# V LECTURE NOTES

# 1. Keynote Lecture

## “Impacts and Responses of Climate Change”

## -New Challenge for Infrastructure Management-

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The 19th Meeting on Public Works R&D in Asia

# Impacts and Responses to Climate Change -New Challenge for Infrastructure Management

16 November 2010

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## Contents of Presentation

1. Trend of Natural Disasters in Asia
2. Future Prediction of Climate Change
3. Coastal Impacts in the Asia and Pacific Region
4. Response to Climate Change
5. Wise Adaptation and Relation with Sustainability

# 1. Trend of Natural Disasters in Asia

## Occurring Impacts

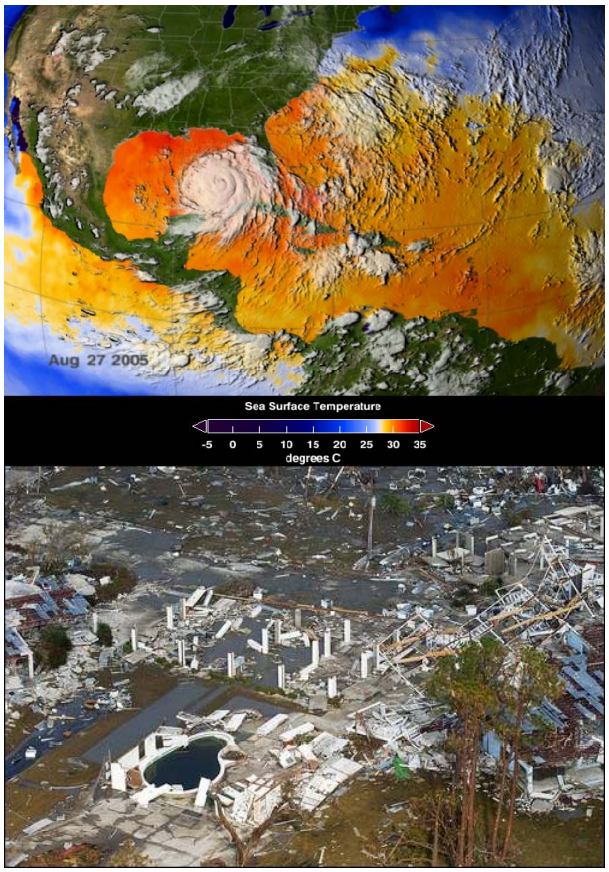
2003 European heat wave
Excess deaths in France (14,802), U.K.(2,045) etc.

2004 Typhoon damages in Japan

2005 Hurricane Katrina
Losses of US$96 billion.

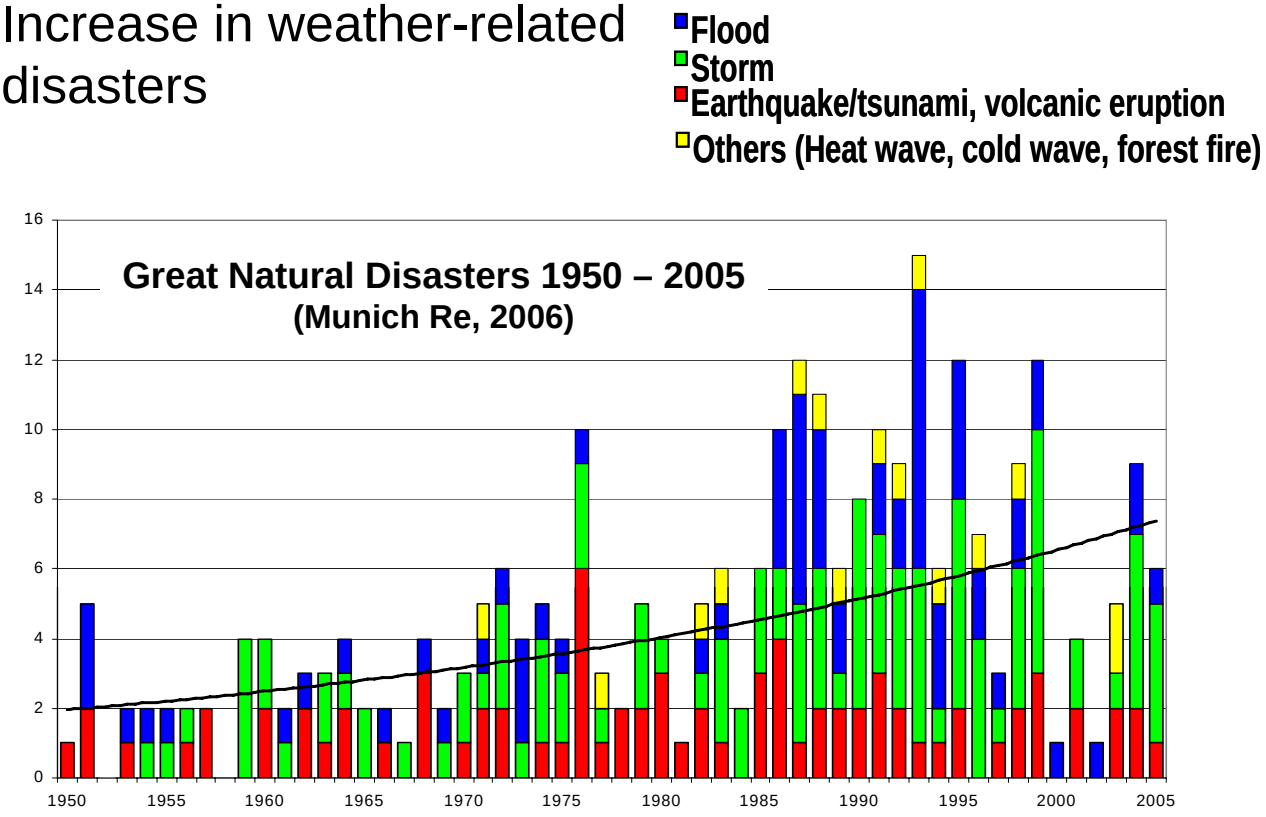
2007 Heat waves and bushfires in Greece

2010 Floods in Pakistan, Japan's historical hot



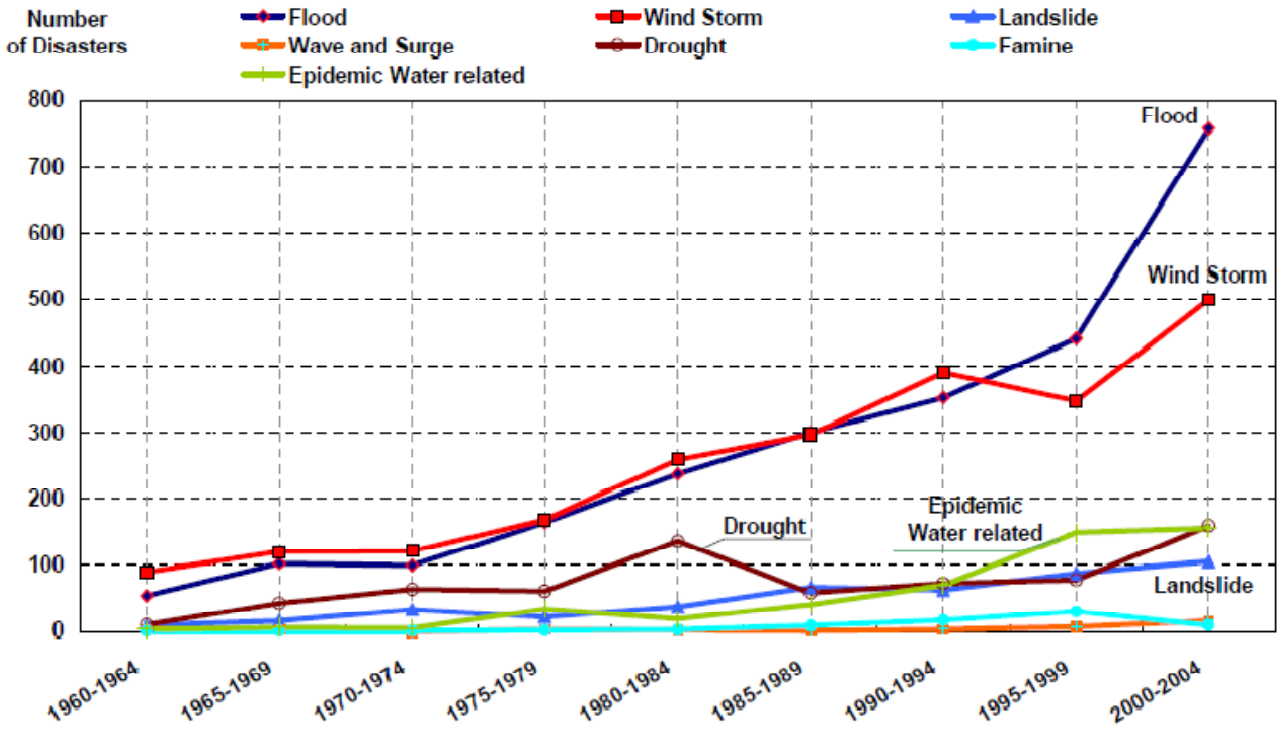
# Present Impacts: Increasing Disasters

- Increase in weather-related disasters

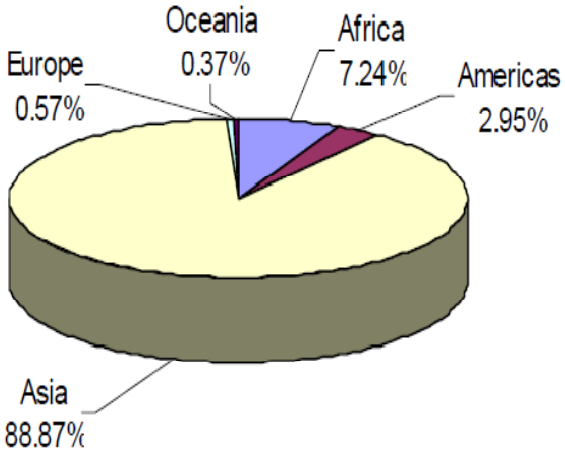



# Global trend of natural disasters, 1960 to 2004

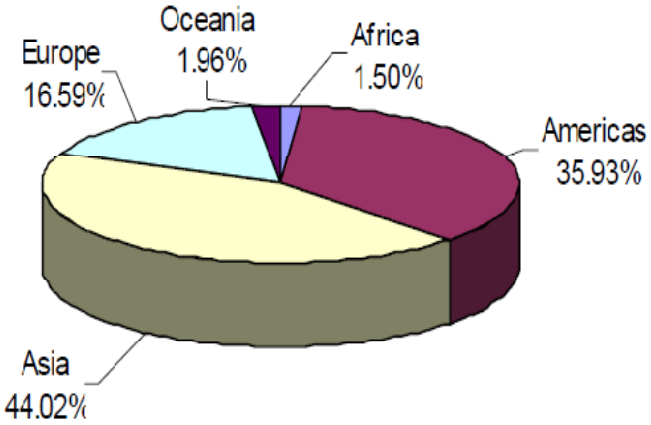
(PWRI, 2005)



# Regional Distribution of Damages, 1975 to 2005

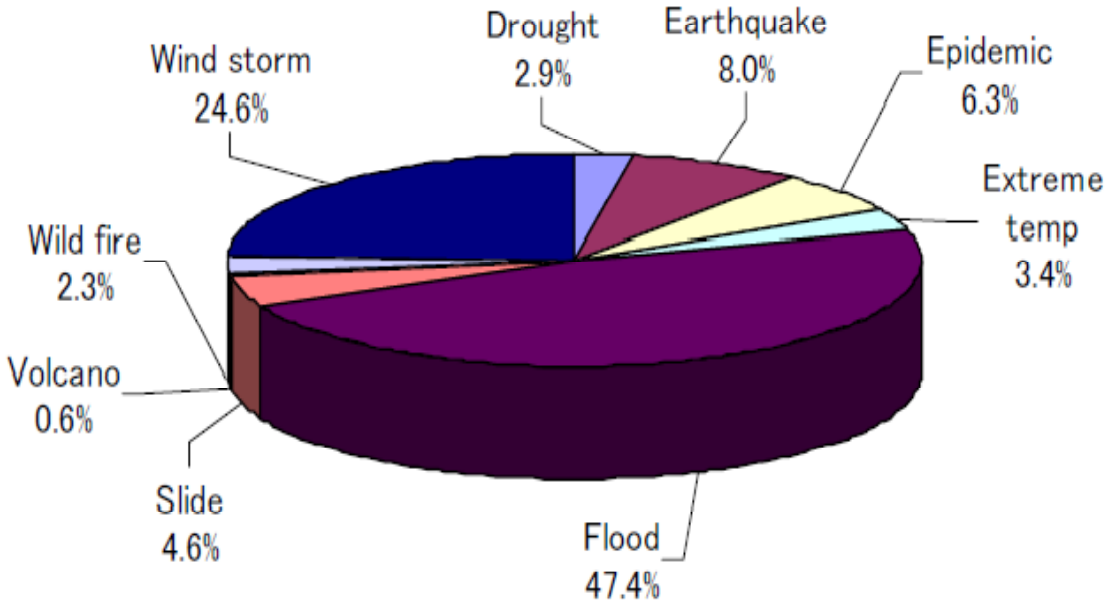



Affected people



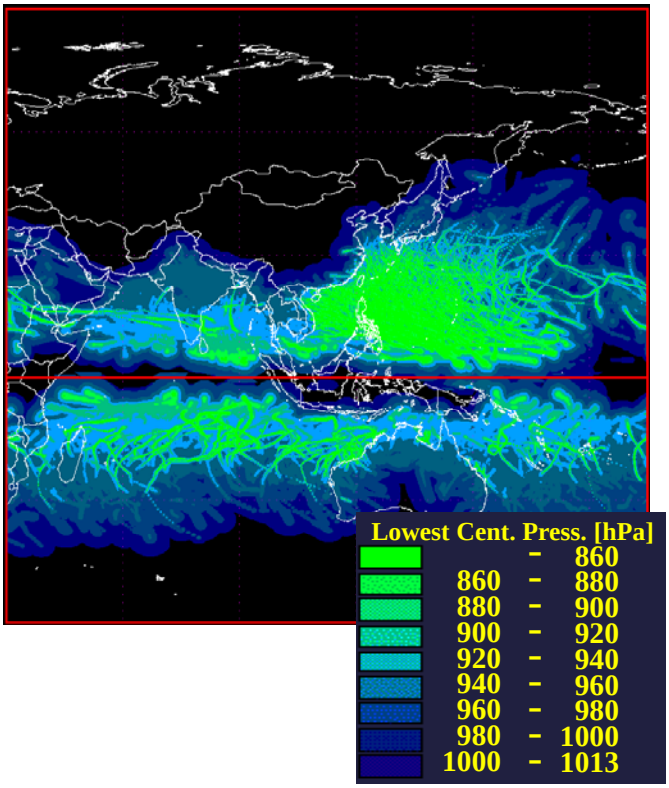

Economic damages

# Types of natural disasters in Asia in 2005 (ADRC, 2006)

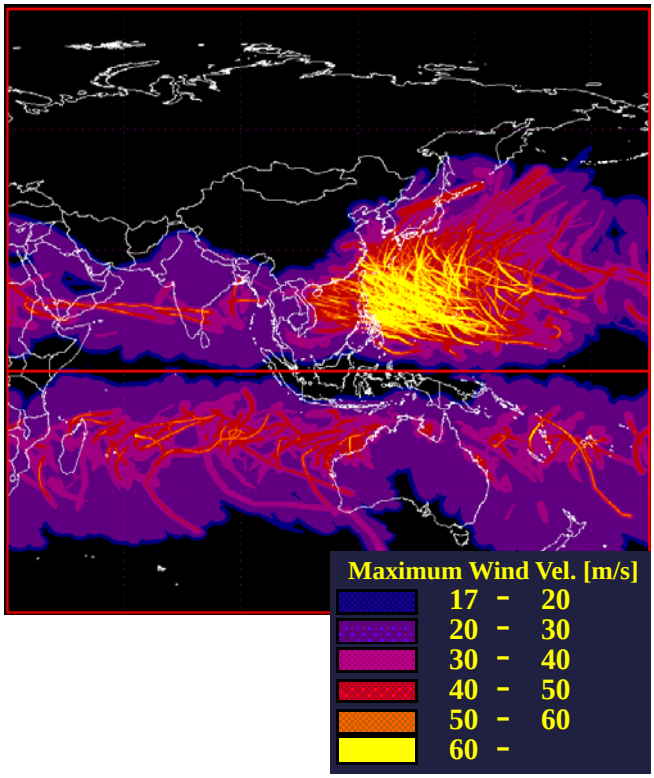


# Estimated Typhoon Parameters

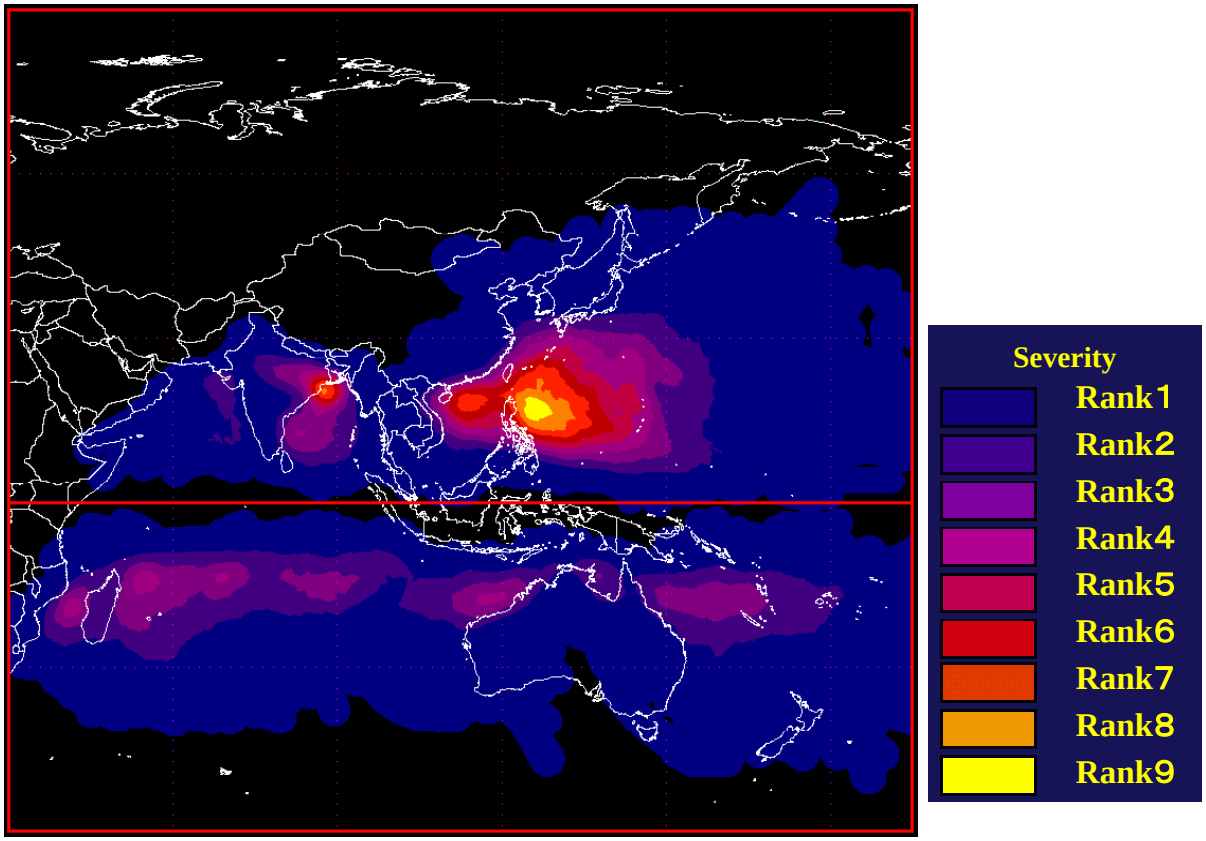
## Lowest Center Pressure



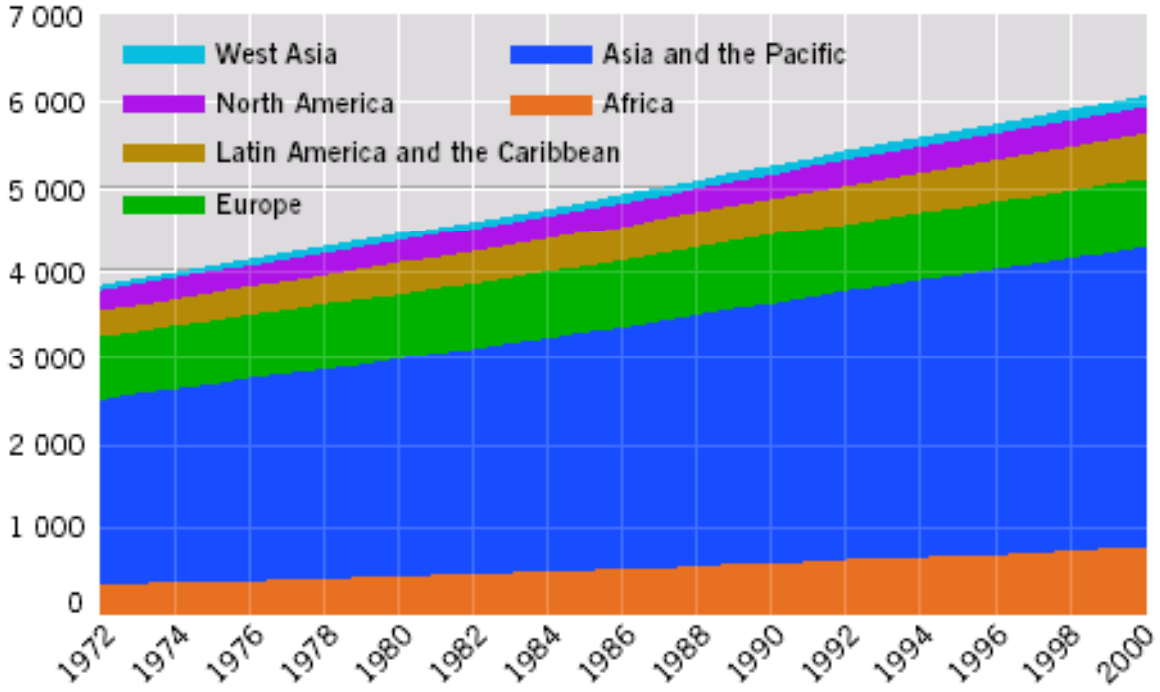

## Maximum Wind Velocity




# Hot Spots of Typhoon Impacts

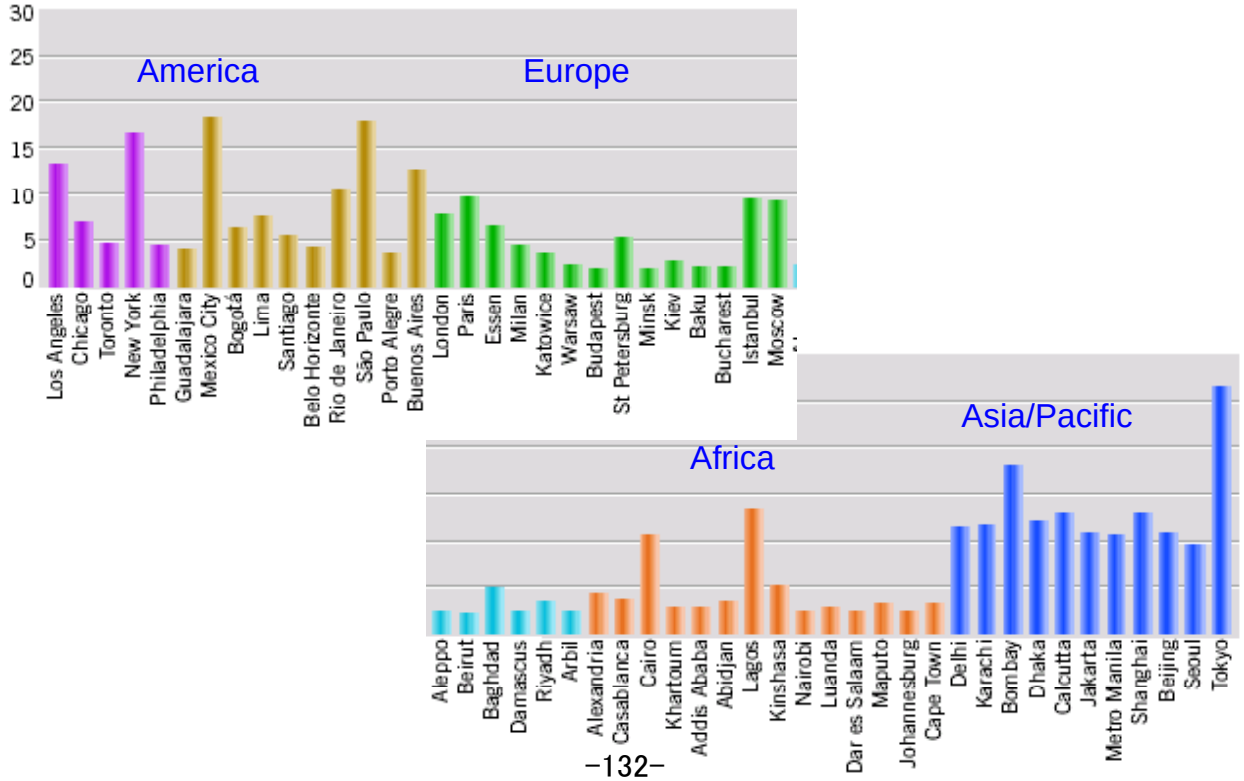


# Population Growth in Asia




World population is currently growing at 77 million a year, with two-thirds of the growth in Asia and the Pacific

# Mega-Cities in the World



Relative vulnerability of coastal deltas by sea-level trends to 2050 (extreme >1 million; high 1 million to 50,000; medium 50,000 to 5,000)


## 2. Future Prediction of Climate Change

# 2.1 Scientific Assessment of Global Warming IPCC's Role

- Intergovernmental Panel on Climate Change (IPCC)

  Jointly established by WMO and UNEP in 1988

  IPCC's role is assessment of the latest scientific understanding.

- IPCC Assessment Reports

  1990 First Report
  1995 Second Report
  2001 Third Report (TAR)
  2007 Fourth Report (AR4)
  2014 Fifth Report (AR5)

- Working Groups(WG)

  WG1 The Physical Science Basis
  WG2 Impacts, Adaptation and Vulnerability
  WG3 Mitigation of Climate Change
  Synthesis Report

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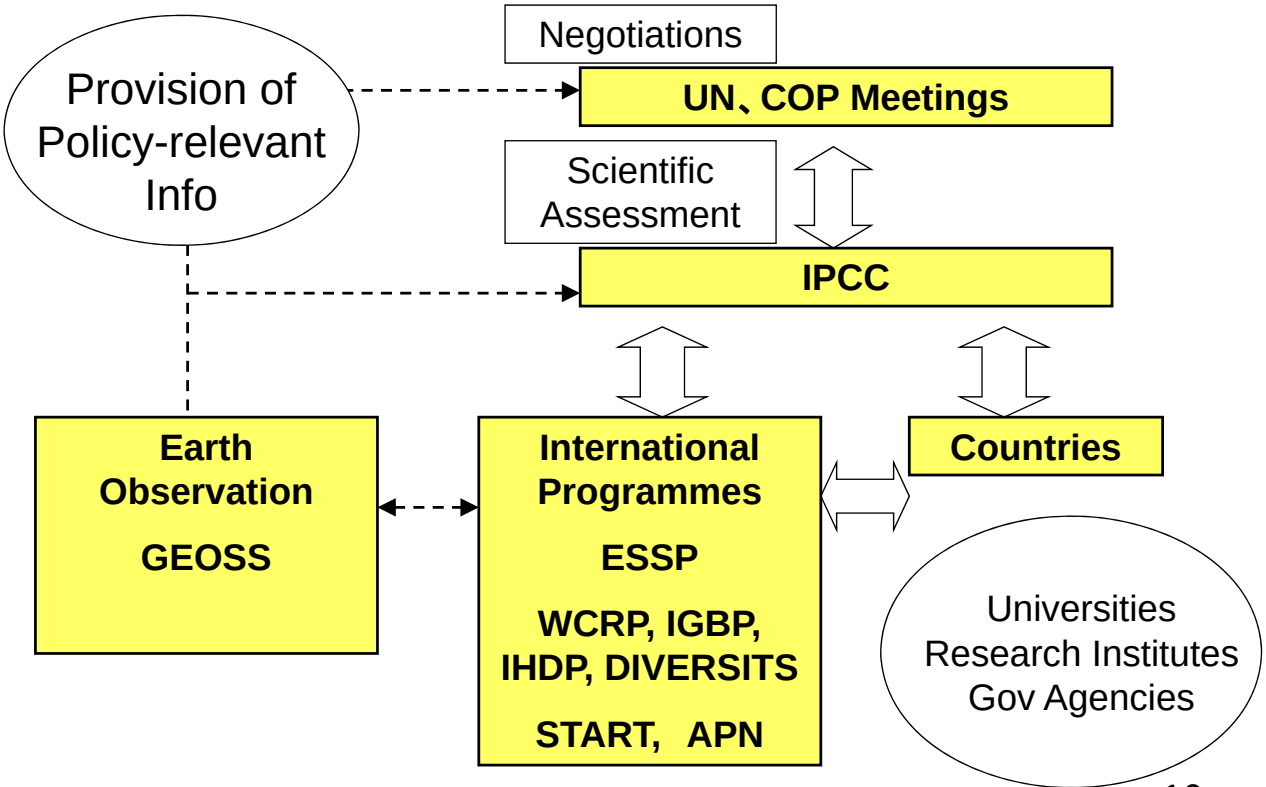
# Flow of Scientific Knowledge

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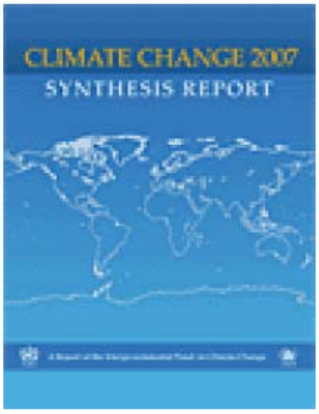
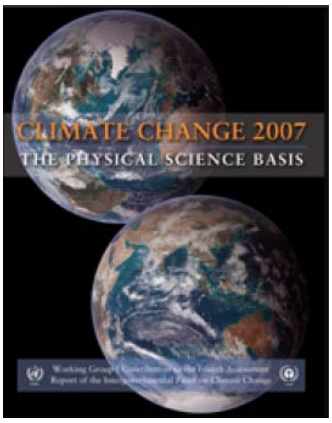
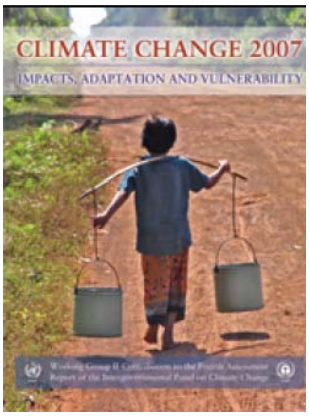


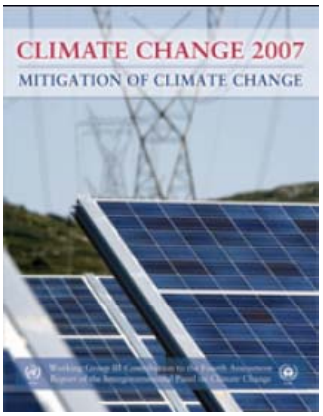

Synthesis Report




WG1




WG2




WG3



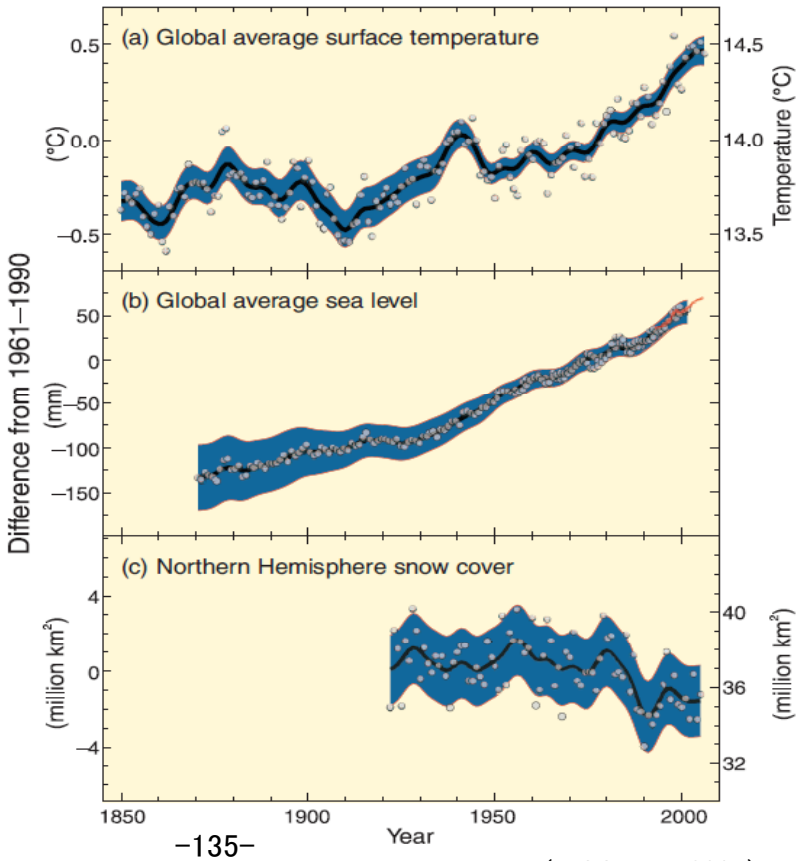
# 2.2 Observed Changes

Changes in

- Global average surface temperature

- Global average sea level

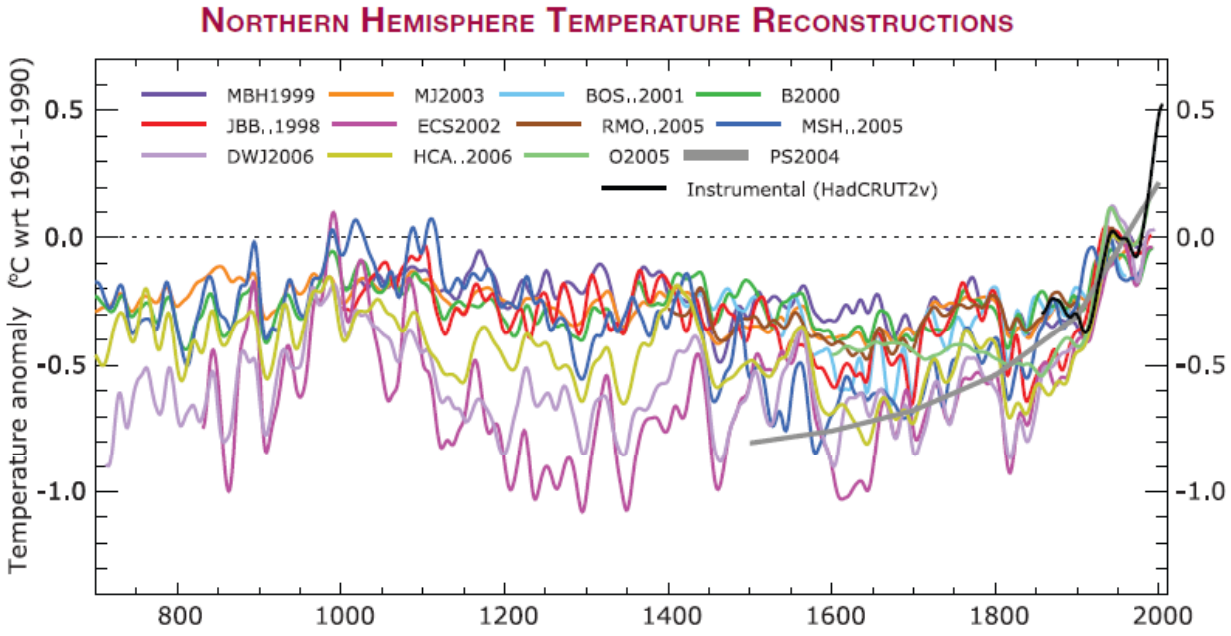
-Northern Hemisphere snow cover






（IPCC AR4，2007）

# Long-term Trend of Northern Hemisphere Temperature




0.74℃ increase for the past 100 yrs

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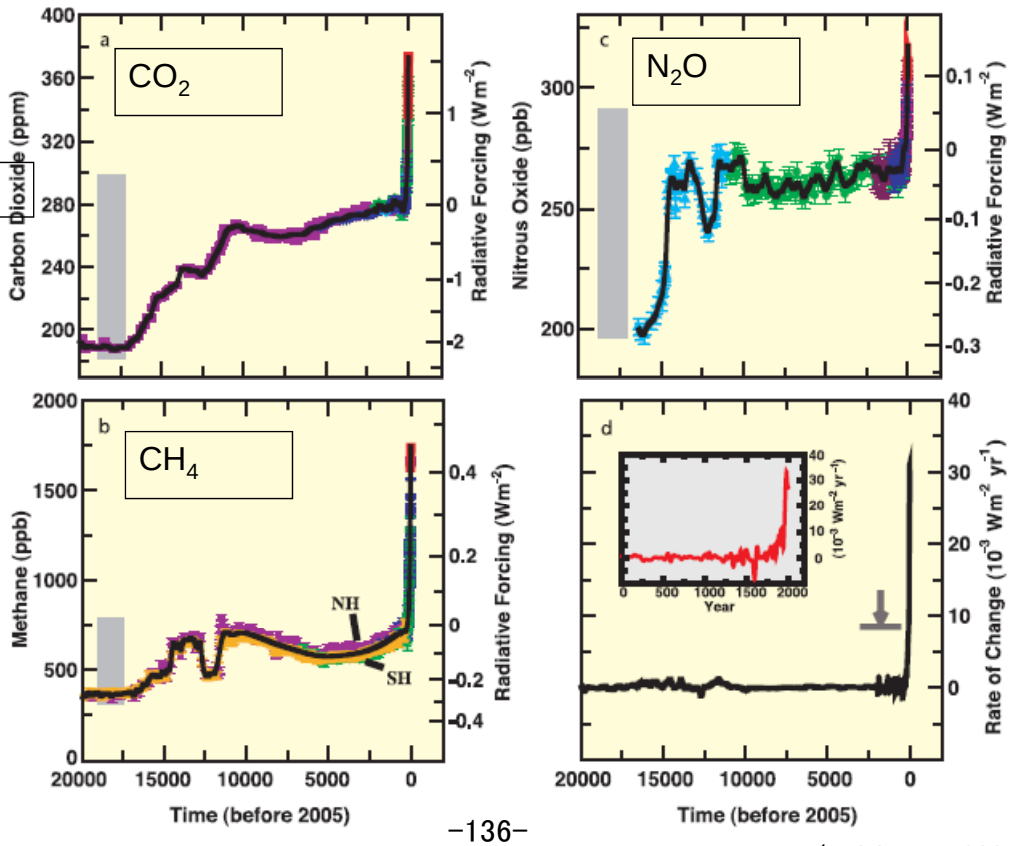
（IPCC AR4，2007）

# Changes of GHG Concentration -20,000yrs

280ppm

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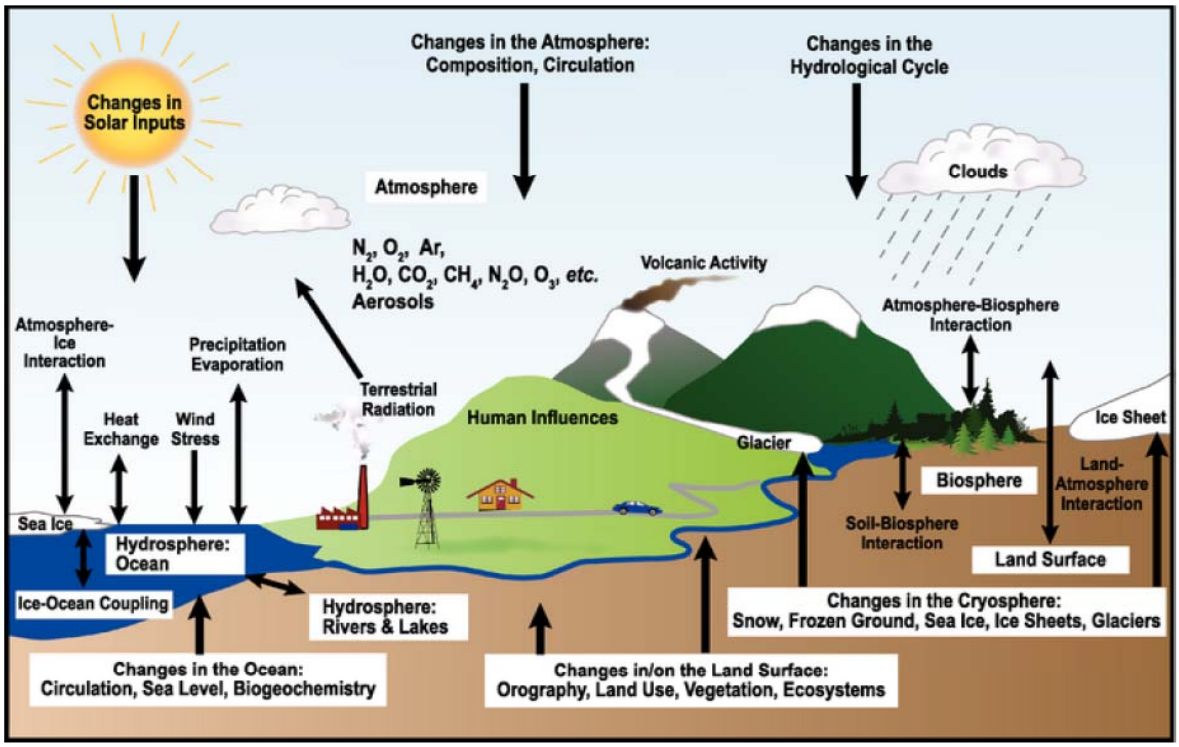
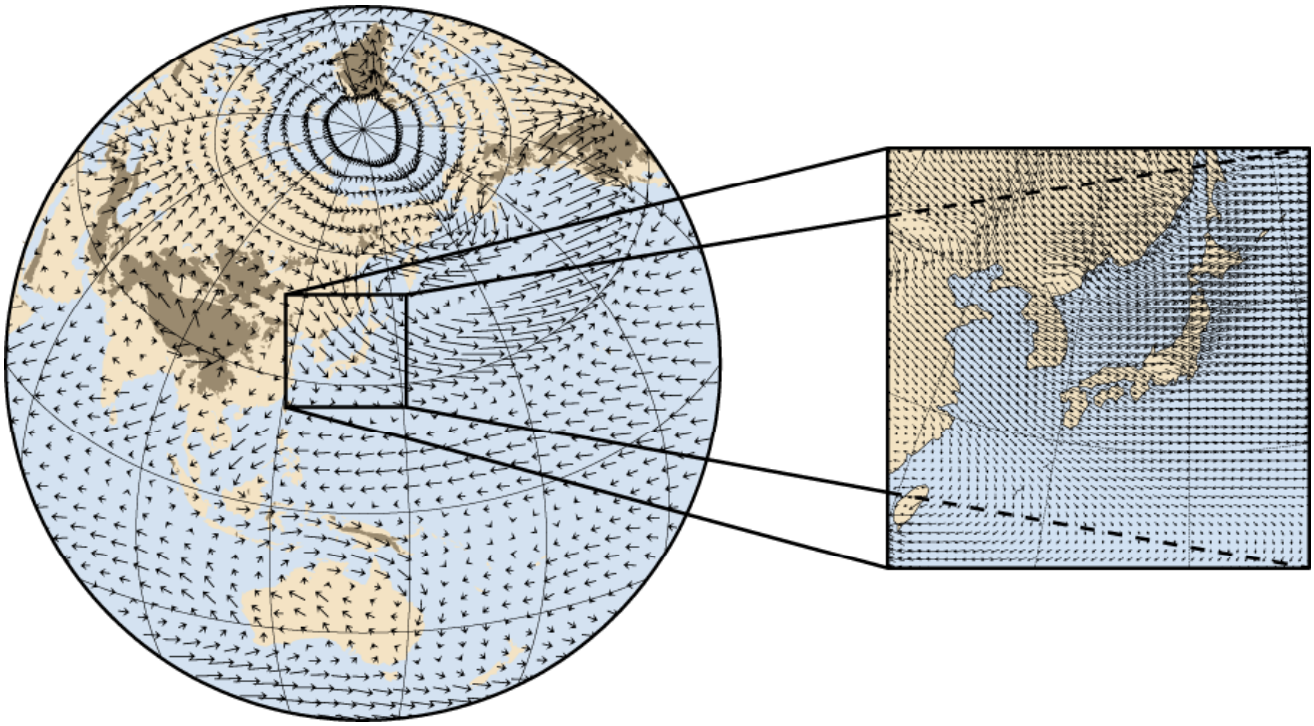
（IPCC AR4，2007）

# 2.3 Prediction of Climate Change
## Modeling Climate System

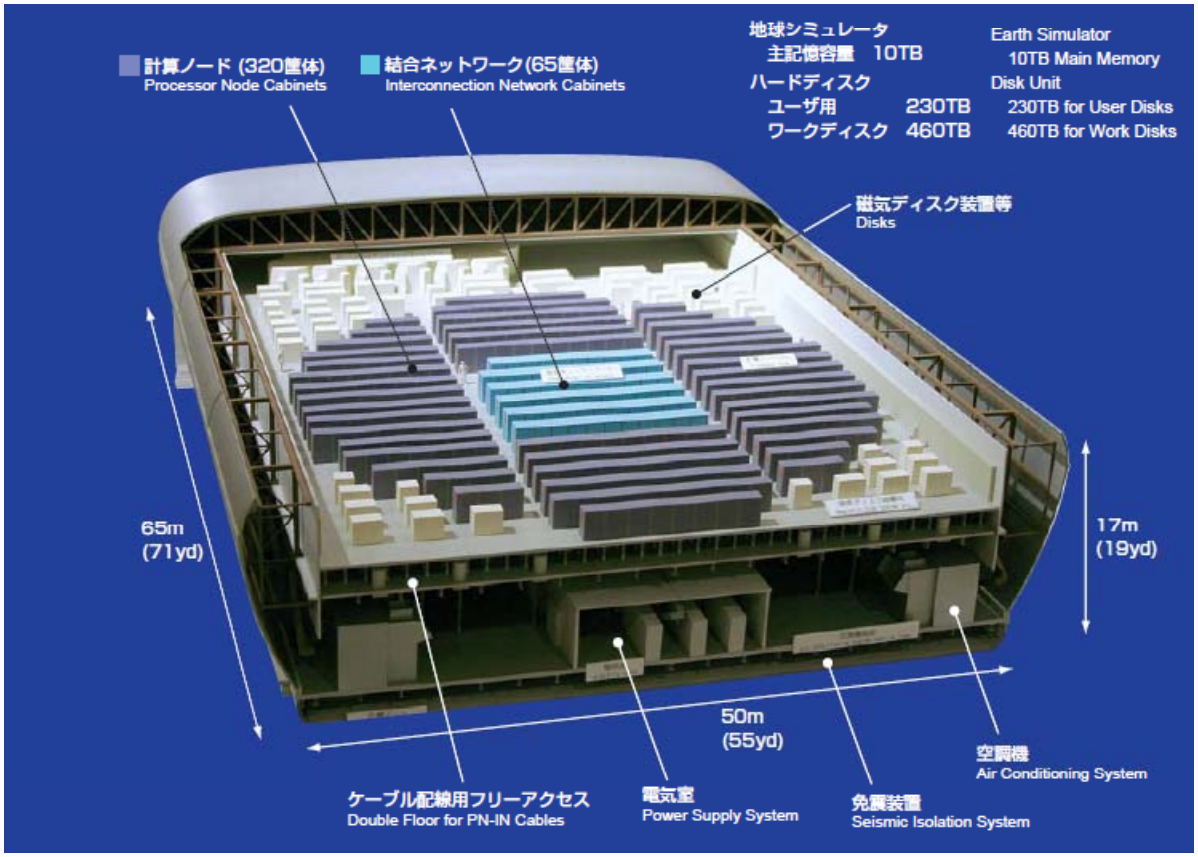



(IPCC WGI AR4, 2007)

## GCM and Regional Model (Nesting)



# Earth Simulator

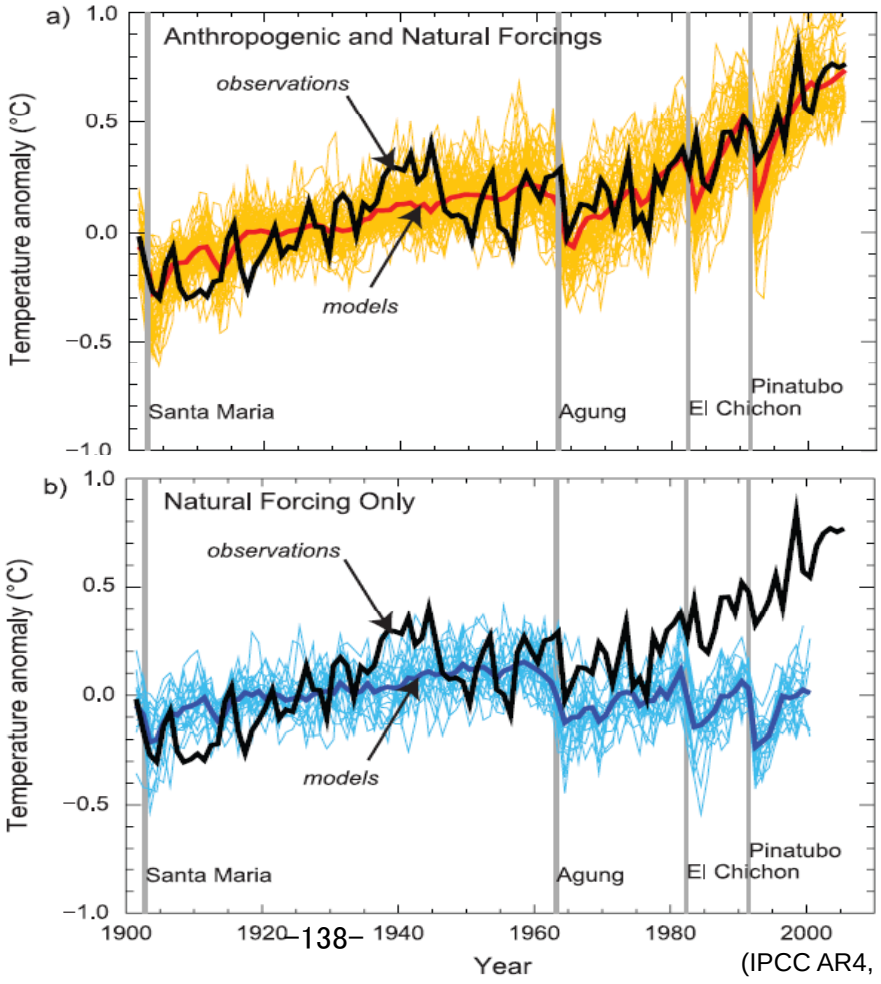



(JAMSTEC Pamphlet)

# Comparison Observed and Modeled

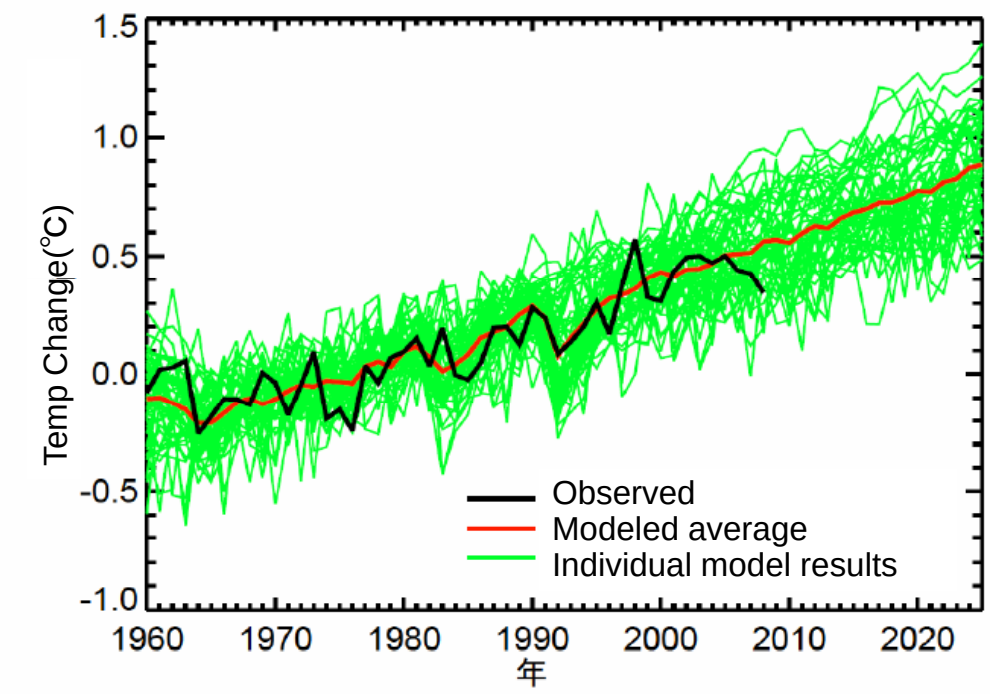
a)Natural＋GHG

b)Only natural




(IPCC AR4, 2007)

# Overall Comparison of Observed and Modeled Temp




1960～2025 年の気温変化の観測結果と予測シミュレーション
英国気象局ハドレーセンター作成の世界平均気温観測値（HadCRUT3）及び IPCC AR4 で使われた複数の気候予測モデルのシミュレーション結果（世界気候計画の結合モデル比較プロジェクト（WCRP CMIP3）マルチモデルデータセット）をプロットしたもの。
作成：国立環境研究所

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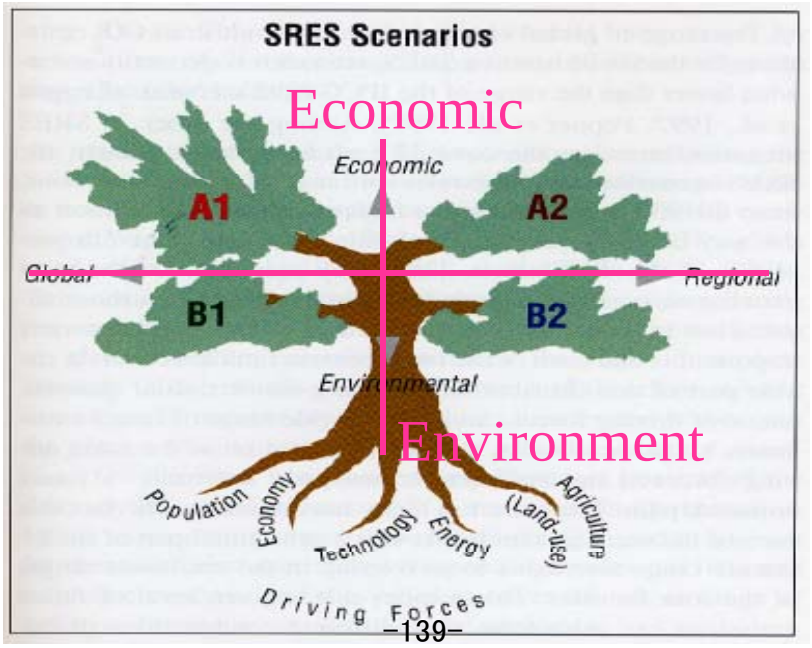
# Scenario-based Approach for Climate Prediction

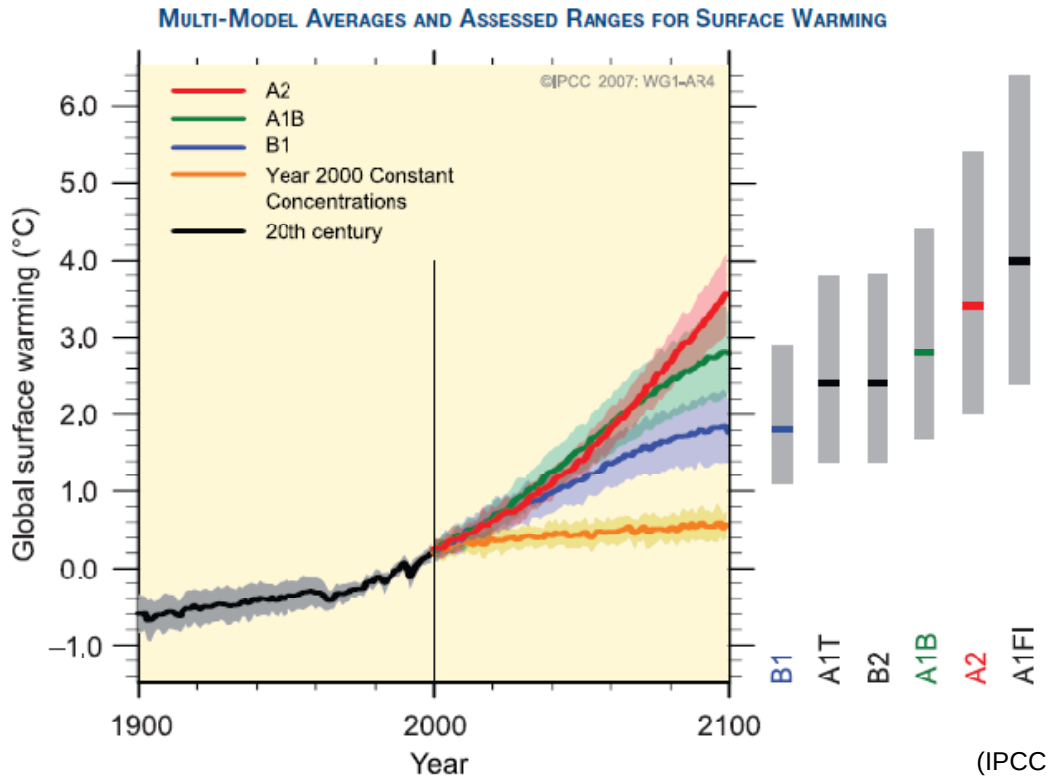
Future emissions of Green House Gases are estimated based on scenarios for future societies. Six scenarios (SRES scenarios) were used for climate prediction.



