# River management in Japan
## －With focus on river levee－

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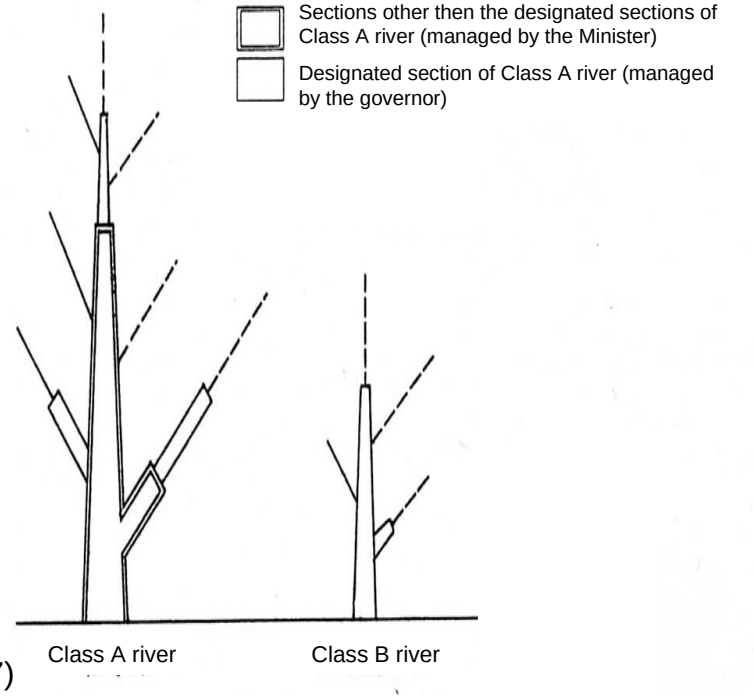
# Objectives of river management

**Article 1 of the River Law**

- Prevent damages during floods and high water
- Use rivers properly
- Maintain the normal functions of running water
- Improve and protect river environment

# Classes of rivers and river managers

**The river manager is specified for each river by the River Law and administers the river on the basis of the authority.**




Details of the rivers in Japan (as of April 30, 2007)

| | Number of river systems | Total length of the rivers | Manager | Note |
|---|---|---|---|---|
| Class A river systems | 109 | 87,834km | Minister of Land, Infrastructure and Transport | The designated sections (77,262 km) are administered by prefectural governors. |
| Class B river systems | 2,726 | 35,858km | Prefectural governor | |

# Actual activities of river management

## Normal time

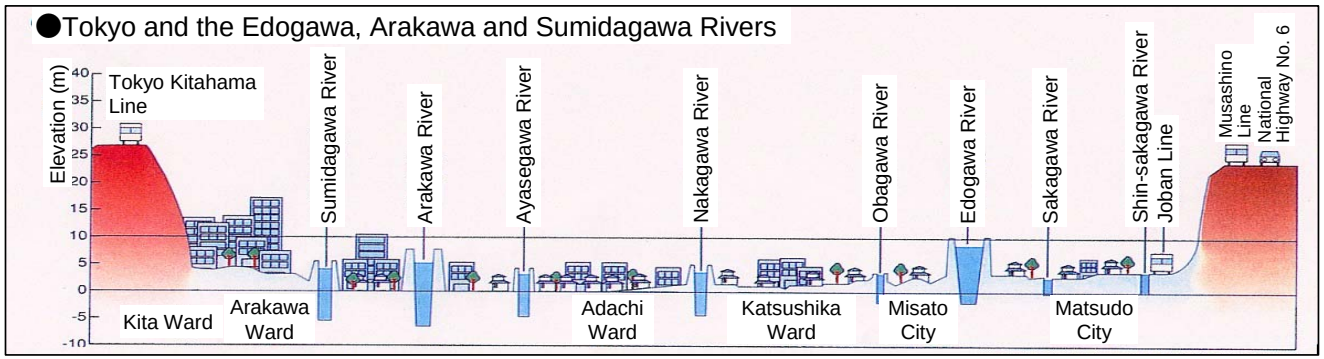
- Daily patrol of the river
- Maintaining and controlling river administration facilities (levee, sluices, etc.)
- Management of the river space
- Control of running water in the river

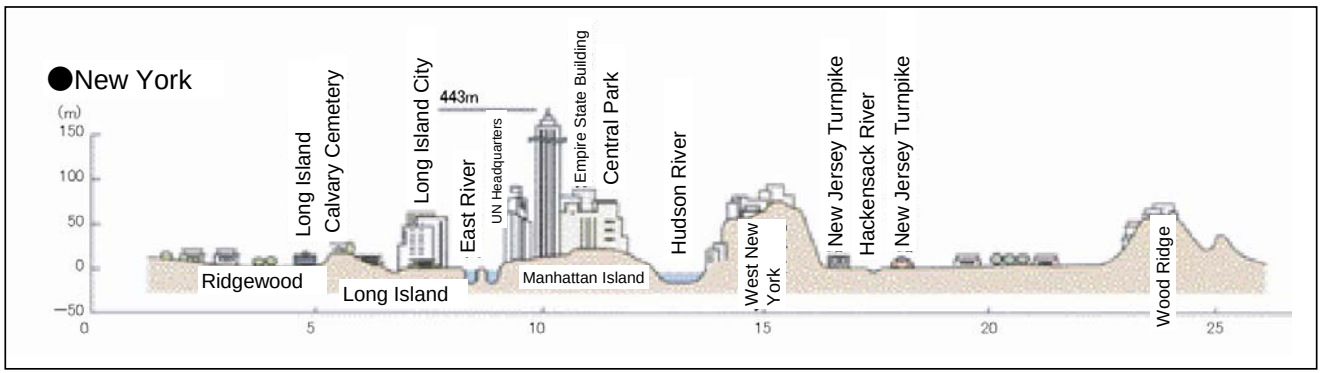
## During floods

- Patrolling the river during floods
- Draining behind levee
- Flood fighting

# Importance of levee management

Major cities in Japan spread in areas below the design high water levels.
Once the levee breaks, serious inundation occurs.
Levee management is one of the most important flood control activities in Japan.



