River Basin Management in Japan
- Flood Control Measures, Water Resources Management -

Hitomi Godou
Director of River Information Office, River Bureau
Ministry of Land, Infrastructure, Transport and Tourism
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Flood management

1896

Birth of modern river management system

1964

Establishment of systems for systematic flood management and water utilization

- Introduction of integrated management system for river systems
- Establishment of water utilization rules and regulations

1997

Establishment of integrated river management system for flood management, water utilization and environmental conservation

- Improvement and conservation of river environment
- Introduction of a system for river planning reflecting the opinions of local community

History of the River Act
Transition from the old system to the new system due to the River Law amendment

Old system

- Master plan for river works
  - Drafting of master plan for river works
  - Adoption of master plan for river works
  - Content: basic policy; design flood; design flood discharge, etc.; major river work items
  - River Council (Class A river systems)

New system

- Basic policy for river improvement
  - Drafting of basic policy for river improvement
  - Adoption and announcement of basic policy for river improvement
  - Content: basic policy, design flood, design flood discharge, etc.
  - Infrastructure Development Council (Class A river systems)
  - Prefectural river councils (Class B river systems)

- River improvement plan
  - Draft
  - Adoption of draft river improvement plan
  - Content: goal of river improvement, river works, scope of river maintenance
  - Academic experts
  - Reflecting public opinions by, for example, holding public hearings
  - Head of local government
Outline of Law on Measures against Inundation Damages in Designated Urban Rivers

Because previous each law has limited enforcement, this law strengthens countermeasures and assures flood control in river basin.

- Designate urban river (basin)
  - Urban area covers more than 50% of river basin
  - Average annual damage (occurred or predicted) exceeds 1 billion yen (= $10mil)
  - Because of urbanization, it is difficult to control flood by constructing river facilities or flood control dams

- Formulate river basin flood control plan
  - 4 members (river and sewage administrators, governors, and mayors) make the plan together

- Implementation of measures
Outline of Tsurumi River (Geography)

- River basin area: 235km²
- Main stream length: 42.5km
- Hill / tableland: 70%
- Alluvial lowland: 30%

Riverbed gradient: 1/250

Riverbed gradient: 1/1,000
Outline of Tsurumi River (Urbanization and population increase)

Urbanization ration has increased by **75%** in 50 years

- **1958**: 10%
- **1966**: 20%
- **1975**: 60%
- **Present**: 85%

Rapid economic growth has turned natural area into urban area.

### Natural Area

- 450,000
- 700,000
- 1,880,000

### Urban Area

- 700,000
- 1,200,000
- 1,880,000

Typhoon Karinogawa in Sep 1958

Typhoon No.17 in Sep 1976
Population increased by 1.4 million in 50 years
- 85% of river basin area urbanized
- Typical urban river

As a result
- Discharge into river has become faster
- Peak runoff has becomes bigger

Function of keeping and retarding water became weakened

Outline of Tsurumi River (Effect of urbanization)

Before development
Slight urbanization

Peak runoff reaches its peak in 1/3 of time

After development
Significant urbanization

Before Development
770 m³/s

Present
1,300 m³/s

Volume Doubles

2~3 hours
10 hours

Runoff reaches its peak in 1/3 of time
River related projects in Tsurumi River Basin inundation control plan

Future flood control
Existing retarding basin

【Administrator】
- MLIT
- Tokyo Metropolitan
- Kanagawa Prefecture
- Yokohama City
Specifications for the Tsurumi River multi-purpose runoff retardation area

- Service started: June 15, 2003
- Area: 84 ha
- Total reservoir capacity: 3.9 million m$^3$
- Floodwater regulation
  (Temporary channel) Runoff retardation area collects 200 m$^3$/sec.
  (Planned river channel) Runoff retardation area and floodway collect 700 m$^3$/sec.
Sewerage projects in Tsurumi River Basin inundation control plan

Natural drainage area
Pump drainage area (Name)
Rainwater storage tube (Name)
Development of facilities for target rainfall

Planned discharge in pump drainage areas

<table>
<thead>
<tr>
<th>City</th>
<th>Discharge area</th>
<th>Planned discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokohama</td>
<td>Tsuzuki</td>
<td>17m³/s</td>
</tr>
<tr>
<td></td>
<td>Kouhoku</td>
<td>142m³/s</td>
</tr>
<tr>
<td></td>
<td>Hokubu</td>
<td>189m³/s</td>
</tr>
<tr>
<td>Kawasaki</td>
<td>Kase</td>
<td>55m³/s</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>402m³/s</td>
</tr>
</tbody>
</table>