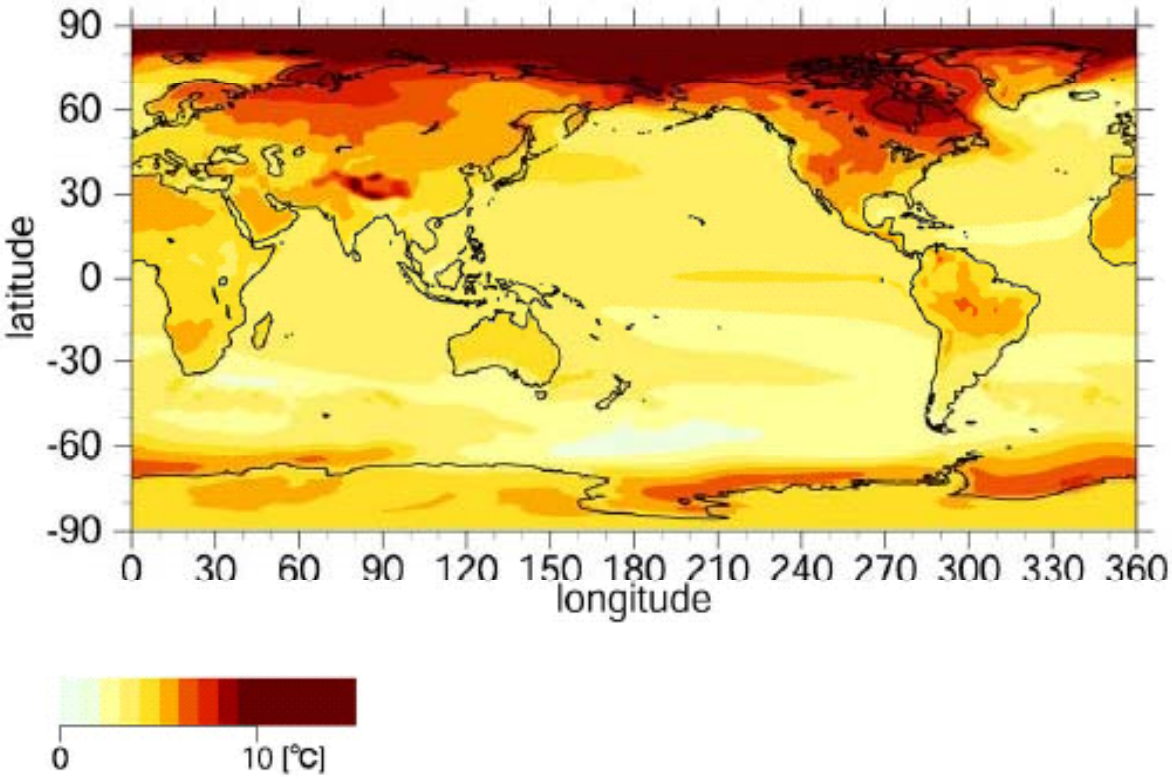

Global

Regional

# Climate change projection given by IPCC's Fourth Assessment Report (AR4)



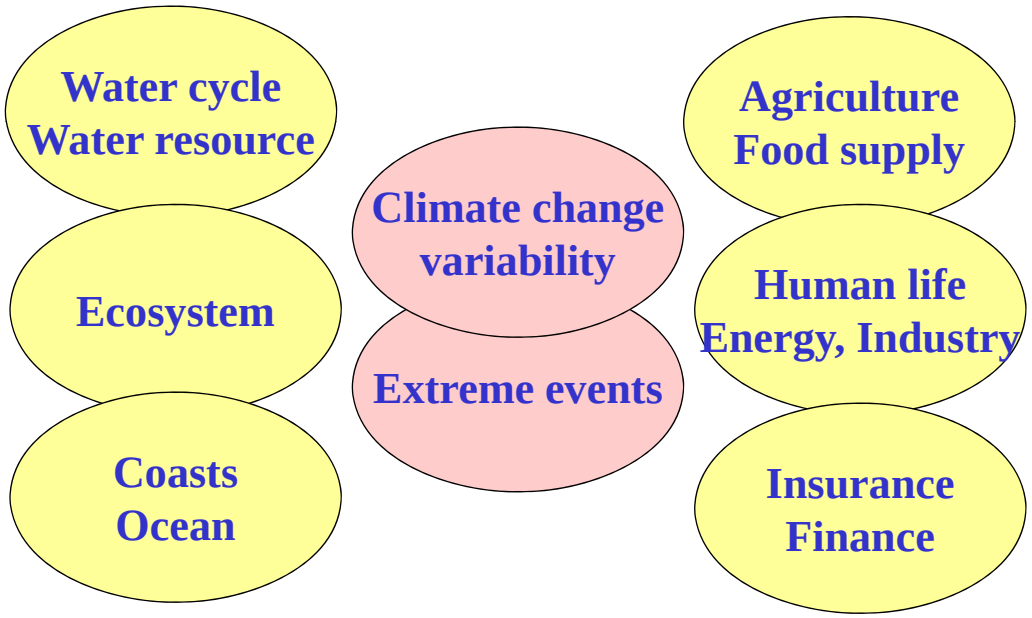

(IPCC AR4, 2007)




## Regional Distribution 2071-2100

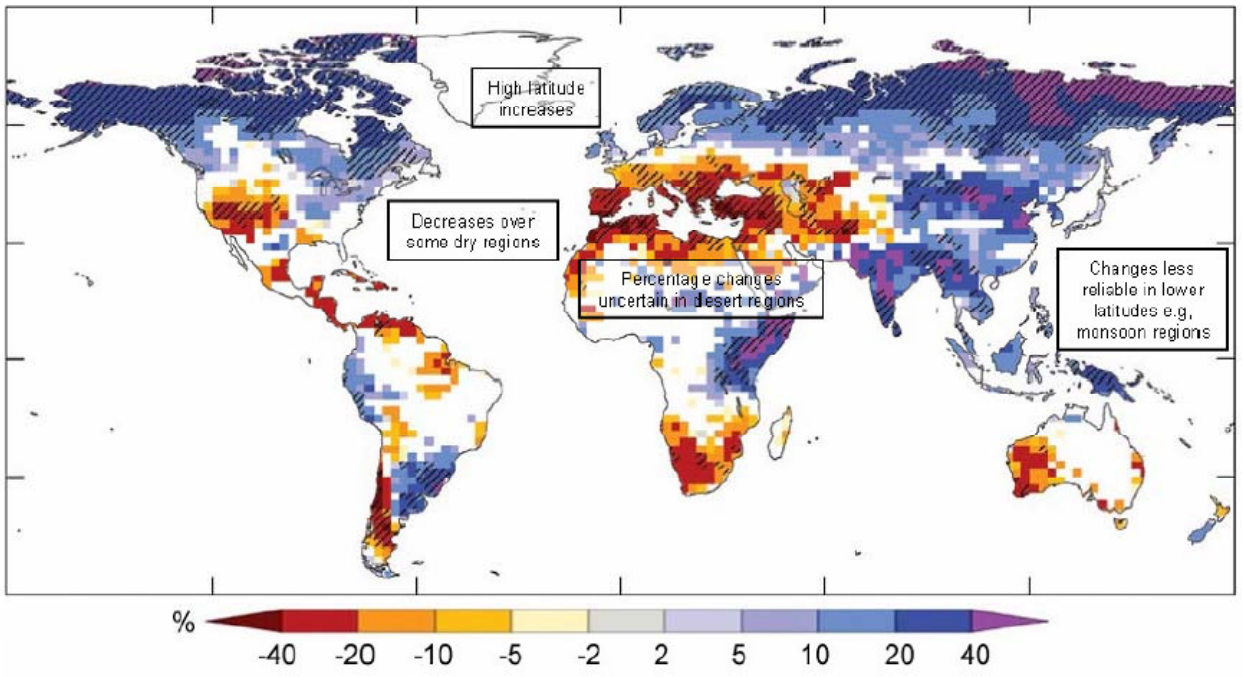
(Univ. Tokyo, NIES and JAMSTEC, 2007)

# 2.4 Overall Impacts of Climate Change




# Changes in Run-off

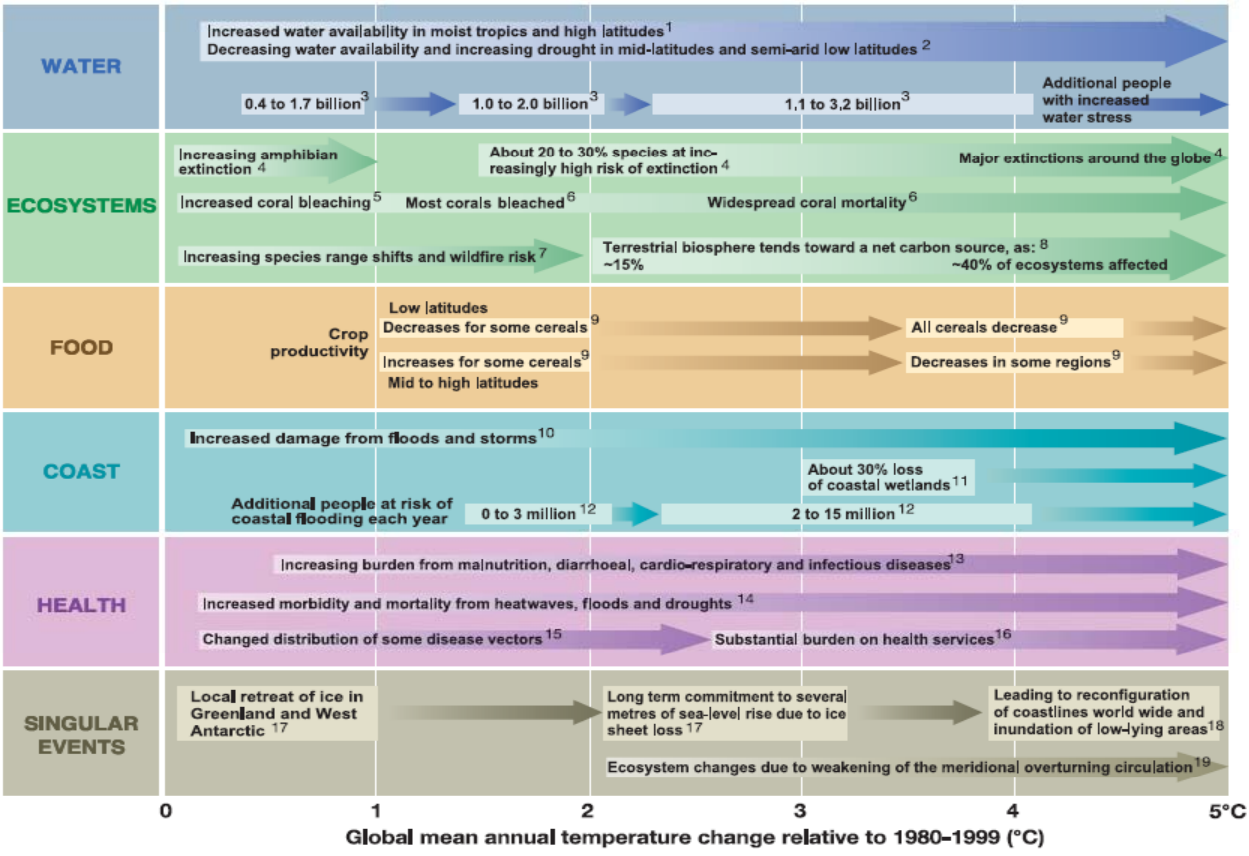
**Projections and model consistency of relative changes in runoff by the end of the 21st century**






(IPCC AR4, 2007)

# Overall Impacts Shown in AR4




（IPCC AR4，2007）

# Major Findings of AR4

• Major impacts are likely to occur in water resources, ecosystem, food supply, coastal areas, human health and settlement. Impacts would vary with regions which have different changes and adaptive capacity.

• All regions may have negative economic consequences if global average temperature increase over 2 to 3 degree C.

• Climate change could impede nations' abilities to achieve sustainable development pathways.

• A portfolio of adaptation and mitigation measures can diminish the risks associated with climate change.

- Mitigation to avoid "unmanageable"
- Adaptation to prepare "unavoidable"

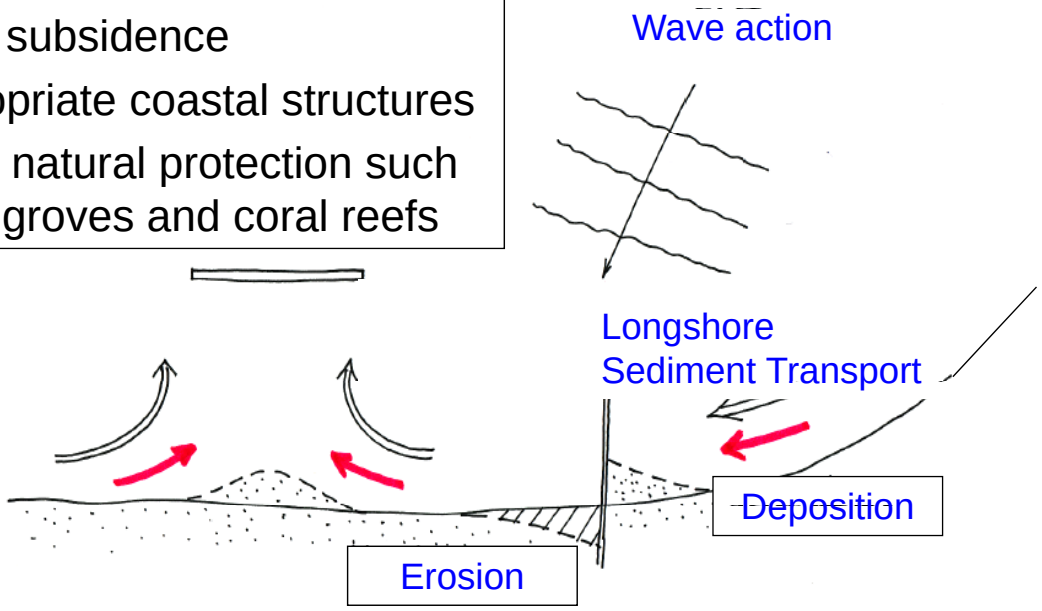
# 3. Coastal Impacts in the Asia and Pacific Region

## Typical Coastal Impacts

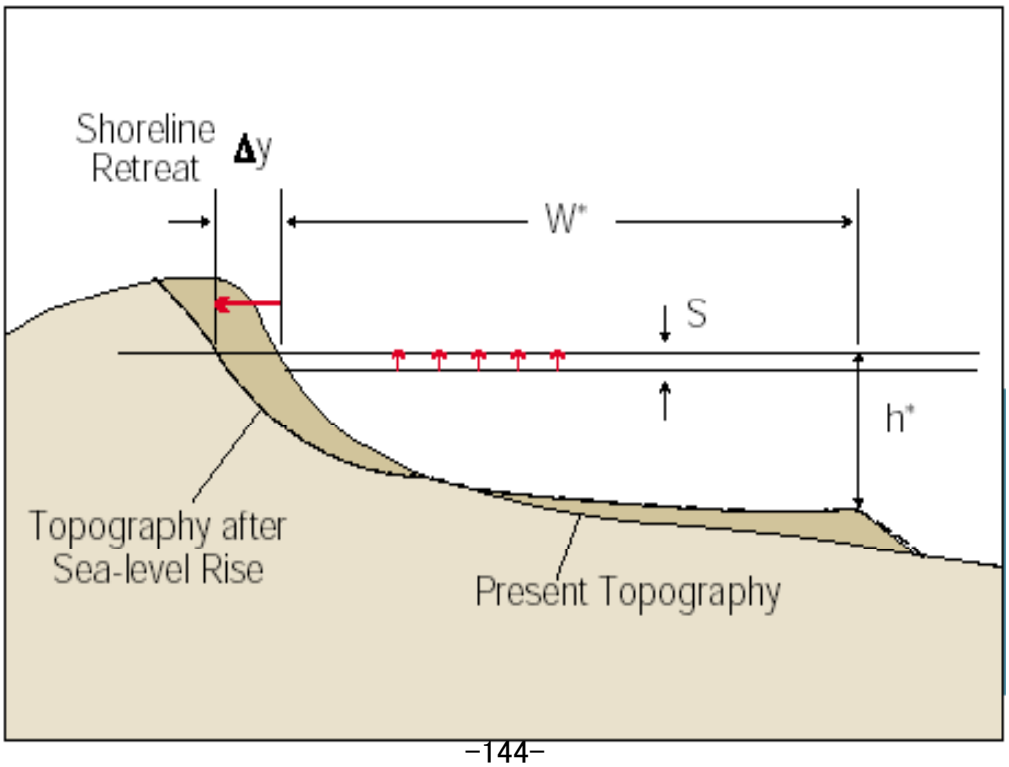
1. Coastal erosion
   - Sandy beaches
   - Mangrove coasts
2. Inundation and flooding
   - Flood due to storm surges
3. Salt water intrusion to aquifers and rivers

# 3.1 Coastal Erosion

1. Loss of Sediment supply from rivers
2. Changes in relative sea level
   - Sea-level rise
   - Land subsidence
3. Inappropriate coastal structures
4. Loss of natural protection such as mangroves and coral reefs

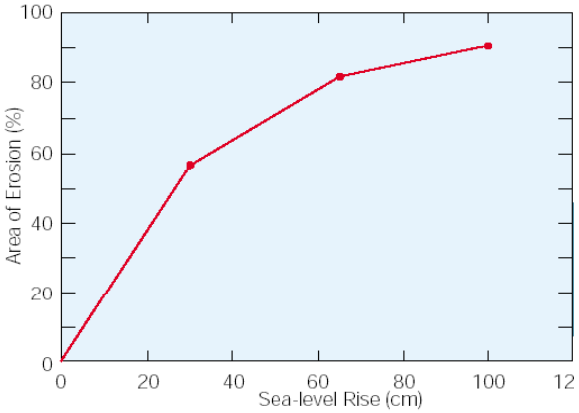



# Erosion of sandy beaches due to SLR



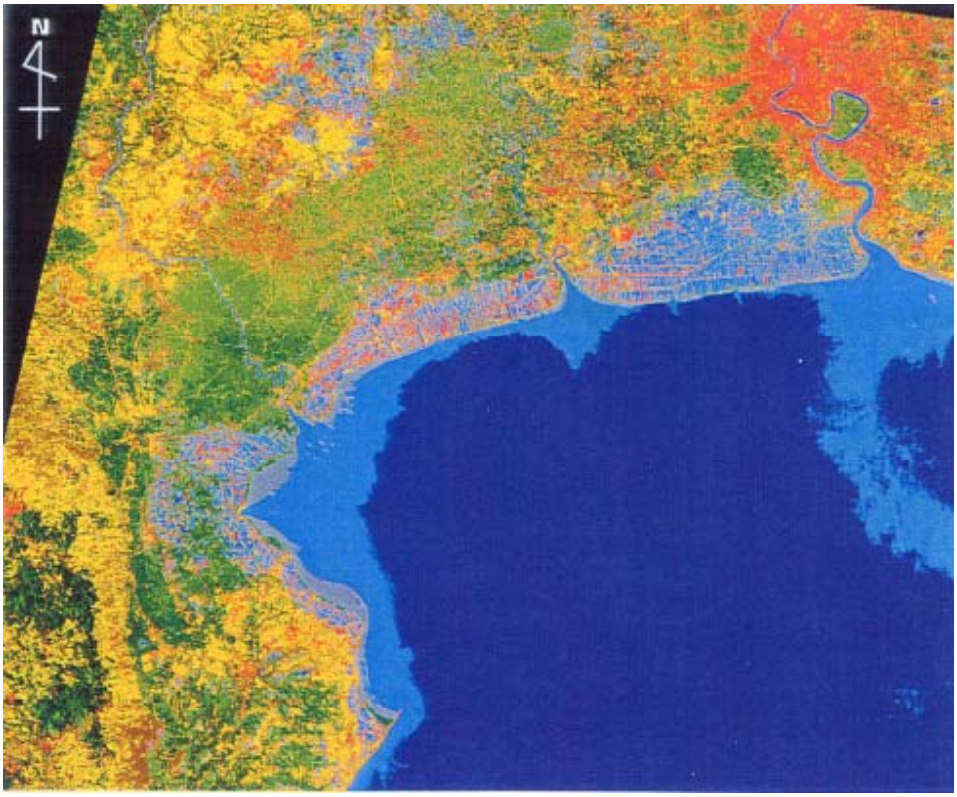
# Erosion of Japanese coasts

- Japan lost about 100km$^2$ of sandy beaches for the past 100years.
- Heavy measures against erosion.
- Will the national land be covered by concrete walls?

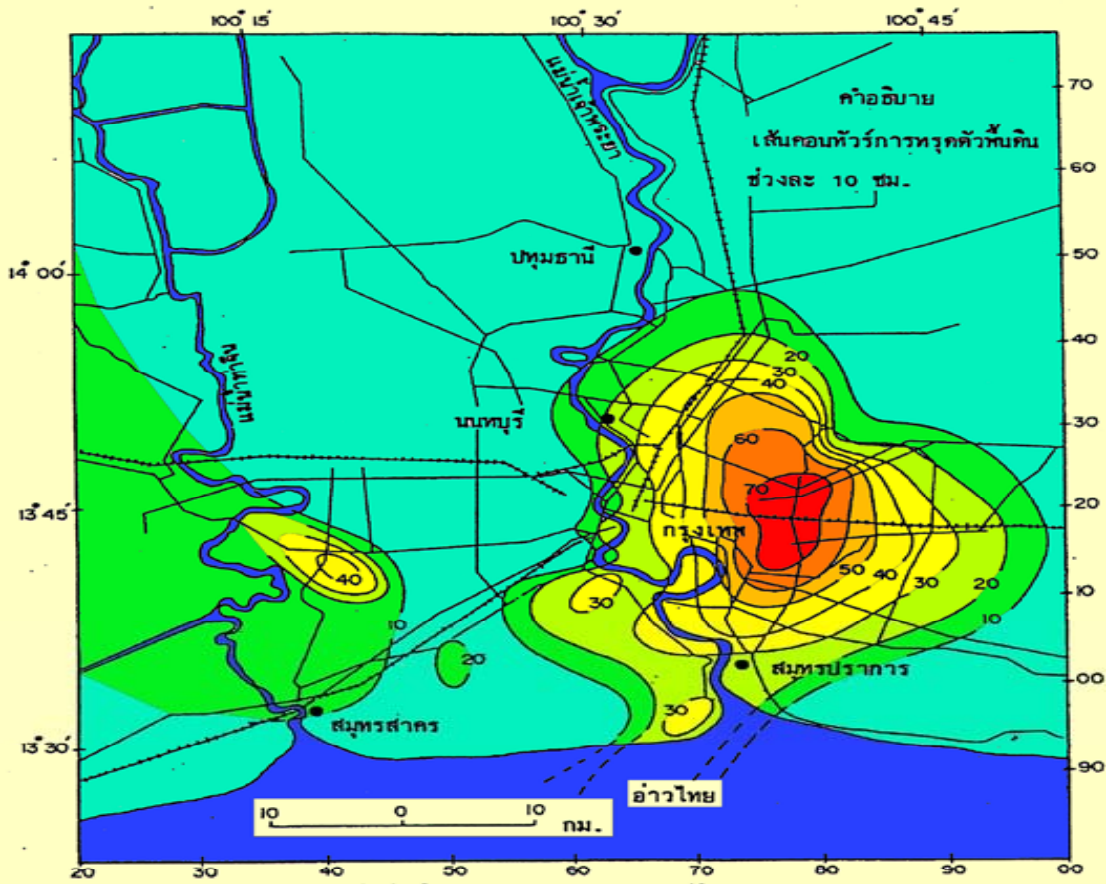



# Erosion of Mangrove in Thailand

# Satellite image around river mouth of Chaophraya



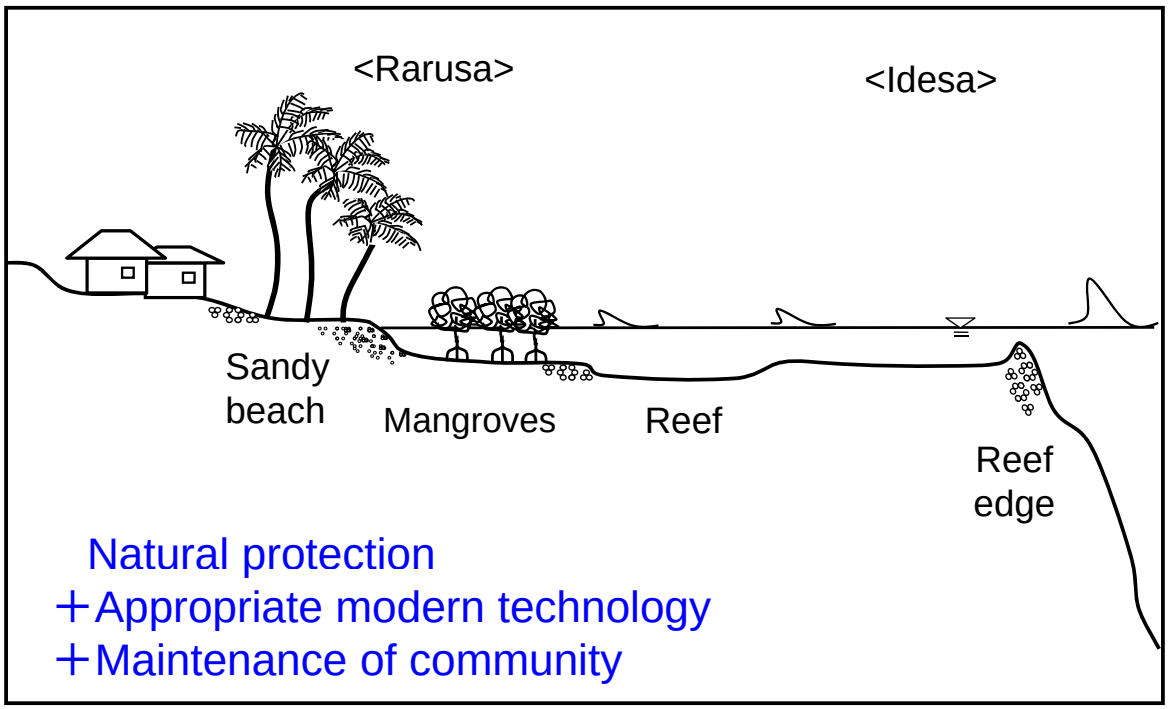

Erosion at the front




Ground Subsidence in Bangkok Source:Somkid(2002)

Community-level adaptation in Fiji

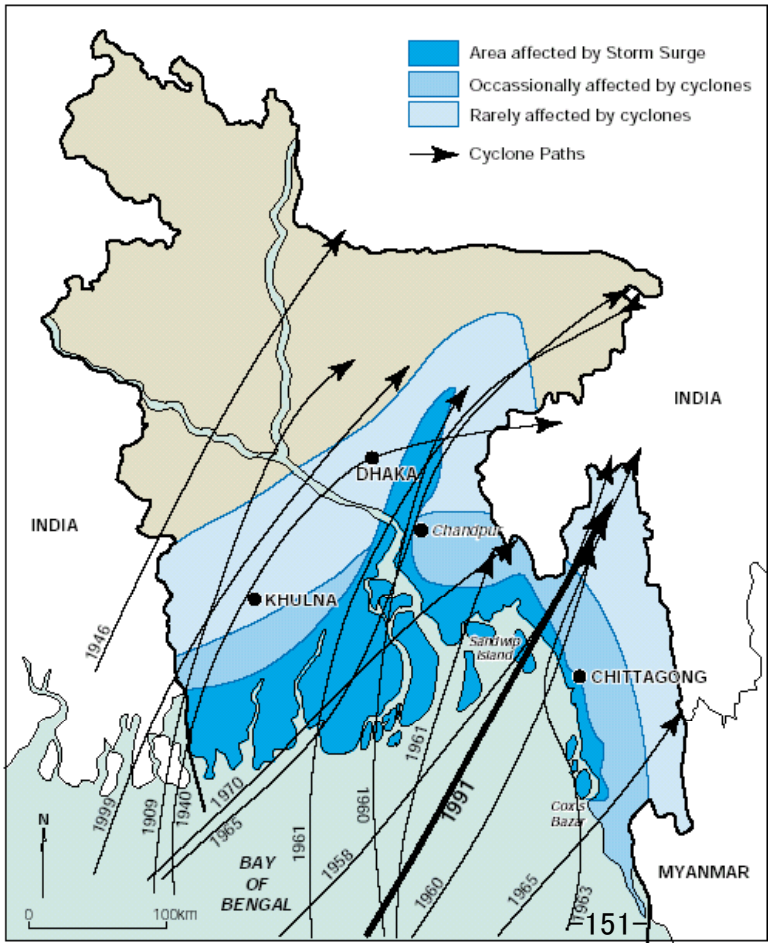
## Combining Traditional Wisdom and Technology




Natural protection
＋Appropriate modern technology
＋Maintenance of community

## What should we do against coastal erosion?

1. Maintain the sediment flow from mountains to the coasts.
2. Maintain the sediment transport along the coast. We need a careful planning and design for coastal structures so that they will not obstacle the flow of sediment.
3. Preserve natural protection as much as possible, such as sandy beaches, mangroves, wetlands, and coral reefs.
4. Apply well-designed structures.




## 3.2 Inundation and Flooding by Storm Surges

Tropical Cyclones in Bangladesh

## History of Cyclone Damages

| Date | Max Wind (m/s) | Max Wind Radius (km) | Storm surge (m) | Casualties (people) |
|---|---|---|---|---|
| 30 Oct 1960 | 57.5 | 74 | 4.57-69.10 | 5,179 |
| 9 May 1961 | 40.8 | 64 | 2.44-3.05 | 11,468 |
| 28 May 1963 | 55.6 | 74 | 4.27-5.18 | 11,520 |
| 11 May 1965 | 58.1 | 74 | 3.66 | 19,279 |
| 31 May 1965 | 44.7 | 64 | 6.10-7.62 | 12,000 |
| 23 Oct 1966 | 40.3 | 64 | 6-6.67 | 850 |
| 12 Nov 1970 | 61.7 | 74 | 6.10-9.14 | 500,000 |
| 24 Nov 1974 | 44.7 | 64 | 2.8-5.2 | 200 |
| 9 Nov 1983 | 33.3 | 64 | 3.05-4.57 | 11,069? |
| 25 May 1985 | 42.5 | 64 | 3.05-4.57 | 11,069? |
| 29 Nov 1988 | 44.4 | 64 | 1.52-3.05 | 5708 |
| 29 Apr 1991 | 62.5 | 74 | 6.10-7.62 | 138,000 |
| 25 Nov 1995 | 58.3 | 74 | - | 650 |
| 19 May 1997 | 55.6 | 74 | 4.6 | 126 |
| 26 May 1997 | 41.7 | 74 | 3.0 | 70 |
| 16 May 1998 | 45.8 | 74 | 1.83-2.44 | - |

# Countermeasures in Bangladesh

**Combination of hard structures and soft measures**

**Hard Structure**

- Cyclone shelters: High buildings
- Evacuation roads to shelters
- Coastal dykes
- Aforestation of coastal forests
- Raising ground（*Killa*）for livestock

**Soft Measures**

- Disaster prevention Plan
- Early warning for cyclones
  (Radar system for cyclone observation)
- Peoples awareness raising and education
- Workshops in communities（*para*）
- Evacuation practices

## Combining Early Warning and Hard Measures

## Cyclone Shelter (Chittagong Port City )


## Evacuation Road to a Cyclone Shelter

## (South-west coastal region of Bangladesh )

## Coastal Aforestation
## (Cox's Bazar Beach in the south-east costal region )


## Risk and Countermeasures in the A/P region

- Population of the region will nearly double at the end of the 21st century.
  - ✓ 3.7 billion in 2000 to 7.4 billion in 2100
- Increased population concentrate to the coastal areas. Poor migrants will live in unsafe, unsanitary low-lying areas.
- The problem is how to ensure the safety and security for the several thousands of millions people.
  - ✓ Regulation of unmanaged urban growth
  - ✓ Long-term urban planning and disaster prevention plans
- Sustainable economic growth is needed to achieve these policies.

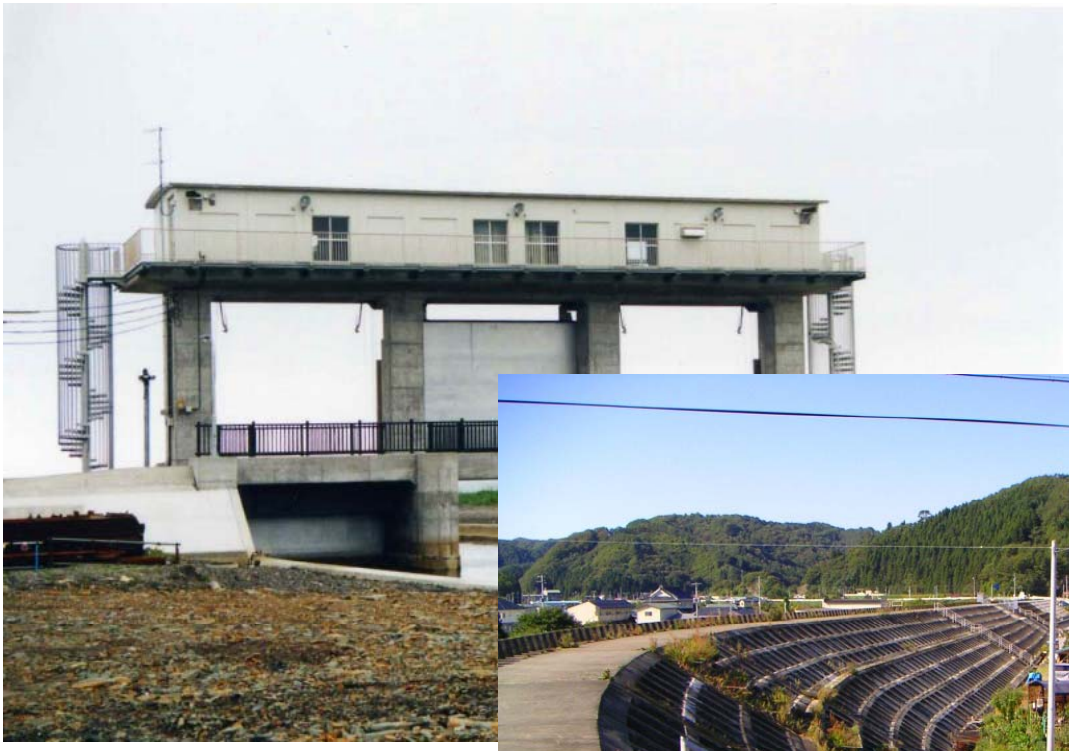
# Japan's Comprehensive Policy against Natural Disasters

## Basic Strategy

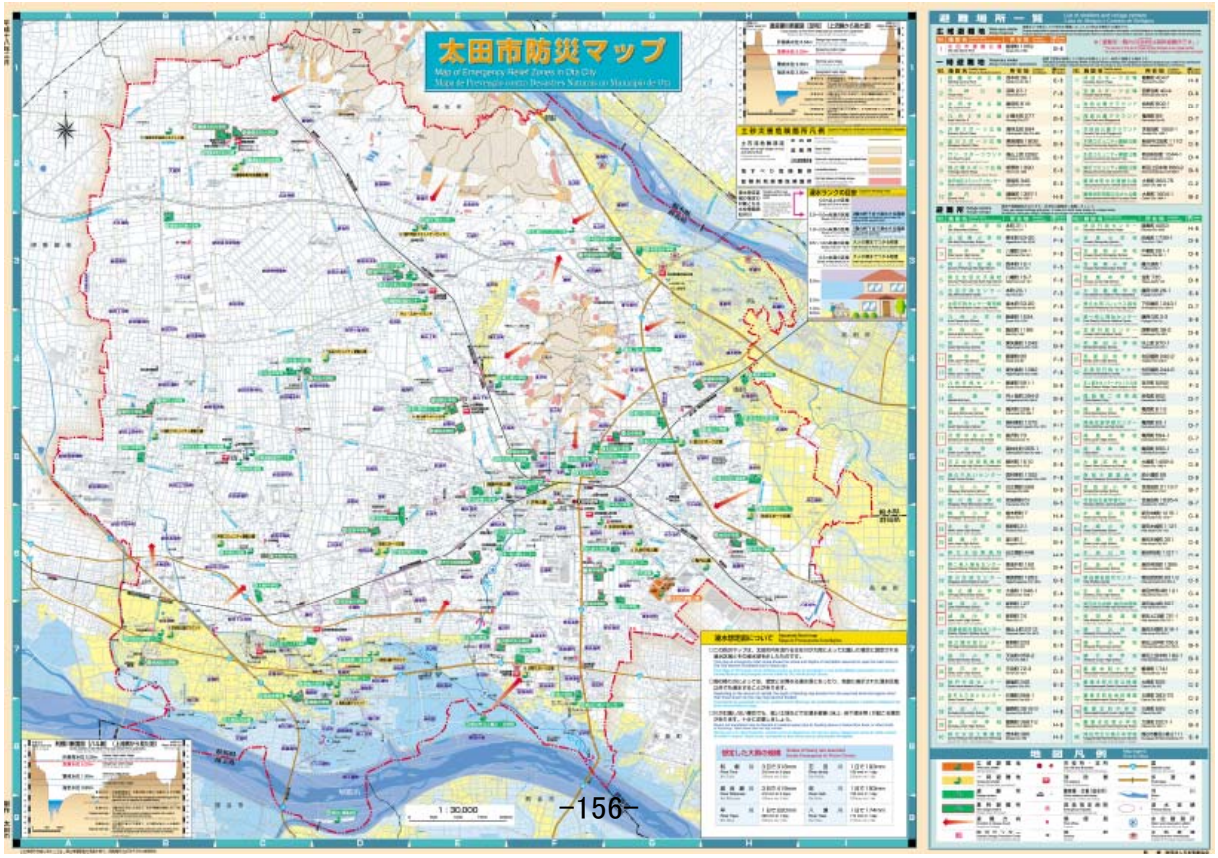
- ○ Combining soft and hard measures
- ○ Introduction of multiple measures to grade up the social preparedness as early as possible
- ○ Re-construction of communities' resilience and preparedness

## Policy

① Introduction of flexible measures to respond to the recent trends of increasing natural disasters, including land use planning and facility operation.
② Strengthening the risk management function of local governments.
③ Provision of relevant information for evacuation.
④ Raising peoples awareness through dissimilation of the past experience and new knowledge on natural disasters.
⑤ Re-construction of communities' preparedness through education, practices, advertisement etc.
- combination of self-, mutual- and public supports



# Information Infrastructure
# -Hazard Map and Evacuation Practices



# 4. Response to Climate Change

## Responses to Climate Change

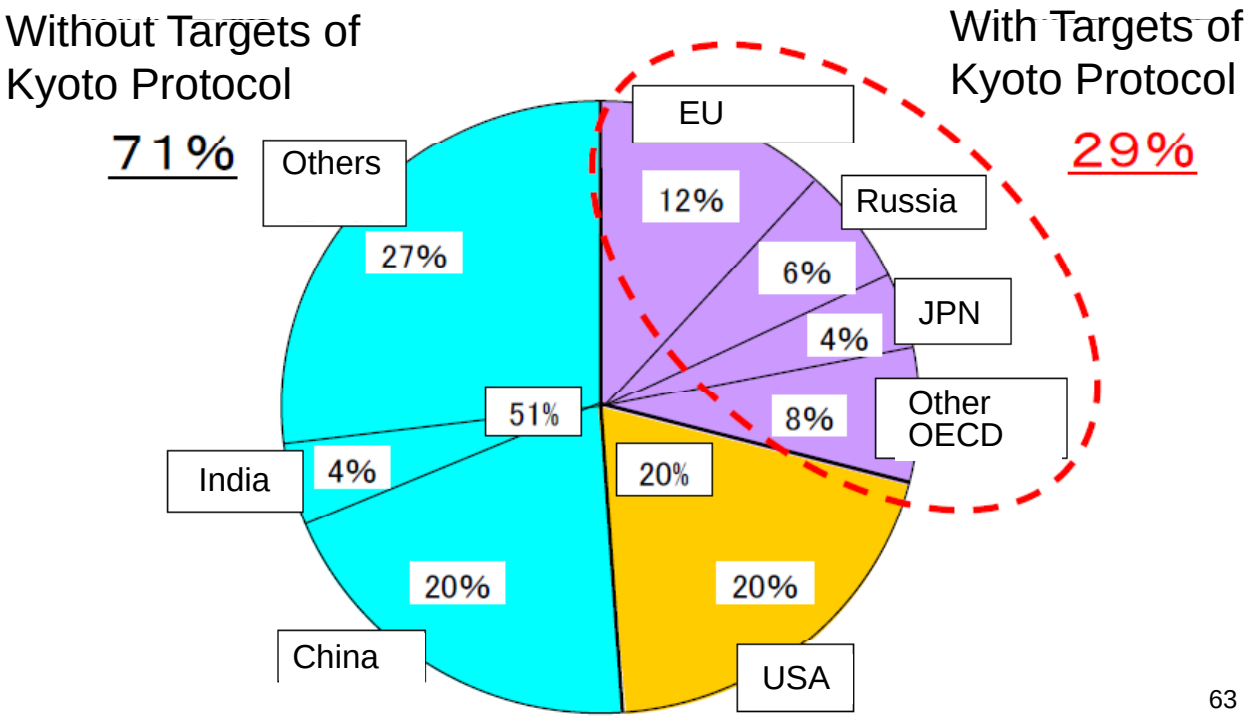
Mitigation : Reduce GHGs emission

Adaptation: Adjustment of natural and human systems to cope with warmer world

### Role of adaptation

A portfolio of adaptation and mitigation is the only way to diminish the risks associated with climate change.

# Global $CO_2$ Emission and Kyoto Protocol

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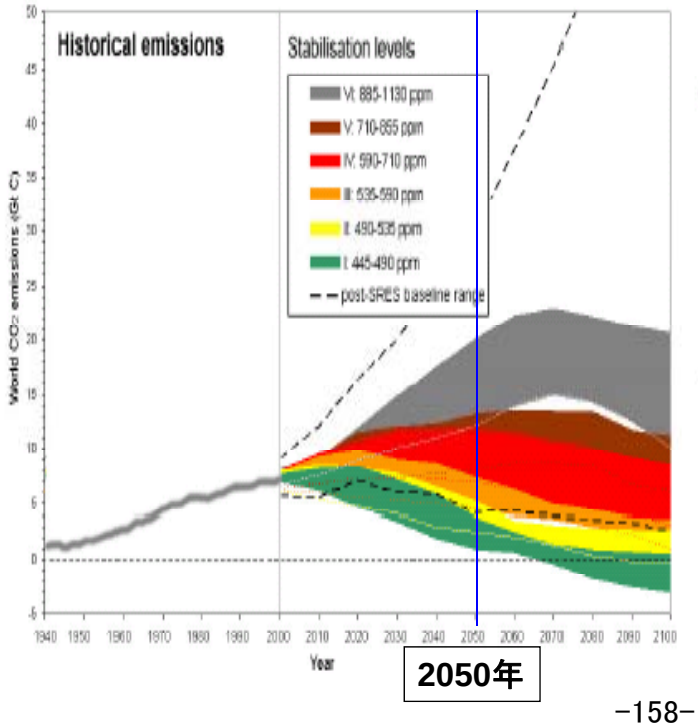
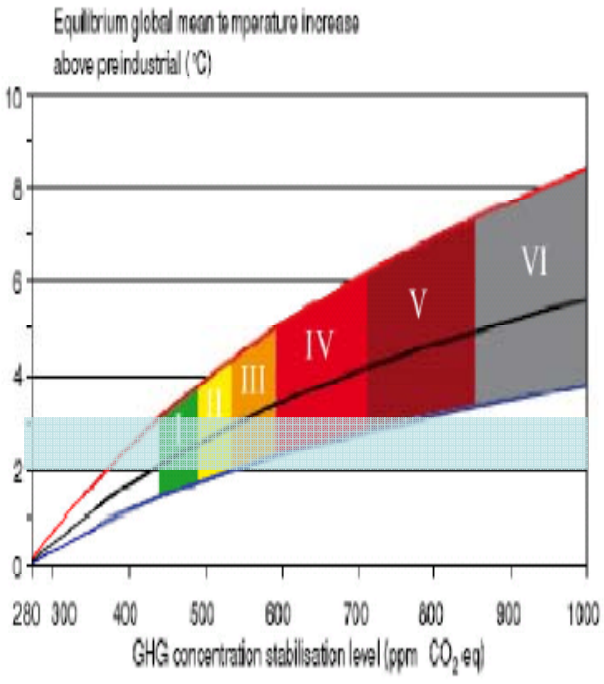
# Stabilization Pathways

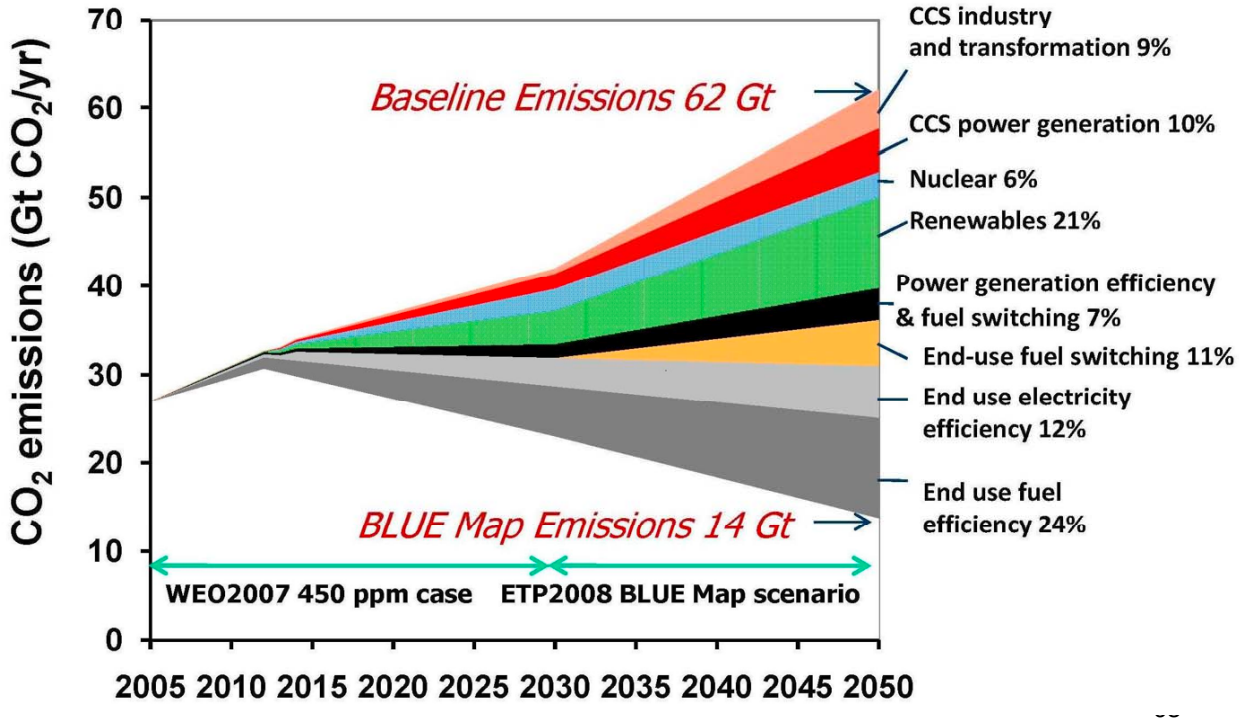


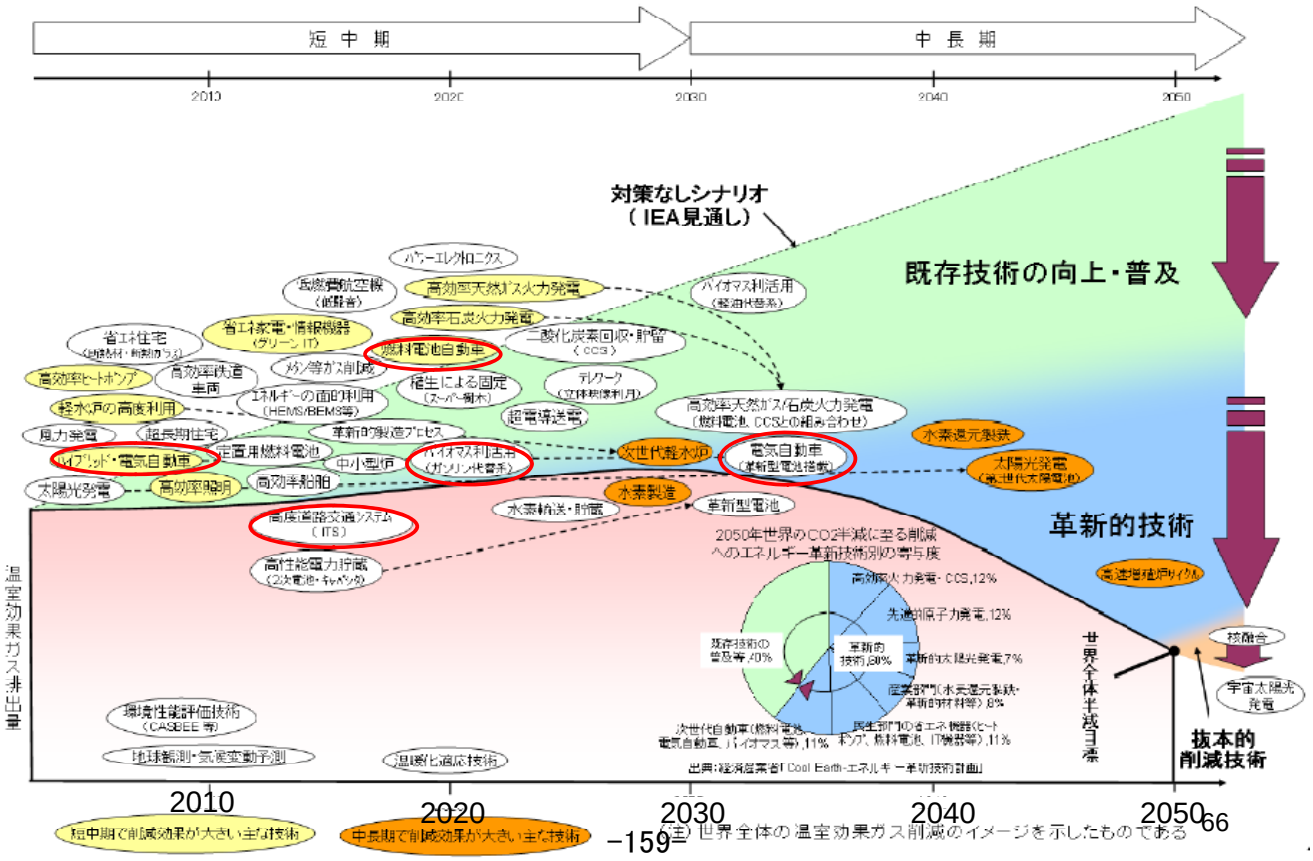



（IPCC WGIII AR4 SPM）

# Estimate to Achieve the Goal of 50% Reduction in 2050
## （IEA(2008）Energy Technology Perspectives 2008)

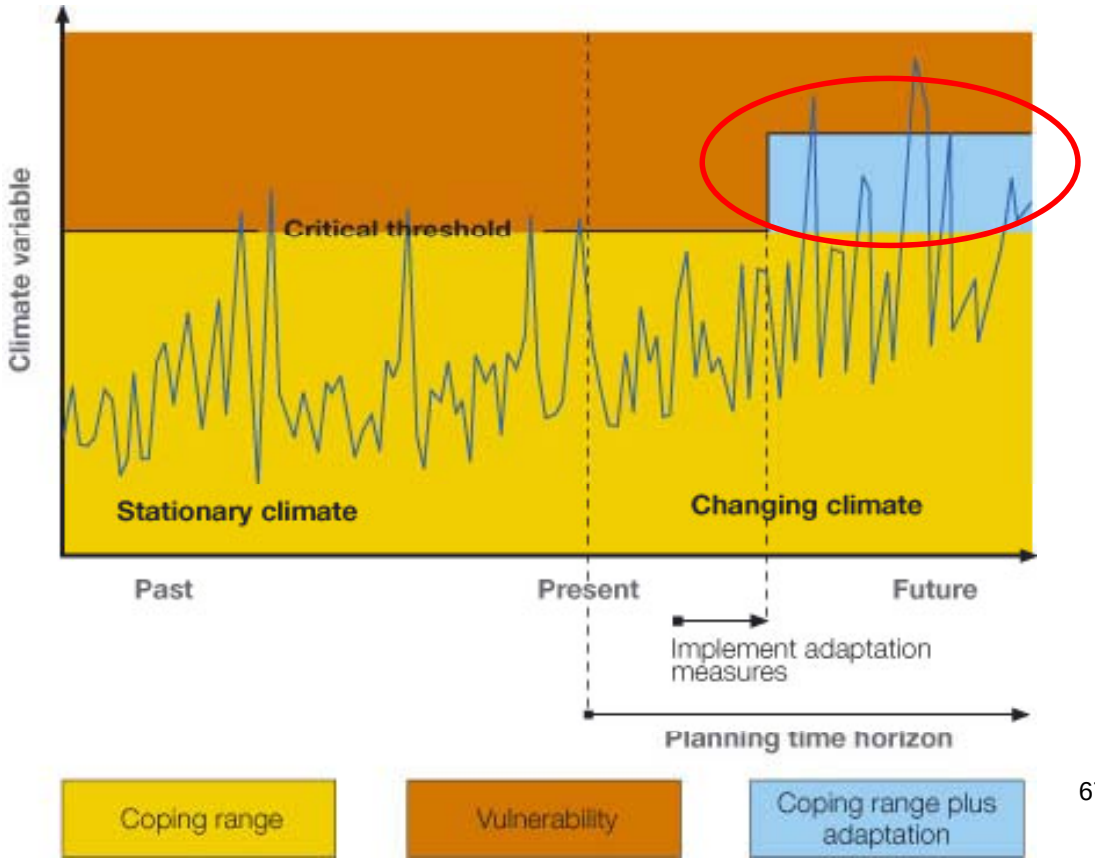



# Trend of Technology Development




（注）世界全体の温室効果ガス削減のイメージを示したものである

# Climate Change Adaptation

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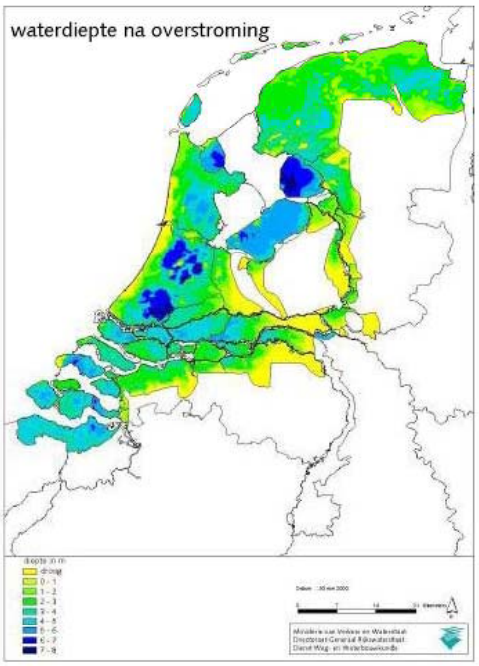
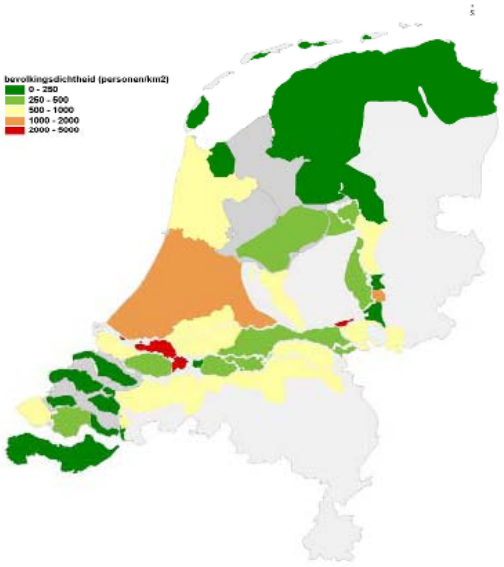
# Concept of Coastal Adaptation

| | |
|---|---|
| **Retreat** | **Move from dangerous areas**<br>**Development regulation for disaster-prone coastal areas**<br>**Land use planning**<br>**Evacuation from highly vulnerable coastal areas**<br>**Immigration** |
| **Accommo dation** | **Change use and living patterns**<br>**Changes of land use patterns**<br>**Protection of mangroves**<br>**Disaster insurance** |
| **Protection** | **Protect societies from risks**<br>**Protection by hard structural measures**<br>**- Dikes, seawalls, floodgates**<br>**- Anti-erosion measures**<br>**- Water resource management**<br>**Protection by soft technologies**<br>**- Anti-erosion measures**<br>**- Conservation of coastal ecosystems**<br>**- Early-warning systems**<br>**- Evacuation practices**<br>**- Awareness raising** |

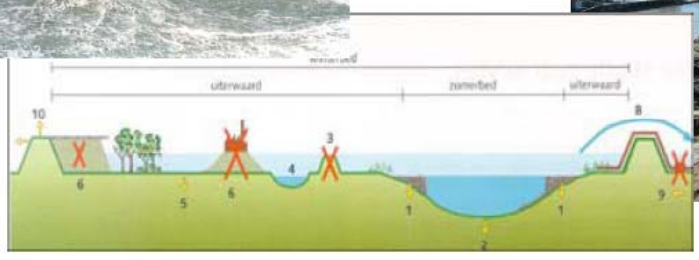
# The Netherlands' Policy






# 1. Protection: Reduce Flooding



## 2. Urban Planning: Preparedness



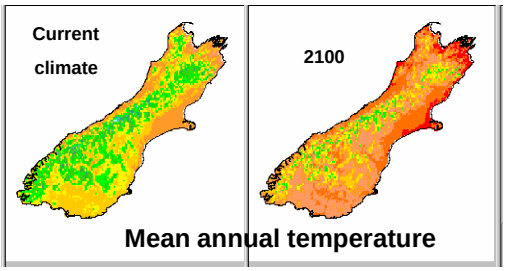
## 3. Risk Management: Reduce damages

Flood fighting


Evacuation

# Utilize Favorable Conditions

**Grape cultivation for wine in the South Island, NZ**




# Needed Adaptive Capacity (Resilience)

| | |
|---|---|
| **Resources** | Financial and infrastructures |
| **Human resources** | Human power |
| **Knowledge** | Basic scientific knowledge, and people's understanding |
| **Access to information** | Personal and aggregate capacity to approach to the scientific information |
| **Technology** | Basic and applied technologies |
| **Social institution** | Variety of social organizations to support safety net |
| **Community** | Social group for mutual support |
| **Ability of Risk management** | Social ability to handle potential risks |

# 5. Wise Adaptation and Relation with Sustainability

## Wise Adaptation

- How to plan adaptation under uncertainties in climate projection, effects of mitigation, social changes etc?
- Introduce effective, efficient, flexible adaptation.