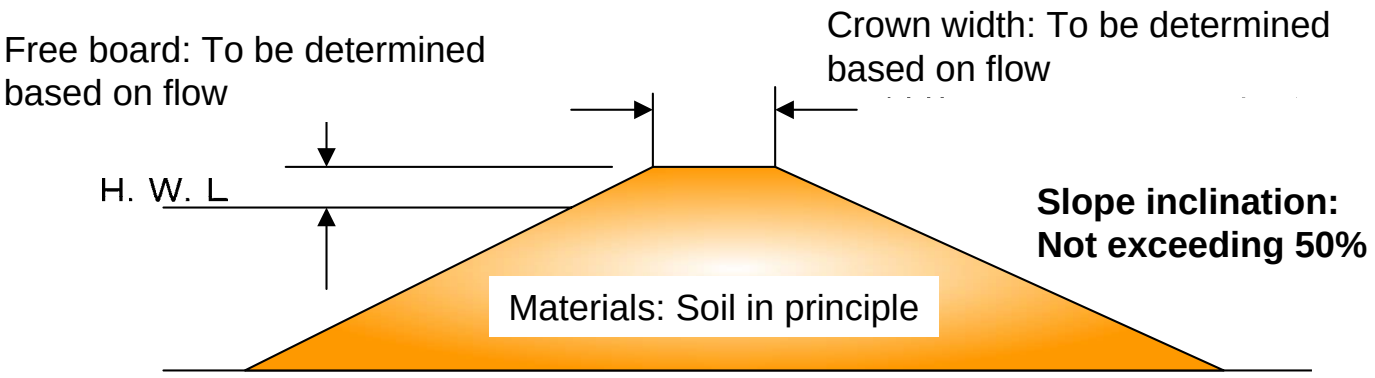



# Functions and shapes of river levee

**Cabinet Order Concerning Structural Standards for River Administration Facilities, etc. (1976 #)**

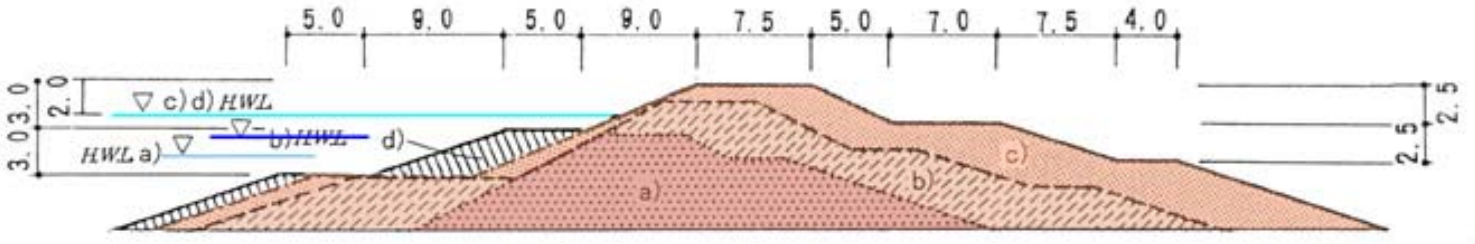
Required function: Ensure safety against ordinary actions of running water not exceeding the design high water level as one body with revetment, spur dykes, etc.

Required configuration: Secure the specified levee height, crown width and slope inclination



# Levee is a structure of a long history

Most levees have been repetitively reinforced by increasing the height and/or width, etc.

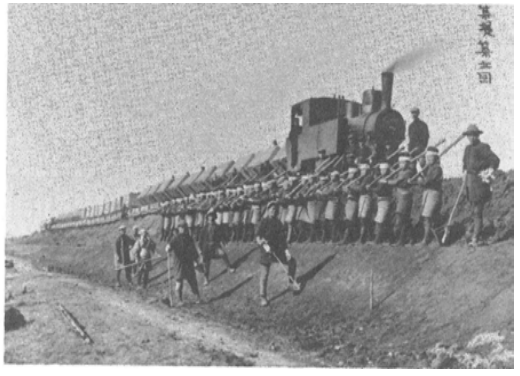



a) Improvement project (1911)
b) Reinforcement project (1949)
c) Revised improvement project (1949)
d) New revised improvement project (1980)

Historical changes in the cross section of the levee along the Edo River

# Construction methods have differed depending on era.

The construction methods of levees (for filling and compacting earth, etc.) have varied reflecting the technological and economical capabilities of the age.



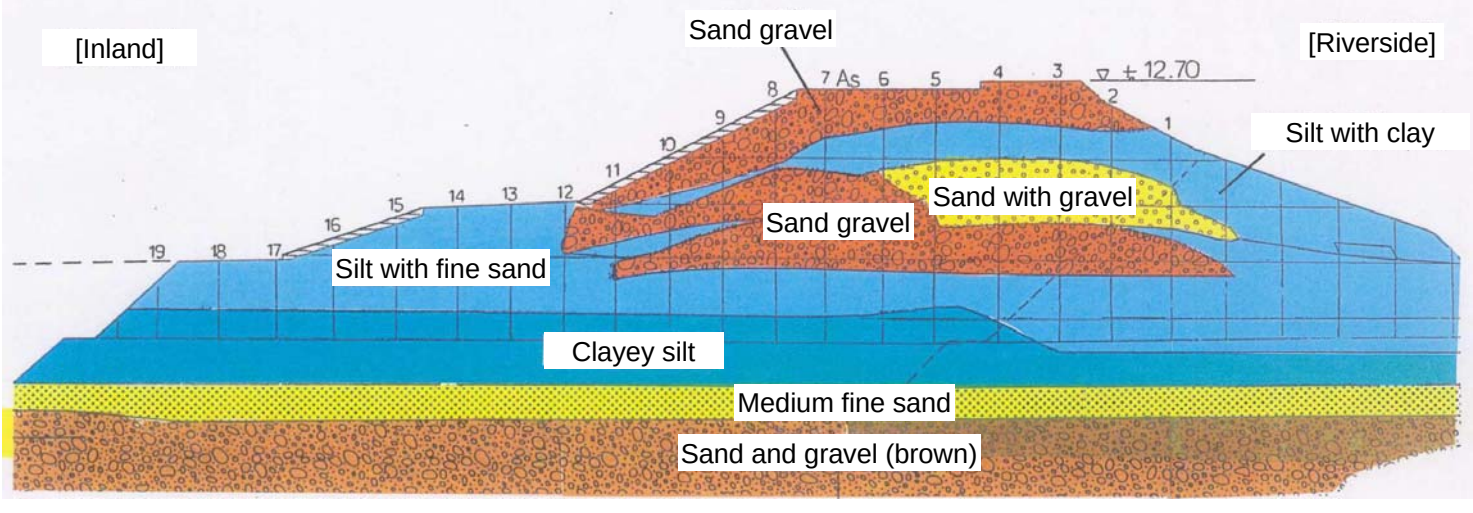
**Early 20th century (Tone River)**

**1940's (Watarase River)**

**Today's construction methods (Benching and roller compaction using tire rollers for expanding the width of the levee)**

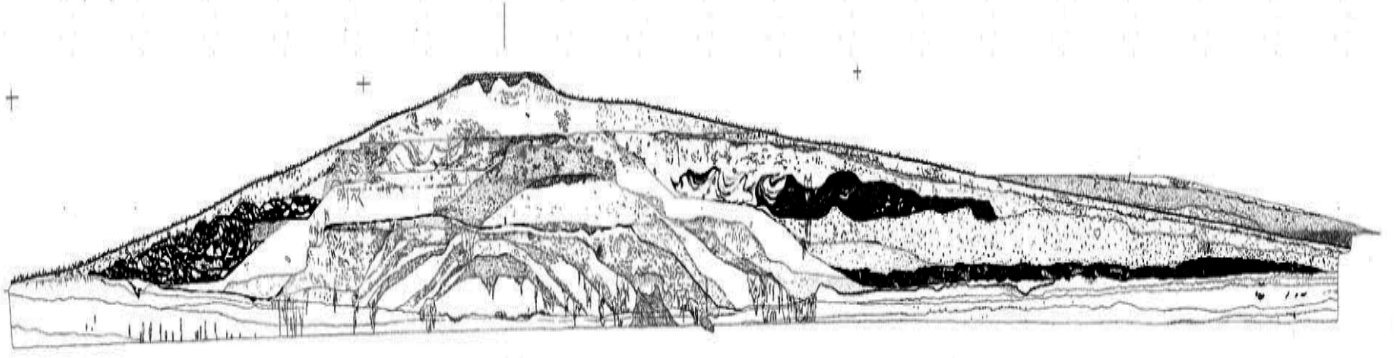
# Complicated soil composition

Levee has mainly used the soil produced at the site and other materials that have varied by project.



