

Thank you very much, Mr. Chairman, for your kind introduction.

Ladies and Gentlemen:

I feel greatly honored to be given the opportunity to speak at this conference. The title of my talk today is "Urbanization and Flood Control Methodology in Japan".

The conditions surrounding flood control in Japan are extremely severe. This is due to the topographical and meteorological characteristics of rivers in Japan. Furthermore, a large proportion of the Japanese have always lived in danger of floods.

The situation was worsened by the rapid economic growth that took place between the 1960's and the oil crisis of 1973. The improvement work on rivers could not keep pace with the rapid progress of urbanization that took place during this period, especially in the three metropolitan regions around Tokyo, Osaka and Nagoya, and the result has been a marked increase in flood damage including types of flood damage unknown in the past.

Here, an attempt is made at an analysis of how the progress of urbanization has altered the patterns of flood disasters, together with a presentation of the flood control measures that are being undertaken in Japan in response to the new situation.

First, I would like to talk about the natural and social characteristics of rivers in Japan.

Then, I would like to talk about the problems of flood control brought about by the rapid progress of urbanization.

Finally, I would like to talk about the measures being undertaken in Japan today.

## **SLIDE 1**

First, I would like to talk about the natural and social characteristics of rivers in Japan.

May I have the first slide? And dim the lights, please.

Japan consists of four islands and numerous smaller islands extending over a distance of 2,000 km from southwest to northeast. Its width, however, even at its widest point, does not go much beyond 300 km, and this narrow chain of islands is traversed by mountains with peaks reaching over 2,000 and 3,000 m.

## **SLIDE 2**

These topographical conditions mean that the rivers are short and steep, and catchment areas are small. Due to these topographical conditions, habitable land accounts for only around 30% of the total area. Of this 30%, around one-third is found on plains, and most of these plains are flood plains.

### **SLIDE 3**

This figure shows the average monthly precipitation in Tokyo, London and New York. Between June and mid-July every year, known as the *BAI-U* front settles over Japan, frequently causing concentrated rainfall. Between August and September, tropical cyclones turn into what are known as typhoons and these too produce heavy rainfall in Japan, often resulting in major flood disasters.

The average annual rainfall in Japan is 1,800 mm, which is significantly higher than the world average of 800 mm.

These topographical and meteorological conditions surrounding rivers in Japan produce the following characteristics.

### **SLIDE 4**

In this figure, a comparison is made of the riverbed slopes of major rivers. The steep gradients of the catchment-areas and the shortness of the rivers in Japan make for the steep riverbed gradients and fast runoff and flood water.

### **SLIDE 5**

In this figure, a comparison is made of the discharge hydrographs of major rivers. It is meant to show you how steep the hydrographs of Japanese rivers are. The peak discharges per unit catchment area are greater by one or even two figures in comparison with those in other countries.

The maximum discharge may be as much as 200 to 400 times the minimum discharge which are proportions far greater than those found in most countries.

The Japanese society has developed around rice cultivation and their settlements have been formed within flood-risk areas since ancient times.

This land use pattern has remained unaltered to this day, and housing and industrial assets are found concentrated in the areas along rivers, which are exposed to risks of floods.

### **SLIDE 6**

As shown in this figure, nearly 50% of the population live within flood-risk areas, which account of 10% of the total land area. And nearly 70% of all the assets are located in these flood-risk areas.

## **SLIDE 7**

This might be compared with the situation in the United States, where only 9% of the population live in flood-risk areas accounting for 7% of the total land area.

## **SLIDE 8**

Most countries in Europe and America have larger plain areas and, at the same time, wider use is made of the hilly areas outside the flood-risk areas. This means that floods, when they occur, affect only the narrow strips of land along the river channels. In Japan, on the other hand, one has no choice but to make intensive use of the alluvial plains that lie below the flood water descents safely down the river channels by employing artificial means to keep it within the boundaries of the channels.

Next, I would like to talk about the problems of flood control brought about by the rapid progress of urbanization.

The rapid progress of urbanization has brought about two main problems in terms of flood control.

First, urbanization has raised the flood damage potential. Once floods occur, they may cause irrecoverable damage.

Second, types of floods and types of damage were altered by urbanization.

## **SLIDE 9**

Between the 1960's and the first oil crises of 1973, the Japanese economy underwent a rapid growth rarely paralleled elsewhere in the world, with a rapid development of the heavy chemical, machinery and other industries, as well as a marked improvement of the living standards. This rapid growth of the economy led to a rapid progress of urbanization, especially in the three metropolitan areas around Tokyo, Osaka and Nagoya, creating a heavy concentration of the population and assets in urban areas. The work for improvement of rivers could not keep pace with this rapid urbanization and the result was the frequent occurrence of "urban" flood disasters starting in the late 1960's, necessitating an urgent implementation of improvement work on rivers in urban areas.