- Short-term and long-term planning

1) Short-term adaptation "real time adaptation"
   - respond to occurring climatic extremes
   - monitoring/early warning e.g. new radar system
   - evacuation

2) Long-term adaptation "adaptive adaptation"
   - flexible adjustment of adaptation planning

# Elements of Wise Adaptation

1. Impact/vulnerability assessment at local level
2. Monitoring/early warning
3. Soft options first, then hard options
4. Incorporate CC adaptation to renewal cycle of infrastructure
5. Co-benefit approaches for mitigation and adaptation
6. Collaboration of ministries
7. Participation of stakeholders and capacity building

+ etc

# Climate Change Adaptation in Green Innovation

• In 2090, the Japan's Prime Minister declared 25% reduction of GHG emission by 2020 in the UN General Assembly to call for collaborative efforts of many countries.

• In 2010, the Japanese Government set New Economic Growth Strategy to respond to the three major constraints.
1) climate change
2) aging society
3) economic growth

• Major targets include;
1) Green innovation towards a low carbon society
2) Life innovation for active aging society
and others

This means that green innovation becomes a major driver for the new economic growth.

# Climate Change Adaptation in Green Innovation

- Green Innovation consists of mitigation and adaptation as two pillars.

- Changes in perception for climate change countermeasures
  - turning “passive” to “active”
    1) to avoid adverse impacts
    2) to promote new social values
       - opportunity to transform to a safer society with high QOL
       - opportunity to solve other problems
       - opportunity for new business for low-carbon and CC adaptive society




<Large Cities>

Public Transport
Efficient Energy Use
Potential flood risk
Heat island
Aging society


Social Experiment for Low-Carbon/ CC Adaptation Cities
- A way of learning by doing

<Local Cities>

Compact city
Co-benefit of mitigation and Adaptation


<Rural Areas>

Local production/consumption of food and energy
Conservation of ecosystem

# Adaptation and Sustainability
# Some Key Issues (1)

1. As developing countries are already vulnerable to the present climatic conditions, win-win approach is effective to developing countries.

- "Win-win" means to be effective both to the present vulnerability and future impacts.
  Increase of their responsive ability to the current disasters will also strengthen their preparedness and resilience to the impacts of future climate change.

## Key Issues on Adaptation (2)

2. The success of adaptation depends on the adaptive capacity (i.e. resilience) of each country and local community.

- Enhancing adaptive capacity to the current climate variability and future climate change is one of the most important goals of an adaptation policy.

- From this viewpoint, it is also important to utilize and enhance the local and indigenous knowledge.
  It is a major challenge to incorporate the traditional knowledge and technologies in modern science and technology.

## Key Issues on Adaptation (3)

3. Human security and sustainable development

- Adaptation to improve society's resilience to climate change and human security also constitutes an important policy towards achieving sustainable development.

- Adaptation is not a single policy, but a comprehensive approach to development policies, such as poverty reduction, agricultural development, water resources management and disaster prevention. (Mainstreaming adaptation)

## Key Issues on Adaptation (4)

4. The real world is under multiple stresses.

- Global warming is not the only constraint to the society. Human society also faces other problems.
  e.g. environmental pollution, loss of biodiversity, changes in land use due to economic development, population growth and economic globalization.

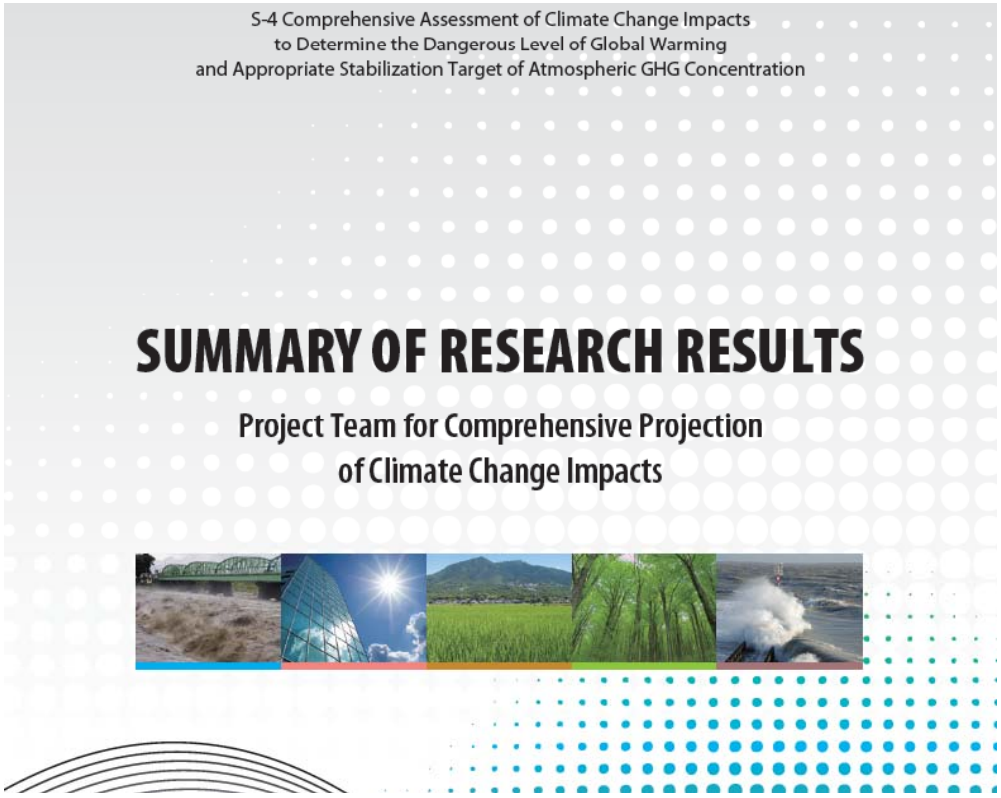
- As adaptation to climate change has co-benefits to other stresses, it will be a measure to ensure the safer societies and healthy basis for future development. In this sense, adaptation is a major component of the policy toward sustainable development.

# Summary

1. The Asia and Pacific region is already vulnerable to the present natural disasters and climatic conditions.
2. Climate change and sea-level rise will cause more threats on the growing population and economic development in the region.
3. Natural disasters, water resources, food security and human health will be a major threats to the region. Adaptation to these issues needs a long lead time.
4. Adaptation is a major response to climate change. Adaptation should be incorporated to the development policies. In this sense, adaptation is a component of sustainable development.

# Appendix

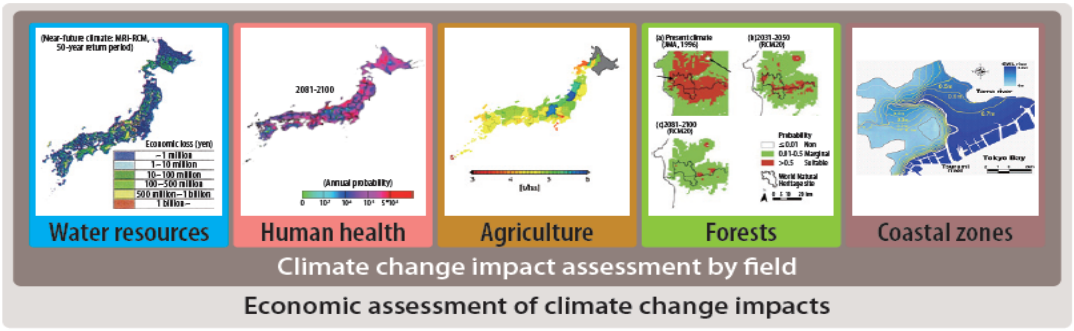
## New Japanese Initiative: Comprehensive Assessment and Adaptation S-4 and S-8



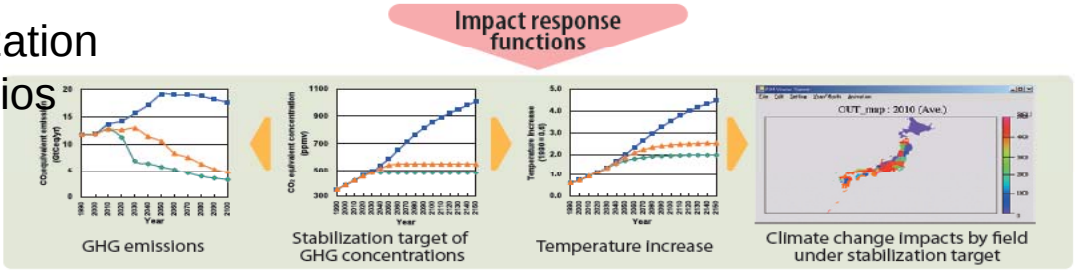



## S-4: Purposes and Structure

Target Areas



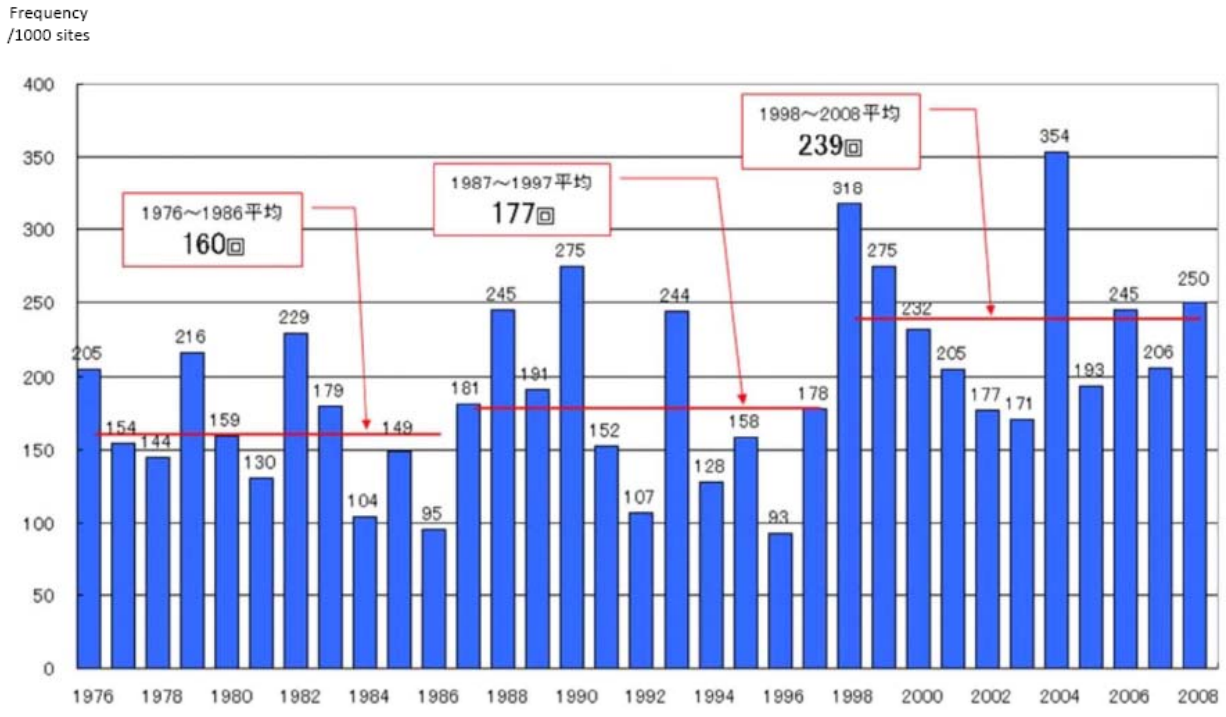

Stabilization Scenarios




- Distribution of damages
- Damage costs for different emission pathways
- Foundation for national CC policy

# Comprehensive Assessment in Japan

## Changes in Frequency of Heavy Rain Events (>50mm/hr)




(Source) Meteorological Agency (2009)



# Land Slide due to Record Rainfall

## July 2009

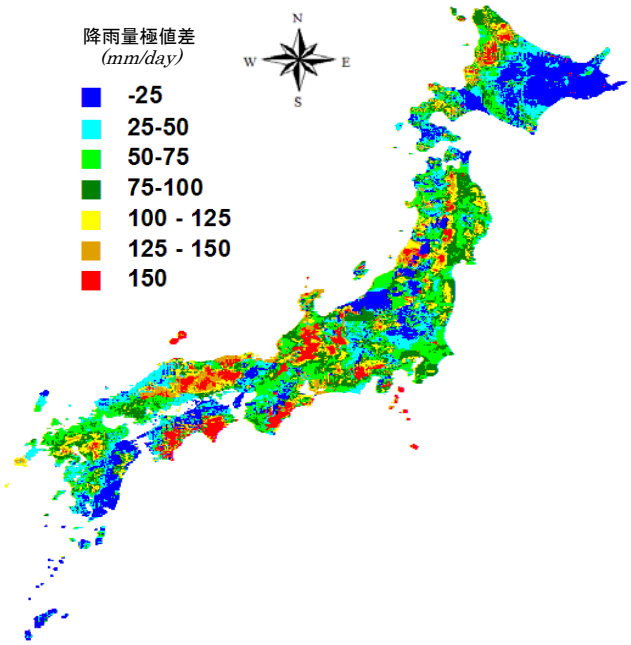


(Source) Japan Society of Civil Engineers

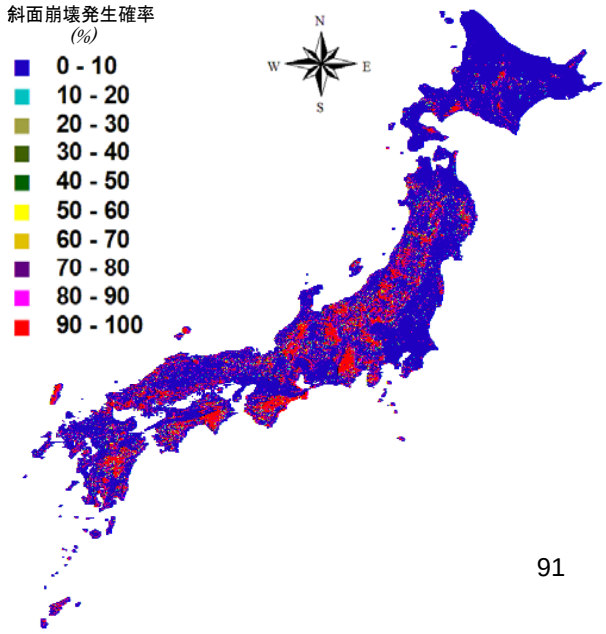
# Distribution of Disaster Risks

## Changes in Precipitation In 2030

- 1/50 present becomes 1/30




## Increased land slide probability in 2050

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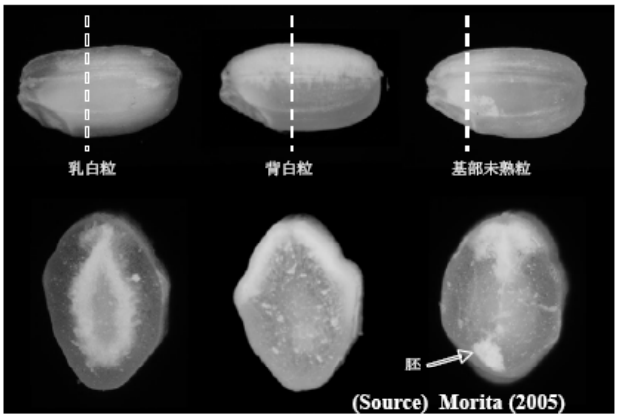
# Agriculture – Quality Degradation

High Temperature Injury of Ripening in Rice




Mandarin orange could suffer from High Temperature and Water Shortage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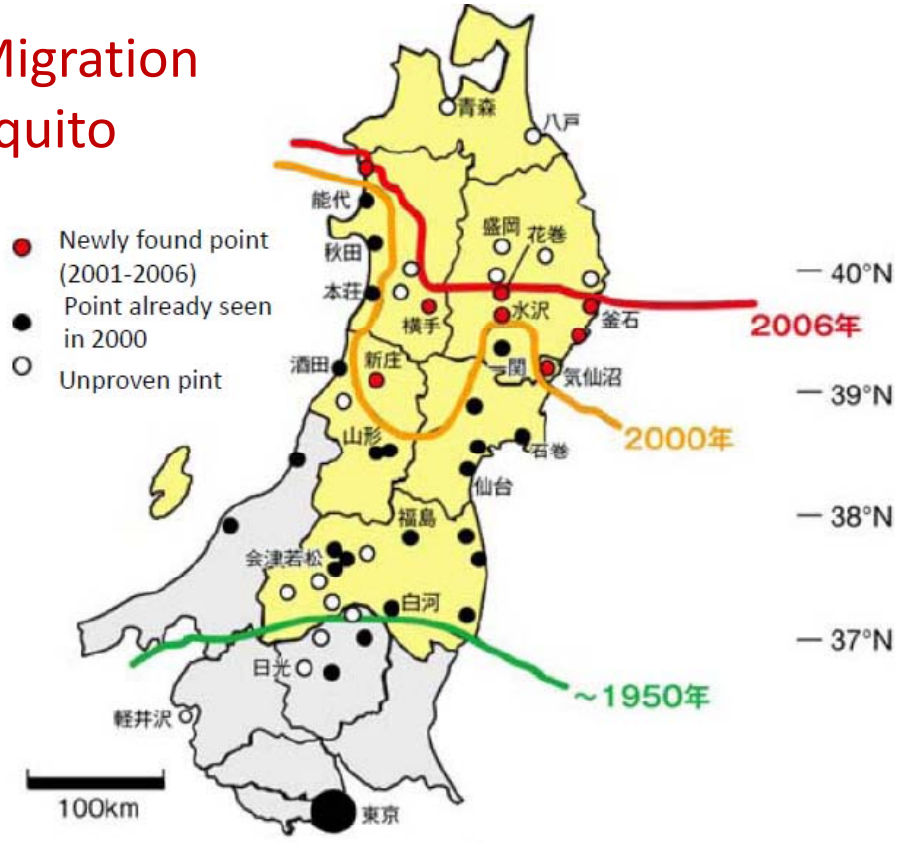
# Northward Migration of Tiger Mosquito

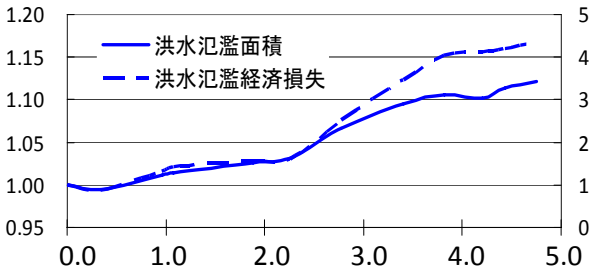



出典：Kobayashi, M. et al., 2008

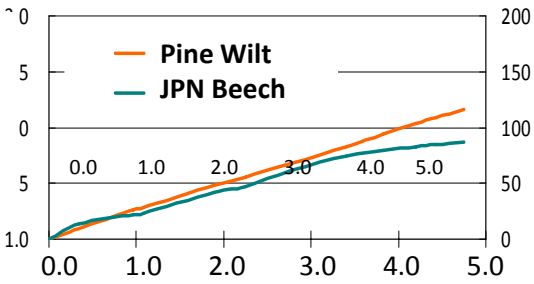


# Impacts Functions for Dangerous Level

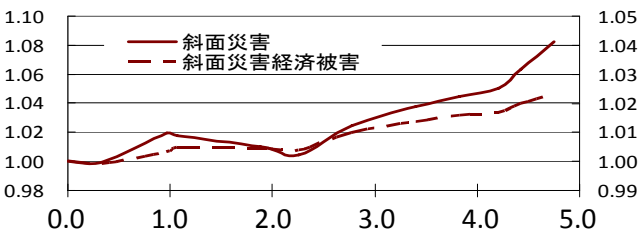
## Flood Risk



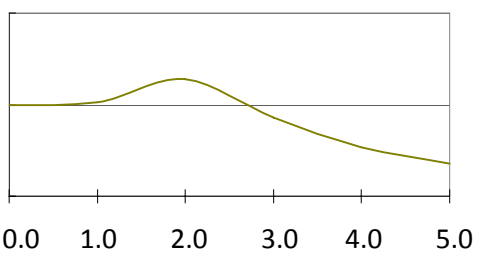

## Forests




## Land Slide

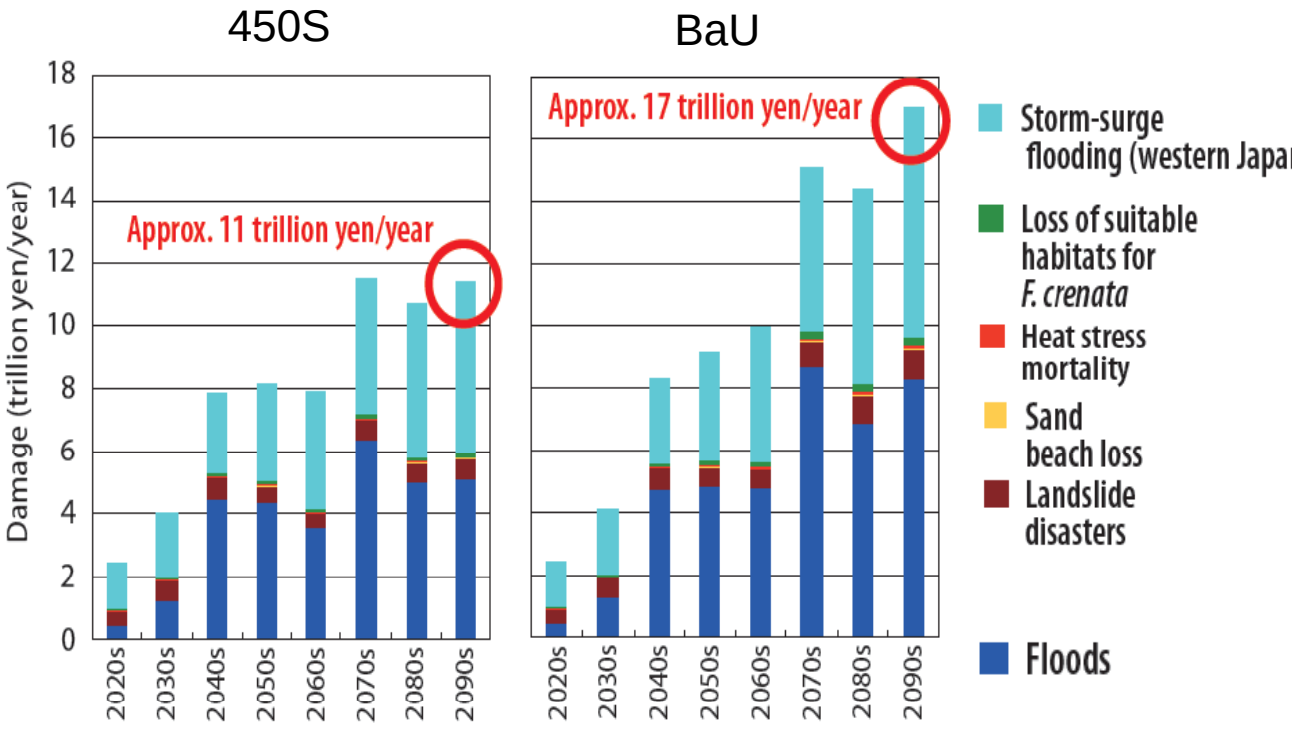



## Rice Yield




Average Temperature Rise (1990=0℃)

# Difference in Damage Costs in 21st C

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# Ⅴ-2. Lecture

# “Introduction to ICHARM and its Regional Cooperation activities on water-related disaster management - in partnership with ADB”

Mr. Katsuhito MIYAKE

# Introduction to ICHARM and its Regional Cooperation activities on water-related disaster management

- *in partnership with ADB*

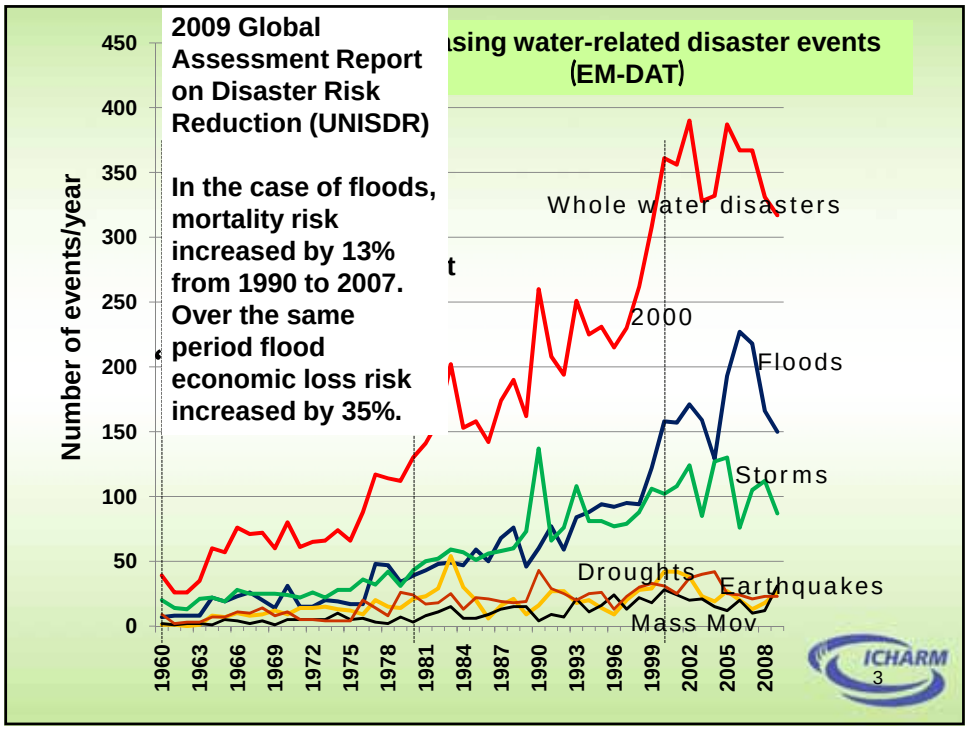
Katsuhito Miyake
Team Leader,
Disaster Prevention Research Team,
International Centre for Water Hazard and Risk Management
under the auspices of UNESCO (ICHARM)

19th International Meeting on Public Works Research and Development
17 November 2010


1

# Introduction to ICHARM and its typical activities


2


2009 Global Assessment Report on Disaster Risk Reduction (UNISDR)
In the case of floods, mortality risk increased by 13% from 1990 to 2007. Over the same period flood economic loss risk increased by 35%.
sing water-related disaster events (EM-DAT)
Number of events/year
Whole water disasters
2000
Floods
Storms
Droughts
Earthquakes
Mass Mov
ICHARM
3


ICHARM
ICHARM
International Centre for Water Hazard and Risk Management
under the auspices of UNESCO
hosted by PWRI, Tsukuba
October 2005
33rd UNESCO General Conference
JPN proposal accredited by 191 countries
3 March, 2006 in Paris
6 March, 2006 at Tsukuba
水災害・リスクマネジメント国際センター開所式
ICHARM is based on rich experience of Japan's WRDRR
4

# ICHARM Objective

International Centre for Water Hazard and Risk Management
Since 6 March 2006

- **To be the global Center of Excellence to provide and assist implementation of the best practicable strategies to localities, nations, regions and the world to manage the risk of water related hazards including floods, droughts, land slides, debris flows and water contamination.**
  - **At the first stage the priority is on flood-related disasters**

ICHARM
5

# Director of ICHARM
# Dr. Kuniyoshi TAKEUCHI

**Profile of Dr. Takeuchi**

- 1968 MS in Civil Engineering from University of Tokyo, Japan
- 1972 Ph.D in Ciyt and Regional Planning from University of North Carolina at Chapel Hill,USA
- 1982 Dr. Eng. in Civil Engineering from University of Tokyo, Japan
- 1982 Professor in Faculty of Engineering, University of Yamanashi, Japan
- 2003 Professor in Interdisciplinary Graduate School of Medical and Engineering, University of Yamanashi, Japan
- 2006 Director, ICHARM

- 1998--2000 Chairman of the Inter-Governmental Council of UNESCO International Hydrological Programme (IHP)
- 1998--2000 Deputy President of International Water Resources Association (IWRA)
- 2005 President of International Association of Hydrological Sciences (IAHS)
- 2000-- Chairman of Japan National Committee for the UNESCO International Hydrological Programme (IHP)

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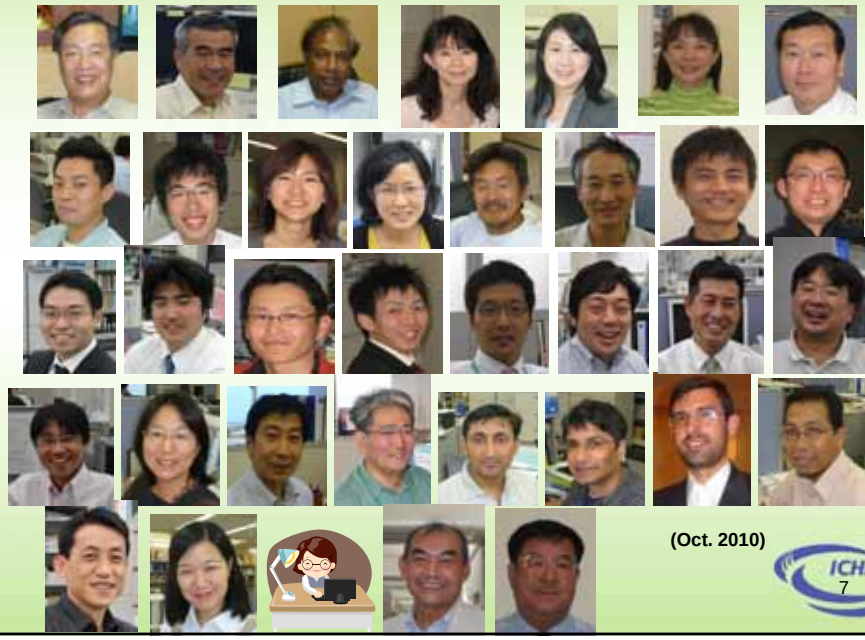
# ICHARM members



(Oct. 2010)

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UN WWDR II (2006)

- Flood risk analyses in diverse localities in developing countries
- Development of flood warning systems that use satellite observations and other advanced technology
- Development of flood hazard mapping procedures able to meet various environmental and social conditions
- Development of community water hazards risk aversion systems with advanced flood warning and flood hazard maps as available means
- Promotion of basic research on hydrological measurement, analysis, and forecast to support ICHARM activities
- Participation in international research programs such as World Water Assessment Programme, International Flood Initiative, Group of Earth Observations and Predictions in Ungaged Basins

**Research**

Data

Curriculum

Results

Participation

Knowledge

Network

Flood Hazard Mapping Training

**Information networking**

- Creation of a worldwide and inter-disciplinary network of practitioners, researchers and course graduates in the field of integrated water risk management
- Collection, analysis and dissemination of information and experiences regarding water-related disasters worldwide
- Timely organization of investigation teams when catastrophic water hazards occur
- Organizing and sponsoring workshops and symposia

**Training**

- Training courses on practical risk reduction systems incorporating existing social diversities, for public officers and decision makers
- Human resources development for integrated flood risk management in cooperation with universities and related institutes worldwide
- Training courses of flood hazard mapping and river and dam engineering for researchers and engineers
- Providing follow-up activities for course graduates in their home countries

8

## Research activities by ICHARM

9

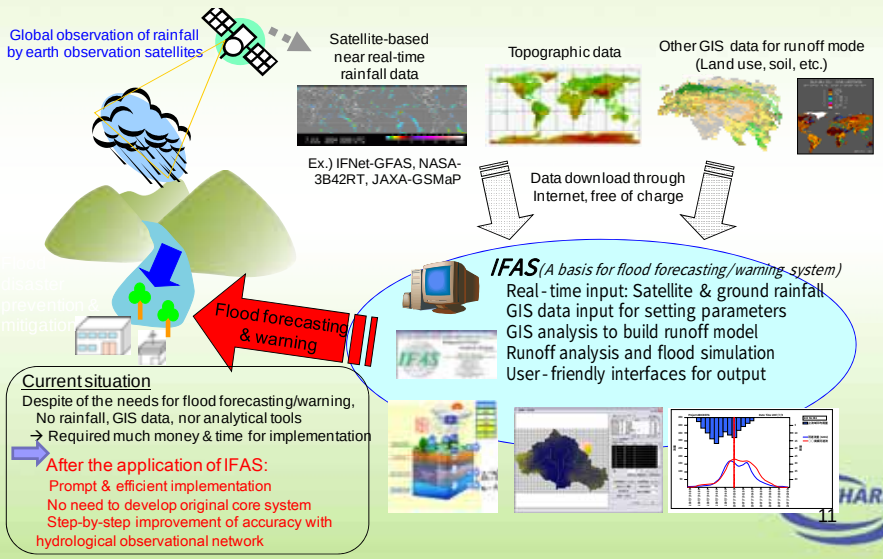
## Research activities by ICHARM

Satellite-based rainfall application
& IFAS (Integrated Flood Analysis System)

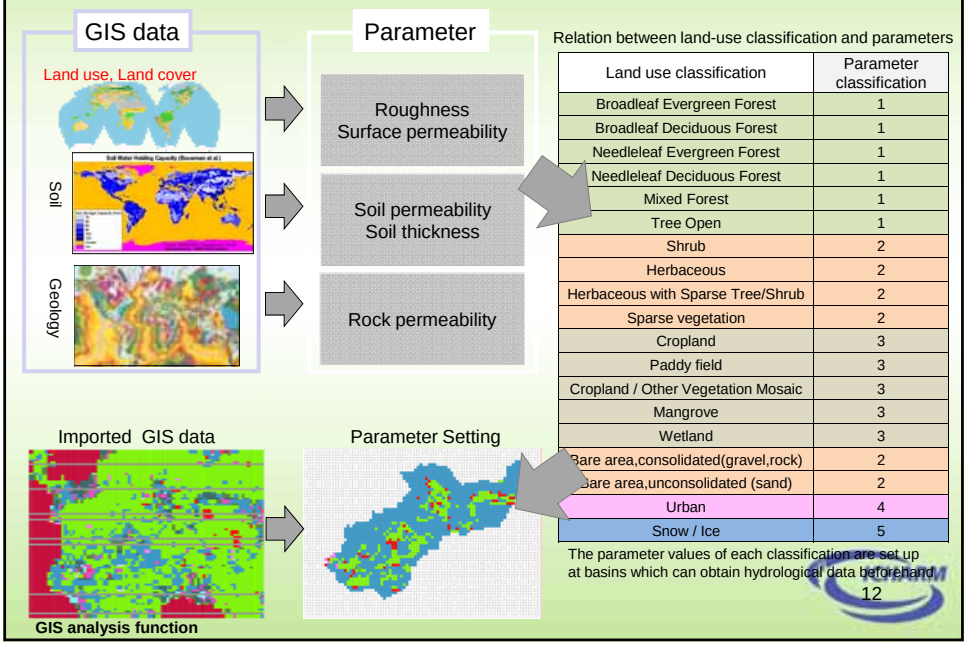
10

# Integrated Flood Analysis System IFAS

***Toolkit to implement "Global Flood Alert System (GFAS) – Streamflow"***




# Parameter estimation using global GIS data



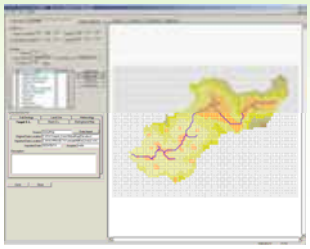

Relation between land-use classification and parameters

| Land use classification | Parameter classification |
|---|---|
| Broadleaf Evergreen Forest | 1 |
| Broadleaf Deciduous Forest | 1 |
| Needleleaf Evergreen Forest | 1 |
| Needleleaf Deciduous Forest | 1 |
| Mixed Forest | 1 |
| Tree Open | 1 |
| Shrub | 2 |
| Herbaceous | 2 |
| Herbaceous with Sparse Tree/Shrub | 2 |
| Sparse vegetation | 2 |
| Cropland | 3 |
| Paddy field | 3 |
| Cropland / Other Vegetation Mosaic | 3 |
| Mangrove | 3 |
| Wetland | 3 |
| Bare area,consolidated(gravel,rock) | 2 |
| Bare area,unconsolidated (sand) | 2 |
| Urban | 4 |
| Snow / Ice | 5 |

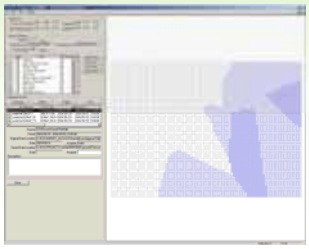
The parameter values of each classification are set up at basins which can obtain hydrological data beforehand.

# Interface display

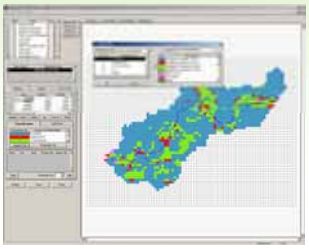
Main display



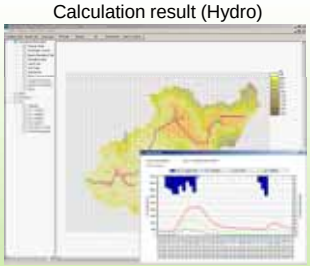
Edit display of rainfall data



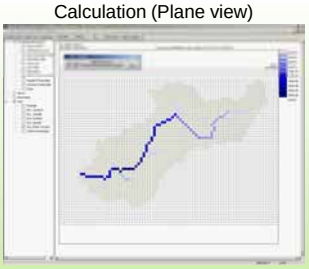
Setting display of parameter



Calculation result (Hydro)



Calculation (Plane view)



Plane view on Google Map

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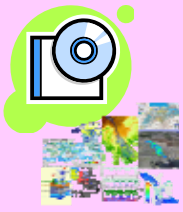
# Development of local ownership of flood forecasts

System



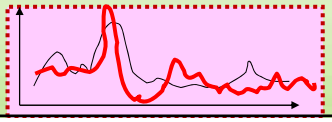
Training

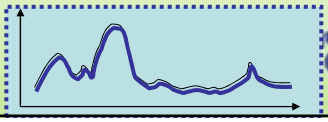
Global Data



Local Data







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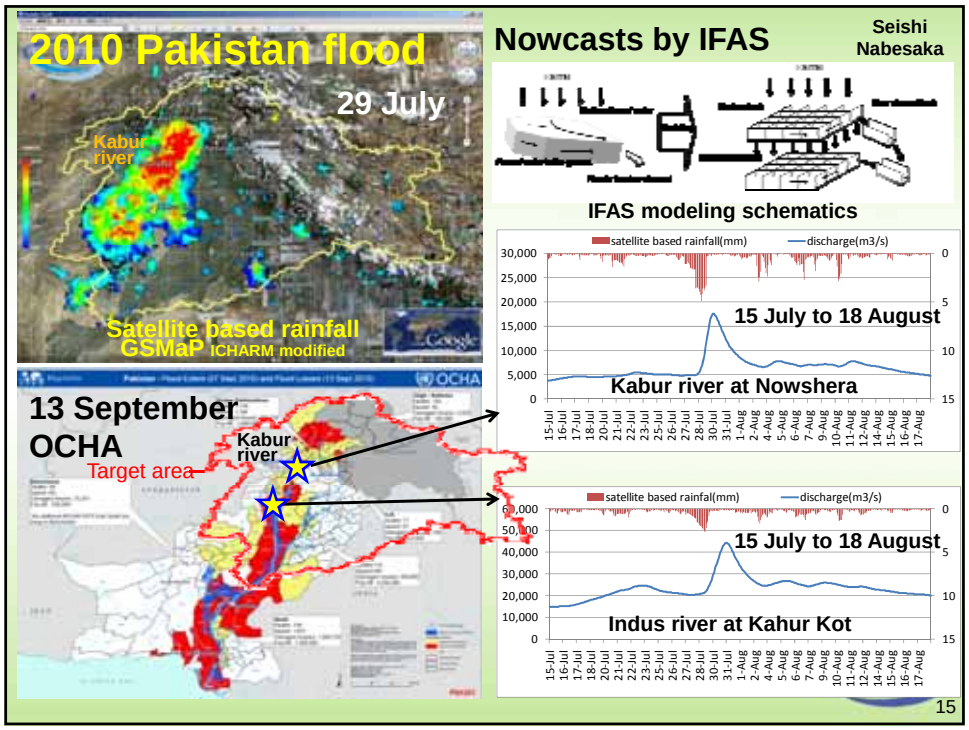
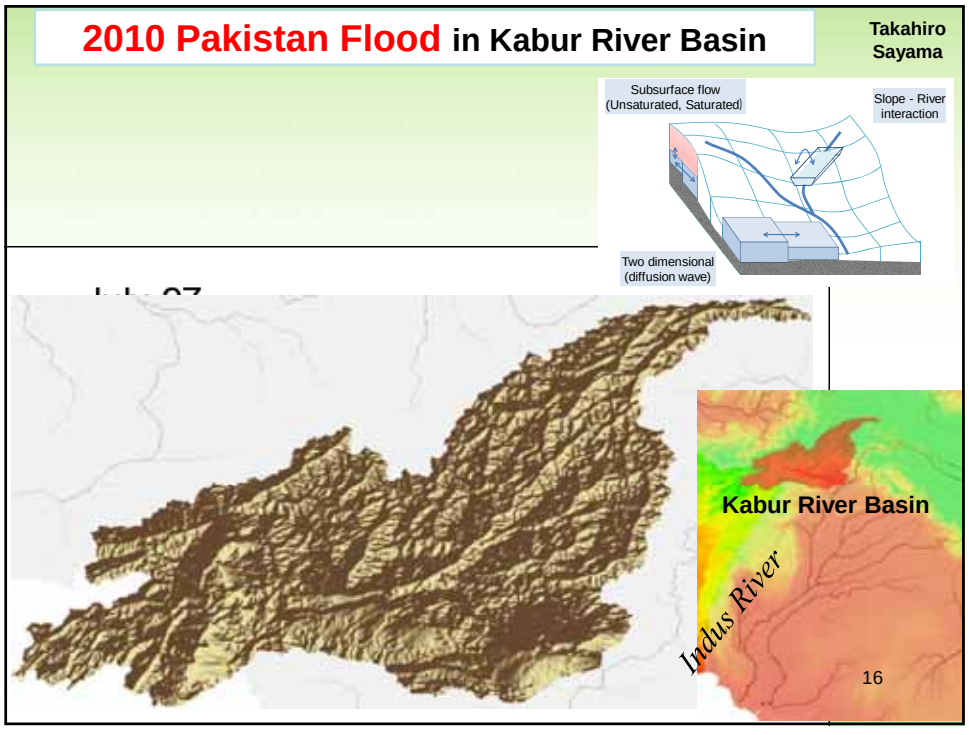
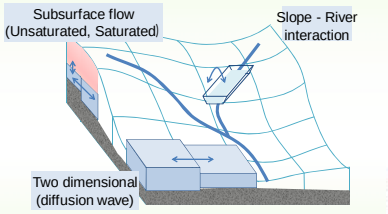
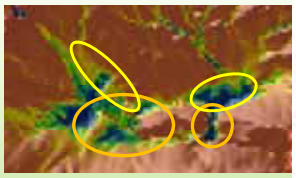

2010 Pakistan flood
29 July
Kabur river
Satellite based rainfall
GSMaP ICHARM modified
13 September
OCHA
Kabur river
Target area
Nowcasts by IFAS
Seishi Nabesaka
IFAS modeling schematics
satellite based rainfall(mm)
discharge(m3/s)
15 July to 18 August
Kabur river at Nowshera
15 July to 18 August
Indus river at Kahur Kot
15


2010 Pakistan Flood in Kabur River Basin
Takahiro Sayama
Subsurface flow
(Unsaturated, Saturated)
Slope - River interaction
Two dimensional
(diffusion wave)
Kabur River Basin
Indus River
16

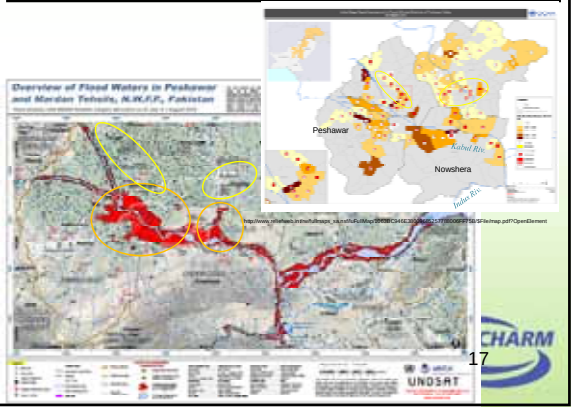
## Comparison between satellite-based inundation extent and inundation simulations with a ICHARM's Rainfall-Runoff-Inundation (RRI) Model for Pakistan flood, August 2010



Sayama et al.(2010)

Runoff-inundation simulation can **interpolate missing satellite-based information** on flood inundation area caused by flash flood.




17

## Research activities by ICHARM

Automatic river flow & sediment discharge observation using non-contact current meter and unmaned-boat-mounted ADCP

(In cooperation with MLIT & NILIM)

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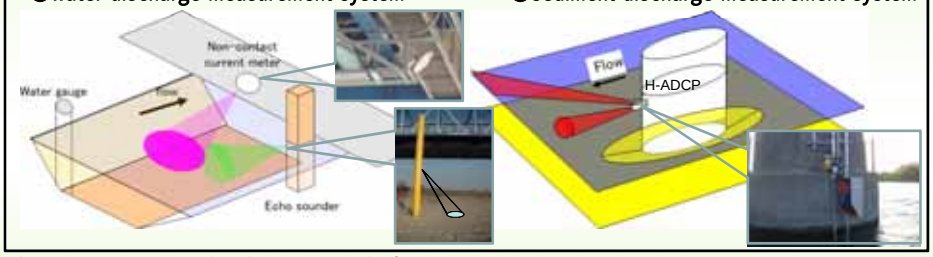
## Development of automatic flood/sediment discharge observation system (2009-2011)

### ◆Purpose

ICAHRM and NILIM have jointly started a research project since May 2008 for the enhancement of water/sediment discharge observation technology. The final target of the project is to provide **a practical technique for automatic flood flow/sediment-discharge observation system**.

### ◆Automatic observation system

**●water discharge measurement system** **●sediment discharge measurement system**




The system is planned to be composed of

1) flood flow observation with non-contact current meter
2) river-bed observation with echo sounder installed in river flow with oblique angle
3) water surface slope measurement with water-level gauge
4) river-bed and bed load discharge observation with a H-ADCP

For verification purposes, cross sectional measurement with an Acoustic Doppler Current Profiler(ADCP) is conducted during flooding

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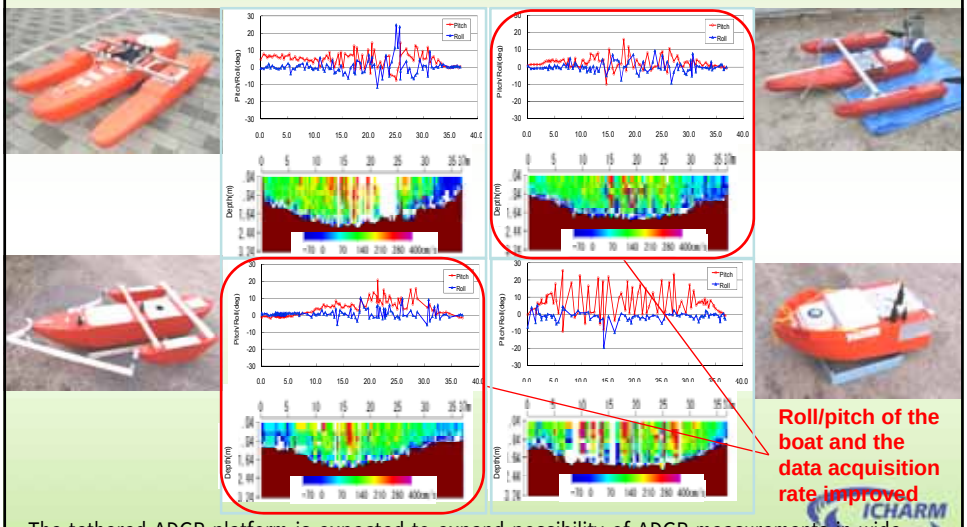
## ◆Development of tethered ADCP platform ～Field observation for boat test～

For verification of the automatic observation system, we have to establish a measuring method for flood flow using a tethered ADCP.

We carried out field observations and proposed a structure of the tethered ADCP platform for high-speed-flow measurements from a viewpoint of safety and measurement accuracy improvement.




**Roll/pitch of the boat and the data acquisition rate improved**

The tethered ADCP platform is expected to expand possibility of ADCP measurements in wide variety of flooding condition with high flow and suspended objects/sediments of steep rivers.

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# Research Activities
## Risk Factor Analysis Series

Reports published
- Bangladesh
- Sri Lanka
- The Philippines
- Hatiya Island, Bangladesh

Reports to be published
- Honduras
- Infanta, the Philippines


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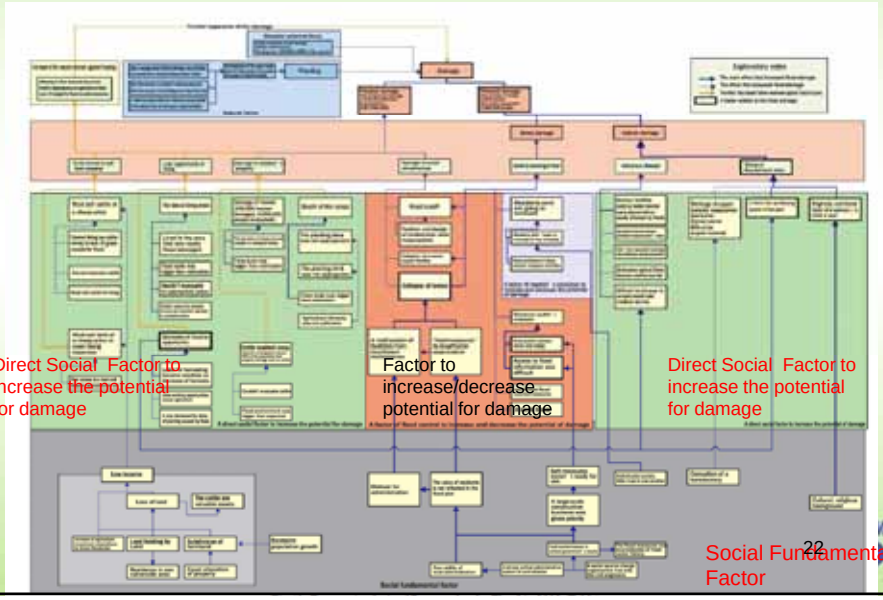
ICHARM's Factor Analysis of disasters
Bangladesh Flood case in 1998

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## Research on sustainable measures for tsunami damage mitigation

**[ Activities ]**

(1) investigation on the possible measures of comprehensive tsunami disaster prevention based on the potential tsunami hazard and the existing land use in the target area;
(2) assessment and development of education materials on comprehensive tsunami disaster prevention
(3) study on the potential implementation of coastal vegetation as a tsunami barrier; and
(4) development of guideline for planning and design of tsunami mitigative coastal vegetation belt.

**[ Output ]**

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## Research on practical application of local experience on disaster management

**[FY2010]**

Collection of local traditions, legends, techniques in Japan and other countries

**[FY2011]**

Study on rationality of collected knowledge, compilation of knowledge

- Similarities (time, climate, topography, materials, social conditions, ideas, etc.)
- Validation from scientific viewpoint

**[FY2012]**

Preparation of draft GL, peer review by selected country experts

GL/handbook compilation on local DM experience

Sharing knowledge through PWRI publication, wikipedia, etc.


**[provide best practices and assist implementation]**

Debris flow breaker

Stone Monuments, local history book, local legends, etc.