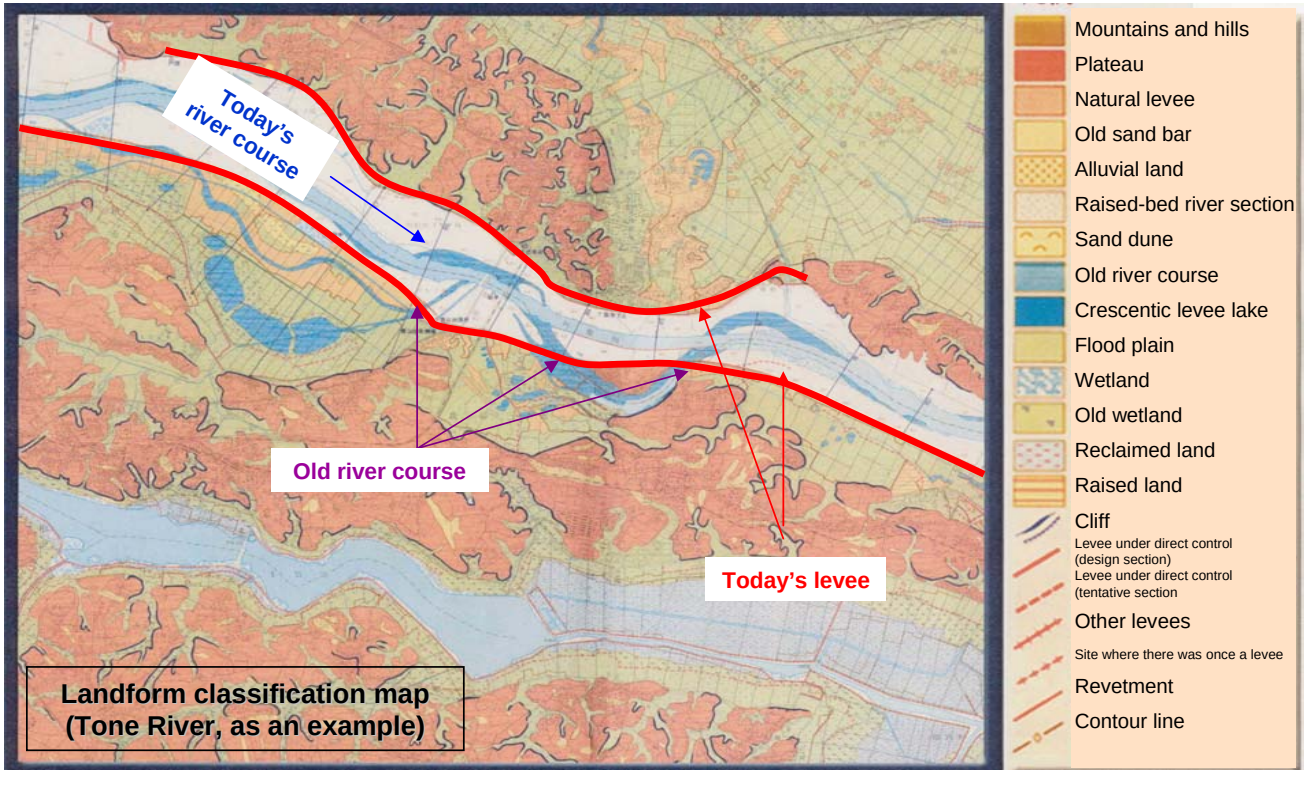
# Example of soils constituting levee bank

The bank has a complicated constitution of gravels, sand, clay, silt, etc.



# Complicated foundation ground

Most plains in Japan are alluvial plains, which were formed by sediment accumulation during floods of rivers.
The majority of river levees are constructed on old river courses, and thus the foundation ground is complicated.



# Engineering design and checking of levee

## July 2002 Design Guideline for Rive Levee

- **New levees shall be checked for safety when designing.**
- **Existing levees shall be checked for safety.**

(Performances required to levee)

- Resisting seepage
  - ◯ Safe against sliding failure
  - ◯ Safe against piping failure
- Resisting erosion
  - ◯ Safe against direct erosion (of the riverside slope and toe surfaces)
  - ◯ Safe against lateral erosion (erosion and scouring of flood plain)
- Resisting earthquake
  - ◯ Safe against secondary damage (by preventing outflow of river water accompanying levee deformation)

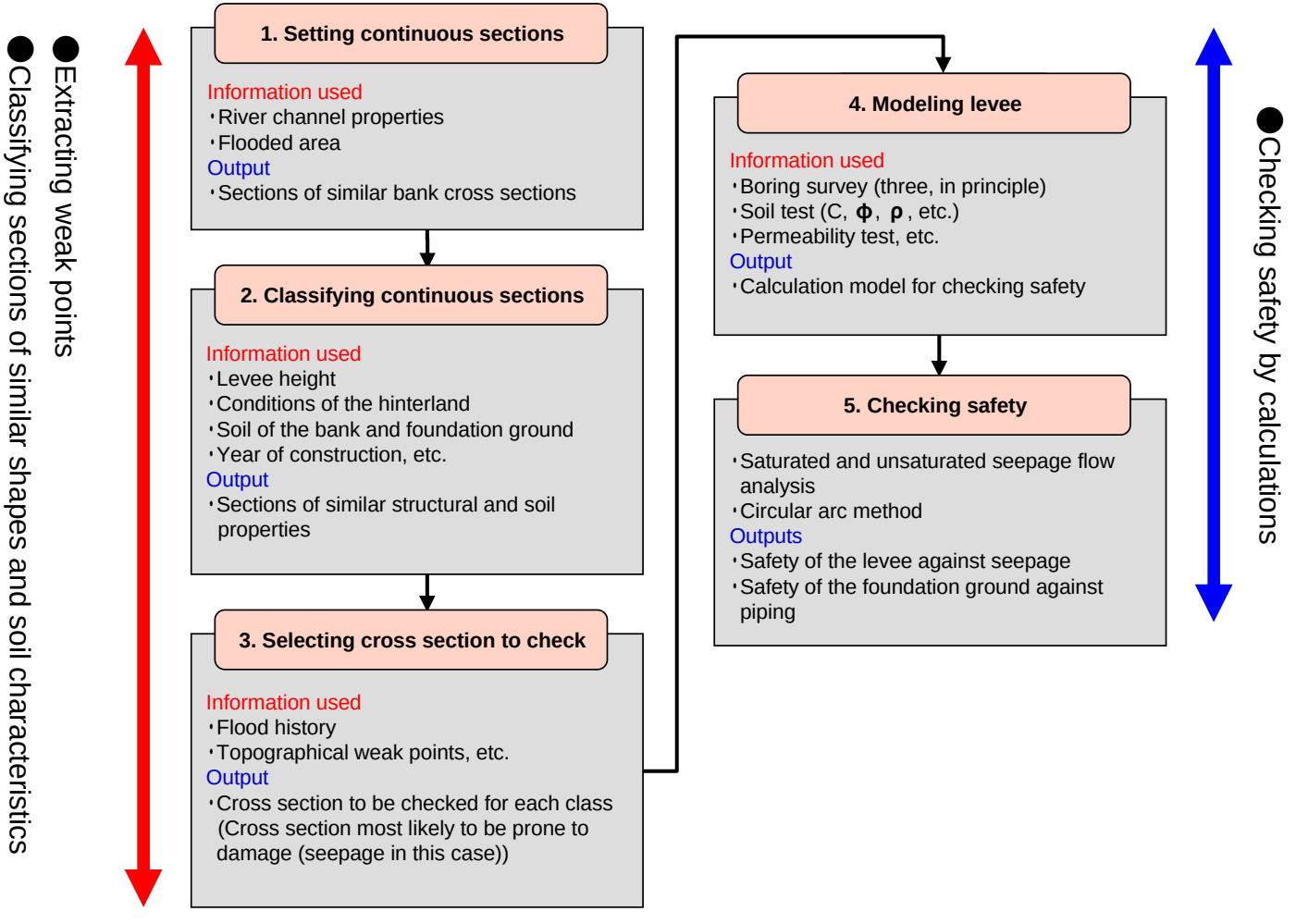
# Example of a burst in levee caused by seepage and overflow combined ①


