~ Jan. 23	2,164	644
LPG Association		Jan. 14 ~ Jan. 23	381	106
Shizuoka Gas Co.		Jan. 14 ~ Jan. 24	388	127
Total			49,592	Vehicles 7,789 Ships 25 Aircrafts 2

Table 3-5 Recommendations of Refuge

Municipality	District	Issued Date of Recommendation	Reason
Matsuzaki Town	Uchino	19:30, Jan. 17	Possibility of landslide
Matsuzaki Town	Ikeshiro	19:30, Jan. 17	Possibility of landslide
Shimoda City	Takeyama in Kakizaki	15:00, Jan. 18	Possibility of rock fall

Table 3-6 Number of Evacuees

Municipality	District	Refuge Place	Number of Evacuees	Refuged Date	Returning Home Date	Cause of Evacuation
Kawazu Town	Mitakairiya	Acquaintance House Apartment House	48	Jan.16, 10:00	Each evacuee returned home by his judgement	Possibility of Landslide
	Mitakahama	Same as above	94	Jan.16, 17:00		Possibility of Rock Fall
	Nashimoto	Same as above	80	Jan.18, 16:00		Possibility of Landslide
	Nawaji	Same as above	1			Possibility of Landslide
	Total		223			
Higashi-izu Town	Kitagawa	Public Hall	8	Jan.14, 12:50		Possibility of Landslide
	Tamachi-ohata	Acquaintance House	53	Jan.21, PM		} Possibility of Overturning of a Hotel Building
	Inatori	Hotel	48	Jan.21, PM		
	Total		109			
Amagi- yugashima Town	Kayano	Acquaintance House	7	Jan.14, 16:00		Possibility of Landslide
	Total		7			
Grand Total			339			

Table 3-7 Rehabilitation of Water Supply Facilities

Area	Supplying Population	Capacity	Restored Date	Emergency Measures
Shimoda City Water Supply	29,982	Ochiai 25,000 m ³ /day Kawauchi 2,000 m ³ /day	Jan. 17, 17:00	Water Wagon of 1.5 t (1)
Higashi-izu Town Water Supply	14,498	Shirata River 20,000 m ³ /day	Jan. 24, 17:00	Water Boat (2), SDF Water Wagon (22)
Kawazu Town Water Supply	6,302	Ozeki Mine Sasahara 11,500 m ³ /day Mitakairiya 500 m ³ /day	Jan. 20, 14:00	Water Wagon (7)
Minami-izu Town Water Supply	5,662	Ishii 5,159 m ³ /day	Jan. 14, 20:00	
Higashi-izu Town Okawa Areal Water Supply	1,095	225 m ³ /day	Jan. 15, 15:00	
Kawazu Town Kami Areal Water Supply	1,768	360 m ³ /day	Jan. 21, 15:00	Water Wagon (1)
Kawazu Town Onabe Areal Water Supply	245	60 m ³ /day	Jan. 21, 12:00	Water Wagon (1)
Kawazu Town Kamisagano Areal Water Supply	279	70 m ³ /day	Jan. 19, 15:00	Water Pool (1)
Kawazu Town Nashimoto Areal Water Supply	320	100 m ³ /day	Jan. 26	Water Pool, 500 l (2)
Matsuzaki Town Water Supply	519	6,200 m ³ /day	Jan. 17, 18:00	
Nishi-izu Town Water Supply	8,500	7,500 m ³ /day	Jan. 18, 18:00	
Nishi-izu Town Shirakawa Areal Water Supply	160	60 m ³ /day	Jan. 16, 18:00	
Nishi-izu Town Miyagahara Areal Water Supply	178	45 m ³ /day	Jan. 17, 17:00	
Nishi-izu Town Yoshinohata Areal Water Supply	160	85 m ³ /day	Jan. 16, 18:00	
Kamo Village Ukusu Areal Water Supply	1,760	635 m ³ /day	Jan. 16, 15:00	
Kamo Village Arori Areal Water Supply	2,311	465 m ³ /day	Jan. 17, 18:00	

Table 3-8 Restoration of Electric Power, Gas and Telephone Facilities

	Municipality	Number of Residents out of Services	Restoration
Electric Power	Shimoda City Kawazu Town Higashi-izu Town	} 15,000	Restored temporarily by Jan. 15, 19:15
LPG	Kawazu Town Higashi-izu Town	2,800 5,200	Inspected the overturned gas cylinder by Jan. 17
Gas Supply	Shimoda City	2,000	Inspected the gas pipes by Jan. 14
Telephone	Higashi-izu Town Kawazu Town Shimoda City Ito City Nishi-izu Town	160 140 30 30 70	Restored temporarily by Jan. 16 except Nashimoto, Kawazu Town by Jan. 25

Table 3-9 List of Traffic Control

Num- ber	Route	Site	Traffic Control			
			Cause	Started Date	Rescinded Date for Emergency Vehicles	Retrieval
1	Route 135 (Ex-nation- al High- way)	Akazawa, Ito City	Landslide Rock Fall	Jan. 14, 13:00		X
2	"	Okawa, Higashi-izu Town	Landslide	Jan. 14, 13:00		X
3	"	Atagawa, Higashi-izu Town	Landslide	Jan. 14, 13:00	Jan. 14, 19:00	
4	"	Kurone, Higashi-izu Town	Landslide	Jan. 14, 13:00		X
5	"	Kurone, Higashi-izu Town	Landslide	Jan. 14, 13:00		X
6	Route 136	Kami-funahara Amagi-yugashima Town	Landslide	Jan. 15, 8:00	Jan. 15, 9:40	Jan. 15, 17:00
7	"	Yagisawa, Doi Town	Landslide	Jan. 15, 8:00	Jan. 15, 9:40	Jan. 16, 12:00
8	"	Komine, Doi Town	Landslide	Jan. 15, 8:00	Jan. 15, 9:40	Jan. 16, 12:00
9	"	Fukada, Kamo Village	Landslide Rock Fall	Jan. 15, 8:00		Jan. 16, 12:00

(Table 3-9 continued)