Mattress made of trees and stone

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# Capacity building at ICHARM

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## Ongoing Training/academic Courses at ICHARM

Under JICA's Technical Cooperation Project

| | |
|---|---|
| Short-term | Local Emergency Operation Plan with Flood Hazard Maps (2009, 2010 and 2010) |
| Short-term | Capacity Development for Adaptation to Climate Change in Asia- Climate Change Analysis: 5 weeks (in 2011) |
| Long-term | Water-related Risk Management Course (Disaster Management Policy Program with GRIPS) One-year Master's degree course launched in 2008 |
| Short-term | Follow-up seminars on Flood Hazard Mapping |

| | |
|---|---|
| Long-term | Ph. D degree Course Three-year course launched in 2010 |

Ad-hoc Trainings

Short-term training courses on IFAS

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## Flood Hazard Mapping exercises




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# Master's degree course

- Partners
  - ICHARM - Teaching, supervision and assessment
  - GRIPS - Degree awarding institution
  - JICA – Provides financial sponsorship
- Duration – One year (October –September)
- Modes of teaching
  - Lectures
  - Assignments (Tutorials)
  - Field visits
  - Individual studies leading to a thesis
- Successful candidates are awarded the degree of Master of Disaster Management by the National Graduate Institute for Policy Studies (GRIPS)

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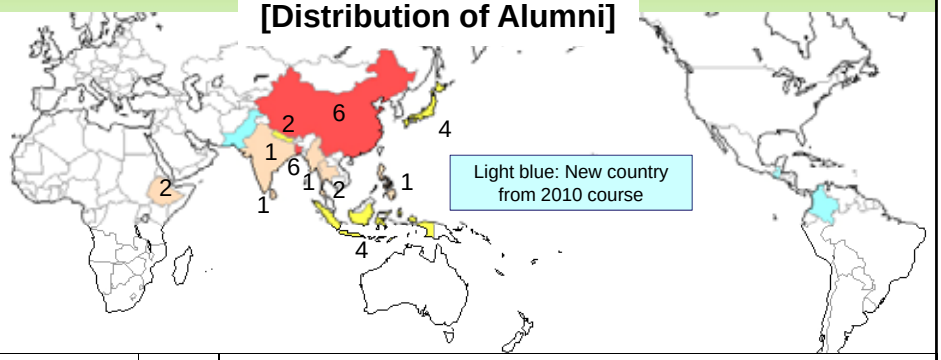
## [Distribution of Alumni]




| Country | Total | Organization |
|---|---|---|
| Bangladesh | 6 | Bangladesh Water Development Board |
| China | 6 | Bureau of Hydrology, Ministry of Water Resources, etc. |
| Ethiopia | 2 | Ministry of Water Resourse, Dire Dawa University |
| India | 1 | Water Resource Dept., Govt. of Assam |
| Indonesia | 4 | Ministry of Public Works |
| Nepal | 2 | Department of Water Induced Disaster Prevention |
| Myanmar | 1 | Ministry of Agriculture and Irrigation |
| Philippines | 1 | Department of Public Works and Highways |
| Sri Lanka | 1 | Department of Irrigation |
| Thailand | 2 | Royal Irrigation Department, Ministry of Agriculture and Cooperatives |
| Japan | 4 | Consulting companies, Japan Water Agency |

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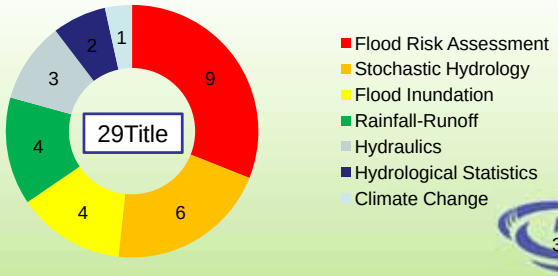
## [Course]

| Category | | Course |
|---|---|---|
| Basic Study | Management Basis | Disaster Mitigation Policy |
| | | Disaster Risk Management |
| | | Integrated Flood Risk Management |
| | Engineering Basis | Computer Programming |
| | | Hydrology (Basic, Advanced) |
| | | Hydraulics (Lecture & Practice) |
| Application | Management Application | Local Disaster Management and Hazard Mapping |
| | | Practice on Local Disaster Management Plan |
| | Engineering Application | Urban Flood Management |
| | | Flood Hydraulics and Sediment Transport |
| | | Mechanics of Sediment Transportation and Channel Changes |
| | | Dam Development & Management |
| | | Sabo Development & Management |
| | | Practice on Flood Hazard Modeling & Flood Forecasting |

## [Master's Thesis]

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# Ph. D. degree course

- Started in October 2010
- Entry requirement – Masters degree or equivalent in a relevant field
- Duration – 3 years
- Mode of training
  - Lectures on advanced topics in Hydrology, Flood Hydraulics and Sediment Transport, Integrated Flood Management, Hydraulics, River Morphology, etc.
  - Individual research leading to a high quality thesis
  - Certain graduate courses in Tokyo University will also be open to the students
- Criteria for award of Ph. D. degree
  - Research performance to be judged by a committee of examiners
  - Publication of 2 peer reviewed journal papers
- Financial support – By way of part time employment at PWRI.
- Ph.D. students will also be encouraged to help Masters students

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<List of Training Program in the last 5 years>

# ICHARM Short Training Course

| | Training Program | Year | Number of Total Participant |
|---|---|---|---|
| ① | Flood Hazard Mapping Training Course | FY2004-FY2008 | 76 |
| ② | UN/ISDR Comprehensive Tsunami Disaster Prevention Training Course | FY2008 | 11 |
| ③ | Local Emergency Operation Plan with Flood Hazard Map | FY2009- | 10 |
| ④ | Capacity development for Adaptation to Climate Change in Asia | FY2010 | 5 (Tentative) |

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# Information Networking activities by ICHARM

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## Asia-Pacific Water Summit(APWS) and regional knowledge hubs

- On 3-4 Dec. 2007, the 1st Asia-Pacific Water Summit was organized, inviting app. 300 high-level guests from the region.
- ICHARM acted as Lead Organization for priority theme “Water-related Disaster Management”.
- During APWS, it was agreed that Regional Knowledge Hubs would be established to serve for reducing water problems in the region.


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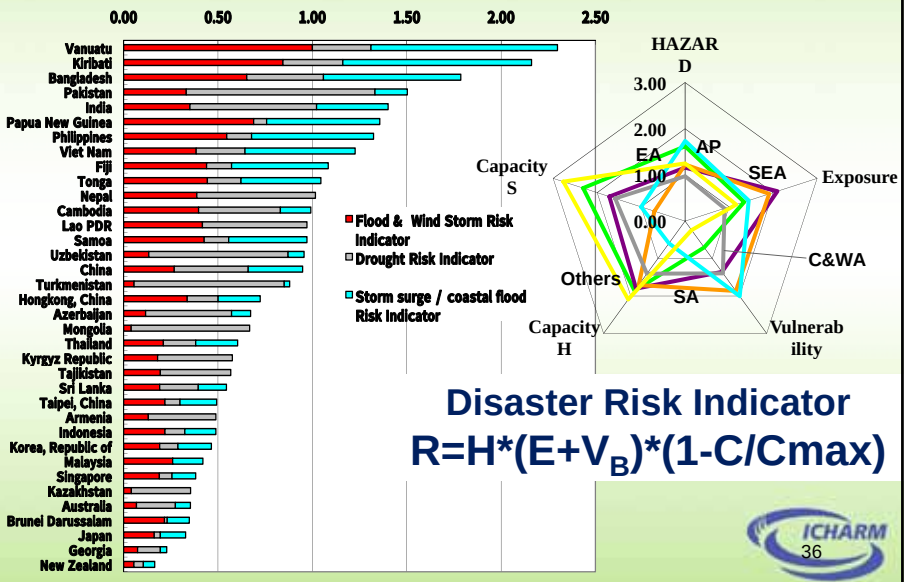
## Contribution to Asian Water Development Outlook

### Ranking of Water Related Disaster Risk




### Disaster Risk Indicator

$$R=H*(E+V_B)*(1-C/Cmax)$$

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[ICHARM Publications]

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[ICHARM Newsletter & Leaflet]


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# Regional Technical Assistance in collaboration with ADB

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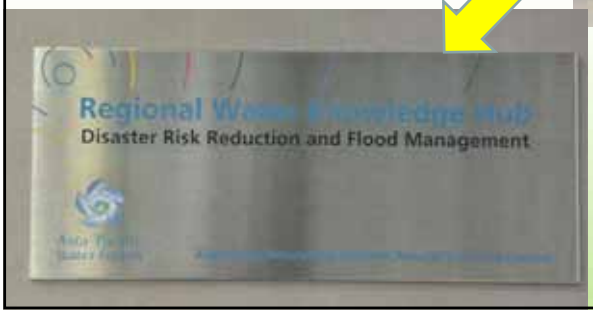
## ICHARM was designated as Regional Water Knowledge Hub for Disaster Risk Reduction and Flood Management under the APWF

ICHARM Entrance

Knowledge Hub Plate

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## *Our Challenge: Localism*

*Localism* is a principle that takes into account local diversity of natural, social and cultural conditions, being sensitive to local needs, priorities, development stage, etc., within the context of global and regional experiences and trends, to be needs driven rather than supply driven, responsive to respective local realities.

Research programs should be coupled with capacity building, by closely working with local institutions, knowledge partners, engineers/scientists

## Inauguration of Regional Technical Assistance with ADB

Director-General Yao (left), Chief Executive Sakamoto (center) and Director Takeuchi (right) shake hands at the signing ceremony.

- On 13 November 2009, Partnership Agreement was signed between PWRI/ICHARM and ADB
- ADB provides funds for operational cost and consulting service procurement, ICHARM provides Expert services, etc.

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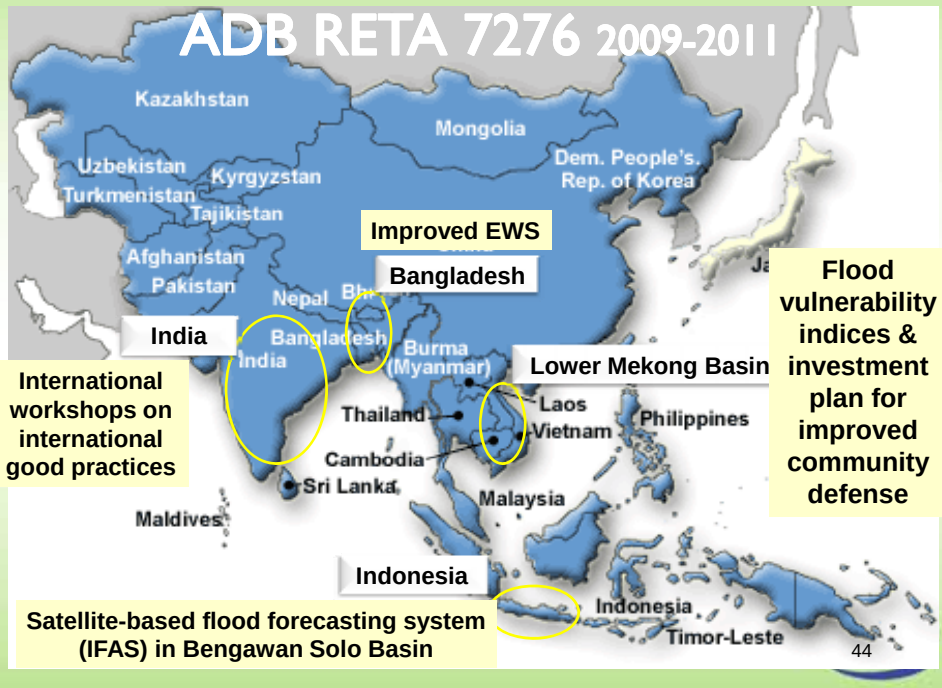


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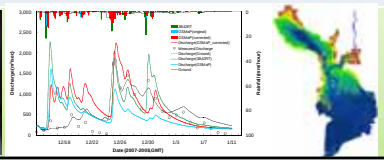
## Project Support

| Country | Area | Project support content |
|---|---|---|
| **Indonesia** | **Bengawan Solo river** | **✓ Satellite-supported flood alert system**<br>**✓ Capacity building on local disaster management** |
| **Bangladesh** | **Country** | **✓ Technical support of current EWS for improvement**<br>**✓ Capacity building of engineers and managers** |
| **India** | **TBD** | **✓ Capacity development through exchange visits and meetings.** |
| **Lower Mekong basin** | **Cambodia Laos Vietnam** | **✓ Support MRC in developing flood vulnerability indices** |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Regional Technical Assistance in collaboration with ADB

## - Local application of IFAS to Bengawan Solo river basin in Indonesia

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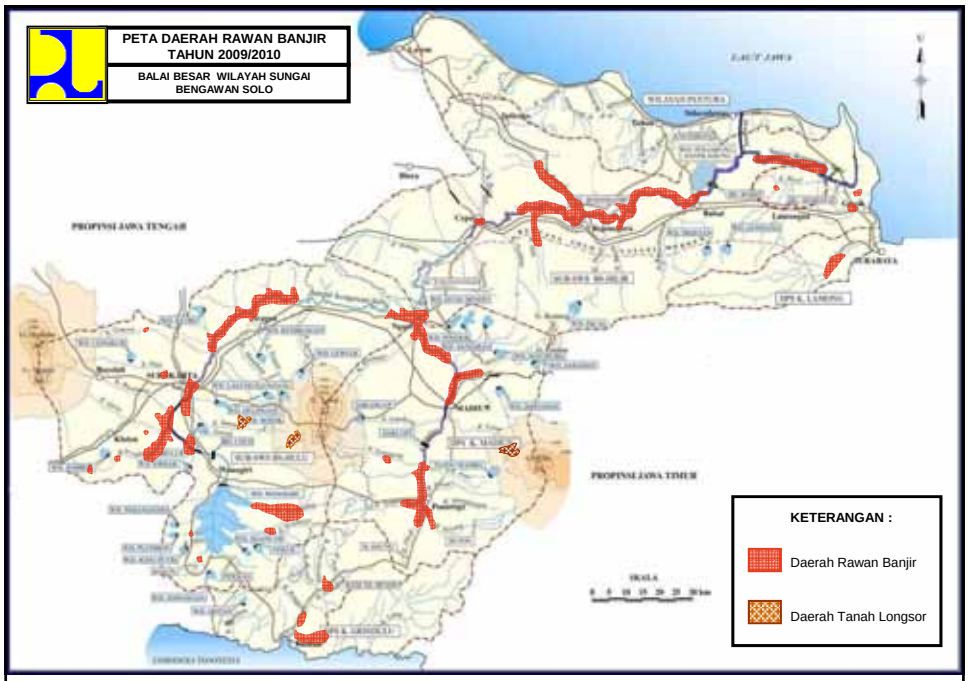
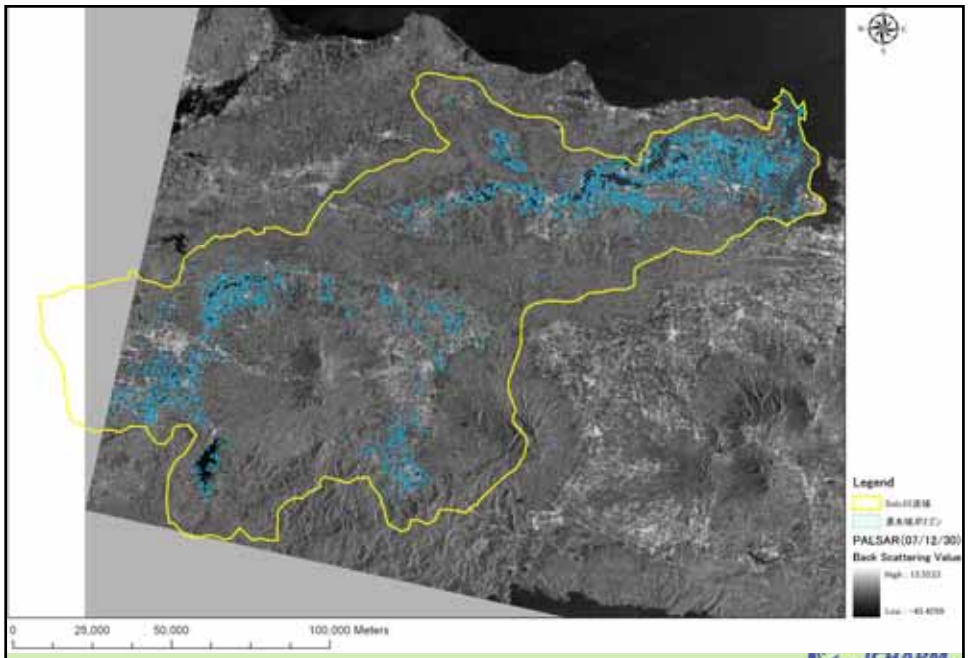



Flood plain area in Bengawan Solo river basin in 2009




Flood plain area in Bengawan Solo river basin in 2007

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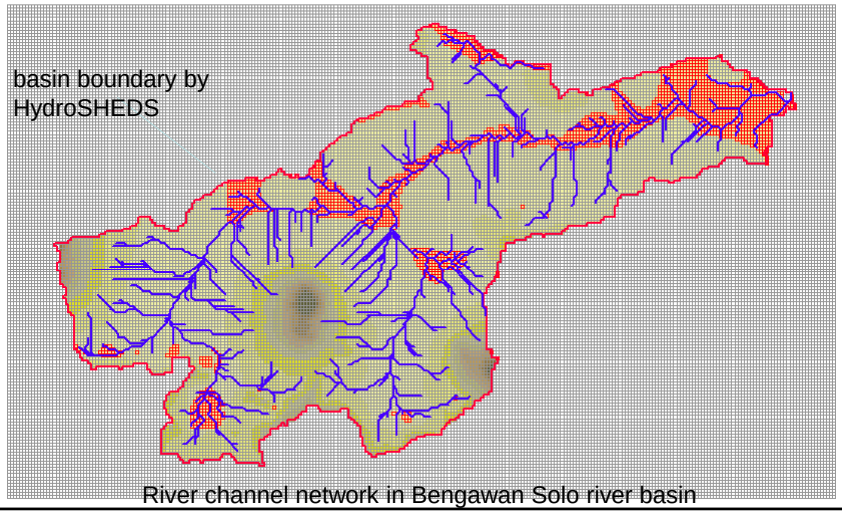
# Current situation of IFAS modeling

Topography : Global map
Basin boundary : HydroSHEDS
Cell size : 1km
Time interval : 1h
Land cover : Global map

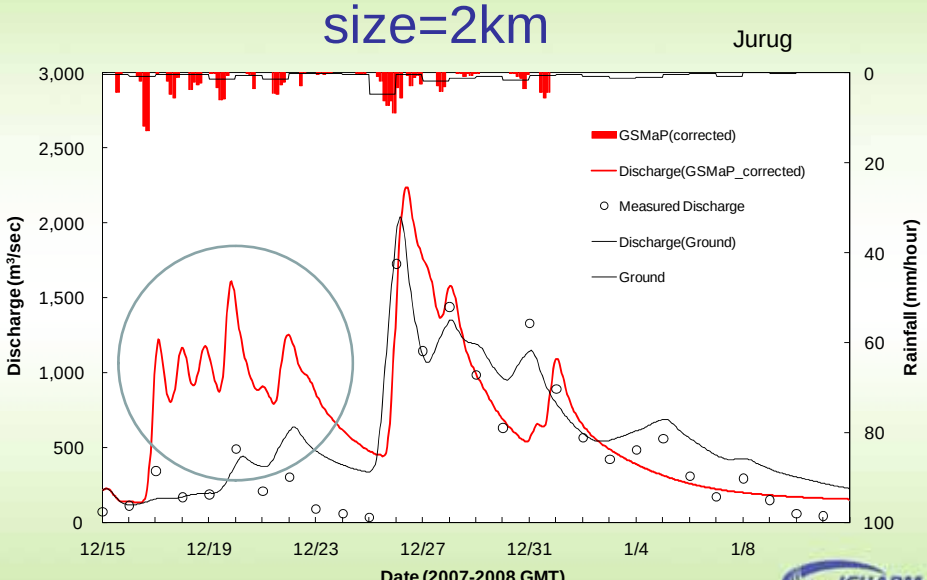
Model check time : 30min
Calculate time : 45min

It is necessary too much time to calculate discharge.




River channel network in Bengawan Solo river basin

# Experimental Calculation cell size=2km

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Regional Technical Assistance in collaboration with ADB

# Community Based Flood Disaster Risk Management

## in Solo River Basin, Indonesia

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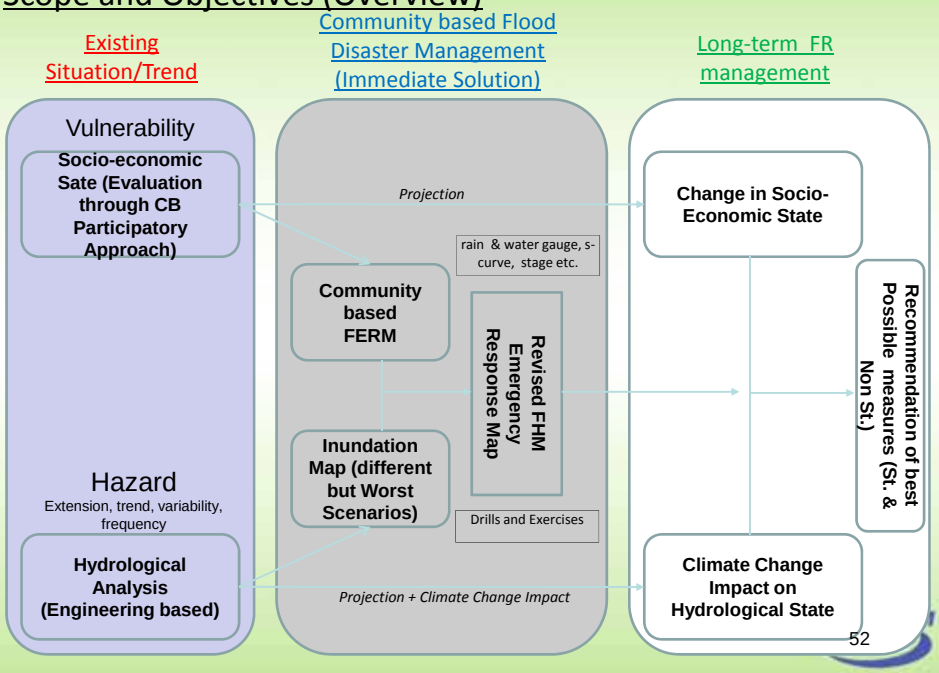
## Scope and Objectives (Overview)

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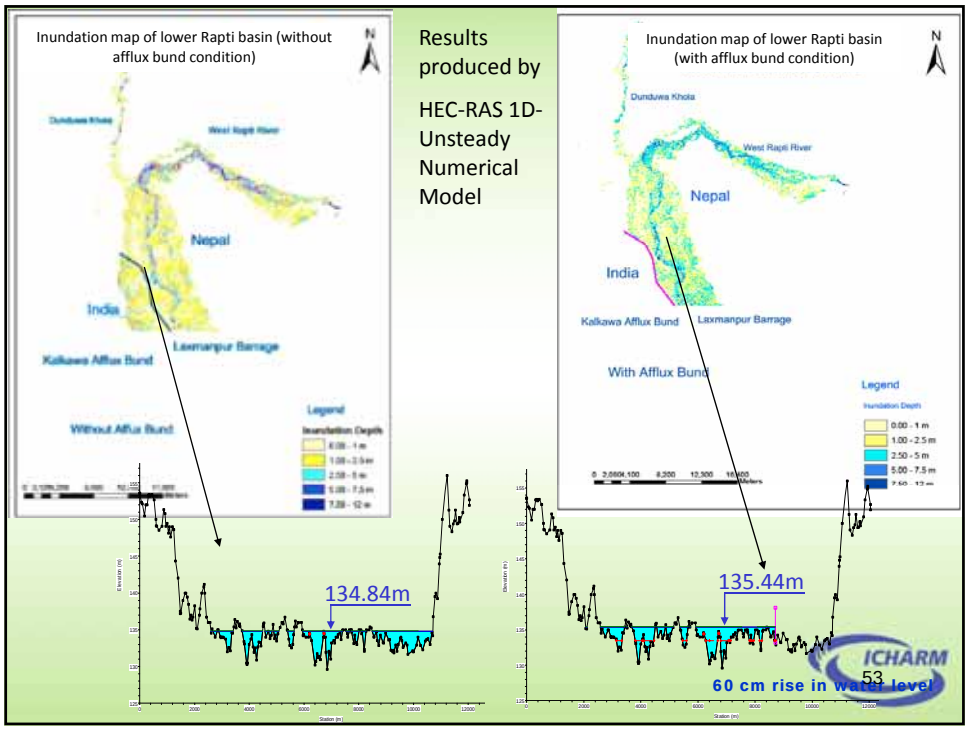
Inundation map of lower Rapti basin (without afflux bund condition)
Nepal
India
Kalkawa Afflux Bund
Laxmanpur Barrage
Without Afflux Bund
Legend
Results produced by
HEC-RAS 1D-Unsteady Numerical Model
Inundation map of lower Rapti basin (with afflux bund condition)
Dunduwa Khola
West Rapti River
Nepal
India
Kalkawa Afflux Bund
Laxmanpur Barrage
With Afflux Bund
Legend
134.84m
135.44m
60 cm rise in water level
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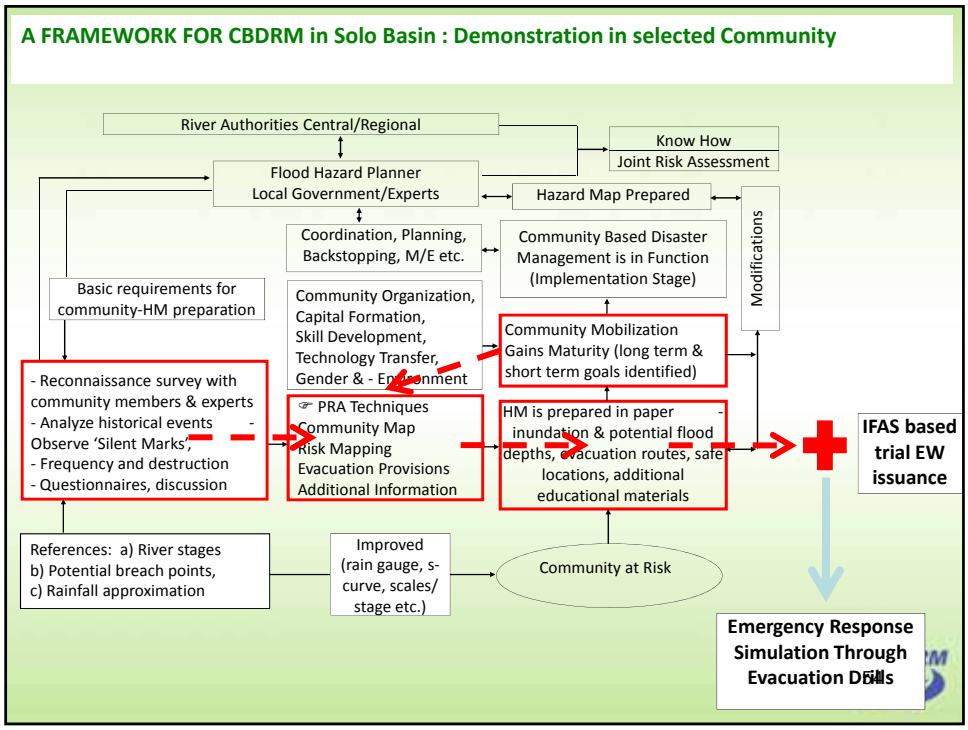
A FRAMEWORK FOR CBDRM in Solo Basin : Demonstration in selected Community
River Authorities Central/Regional
Know How
Joint Risk Assessment
Flood Hazard Planner
Local Government/Experts
Hazard Map Prepared
Modifications
Coordination, Planning, Backstopping, M/E etc.
Community Based Disaster Management is in Function (Implementation Stage)
Basic requirements for community-HM preparation
Community Organization, Capital Formation, Skill Development, Technology Transfer, Gender & - Environment
Community Mobilization Gains Maturity (long term & short term goals identified)
- Reconnaissance survey with community members & experts
- Analyze historical events
Observe 'Silent Marks',
- Frequency and destruction
- Questionnaires, discussion
☞ PRA Techniques
Community Map
Risk Mapping
Evacuation Provisions
Additional Information
HM is prepared in paper
inundation & potential flood depths, evacuation routes, safe locations, additional educational materials
IFAS based trial EW issuance
References: a) River stages
b) Potential breach points,
c) Rainfall approximation
Improved (rain gauge, s-curve, scales/ stage etc.)
Community at Risk
Emergency Response Simulation Through Evacuation Drills

Regional Technical Assistance in collaboration with ADB

# - Review of Flood Early Warning Systems in Bangladesh

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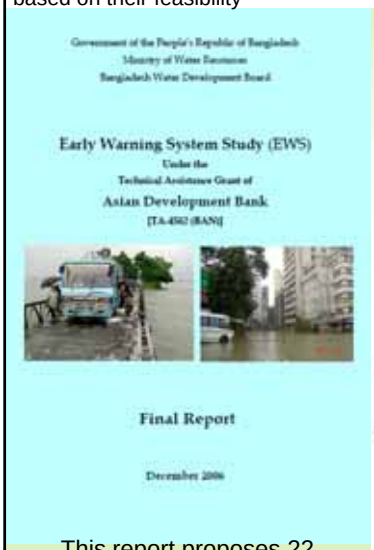
Bangladesh: Under the supervision of ICHARM, Consulting team members will carry out technical review of EW systems and rank the proposed interventions including those proposed by TA-4562 based on their feasibility




This report proposes 22 interventions for the improvement of EW system in Bangladesh

| |
|---|
| 1. Review documentation on EW |
| 2. Identify, visit and review relevant institutes activities on EW |
| 3. Assess existing systems and performance |
| 4. System evaluation based on SWOT＋AHP & MCR analysis |
| 5. Priority ranking of proposed interventions |
| 6. Ranking based on the feasibility a-h |
| 7. Stakeholders meeting for information dissemination |
| 8. Recommend measures and drafting the reports |

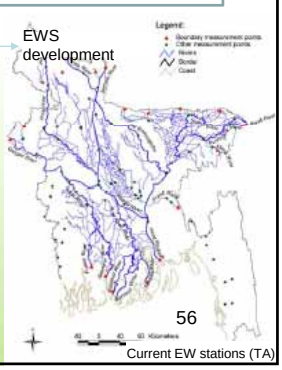
Study will give feed back to PPTA

Project Preparatory Technical Assistance (PPTA)

Target areas

EWS development


FHM of Bangladesh (BWDB)




Current EW stations (TA)

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| Activity | Intervention | Tentative Cost (US$ million) | Duration | Type of intervention |
|---|---|---|---|---|
| B. Improve flood forecasts to meet demands of end-users | B1. Expanding the flood forecasting system to cover all flood prone areas | 2.00 | 3 years | Consultancy, field operations |
| | B.2 Preparing detailed flood forecasts at regional and local levels | 3.50 | 3 years | Consultancy, field operations |
| | B.3: Extending lead times by preparing medium term and long term forecasts | 6.80 | 5 years | Consultancy, field operations |
| | B.4: Preparing detailed forecasts to assess performance of key infrastructure and agricultural land during floods | 2.00 | 3 years | Consultancy, field operations |
| | B.5: Preparing flood forecasts for metropolitan cities (Dhaka) and urban areas | 1.00 | 2 years | Consultancy, field operations |
| | B.6: Implementing forecasting tools for storm surge areas | 5.00 | 5 years | Consultancy, field operations |
| | B.7 Developing and implementing forecasting tools for flash floods | 1.00 | 2 years | Consultancy, field operations |
| C. Improve the extent of coverage and the penetration of the early warning system | C.1 Establishing network of key stakeholders to develop system for disseminating flood warnings | 5.91 | 5 years | Consultancy, training, equipment |
| | C.2 Developing packages of flood forecasting information in response to needs of different end users | 3.00 | 1 year | Consultancy, training, equipment |
| | C.3 Extending existing systems for disseminating flood warnings from national to local levels | 1.50 | 3 years | Consultancy, training, equipment |
| | C.4 Developing people-centered flood warning and dissemination | 2.00 | 5 years | Equipment, consultancy |
| D. Expand coordination between key institutions in early warning system | D.1: Institutional study for the BWDB hydrological services | 0.70 | 1 years | Consultancy |
| | D.2: Strengthening of BWDB in forecast Dissemination | 0.50 | 2 years | Consultancy, training, equipment |
| | D.3: Strengthening the key institutions involved in the early warning system | 3.02 | 3 years | Consultancy, field activities, training |
| | D.4: Enhancing national, regional and international awareness of flood forecasting | 0.25 | 5 years | Workshops Training |

| Activity | Intervention | Tentative Cost (US$ million) | Duration | Type of intervention |
|---|---|---|---|---|
| A. Increase accuracy and timeliness of input data for forecasting | A.1 Upgrading collection and transmission systems for rainfall and water level data | 11.50 | 2 years | Equipment, construction |
| | A.2 Enhancing the existing manual data collection system of BWDB | 1.30 | 3 years | Equipment Training |
| | A.3 Updating DEM to increase spatial extent of forecasting in flood prone area of Bangladesh* | 6.00 | 2 years | Consultancy Investment, Equipment |
| | A.4 Improvement of data exchange mechanism with riparian countries | 0.30 | 3 years | Workshops, visits |
| | A5. Installing additional Doppler Radar at Moulvi Bazar ** | Not applicable | 2 years | Equipment, construction |

| Activity | Intervention | Tentative Cost (US$ million) | Duration | Type of intervention |
|---|---|---|---|---|
| | D.5: Develop process to make flood forecasts and warnings useful to infrastructure managers | 0.75 | 3 years | Training, investment (equipment) |
| | D.6: Establishing mechanism for monitoring, evaluation and feedback of early warning system | 1.13 | 3 years | Consultancy, training, equipment |
| | Total Cost (excluding A2 and A3**see Notes) | 33.16 | - | - |

Notes: * JICA has committed funds for this project with Survey of Bangladesh (SoB). BWDB/FFWC should request SoB to prioritize preparation of DEM for flood-prone areas

**JICA has committed funds for this project but implementation has not yet started

| Pre-Feasibility Package | | | |
|---|---|---|---|
| A1 Upgrading collection and transmission of rainfall and water level data | B1 Expanding flood forecasting to cover all flood prone areas | C1 Establishing network of key stakeholders for disseminating flood forecasts | D1 Institutional study for the BWDB's Hydrologic Services |
| A2 Enhancing BWDB's manual data collection system | B3 Extending lead times of forecasts | | D3 Strengthening key EWS institutions |
| | B7 Developing and implementing forecasting tools for flash floods | | D4 Establishing monitoring, evaluation and feedback |



## Check Lists for Review*

### Risk Knowledge (Hazard Map, Education, Risk Perception)

Checklist

1. Organizational Arrangements Established
- Key national government agencies involved in hazard and vulnerability assessments identified and roles clarified (e.g. agencies responsible for economic data, demographic data, land use planning, social data etc).
- Responsibility for coordinating hazard identification, vulnerability and risk assessment assigned to one national organization.
- Legislation or government policy mandating the preparation of hazard and vulnerability maps for all communities in place.
- National standards for the systematic collection, sharing and assessment of hazard and vulnerability data developed, and standardized with neighbouring or regional countries, where appropriate.
- Process for scientific and technical experts to assess and review the accuracy of risk data and information developed.
- Strategy to actively engage communities in local hazard and vulnerability analyses developed.
- Process to review and update risk data each year, and include information on any new or emerging vulnerabilities and hazards established.

2. Natural Hazards Identified
- Characteristics of key natural hazards (e.g. intensity, frequency and probability) analysed and historical data evaluated.
- Hazard maps developed to identify the geographical areas and communities that could be affected by natural hazards.
- An integrated hazard map developed (where possible) to assess the interaction of multiple natural hazards.

3. Community Vulnerability Analysed
- Community vulnerability assessments conducted for all relevant natural hazards.
- Historical data sources and potential future hazard events considered in vulnerability assessments.
- Factors such as gender, disability, access to infrastructure, economic diversity and environmental sensitivities considered.
- Vulnerabilities documented and mapped (e.g. people or communities along coastlines identified and mapped).

4. Risks Assessed
- Interaction of hazards and vulnerabilities assessed to determine the risks faced by each region or community.
- Community and industry consultation conducted to ensure risk information is comprehensive and includes historical and indigenous knowledge, and local information and national level data.
- Activities that increase risks identified and evaluated.
- Results of risks assessment integrated into local risk management plans and warning messages.

5. Information Stored and Accessible
- Central 'library' or GIS database established to store all disaster and natural hazard risk information.
- Hazard and vulnerability data available to government, the public and the international community (where appropriate).
- Maintenance plan developed to keep data current and updated.

### Monitoring and Early Warning (Data, Interpretation/Analysis, Quality

Checklist

1. Institutional Mechanisms Established
- Standardized process, and roles and responsibilities of all organizations generating and issuing warnings established and mandated by law.
- Agreements and interagency protocols established to ensure consistency of warning language and communication channels where different hazards are handled by different agencies.
- An all-hazard plan to obtain mutual efficiencies and effectiveness among different warning systems established.
- Warning system partners, including local authorities, aware of which organizations are responsible for warnings.
- Protocols in place to define communication responsibilities and channels for technical warning services.
- Communication arrangements with international and regional organizations agreed and operational.
- Regional agreements, coordination mechanisms and specialized centres in place for regional concerns such as tropical cyclones, floods in shared basins, data exchange, and technical capacity building.
- Warning system subjected to system-wide tests and exercises at least once each year.
- A national all-hazards committee on technical warning systems in place and linked to national disaster management and reduction authorities, including the national platform for disaster risk reduction.
- System established to verify that warnings have reached the intended recipients.
- Warning centres staffed at all times (24 hours per day, seven days per week).

2. Monitoring Systems Developed
- Measurement parameters and specifications documented for each relevant hazard.
- Plans and documents for monitoring networks available and agreed with experts and relevant authorities.
- Technical equipment, suited to local conditions and circumstances, in place and personnel trained in its use and maintenance.
- Applicable data and analyses from regional networks, adjacent territories and international sources accessible.
- Data received, processed and available in meaningful formats in real time, or near-real time.
- Strategy in place for obtaining, reviewing and disseminating data on vulnerabilities associated with relevant hazards.
- Data routinely archived and accessible for verification and research purposes.

3. Forecasting and Warning Systems Established
- Data analysis, prediction and warning generation based on accepted scientific and technical methodologies.
- Data and warning products issued within international standards and protocols.
- Warning analysts trained to appropriate international standards.
- Warning centres equipped with appropriate equipment needed to handle data and run prediction models.
- Fail-safe systems in place, such as power back-up, equipment redundancy and on-call personnel systems.
- Warnings generated and disseminated in an efficient and timely manner and in a format suited to user needs.
- Plan implemented to maintain, monitor and evaluate operational procedures, including



*Based on UNISDR Recommendation

## Check Lists for Review Continue

### Dissemination and Communication (Networking, Reliability on Forecasting, Forms of Warning)

Checklist

**1. Organizational and Decision-making Processes Institutionalised**

- Warning dissemination chain enforced through government policy or legislation (e.g. message passed from government to emergency managers and communities etc).
- Recognized authorities empowered to disseminate warning messages (e.g. meteorological authorities to provide weather messages, health authorities to provide health warnings).
- Functions, roles and responsibilities of each actor in the warning dissemination process specified in legislation or government policy (e.g. national meteorological and hydrological services, media, NGOs).
- Roles and responsibilities of regional or cross border early warning centres defined, including the dissemination of warnings to neighbouring countries.
- Volunteer network trained and empowered to receive and widely disseminate hazard warnings to remote households and communities.

**2. Effective Communication Systems and Equipment Installed**

- Communication and dissemination systems tailored to the needs of individual communities (e.g. radio or television for those with access; and sirens, warning flags or messenger runners for remote communities).
- Warning communication technology reaches the entire population, including seasonal populations and remote locations.
- International organizations or experts consulted to assist with identification and procurement of appropriate equipment.
- Multiple communication mediums used for warning dissemination (e.g. mass media and informal communication).
- Agreements developed to utilise private sector resources where appropriate (e.g. amateur radios, safety shelters).
- Consistent warning dissemination and communication systems used for all hazards.
- Communication system is two-way and interactive to allow for verification that warnings have been received.
- Equipment maintenance and upgrade programme implemented and redundancies enforced so back-up systems are in place in the event of a failure.

**3. Warning Messages Recognised and Understood**

- Warning alerts and messages tailored to the specific needs of those at risk (e.g. for diverse cultural, social, gender, linguistic and educational backgrounds).
- Warning alerts and messages are geographically-specific to ensure warnings are targeted to those at risk only.
- Messages incorporate the understanding of the values, concerns and interests of those who will need to take action (e.g. instructions for safeguarding livestock and pets).
- Warning alerts clearly recognisable and consistent over time and include follow-up actions when required.
- Warnings specific about the nature of the threat and its impacts.
- Mechanisms in place to inform the community when the threat has ended.
- Study into how people access and interpret early warning messages undertaken and lessons learnt incorporated into message formats and dissemination processes.

### Response Capacity at User Level (Warning Quality, Emergency Preparedness, Response)

Checklist

**1. Warnings Respected**

- Warnings generated and distributed to those at risk by credible sources (e.g. government, spiritual leaders, respected community organizations).
- Public perception of natural hazard risks and the warning service analysed to predict community responses.
- Strategies to build credibility and trust in warnings developed (e.g. understanding difference between forecasts and warnings).
- False alarms minimised and improvements communicated to maintain trust in the warning system.

**2. Disaster Preparedness and Response Plans Established**

- Disaster preparedness and response plans empowered by law.
- Disaster preparedness and response plans targeted to the individual needs of vulnerable communities.
- Hazard and vulnerability maps utilized to develop emergency preparedness and response plans.
- Up-to-date emergency preparedness and response plans developed, disseminated to the community, and practiced.
- Previous disaster events and responses analysed, and lessons learnt incorporated into disaster management plans.
- Strategies implemented to maintain preparedness for recurrent hazard events.
- Regular tests and drills undertaken to test the effectiveness of the early warning dissemination processes and responses.

**3. Community Response Capacity Assessed and Strengthened**

- Community ability to respond effectively to early warnings assessed.
- Response to previous disasters analysed and lessons learnt incorporated into future capacity building strategies.
- Community-focused organizations engaged to assist with capacity building.
- Community and volunteer education and training programmes developed and implemented.

**4. Public Awareness and Education Enhanced**

- Simple information on hazards, vulnerabilities, risks, and how to reduce disaster impacts disseminated to vulnerable communities and decision-makers.
- Community educated on how warnings will be disseminated and which sources are reliable and how to respond to different types of hazards after an early warning message is received.
- Community trained to recognise simple hydro-meteorological and geophysical hazard signals to allow immediate response.
- On-going public awareness and education built in to school curricula from primary schools to university.
- Mass media and folk or alternative media utilized to improve public awareness.
- Public awareness and education campaigns tailored to the specific need of each audience (e.g. children, emergency managers, media).
- Public awareness strategies and programmes evaluated at least once per year and updated where required.

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## Check Lists for Review Continue (Cross-cutting Issues)

### Governance and Institutional Arra. (SOD, Communication Among, Collaboration)

Checklist

**1. Early Warning Secured as a Long Term National and Local Priority**

- Economic benefits of early warning highlighted to senior government and political leaders using practical methods such as a cost-benefit analysis of previous disasters.
- Examples and case studies of successful early warning systems disseminated to senior government and political leaders.
- Early warning role models or "champions" engaged to advocate early warning and promote its benefits.
- The priority natural hazard risk requiring an early warning system identified, and operational arrangements within a multi-hazard framework established.
- Early warning integrated into national economic planning.

**2. Legal and Policy Frameworks to Support Early Warning Established**

- National legislation or policies developed to provide an institutional and legal basis for implementing early warning systems.
- Clear roles and responsibilities defined for all organizations (government and non-government) involved in early warning.
- Overall responsibility and authority for coordination of early warning assigned to one national agency.
- One political leader or senior government official empowered by law as the national decision maker.
- Policies developed to decentralise disaster management and encourage community participation.
- Local decision making and implementation of early warning systems placed within broader administrative and resource capabilities at the national or regional level.
- Regional and cross-border agreements established to ensure early warning systems are integrated where possible.
- Relationships and partnerships between all organizations involved in early warning institutionalised and coordination mechanisms mandated.
- Early warning integrated into disaster reduction and development policies.
- Monitoring and enforcement regime in place to support policies and legislation.

**3. Institutional Capacities Assessed and Enhanced**

- Capacities of all organizations and institutions involved assessed and capacity building plans and training programmes developed and resourced.
- Non-governmental sector engaged and encouraged to contribute to capacity building.

**4. Financial Resources Secured**

- Government funding mechanism for early warning and disaster preparedness developed and institutionalised.
- Access to funding at the international or regional level explored.
- Public/private partnerships utilised to assist with early warning system development.

### Socio-cultural Aspect , Participation (TBD)

Checklist

**1. Warnings Respected**

- Warnings generated and distributed to those at risk by credible sources (e.g. government, spiritual leaders, respected community organizations).
- Public perception of nat[illegible]zard risks and the warning service an[illegible]redict community response[illegible]
- Strategies to build[illegible] warnings develo[illegible] difference between[illegible]
- False alarms minimised[illegible] communicated to maintain[illegible] warning system.

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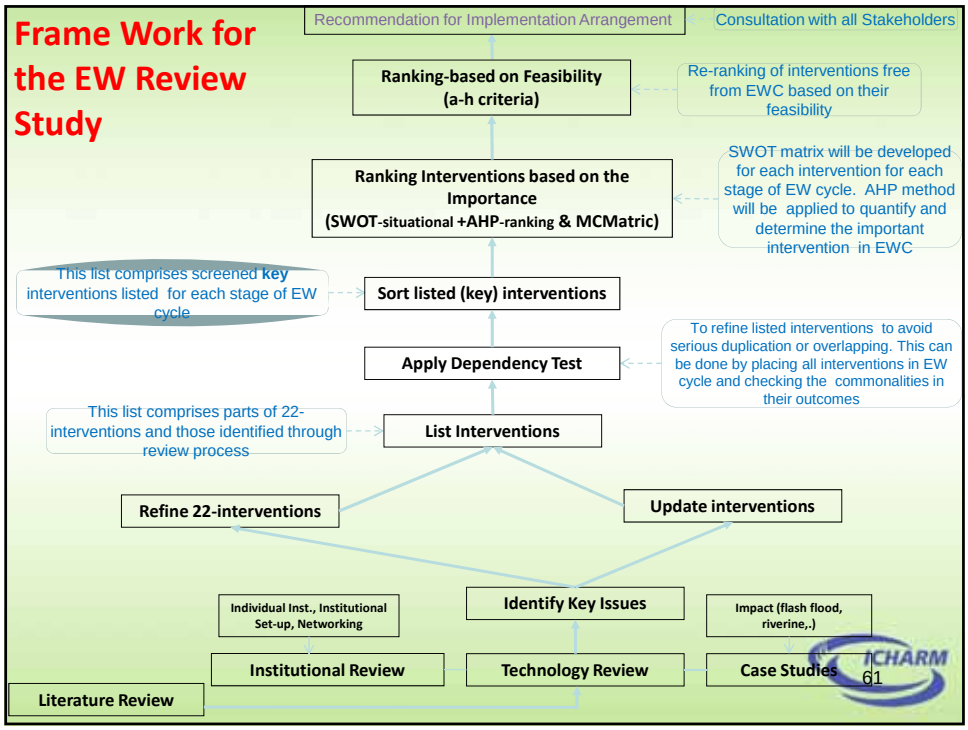
**[illegible]blic Awareness and Education [illegible]nced**

- [illegible]rmation on hazards, [illegible]sks, and how to reduce [illegible]sseminated to vulnerable [illegible]on-makers.
- [illegible]e warnings will be [illegible]es are reliable [illegible]es of [illegible]ge is received.
- Community trai[illegible]e hydro-meteorologic[illegible]al hazard signals to allow imme[illegible]se.
- On-going public awareness[illegible] education built in to school curricula from primary schools to university.
- Mass media and folk or alternative media utilized to improve public awareness.
- Public awareness and education campaigns tailored to the specific need of each audience (e.g. children, emergency managers, media).
- Public awareness strategies and programmes evaluated at least once per year and updated where required.

To Be Determined

60

*Based on UNISDR Recommendation

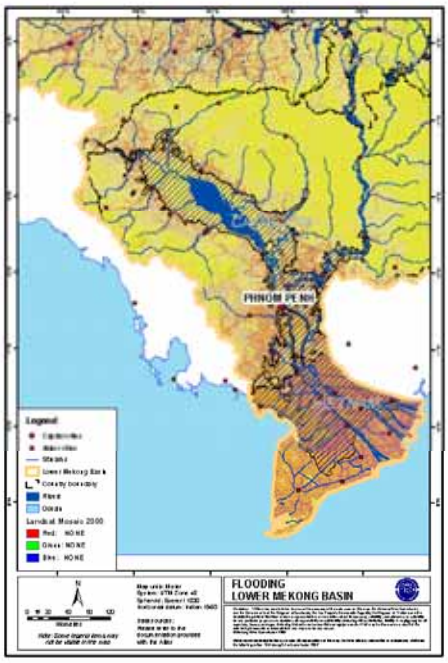



Regional Technical Assistance in collaboration with ADB

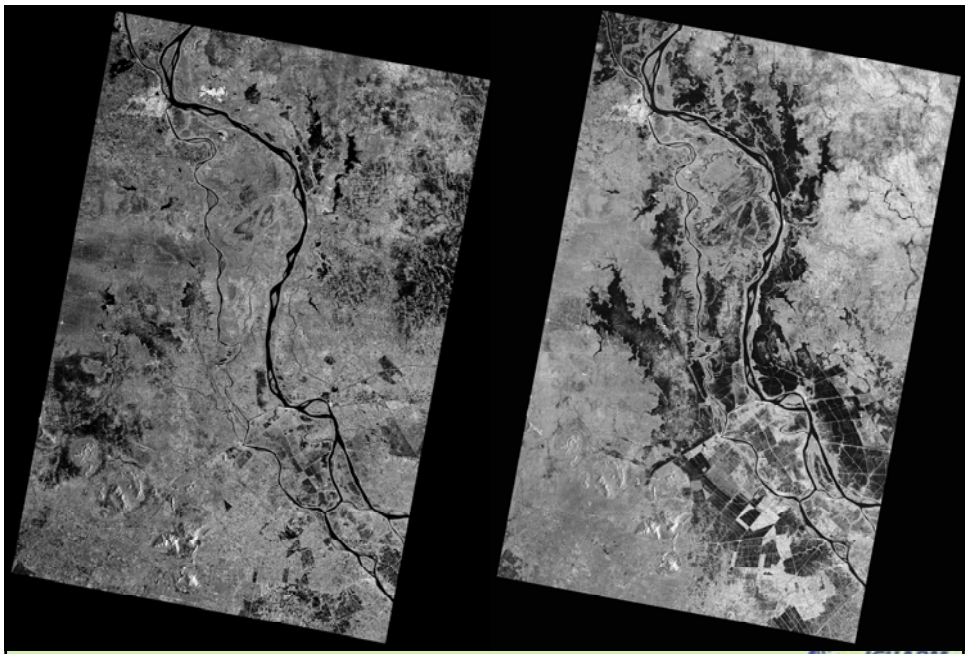
# - Development of Flood Vulnerability Indices in Lower Mekong Area

ICHARM

62




63

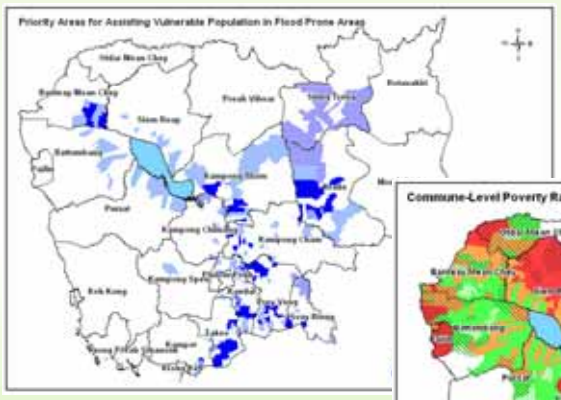


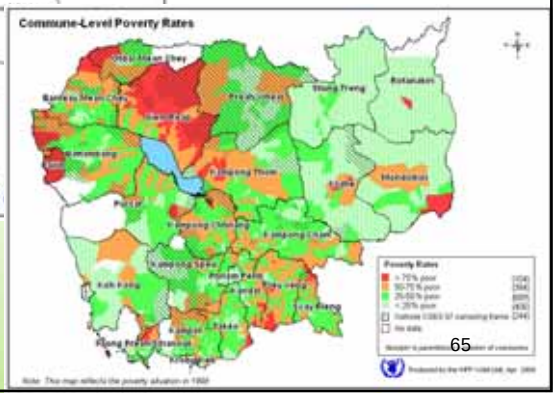
TerraSAR 2010 Aug.10

TerraSAR 2010 Sep.10

64

## Based on past achievement, FVI will be proposed




65

## Proposed Activities for LMB
## 5 phased activities

Phase 1 (Fact finding and concept development) and 2 (Pre-consolidation of data and info.) are completed.

Phase 3; Consolidation of data, concept and proposed methodology;

proposed activities are mostly logistic, organizational issues and, data compilation for indices development are included in this phase.

Phase 4; Survey design and execution, analysis and verification of FVIs.:

mostly field survey in six Cambodian villages

Phase 5: Projection of local vulnerability indices to regional scale

ICHARM

66

ICHARM is trying hard to disseminate and extend knowledge that contribute to water-related disaster risk reduction

Please visit ICHARM website at

http://www.icharm.pwri.go.jp/

*Thank you very much for your attention.*

# Ⅴ-3. Lecture

# “The affection of the climate change on the flood prevention and the adaptation measures”

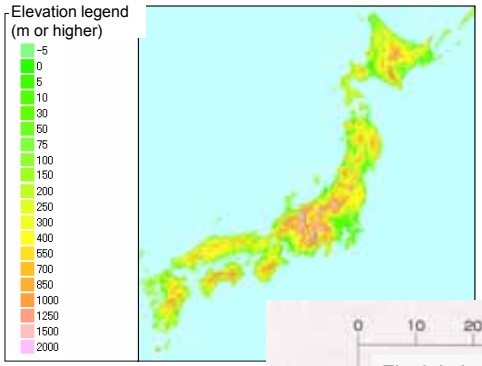
Mr. Atsushi HATTORI

# The affection of the climate change on the flood prevention and the adaptation measures

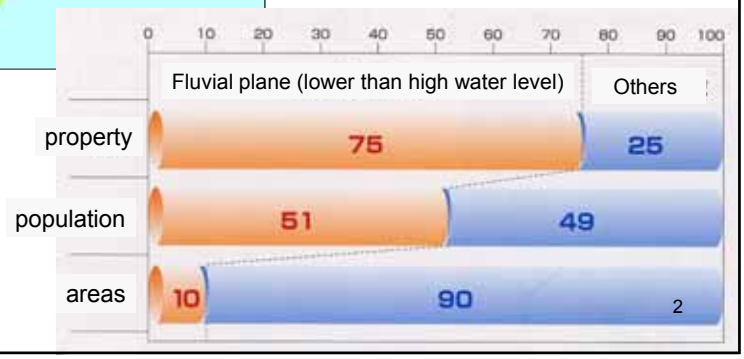
Atsushi HATTORI
Head of River Division
River Department, NILIM

1

## Natural and Social condition of Japan



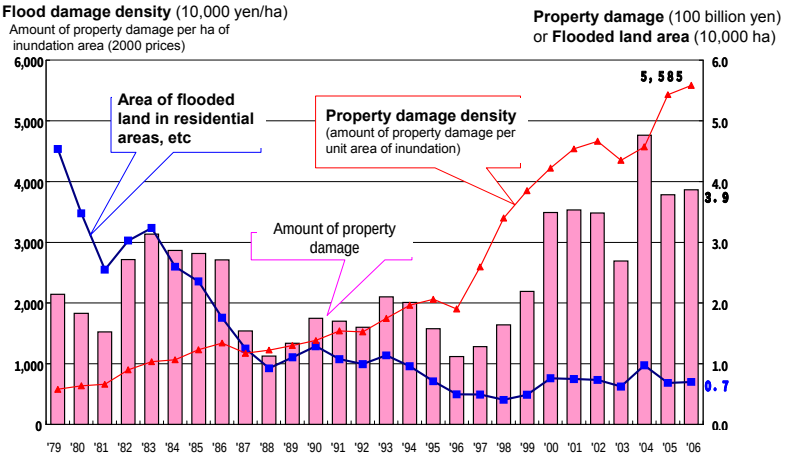

About half of all national population and three quarters of assets concentrate in the alluvial plains, which is about 10% of all nation's land.
→Devastating damage is anticipated when flood occurs.




