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FLOOD CONTROL COUNTERMEASURES IN JAPAN

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1. The Main Characteristics of Rivers in Japan

The main natural characteristics of Japanese rivers are:

i) The rivers have extremely steep gradients in comparison with rivers in other countries due to Japan's mountainous topography.

ii) Precipitation is high. Particularly in the rainy and typhoon seasons, where heavy rainfall is concentrated within a short time.

As a result of these characteristics:

i) Floodwater discharge occurs within a very short time after the beginning of rainfall, and the length of time that the floodwaters continue is relatively short.

ii) There is a significant difference in the discharge during normal periods and the discharge during a deluge. The floodwater discharge per unit catchment area is extremely large in comparison with that of the rivers in other countries.

iii) Floodwater discharge flows are extremely rapid, scouring turbulent flow and erosion are considerable.

At the same time, as Japan is very mountainous, the country's population, resources, and metropolitan functions tend to be concentrated in the alluvial plains, the so-called floodplains, that account for a mere 10% or so of the national land area. It is said that about 50% of the total population, and around 75% of the total property are concentrated in such floodplains. There is always the inherent danger of severe damage and disruption to the daily lives and economic activities of the inhabitants in the event of flooding of the rivers.

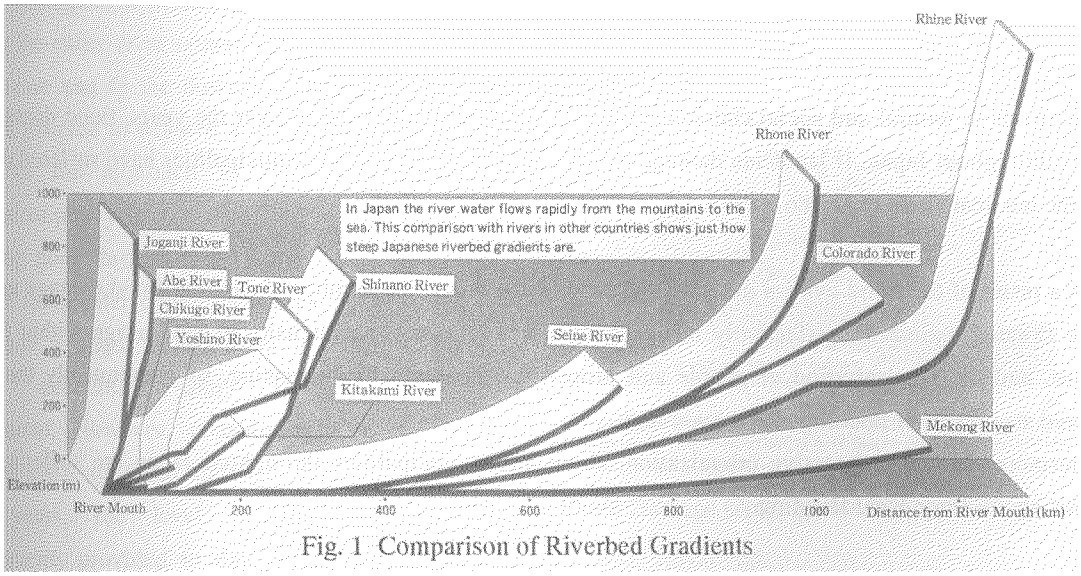

Fig. 1 Comparison of Riverbed Gradients

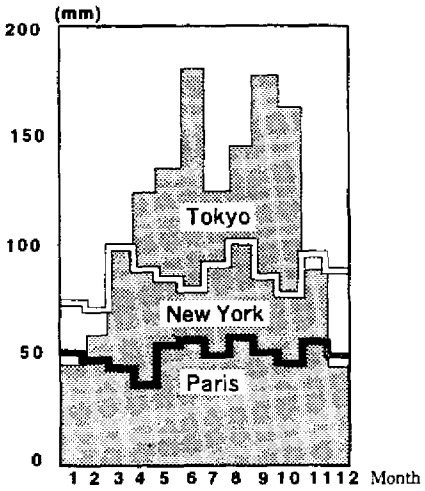

Fig. 2 Comparison of Precipitation in Major Cities

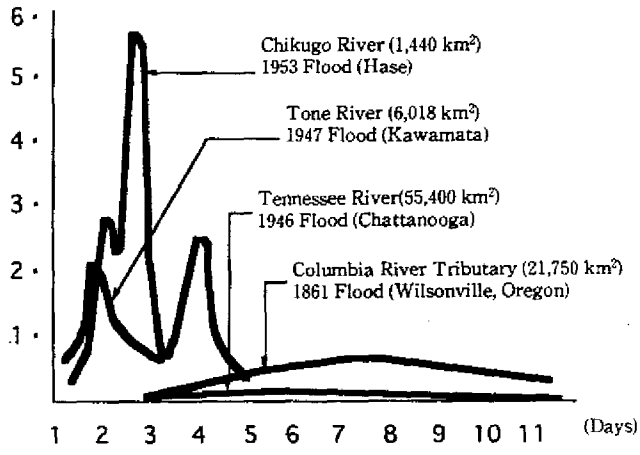

Fig. 3 Floodwater Duration Time and Floodwater Discharge per Unit Catchment Area

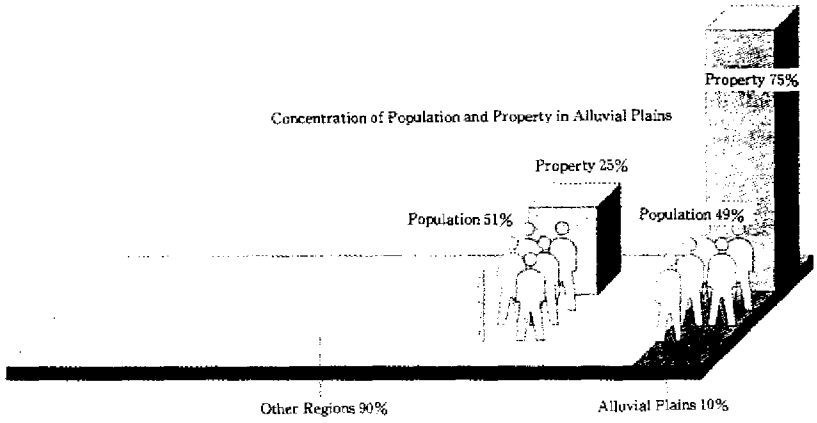

Fig. 4 Concentration of Population and Property in Alluvial Plains

2. Flood Damage in Japawxn