Number	Route	Site	Traffic Control			
			Cause	Started Date	Rescinded Data for Emergency Vehicles	Retrieval
10	P.P.R. Shuzenji-Shimoda	Yoichizaka, Amagi-yugashima Town	Rock Fall	Jan. 14, 13:00	Jan. 14, 15:00	X
11	"	200 m far from Toll Gate	Landslide	Jan. 14, 13:00	Jan. 14, 15:00	
12	"	more 200 m far from Toll Gate	Landslide	Jan. 14, 13:00		X
13	"	Kawaaino, Kawazu Town	Landslide	Jan. 14, 13:00		X
14	P.P.R. Shimoda-Matsuzaki	Akebuse, Matsuzaki Town	Rock Fall	Jan. 14, 13:00	Jan. 14, 13:00	
15	"	Yokokawa, Shimoda City	Rehabilitation Works	Jan. 16, 11:00		
16	P.P.R. Ito-Nishiizu	Miyagahara, Nishi-izu Town	Landslide	Jan. 14, 14:00		X
17	"	Yaemeno, Nishi-izu Town	Landslide	Jan. 15, 8:00		X
18	"	Mochikoshi, Nishi-izu Town	Landslide	Jan. 14, 13:00	Jan. 14, 13:00	X
19	"	Kokushi-toge, Naka-izu Town	Landslide Rock Fall	Jan. 15, 9:30		Jan. 15, 14:25
20	P.R. Ito — Kawana—Yawatano	Futo, Ito City	Landslide Rock Fall	Jan. 14, 13:00		Jan. 14, 19:00 (One Lane)
21	P.R. Atagawa—Katase	Atagawa, Higashi-izu Town	Landslide	Jan. 14, 13:00		X
22	P.R. Yugashima—Matsuzaki	Onabe, Kawazu Town	Landslide	Jan. 15, 8:00		X
23	"	Ikeshiro, Matsuzaki Town	Landslide	Jan. 15, 8:00		X
24	P.R. Shimodako	Benten-bridge, Shimoda City	Subsidence of Bridge	Jan. 14, 13:00		
25	P.P.R. Shuzenji-Shimoda	Sakagawa, Kawazu	Rehabilitation Works	Jan. 17, 9:00		X
26	Route 135 (Higashi-izu Toll Road)	Okawa, Higashi-izu Town	Slope Failure	Jan. 14, 13:00		
27	"	Naramoto, Higashi-izu Town	Slope Failure	Jan. 14, 13:00		

P.P.R. : Principal Prefectural Road

P.R. : Prefectural Road

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(Fig. 3-1 continued)

Date	Earthquake phenomena	Countermeasures			
		Establishment of Disaster Rehabilitation Center	Relief and Rehabilitation	Reconstruction	Information
Jan. 15	0:12 ~ 18:53 II, 15 times III, 10 times in Shimoda in which 5.7 of magnitude was the maximum	14:50 Shimoda C. 8:00 Nishi-izu T. Kamo V.	Five hundred tourists evacuated from Higashi-izu T. by ship 16:00 Accounting Superintendent of Prefectural Government left to Kawazu 20:45 SDF arrived at Kawazu 9:30 Investigation group of National and Prefectural government set off to the damaged area 19:15 Electric power supply in Higashi-izu and Kawazu T. was resumed	19:30 Disaster Relief Law was adopted to Higashi-izu and Kawazu T.	15:50 Temporary Announcement on the volcano by Ohshima Observatory 22:20 Temporary Announcement on the volcano by Ohshima Observatory
Jan. 16	II, 5 times III, 3 times in Shimoda				

(Fig. 3-1 continued)

Date	Earthquake phenomena	Countermeasures			
		Establishment of Disaster Rehabilitation Center	Relief and Rehabilitation	Reconstruction	Information
Jan. 17	9:44 ~ 21:06 II, 4 times in Shimoda	8:00 Kawazu Office of Prefectural Government	Route 135 was resumed exclusively for the emergency vehicles		Exclusive circuit between Shimoda Construction Office and Shimoda Branch Office
Jan. 18	5:22 ~ 9:38 II, 2 times in Shimoda		19:30 Residents evacuated in Matsuzaki T. because of the possibility of landslide 11:40 Governmental investigation group came to the damaged area		13:30 Announcement on the aftershocks to Shimoda Branch Office Slight panic was generated.
Jan. 19	17:45 III in Izu-Ohshima		15:00 Residents evacuated in Shimoda C. because of the possibility of rock fall		
Jan. 20			Temporary dwellings were constructed in Kawazu T.		
Jan. 21			Works to prevent rock fall in Shimoda C. was completed		
Jan. 22			15:00 Evacuees in Shimoda C. returned home		

(Fig. 3-1 continued)

Date	Earthquake phenomena	Countermeasures			
		Establishment of Disaster Rehabilitation Center	Relief and Rehabilitation	Reconstruction	Information
Jan. 24			17:00 Water supply in Inatori, Kawazu T. was recovered		Shimoda Branch Office reported the outline of the loss
Jan. 25			Facilities of JTTPC were recovered		
Jan. 26					
Jan. 27					
Jan. 28					
Jan. 29			SDF withdrawn from Mitaka-iriya, Kawazu T.	Explanation meeting on disaster relief loan of the Housing Loan Corporation in Higashi-izu T.	
Jan. 30		Closed in Shimoda C., Amagi-yugashima T.	Resumption of the sections of Ito ~ Inatori and Kawazu ~ Shimoda of Izu-kyuko Railroad Co. Ltd.		
Jan. 31					