2

# The amount of flood damage is on the increase

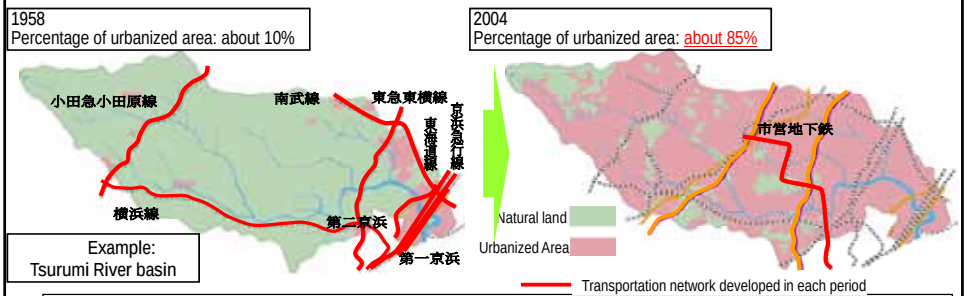
→Although the area of inundation had been on the decrease because of flood control measures, it has been showing a slightly increasing trend in recent years. Mainly because of the urbanization of flood-prone areas and the increase in flood-vulnerable property, the amount of damage has been showing a tendency to increase.



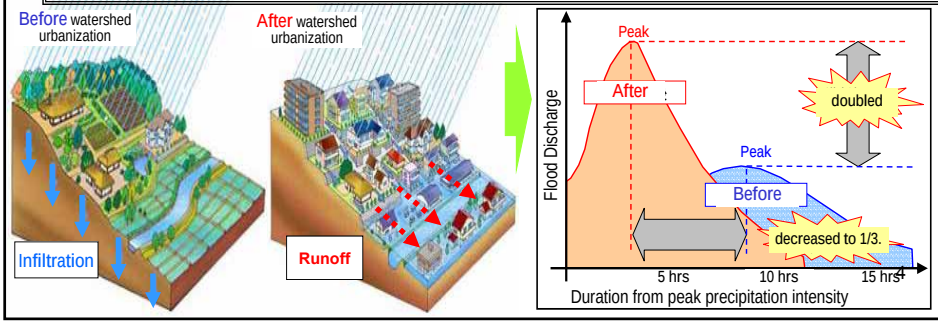

Notes: 1. Averages in the last five years
2. The amount of property damage and flood damage density include business interruption loss.
3. Source: 2006 Flood Statistics combined by River Bureau, Ministry of Land, Infrastructure, Transport and Tourism
4. 2000 prices

3

The resultant urbanization has caused the water retention and detention functions of the watersheds to decline.



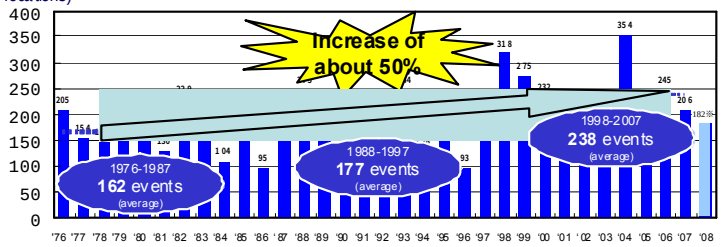

As runoff increases, the time to peak runoff decreases.



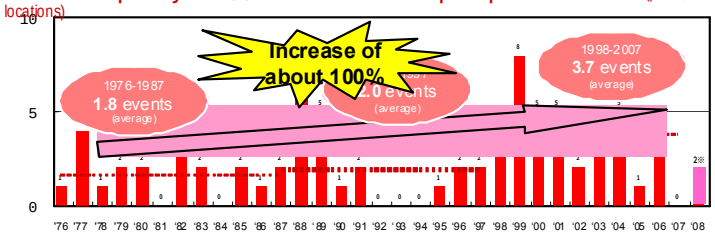

4

## Both hourly rainfall and daily rainfall tends to increase.

Annual frequency of 50 mm/hour or more precipitation events (per 1,000 locations)



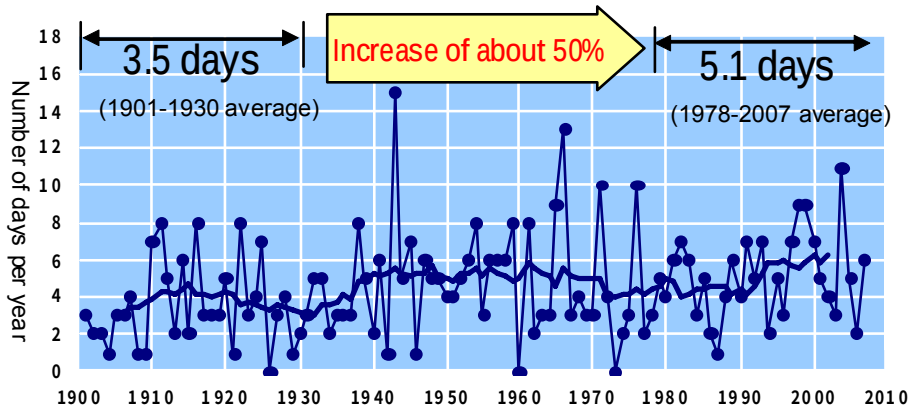

Annual frequency of 100 mm/hour or more precipitation events (per 1,000 locations)




・The annual frequency of precipitation events with different hourly precipitations was calculated from AMeDAS data obtained from about 1,300 locations in Japan.
・The 2008 data are data obtained on or before September 2, 2008.

5

## Annual frequency of days with a daily precipitation of 200 mm or more




The annual frequency of days with a daily precipitation of 200 mm or more calculated from measurements obtained at 51 locations in Japan. Both values in each year (thin line) and 11-year moving averages (thick line) are shown. (JMA data)

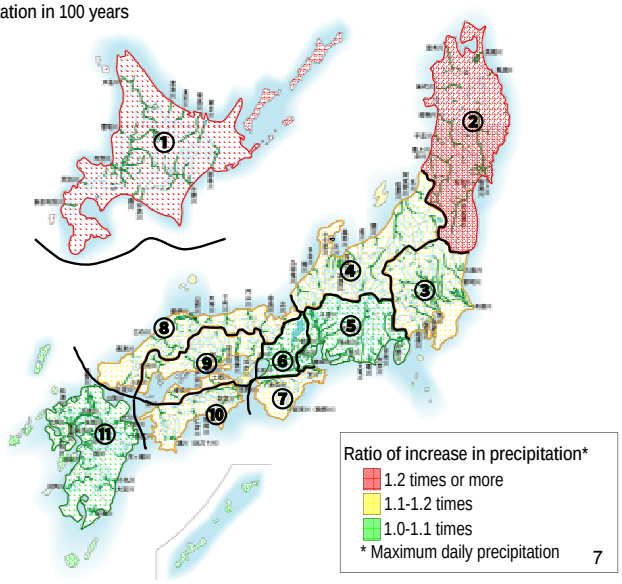
Increasing frequency of heavy rains: The trend is expected to continue.

6

**In future, precipitation is likely to increase throughout the country.**

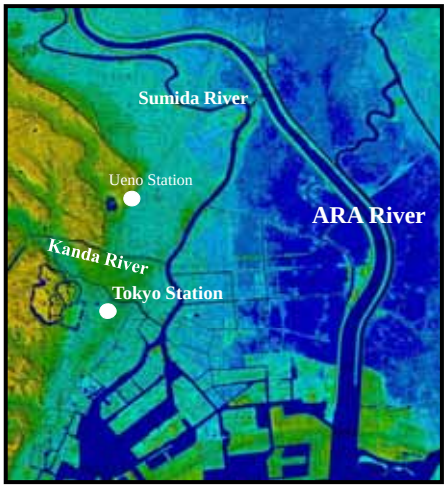
Projections of increase in daily precipitation in 100 years

| | | |
|---|---|---|
| ① | Hokkaido | 1.24 |
| ② | Tohoku | 1.22 |
| ③ | Kanto | 1.11 |
| ④ | Hokuriku | 1.14 |
| ⑤ | Chubu | 1.06 |
| ⑥ | Kinki | 1.07 |
| ⑦ | Southern Kii | 1.13 |
| ⑧ | Sanin | 1.11 |
| ⑨ | Setouchi | 1.10 |
| ⑩ | Southern Shikoku | 1.11 |
| ⑪ | Kyushu | 1.07 |



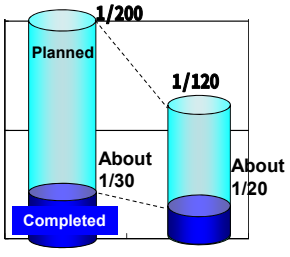

7

## Relatively Low Level of Flood Protection Safety Compared with the High-Degree Land Use




Prepared by Geospatial Information Authority of Japan

**Influence of increased precipitation 100 years from now on the flood safety level of Ara River**




**Flood safety (return period) will decrease to about 1/2 of the target level in 100 years because of 10 to 20% increase of Rainfall.**

8

# Climate Change : Adverse Affects of Concern

Doubled Hardship for Flood safety Administrators

Relatively Low Level of Flood Protection safety Compared with the high-degree land use

Increasing Flood-Disaster Risk under the ongoing Climate Change

9

# Direction of future MLIT efforts

The goal: Working toward "zero victims"

Complete protection from increasingly severe floods is difficult to achieve.

①Studies are conducted on ways to achieve **"zero victims."**

②In the areas where key state functions are concentrated, priority measures such as **measures to prevent serious damage on key state functions are to be taken.**

⇨ Minimization of damage

Measures to cope with growing external forces

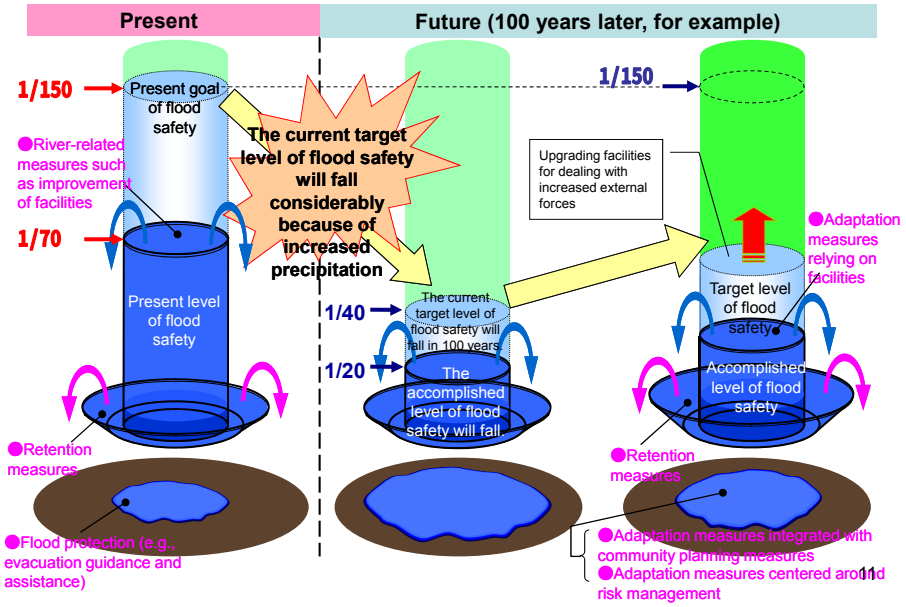
◆Multi-layered flood control measures

・In addition to the flood control measures designed to ensure safety from the design-basis discharge, watershed-based measures are also taken to ensure safety from growing external forces.

10

# Multi-layered flood control measures

(present level of flood safety shown in red) (future level of flood safety shown in blue)



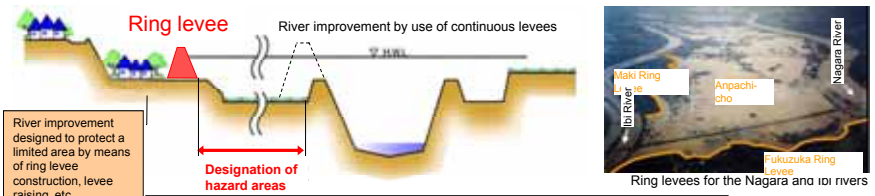



## Adaptation measures implemented in cooperation with local community

**Adaptation measures coordinated with changes in social structure**

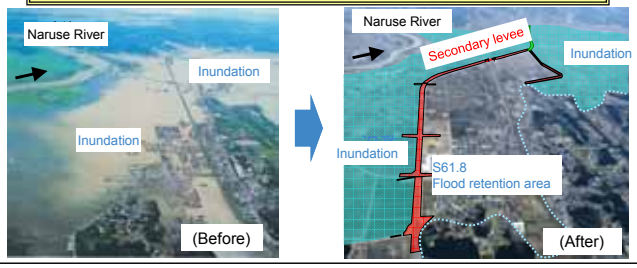
- **Land uses permitting inundation and community planning measures are used to cope with floods beyond the flood control capacity of facilities.**

**Flood damage mitigation measures coordinated with land use regulation and steering**




Ring levees for the Nagara and Ibi rivers

**Inundation control by use of secondary levees, etc., to prevent further expansion of damaged areas**

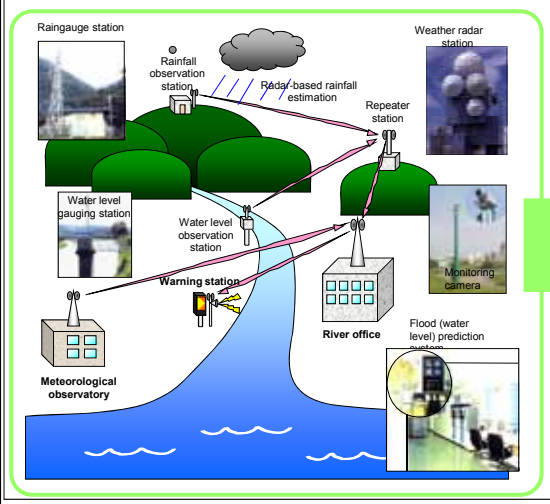


# Adaptation measures centering on risk management

**Integrated damage mitigation and restoration/recovery measures from the viewpoint of risk management**

- **Improving forecasting/warning technology and systems by strengthening observation systems and improving rainfall/runoff prediction technology**

**Improvement of real-time information sharing and flood forecasting by providing rainfall and water level information through cellular phones, Internet, public safety radio communications systems, etc.**




**Providing information through cellular phones and PCs**

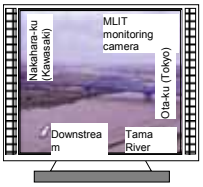
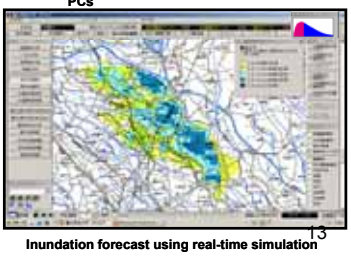



**Image data distribution to TV channels**

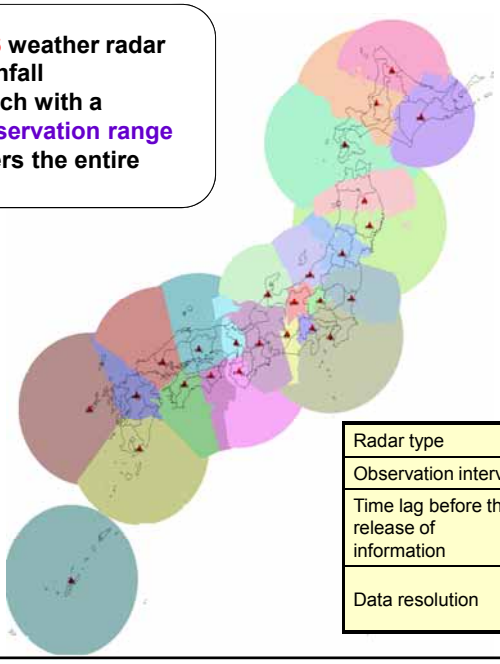


**Inundation forecast using real-time simulation**

13

# Weather Radar Observation Network

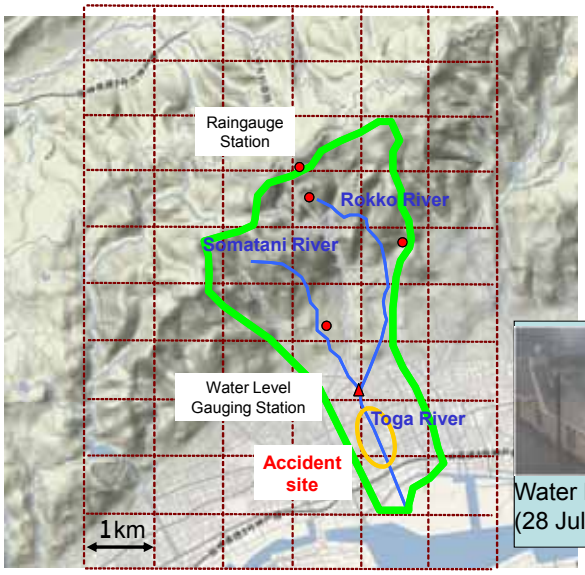
**A network of 26 weather radar systems for rainfall observation, each with a quantitative observation range of 120 km, covers the entire country.**



| | |
|---|---|
| Radar type | C band radar |
| Observation interval | 5 min. |
| Time lag before the release of information | 5 to 10 min. |
| Data resolution | 1km |

14

## An emerging type of disaster caused by localized heavy rain




= C Band Radars' Resolution

- **On July 28, 2008, the Toga River (Class B river) swelled rapidly because of localized heavy rainfalls.**
- **At Kabutobashi, a water level rise of 1.3 m in 10 minutes was observed.**
- **Five people including school children were drowned.**

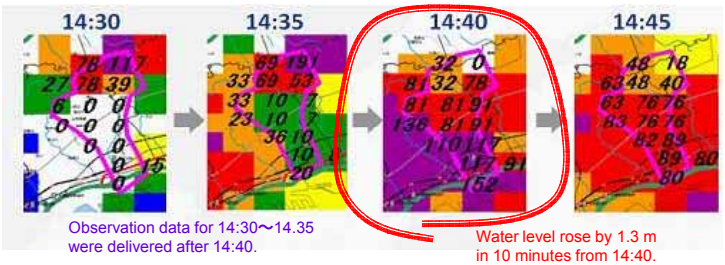
Water level rose 1m34cm in 10 minutes.
(28 July 2008 14:40〜14:50)

Prepared by FRICS Information Development Division

15

## Necessity of radar rainfall observation systems capable of detecting localized heavy rainfalls in urban areas

**Time lag between observation and information delivery**

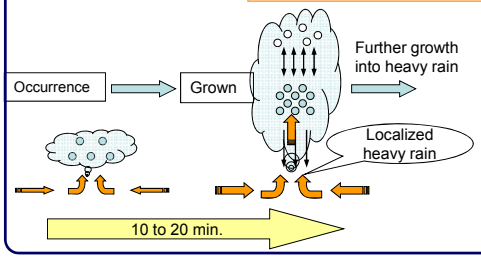



Observation data for 14:30〜14.35 were delivered after 14:40.

Water level rose by 1.3 m in 10 minutes from 14:40.

Prepared by FRICS Information Development Division

**Radar rainfall observation system capable of detecting localized heavy rains**




**Monitoring by use of X band radar**

**(1) Monitoring of "guerilla type" heavy rain that occurs suddenly and grows heavier rapidly**

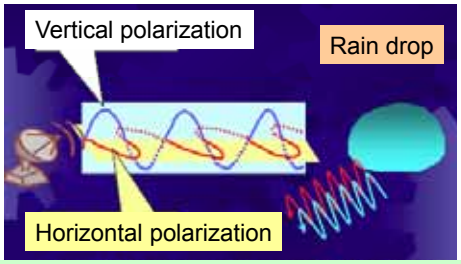
- Spatial resolution of the order of 100 m

**(3) Providing information in real time**

- Updating information at 1 minute intervals

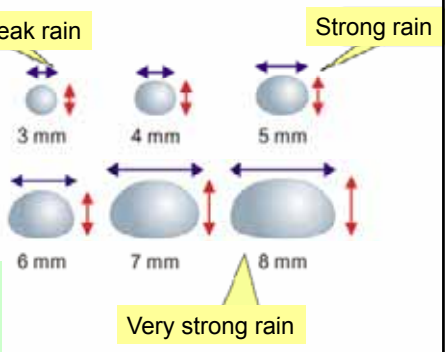
16

# How to monitor the precipitation by X-band MP radar




Since the rain drop is flat, we receive different signals for vertical and horizontal polarization.

→Phase difference is to be generated.



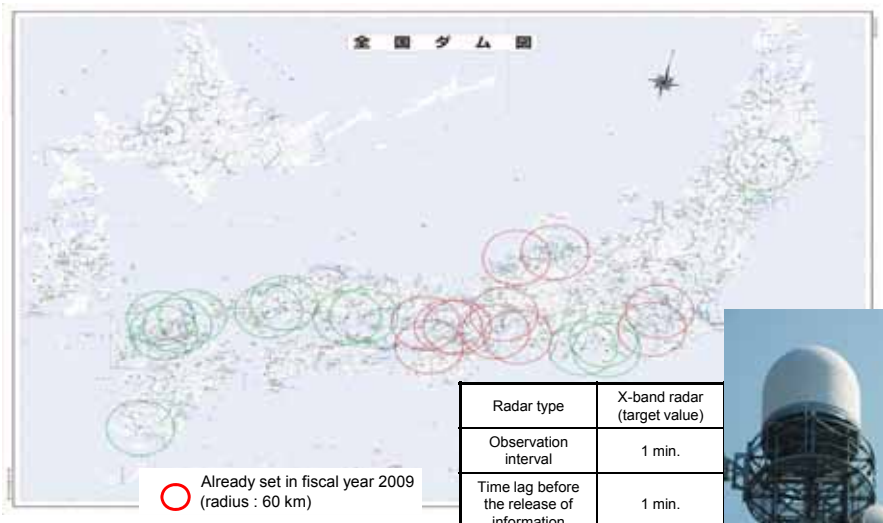

The stronger the rainfall,
The flatter the rain drop.

We estimate the precipitation from the phase difference between vertical and horizontal polarization.
(The bigger the phase difference, the stronger the rainfall)

17

## Development of X-band MP radar network

**26 radar systems will be installed in urban areas in Japan.**



Already set in fiscal year 2009 (radius : 60 km)

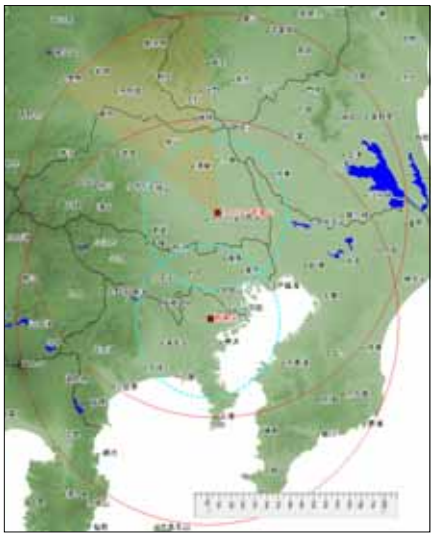
To be set in fiscal year 2010 (same)

| | |
|---|---|
| Radar type | X-band radar (target value) |
| Observation interval | 1 min. |
| Time lag before the release of information | 1 min. |
| Resolution of provided data | 250m |

18

# Monitoring range of X-band MP radar

Near Tokyo



Near Nagoya

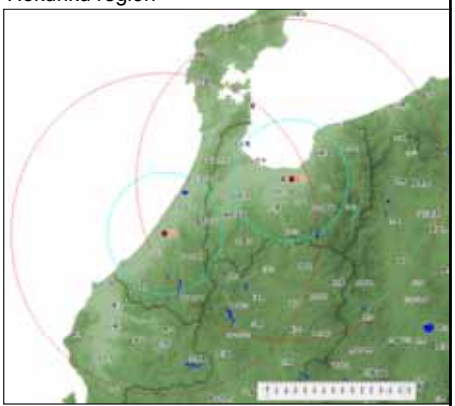
19

Red circle：80km radius Blue circle：30km radius

# Monitoring range of X-band MP radar

Near Osaka

Hokuriku region

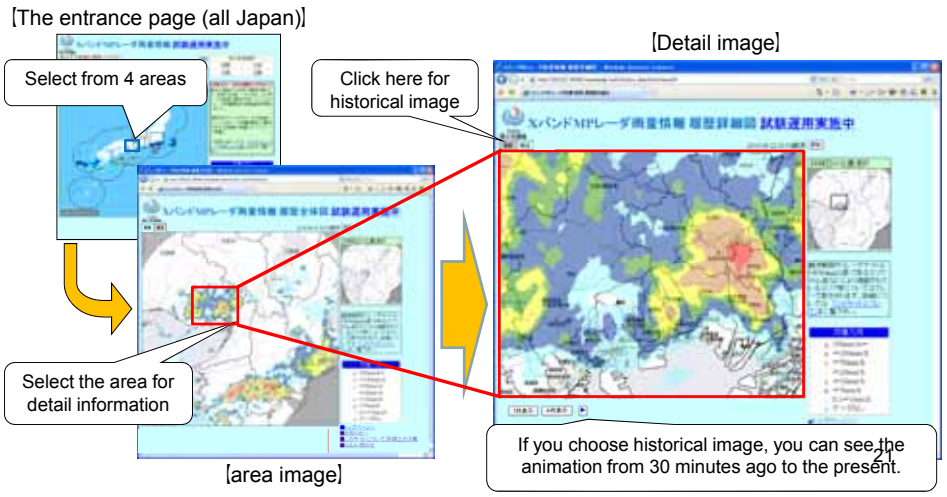


20

Red circle：80km radius Blue circle：30km radius

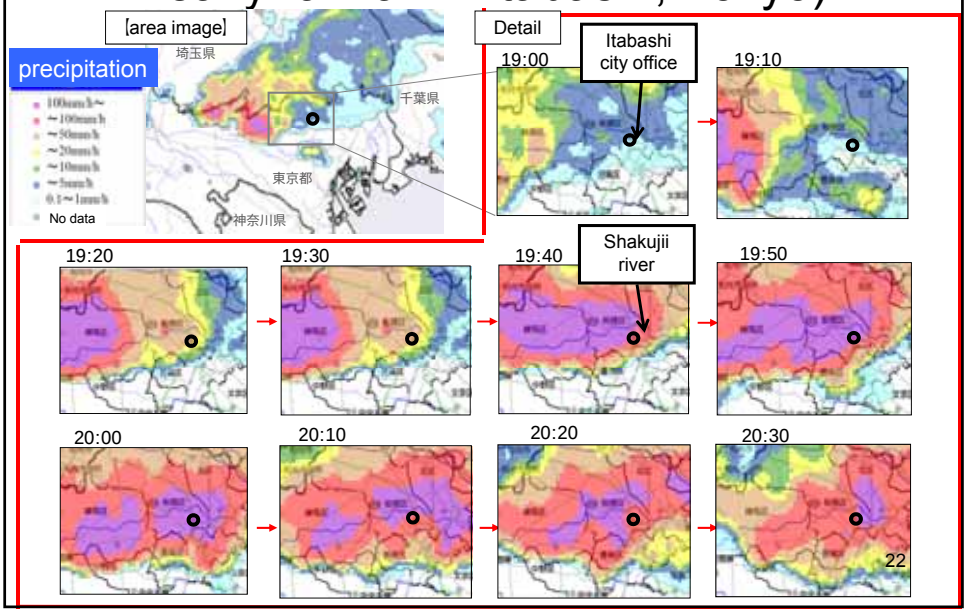
# Provision of X-band MP radar precipitation information on the Web

○In 4 areas, we are providing the precipitation information by X-band MP radars on the Web.
○Real time precipitation distribution (every minute) and historical image (from 30 minutes ago to the present).
○http://www.river.go.jp/xbandradar/



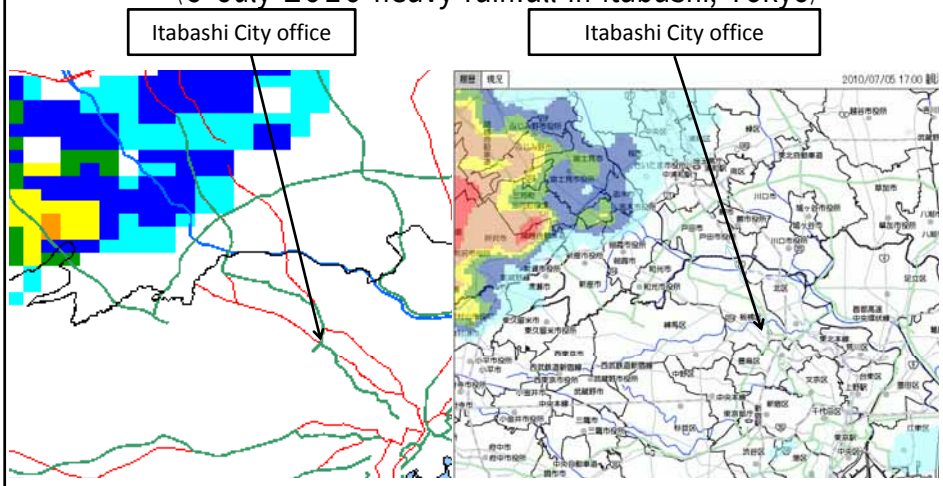

21

# Example (5 July 2010, heavy rainfall in Itabashi, Tokyo)




22

## Comparison between C-band and X-band MP radar
(5 July 2010 heavy rainfall in Itabashi, Tokyo)




C-band radar

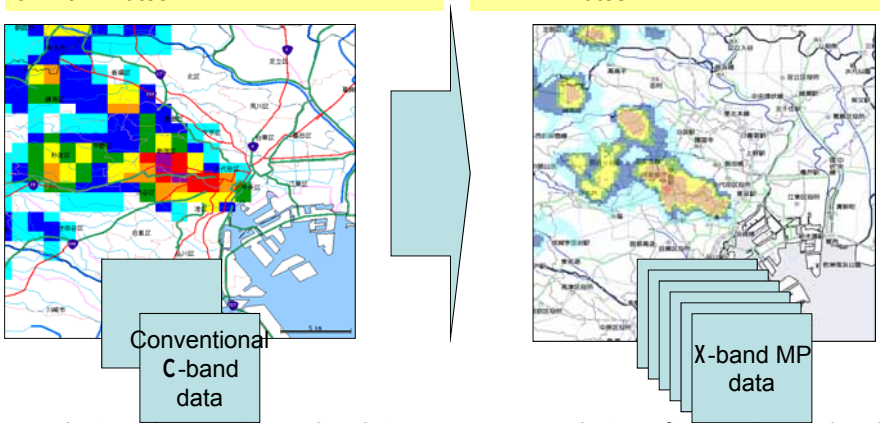
X-band MP radar

23

## Comparison between conventional C-band and X-band MP

Conventional C-band radar observation
Minimum unit: 1km mesh
Interval: 5 minutes
Required time for data distribution:
5〜10 minutes

X-band MP radar observation
Minimum unit: 250m mesh
Interval: 1 minute
Required time for data distribution:
1〜2 minutes




5 minutes after an observation data
→2 observation data are available

5 minutes after an observation data
→6 observation data are available

24

* Observation radius for C-band radar is 120km, for X-band MP 60km.

Prediction on the annual maximum precipitation under the climate change

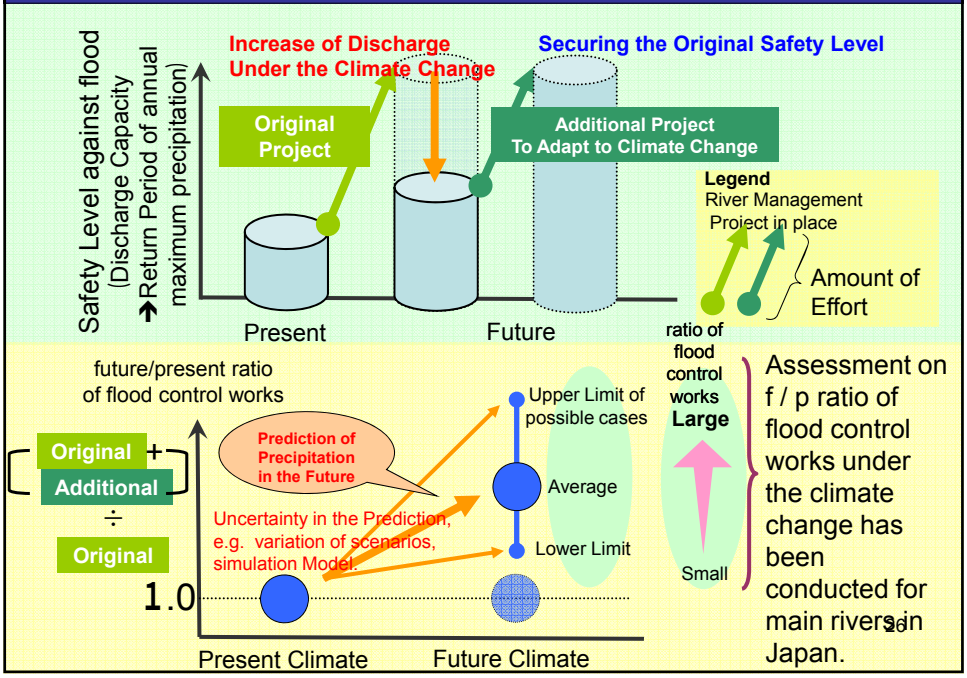
Influence on the flood control works

Grasp the relation between them, and facilitate the debate on the adaptation measures depending on the prediction data under the climate change.

・Introduction of the nationwide, common, and simple measures. →Flood control works index V
・Enable the effective debate depending on the differences among the rivers.
・Apply the measures all over Japan.
・Connect the results to the debate in the field.

25

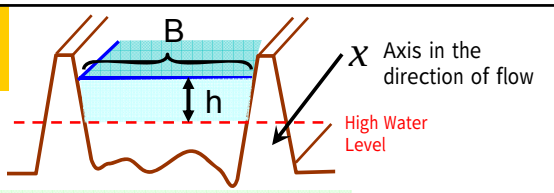
## River Discharge Capacity Assessment under the Climate Change



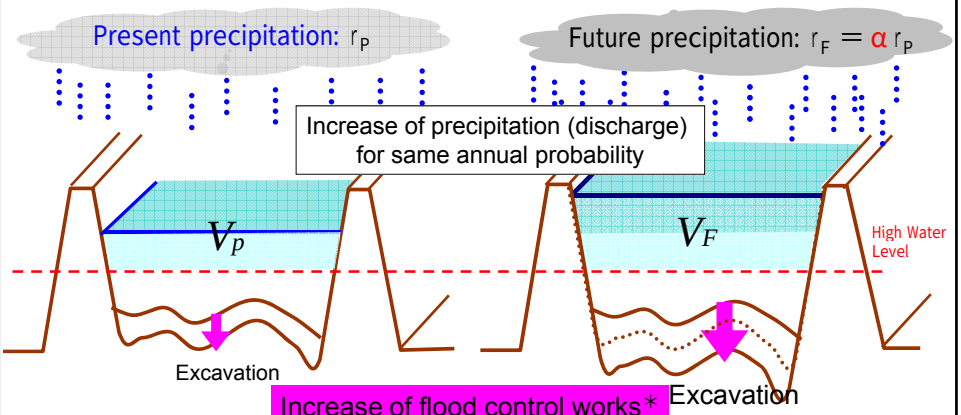

26

## Definition of flood control works index: V

$$V = \int_{\text{total river}} Bhdx$$




## future/present ratio of flood control works: $V_F/V_P$




Increase of flood control works*

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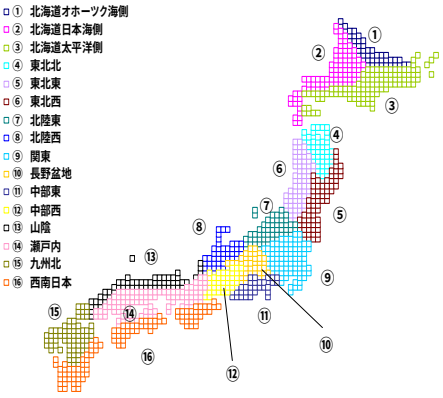
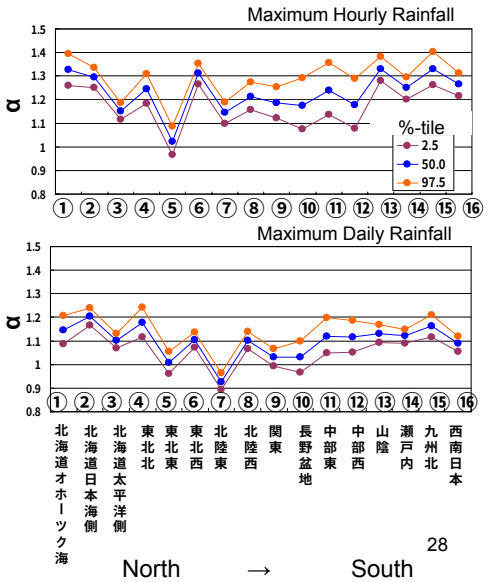
* We can replace "Excavation" by other measures, e.g. relocation of levees, dam construction.

## Increases in maximum hourly and daily precipitation

* Prediction data was provided by Japan Meteorological Research Institute

- **Comparison of the maximum daily precipitations 100 years from now in 16areas in Japan.**
- **Although the ratios of increase vary among the areas, almost all areas show a value greater than one.**




**Future precipitation (the median of the values calculated as shown below) was estimated from**

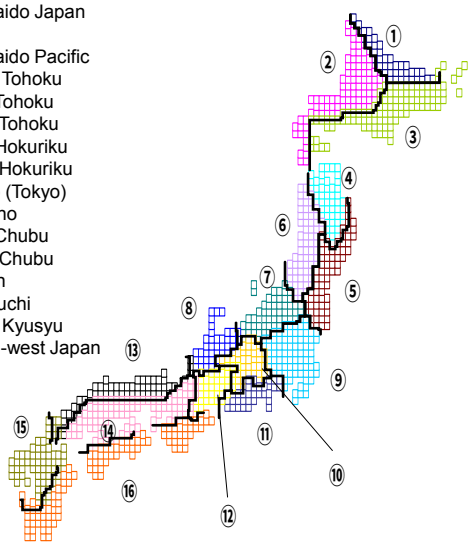
$$\alpha = \frac{\text{2080－2099 average}}{\text{1979－1998 average}}$$

**which was calculated from the maximum hourly and daily precipitations at different survey points obtained from RCM5km (A1B scenario).**

28

## Future/present ration α on the maximum daily precipitation in a year for each region

①Hokkaido Okhotsk
②Hokkaido Japan sea
③Hokkaido Pacific
④North Tohoku
⑤East Tohoku
⑥West Tohoku
⑦East Hokuriku
⑧West Hokuriku
⑨Kanto (Tokyo)
⑩Nagano
⑪East Chubu
⑫West Chubu
⑬San-in
⑭Seto-uchi
⑮North Kyusyu
⑯South-west Japan



| Region | lower | middle | upper |
|---|---|---|---|
| ① | 1.10 | 1.12 | 1.15 |
| ② | 1.18 | 1.19 | 1.21 |
| ③ | 1.25 | 1.27 | 1.28 |
| ④ | 1.20 | 1.22 | 1.25 |
| ⑤ | 1.27 | 1.29 | 1.32 |
| ⑥ | 1.26 | 1.27 | 1.29 |
| ⑦ | 1.13 | 1.15 | 1.17 |
| ⑧ | 1.10 | 1.12 | 1.14 |
| ⑨ | 1.19 | 1.21 | 1.23 |
| ⑩ | 1.01 | 1.03 | 1.05 |
| ⑪ | 1.08 | 1.10 | 1.13 |
| ⑫ | 1.03 | 1.05 | 1.08 |
| ⑬ | 1.05 | 1.07 | 1.08 |
| ⑭ | 0.98 | 0.99 | 1.01 |
| ⑮ | 1.14 | 1.16 | 1.17 |
| ⑯ | 1.05 | 1.06 | 1.07 |

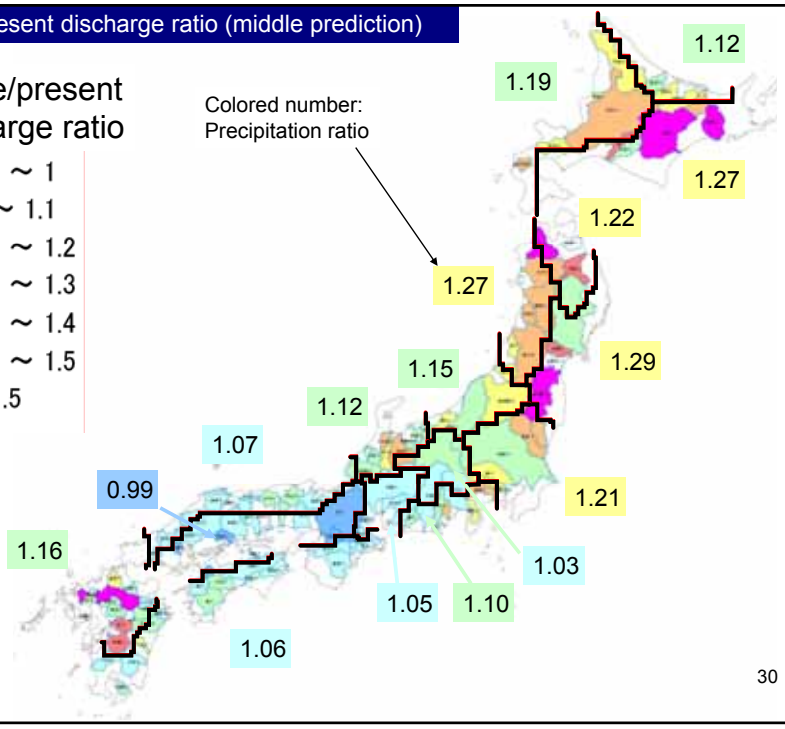
29

## Future / present discharge ratio (middle prediction)

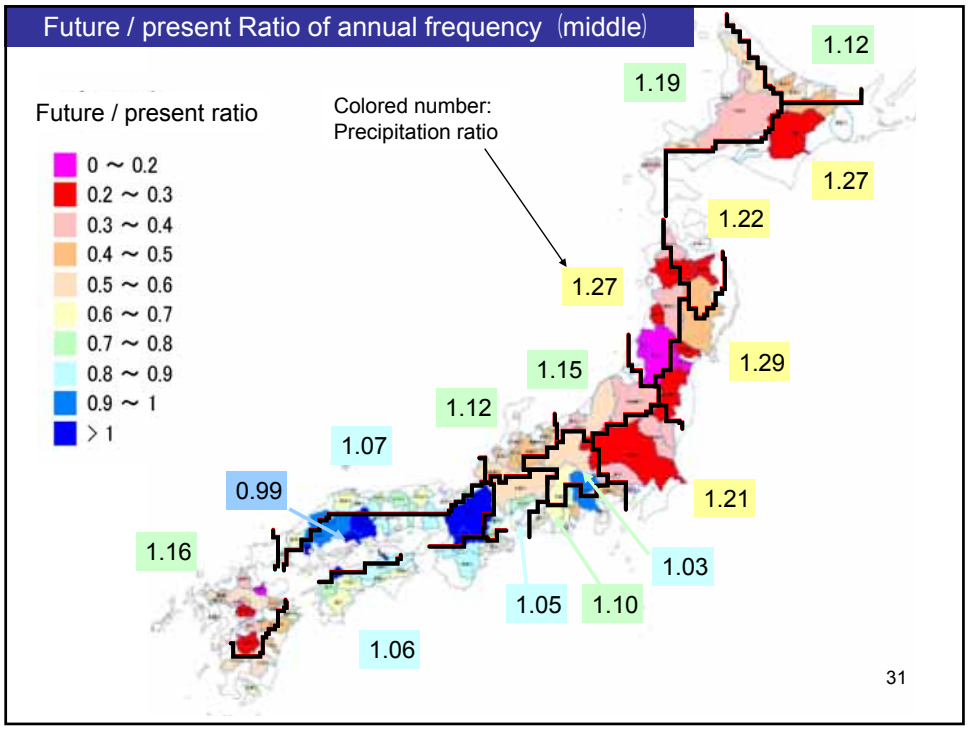
Future/present discharge ratio

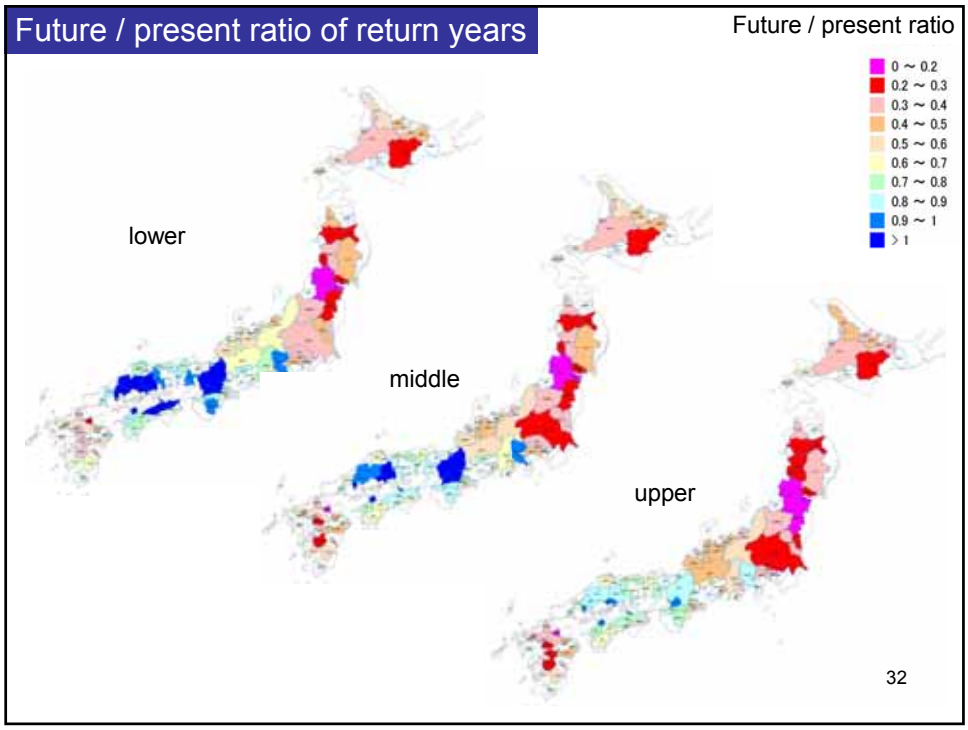
- 0.9 ～ 1
- 1 ～ 1.1
- 1.1 ～ 1.2
- 1.2 ～ 1.3
- 1.3 ～ 1.4
- 1.4 ～ 1.5
- ＞ 1.5

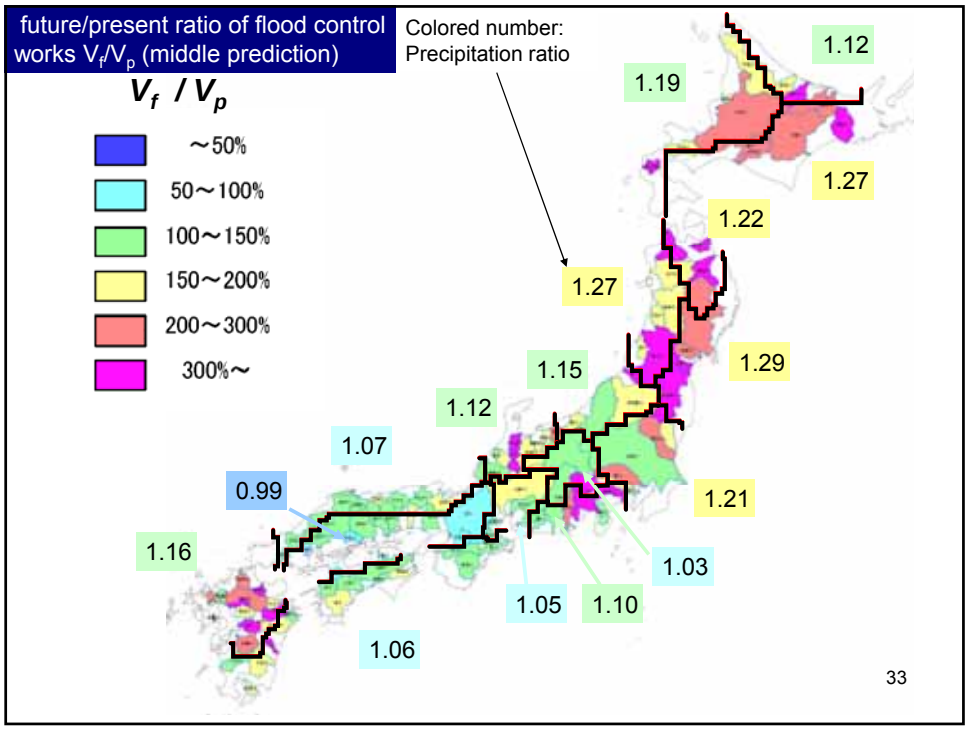
Colored number: Precipitation ratio

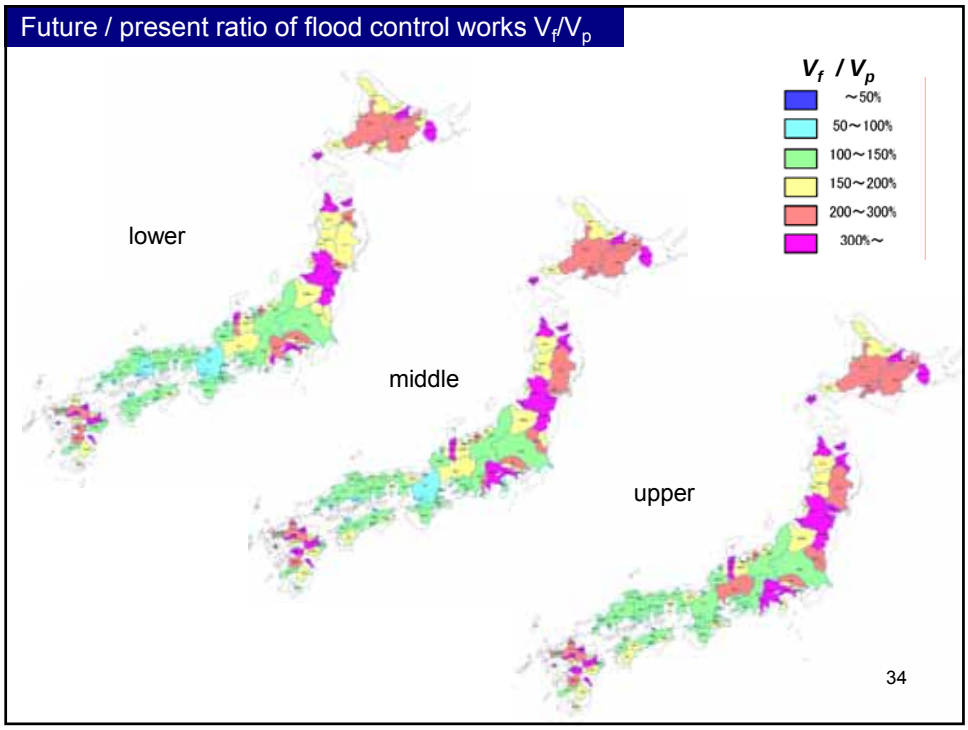



30

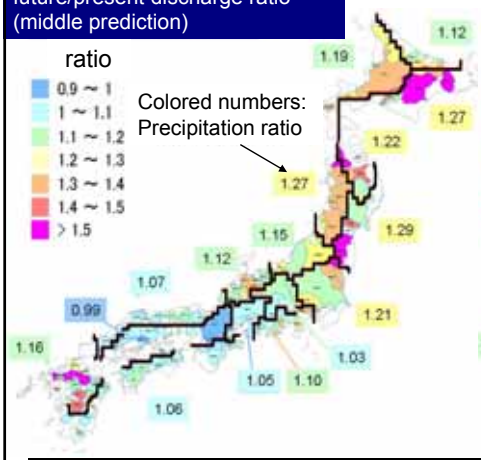

Future / present Ratio of annual frequency (middle)
Future / present ratio
0 ～ 0.2
0.2 ～ 0.3
0.3 ～ 0.4
0.4 ～ 0.5
0.5 ～ 0.6
0.6 ～ 0.7
0.7 ～ 0.8
0.8 ～ 0.9
0.9 ～ 1
> 1
Colored number:
Precipitation ratio
1.12
1.19
1.27
1.22
1.27
1.29
1.15
1.12
1.07
0.99
1.21
1.16
1.03
1.05
1.10
1.06
31


Future / present ratio of return years
Future / present ratio
0 ～ 0.2
0.2 ～ 0.3
0.3 ～ 0.4
0.4 ～ 0.5
0.5 ～ 0.6
0.6 ～ 0.7
0.7 ～ 0.8
0.8 ～ 0.9
0.9 ～ 1
> 1
lower
middle
upper
32

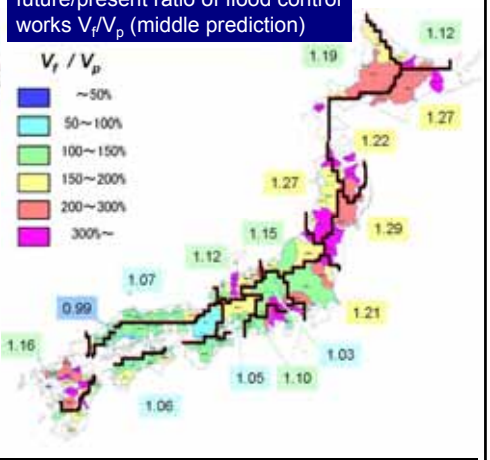

future/present ratio of flood control works $V_f/V_p$ (middle prediction)
Colored number:
Precipitation ratio
$V_f$ / $V_p$
～50%
50～100%
100～150%
150～200%
200～300%
300%～
1.12
1.19
1.27
1.22
1.27
1.29
1.15
1.12
1.07
0.99
1.21
1.16
1.03
1.05
1.10
1.06
33


Future / present ratio of flood control works $V_f/V_p$
$V_f$ / $V_p$
～50%
50～100%
100～150%
150～200%
200～300%
300%～
lower
middle
upper
34

future/present discharge ratio (middle prediction)




future/present ratio of flood control works $V_f/V_p$ (middle prediction)




| | | Precipitation ratio **α** (result of A1B scenario, GCM20) | Discharge ratio | Future/present ratio of flood control works $V_f/V_p$ |
|---|---|---|---|---|
| Average of all basins (from 2080 to 2099) | Lower prediction | 1.07 | 1.10 | 1.50 |
| | Middle prediction | 1.12 | 1.20 | 1.75 |
| | Upper prediction | 1.18 | 1.30 | 2.05 |

35

# Ⅴ-4. Lecture

# “New Role of Sewerage System in the Low-carbon Society”

Mr. Masashi OGOSHI

# New Roles of Sewerage System for the Low-Carbon Society

National Institute for Land and Infrastructure Management


## Outline

- Progress and Current status / future trend of wastewater treatment and reuse
- New roles of sewerage system for the low-carbon society
  - Reduce GHG emission by N2O control
  - Reduce GHG emission utilizing bio-mass energy
  - Waste heat recovery from sewage

2

## WATER RESOURCES

Limited affordable water resources

- 97.47 % - Sea Water
- 1.76 % - Glacier
- 0.76 % - Ground Water
- 0.01% - Surface Water
- = 0.1 million $km^3$

(2003)

3

## ARTIFICIAL WATER SYSTEM

Water Works

&

Sewer Works

Water treatment

&

Wastewater treatment

4

## PROGRESS OF WASTEWATER TREATMENT

19C SS removal

↓

20C BOD removal by CAS

↓

Nitrogen and Phosphorus removal by Modified AS

5

## CONTROL OF INFECTIOUS MICROORGANISMS

Disinfection by Chlorination

Indicator Organism

Total Coliforms ～ bacteria ～ fecal pollution

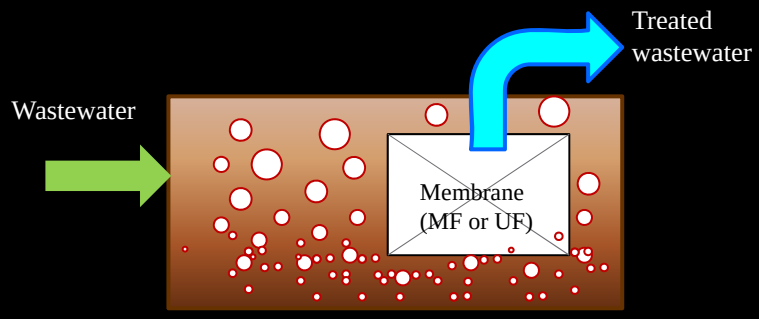
Diarrhea / Protozoan or Viral

appropriate indicator unknown

High removal rate by MBR

6

## MBR




Activated Sludge Reactor

CAS, BNR, AO, A2O

7

## WATER REUSE /RECYCLE

### Cascade type

Tap → Miscellaneous use → reclamation → toilet flushing → Sewer → MWTP → irrigation → natural waters

### Recycle type

Sewer → Satellite purification → Miscellaneous uses → Sewer → MWTP → miscellaneous water pipe → toilet flushing → Sewer

8

## PROGRESS OF WASTEWATER TREATMENT

SS removal
↓
BOD removal by CAS
↓
Nitrogen and Phosphorus removal by Modified AS
↓
Microorganisms, Virus, and
DOM (Pesticide, PCB, Dioxin, EDs., etc. ) removal
by Membrane
MF NF RO
Smaller < energy < Larger

9

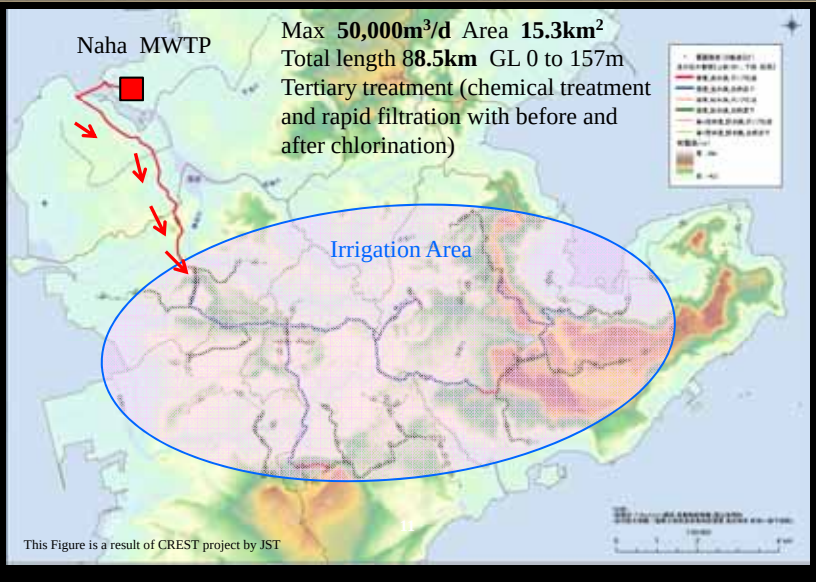
## ENERGY SAVING WATER REUSE /RECYCLE

River/Lake – Aqueduct – Purification Center – Water pipe – Distribution Pond – Service pipe – Tap - - - - - Drain – Sewer – MWTP – Public water

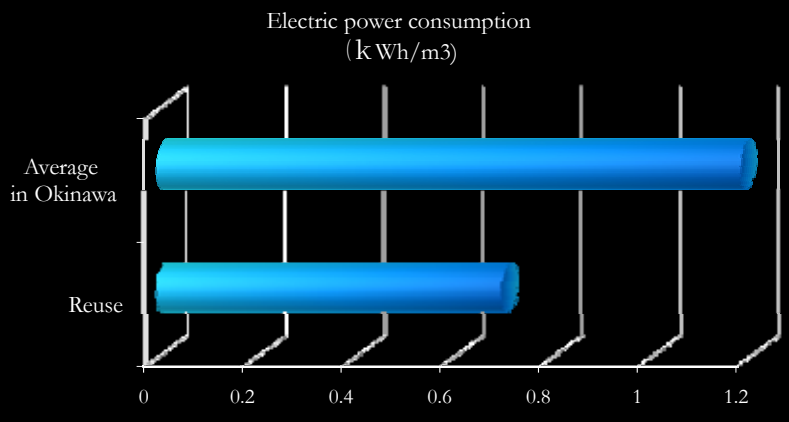
Reuse treated wastewater
&
Save fresh water
Save energy for water transport
Save energy for water treatment
Regenerate water environment down stream the intake point

10

## ESTIMATION OF ENERGY CONSUMPTION IN OKINAWA WATER REUSE FOR IRRIGATION



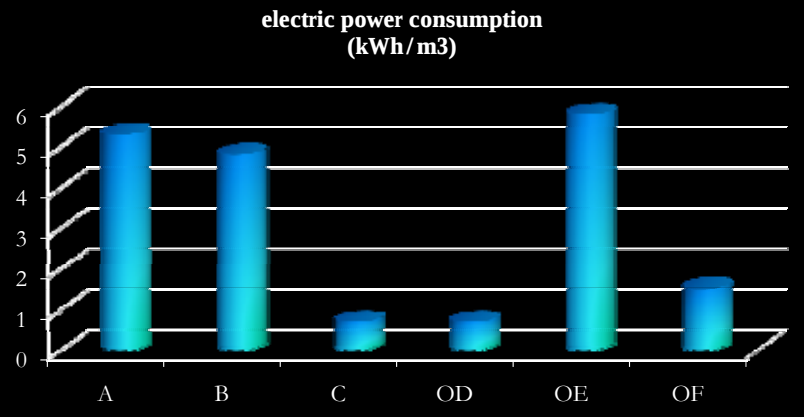

## RESULT OF ESTIMATION IN OKINAWA




Average Energy Consumption for water supply in Japan 0.55 kWh/m3

This figure is a result of a CREST project in 2009 by JST

## OTHER EXAMPLE OF ENERGY CONSUMPTION FOR WATER REUSE

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## CONCLUSION OF WASTEWATER TREATMENT AND WATER REUSE

- We can control the water pollution due to excess BOD, Nitrogen and Phosphorus.
- We have still difficulties to control the pollution caused by pharmaceuticals and chemicals.
- Upgrading of wastewater treatment makes it easy to use the reclaimed water, especially application of membrane technologies. But membrane separation consumes a lot of energy.
- We have begun the study about energy saving new water system which is constructed by water works, sewer works and water reuse. Thinking about these 3 systems as one water system, it will be possible to get more efficient water utilizing system.
- Existing water reuse systems are not energy saving itself alone.