**Maruyama River October 2004**

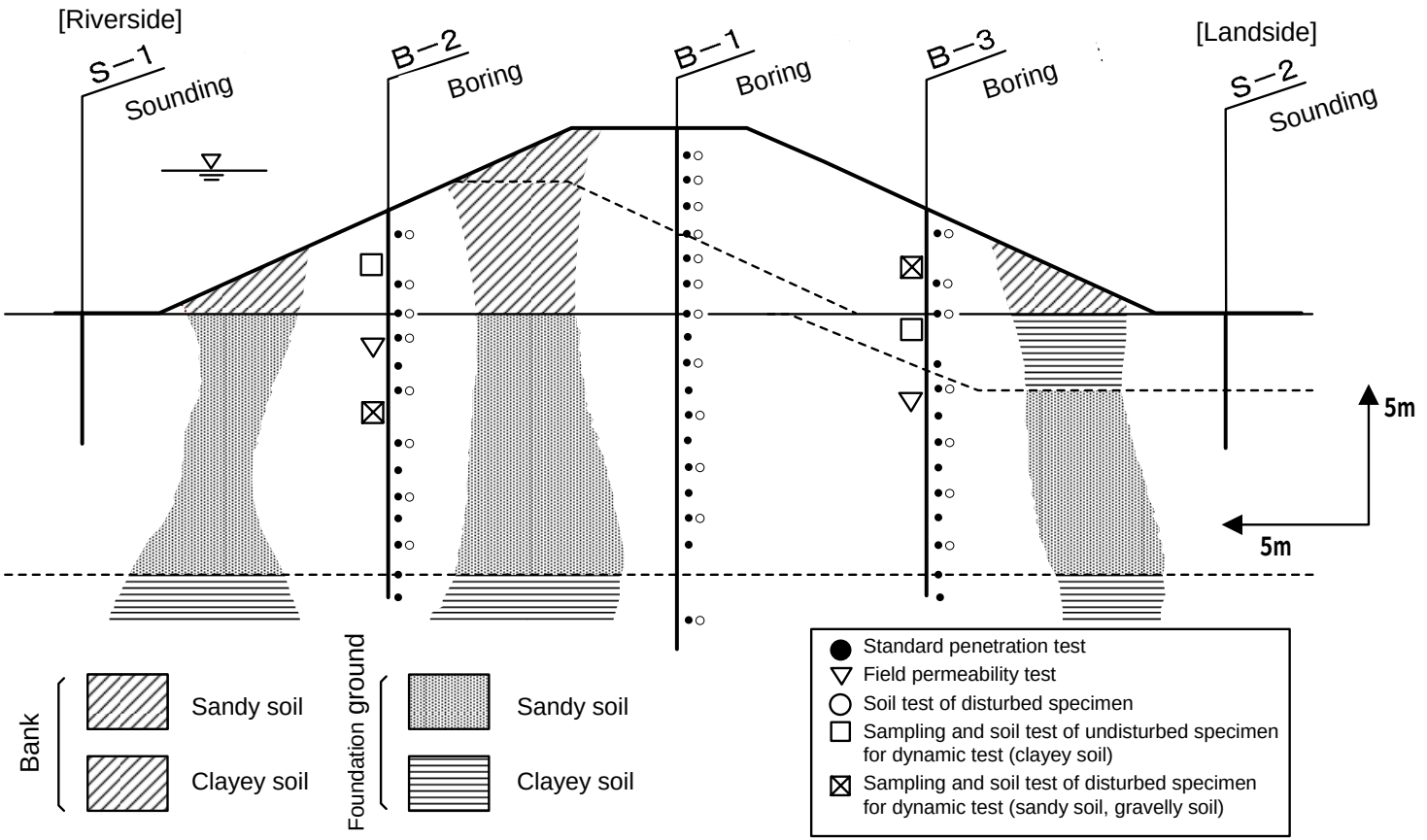
# Example of a burst in levee caused by seepage and overflow combined ②


**Maruyama River October 2004**

# Flow of checking safety against seepage



# Investigation on seepage (① Soil survey)




Survey across levee (Example)

# Investigation on seepage (② Checking safety)

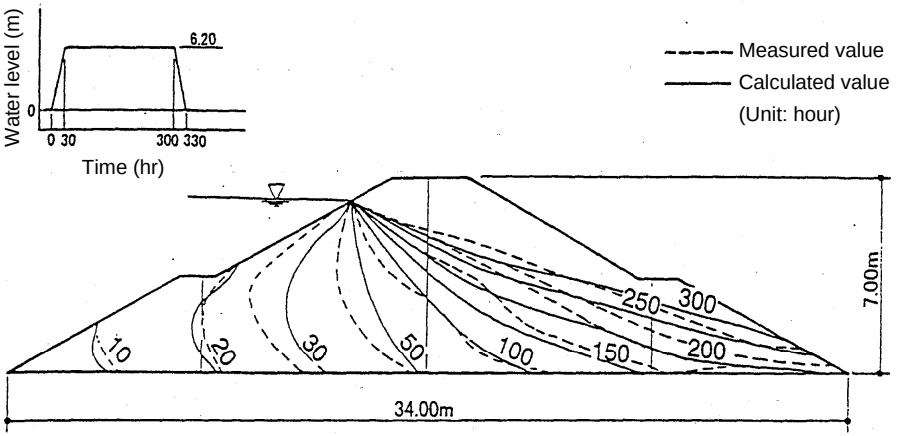
## Sliding failure

- Assessment based on the safety factor calculated by the saturated and unsaturated seepage flow analysis plus the circular arc method

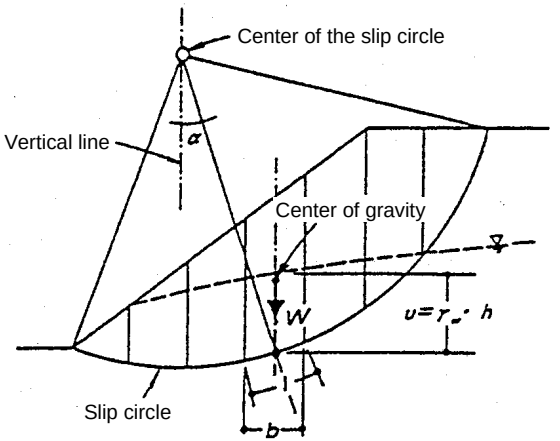
**Fs≧1．2×α1×α2　(Riverside slope)**

α1：Coefficient of the bank history (1.0, 1.1, 1.2　Complicated # larger value)

α2：Coefficient of the foundation ground (1.0, 1.1　With dangerous landform # larger value)