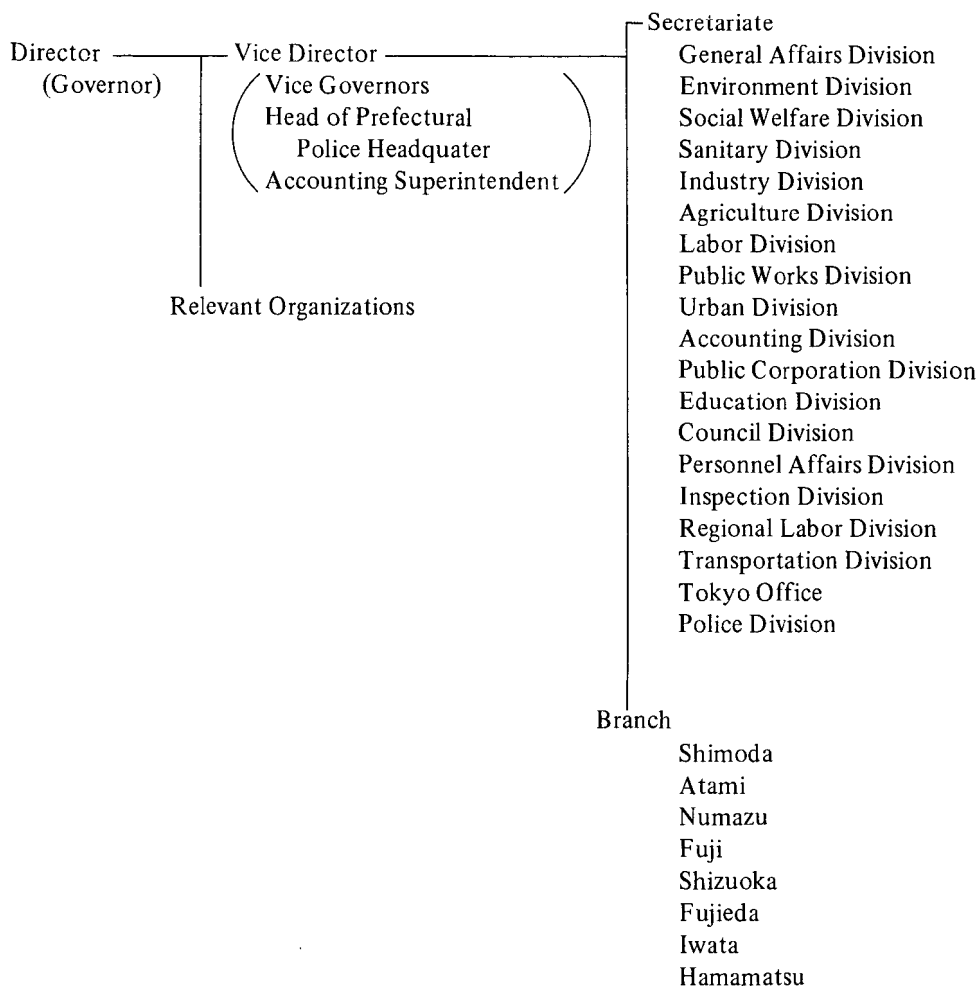


Fig. 3-2 Structure of Rescue and Rehabilitation Center of Shizuoka Prefectural Office

