River Basin Management, Adv.

Chapter 3 FLOOD DISASTER MITIGATION

Flood Protection

(1) Flood protection along a river ← *River manager* (MLIT)
Target area : floodplain = high human activities
Protected by flood levee →design flood discharge after dam control Q_D

Design flood before dam control $Q_D+\underline{\Delta Q}$ ←Runoff process←Design rainfall (return period)
Peak cut by dam
Design rainfall=watershed average, accumulated rainfall during 1 event of rainfall

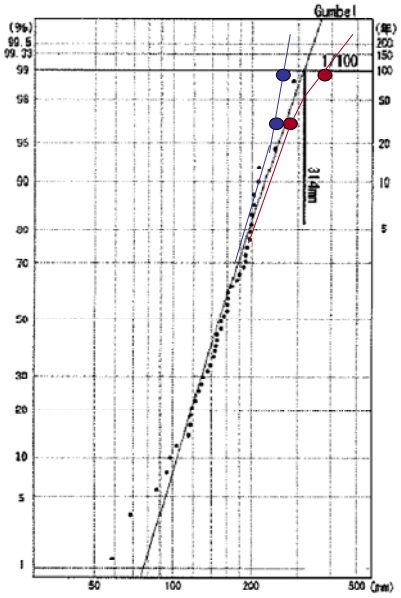
(2) Rainfall Drainage
From area surrounded by continuous levee
Drainage networks, sluice gates, sluice conduits, pumping stations
Agricultural area ← *Water resources and land improvement Association* (agriculture)
Urban drainage = Sewage system ←*Municipality*
= rainfall drainage + waste water treatment
Composite system or Separate system
(early developed area) (newly developed area)
Composite sewage system over flow (CSO)
= overflow of untreated waste water durinfg intensive rainfall (mm)
Design rainfall=local rainfall intensity (mm/hr)

(3) Design of infrastructures
(flood protection along a river or drainage system)
↑
Target rainfall : probabilistic
←Statistical analysis =concept of "Return period"
Statistical data = finite number of data (a few decades)
Accumulated probability (probability of exceed)
Fitting to "extreme probability"
↓ assuming "statistical population"
Without extraordinary data
Locally, temporally extraordinary rainfall data should be removed (omitted) from the statistical analysis
Statistical estimation
Probabilistic phenomena
Random occurrence ←random number (uniformly distributed)

Depending on the phenomena　　characteristic PDF (probability density function)

↓

Estimation of design rainfall corresponding to the “return period”



Preparedness against Flood Disaster

↑

Vulnerability⇔Resilience

(1) Flood disaster mitigation

= Preparedness against flood disaster

= Flood protection←Infrastructure (hardware)

Flood levee + dam　　along river

Drainage (sewage system)　floodplain area with human activities

+Software=”How to prepare disasters”　←*Municipality, Prefecture*

Evacuation

Emergency response

Recovery, Restoration

↑

Forecast←Minitoring and prediction of processes

Weather: Typhoon, Front behavior　←Climate, *Meteorology*

Flood　←Runoff, *Hydrology*

Inundation　←Incident (Overflow, Levee breach, Stop of pumping, etc.)

“Inundation map”　　↑

↓　　“Flood fighting” (team)

↑ *request*

Suggestion or Command for Evacuation　←*Mayors*

Preparation for Evacuation : support and refuge

Making and distributing “Hazard map” to inhabitants

↑ (from "inundation map" against design flood)

Information & Communication

Category of flood-inundation disasters

(1) Slow development of flood infrastructure

Long time project:

Vision return period of 200 years for metropolis (for example)

Master plan completion within 20-30years

(around the level lower than the vision, maximum discharge after the war)

Recent low level of economic development

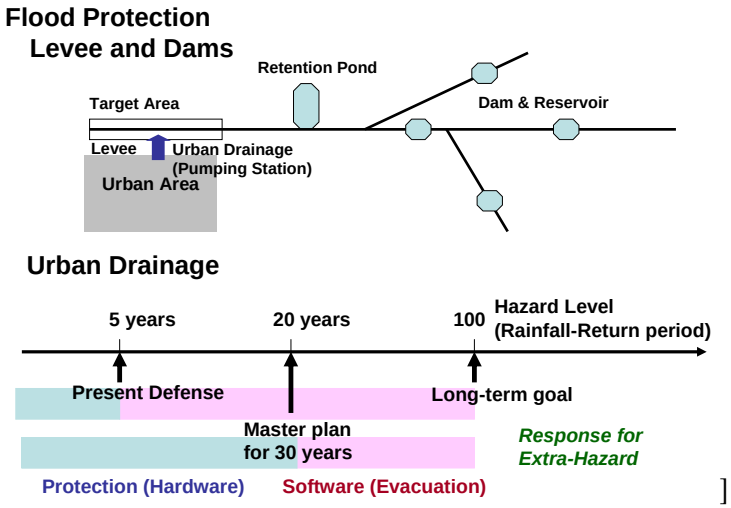
Environmental effects ←*Environmental Impact Assessment*

Public opinion against public works (in particular, dams)

Obvious gap of the safety between the present situation and the planned level

Present situation – Master Plan – Vision

(1/10) (1/50) (1/200)



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Insufficient dimensions of river cross-section, dimension of levee, dam control, etc.