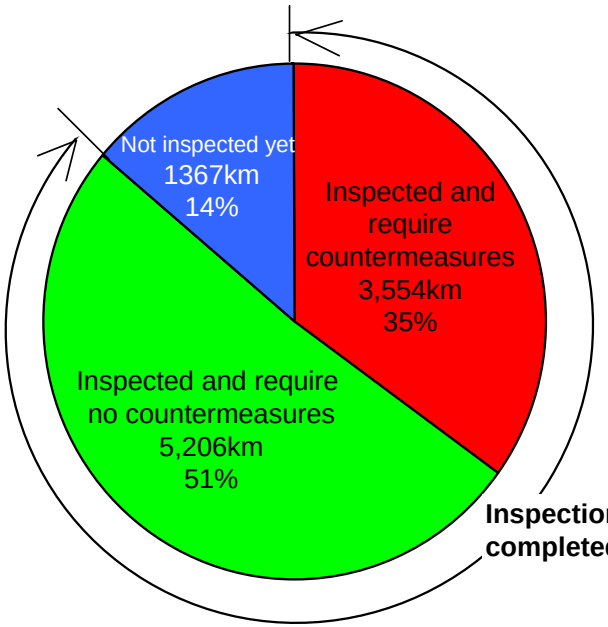

Seepage flow analysis




Circular arc method

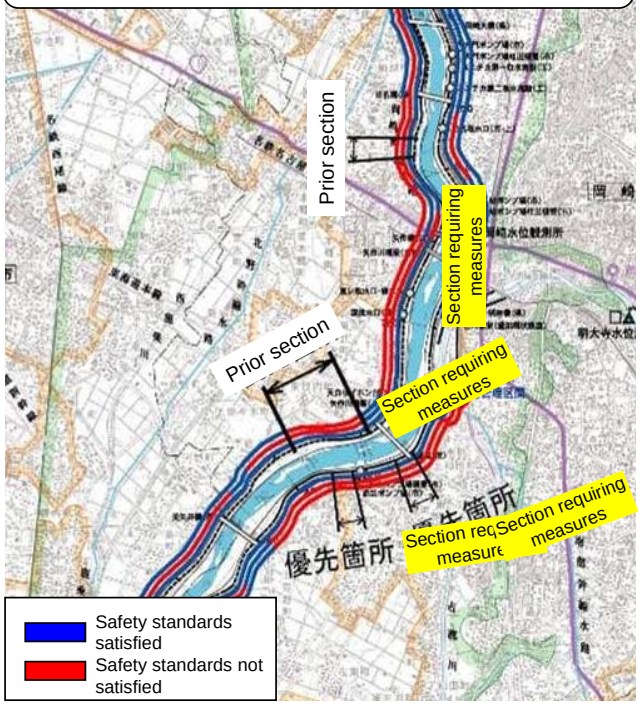
# Present state of safety inspection along the rivers under the jurisdiction of the national government

○ Of the entire levee of about 10,000 km, 8,800 km has been inspected for safety by the end of March 2008.
○ About 3,500 km was found to be insufficient in safety against seepage.
○ Inspection of the remaining 1,400 km will b completed by the end of fiscal 2009.




Percentage of levee sections inspected for safety against seepage
(As of the end of March 2008)

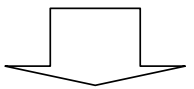
An example of publishing sections requiring countermeasures (Yahagigawa River)



# Executing reinforcing measures

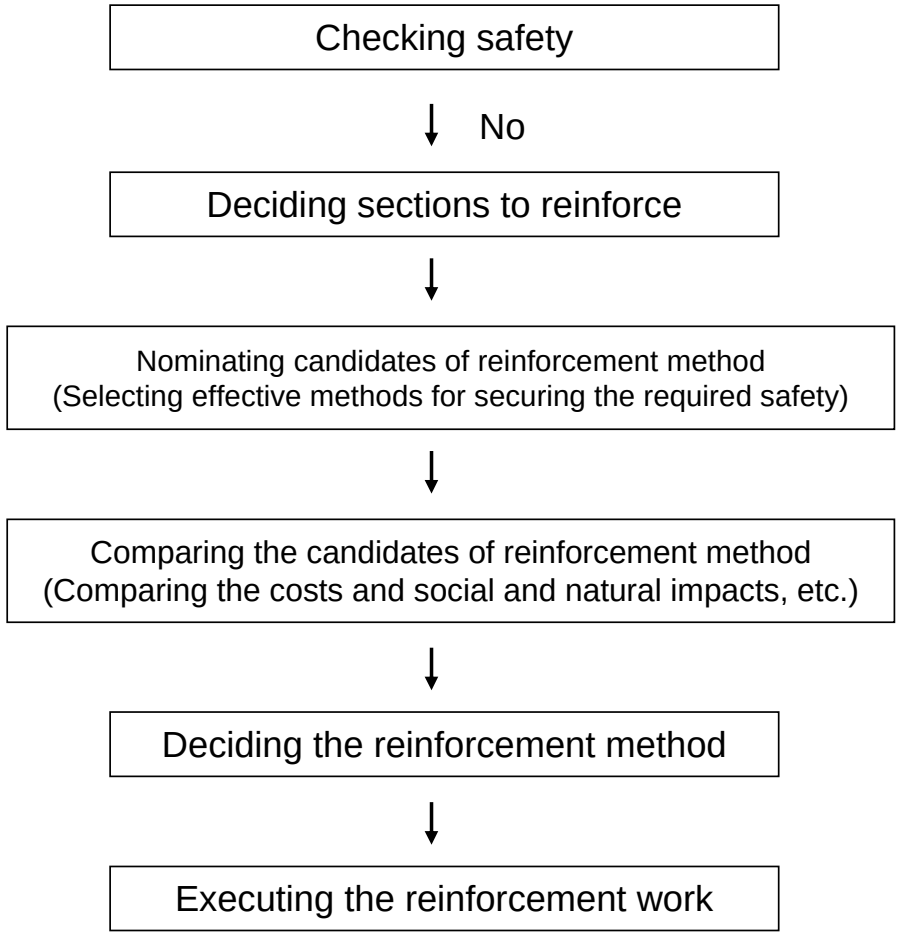
●A three-year priority project started in 2007 to reinforce the 48 km sections that were found to be especially unsafe and have a history of damage.

●The other sections will be reinforced by patrolling during floods and monitoring damage, and careful flood-fighting activities will be carried out.

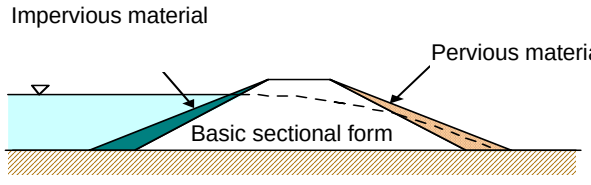
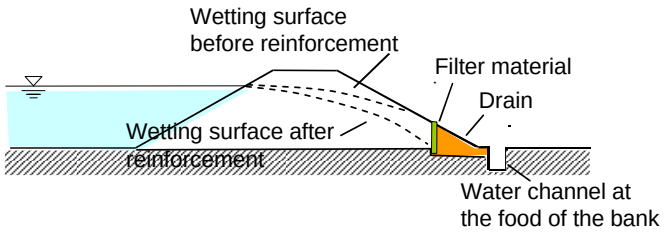
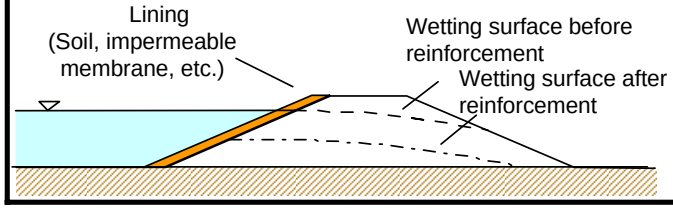


After completing safety inspection by the end of fiscal 2009, a full-scale reinforcement project will be executed by selecting sections of top priority based on safety, history of damage, population in estimated flooded areas, and the conditions of the hinterland.