Due to these natural and social characteristics, despite the measures taken over the years. flood damage still occurs throughout Japan. If landslide damage is included, about 90% of all municipalities have suffered damage over the ten years between 1986 - 1995.

As a result of the flood control measures taken over the years, the number of cases of flood damage and area of the flooded regions has effectively been reduced. Nevertheless, the intensity of land usage within flooded regions, and the concentration of people and property are continually increasing, so consequently the losses incurred as a result of flooding still remain high.

Furthermore, due to progressive urbanization, about 450 municipalities throughout Japan are suffering from chronic above-floor-level flooding.

3. Current Flood Controls in Japan

3.1 The History of River Improvements in Japan

Since early times the Japanese have had to tackle flood damage under severe natural environmental conditions, and even in recent years large scale flooding still regularly occurs. Flood control projects are one of the main priorities for the provision of a safe social infrastructure.

Major river flood control projects have been actively carried out for a period of about 100 years since 1896, when the act on river was enacted. In 1960, as a result of the major damage caused by the Isewan Typhoon, the " Mountain and Flood Emergency Measures Law" was enacted. As a long term plan based on this act, the first "Flood Project 5-Year Plan" was conceived, representing the policy of a planned approach to the promotion of countermeasures. In 1964, the act on river was amended so that river management, that was hitherto carried out on a regional basis, would now be carried out for each river system, and the "Basic River Works Plan" was formulated. This change from regional management to management covering the entire river system, from the upstream end to the downstream end, was planned to achieve a major change in the approach to river management policy.