→Necessary development of flood protection works based on "master plan"

to continue to complete the "vision"

Present efforts for flood disaster mitigation:

Evacuation ← Hazard map

(2) Extraordinary Intensive Rainfall

Statistically extraordinary intensive rainfall

Locally concentrated heavy rainfall during short period

Examples: Iga-river（Okazaki, Aichi）2008

Toga-river（Kobe, Hyogo）2008

Kani-river（Kani, Gifu） 2010

Difficulty in monitoring

C band rader 2km 10min. all Japan

X band MP rader 500m 1mm (higher resolution) *partially covered after 2010*

Difficulty in prediction

Initiation

Migration (convection)

Development (transformation, structural change)

Short leading time

Monitor→Predict of rainfall→River flow discharge→Inundation→Evacuation

Runoff

Dangerous points:

Houses along river (outside of levee)

Houses located in low spot (including underground facilities)

Recreation or amenity space in river with high revetment without runaway

→*Should be removed, improved*

(3) Excess Flood over Vision (Catastrophe)

Return period of event > Return period in vision

Strategy

Infrastructure: Super levee (free breach)

Risk management – Emergency Response

Evacuation (controlled)

Strategic operation to avoid serious damage

Evacuation Assisted by Hazard Map

(1) Preparing Hazard Map

Assumed rain fall for vision for present situation

→Assumed inundation map *provided by river managers*

Maximum inundation depth overlaid the inundation simulation results for several events when levee breaches occur several possible sites during flood in river under present situation. *insufficient height of levee*

insufficient cross-section with incomplete dam control

→Hazard map *prepared by Municipality*

(2) Levee breach and Inundation

Inundation←Levee breach

Fluvial process of river, levee and floodplain

Simultaneous analysis is recommended!

Breaching process should be analyzed:

Temporal change of breach dimension→Inpuflow for inundation

Interaction with river bed deformation

Importance of floodplain morphology: scour hole, deposition

Effect of river flow
Effect of plane view of river (bending, meandering)
Effect of levee cross-section *etc.*

(3) How to use Hazard Map
Who should know: Inhabitants, Flood fighting team, Mayor
(*responsible to issuing evacuation suggestion*)
Self support, Community support, Public support
Recognition of risk of flood disaster

(4) Evacuation with Hazard Map
Inundation process = spatio-temporal variation of inundation depth
Position of people in evacuation (origin to destination) = spatio-temporat change
Local safety level (risk level) depends on:
Local hydraulic condition
Potential of evacuee (age, sex, handicap, knowledge, …)

Risk Management for Large Scale Flood with Excess of Flood Protection Vision

requires large scale evacuation

(1) Experience of Hurricane Katrina (USA, 2005)
New Orleans City was totally inundated and more than 1000 peoples were killed.
↑
High storm surge
Levee breach in drainage canals and navigation canal
Inundation
Many peoples who could not evacuate and rejected evacuation

Role of FEMA (Federal Emergency Management Agency)
→Emergency management, risk management, catastrophy management

Wide-range pre-evacuation←*proper information*
Response to catastrophic disaster
SWEAT (Security, Water, Electricity, Access, Telecom)
Closing levee breach, Unwatering
Trailer house, Debris removal
Provide ice, water and power
ESF (Emergency support functions)

Investigation of cause of disaster→Emergent restoration
↓ *IPET (Inter-agancy Performance Evaluation Task)*
Restoration ←ASCE Review

Redundancy, Risk informed planning, Assisted evacuation, *etc*.

(2) Tokai Nederland Takasio and Flood Regional Councils

Lowland high surge (Ise-bay area)

Area below the sea level: 336km^2 (400km^2 in New Orleans)

Population: 0.9 million (0.66 million in New Orleans)

(similar to Tokyo-bay, Osaka-bay areas)

Experience of "Ise-bay Typhoon Disaster" 1959

Working Group: discussion to make action plan for risk management

↓ *early weather forecast for big typhoon*

pre-evacuation by public transportation

secondary evacuation from inundated area

← *Information Integrated Center*→*Joint Emergency Operating Center*

↑ ↓

Early and accurate weather forecast *Incidence response*

(30hrs before the typhoon landing)

Organizing of the Councils (tops of various organizations)

Vulnerability of Urban Flood Disaster

Structural vulnerability

Complicated structure (including underground facilities)

Rapid runoff, Rapid flow, *etc*.

Social vulnerability

Weak relationship among neighborhood

Various categories of peoples (inhabitants, working, shopping, on travel, etc.)

Vulnerable life style

Separately living of family member,

depending on life line, furniture, electric products, etc.

vulnerable *debris*

Influence of Global Warming

Global warming → Climate change → Extraordinary weather

↑ (extraordinary events, excess of the present statistics)

Mitigation against global warming

Adaptation for global waming (climate change)

Change in return period-rainfall relation

Drought, Heavy rainfall (flood), Typhoon,

Flood protection level

Decrease due to global warming

Increase by public works achievement