# Flow of executing works for reinforcing levee

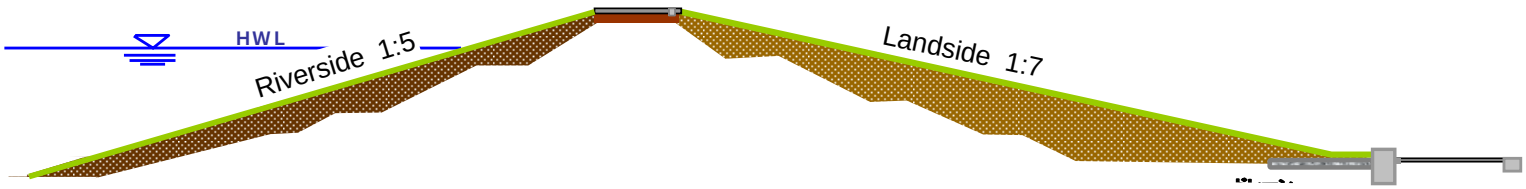


# Standard reinforcement methods (against seepage)

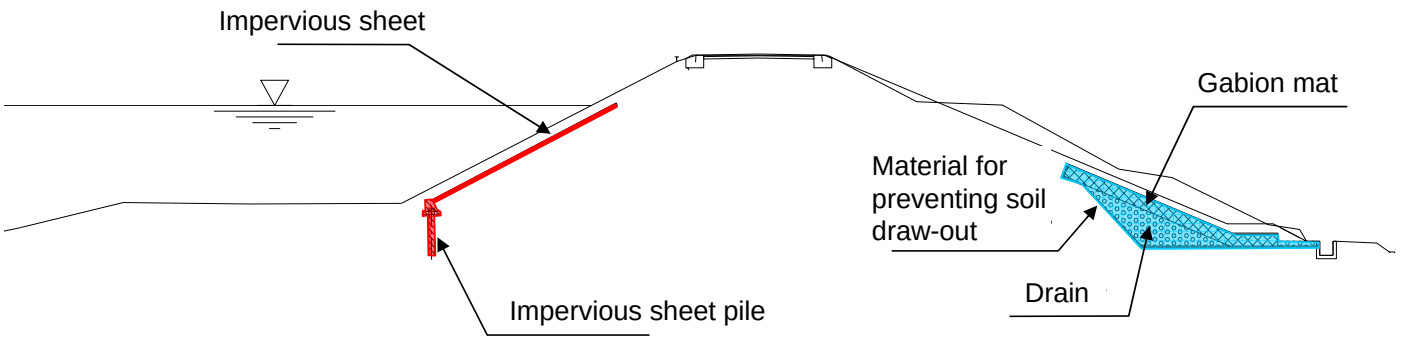
| | |
|---|---|
|  | **Widening of the cross section (Widening)**<br>・The hydraulic gradient is reduced by elongating the seepage route.<br>・The safety of slopes against sliding is improved by reducing the inclination. |
|  | **Drain method**<br>・The discharge of water penetrated into the bank is accelerated by replacing the toe of the inland slope by highly permeable materials.<br>・Rises in the wetting surface are controlled, and the drops in the shear strength of the bank are prevented.<br>・The stability of the slopes is improved by replacing the toes by drain materials of large shear strength. |
|  | **Coating of the riverside slope**<br>・The riverside slope is coated by impervious material (either soil or artificial material) to prevent the river water from penetrating into the bank, rain water from seeping from the crown, and the shear strength of the bank from dropping. |

# Example of seepage control

## Example of widening (Tone River)




## Lining the riverside slope + drain method



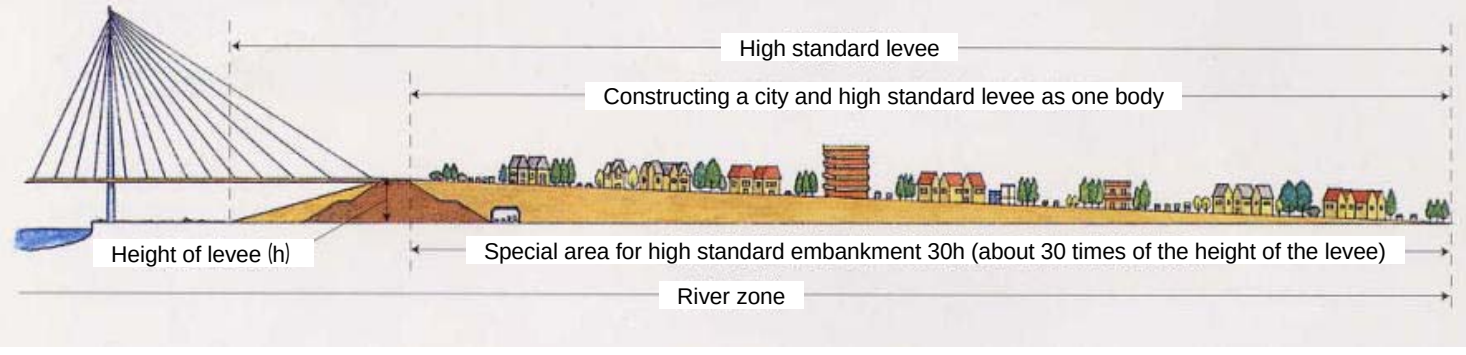
# Prevention of Serious Damage by Super levee

○High standard levee (super levee) is being constructed along the six major rivers in the Tokyo and Kinki Metropolitan areas, where levee break is estimated to cause very serious damages.

○Super levee is much wider than ordinary levee expanding wide under cities, and

1) Does not break even when water overtops,
2) Does not break even when water seeps, and
3) Is strong against earthquakes.

○Landuse in river zones has been strictly regulated by the River Law. The Law was revised in 1991 stipulating the zone from the top of the slope to the toe of the landside slope of super levee to be a special zone, enabling the top of super levee to be used as ordinary land.



# Need of super levee

During an unexpectedly large-scale flood, water overtops and may break the levee.

During an unexpectedly long and large-scale flood, water seeps and may break the levee.

During a great earthquake, the soft ground may liquefy, causing serious damage to city structures at the site.

**Ordinary levee**

**Ordinary levee**

**Ordinary levee**

**Super levee**

**Super levee**

**Super levee**

Overtopping water flows slowly on the levee and does not break the levee.

Even when water seeps in the levee during a long and large-scale flood, the levee does not break because it is wide.

The levee is strong against liquefaction because the soft ground is improved when necessary and the slope is gentle.