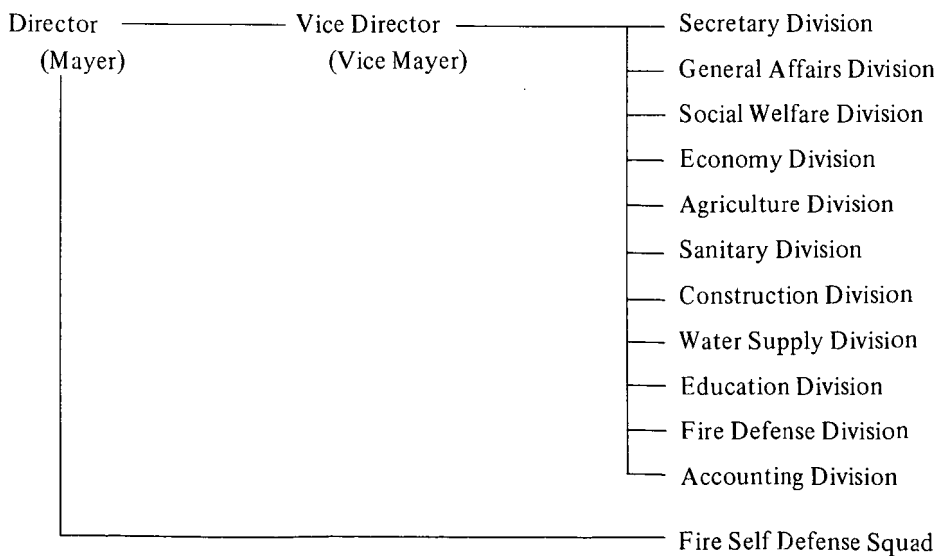


Fig. 3-3 Structure of Rescue and Rehabilitation of Shimoda City Office

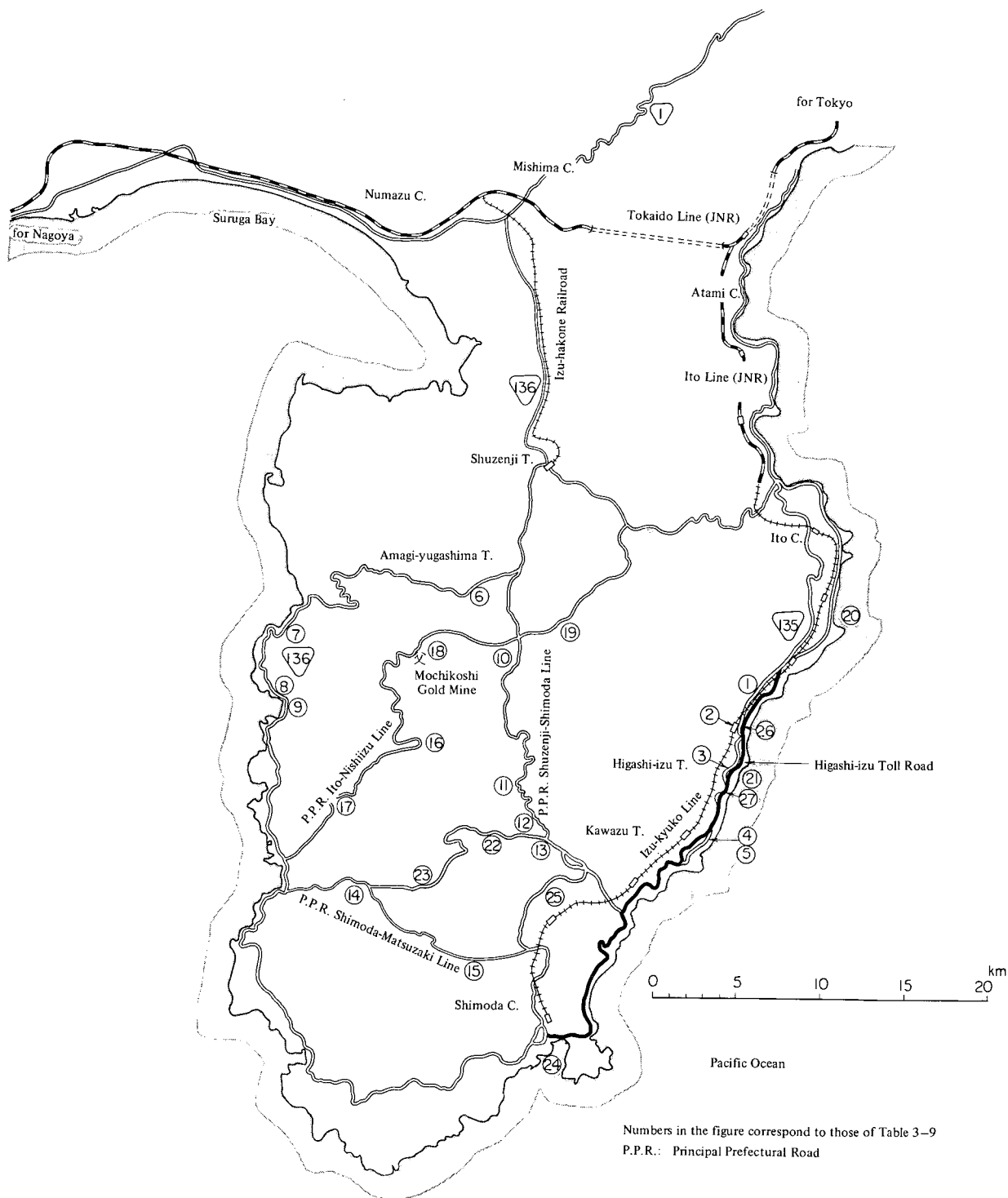


Fig. 3-4 Transportation Network in Izu Territory

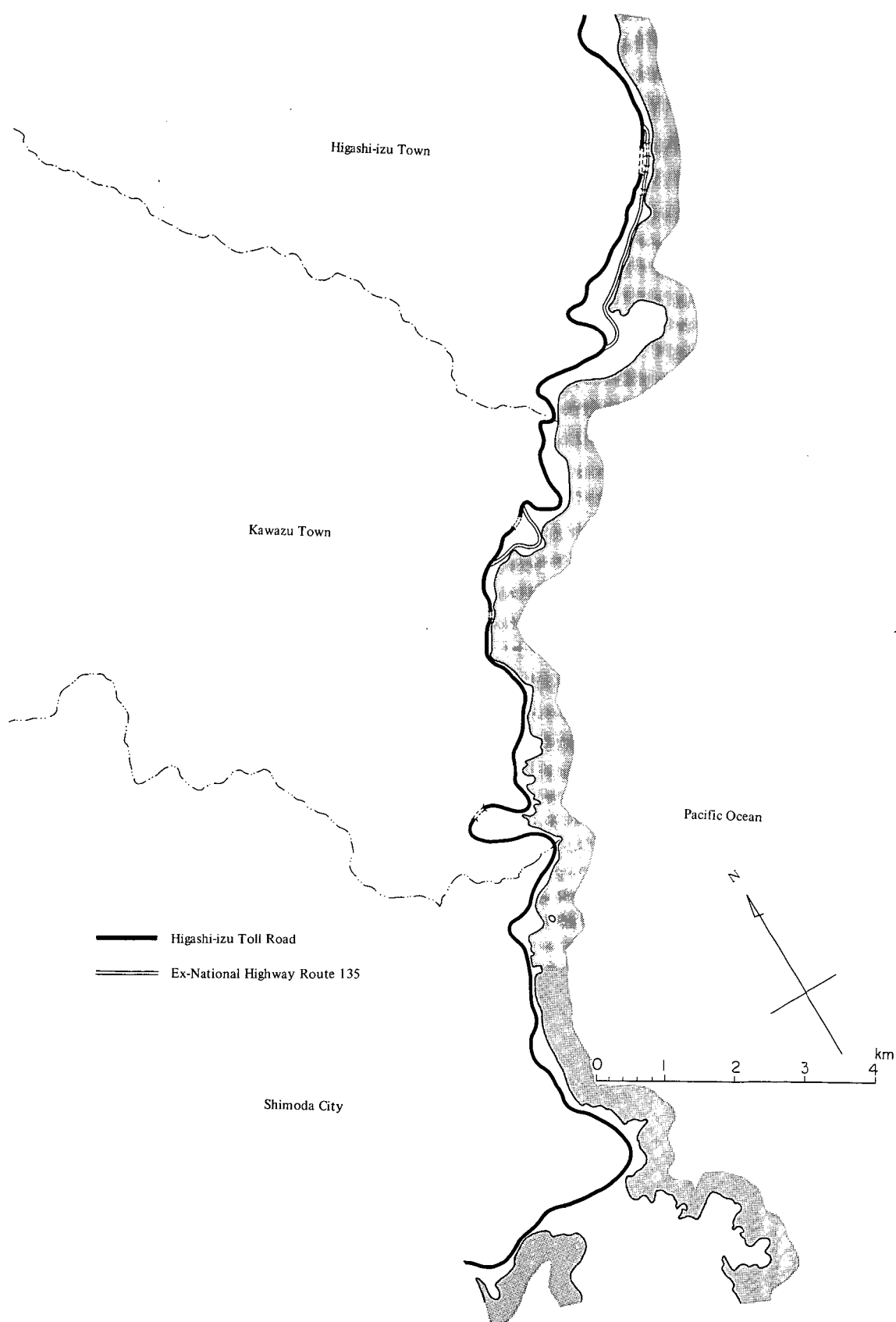


Fig. 3-5 Route of 135th National Highway

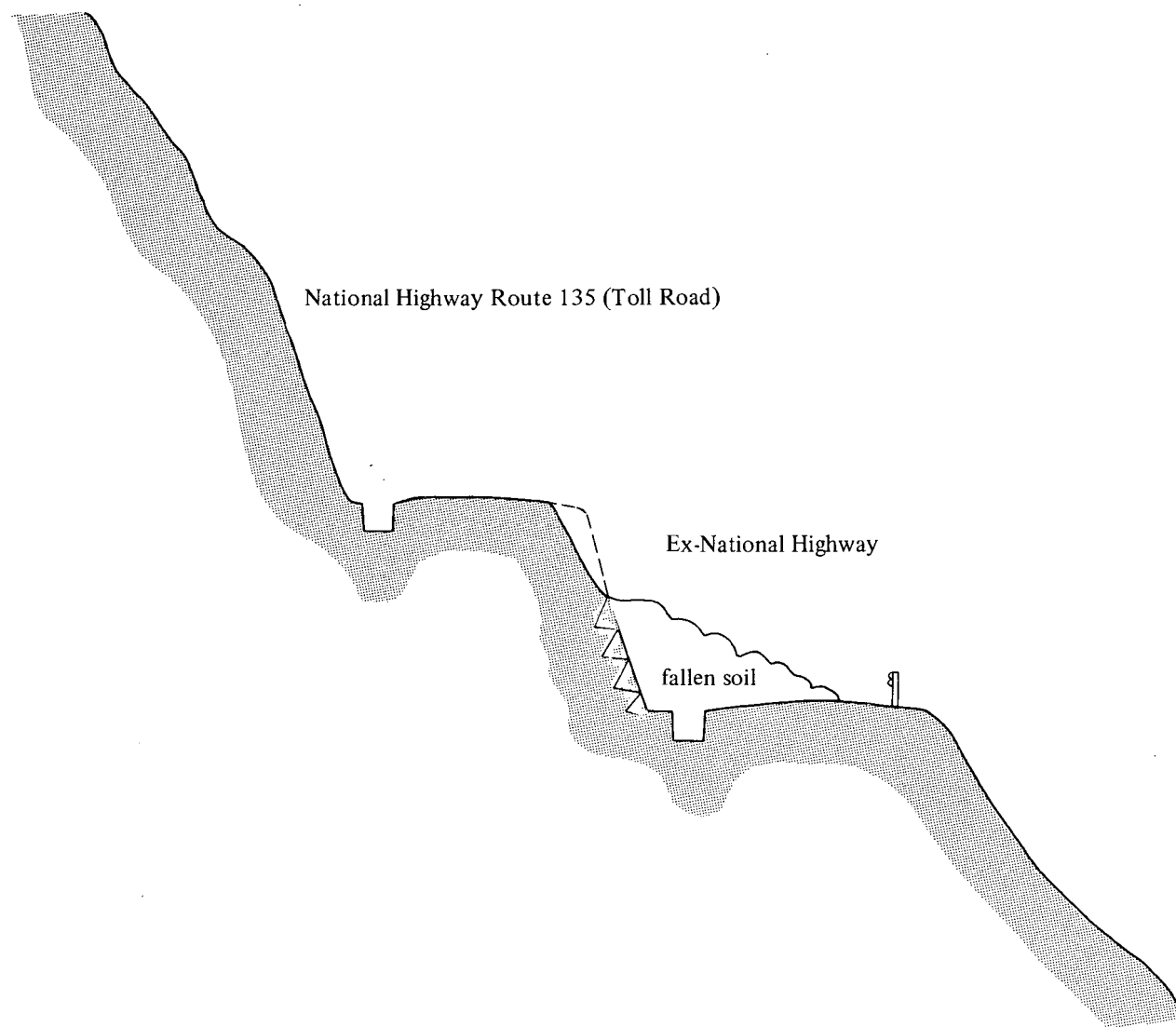


Fig. 3-6 Abstract of the Landslide at Route 135

4. Reconstruction

4.1 General Description

After the emergency period it gradually gets on to the permanent countermeasures of reconstruction.

Reconstruction could be defined as the assembly of several measures and works in order to have recovered the economy to the pre-disaster level. The reconstruction measures of relevant administrations and enterprises are introduced in this chapter.

4.2 Application of Law Systems for Relief

The law systems applied by the relevant administrations are listed below :

1) Disaster Relief Law

Disaster Relief Law was applied in ;

Higashi-izu Town	19:30, January 15
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Kawazu Town	19:30, January 15
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2) Designation of Violent Disaster

Designation of Violent Disaster is under consideration for the time being by the Cabinet. The damage of agriculture and minor enterprises in Higashi-izu and Kawazu Towns will possibly be designated. Only Kawazu Town will possibly be designated for the violent disaster concerning public works.

3) Loans

People whose dwelling was totally or half destroyed by the earthquake were qualified to have the disaster relief loan of the Housing Loan Corporation. The explanation meetings were held in Kawazu and Higashi-izu Towns on Jan. 28 and 29 respectively.