## **SLIDE 10**

A typical case is that of the Tsurumi River, which flows through the Keihin (Tokyo-Yokohama) Industrial Zone. Build areas covered only 10% of the river basin in 1958. By 1988, 77% of the river basin had been urbanized, and it is expected that the urbanization rate will reach 95% in the future.

## **SLIDE 11, 12**

Such a process would naturally involve the movement of housing and other properties into the flood-risk areas along the river. It may be seen that by 1989 a large number of houses had been built within the area inundated in 1966.

## **SLIDE 13**

As can be seen in this table, there has been a steady increase in assets in Japan. Most of these assets are concentrated within the flood-risk areas, meaning that the potential for flood damage has greatly increased with the progress of urbanization. The same densely-populated cities also accommodate various central administrative and economic institutions. Tokyo, for example, is home to a large number of international financial institutions, and the paralysis of the urban functions in a major city in Japan, which plays an important role in the world economy, could result in a serious disruption of economic on a worldwide scale.

Furthermore, the large-scale use of the underground in these cities provides another factor contributing to the potential flood damage, as many of the lifeline utilities installed underground are liable to damage by water.

In these large cities, therefore, the failure of the embankment and subsequent large-scale flooding could result not only in the loss of a large number of lives and assets, but also in serious social and economic confusion affecting the whole country on a scale exceeding our imagination.

## **SLIDE 14**

This figure shows what the situation would be, if a flood, which actually occurred in September 1947, were to occur today.

One can see how the arrival time of the flood discharge has been shortened.

## **SLIDE 15**

Comparing the damage, we see huge increases in the uninundated area, as well as the population, housing and assets affected.

## **SLIDE 16**

In river basins which have not undergone urban development, most of the rainfall is stored and retained in upstream areas either through seepage into the ground or storage in paddy fields and reservoirs, resulting in a reduction of the runoff to downstream areas.

With the progress of development, however, the ground surface is covered with concrete and asphalt, and forests, paddy fields and reservoirs are lost, resulting in an increase in the runoff to downstream areas and in the flood damage in low-lying areas.

Besides the increase in the quantity of the runoff, urban development also results in a shortening of the time before the arrival of the peak discharge. In the case of the Tsurumi River, the arrival time, which was around 7 hours time reduces the possibility of preventing flood damage through flood-fighting activities, as well as reducing the time available for communication of flood warnings and other information to the residents and for the actual evacuation.

Finally, I would like to talk about the measures being undertaken in Japan today.

#### **SLIDE 17**

The plans being promoted at present include that for the construction of embankments that will not fail even when the flood discharge exceeds the design scales and overtops the embankments. The plan covers a total stretch of 800 km along six rivers in five river systems, including the Tone and Yodo river systems, and the work in those section, whose failure would have direct effects on the central areas of cities, is due for completion soon after of the 21st century.

These "high-standard" embankments (super levees) are given structures and configurations capable of withstanding floods exceeding the design scales, mainly by providing them with large widths, corresponding to around 30 times their heights.

#### **SLIDE 18**

The land on top of these embankments is made available for normal uses, and this leads to a removal of the barrier that has been created between the river and the urban area by conventional embankments, allowing for the creation of a cityscape with open access to water and greenery.

#### **SLIDE 19**

"Comprehensive flood control", involving measures such as provision of administrative guidance to ensure appropriate land use, will be implemented in those areas where there has been a rapid alteration of land use, which might seriously affect flood control safety.

This applies especially to those river basins undergoing rapid urban development and those river basins that are already heavily urbanized, where a positive promotion will be made of measures, such as those for the maintenance and restoration of the capacities of the river basins for runoff and retention, with the aim of providing levels of safety in correspondence with the levels of development and maturity of these areas.

### **SLIDE 20, 21, 22, 23**

The measures undertaken under "comprehensive flood control" projects include those for river channel improvement and construction of retarding basins and regulating reservoirs, as well as construction of sewage networks and other catchment area measures, which are implemented in a systematic manner to raise the level of safety against floods.

The increase in flood damage due to urbanization, which we have experienced in Japan, is something that could also occur in future in the developing countries. One of the lessons to be learned from our experience is the importance of preserving the capacities of the river basins for runoff storage and retention when promoting development.

Thank you very much for your attention.