Having gone through this history, Japanese floodwater countermeasures have made a major contribution to Japan's economic and city development. However, considering the occurrence of flood damage in recent years, the level of the improvements provided to date still

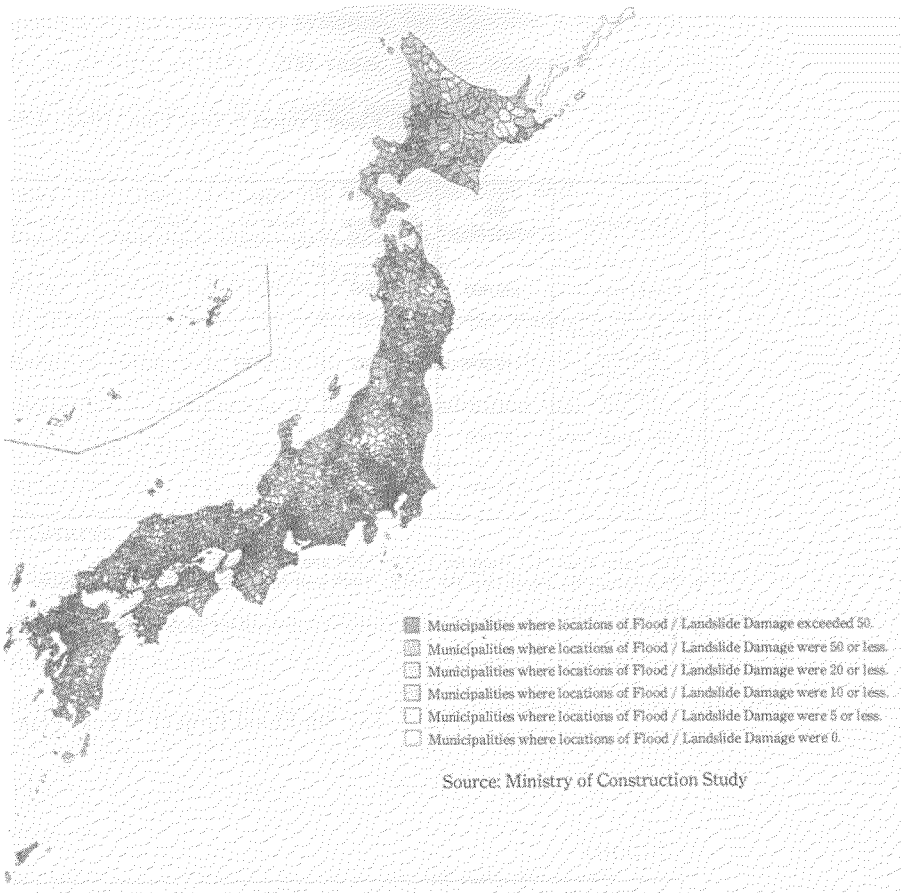

Fig. 5 Occurrences of Flood and Landslide Damage

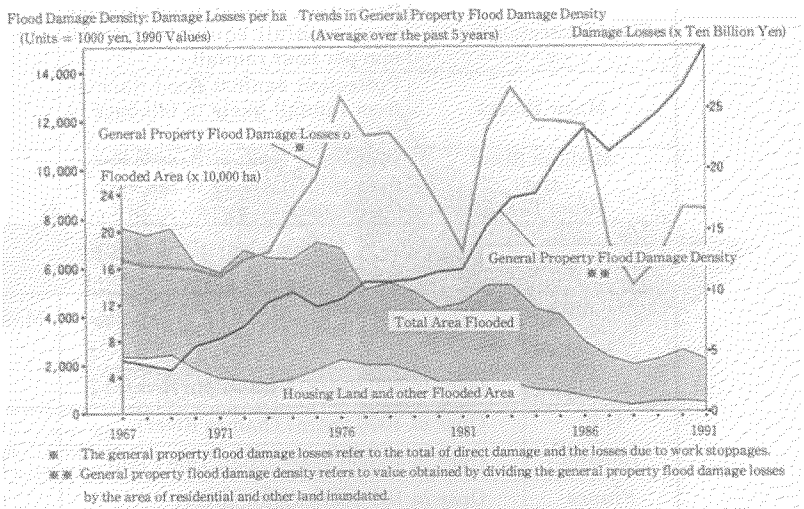

Fig. 6 Trends in Flood Damage (Average over the past 5 years)

fall short of what is required. Faced with the situation described above, the 8th Flood Project 5-Year Plan, that started in 1992, is currently being executed

The 8th Flood Project 5-Year Plan (1992 - 1996)

(Units 100 million yen)

Classification	8th 5-Year Plan	1992 Budgetary Appropriation	1993 Budgetary Appropriation	1994 Budgetary Appropriation	1995 Budgetary Appropriation	1996 Budgetary Appropriation	Percentage of Cumulative Progress (%)
Flood Projects	109,000	21,366	25,147	19,919	26,516	20,111	103.9
Disaster Related - Regional Independent Projects	40,100	8,182	9,680	7,740	8,676	8,349	106.3
Coordinating Costs	25,900						
Total	175,000	29,548	34,827	27,659	35,192	28,662	

Note
1 The values for execution for 1992 - 1995 are corrected
2 The values for execution for 1992 - 1995 and the estimated expenditure for 1996 includes NTT A-Type non interest loans
3 The figures for disaster related - regional independent projects from 1995 onwards are estimated values

Fig. 7 The 8th Flood Project 5-Year Plan

(Japan)

	8th Flood Project 5-Year Plan	
	Works Content (Immediate Targets)	Anticipated Completion End of 1991 -> End of 1996
Flood Protection Ratio	Protection against flood damage from rainfall equivalent to 50 mm per hour rainfall	45% → 53%
Major Rivers	Protection against flood damage from rainfall likely to fall once in 30 - 40 years	62% → 69%