Tourism enterprises received the loans of People's Finance Corporation and Minor Enterprises Finance Corporation.

4) Exemption of Tax

The fixed property tax of the razed houses was exempted.

The enterprises suffered some damage were exempted from the enterprise tax, real estate acquisition tax, auto tax, and automobile acquisition tax. The restaurant tax was also deferred.

Compulsive car inspection was deferred for a month in the damaged district.

5) Aid

Shizuoka Prefectural Government decided to aid the people, whose residential land is dangerous for landslide due to the earthquake, in the case when its preventive cost exceeded 500 thousand yen. The Government aided half of the expense which reached 53,900 thousand yen in total.

4.3 Reconstruction Works of Public Utilities

Reconstruction works of civilengineering, agricultural and educational facilities have been performed or are being prepared. Table 4—1 shows the public works of civilengineering structures qualified for the national subsidy. Ministry of Construction urgently qualified first 39 reconstruction sites for the subsidy from 15 th through 17 th of February. Other qualification by the ministry is to be followed soon.

4.4 Other Articles concerning Reconstruction Measures

Izu-kyuko Railroad Co. Ltd has considered the reconstruction method of the Inatori tunnel, a most heavily damaged structure, in order to resume the blocked section as early as possible. The tunnel had been constructed in a circular section as illustrated in Fig. 4—1 and had been left with a space to the construction limit. The interior lining inside the existing one is the likliest method of reconstruction so far.