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## GLOBAL WARMING & SEWERAGE AFFECT TO WATER UTILIZATION

Increase of drought & flood

Increase of irrigation water for food production

Increase of water consumption in urban area related to temperature rising

↓

Increase of water needs

↓

Increase of assist by water reuse

15

## MITIGATION OF GLOBAL WARMING BY SEWER WORKS

### 1. Reduce GHG emission from sewerage works.

The major source of GHG emission in the MWTP is electric power consumption.

* Exchange energy saving machines from old and inefficient things.
* Refine control system to the smart one that works to reduce inefficient operation.

etc.

2nd big source is the furnace for sewage sludge incineration.

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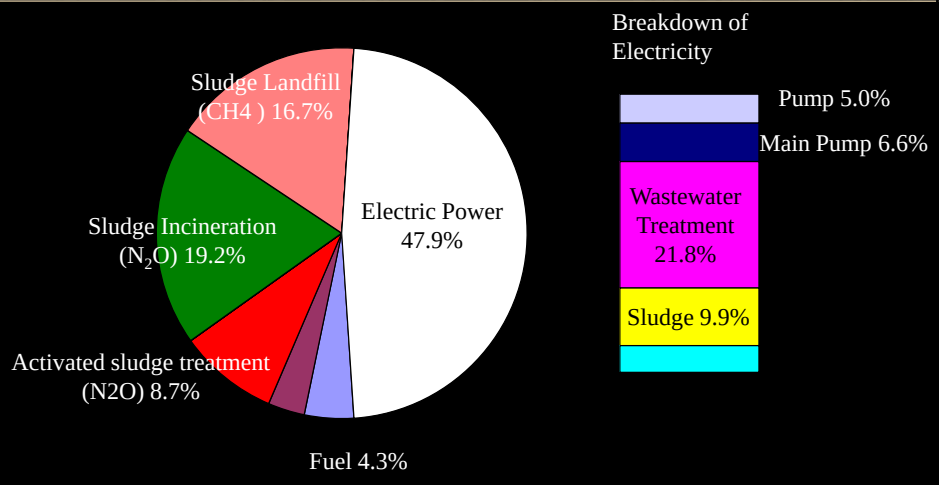
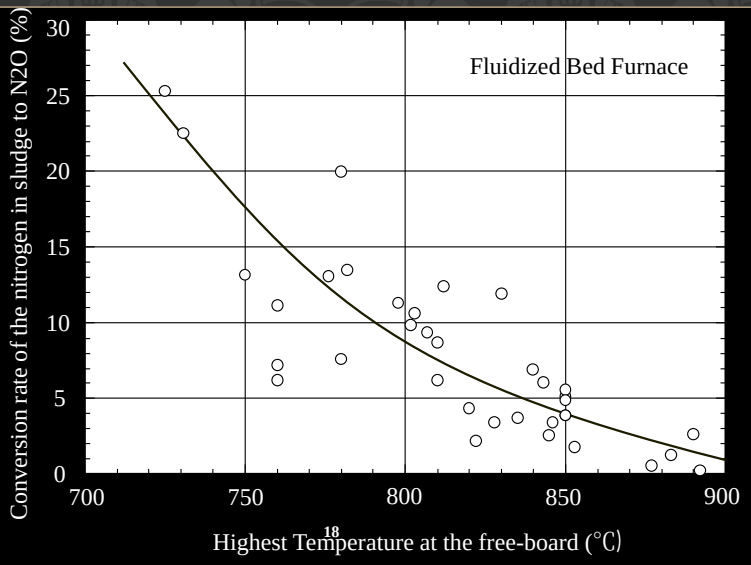
## GHG EMISSION IN MWTP



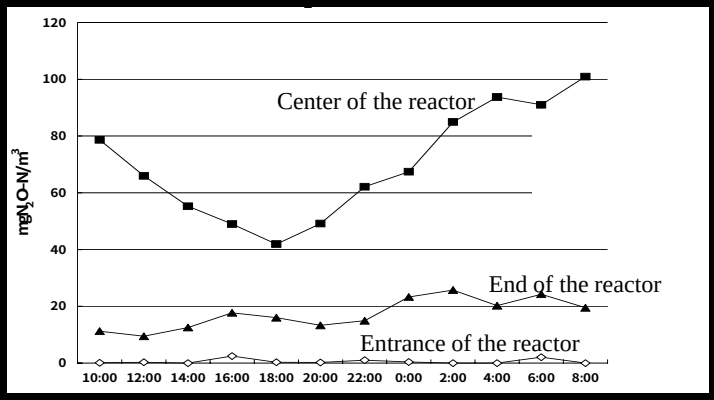

17

## REDUCTION OF GHG EMISSION FROM MWTP




18

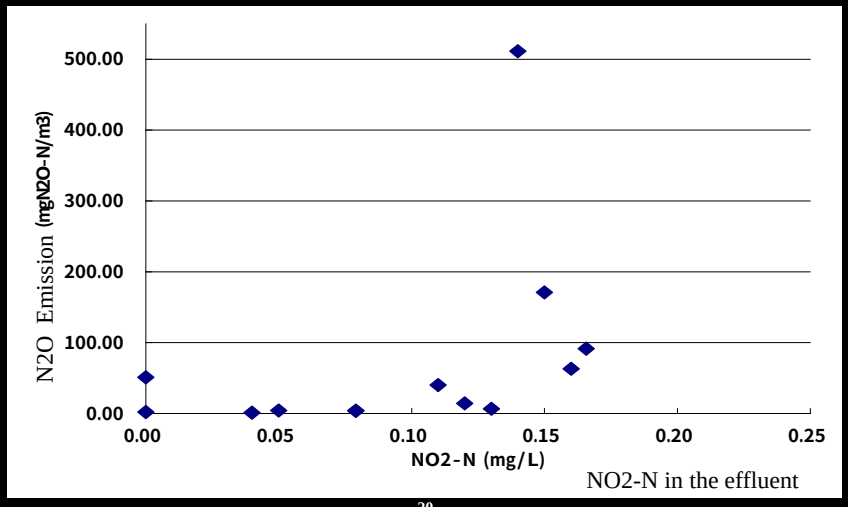
## HOW TO CONTROL N2O FROM AERATION TANK




Time(hr)

19

## HOW TO CONTROL N2O FROM AERATION TANK




NO2-N in the effluent

20

## EFFECTIVE USE OF BIOMASS ENERGY

Sewerage sludge is a bio-mass.

**2. Use sewerage sludge as an energy resource and reduce fossil fuel utilization.**

As Methane gas from Anaerobic digester
Additional biomass
House garbage,
Plant branches and leaves
Etc.

21

## SLUDGE TREATMENT AND UTILIZATION

BOD, SS etc. are exchanged to sludge and removed from wastewater.

Thickening 2% solid 98% water → Anaerobic Digestion

**Methane Gas**

Dewatering, 20% solid 80% water → Composting, etc.

**Fertilizer**

Incineration

Landfill

**RDF**

**Bio Gass**

**Carbonization**

22

## EFFECTIVE USE OF BIOMASS ENERGY


## OTHER GHG REDUCING TECHNOLOGY OF SEWERAGE

# 3. Waste Heat Recovery using sewer system

Waste Heat dispose to sewage

Sewerage transport waste heat

Heat Recovery from sewage

Areal Heating and Air-Conditioning Center
Office, Factory, Shops, etc.

24

## CONCLUSION

About the control of GHG emission from sewerage system, we knew that

The temperature of the free-board in fluidized bed furnace should be higher than 850 ℃.

The nitrite nitrogen concentration in the secondary effluent should be less than 0.1mg/L.

We have seen various technologies to use bio-mass energy efficiently.

Combine with local biomass and sewage sludge, MWTP is possible to become a areal center of the low-carbon society.

Thank you for your kind attention.

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# Ⅴ-5. Lecture

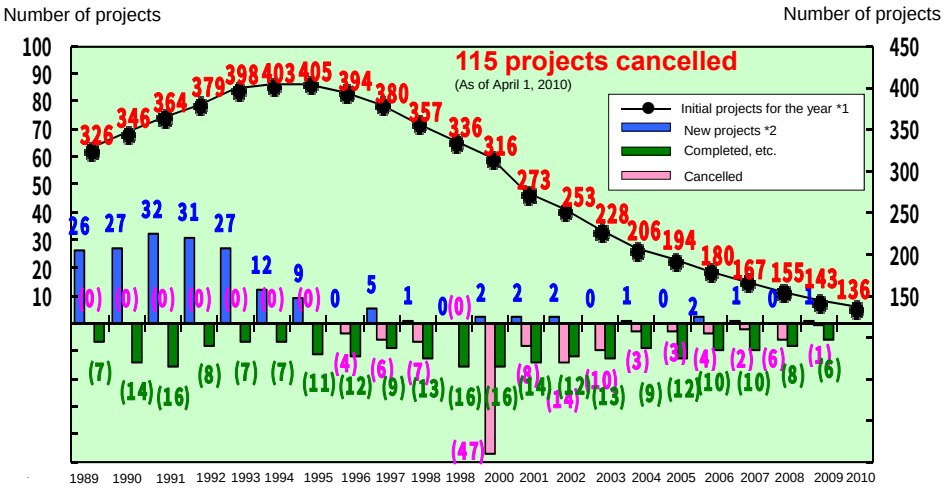
# “Newly-Proposed Operation Rules against Floods Exceeding Design”

Mr. Shinya MITSUISHI

# Newly-Proposed Operation Rules against Floods Exceeding Design.

Head of Water Management and Dam Division, River Department,
National Institute for Land and Infrastructure Management
Ministry of Land Infrastructure, Transport and Tourism, Japan
Dr Shinya Mitsuishi (D.Eng)

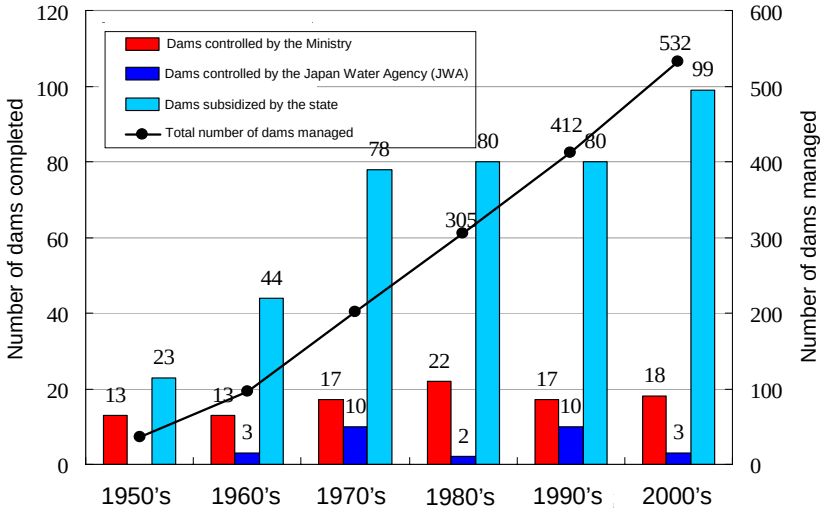
## Dam Projects in Japan




*1 The number of projects implemented does not include projects in liquidation due to cancellation, existing ones during amortization by the Japan Water Agency, and those during refund of construction contribution of power suppliers, etc.
*2 The number of new projects does not include the total of new site investigation and new construction (changes in projects such as transition from site investigation to construction and from normal subsidized projects to those of reservoirs for domestic use.)

2

# Dam Management in Japan




3

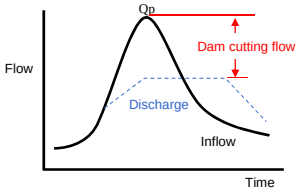
# Basic Principles for Flood Control Operations

1. Reliable operations and definite effect
2. Ensured safety (safety of downstream rivers and facilities including dams)
3. Prompt response to flood changes
4. Per-flood adaptation and effect maximization

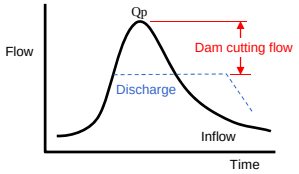
4

# Dam Flood Control Methods in Japan

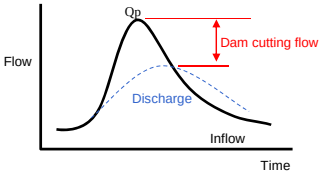
**Constant rate/amount discharging method**



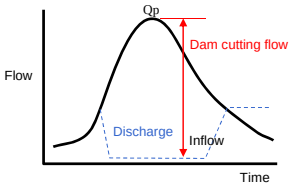

**Constant discharging method**




**Natural regulation method** (No gate or constant opening)




**Inconstant rate regulation method**




Constant rate/amount discharging method to be used in major dams

5

# Dam Operations for Excess Floods

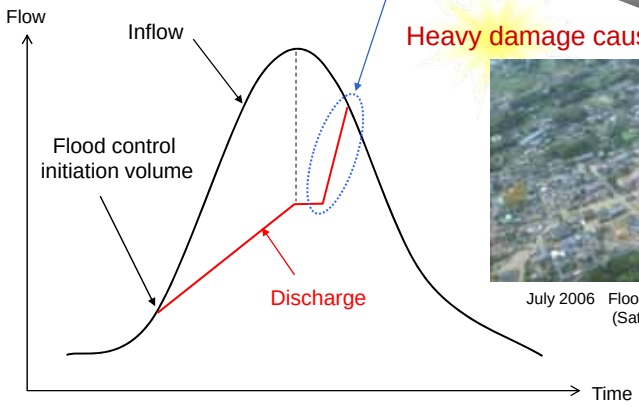
**Special discharge operations**

(Discharge volume is matched to inflow volume in response to insufficient dam capacity)

**Significant increase in discharge**

**Heavy damage caused**

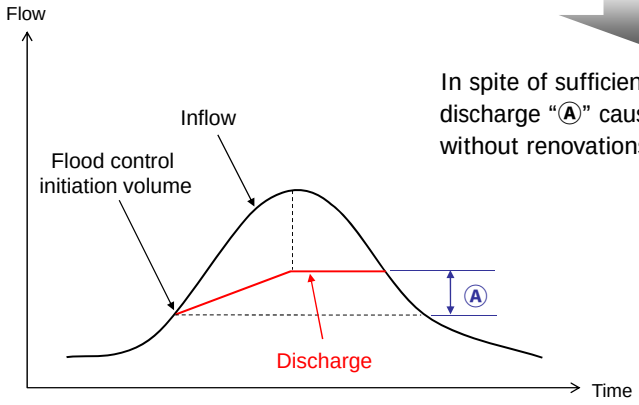
July 2006 Flood inundation in the Sendai River (Satsuma, Torai district)




6

# Dam Operations for Smaller Floods

Flood control initiation volume :
Set based on the discharge capacity in sections without renovations




In spite of sufficient dam capacity, discharge "Ⓐ" causes damage in sections without renovations.

7

# Dam Flood Control Utilizing Rainfall Prediction

Aim: To minimize discharge volumes by predicting total dam inflow volumes, based on rainfall predictions, and comparing this to available dam capacity

- Predict rainfall in area upstream from dam using WRF 48-hour rainfall prediction
- Deal with rainfall events much higher and lower than the rainfall prediction by setting large and small errors in the WRF model
- Accurately determine effective rainfall (runoff) volume by calculating basin infiltration capacity, including initial rainfall loss and ground water retention capacity
- Manage flood control capacity and water use capacity in an integrated manner
- Decide dam operations to apply by comparing predicted inflow volume with available dam capacity
- Minimize damage to downstream area by maximum utilization of available dam capacity

8

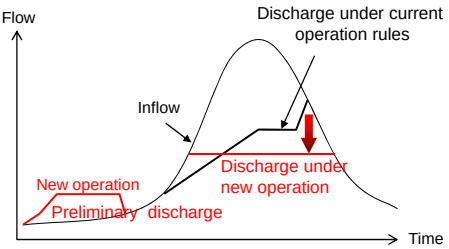
# Merits of Dam Operation Methods Using Rainfall Prediction

If rainfall prediction is utilized...

### *Against excess floods*

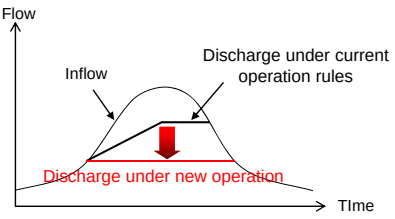
Preliminary discharge to secure greater flood control capacity together with constant discharging will lead to a reduction of maximum discharge volume, minimizing damage.

The ability to predict rainfall enables us to utilize water use capacity for flood control.



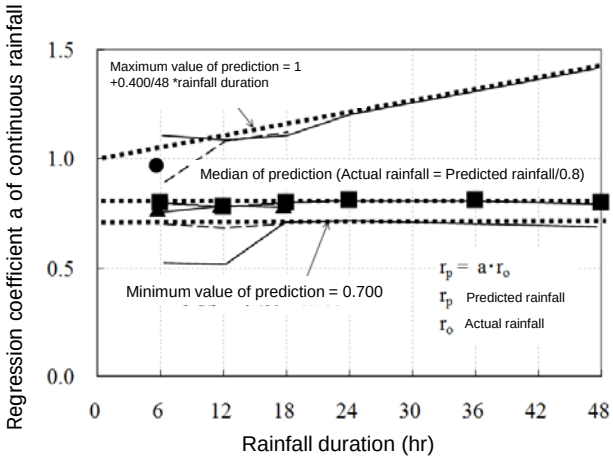

### *Against smaller floods*

In cases where flood control capacity is deemed to exist, downstream damage can be eliminated by proactively storing flood water in this flood control capacity.




9

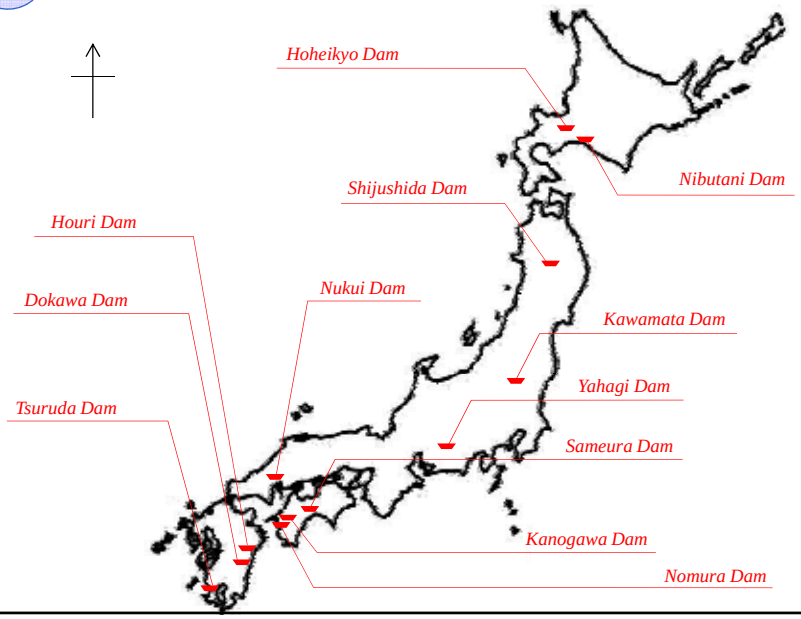
# Setting of Errors in Rainfall Prediction




Relation between rainfall duration and predicted rainfall/actual rainfall

10

# Simulation Conducted for 12 Dams




11

# Summary of Simulation Results

| Name of dam | Number of cases examined | Value used to judge suitable operation | The discharge operation at a constant rate upto the harmless discharge rate was conducted | Preliminary discharge took place | The discharge operation above the harmless discharge rate took place | The discharge rate exceeded the design maximum discharge rate | The dam capacity was completely used up |
|---|---|---|---|---|---|---|---|
| Hoheikyo | 12 | maximum | 11 | 0 | 1 | 1 | 1 |
| | | prediction | 11 | 0 | 1 | 1 | 1 |
| | | minimum | 11 | 0 | 1 | 1 | 1 |
| | | Actual operation | 9 | 0 | 3 | 1 | 0 |
| Shijyushida | 7 | maximum | 6 | 4 | 1 | 0 | 0 |
| | | prediction | 6 | 2 | 1 | 0 | 0 |
| | | minimum | 7 | 0 | 0 | 0 | 0 |
| | | Actual operation | 4 | 0 | 3 | 0 | 0 |
| Kawamata | 6 | maximum | 6 | 0 | 0 | 0 | 0 |
| | | prediction | 6 | 0 | 0 | 0 | 0 |
| | | minimum | 6 | 0 | 0 | 0 | 0 |
| | | Actual operation | 5 | 0 | 1 | 1 | 0 |
| Yahagi | 14 | maximum | 13 | 10 | 1 | 0 | 0 |
| | | prediction | 13 | 1 | 1 | 0 | 1 |
| | | minimum | 14 | 0 | 0 | 0 | 1 |
| | | Actual operation | 8 | 0 | 6 | 1 | 0 |
| Nukui | 4 | maximum | 4 | 0 | 0 | 0 | 0 |
| | | prediction | 4 | 0 | 0 | 0 | 0 |
| | | minimum | 4 | 0 | 0 | 0 | 0 |
| | | Actual operation | 3 | 0 | 1 | 0 | 0 |
| Sameura | 10 | maximum | 9 | 1 | 1 | 0 | 1 |
| | | prediction | 9 | 0 | 1 | 0 | 1 |
| | | minimum | 9 | 0 | 1 | 0 | 1 |
| | | Actual operation | 5 | 0 | 5 | 0 | 0 |

| Name of dam | Number of cases examined | Value used to judge suitable operation | The discharge operation at a constant rate upto the harmless discharge rate was conducted | Preliminary discharge took place | The discharge operation above the harmless discharge rate took place | The discharge rate exceeded the design maximum discharge rate | The dam capacity was completely used up |
|---|---|---|---|---|---|---|---|
| Tsuruda | 11 | maximum | 3 | 11 | 8 | 1 | 1 |
| | | prediction | 7 | 9 | 4 | 1 | 2 |
| | | minimum | 5 | 3 | 6 | 1 | 5 |
| | | Actual operation | 0 | 0 | 11 | 1 | 0 |
| Nibutani | 1 | maximum | 0 | 1 | 1 | 1 | 1 |
| | | prediction | 0 | 0 | 1 | 1 | 1 |
| | | minimum | 0 | 0 | 1 | 1 | 1 |
| | | Actual operation | 0 | 0 | 1 | 1 | 1 |
| Kanogawa | 1 | maximum | 0 | 1 | 1 | 0 | 0 |
| | | prediction | 0 | 0 | 1 | 0 | 1 |
| | | minimum | 0 | 0 | 1 | 0 | 1 |
| | | Actual operation | 0 | 0 | 1 | 0 | 1 |
| Nomura | 1 | maximum | 1 | 1 | 0 | 0 | 0 |
| | | prediction | 1 | 1 | 0 | 0 | 0 |
| | | minimum | 0 | 0 | 1 | 0 | 0 |
| | | Actual operation | 0 | 0 | 1 | 0 | 0 |
| Dokawa | 1 | maximum | 0 | 1 | 1 | 1 | 0 |
| | | prediction | 0 | 0 | 1 | 1 | 0 |
| | | minimum | 0 | 0 | 1 | 1 | 1 |
| | | Actual operation | 0 | 0 | 1 | 1 | 0 |
| Hohri | 1 | maximum | 0 | 0 | 1 | 1 | 1 |
| | | prediction | 0 | 0 | 1 | 1 | 1 |
| | | minimum | 0 | 0 | 1 | 1 | 1 |
| | | Actual operation | 0 | 0 | 1 | 1 | 1 |
| Total | 69 | maximum | 53 | 30 | 16 | 5 | 5 |
| | | prediction | 57 | 13 | 12 | 5 | 8 |
| | | minimum | 56 | 3 | 13 | 5 | 12 |
| | | Actual operation | 34 | 0 | 35 | 7 | 3 |

12

# Patterns in Simulation Results

### Cases of maximum values used

Many cases with preliminary discharge operations or discharges at volumes above harmless flow volumes

### Cases of minimum values used

Many cases where entire dam capacity was spent completely

### 50 or so cases of smaller floods

Discharges limited to harmless discharge volumes by carrying out preliminary discharges and so on
(Actual discharge operations at harmless volumes were only conducted in 34 flood events)

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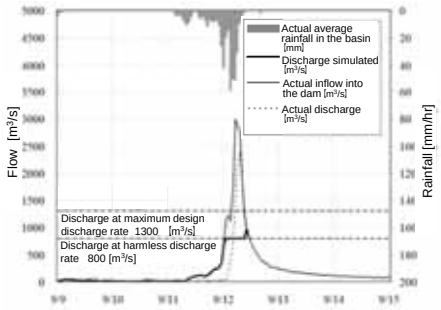
# Simulation Results in Case of Excess Flood




Simulation result of flood in Yahagi Dam as of Sep. 2000

A comparison of operations utilizing the WRF model and actual operations

| Name of Dam | Time of flood | Maximum inflow ($m^3/s$) | Maximum discharge($m^3/s$) | | volume reduced ($m^3/s$) |
|---|---|---|---|---|---|
| | | | Actual | WRF use | |
| *Yahagi Dam* | H12.9 | 2,993 | 2,378 | 974 | 1,404 |
| *Nibutani Dam* | H15.8 | 5,959 | 5,489 | 5,000 | 489 |
| *Dokawa Dam* | H16.8 | 1,005 | 827 | 712 | 115 |

Appropriate preliminary discharge operation and decision to maximize discharge

Reduction of maximum discharge and significant mitigation of damage

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# Application in Actual Dam Management

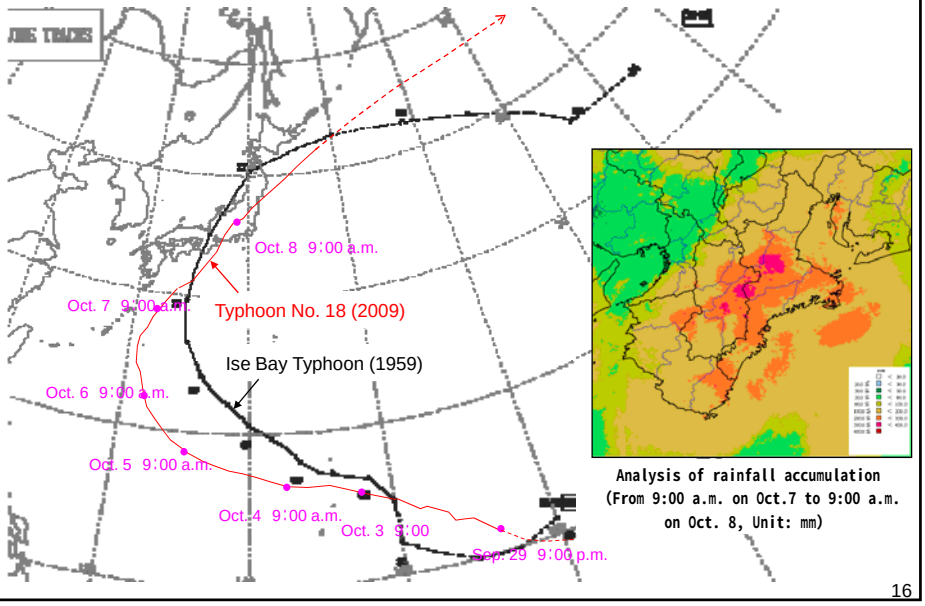
## Integrated operations at the three dams in the Nabari River upstream area

- Heavy rain predicted in October 2009 from typhoon No. 18.
- Possible inundation of the downstream river area even if routine operating regulations were exercised at the three dams managed by the JWA
- The Ministry of Land, Infrastructure, Transport & Tourism instructed the 3 dam management offices to store above-operating regulation levels of flood water in the dams (called 'integrated dam operations')
- Flood damage in the urban area of Nabari City avoided

A photograph of Nabari Ohashi downstream in the Nabari River, taken on Oct. 8, 6:34)

15

# Course of the Ise Bay Typhoon (in 1959) and the Typhoon No. 18 (in 2009)

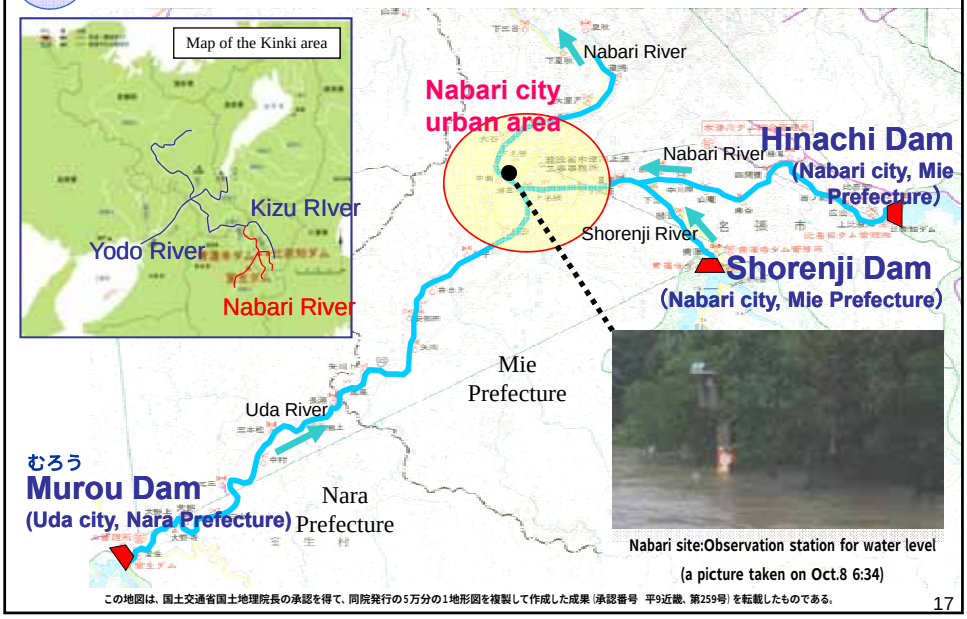





Analysis of rainfall accumulation (From 9:00 a.m. on Oct.7 to 9:00 a.m. on Oct. 8, Unit: mm)

16

# Location of Nabari City and Three Dams



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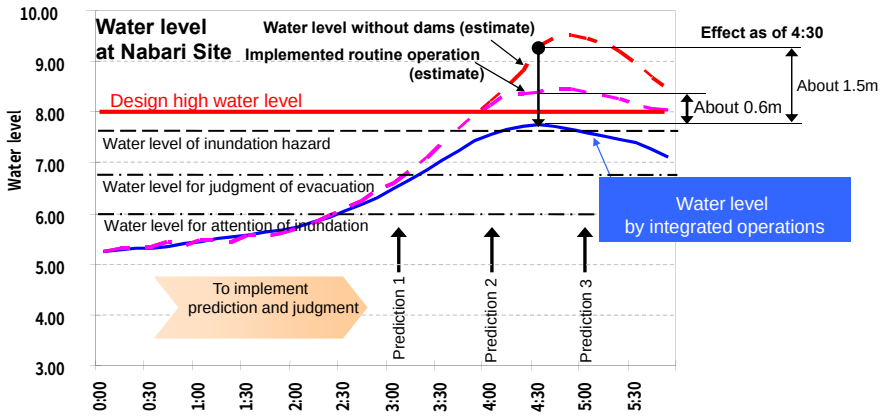
# Overview of Integrated Operations by the Three Dams

Each routine dam operation based on control regulations could cause inundation of the Nabari River, which threatened to exceed the design high water level at the Nabari Site.

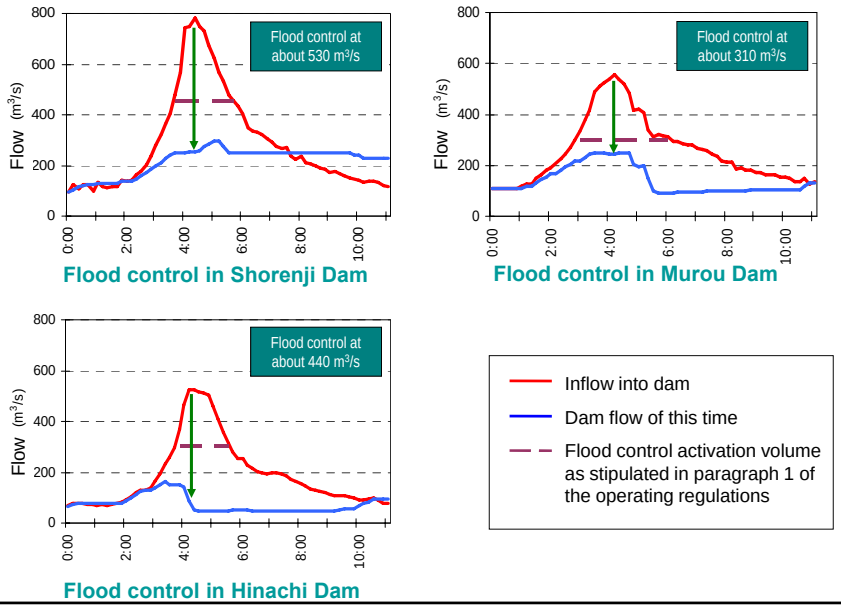
Implementation of integrated operations by the three dams

Water level of the Nabari River was kept lower than the design high water level, preventing flood damage to an estimated 1,180 houses.




18

Flood control operations carried out under the three dam integrated operations meant that expected flood damage to 1,180 houses in the Nabari urban area was avoided.

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# A Comparison with the Ise Bay Typhoon

| Details | | | Typhoon No. 18, 2009 | Typhoon No. 15 (Ise Bay typhoon), 1959 |
|---|---|---|---|---|
| Scale | | Period | Sep. 29 2009 (21:00) to Oct. 9 2009 (15:00) | Sep. 21 1959 (21:00) to Sep. 27 1959 (21:00) |
| | | Lowest pressure | 910 hpa | 895 hpa |
| | | Maximum speed | 55 m/s | 75 m/s |
| | At time of landfall | Central pressure | 955 to 960 hpa | 925 hpa |
| | | Maximum speed | 40 m/s | 50 m/s |
| | | Radius of storm | 220 km (South East), 170 km (North West) | 250 km |
| Rainfall in the Nabari River upstream | | 1-hour rainfall | 65 mm | 58 mm |
| | | 3-hour rainfall | 143 mm | 137 mm |
| | | Cumulative rainfall | 315 mm | 393 mm |
| Situation in Nabari city | Rainfall | 1-hour rainfall | 41 mm | 43 mm |
| | | Cumulative rainfall | 239 mm | 342 mm |
| | Damage situation | Death toll | - | 11 |
| | | Number of missing | - | 1 |
| | | Swept houses | - | 102 |
| | | Demolished houses | 1 | 180 |
| | | Partially destroyed | - | 525 |
| | | Flood above floor | 1 | 1,434 |
| | | Flood below floor | 27 | 848 |

3-hour rainfall was equivalent to that of the Ise Bay typhoon!

Significant reduction in damage in Nabari City

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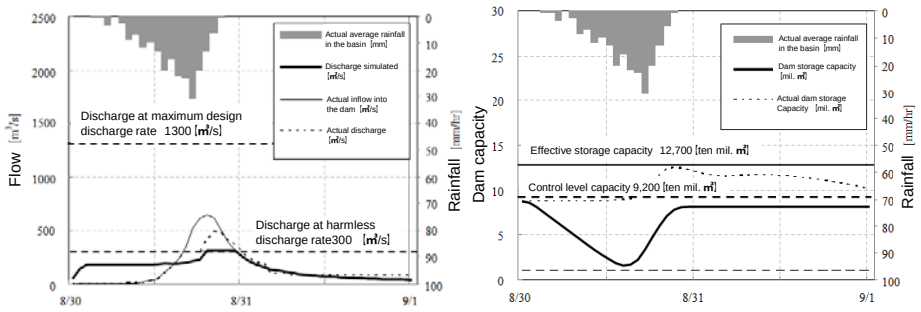
# Articles Related to Typhoon No. 18


中日新聞(平成21年10月21日)


産経新聞(平成21年10月9日)



# Example of Water Use Capacity Non-fulfillment




Simulation results for the flood at Nomura Dam in August 2004

Where the maximum WRF model error (1.43) was used, large preliminary discharge operations carried out based on excessive rainfall level predictions resulted in an inability to fulfill water use capacity after the flood.

## Improvement of the Method for its Practical Application to Dam Management

1. Improvement of operation methods
2. Clarification of rainfall prediction errors of the WRF model
3. Improvement of dam facilities

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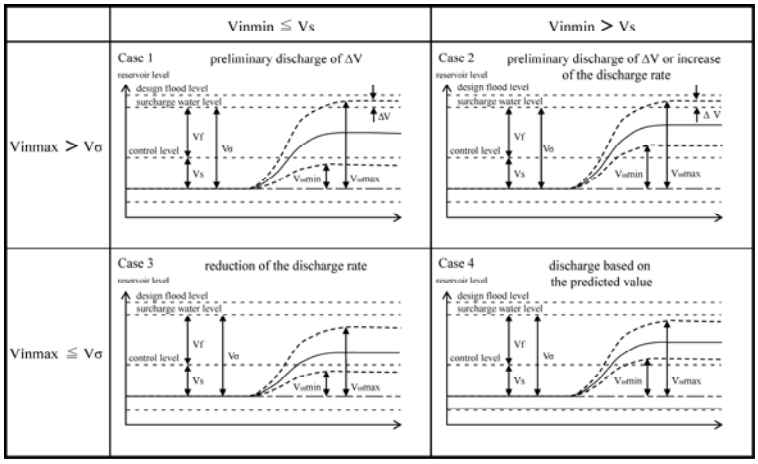
## Reservoir Water Level and Discharge Operations Based on Rainfall Prediction Errors




Vf : flood control capacity
Vs : available capacity for water use at the time of prediction
Vσ = Vf + Vs : available capacity at the time of prediction

Vinmax : reservoir level based on the maximum WRF prediction value
Vinmin : reservoir level based on the minimum WRF prediction value

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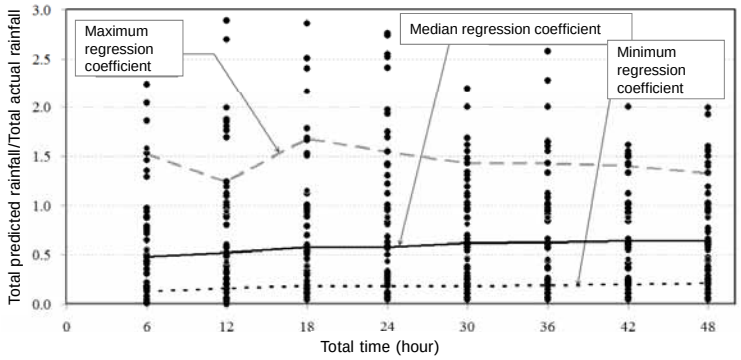
# Clarification of Rainfall Prediction Errors of the WRF Model




WRF model rainfall prediction for 14 small to large floods in 10 dams

Compare to actual rainfall and examine error

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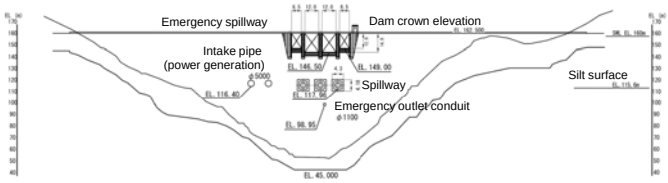
# Improvement of Dam Facilities



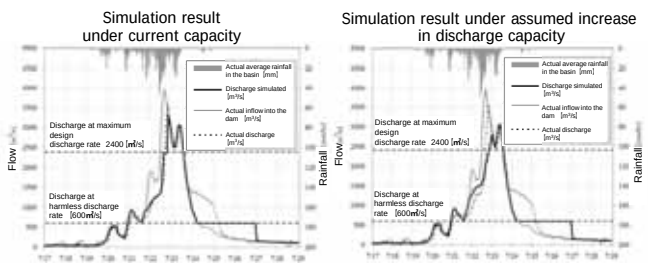

Discharge facility in Tsuruda Dam

**Only three conduit gates**

Not possible to smoothly carry out operations where discharge rate is increased to match the inflow rate, or preliminary discharge operations

↓

Add one conduit gate and examine effect




Effect of improvements in discharge facilities at Tsuruda dam (July 2006 flood event)

Matching operations can be carried out smoothly

Maximum discharge volume reduced by 243 $m^3/s$

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# Conclusions

1. This method enables the control of flood damage for many flood events by reducing maximum discharge volumes through preliminary discharge operations and so on, even in the case of excess floods.
2. With this method, discharges can be kept to harmless discharge volumes for many smaller floods.
3. To minimize the risks posed by rainfall prediction errors, it is necessary to correctly understand the characteristics of such errors, and reflect that in any flood control decisions.
4. For those dams where the capacity of spillway gates and so on is insufficient, it is desirable to remodel them so that preliminary discharges etc. can be carried out effectively.

# Ⅴ-6. Lecture

# “Sediment Disaster Forecasting and Warning System”

Mr. Masaki MIZUNO

# Sediment Disaster Forecasting and Warning System

SABO (Erosion and Sediment Control) Division
Research Center for Disaster Risk Management
National Institute for Land and Infrastructure Management

Masaki MIZUNO

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## Today's topics

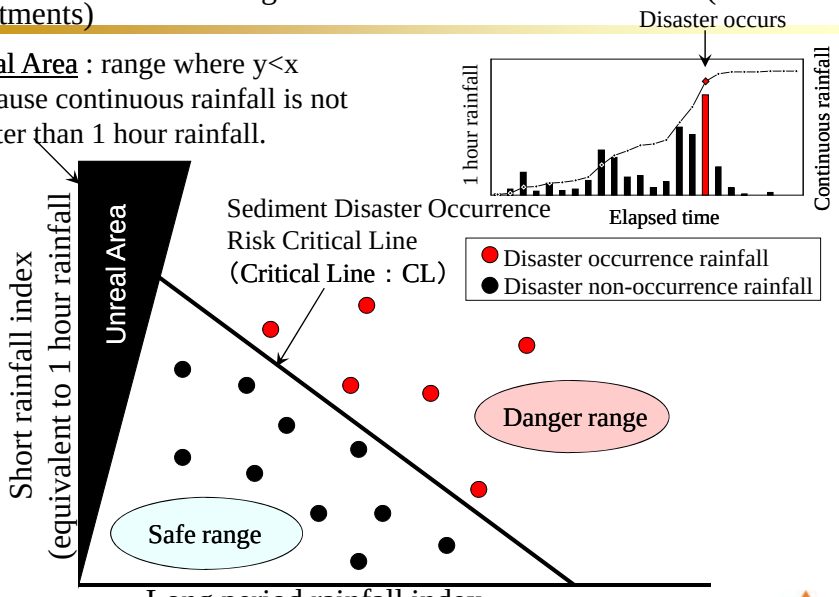
1. Sediment Disaster Warning and Evacuation Critical Rainfall Setting Method（The conventional method ）
2. Study of a new CL setting method（Setting CL using RBFN ）
3. Sediment Disaster Forecasting and Warning System in Japan（Preparation and Announcement of Sediment Disaster Warning Information）
4. Actual operation of sediment disaster warning information system

（The conventional method ）

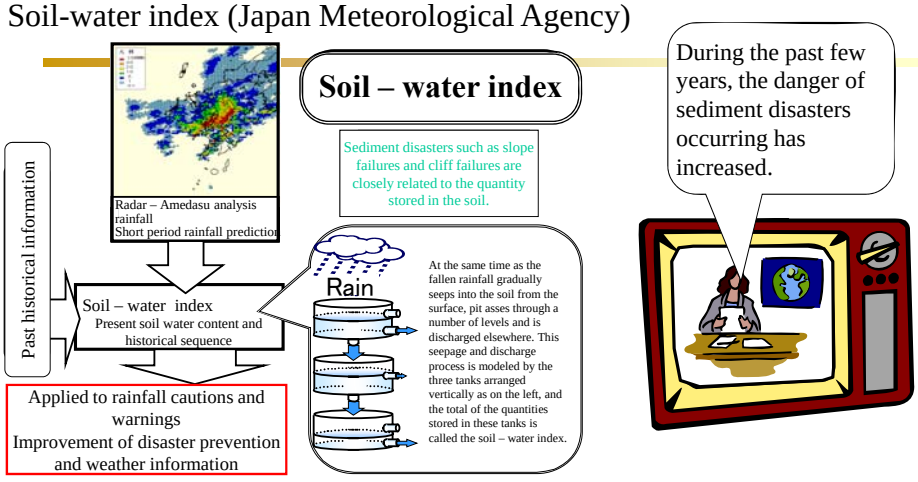
Sediment Disaster Warning and Evacuation Critical Rainfall (sabo departments)

Unreal Area : range where y<x

*Because continuous rainfall is not greater than 1 hour rainfall.



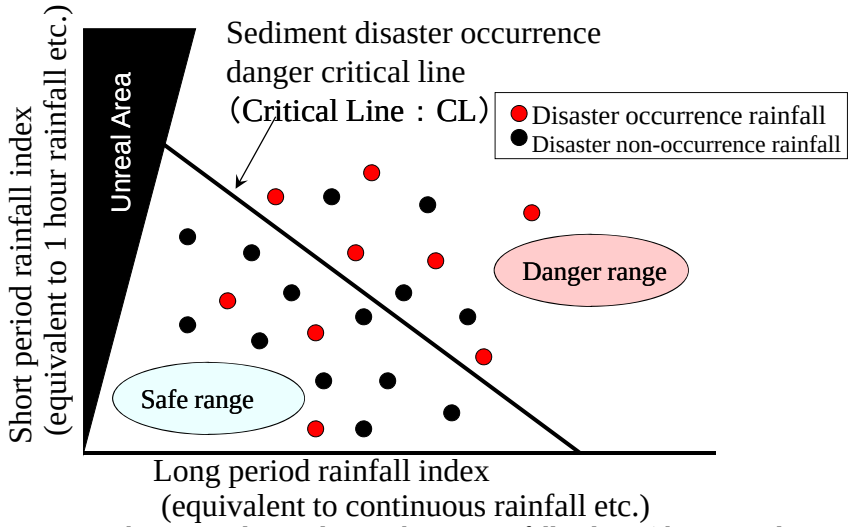

Soil-water index (Japan Meteorological Agency)




At a meteorological observatory, in circumstances where a heavy rainfall warning has been issued, a comprehensive judgment is made according to the soil – water index, meteorological conditions etc., and when the danger of a large sediment disaster occurring is extremely high, the above “key word” is used to change the warning to issue an even more urgent warning.

（The conventional method ）

## Strong points and weak points of the sediment disaster warning and evacuation critical rainfall (sabo departments)

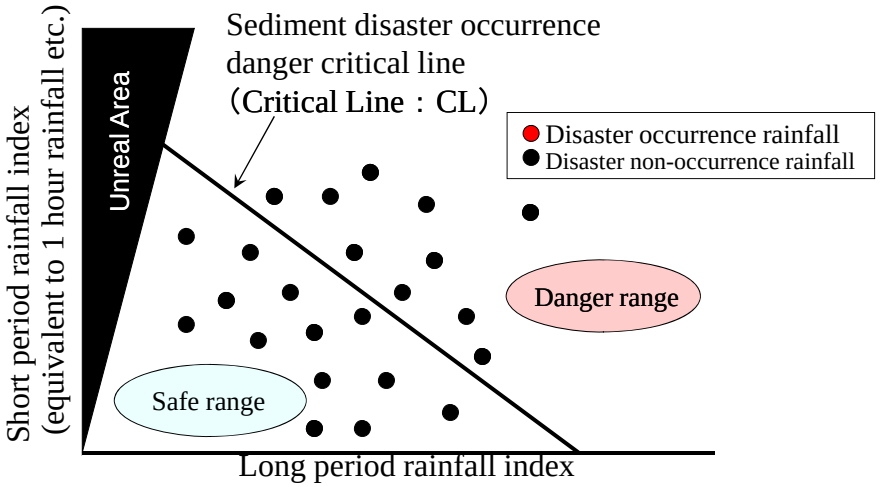



- Danger can be assessed according to the two rainfall indices (short period rainfall and long period rainfall).
- Critical lines may be set subjectively.



（The conventional method ）

## Strong points and weak points of the sediment disaster warning and evacuation critical rainfall (sabo departments)



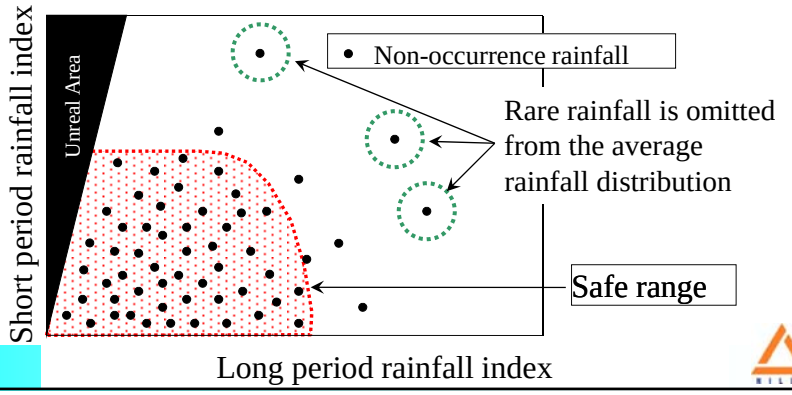

- manDisaster data is needed to set CL.



## Study of a new CL setting method

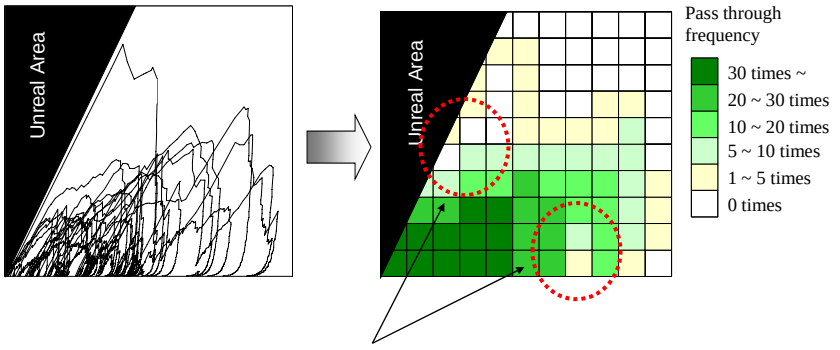
How is CL set in a case where occurrence rainfall is rare (non-existent)?

➔ Range where it is hypothesized that the sediment disaster danger is low based on rainfall experienced in the past (safe range) is specified (range with many experiences in the past).




## Study of a new CL setting method

Meshes are set and the frequency that the non-occurrence snake curve passes through each is counted.



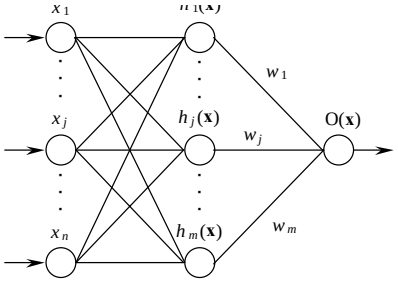

Because a snake curve does necessarily pass through all meshes, the pass-through frequency distribution is discontinuous (uneven).