Medium Sized and Minor Rivers	Protection against flood damage from rainfall likely to fall once in 5 - 10 years	35% → 43%

(U.S.A. and Europe)

	Standard Probability of Flooding	Major River Embankment Completion
U.S.A	Once in 500 years (Mississippi River)	70% (1979)
U.K	Once in 1000 years (Thames River)	Completed (1983)
Holland	Once in 10,000 years (High Tide Plan)	Completed (1985)
France	Once in 100 years (Seine River)	Completed (1988)

Fig. 8 The Condition of River Works

3.2 Flood Control Countermeasures in Japan

In Japan, the flood control countermeasures are carried out by first setting the planning targets for each river system based on the "Basic River Works Plan". Then, based on this plan, works are carried out primarily for the provision of embankments and river widening, as well as dams, retarding basins, floodways, and floodwater control facilities.

In the case of the major rivers (one of Japan's 109 first class river systems), the objective is to provide facilities to cope with a rainfall intensity likely to occur once in 100 - 200 years, but the immediate target is, by the beginning of the 21st century, to provide facilities to cope with a rainfall intensity likely to occur once in 30 - 40 years.

The objective for the medium sized and minor rivers is to provide facilities to cope with a rainfall intensity likely to occur once in 30 - 100 years, but the immediate target is to provide facilities to cope with a rainfall intensity likely to occur once in 5 - 10 years, by the beginning of the 21st century

Nevertheless, despite the efforts made in flood control projects over the years, the standard of flood control facilities provided in Japan is still low. Even the immediate targets for completion by the beginning of the 21st century have only at last exceeded an overall 50% completion. It has to be admitted that the level of flood control provided is significantly low in comparison with other countries.