As for the Mochikoshi mine, Mochikoshi Mine Reconstruction Countermeasures Committee headed by Prof. H. Yamaguchi of Tokyo Institute of Technology has been established since Jan. 28.

Table 4-1 Budget of Rehabilitation Works of Public Civilengineering Facilities

(Budget : 1000 yen)

Construction Office of Prefectural Government	Administrator	River Works		Coastal Works		Sabo Works		Road Works		Bridge		Total	
		Sites	Budget	Sites	Budget	Sites	Budget	Sites	Budget	Sites	Budget	Sites	Budget
Shimoda	Prefecture	16	58,056			5	108,200	253	10,181,371	3	4,298	277	10,351,925
	Municipalities	35	186,905					442	1,480,998	4	35,080	481	1,702,983
Atami	Prefecture							5	36,750			5	36,750
	Municipalities							1	7,500			1	7,500
Numazu	Prefecture							25	414,650			25	414,650
	Municipalities							11	53,600			11	53,600
Total	Prefecture	16	58,056			5	108,200	283	10,632,771	3	4,298	307	10,803,325
	Municipalities	35	186,905					454	1,542,098	4	35,080	493	1,764,083
	Grand Total	51	244,961			5	108,200	737	12,174,869	7	39,378	800	12,567,408

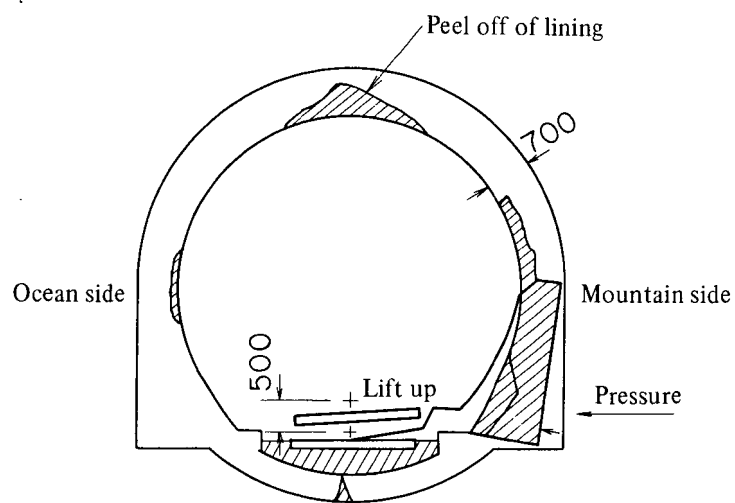


Fig. 4-1 Cross Section of Inatori Tunnel, Izu-kyuko Line

5. Specific Matters Referring Experiences of Past Disasters

5.1 General Description

Emergency measures and reconstruction are obliged to be conducted during the utter confusion among the relevant organizations. Accumulated experiences of past disasters and disaster-oriented, well systematized organizations are both indispensable. This chapter describes how the organizations utilized the experiences and systematized themselves after the disaster.

5.2 Effectiveness of Experiences of Past Disasters

The Izu Peninsula have suffered frequent natural disasters. Kano-gawa typhoon of 1958 killed 1269 people. As for these five years, it has sustained disasters as ;

Izu-hanto-oki earthquake	May,	1974
Flood	July,	1974
Heavy rain	July,	1975
Heavy rain	July,	1976
Kawazu earthquake	Aug.	1976
Heavy rain	Oct.	1976

Consequently people and administrative personnels in the district have well prepared for disaster induced phenomena.

Installing water wagons in each municipality as stated in 3.4 was a typical example of preparation.

The Izu Peninsula is involved in Fuji-Hakone National Park and occupied by many tourists all year around. In the event of the flood of July, 1974, several traffic routes were blocked and tourists stayed in Shimoda City could not refuge to outside. They rushed into Shimoda Port causing slight panic. Referring this experience tourists were ordered after the earthquake to remain in their hotels until the transportation was assured. The municipal offices asked or hired boats of SDF, Maritime Safety Division and private shipping companies to transport them to the safer place as Atami and Ito Cities. Table 5-1 shows the number of tourists brought by ships.

Because the route 135 on the east coast was damaged, Prefectural Construction Office put a priority of reconstruction to its by-pass, a section between Shimoda City and Kawazu Town of Principal Prefectural Road, Shuzenji ~ Shimoda Line. Tourists left in a train at Kawazu St. evacuated through this resumed road to Shimoda City.

Shimoda City has experienced tsunamis (tidal waves) as shown in Table 5-2. Regarding the experiences the City Office has designated the refuge places high up on the hills to evacuate from tsunamis. They have marked the anticipated water level of tsunamis on electric power poles to draw attention of citizens. It entrusted the personnels of a fishermen's union at Shimoda Port to observe the tidal level, besides the data collection by the municipal officials themselves.

Japan Meteorological Agency (JMA) issued the tsunami warning 12:31, Jan. 14. However Shimoda City is located only about 30 km far from the epicenter and the first wave of the tsunami was estimated to reach about 10 minutes after the earthquake, if the average sea depth was assumed to 500 m. Announcing the order to evacuate could be too late in practice. As a matter of fact many citizens evacuated by their own decision to the designated refuge places.

The observed tsunami was about 10 cm and the warning was canceled at 14:15.

5.3 Operation of Organizations

In case of emergency organization system of each administration is not the same as that of usual. It puts emphasis on rescue, rehabilitation and reconstruction of the disaster than the daily business.

In this disaster Kawazu office of Prefectural Government in Kawazu Town Office was exceptionally established, besides the branch in Shimoda City which has been prescribed in a prefectural plan. Kawazu office, headed by an accounting superintendent of prefectural government, controlled the rescue, rehabilitation and reconstruction throughout the damaged area. A meeting was held every morning at Kawazu office attended by personnels of relevant municipalities, branch offices of prefectural government, Higashi-izu Toll Road Office (JHPC), Izu-kyuko Railroad Co. Ltd, SDF and police. They exchanged the information and transmitted it to their mother organizations if required. The accounting superintendent led the meeting, made functioned the organizations effectively and arranged the functions of each organizations.