Planned storage of major facilities

<table>
<thead>
<tr>
<th>City</th>
<th>Storage facility</th>
<th>Planned Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokohama</td>
<td>Shin hasue trunk line</td>
<td>410,000m³</td>
</tr>
<tr>
<td></td>
<td>Kozukue chiwaka trunk line</td>
<td>256,000m³</td>
</tr>
<tr>
<td>Kawasaki</td>
<td>Shibukawa rainwater storage tube</td>
<td>144,000m³</td>
</tr>
<tr>
<td></td>
<td>Egawa rainwater storage tube</td>
<td>81,000m³</td>
</tr>
</tbody>
</table>
Tsurumi river was designated as the first Comprehensive Flood Control River in 1979 to cope with rapid urbanization of river basin.

As a Result

But more retarding ponds are necessary.
Storage, infiltration and forest conservation

Storage facilities in schools, parks and public houses

Infiltration by permeable pavement

Purchase and conservation of forest in developing area
Measures against inundation damage
-Improvement of collecting and providing river information-

Collecting Information

Providing information to the public

- Home Page  Mobile Phone  Information Board

River Management Office (MLIT)

Providing Information

Municipal Office
Water level and Rainfall observation by Telemeter

Branch office

River information provider system

Providing Water level and Rainfall collected by Telemeter

Information provided by the Internet and Mobile phone

Rain gauge station
Location of rainfall observation radar

26 radar stations collect, analyze and provide rainfall data nationwide.
The integrated river information system aims at sharing and standardizing river management data including river water levels and rainfall amounts.

River information systems were originally developed by each regional development bureau. They have been integrated into a national river information system. Regional development bureaus can customize the system based on their requirements.

Software are separated from hardware. Improvement cost and life-cycle cost are reduced.

The system also provides rainfall forecasts of Japan Meteorological Agency and rainfall data of the Road Bureau.
Upgrading rainfall forecast in corporation with related organizations

Aim at **early flood prediction for localized heavy rainfall** by establishment of Rainfall Prediction Model considering localized rainfall development and movement by corporation with institutions concern

- Locate radar in a triangular shape in urban area
- High resolution and real-time rainfall observation within 60km range from radar
- Furthermore, prediction accuracy is improved by three-dimensional observation of rainfall within the triangle area

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**Strengthen observation of localized heavy rainfall and information service**

**Image of X-band radar system**

**Area with resolution of 250m**

**Location of weather radar**

**Image of cumulonimbus glow**

**Glowing cloud**

**Generation**

**Wind**

**aerosol**

**Start raining**

**Rainfall observation by X-band radar**

**Rainfall observation by current C-band radar**

**Initial stage of rainfall**

**Heavy rain level**

**Hail**

**Heavy Rainfall**
Water Resources Development Basic Plan

- Purpose-specific demand forecasts and supply for 7 river system

Japan Water Agency (JWA)

- Established in 1962 to promote water resources development

Area

<table>
<thead>
<tr>
<th>7 River Systems regions</th>
<th>Other regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.7%</td>
<td>83.3%</td>
</tr>
</tbody>
</table>

Population

<table>
<thead>
<tr>
<th>7 River Systems regions</th>
<th>Other regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.2%</td>
<td>48.8%</td>
</tr>
</tbody>
</table>

Industrial shipments

<table>
<thead>
<tr>
<th>7 River Systems regions</th>
<th>Other regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>47.9%</td>
<td>52.1%</td>
</tr>
</tbody>
</table>
Discussion Solicitation of views

Cabinet decision
Decision by Minister of Land, Infrastructure, Transport and Tourism (MLIT)

Preparation of cabinet decision

Basic study
(water supply prediction survey, etc.)

Designation of river systems for water resources development

Deliberation by the Subcommittee on Water Resources Development, National Land Development Council

Relevant Stakeholders

Solicitation of views

Relevant prefectures

Cabinet decision
Decision by Minister of Land, Infrastructure, Transport and Tourism (MLIT)
Effect of Basic Plans (Tone/Ara River System)

Minimizing the Gap between Demand and Supply

- Planned water supply volume: Volume of water developed by dams, etc. (not including facilities under construction and water diverted under agricultural rationalization projects in the winter.)
- Vested water volume: sum of secured water rights and provisional water rights

Phase I Full Plan (1963 - 1970) Tone River system
Phase II Full Plan (1970 - 1975) Tone River system
Phase III Full Plan (1976 - 1985) Tone River system and Ara River system
Phase IV Full Plan (1988 - 2000) Tone River system and Ara River system

- Water volume (m³/s)
- Year

- Planned water supply volume
- Vested water volume (domestic water and industrial water)
- Predicted demand and target value for supply
Variability of extreme events is increasing due to climate change.