3.3 Integrated Flood Control Countermeasures

During the rapid economic growth in Japan after the war, came rapid urbanization in the alluvial plains in which there exists a high risk of river flooding. For this reason, the population, resources, and core functions of the cities grew rapidly in the urban regions, while at the same time agricultural and forest land was rapidly utilized in the disorderly urban development. This process caused loss of water retention and pondage functions and increases in the river discharge during flooding. The provision of flood control facilities was unable to keep up with this urbanization with the result that, from the period around 1965, the level of flood safety dropped and flood damage occurred frequently in urban areas.

The more the flood control countermeasures come to fruition, the more the city functions and residential areas become concentrated in the floodplains increasing the damage potential.

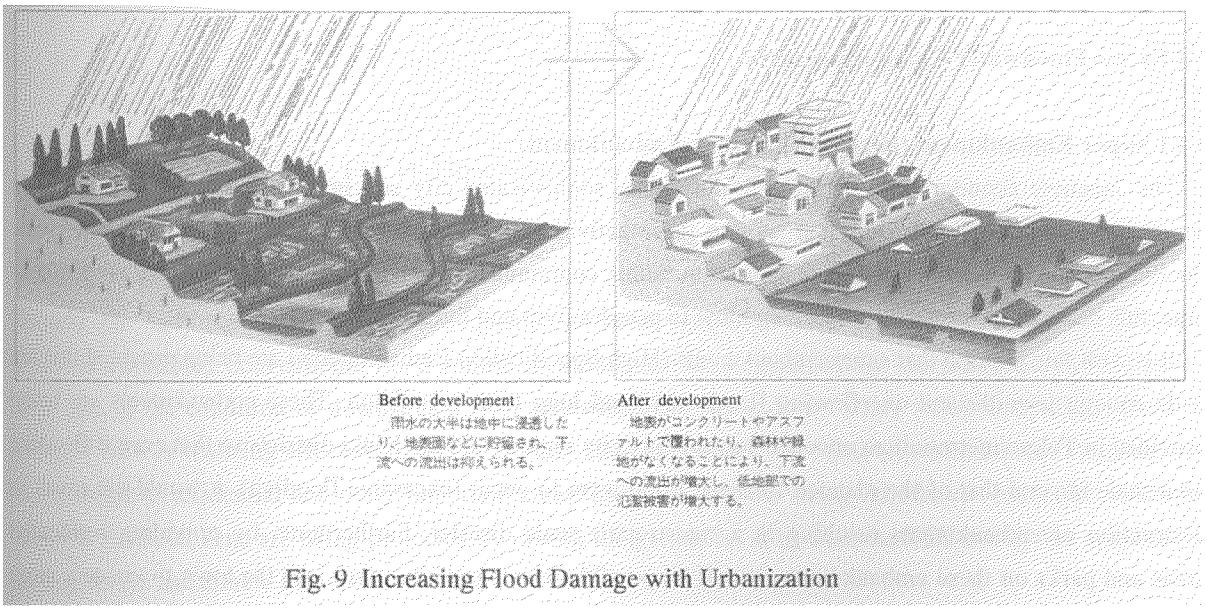

Fig. 9 Increasing Flood Damage with Urbanization

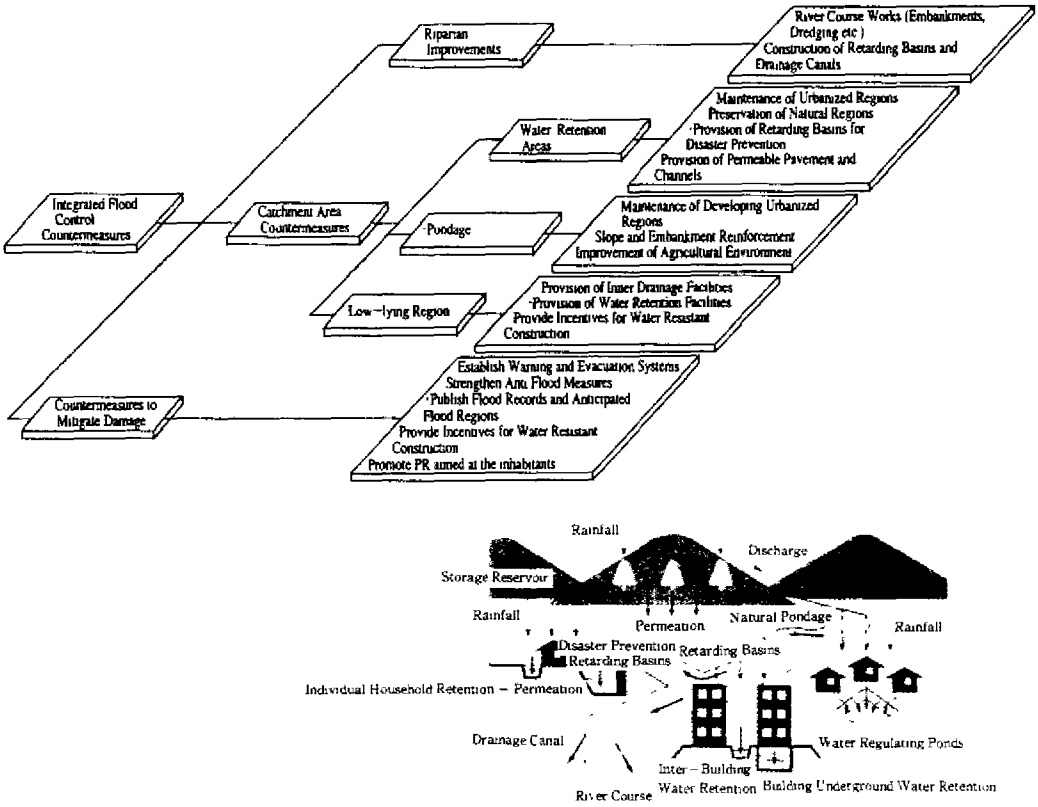

Fig 10 Schematic of Integrated System of Flood Control Countermeasures

From 1975, to meet the needs of this situation, in regions such as river basins having particularly extensive urbanization, "integrated flood control countermeasures" have been promoted. These countermeasures, while developing existing flood control facilities, integrate methods of mitigating flood damage such as providing facilities to preserve and improve the water retention and pondage functions of the catchment area, catchment area countermeasures such as land usage and building construction that is safer with respect to flood damage, and the provision of a warning and evacuation system.

3.4 Excess Floodwater Countermeasures

3.4.1 Super Embankment (High Specification Embankment)

The Japanese economy and society rely on highly sophisticated city and industrial activity. If the area in which the central core functions that support these activities are located becomes inundated, and large scale flooding paralyzes city functions such as transportation, communications, and lifelines for an extended period of time, this deals an immeasurably crushing blow to peoples lives and to the economy.

It is with this in mind that super embankments (High Specification Embankments) are being provided that are wide enough to withstand overflowing floodwaters and long term inundation. These embankments are being provided in Tokyo metropolitan area and surrounding city regions and the Kinki districts so that even if flooding on a scale beyond that of the planned foreseen flood were to occur (excessive flooding), it would not result in destruction of embankments resulting in a catastrophic scale disaster. Furthermore, by providing residential areas and parks on these embankments, it will be possible to integrate the river into the town to create a more pleasurable urban environment.