In the event of the eruption of Mt. Usu of 1977, ⁶⁾ Iburu Branch Office of Prefectural Government played an important role in collection and exchange of information. The equivalent organization here was Kawazu office. The reason why a temporary organization, Kawazu office, was set up can be considered as ;

- 1) The scale of the disaster of Mt. Usu eruption was smaller than that of Izu-ohshima-kinkai Earthquake. Prefectural Government did not judge a front base was necessary,
- 2) Shizuoka Prefectural Government judged that establishing an advanced office was more effective for the business referring to the experiences of the accounting superintendent to several natural disaster, and,
- 3) Shimoda Branch of prefectural government was set up at Shimoda Tax Office. It did not accostomed with the affairs of natural disasters because it was usually responsible for the tax collection.

The director of Prefectural Construction Office in Shimoda led the reconstruction works of public facilities in Kawazu office.

5.4 Other Specific Matters

The information about the damage caused by a disaster is generally too enormous to be collected only by the relevant administrations. The instruction to avoid the danger of disaster covering whole alternative cases must be too complicated to be prepared. If the instruction as above were prepared, a time lag due to the dissemination is inevitable. Therefore people are required to defend themselves from natural disasters to some

extent. In the Izu Peninsula a community system and a fire self defense squad had been well organized, and it contributed the collection and transmission of information.

Pressmen are apt to disturb the business of administrations by interrupting by an interview. The mayor of Kawazu Town set his desk in a front hall of the office building to receive pressmen by himself.

Table 5-1 Emergency Conveyance of Tourists by Ships (as of Jan. 14 and 15)

Departure Place	Ship Owner	Destination	Member of crew
Shimoda City	Self Defense Forces	Ito	227
	Tokai Shipping Co.	Atami	743
	Tokai Shipping Co.	Inatori	143
	Izukyu Shipping Co.	Inatori	121
	Total		1234
Higashi-izu Town	Izukyu Shipping Co.	Ito	300
	Self Defense Forces	Ito	70
	Tokai Shipping Co.	Atami	450
	Fishing Boat	Kitagawa ~ Yawatano	50
	Total		870
Matsuzaki Town	Izu-hakone Railroad Co.	Numazu	402
Nishi-izu Town	Izu-hakone Railroad Co.	Numazu	640
Grand Total			3146

Table 5-2 Tsunamis Having Affected Shimoda City

Date	Epicenter	Magnitude	Maximum Water Level Observed (m)		Dead	Houses Carried Away by Tsunami	Half-destroyed Houses	Flooded Houses	Sunk Ships
Feb. 3, 1605	Off Nankaido Off Boso Peninsula	7.9							
Dec. 31, 1703	Sagami Bay	8.2			27	332	160		81
Oct. 28, 1707	Tokaido, Nankaido	8.4	Shimoda 5.6 Okakata 4.4 Kakizaki 6.7		11	857	55		93
Dec. 23, 1854	Off Tokaido	8.4	Shimoda 5.7		122	841	30		about 30
Dec. 24, 1854	Off Nankaido	8.4	Okakata 4.8 Kakizaki 6.7						
Sept. 1, 1923	Sagami Bay	7.9	Kakizaki 4.6 Sotoura 4.1			2	9	334	
Dec. 7, 1944	Kumano-nada	8.3	Suzaki-Town 2.1 Daiku Town 1.9 Kakizaki 2.5					186	86
Dec. 21, 1946	Off Nankaido	8.1						245	26
Nov. 5, 1952	Off Kamchatka Peninsula	8.3	Shimoda 1.5					120	
May 24, 1960	Off Chile	8.3~8.5	Shimoda 1.14					38	

6. Lessons from this Disaster

6.1 Lessons on the Post-earthquake Countermeasures

Grasping the damage of a disaster is the premise to perform post-earthquake countermeasures.

In this disaster most relevant administrations collected the information on the damage except that of highways by the end of the day of the earthquake. As for highways it took three days to grasp the damage.

It is recommendable in Japan, where mountains are steep and many trunk lines of transportation concentrate to a narrow flat, to develop an effective and quick measures to survey the damage.

Telecommunication networks, as JTTPC's and emergency wireless of Prefectural Government, functioned satisfactorily except the confused period of JTTPC's network for a few hours. Expanding and strengthening emergency networks should be more encouraged.

Shizuoka Public Safety Commission (SPSC) ordered to stop the traffic where the road was blocked by landslides, etc. in cooperation with the road administrators. It gave the privilege to pass the road resumed based upon the Disaster Countermeasures Basic Law to emergency vehicles for about a week. The owner of a vehicle who wanted to get the privilege applied to SPSC. When it was qualified, a specific seal was granted to paper on the front glass. The number of vehicles qualified reached 7395, which disturbed the rehabilitation and reconstruction of road to some extent. Whether the reconstruction of native slopes upper the road, which are administered by the Forestry Bureau is performed by the Forestry Bureau or by the road administrator, is still suspended.

6.2 Lessons on the Organizational Systems

During the emergency each section related to rehabilitation and reconstruction is very busy. Overwhelming business burdens them and still rapidness is demanded. Therefore each section tries to have put a priority to its own business. Exchanging the information and adjusting among several sections is inclined not to be smooth. To solve this problem following measures can be mentioned :

- 1) Increasing the opportunity to exchange the information as much as possible,
- 2) Establishing a mighty section or post to supervise other sections.

In case of Mt. Usu eruption (Reference 6)), authorities concerned harmonized their duties by employing the first measures above. In this earthquake the accounting superintendent corresponded to the post in the second measures. He did not have any institutional right to supervise other organizations than the Prefectural Government Office and its branch offices. But he substantially controlled the business of the administrations and relevant organizations in the damaged area. It prevented the conflict of opinion among several sections and organizations.

Dispatching the accounting superintendent to the disaster-hit area and having supervised various organizations in the emergency seems to be almost fixed, regarding the experiences of past disasters in Shizuoka Prefecture. He had visited Izu territory for five times for disaster relief. He knew well in detail about this area. It contributed a lot to the rehabilitation and reconstruction of this disaster.

The person who controls whole sections and organizations relevant to a disaster should possess not only the mighty authority but also many experiences to cope with the disaster rehabilitation and reconstruction, which bring an abnormal period to organizations.