⇒ Subjective judgments are made to set the safe range.

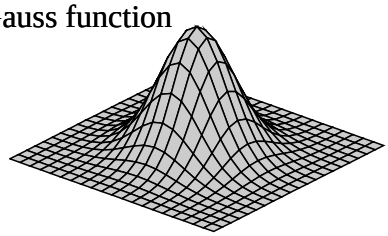
Isn't there a method of setting more objectively?

## Study of a new CL setting method

### Study of the applicability of the RBF network (Radial Basis Function Network)




Gauss function



Input layer ($n$) Intermediate layer ($m$) Output layer (1)

$$h_j(\mathbf{x}) = \exp(-\|\mathbf{x}-\mathbf{c}_j\|^2 / r^2)$$

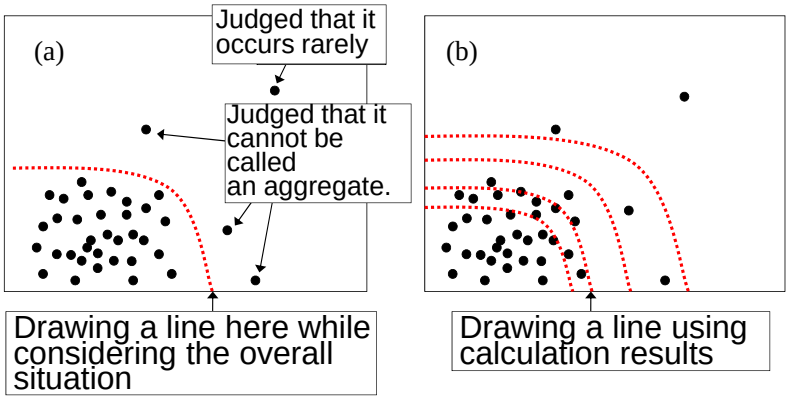
### Learning by an RBF network

$$E = \sum_{i=1}^{p} \left(y_i - O(\mathbf{x}_i)\right)^2 + \sum_{j=1}^{m} \lambda_j w_j^{\,2} \rightarrow Min$$

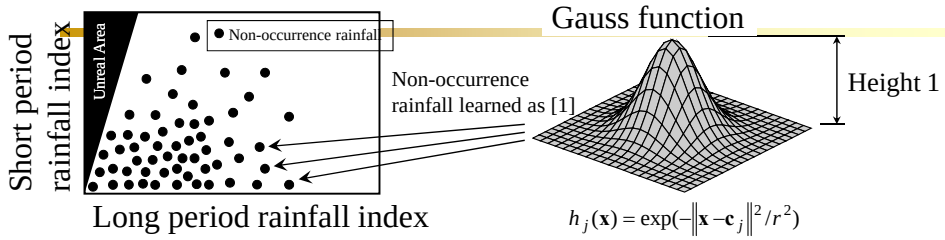


## Study of a new CL setting method

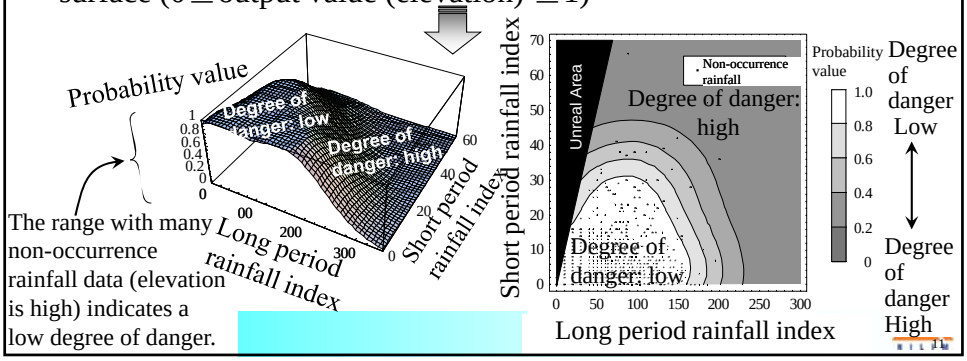
### Image of Task of Preparing the Range of the Aggregate of Points




# Study of a new CL setting method

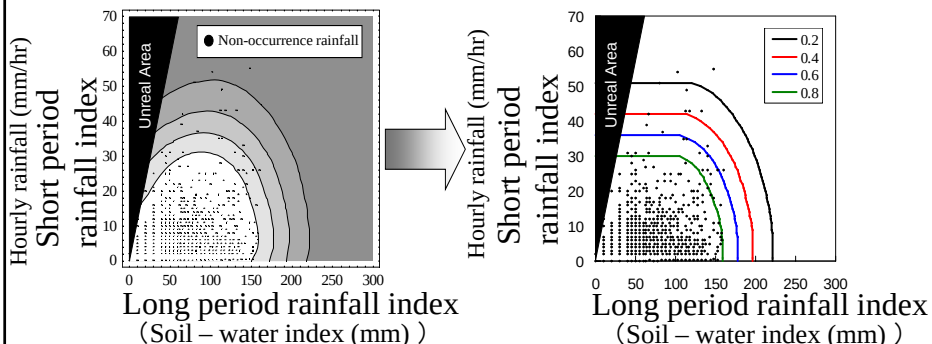



Gauss functions are superimposed to set the response curved surface (0≦output value (elevation) ≦1)




# Study of a new CL setting method

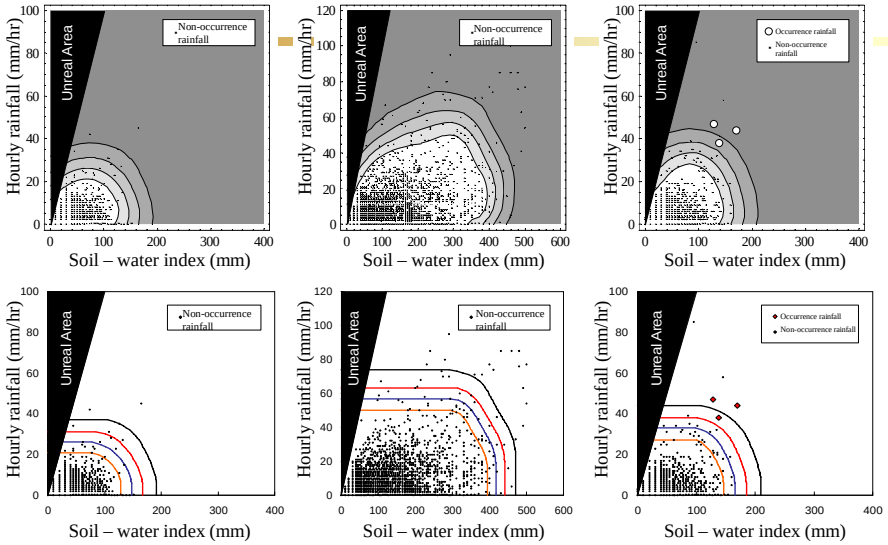
From the response curved surface set based on non-occurrence rainfall, an optional equiprobability value line is abstracted (slightly corrected to prevent contradiction with phenomenon)




An equiprobability value line judged to be suitable according to its relationships with the false alarm rate, frequency warnings are issued, and rainfall warnings is set.

⇒ Objective CL can be easily set.

## Results of applying the new CL setting method




For what kind of region can average rainfall distribution be easily reproduced
⇒ Using the RBF network to set CL is judged effective.



## Merits of using an RBF Network

- CL can be set using multiple non-occurrence rainfall data, even in regions where there is little disaster data or where there is no disaster data.
- The safe range can be specified automatically based on rainfall distributions experienced in the past (extremely objective).
- The specification of the safe range can be automated to a certain degree using the RBF network, so efficiency can be greatly improved.

* CL must be set for all meshes (380,000 meshes nationwide: approximately 80,000 meshes/1 prefecture), and the conventional CL setting method is very time consuming and laborious.

The result ⇩

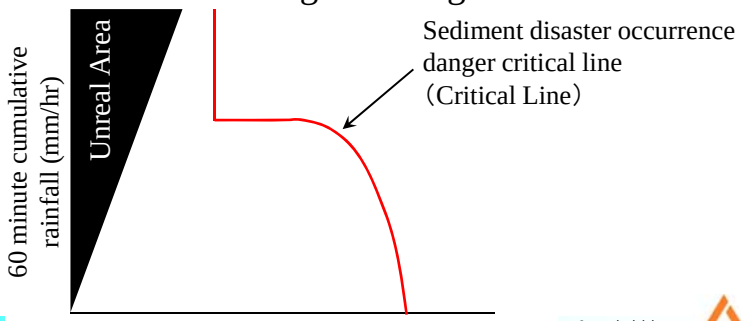
This method is adopted to set the sediment disaster warning information preparation and announcement standards.

## CL setting methods using RBF Network

CL setting methods when using RBF network with sediment disaster warning information:

(1) CL is set for each mesh unit of the data provided by the Meteorological Agency
(2) CL is set for meshes without disasters applying the standard value set in municipality units with necessary modifications.
(3) CL is for meshes with disasters considering the captured disasters.
(4) CL is set considering the lower limit value of the soil – water index.

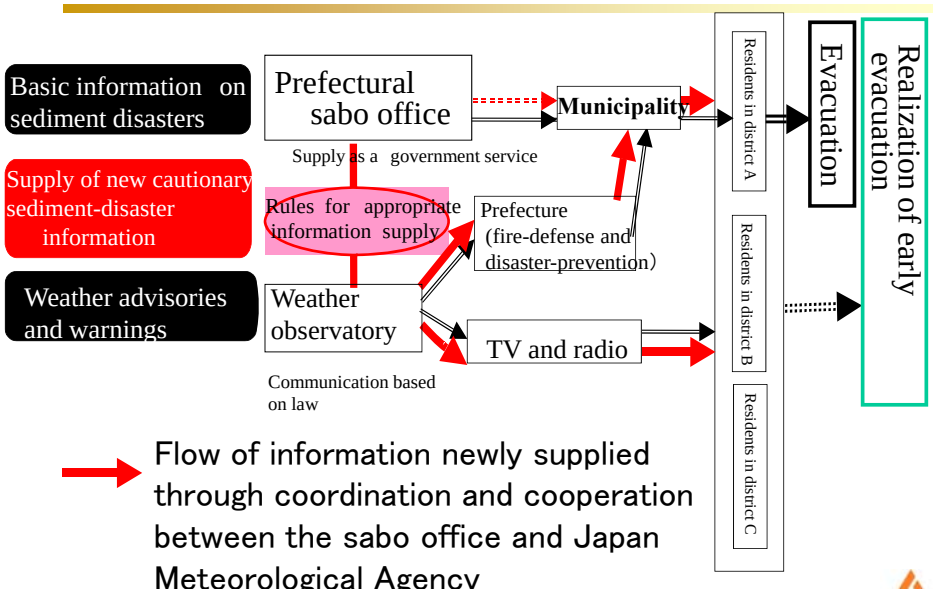
### Standard form of the Setting CL using RBFN






## Sediment Disaster Forecasting and Warning System in Japan

preparation and announcement of sediment disaster warning information



# Example of cautionary sediment-disaster information

**Cautionary sediment-disaster information for AA Prefecture, item No. X**

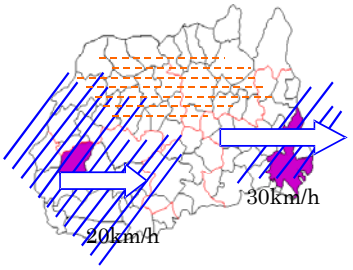
Time: △△ Date:□□□□

Joint announcement by AA Prefecture and BB Regional Weather Observatory

Municipality in which warning issued:

CC district, DD City

It is expected that the danger of sediment disaster due to heavy rains will rise significantly within the next two hours. Please take thorough steps to provide warning in sediment disaster-prone areas and surrounding areas. It is expected that the maximum rainfall in municipalities targeted by this warning could reach 60 mm in some places over the next three hours.




**Explanation**

- Municipality in which warning
- Region in which seismic intensity was ?? or more during the EE Earthquake
- Area of actually measured heavy rain (30 mm per hour or more)
- Length of arrow corresponds to hourly movement distance

For inquiries, please contact:

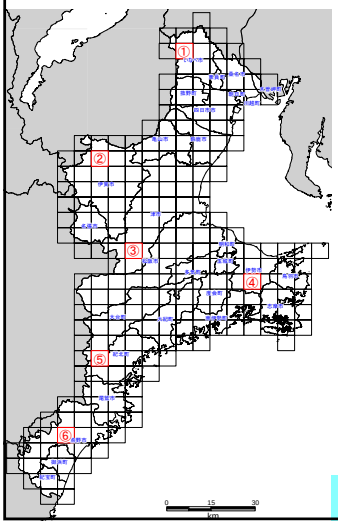
Sabo Office, AA Prefecture: 111-111-1111

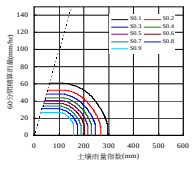
BB Regional Weather Observatory: 222-222-2222



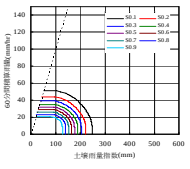
# Actual operation of sediment disaster warning information system

1. The CL is set for each 5 km mesh.

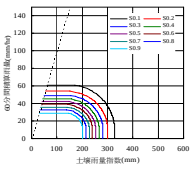


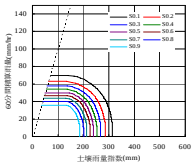
①Inabe City



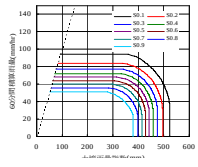
②Iga City



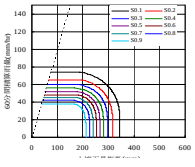
③Tsu City



④Ise City



⑤Oodai Town

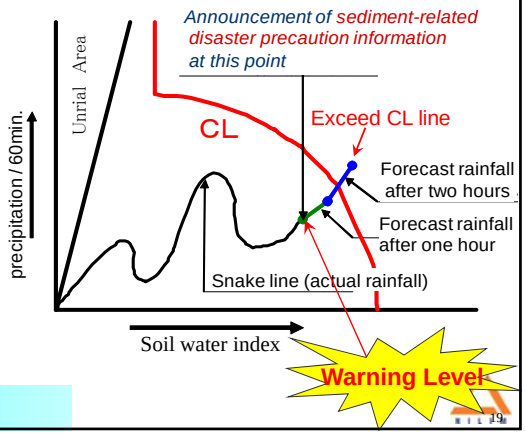


⑥Kumano City

# Actual operation of sediment disaster warning information system

2. The snake line is drawn using both actual (observed) rainfall data and predicted rainfall data.

- 1st Step: Draw a snake line
  X axis -> Soil rainfall index
  Y axis -> 60-minute rainfall
  Both are actual (observed) data.
- 2nd Step: Forecast a snake line after one hour and two hours
  Points in one and two hours later are estimated using rainfall-forecast data.
- 3rd Step: Judgment
  If the points in two hours later locates outside the critical line (CL), the sediment disaster warning information is issued.

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# Actual operation of sediment disaster warning information system

3. The sediment disaster warning information is issued for the unit of each municipality.

This is because the municipality has responsibility to issue emergency calls to the residents.


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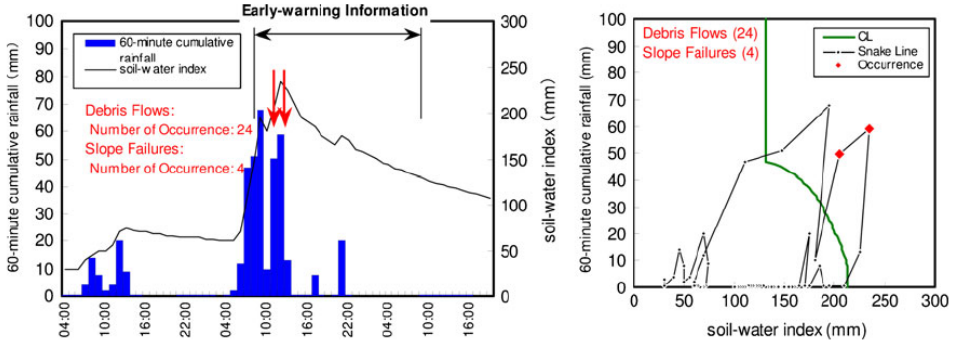
## Example：Case of sediment disaster occurrence by heavy rainf in *Yamaguchi* Pref.

The case of actual sediment disaster happened on July 21, 2009 in *Yamaguchi* Pref.



## Example of snake line progress using RBFN

• On 21st July 2009, 65 debris flows and 105 slope failures occurred in Yamaguchi Prefecture.
• 14 people died as a result of these mass movements.
• The time series of 60-min rainfalls and soil–water index, the timings of occurrence of debris flows and slope failures, and the period of early-warning information issue are shown in the left figure.
• The progress of the snake line and the timing of the disasters (red box) in the damaged area are shown in the right figure.




**The disasters occurred when the snake line exceeded the CL and went into the danger range**
**→CL adequately captured the timing of these disasters occurrences**

Thank you for your attention

# Ⅴ-7. Lecture
# “ITS Deployment in Japan”

Mr. Fumihiko KANAZAWA

The 19th Conference on Public Works Research and Development in Asia
Session on Intelligent Transport Systems
November 18th, 2010

# ITS Deployment in Japan

**November 2010**

**Fumihiko KANAZAWA**
Intelligent Transport Systems (ITS) Division,
National Institute for Land and Infrastructure Management (NILIM)$_0$
Ministry of Land, Infrastructure, Transport and Tourism (MLIT), JAPAN

## Definition of Smartway

**Definition of Smartway**

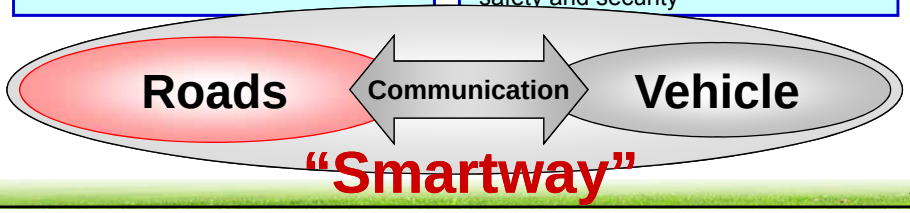
Smartway: a road system which can exchange various types of information among cars, drivers, pedestrians, and other roadway users.

**Foundation for the deployment of various ITS services**

- Realize integrated ITS to provide safe, smooth road transportation and positive environment.

**Foundation for affluence and comfort in life and society**

- Realize efficient mobility for people, goods, and information
- Realize comfortable living spaces
- Build infrastructure that provides safety and security




1

## Joint Research by Public-private Collaboration

Smartway Project Advisory Committee established as the core of industry-academia-government collaboration (2000)

Smartway Project Advisory Committee
- Proposals based on social and technical trends

Working groups under the Smartway Project Advisory Committee

Smartway Partner Council
- Private companies and organizations

- Joint research on the Next-generation road service system (2005-2008)
- Public-private joint research with 23 companies
- Joint development of roadside equipment and onboard units

2

## Hisory towards nationwide deployment

- "ITS Enter the Second Stage: Smart Mobility for all"

(A proposal by Smartway Project Advisory Committee: Aug. 2004)

- Public-Private Joint Research

(Drafting of technical specification)

- The Smartway open trial Demo 2006

(Tests on NILIM's test course: Feb, 2006)

- Publication of technical specifications
- Smartway 2007 Demo & ITS Safety 2010

(Tests and demonstration on public roads)

- Nationwide deployment

3

## Development of Service Application

- Categorization of problems to be solved
- Service definition
- Setting service evaluation index and method

→ Development of service applications

↓

- Tests using driving simulators

↓

- Driving tests on test course

↓

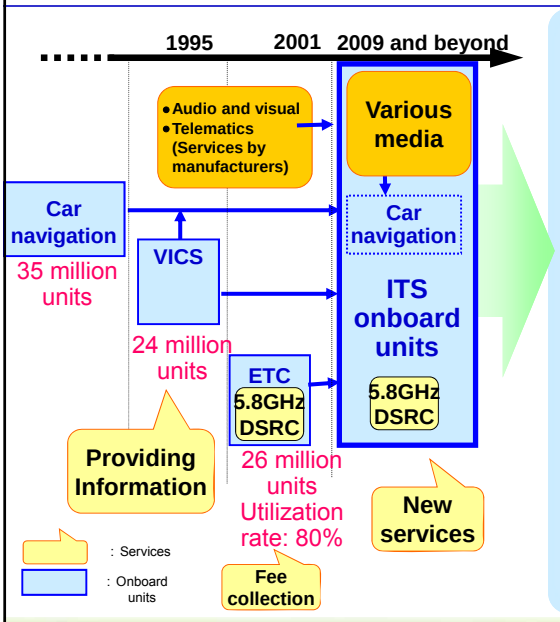
- System verification tests on public roads

↓

- Driving tests on public road

4

## Various Services with Open Platform




**<Various applications >**

- ◆ Providing wide area traffic information
- ◆ Providing traffic information in easily understandable audio form
- ◆ Providing information to support safe driving
- ◆ Providing information at parking areas, and rest areas

+

ETC

+

**Private sector services**

- ◆ Providing information based on requests
- ◆ Cashless payments

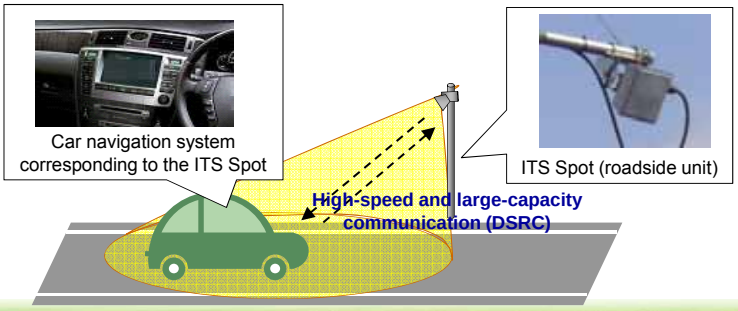
5

# Expansion of Next-Generation ITS

- Car Navigation system and ETC evolve and integrate, then various services will be realized all in one.
- These services are realized by the high-speed and large-capacity communication (5.8GHz DSRC) between the “ITS Spot” installed on the roadside and the in-vehicle car navigation system corresponding to the ITS spot services
- Various services such as providing wide-area traffic information or image are realized by the high-speed and large-capacity communication

Car navigation system corresponding to ITS spot services have been released on October 2009

ITS spots are deployed nationwide (around 1,600 units are installed mainly on expressways)

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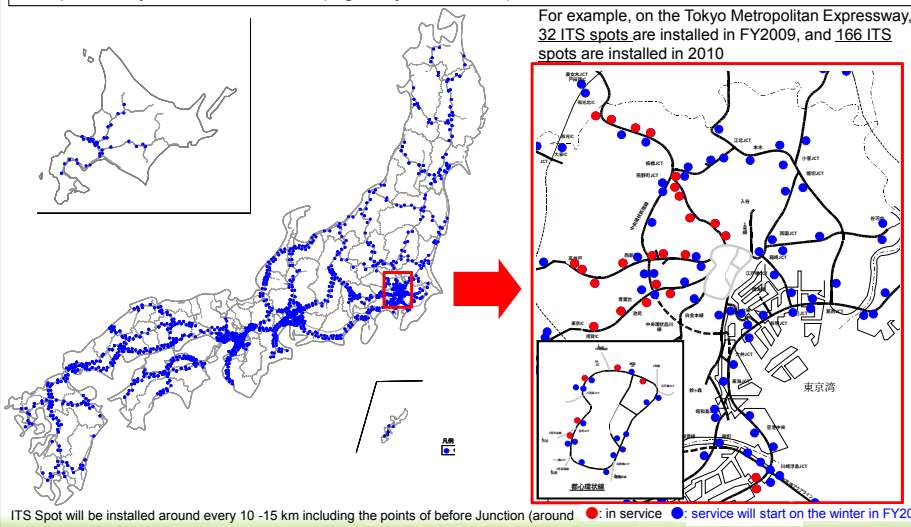
# Deployment of ITS Spots

- Around 1,600 ITS spots are installed mainly on the expressways nationwide
- Around 50 ITS spots are installed at the expressway rest areas including Tomei and Meishin Expressway and Michi-no-Eki (highway rest areas).

For example, on the Tokyo Metropolitan Expressway, 32 ITS spots are installed in FY2009, and 166 ITS spots are installed in 2010




ITS Spot will be installed around every 10 -15 km including the points of before Junction (around 90 points) on the intercity expressways and around every 4 km on the urban expressways

●: in service ●: service will start on the winter in FY2010

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## State of Release of Car Navigation System Corresponding to ITS Spot

- 5 manufacturers release car navigation system corresponding to ITS Spot (as of June 2010)
- Around 10 million units will be shipped in 5 years (estimated by ITS Japan)

**Toyota** [released on October 2009]

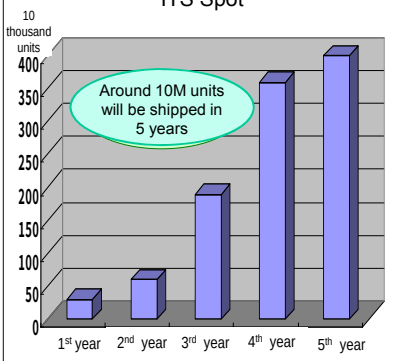
**Pioneer** [released on October 2009]

**Panasonic** [released on March 2010]

**Mitsubishi Electric Co.** [released on October 2009]

**Mitsubishi Heavy Industries** [released on March 2010]

Popularization Estimate of Car Navigation System Corresponding to ITS Spot




Source: ITS Japan

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## New Smartway services (ITS Spot Services) will be launched for comfortable and safety driving.

### ITS Spot Services will be launched after winter of 2010.

- ITS Spot services include three basic services.

Three basic services

【**Dynamic route guidance**】 Smarter route guidance considering wide area road traffic data

【**Safety driving support**】 Preventing from scaring drivers by previous cautions

【**ETC**】 Electronic Toll Collection

Other services

- Access to the Internet at highway rest areas (accepted by some car navigation products)
- Update digital road map database in car navigation system

- More additional services including fee settlement, sightseeing guidance and commercial vehicle support will be deployed in the future.

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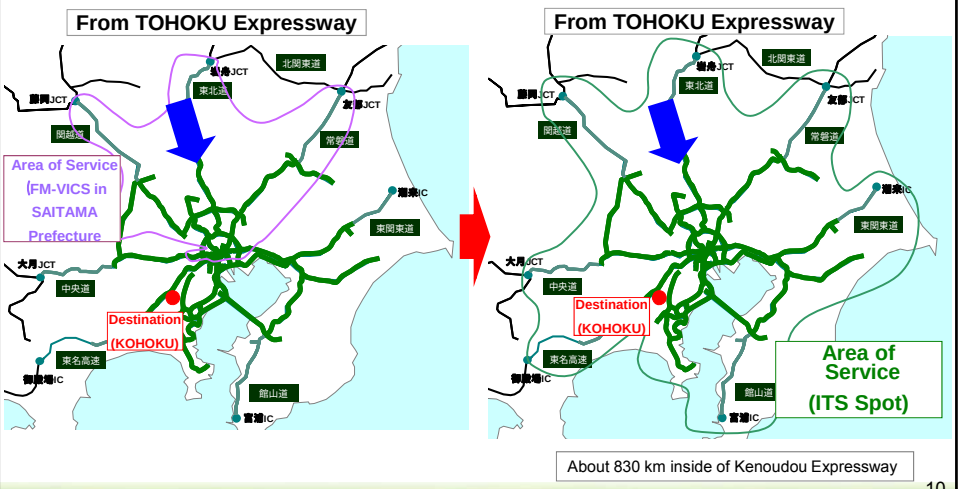
## [Dynamic Route Guidance]
## Providing travel time data of broad area

○ Required travel time data of the entire metropolitan areas is provided to enable car navigation systems to determine the optimum route with real time data.

○ Road networks can be utilized effectively.




About 830 km inside of Kenoudou Expressway

10

## [Assisting safety driving]
## Reducing close-call experiences by alerting drivers in advance

○ Though ITS Spot usually provides road traffic information, in unusual case, ITS Spot provides safety driving support information with considering road conditions.

### Cautions of obstacle on road

★On the Metropolitan Expressway, about 50,000 obstacles are found every year.

(on average, 140 per day and one in 10 minutes)

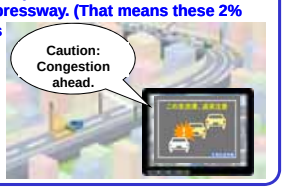
★TMC broadcasts caution simultaneously


(Cautions are provided previously)

### Caution to notify traffic congestion beyond

★Traffic accidents occurring in only 2% of length of the Metropolitan Expressway account for about 20% of all accidents on the expressway. (That means these 2% sections

★60% of rear-end type collisions have been reduced at Sangubashi Curve.




### Providing still images of snow, fog and other weather hazards or traffic congestion in tunnels.

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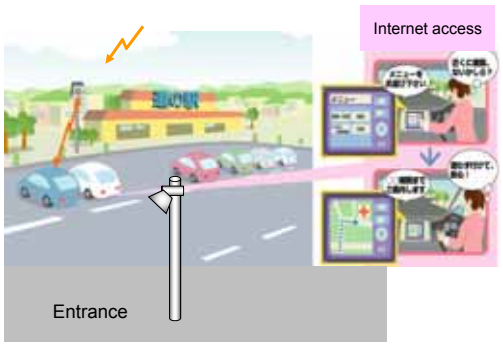
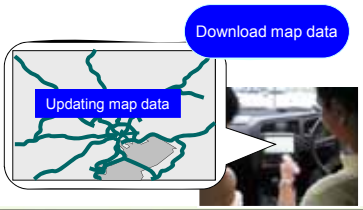
## Internet Access in Highway Rest Areas (accepted by some car navigation products)

- Access the Internet via car navigation system in highway rest area
- Enable to update digital road map database in car navigation system

**Function**




**Examples**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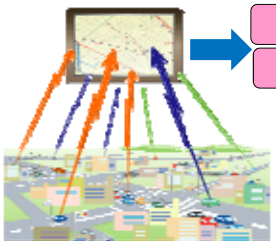
## Collection of Probe Data

○ Collection of probe data* from vehicles will enable you to comprehend and to provide detailed and high accurate traffic information.



**Providing Road Traffic Information**

**Managing roads and traffic**

***Probe data: vehicle position and speed data which were acquired when each vehicle travelled**

Additionally

○ **Make levels of route services transparent in good accuracy**
○ **Grasp tasks in local transportations accurately then take advantage of it to low cost and efficient measures**

| 【Conventional observation methods】 | 【Continuous high-accuracy observation by ITS】 |
|---|---|
| Speed: Point survey of travel speed | Speed：Collecting travel time data in survey section |
| Traffic volume: Manual traffic count survey Every-five-year Road Census (one-day survey in autumn) | Traffic volume：365-day 24 hours observation Use of traffic counters |

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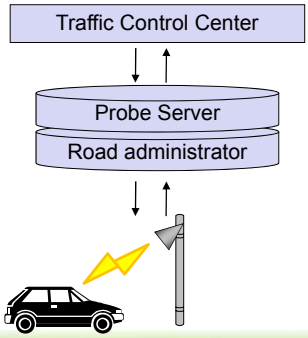
## Expansion of ITS in the Future (Utilizing Probe Data)

■Utilize probe data for collecting and analyzing traffic flow information

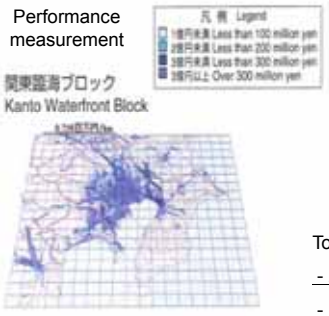
- Effective road plan
- Performance Measurement
- Information Provision for avoiding traffic jam
- Bus location system

⇒ •High-developed operation and Management of road services

•Reduction CO2 emission and energy saving as optimizing traffic flow in the road network

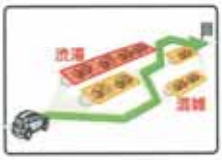



Performance measurement




Source: ITS Handbook

High density traffic information using probe data

To use optimal route,

- 20% cut down travel time
- 17% cut down CO2 emission

Source: Nissan

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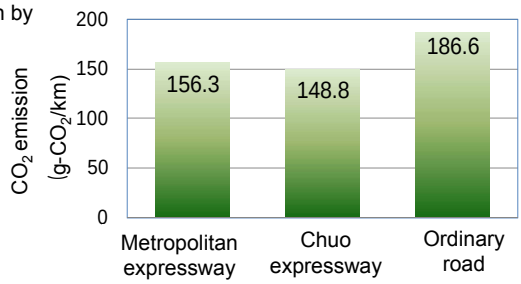
## Expansion of ITS in the Future (Example of Utilizing Probe Data)

- Travel record of a vehicle installed an ITS on-board unit is acquired
- CO2 emission is calculated by a travel record

Calculation each route is possible (for example, each of urban expressways, intercity expressways, ordinary roads)

[$CO_2$ emission by each road]




[The calculation formula of the CO2 emission]

A gasoline-powered car (kg CO2) = $d\{2019/v - 2.087v + 0.01865v2 + 156.05\}$

$v$: Average travel speed (km/h)  $d$: distance (km)

The source: Fuel consumption rate in the vehicle travel and CO2 emission coefficient, Engineering works technical documentation 43-11(2001)

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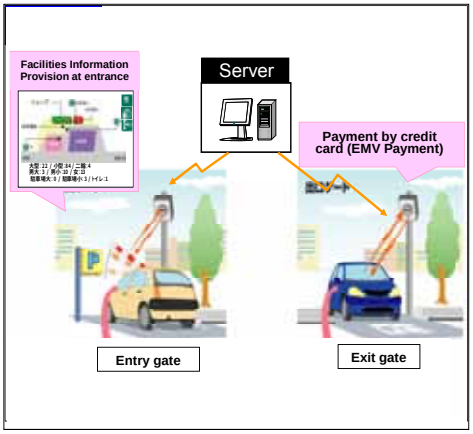
## 【Future Service】 Utilizing Open Platform

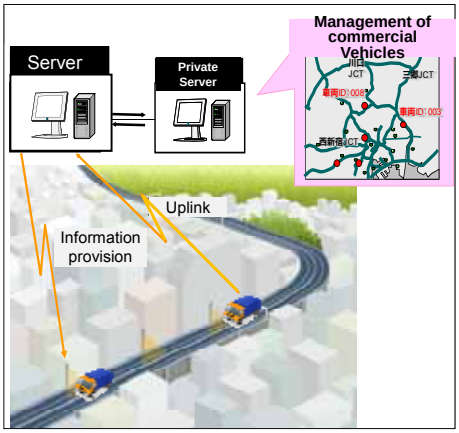
- **Public private joint services using networked ITS Spots (such as payment sightseeing guidance and logistics support)**
- **Promotion of public-private joint research**

Paying by credit card while in the vehicle




○Under establishing the standards of payment services

Utilizing management of commercial vehicles




○Under establishing data formats

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## Deployment of Smartway Services

**Extensive services by the private sector are provided through ITS OBUs (with a high-performance, open platform including multi-application capability).**

Provision of information on tourism and leisure facilities.

**Management of Logistics**

**Provision of services and adoption of ITS OBUs, primarily on expressways**

**Regional Road Traffic Information**

**Assistance System for Safety Driving**

Distributing electronic ads, etc. for outlet stores

Improved security at entrances

Client management

Existing VICS services (24 million VICS)

Text Display

Simple Diagram Display

Map Display

**ETC**
(26 million ETCs)
(Utilization rate: 80%)


**Providing traffic information in audio form (highway radio)**

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Thank you for your attention
18

# Ⅴ-8. Lecture

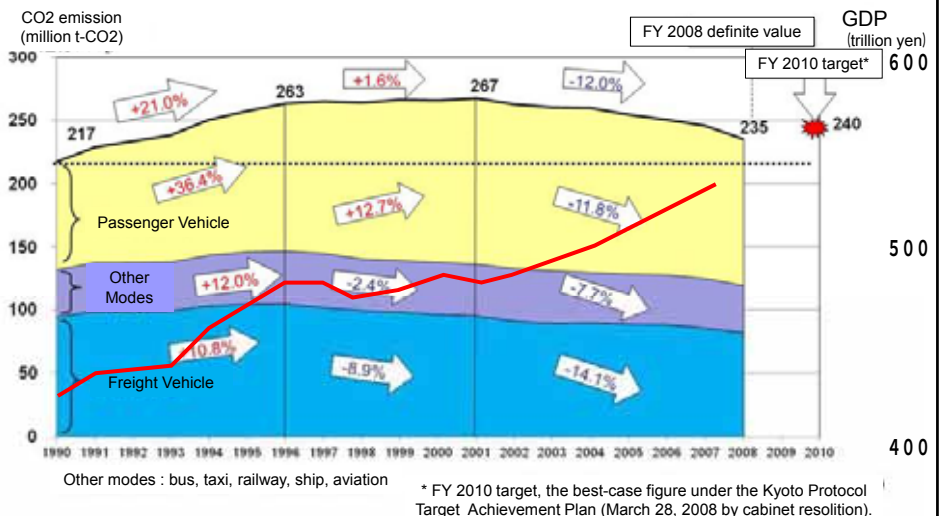
# “Actions of road traffic measure to contribute reduction Greenhouse Gas from transport section and improvement of air quality on roadside in Japan”

Mr. Manabu DOHI

## 1. Reduction Green House Gas from transport section

### (1) $CO_2$ emission from transport section in Japan

- $CO_2$ emissions from transport have been decreasing after peaking in FY 2001(-12%).
- GDP has increased 11% from FY 2001 to FY 2007.




Other modes : bus, taxi, railway, ship, aviation

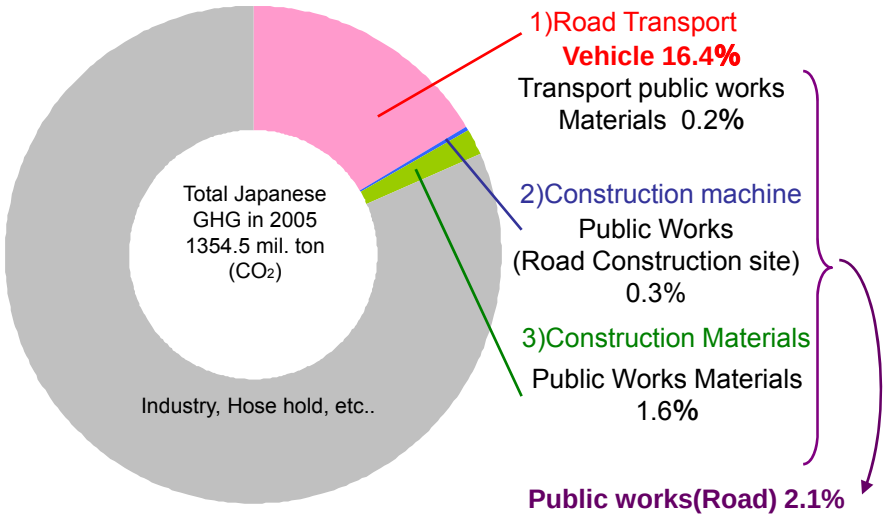
* FY 2010 target, the best-case figure under the Kyoto Protocol Target Achievement Plan (March 28, 2008 by cabinet resolition).

3

## 1. Reduction Green House Gas from transport section

### (1) $CO_2$ emission from transport section in Japan

- 16% of CO2 emission is from Road Transport,
- 2% of CO2 emission is from Public Works(Road)

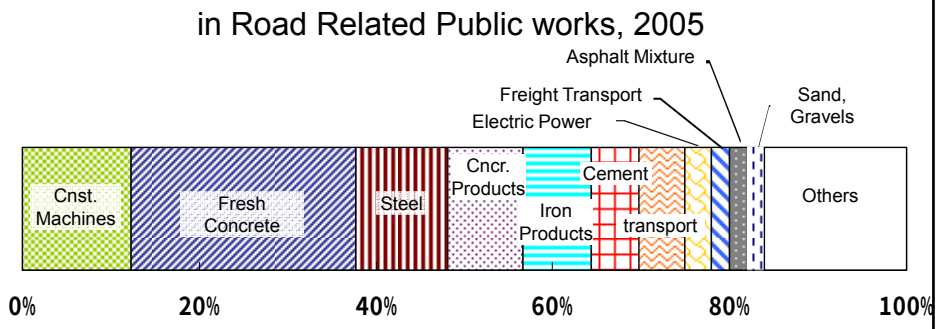



4

## 1. Reduction Green House Gas from transport section

### (1) $CO_2$ emission from transport section in Japan

- Mainly from Cement and Steel
- LCCO2 is important




5

## 1. Reduction Green House Gas from transport section

### (2) Law system about prevention of global warming in Japan

○Law concerning the promotion of the measures to cope with global warming
- Setting of "Kyoto Protocol Target Achievement Plan"
- Requires enterprises with more than certain scale to report GreenHouse Gas emission

<Aim of CO2 emission reduction by sector based on Kyoto Protocol Target Achievement Plan>

| | Base year | FY 2010 emission yardstick | |
|---|---|---|---|
| | Million t-CO2 | Million t-CO2 | Total emissions vs. base year |
| Energy CO2 emissions | 1,059 | 1,079～1,089 | 1.3%～+2.3% |
| Industrial | 482 | 424～428 | -4.6%～-4.3% |
| Clerical and other | 164 | 208～210 | +3.4%～+3.6% |
| Household | 127 | 138～141 | +0.9%～+1.1% |
| Transport | 217 | 240～243 | +1.8%～+2.0% |
| Energy conversion | 68 | 66 | -0.1% |
| Non-energy CO2/CH4/N20 | 151 | 132 | -1.5% |
| Three gases (e.g. HCFC) | 51 | 31 | -1.6% |
| Total greenhouse gas emissio | 1,261 | 1,239～1,252 | -1.8%～-0.8% |

Greenhouse gas reductions at left, including carbon-sink measures and Kyoto mechanisms, will work to meet the Kyoto Protocol's obligation for a 6% reduction.

Road measures on emission reduction in the Kyoto effort：Targeted reduction 4+ million ton

1. Various and flexible discount for expressway use: 0.2+ million ton
2. Development for better bicycle use: 0.3 million ton
3. Promotion of ITS including ETC and VICS: 2.6 million ton
4. Reduction of road work: 0.7 million ton
5. More efforts on eliminating bottleneck railroad crossings: 0.2 million ton

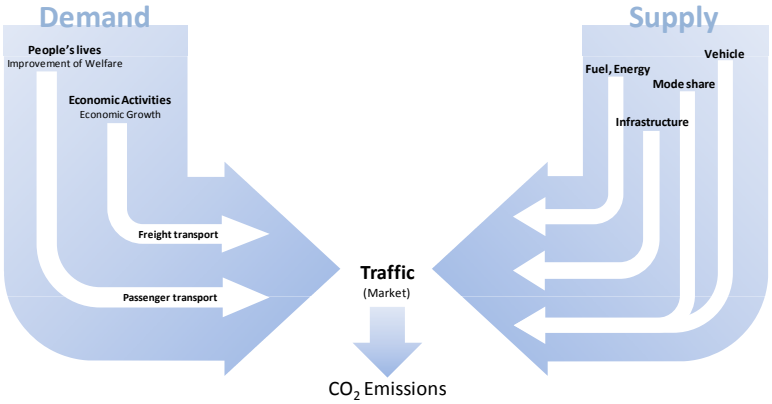
In addition,
- More environmentally vehicle
- Modal shift
(More use of public transportation)
- Smoother traffic flow
- More efficient logistics, etc.

6

## 1. Reduction Green House Gas from transport section

### (3) Basic Idea of CO2 emission reduction from road traffic

- Demand : Traffic closely concerns to economy and life of people
- Supply : Mode share, Infrastructure, Vehicle and Fuel affect on traffic condition




$CO_2$ Emissions = Activity (passenger / freight) x Mode Share x Efficiency (tank to wheel / traffic efficiency) x Fuel carbon content (well/field to tank)

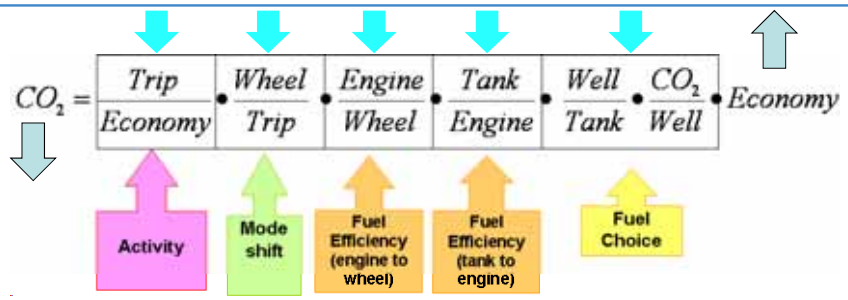
Source : OECD/International Transport Forum, REDUCING TRANSPORT GHG EMISSIONS Opportunities and Costs
URL:http://www.internationaltransportforum.org/Pub/pdf/09GHGsum.pdf



## 1. Reduction Green House Gas from transport section

### (3) Basic Idea of CO2 emission reduction from road traffic

- Every Sector improve their indicators
- Reduction of GHG in not only for Vehicle Sector, but also for Road administration sector

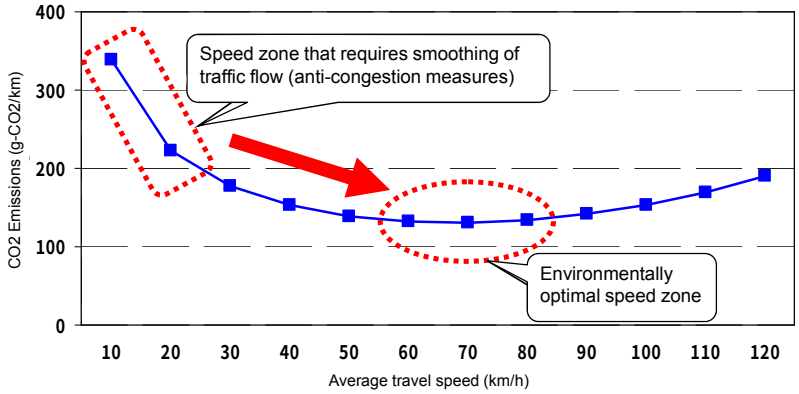



| Each Clause | Image of Clause | Example of Reduction measure |
|---|---|---|
| Trip / Economy | Traffic Demand with Economic Activities | Compact City, Car sharing |
| Wheel / Trip | Modal share | More use of public transportation |
| Engine / Wheel | Improve of Traffic Efficiency | Smoother traffic flow |
| Tank / Engine | Improve of Transportation Efficiency | Improved fuel economy of individual car |
| Well / Tank・CO2 / well | Fuel Choice | Hybrid vehicle, Electric vehicle |

## 1. Reduction Green House Gas from transport section

### (3) Basic Idea of CO2 emission reduction from road traffic

- Accouding to relationship between travel speed and CO2 emissions, CO2 emissions are higher in low-speed and decrease as travel speed increases.
- So, on congested roads, traffic flow smoothing to move traffic to optimal speed zones is an effective means of reducing CO2.

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## 2. Improvement of air quality on roadside

### (1) History of Air Pollution in Japan

1) About 1885 : Ashio Copper Mine Mineral Pollution Incident
Farmland pollution by Cu included effluent, Lacked forest by poisonous gas, so efficient of soil collapse and flood expansion

2) 1950 - 1970 (high economy growth period in Japan)
Break out Four serious environmental pollutions :
Minamata Disease, Niigata Minamata Disease, Itai-Itai Disease (Water pollution by caused Hg or Cd included factory effluent) ,
Yokkaichi Asthma (Air Pollution by caused SOx discharge from petrochemical complex, Healthy influence on respiratory systems such as asthma)
So, in 1967 Japan established Basic Law for Environmental Pollution (Current Environmental Basic Law), and Introduced of air quality standard and regulation regarding factory effluent gas and automobile emissions etc.

3) 1970 – 2000 :
Occur several lawsuit about air pollution on roadside,
Inhabitants are concerned about healthy influence by caused automobile emission (NOx, PM)
Now Nation reach reconciliation with plaintiff, but carries out meetings about improvement action several times a year.