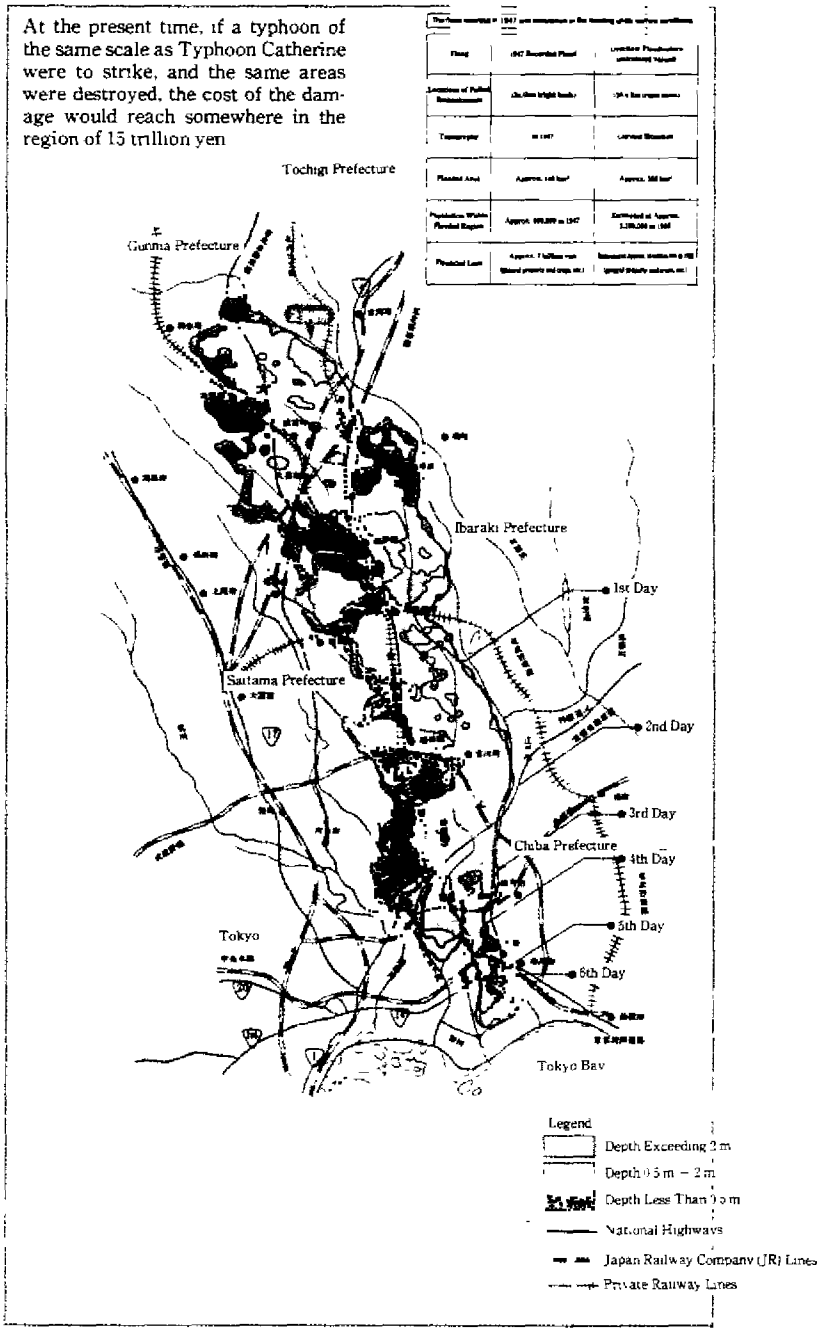

Fig. 11 Flood Simulation for the Tone River

3.4.2 Flood Disaster Prevention

Despite the fact that flooding occurs frequently, in areas where the cost and time involved in providing countermeasures by conventional flood control methods present problems due to the topographical conditions, land use, or the condition of downstream river improvements, methods are being introduced where, from the point of view of realizing effective results at an early stage, a degree of flooding is permitted, and the protection is restricted to residential and other important areas. Methods are now being introduced where the residential areas in the flood zone are being protected by raising the ground level by bulk landfill, and by the construction of ring levees and double line embankments.