# Examples of super levee construction

## Super levee along the Arakawa River (Tokyo)

Before construction

After construction

Close-range view

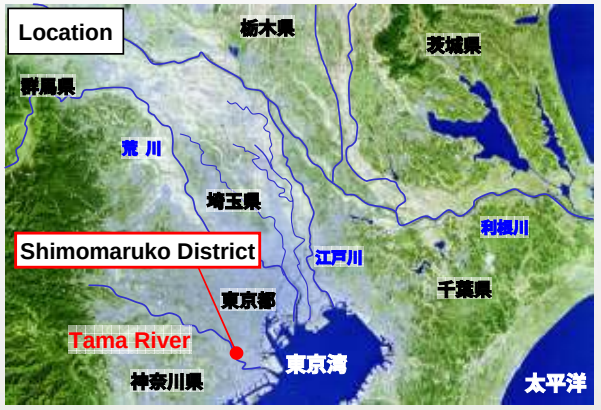
## Super levee along the Yodo River (Osaka)

Before construction

After construction

Close-range view

# Example of super levee construction (Tama River, Tokyo)

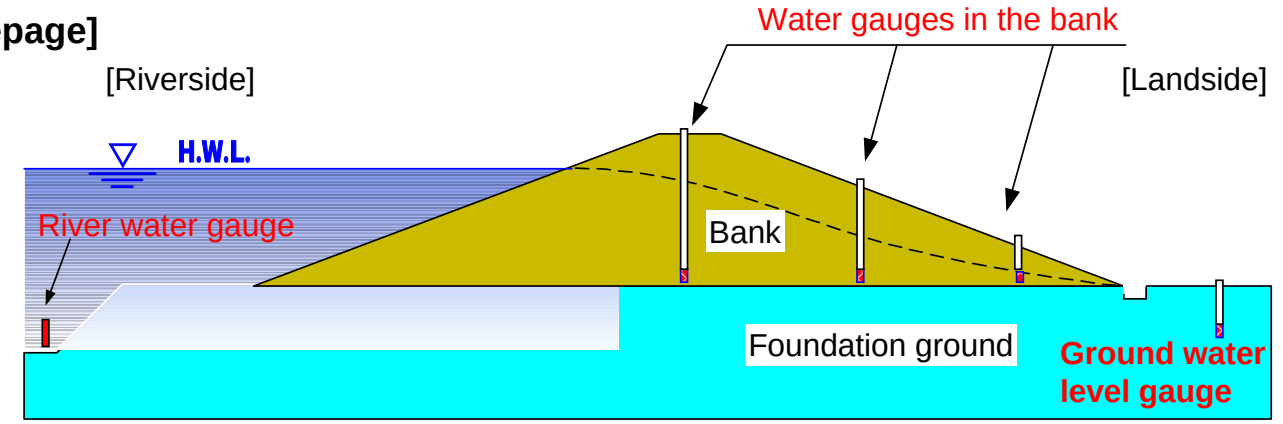



Photographed on April 1, 2007

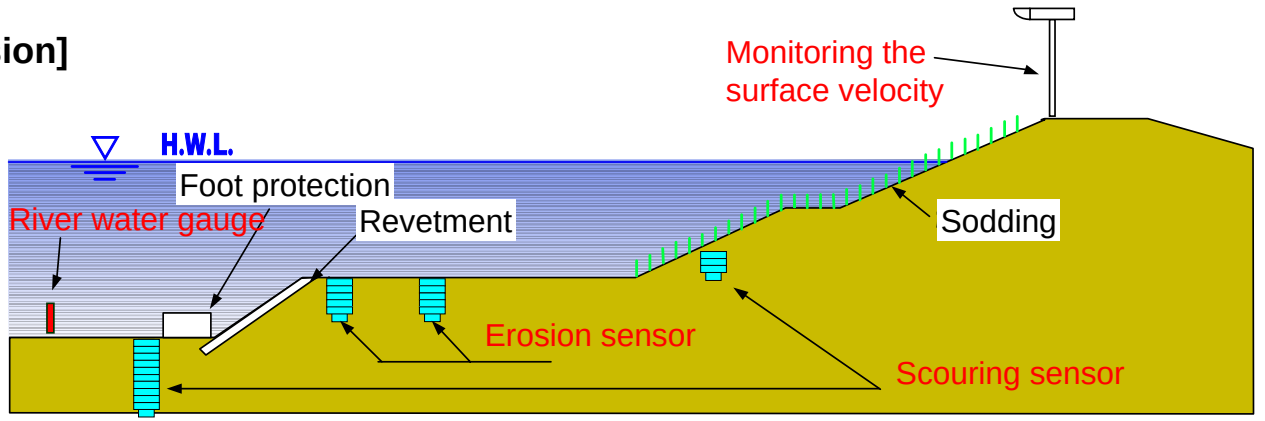
# Monitoring levee

Besides visual monitoring, some levees are monitored using measuring instruments.

