Improvement of Disaster Reduction Management for Urban Floods in Japan

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Category of river water systems in Japan

A class river: 109 river water systems (MLIT)
  Return period: 100 to 200 years
B class river: 2,722 river water systems (Governor)
  Return period: 5 to 10 years

Capacity of drainage in every municipality
50mm/hour (Inundation will occur over this rainfall intensity)
Severe heavy rainfall and drought have been amplified.

Recent increment of heavy rainfall are remarkable.
## Frequent occurrence of heavy rainfall

### 1. No. of occurrence of heavy rainfall more than 50mm/h

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976~85</td>
<td>209</td>
</tr>
<tr>
<td>1986~95</td>
<td>234</td>
</tr>
<tr>
<td>1996~2005</td>
<td>288</td>
</tr>
</tbody>
</table>

### 2. No. of occurrence of heavy rainfall more than 100mm/h

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976~85</td>
<td>2.2</td>
</tr>
<tr>
<td>1986~95</td>
<td>2.2</td>
</tr>
<tr>
<td>1996~2005</td>
<td>4.7</td>
</tr>
</tbody>
</table>
The records for hourly rainfall intensity were broken in 2004.

125 observation points / 1,300 total points since 1970.
The records for daily rainfall were broken in 2004.

111 observation points / 1,300 total points since 1970
Inundation due to river flooding, heavy rainfall and storm surges in 2004

- Yura R., Ty. 23
- Storm surges in Seto Inland Sea, Tys. 16, 18
- Kariyata and Ikarashi Rs., Heavy rainfall
- Asuha R., Heavy rainfall
- Maruyama R., Ty. 23
- Sake R., Heavy rainfall
- Aganogawa R., Heavy rainfall
- Kumagawa R., Ty. 16
- Kimotsuki R., Ty. 16
- Gokase R. and others, Ty. 16
- Nakagawa and Yosino Rs. Ty. 6, 10, 16
- Hijikawa R., Ty. 16
- Niyodo R., Ty. 10
- Kumano R., Ty. 10
- Tomoe R., Heavy Rainfall
- Sake R., Heavy Rainfall
- Storm surges and high waves., Ty. 18

June
- 21: Ty. 6

July
- 13-14: Heavy rainfall
- 31: Ty. 10

Aug.
- 5: Ty. 11
- 17: Ty. 15
- 30-31: Ty. 16

Sept.
- 31: Ty. 16
- 7: Ty. 18

Oct.
- 7: Ty. 22
- 20: Ty. 23
### Victims due to heavy rainfall and typhoon in 2004

<table>
<thead>
<tr>
<th>Indoor/Outdoor</th>
<th>Male/Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor</td>
<td>8 M 2/(2)</td>
</tr>
<tr>
<td>Heavy Rainfall</td>
<td>6/(6)</td>
</tr>
<tr>
<td>21</td>
<td>13 M 9/(6)</td>
</tr>
<tr>
<td>Typhoon</td>
<td>29/(19)</td>
</tr>
<tr>
<td>181</td>
<td>119 M 92/(50)</td>
</tr>
</tbody>
</table>

- Indoor: 8, Male: 2, Female: 2
- Outdoor: 13, Male: 9, Female: 4
How to reduce human damage

Victims more than 65 years old were about 60% of the total.

1. Elderly men have to be careful behavior under heavy rainfall warning or storm warning. • They go out to watch water condition in rice field under heavy rainfall. • They climb the leaky roof for reinforcement under storm condition.

2. Elderly women in rural area have not to evacuate to head family house. We recommend to use public shelters such as school buildings.
Shonai River

Overflow bank

Tokai heavy rainfall disaster in 2000
Top 10 of One Day Rainfall in Nagoya City

Data based on records from past 109 years since 1891 when Nagoya Meteorological Observatory opened.
Warning

Rainfall Intensity (mm/hr)

Total Rainfall (mm)

Time history of rainfall and issue of heavy rainfall and flooding

September 12

2000 Nagoya heavy rainfall disaster
Occurrence of Flooding

After improvement
About 100,000 cars were flooded.
Changes of land use from agricultural land to building land in Nagoya city

Residential area

Agriculture area

1964

Year
1. Quick appearance of flood peak
2. Larger discharge
3. Increased total discharge

After *Urbanization*

Before *Urbanization*
Computer simulation on annual changes of heavy rainfall of more than 100mm/day in summer season
Disaster lessons on flood disasters (1)

• Under global warming, rainfall characteristics have been changed. Probabilistic approach is not applicable.
• Heavy rainfall may begin in the evening and reach maximum at mid night due to cool atmosphere.
• There are two kinds of urban flooding: The first is direct inundation due to heavy rainfall (out of pump station), and the second one with levee breach or overflow.
Disaster lessons on flood disasters (2)

- Combination with typhoon and fronts such as baiu (June to July) and autumn (September) makes long-period rainfall (30 to 40mm/h, duration: 5 to 6 hours) will generate flood disasters in A class rivers with the water basin of more than 1,000 km².
- Area of heavy rainfall is about several ten to several hundred km² so that B class river is dangerous.
- Evacuation has to be started before the occurrence of inundation.
Disaster lessons on flood disasters (3)

- Historically, the location in which the levee breach repeatedly occurs.
- Water can flow even if the bed slope is less than 1/100,000.
- Due to flooding, the first damage will be the suspension of the water supply.
- Recommendation of evacuation preparedness had better to be issued simultaneously at the moment of heavy rainfall and flood warning.
- The primary work of mutual aid in community is to take elderly or handicapped people in shelters.
Kariyata riv. flood disasters in 2004

About 50m
Wooden made temple constructed in 1606
Inundated Junior high school building
Integrated Urban Flood Measure Policy in Japan after 2004

• *Flood Forecasting*
  In a pre-disaster stage, 6 problems are included to verify hazard characteristics and hard-countermeasure maintenance. Flood warning systems is included.

• *Preparedness for Flood*
  In a pre-disaster stage, 6 problems are included to prepare insurance and information. Hazard mapping, land use management, decision making process including residents are included.

• *Anti-flood Measures*
  In a post-disaster stage, 5 problems are included to reduce direct and indirect damage.

• *Recovery Efforts*
  In a post-disaster stage, 2 problems are included to step up the recovery process.
The “Urban Rivers Anti-Flood Measure Act” was implemented in April 2004 in response to the frequent occurrence of urban flooding with the aim of reducing flood damage.

This act is designed so that external water overflow and internal water overflow floods will be addressed holistically taking into account recent frequent occurrences of unusually severe torrential rain. According to this act, prefecture, cities, towns and villages share responsibility for flood prevention measures unlike before. Previously, these cities, towns and villages were directly benefiting from regional development, while prefectures paid for the development and covered the damage from disastrous outcomes. This distorted flood-management system has been corrected by the Act. However, it is foreseeable that designating a river as an urban river for the purposes of the Act will cause cities, towns and villages to share responsibility.
Conclusions

• Due to global warming, we have so frequent urban flood disasters since 1990 in Japan.
• Due to urban flooding, some underground facilities such as subway systems and shopping mall have been in danger of inundation.
• Japanese government has changed the measure policy after these urban flood disasters and 2005 Hurricane Katrina storm surge disasters.
• The new integrated approach and policy for urban flooding have been applied to some typical urban rivers such as the Tsurumi river in Yokohama and the Neyagawa river in Osaka.