In Japan:
- **Annual Precipitation**
- **Average rainfall trend**
- **Variability**

The graph shows the trend of annual precipitation in Japan from 1900 to 2000, indicating an increasing variability of extreme events due to climate change.
Snowfall will dramatically decrease in the northern regions.

In a 100 years’ time, the upstream catchments of the Tone River will have considerably less snow depth.

Changes in annual snowfall (avg. of 2081-2100) vs (avg. of 1981-2000)

Snow depth changes expected 100 years hence (Fujiwara)

Source: Global warming projection vol. 6 (JMA)
# Prolonged droughts are expected due to climate change

<table>
<thead>
<tr>
<th>River Basin</th>
<th>Dam</th>
<th>Irrigation period pattern</th>
<th>Drought periods at present state (days/10yrs)</th>
<th>Drought periods at around 2050 (days/10yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ishikari</td>
<td>Taisetsu</td>
<td>Advanced by 0-10 days</td>
<td>About 60 days</td>
<td>About 30-70 days</td>
</tr>
<tr>
<td></td>
<td>Chubetsu</td>
<td>Advanced by 0-10 days</td>
<td>About 30 days</td>
<td>About 130-180 days</td>
</tr>
<tr>
<td><strong>Tone</strong></td>
<td><strong>8 dams</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Matsubara/ Shimouke</td>
<td>Advanced by 0-40 days</td>
<td>About 30 days</td>
<td>About 100-110 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deferred by 0-60 days</td>
<td>About 30 days</td>
<td>About 90-120 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deferred by 0-30 days</td>
<td>About 50 days</td>
<td>About 70 days</td>
</tr>
</tbody>
</table>

- **Droughts mitigated**: Light blue
- **Droughts exacerbated**: Green

Droughts are expected due to climate change.
Impacts of Climate Change on water quality due to climate change

- Global warming
  - Water temperature rise (remaining warm)
    - Fixed thermocline position
    - Decrease of winter ice cover (increasing light transmission)
  - Decreasing circulation in lakes
  - Increase of E. coli
  - Decrease of bottom-layer DO
  - Leakage of hazardous substances
  - Increase of pests
  - Risk of infectious diseases
    - Increasing pesticide leaks with their increased use
    - Decrease of river DO
    - Leaking hazardous substances
    - Phytoplankton proliferation
    - Bottom sedimentation of remains

- Shifts in precipitation patterns
  - Landslide in rain storm
  - Soil erosion
  - Increased turbidity
  - Leaking iron/manganese

- Use of fossil fuel, etc.
  - Changing nitrogen cycle in the atmosphere
  - Flux into forests/soil (nitrogen saturation)
  - NO₃-N leaking into rivers upstream
  - Savory water
    - Turbidity
    - Smell/taste
    - Color

- Products of treatment
  - Water safety
Basic point of view for promoting IWRM
Addressing adaptation to climate change and social change

**Addressing climate change**
- Prepared for more frequent, extreme events
- Coping with changed hydrological/environmental situation

**Addressing Social needs**
- Coordinated use of water resources
- Ensuring safe water supply and sanitation

**Policy Framework to ensure adaptation to climate change through IWRM**
- Integrating management of water demand and supply
- Integrating water facility planning, designing and operation
- Information sharing and stakeholders’ participation
- Integrating management of surface water and ground water
- Integrating management of water quantity and quality

**Policy Framework to ensure adaptation to climate change through IWRM**
- Integrating management of water demand and supply
- Integrating water facility planning, designing and operation
- Information sharing and stakeholders’ participation
- Integrating management of surface water and ground water
- Integrating management of water quantity and quality
Information system to involve stakeholders in IWRM:
In decision making, consensus building, awareness raising, etc. for adaptation action to climate change.

Development of a clearing house
Simulation on integrated water resources management
Required sub-action

- Policy and regulatory framework
- Groundwater Monitoring and assessment
  - Groundwater level
  - Groundwater quality
  - Withdrawal amount
- Coordination mechanism between managers
- Information Sharing System

Integrating monitoring, withdrawal, and recharge of surface water and groundwater
Effective management by many stakeholders for effective and smooth implementation.