Road in Japan is maintained by various administrators, such as Ministry of Construction, Prefectural Government, Municipality, JHPC and administrators of port and forest, depending upon its classification. In usual each road administrator mutually exchanges the data of its own road and maintains road network cooperatively. Exchanging information should be more assured in the emergency.

Higashi-izu Toll Road of JHPC and ex-national highway route 135 maintained by Shimoda Construction Office run in parallel on the east coast. (Fig. 3-5) Both road administrator put a priority on either route to be firstly resumed. The route was opened to the emergency vehicles on Jan. 17. On the other hand some discredited information on the state of road was announced from each other administrator.

A method of announce the information from plural administrators is to be improved in the future.

6.3 Other Lessons from the Earthquake

1) The organization systems to cope with natural disasters has been satisfactorily developed in Japan, as referred in the existing report on the disaster preparedness. Shizuoka Prefectural Government had improved its organization system and information network, and had stored daily goods for emergency, especially because a seismologist warned the possibility of "Great Tokai Earthquake" to occur within Suruga Bay.¹⁰⁾ The Government had newly established the Earthquake Countermeasures Section in 1977. These measures created the awareness of personnels of administrations and citizens to prepare for the possible earthquakes. For example no fire broke out after the earthquake. Because most people turned off the gas, some of whom even got burnt in the hand.

2) Most roads in the Izu Peninsula are constructed by cutting and banking on a steep slope. The possibility of occurring landslides along the roads is considered to be higher than that of other territory in Japan. In order to improve the situation stated above the road administrator (i.e. Shizuoka Prefectural Government) is planning to construct a new disaster-proof highway consisted mostly of long span bridges and tunnels. This plan is quite reasonable in a sense that the disaster potential should be mitigated according to the basic idea of disaster prevention. However post-disaster countermeasures should not be overlooked. Especially the people in Izu territory have been accustomed to cope with natural disasters. Therefore relying only upon the improvement of facilities is not practical and economical. It is recommended for the reconstruction of roads in the territory to harmonize both pre- and post-earthquake countermeasures.

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Mr. K. Hayashi, Director, et al.
3. Numazu Construction Office, Chyubu Regional Construction Bureau, Ministry of Construction
Mr. J. Taguchi, Director, et al.
4. Shizuoka Prefectural Government Office
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5. Shimoda Tax Office, Shizuoka Prefectural Government
Mr. F. Yamashita, Director, et al.
6. Shimoda Construction Office, Shizuoka Prefectural Government
Mr. M. Suzuki, Director, et al.
7. Municipal Office of Shimoda City
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8. Municipal Office of Amagi-Yugashima Town
Mr. M. Ohkawa, Chief of General Affairs Section, et al.
9. Municipal Office of Kawazu Town
Mr. G. Masaki, Mayor, et al.
10. Municipal Office of Higashi-Izu Town
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11. Higashi-Izu Toll Road Administration Office, Japan Highway Public Corporation
Mr. H. Nakamori, Director, et al.
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[63 : provided by Tokyo Electric Power Co. Ltd.]

APPENDIX

I. Historical Earthquake Records in Shizuoka Prefecture after Documents No. 19

Date and year	Epicenter	Magnitude
Nov. 29, 684 A.D.	Off Tokaido	Very large
July 4, 715	Totomi Area	6.4
818	Sagami Bay	7.9
July 30, 841	Izu Area	7.0
Aug. 22, 887	Nankaido Area	8.6
Oct. 29, 937	Izu Area	—
Dec. 11, 1096	Off Tokaido	8.4
1406	Suruga Area	—
Sep. 11, 1498	Off Tokaido	8.6
Sep. 10, 1510	Off Tokaido	—
March 21, 1589	Off Ohigawa Riv.	6.7
Feb. 4, 1605	Off Tokaido	7.9
Oct. 1626	Off Tokaido	—
March 1, 1633	Sagami Bay	7.1
Sep. 10, 1699		—
Dec. 31, 1703	Sagami Bay or off Boshyu	—
Jan. 2, 1704		8.2
Oct. 28, 1707	Tokaido or Nankaido Area	8.4
Sep. 18, 1711		—
Dec. 23, 1854 (Ansei-Tokai)	Off Tokaido	8.4
Dec. 24, 1891	Middle of Ohigawa Riv.	—
Sep. 1, 1923 (Kanto)	Off Odawara	7.9
Feb. 21 ~ May 17, 1930 (Swarm of Ito Ear.)	Off Ito	
Nov. 26, 1930 (Kitaizu)	North of Izu Peninsula	7.3
July 11, 1935 (Shizuoka)	Shizuoka City	6.7
Dec. 17, 1944 (Tonankai)	Gulf of Kumano	8.3
Apr. 20, 1965	Estuary of Ohigawa Riv.	6.1
May 9, 1974 (Izuhanto oki)	Off Izu Peninsula	6.9
Aug. 18, 1976 (Kawazu)	East of Izu Peninsula	5.4

II. Questionnaire Used in the Interviews to the Personnel of Administrative Organizations

1. Outline of the Damage
2. Organizational Response of the Administration
3. Damage of Urban and Housing Facilities
4. Damage of Hydraulic Facilities
5. Damage and Rehabilitation of Lifeline System
 - a. Highway
 - b. Railroad
 - c. Electric Power
 - d. Telecommunication
 - e. Water Quality
 - f. Water Supply
 - g. Fuel
6. Financial Aids, Loans and Tax Exemptions
7. Losses Valued in Money
8. Other Related Comments

The Investigation on the Rescue and Rehabilitation of the
1978 Izu-Ohshima Kinkai Earthquake

The Investigation on the Rescue and Rehabilitation of the 1978 Izu-Oshima Kinkai Earthquake

Preliminary Report of Investigations on
the Relief and Rehabilitation in the
Izu-Ohshima Kinkai Earthquake of
1978

土木研究所資料第1344号
昭和53年 2 月(1978年)
建設省土木研究所耐震研究室

2

キーワード：伊豆大島近海地震・応急対策・復旧

要旨 1978年伊豆大島近海地震による災害に際してとられ
た復旧等の措置の時間的な経過および措置の実施体制に
ついて国の機関、地方公共団体、公益企業等を主として、
調査した結果を報告するものである。(英文)



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上記のとおり受領しました。

所 属（住所）

氏 名 印