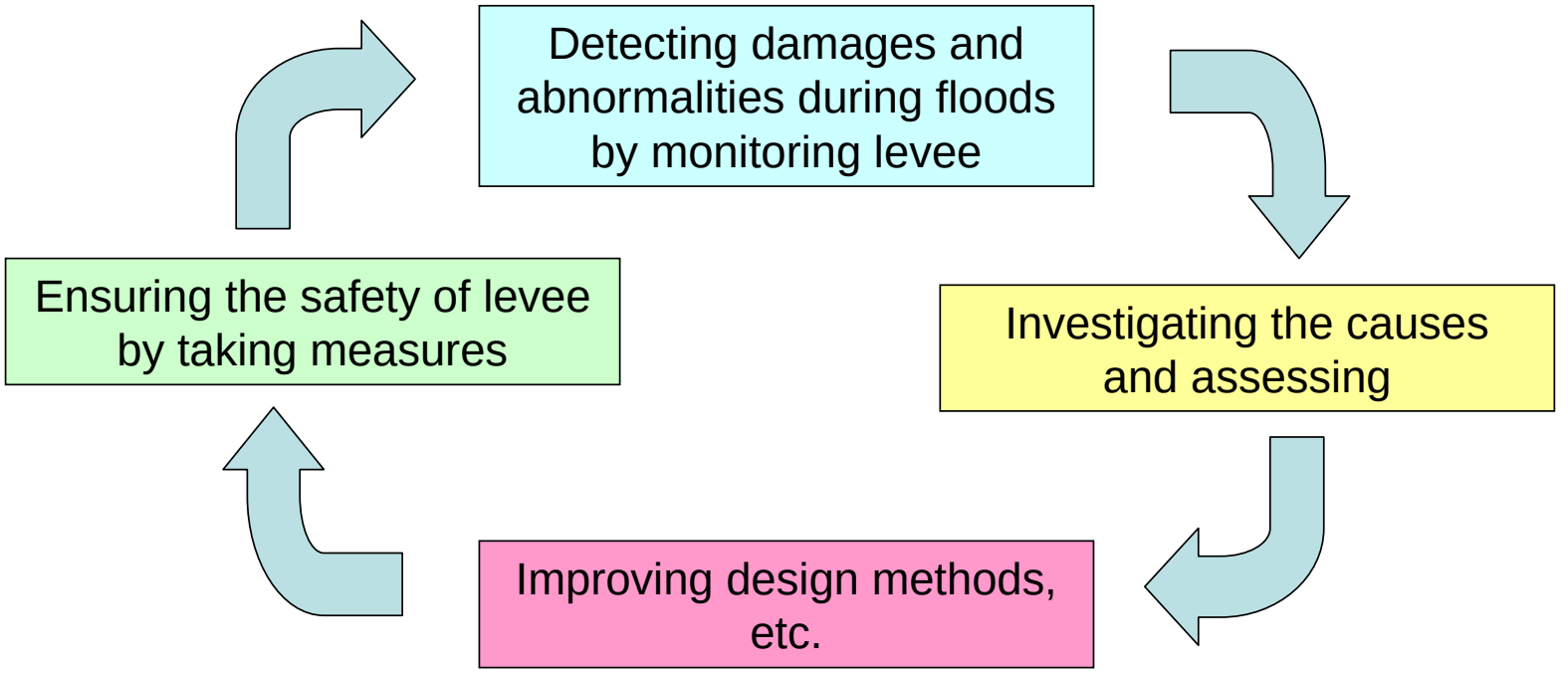
**[Seepage]**



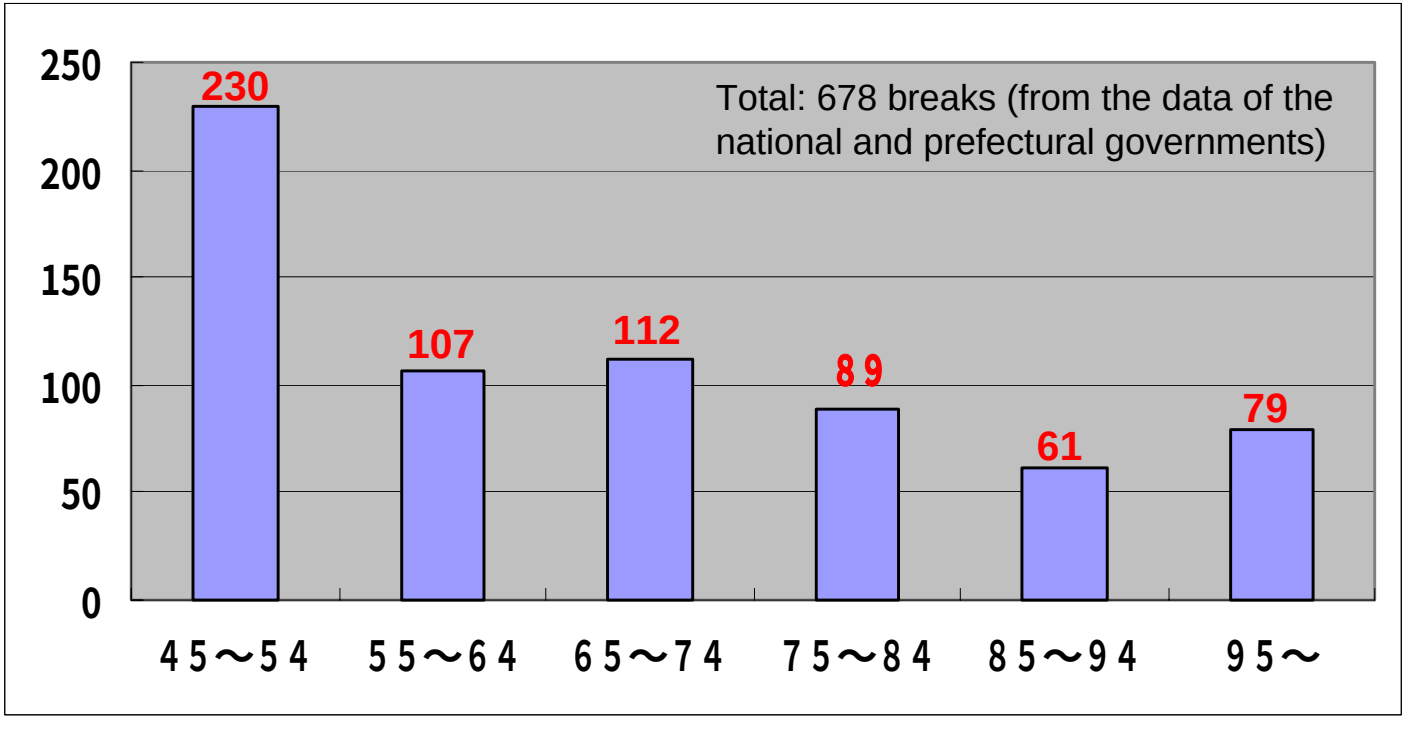

**[Erosion]**



# Spiral up of designing technologies using the results of monitoring



# Number of breaks per year for each decade after 1945



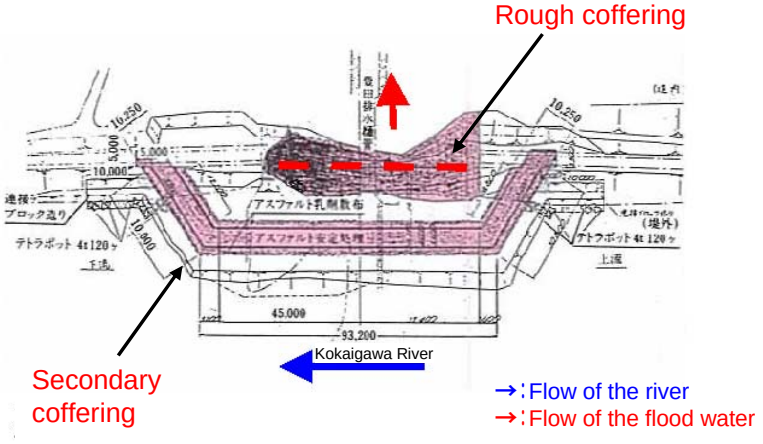

Reference: Actual states of breaking of dykes WWII (2002, River Improvement and Management Division)

# Elaborating technologies for controlling levee (by constructing a risk management system)

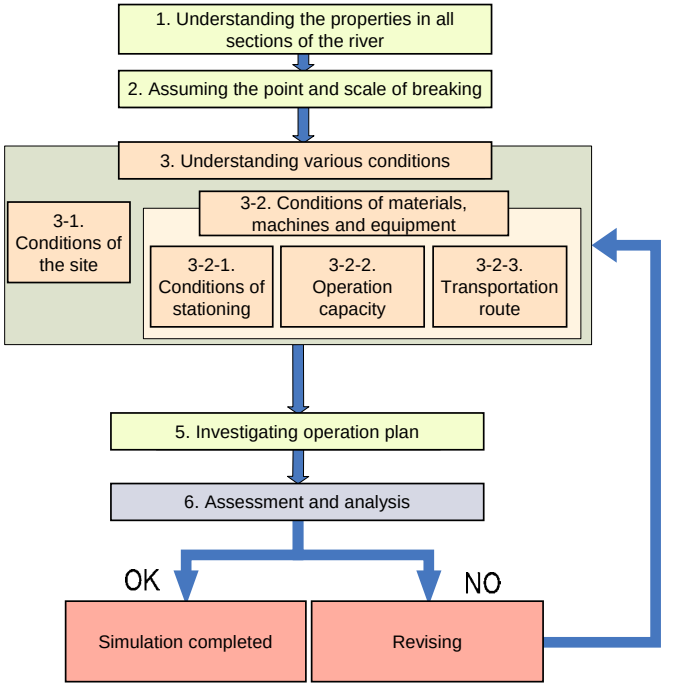
"Simulation of emergency measures during breaking of levee" started in fiscal 2007 in all Offices of River.

## ○Collecting knowledge on emergency measures during breaking of levee

The knowledge on emergency measures during breaking of levee collected by the national government is summarized.




## ○Flow of emergency measure simulation



# Elaborating technologies for controlling levee (by constructing a levee investigation system)

**[Society of the research of levee]**
The society was established in 2008 aiming to always maintain river levees reliable by 1) developing levee technologies, 2) acting as a center of technologies, and 3) promoting education and training.