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## 2. Improvement of air quality on roadside

### (2) Discharge process of air pollution material

**Primary Pollutant**

**Human Origin**

Stationary Source

**Factory / Business establishment, Power station, Incinerator, Dust outbreak institution, etc.**

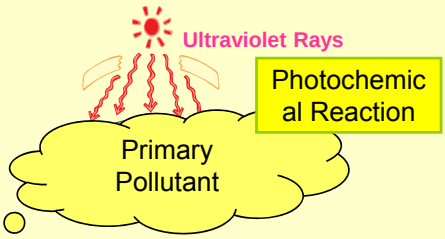
Mobile Emission Source

**Cars, Ships, Airplanes, Machine of Construction / Agriculture, etc.**

**Natural Origin**

**Soil, Ocean, volcano, Forest fire, etc.**

**Secondary Pollutant**




Adsorption → Extinction

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## 2. Improvement of air quality on roadside

### (3) Law system about Air pollution in Japan

○Basic Environmental Law
- Typical 7 environmental pollution (Air pollution, Water pollution, Soil Contamination, Noise, Vibration, Ground Subsidence, Offensive odor )
- Regulates environmental quality standards regarding air quality

○Air Pollution Control Law
- Regulates maximum permissible limits of motor vehicle exhausts
- Regulates maximum permissible limits on the quality of automobile fuel and on the quantity of substances in automobile fuel
- Requires local governments to monitor constantly and report the level of the air pollution

○Law Concerning Special Mesures for Total Emission Reduction of Nitrogen Oxides and Particulate Matter (Automobile NOx PM Law)
*For areas where air pollution is remarkable (three major urban areas),*
- Requires prefectural governors to formulate total emission reduction
- Regulates more intensive limit of motor vehicle exhausts
- Requires enterprises with more than a certain number of vehicles to submit emission reduction plans

○Environmental Impact Assessment Law
○Law Concerning Pollution-Related Health Damage Compensation

12

## 2. Improvement of air quality on roadside

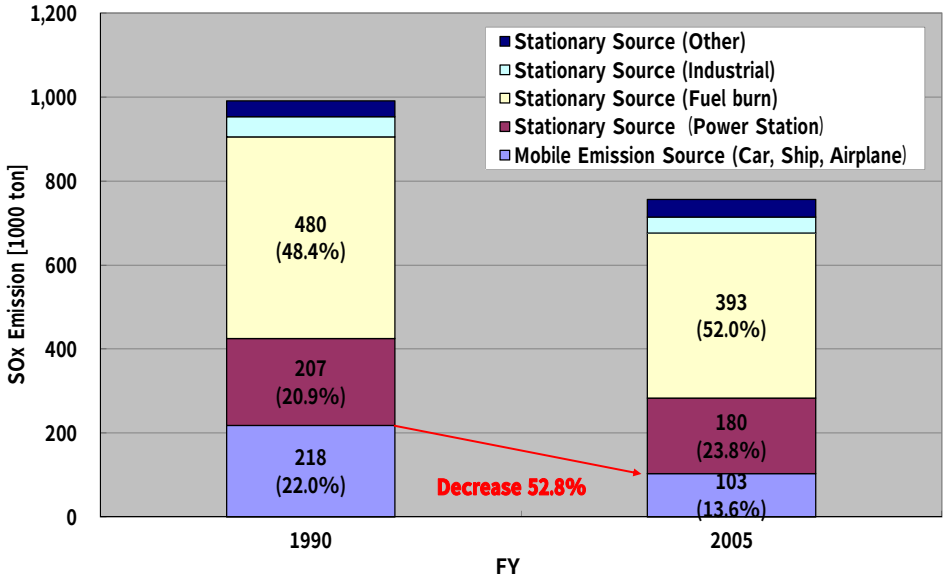
### (4) Standard and Achievement about air quality in Japan

| Substance | Year Started Standard | Environmental conditions | Achieve ratio of Standard (2008) | |
|---|---|---|---|---|
| | | | General Monitoring Station | Roadside Monitoring Station |
| Sulfur dioxide (SO2) | 1973 | Daily average for hourly values shall not exceed 0.04 ppm, and hourly values shall not exceed 0.1 ppm | 99.8 % 1,169st. / 1,171st. | 100 % 72st. / 72st. |
| Nitrogen dioxide (NO2) | 1973 1978Update | Daily average for hourly values shall be within the 0.04-0.06 ppm zone or below that zone | 100 % 1,366st. / 1,366st. | 95.5 % 402st. / 421st. |
| Suspended Particulate Matter (SPM) | 1973 | Daily average for hourly values shall not exceed 0.10 mg/m³, and hourly values shall not exceed 0.20 mg/m3 | 99.6 % 1,416st. / 1,422st. | 99.3 % 400st. / 403st. |
| Carbon monoxide (CO) | 1973 | Daily average for hourly values shall not exceed 10 ppm, and average of hourly values for any consecutive eight hour period shall not exceed 20ppm | 100 % 73st. / 73st. | 100 % 276st. / 276st. |
| Photochemical oxidants (Ox) | 1973 | Hourly values shall not exceed 0.06 ppm | 0.1 % 1st. / 1,148st. | 0 % 0st. / 30st. |
| particulate matter less than 2.5μm (PM2.5) | 2009 | Annual average shall not exceed 15μg/m³, and daily average shall not exceed 35μg/m³ | During construction of Monitoring System | |

※In additions, There are Standard of Benzene, Trichloroethylene, Tetrachloroethylene, Dichloromethane, Dioxins. 13

## 2. Improvement of air quality on roadside

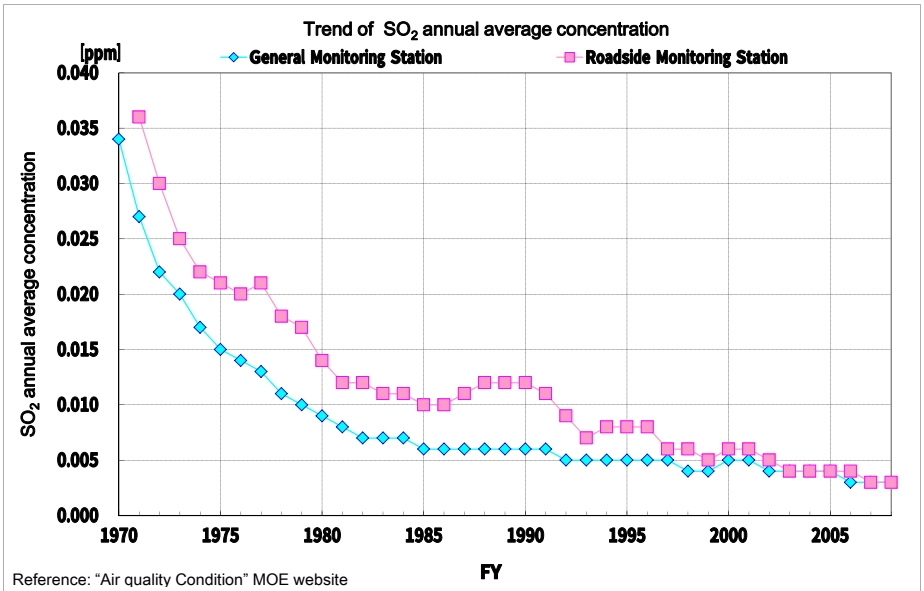
### (5) SOx (Discharge situation by source)




データ出典：OECD, OECD Environmental Data Compendium 2006/2007, Air 14

## 2. Improvement of air quality on roadside

### (5) $SO_2$ (Trend of annual average concentration)




Reference: "Air quality Condition" MOE website

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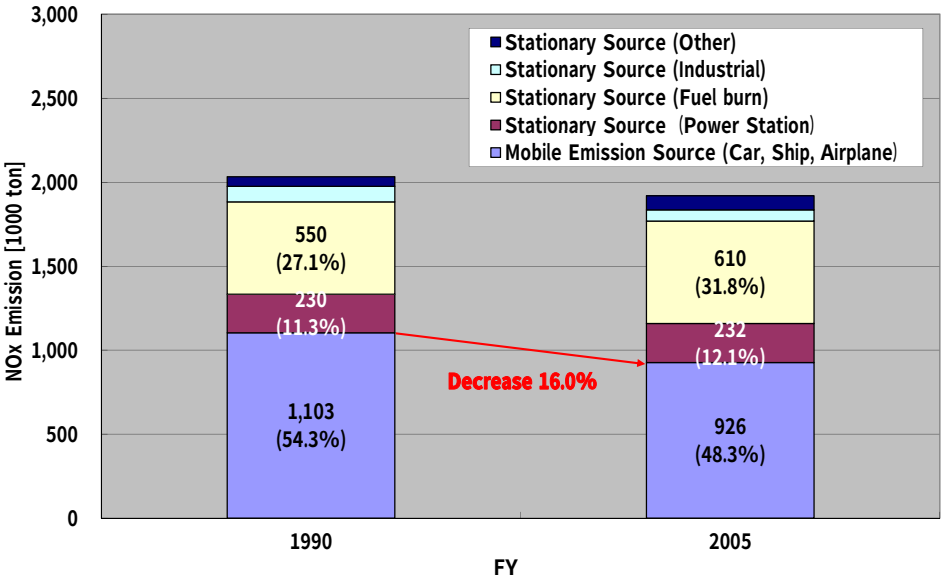
## 2. Improvement of air quality on roadside

### (6) NOx (Discharge situation by source)




データ出典：OECD, OECD Environmental Data Compendium 2006/2007, Air

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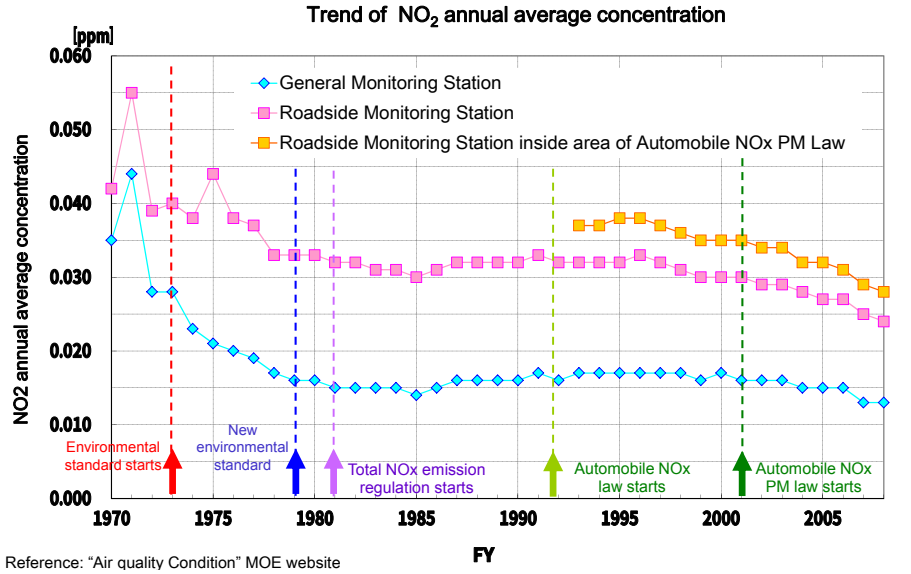
## 2. Improvement of air quality on roadside

### (6) $NO_2$ (Trend of annual average concentration)




Reference: "Air quality Condition" MOE website

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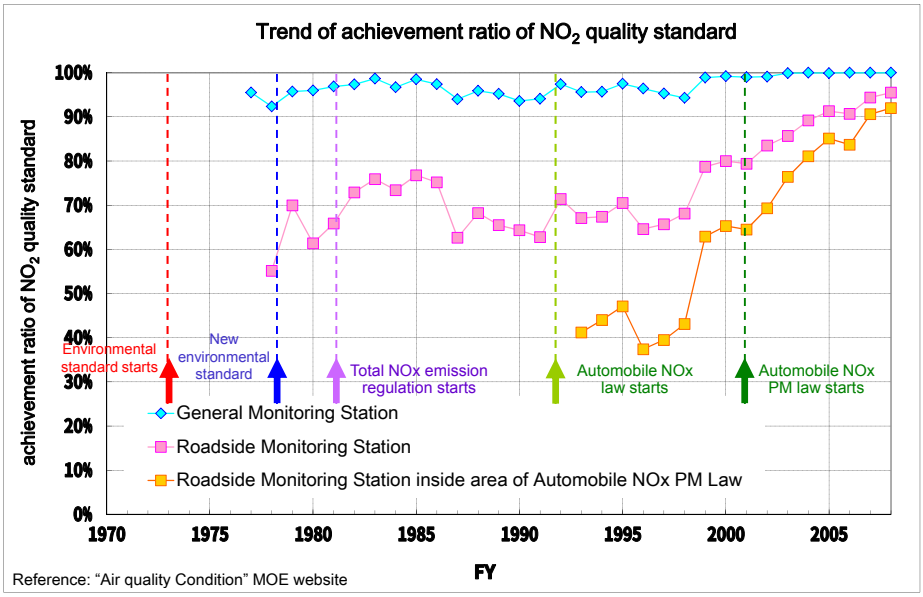
## 2. Improvement of air quality on roadside

### (6) $NO_2$ (Trend of achievement ratio of standard)




Reference: "Air quality Condition" MOE website

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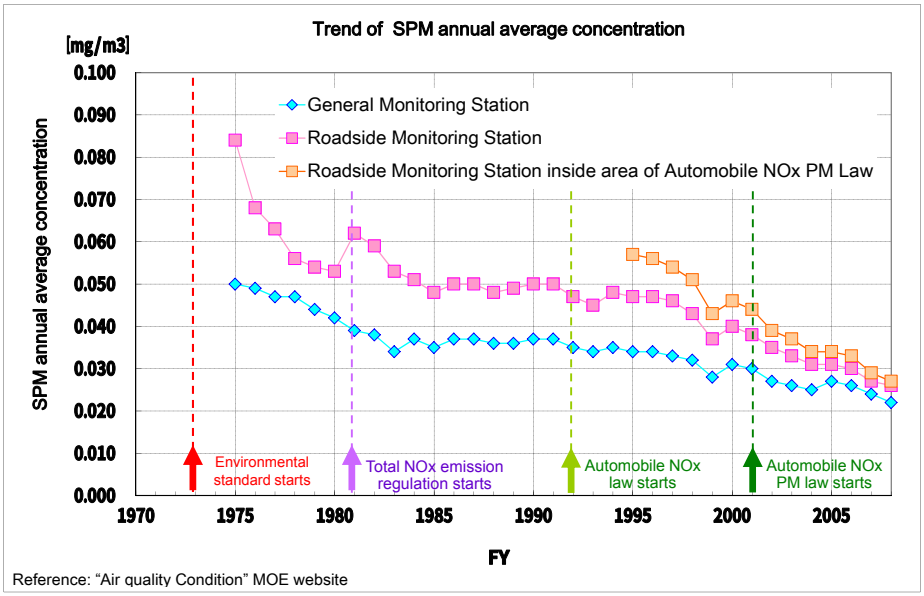
## 2. Improvement of air quality on roadside

### (7) SPM (Trend of annual average concentration)

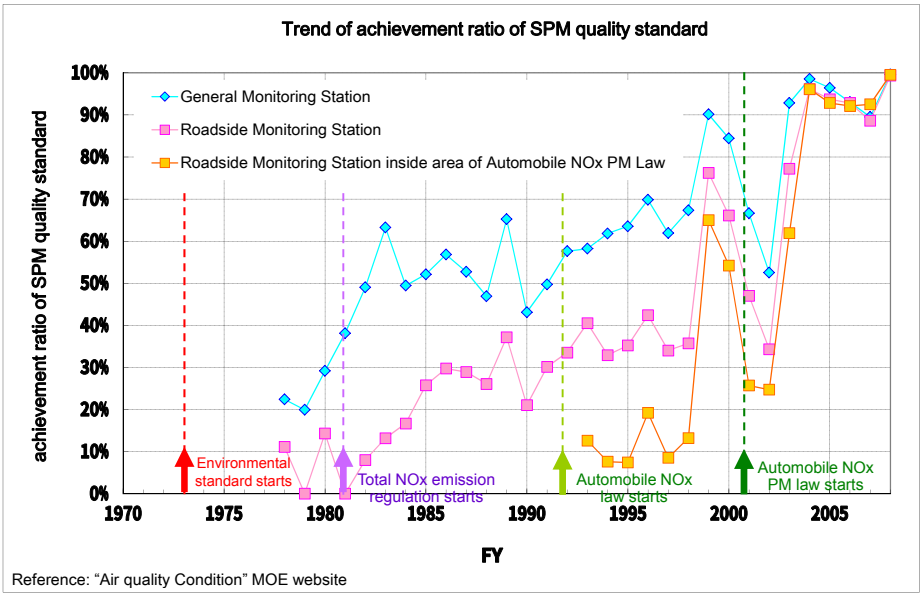



Reference: "Air quality Condition" MOE website

19

## 2. Improvement of air quality on roadside

### (7) SPM (Trend of achievement ratio of standard)




Reference: "Air quality Condition" MOE website

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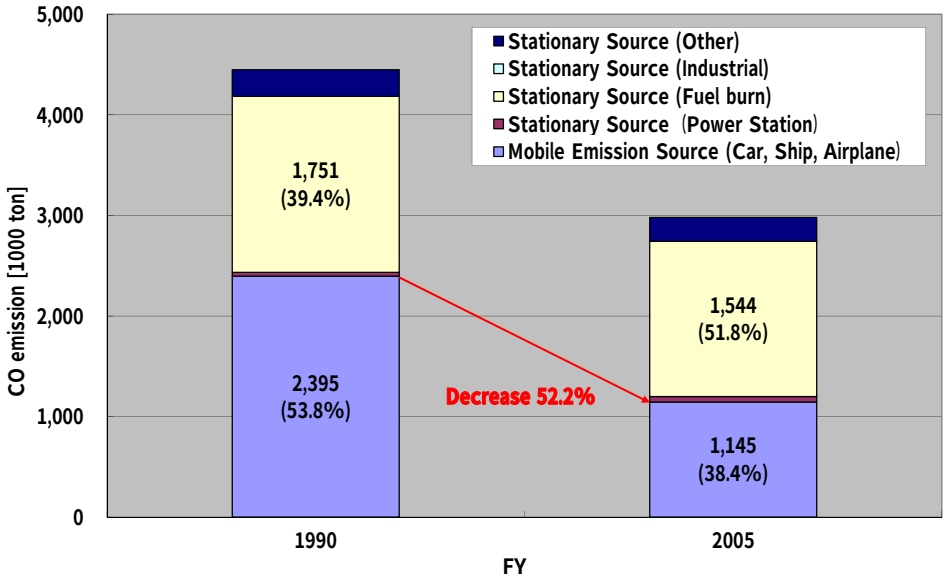
## 2. Improvement of air quality on roadside

### (8) CO (Discharge situation by source)

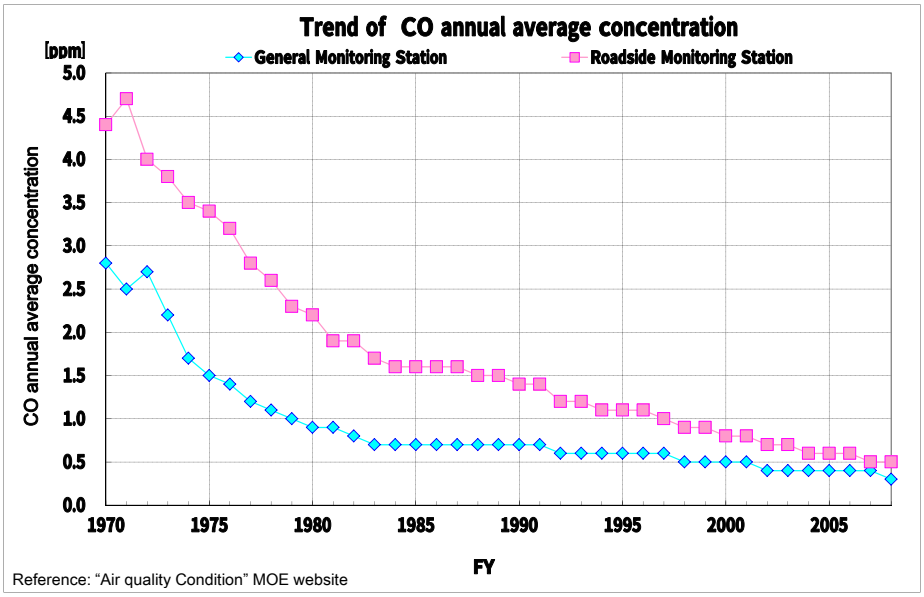



データ出典：OECD, OECD Environmental Data Compendium 2006/2007, Air



## 2. Improvement of air quality on roadside

### (8) CO (Trend of annual average concentration)

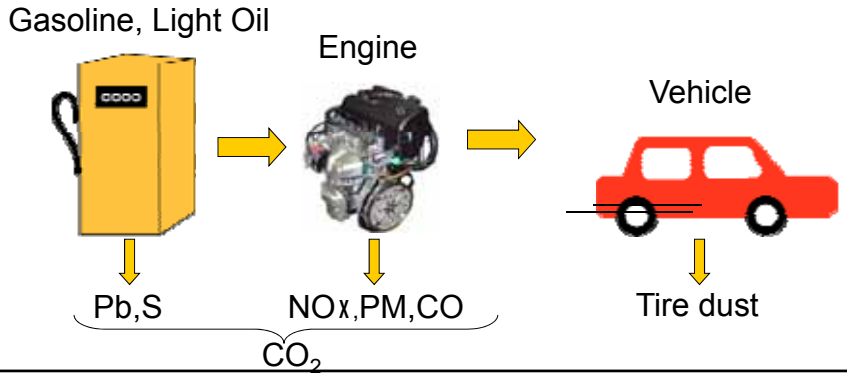



Reference: “Air quality Condition” MOE website

## 2. Improvement of air quality on roadside

### (9) Basic Idea of improvement of air quality on roadside

- Basic idea is to restrain emissions in outbreak source.
- Factor of air pollution is lead (Pb) of gasoline, sulfur (S) of light oil and nitrogen oxide (NOx) , particulate matter (PM) , carbon monoxide (CO) occurring by engine combustion process. So regulations regarding these matters strengthen step by step after 1970's.
- Dust pollution of spike tire is recognized as a social issue in snow areas, so prohibited from sale in 1991.

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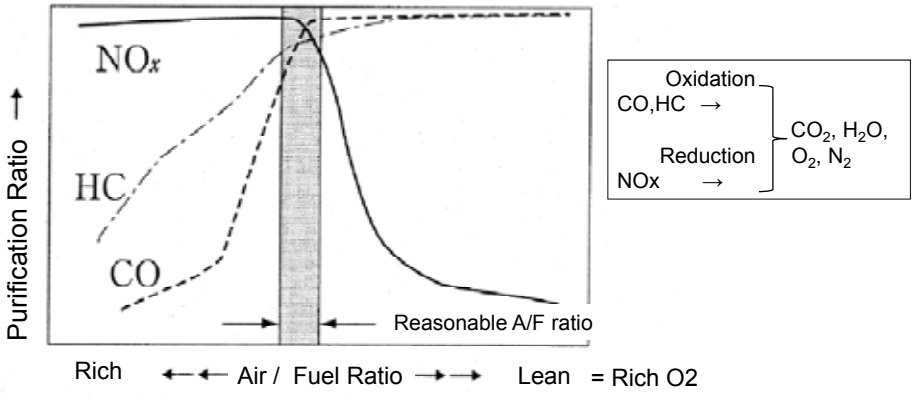
## 2. Improvement of air quality on roadside

### (9) Basic Idea of improvement of air quality on roadside

- In exhaust purification, it is necessary to control air fuel ratio adequately.




Purification characteristic of Three-way Catalyst to reduce emissions

Source : The Handbook regarding Automobile Techunology, Japan Automobile Manufactures Association, Inc.

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## 3. (1) Improved fuel economy of individual car

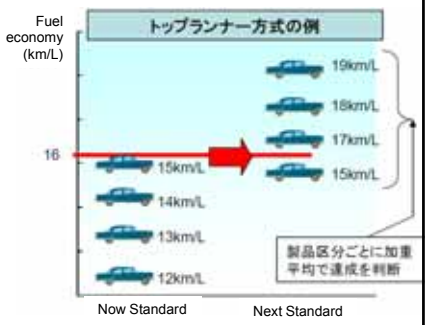
### 1) Higher fuel efficiency standards

- Fuel economy's standard of Gasoline passenger vehicle are intorduced in 1985, and strengthen step by step.
- About other car types, similar standard are introduced gradually.
- Japan adopt Top Runners Approach on discussion of fuel economy standard.

<History of fuel economy standard>

1979 :
Establish of Law Regarding Rationalization of Energy Use
Settle of Standard in 1985 for Gasoline passenger vehicle
1993 :
Settle of Standard in 2000 for Gasoline passenger vehicle
1996 : Settle of Standard in 2003 for Gasoline truck
1998 : Amendment of Law Regarding Rationalization of Energy Use, Introduction of Top Runners Approach
1999 : Settle of Standard in 2005 for Diesel passenger vehicle and truck, Standard in 2010 for Gasoline passenger vehicle and truck
2003 : Settle of Standard in 2010 for Liquefied Petroleum Gas vehicle
2006 : Settle of Standard in 2015 for truck and bus
2007 : Settle of Standard in 2015 for passenger vehicle and small bus and truck
2010 : Now discussing Standard in more future

<Summary of Top Runners Approch>




Source : MLIT website

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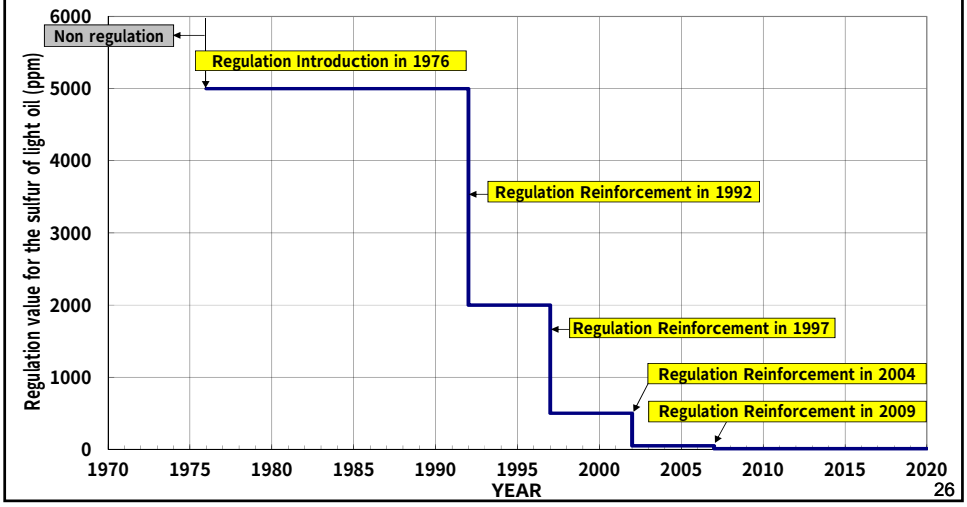
## 3. (1) Improved fuel economy of individual car

### 2) Regulation of Surfur in Light Oil

- About sulfur content in light oil, Japan reinforce step by step after regulation introduction in 1976. (2007's content is about one-500th of 1978's. )
- About lead of gasoline, Japan realize completely lead-free by 1987.

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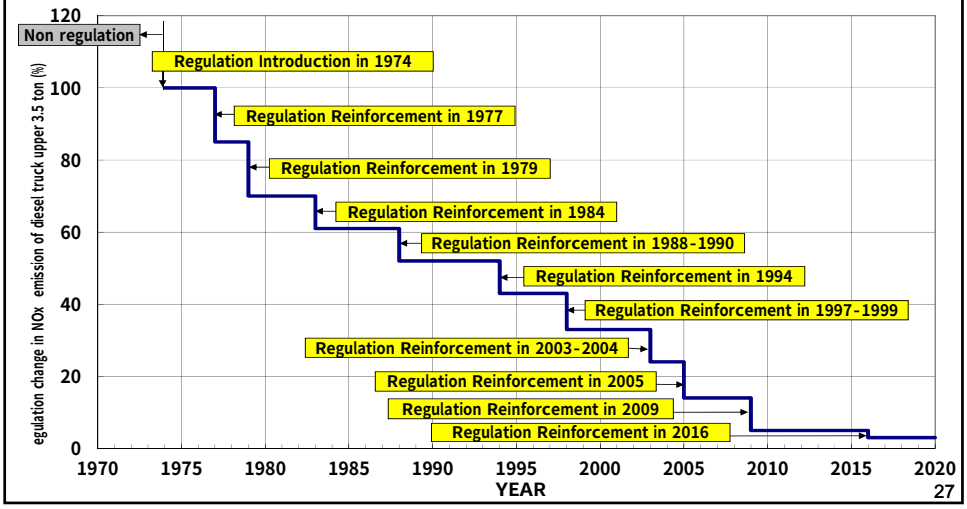
## 3. (1) Improved fuel economy of individual car

### 3) Regulation of car emissions (NOx, PM, etc.)

- About NOx emissions of Diesel large vehicle, Japan reinforce step by step after regulation introduction in 1974. (2016's value is about three-100th of 1974's. )
- About other car types, similar standard are introduced gradually.

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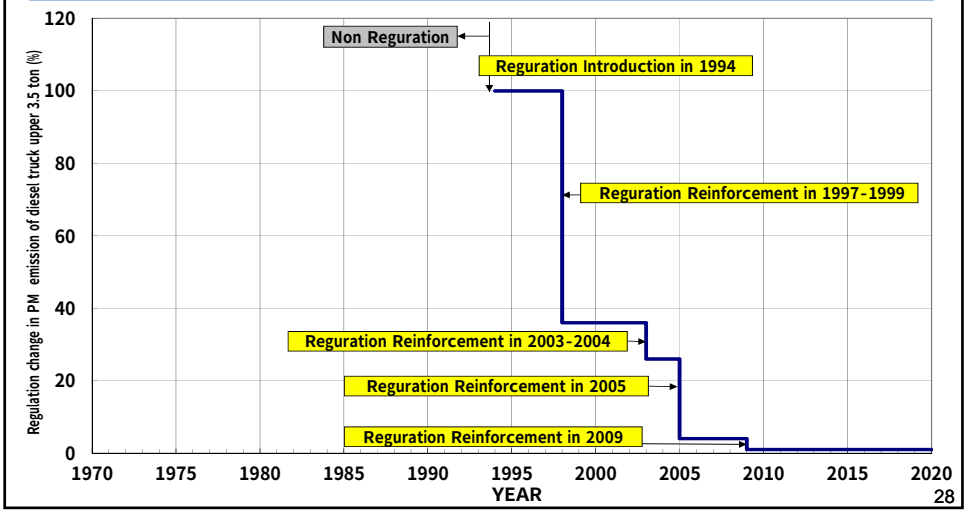
## 3. (1) Improved fuel economy of individual car

### 3) Regulation of car emissions (NOx, PM, etc.)

- About PM emissions of Diesel large vehicle, Japan reinforce step by step after regulation introduction in 1994. (2016's value is about one-100th of 1994's. )
- About other car types, similar standard are introduced gradually.

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## 3. (1) Improved fuel economy of individual car

### 4) Development of Next-Generation Vehicles

- For middle long term, it is necessary to shift to positive use of high electric energy of energy efficiency from conventional fossil fuel.
○So it is important that technology development and spread about new generation vehicles such as electric vehicle, plug-in hybrid vehicle, fuel-cell vehicle.


Source : Japan Automobile Manufactures Association, Inc. website

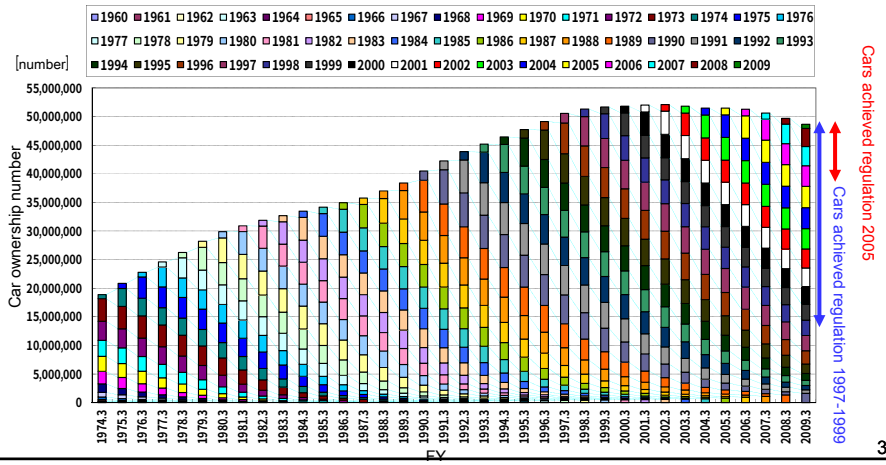


## 3. (1) Improved fuel economy of individual car

### 5) Promotion of spread about Eco-car

- Spread of vehicles satisfied latest emission reguration and fuel economy standards needs a long time, because replacement of vehicle is about 5-10 years.
- So diffusion rate of vehicle satisfied latest emission reguration conformity is about 20-30 percent in 2010.

Trend of car ownership number by model year

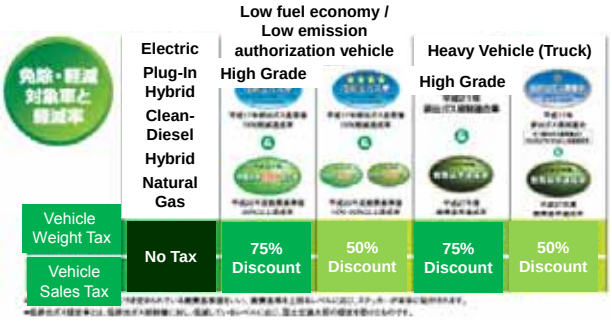


## 3. (1) Improved fuel economy of individual car

### 5) Promotion of spread about Eco-car

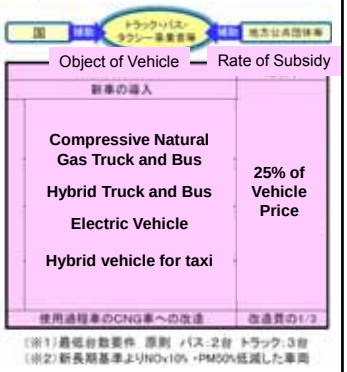
- To promote spread of eco-car, it is necessary courtesy to these.
- Japan intdoduced reduction of taxes and purchase subsidy for a period.

<Summary of tax reduction about eco-car>




Source : Japan Automobile Dealers Association website

<Summary of subsidy about eco-car to logistic enterprise>




Source : MLIT website

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## 3. (1) Improved fuel economy of individual car

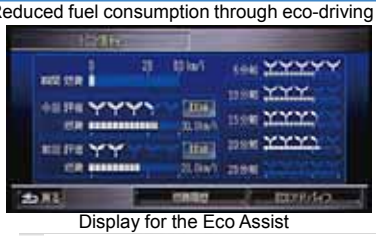
### 6) Eco-driving and other driving methods

- Vehicle emissions change by characteristic of individual's driving and speed up-down.
- So it is effective to reduce of CO2 emissions that Accelerators gently, using engine braking, idling stop, etc.

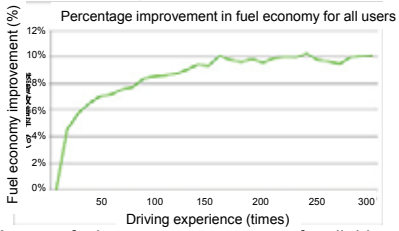
<Recommend about Eco-Driving>


1) Accelerators gently,
2) Avoiding unnecessary acceleration and deceleration,
3) Using engine braking,
4) Restraint of using air-conditioner,
5) Employing idling stop, etc.

<Reduced fuel consumption through eco-driving >



Display for the Eco Assist




Average fuel economy improvement for all drivers

Source : Honda Motor Co., Ltd., website

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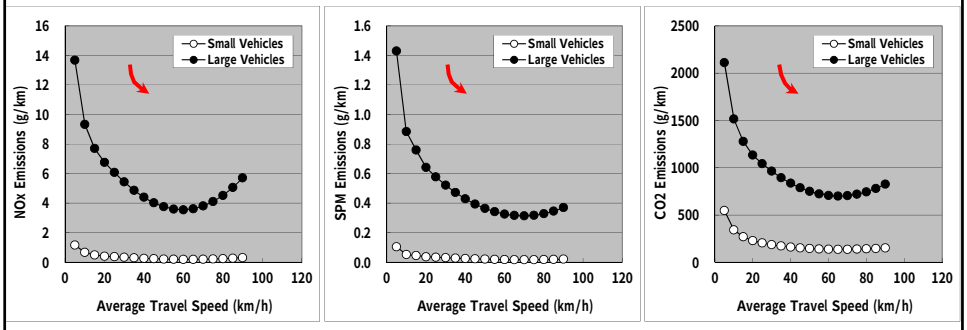
## 3. (2) Improved Traffic Flow

### ①Relation of travel and vehicle emission

- Vehicle emissions are higher in low-speed and decrease as travel speed increases, not only CO2 but also NOx and PM.
- So, on congested roads, traffic flow smoothing to move traffic to optimal speed zones is an effective means of reducing CO2 emissions and improvement air quality on roadside.

NOx PM CO2

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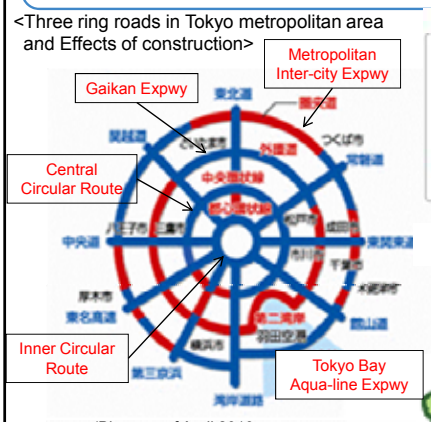
## 3. (2) Improved Traffic Flow

### 2) Construction of Ring Roads in Urban Areas and Bypass

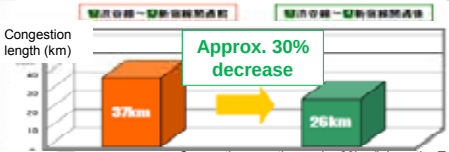
- Major cause of congestion in urban areas is traffic with no business in the city center. So ring roads contribute to rerouting of such traffic, easing traffic congestion and reduction of CO2 emissions.

<Three ring roads in Tokyo metropolitan area and Effects of construction>




(Blue : as of April 2010,
Red : not yet completed)

Source : MLIT website


Congestion : section under 20km/h in entire Tokyo expressway

**CO2 approx. 34,000 tons / year Reduction**

Estimate for expressways and ordinary roads in Tokyo Capital Region (4 prefectures)

Source : Metropolitan Expressway Co., Ltd., website

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## 3. (2) Improved Traffic Flow

### 3) Elimination of Bottlenecks

- Grade separation project of intersection and Measures for bottleneck railroad crossings is effective of easing traffic congestion and reduction CO2 emissions.

＜Grade separation project of intersection (Ordinary National Highway Route 17)＞

Before intersection grade separation

After intersection grade separation

＜Measures for bottleneck railroad crossings (Keikyu Line grade separation projest)＞

Before elevated railway bridge

After elevated railway bridge

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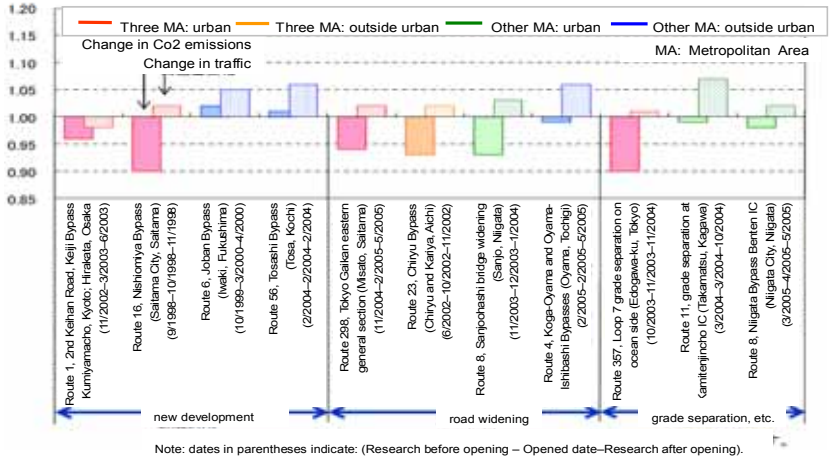
## 3. (2) Improved Traffic Flow

### 4) Effect of various measures to reduce congestion

- By measures to easy traffic congestion, although local traffic density tends to increase, total CO2 emissions f tends to decrease.

＜Changes in CO2 emissions due to bypass construction, lane widening and intersection grade separation＞




Note: dates in parentheses indicate: (Research before opening – Opened date–Research after opening).

Source : Report by Council on Road Measures to Prevent Global Warming in Japan

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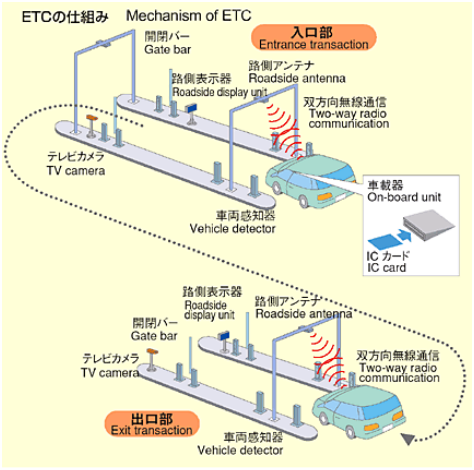
## 3. (2) Improved Traffic Flow

### 5) Utilization of ITS Technology

- Cancellation of temporarily stop on tollgate by ETC and offer of traffic congestion informations to drivers by VICS contribute to easy congestion and reduce CO2, too.

<Mechanism of ETC>




<Traffic congestion guidance using VICS>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## 3. (2) Improved Traffic Flow

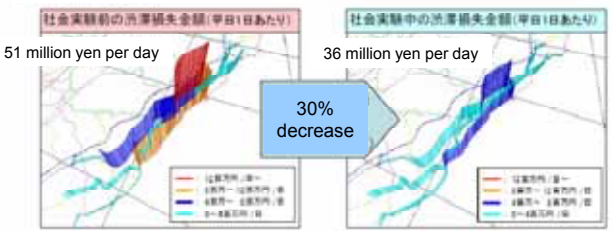
### 6) Various and flexible discount for expressway use

- In section where traffic congestion of general road is remarkable, reducing price for toll road side by side contribute to relax traffic congestion and reduce CO2 emissions.

< Example of various and flexible discount for expressway use >


Traffic volume : Expressway is 7% increase,
National road is 8% decrease
Time required : National road is 30% decrease

< Change of congestion loss cost >




Before toll discount　　After toll discount

Source : MLIT website

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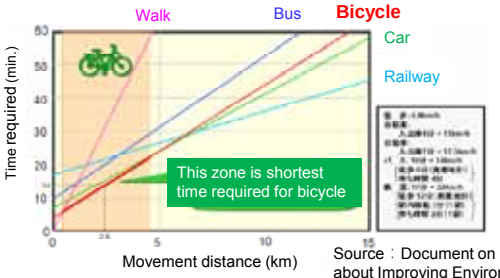
## 3. (3) Diverting and Reduction of road traffic

### 1) Improving Environments for cycling

- Bicycle is most effective for trip within 5km.
- So Japan promote construction of bikeway and bicycle parking near stations.

<Relation of movement distance and time required by transport mode>




Source：Document on conference of new idea about Improving Environments for cycling

<Example of Improving Environments for cycling >

bikeway

Bikeway on sidewalk

bicycle parking near station

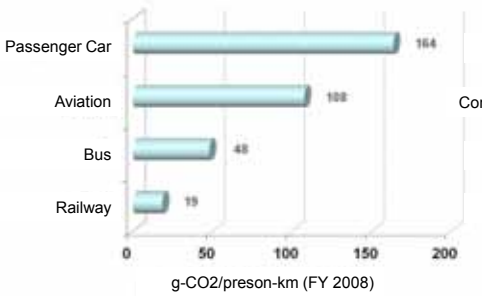


## 3. (3) Diverting and Reduction of road traffic

### 2) Promote Transit

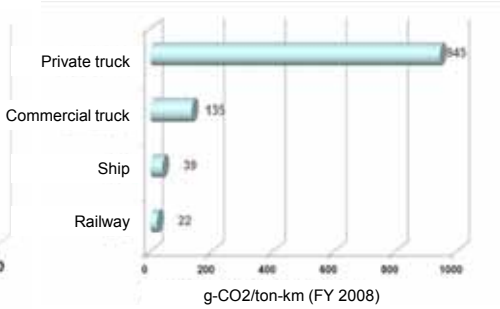
- Buses and railways amit less CO2 per person-km than passenger cars.
- Commercial trucks emit less CO2 pre ton-km than presonal truck, ship and railway emit even less.

< CO2 emissions per person by transport mode >




g-CO2/preson-km (FY 2008)

< CO2 emissions per cargo volume by transport mode >




g-CO2/ton-km (FY 2008)

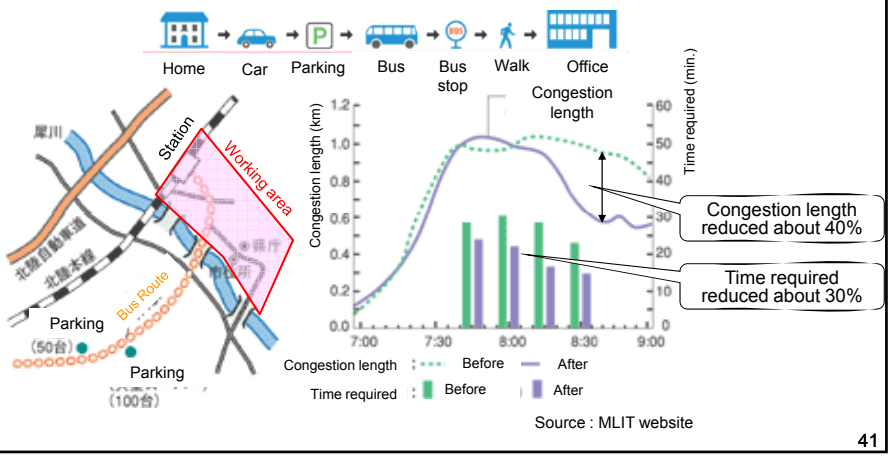
Source : MLIT website

## 3. (3) Diverting and Reduction of road traffic

### 2) Promote Transit

- It is necessary for CO2 reduction to shift automobile traffic to transportation mode such as buses and railways.
- “Park and Ride” is one of these measures (Traffic Demand Management).

< Traffic congestion reduction effect by adoption of park and ride >




Source : MLIT website

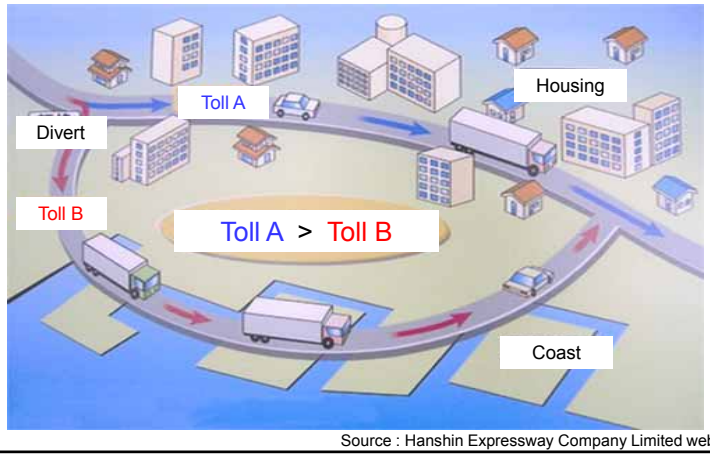
41

## 3. (3) Diverting and Reduction of road traffic

### 3) Environmental Road Pricing

- In areas where air is polluted with NOx etc. , particularly in sections where traffic congestion is remarkable, through truck traffic can be routed around by implementing environmantal road pricing to lower tolls on detour routes.
- This can shift traffic and contribute to easing traffic congestiion.

< Image of environmental road pricing >




Source : Hanshin Expressway Company Limited website

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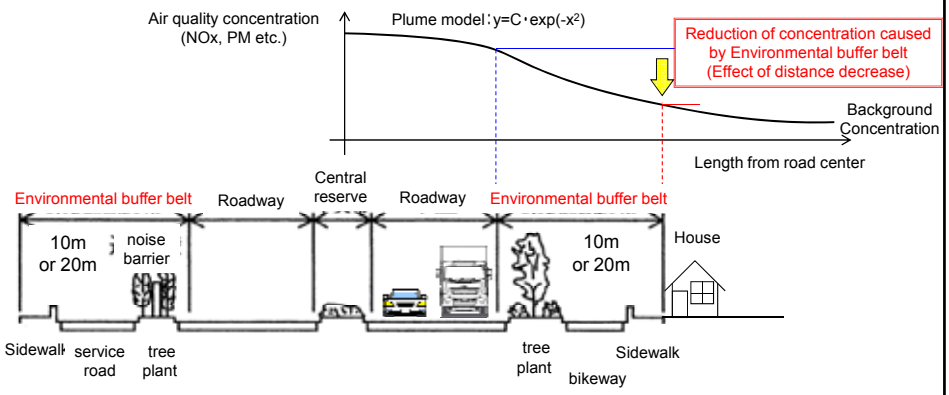
## 3. (4) Other measures for Air quality

### 1) Environmental Buffer Belt

- Construction of environmental buffer belt contributes to improve of air quality environmental on roadside by keep away distance of roads and houses.




Source : Commentary and use of road structure law, Japan Road Association, 2004



## 3. (4) Other measures for Air quality

### 2) SPM / NO2 Removal System in ventilation towers

- SPM removal system (electrostatic precipitator) and $NO_2$ removal system (absorption) are installed in ventilation towers in areas where air quality is still bad.
- Effects: More than 80% of SPM and 90% of $NO_2$ are removed.

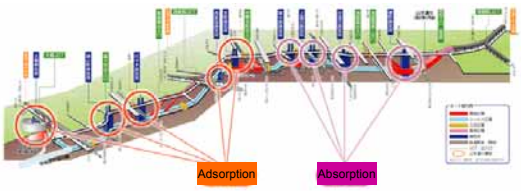
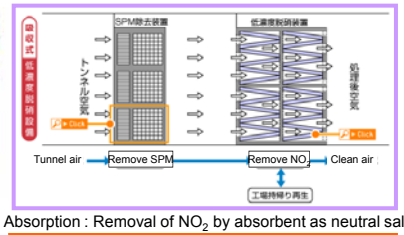
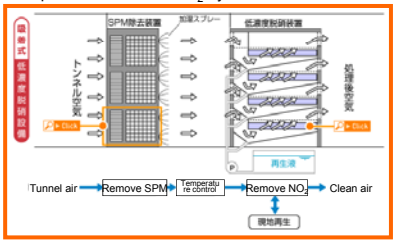



Figure of Central Ring Road Shinjuku Line


Figure of a ventilation station




Absorption : Removal of $NO_2$ by absorbent as neutral salt




Adsorption : Removal of $NO_2$ by adsorbent

Source: Metropolitan Expressway Co. Ltd website

November 18, 2010 The 19th Meeting on Public Works Research and Development in Asia
Presentation for about 30 minutes

# Actions of road traffic measure to contribute reduction Greenhouse Gas from transport section and improvement of air quality on roadside in Japan


## Manabu DOHI

Senior Researcher, Road Environment Division,
National Institute for Land and Infrastructure Management,
Ministry of Land, Infrastructure, Transport and Tourism




## ABOUT TODAY'S PRESENTAION MENU

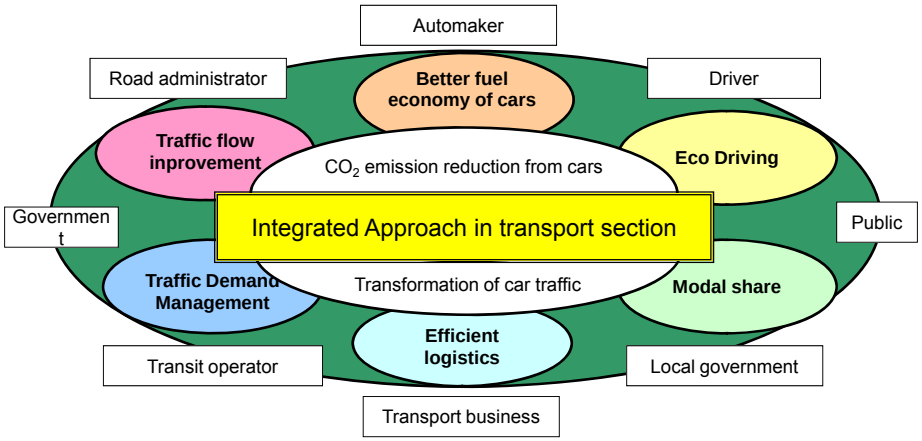
1. Reduction Green House Gas from transport section
   - *$CO_2$ emission from transport section,*
   - *Law system about prevention of global warming,*
   - *Basic Idea of CO2 emission reduction from road traffic*

2. Improvement of air quality on roadside
   - *History of Air Pollution, Discharge process of material,*
   - *Law system about Air pollution, Standard and Achievement,*
   - *Basic Idea of improvement of air quality on roadside*

3. Actions of road traffic measure in Japan, to contribute 1.&2.
   - *Improved fuel economy of individual car*
   - *Improved Traffic Flow*
   - *Diverting and Reduction of road traffic*
   - *Other measures for Air quality*

# 4. Conclusion

- In ordar to reduce CO2 emissions in transport section and improve air quality on roadside, it is important to take a integrated approach in which various sectors such as roads, automobiles, transport planning, logistics, and urban planning

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# Ⅴ-9. Lecture

# “Promotion of roadside noise abatement based on Environmental Impact Assessment”

Mr. Hiroshi YOSHINAGA

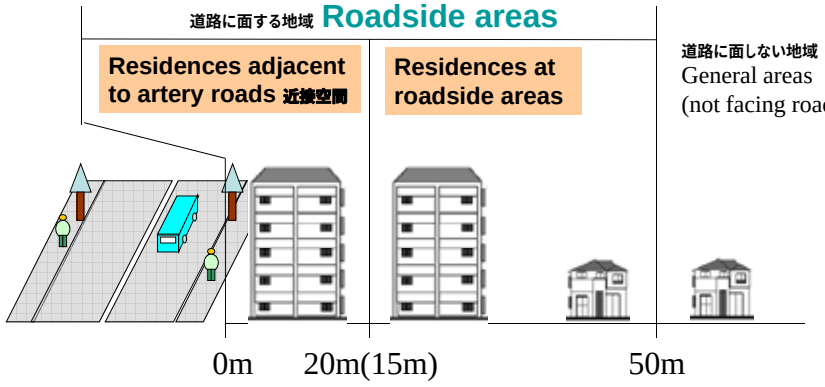
# 13 Promotion of roadside noise abatement based on Environmental Impact Assessment

**Mr. Hiroshi YOSHINAGA**
**Senior Researcher,**
**Road Environment Division,**
**Environment Department, NILIM**

## Promotion of roadside noise abatement based on Environmental Impact Assessment




## 騒音の環境基準 Environmental Quality Standards for Noise

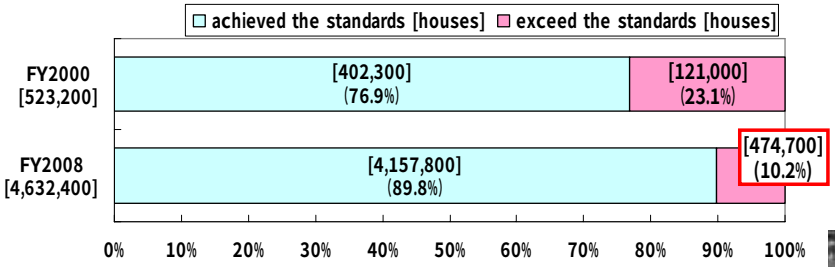



| | | |
|---|---|---|
| 昼間 Daytime (6:00-22:00) | 70dB | 60 dB (A)<br>65 dB (B,C) |
| 夜間 Nighttime (22:00-6:00) | 65dB | 55 dB (A)<br>60 dB (B,C) |

(地域の類型 Area type)

## 騒音の状況 Current status of road traffic noise in Japan

Evaluation of `Environmental Quality Standards for Noise' at the Areas Facing Roads

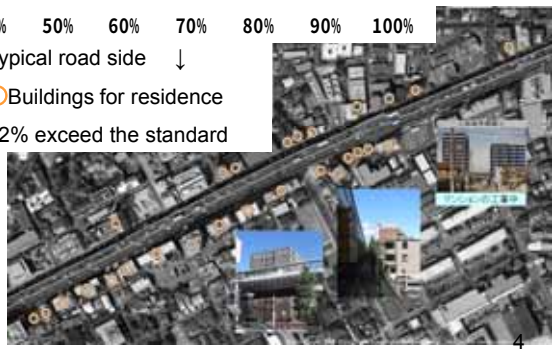



↑ Ministry of the Environment, FY2008
Express way(1,165km), National Highway(9,687km), State road etc. (15,302km)

Typical road side ↓

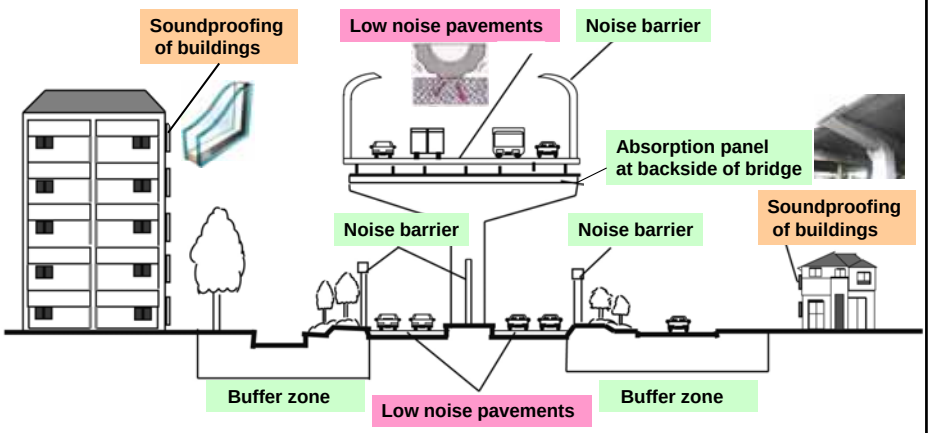
○Buildings for residence

82% exceed the standard



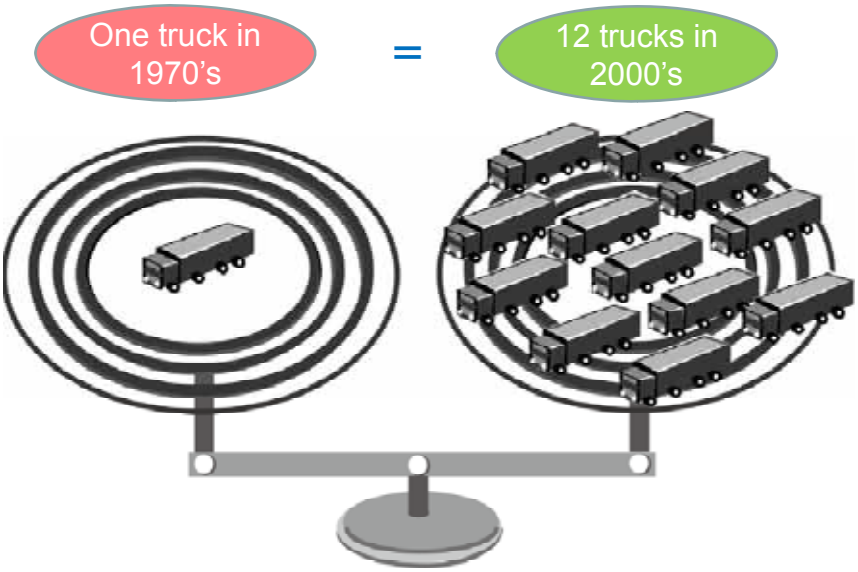
4

## 騒音対策 Noise Abatement Measures



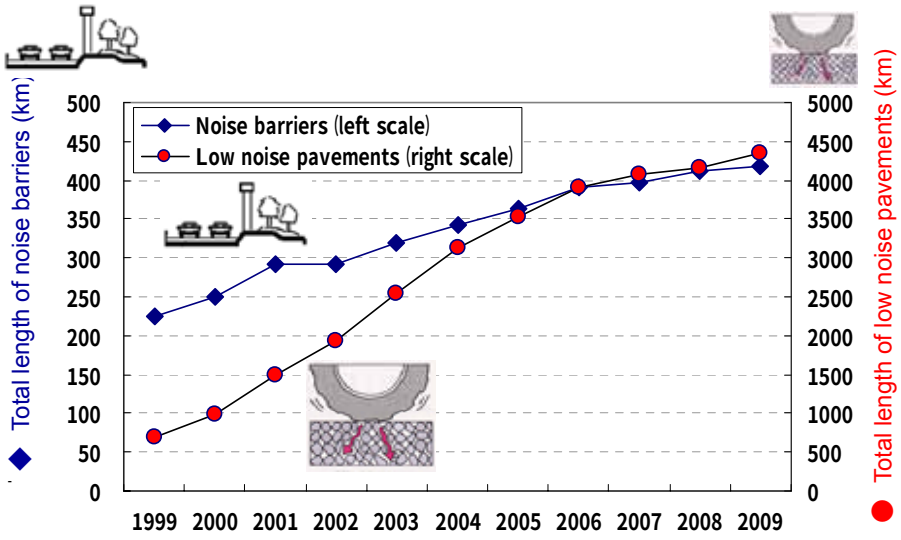

| Noise control at sound source | Noise control on propagation route | Noise control at sound receiving point |
|---|---|---|
| Vehicle Unit Regulation<br>Low noise pavements<br>Regulation on speed | Noise barrier, Absorption panel at backside of bridge<br>Adoption of underground road structure<br>Buffer zone | Soundproofing of buildings |

## 騒音対策 Noise Abatement Measures




**Vehicle Unit Regulation – acceleration noise energy**

## 騒音対策 Noise Abatement Measures




National Highway under Direct Control of Ministry of Land, Infrastructure, Transport and Tourism. 8817 km in 2009.

## 騒音対策 Noise Abatement Measures – Noise barrier

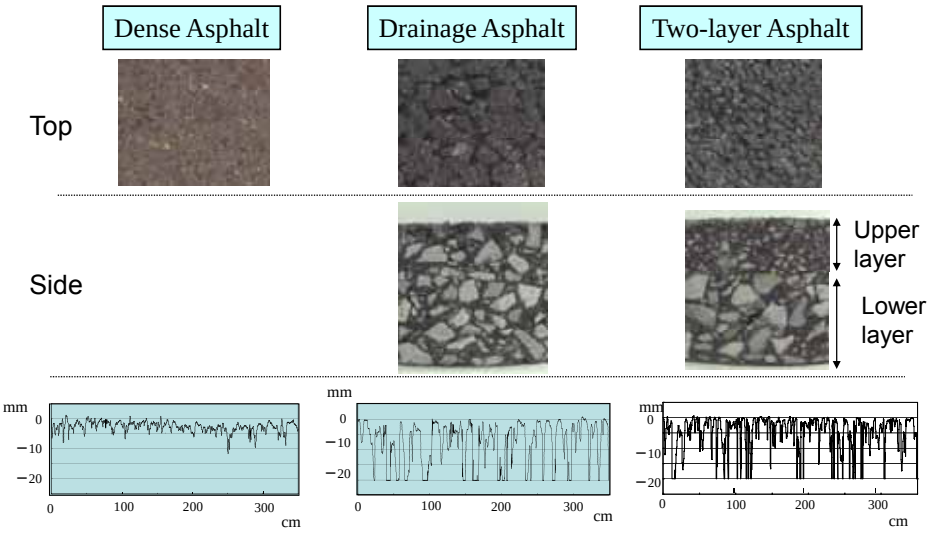
**Noise barriers**

| | | |
|---|---|---|
|  Translucency |  Large (8m high) |  Overhung |
|  Vegetation covered |  Edge modified |  Edge modified |

## 騒音対策 Noise Abatement Measures – Pavement

Textures of Dense, Drainage and Two-layer asphalt concrete pavement

- Two-layer asphalt concrete pavement has middle smoothness




## 計画的に施された騒音対策 Systematically executed noise controls

## based on Environmental Impact Assessment

# Ⅴ-10. Lecture
# “Pavement Technologies in Japan”

Mr. Kazuyuki KUBO

# Pavement Technologies in Japan

## ~Measures against Environmental Issues~

Kazuyuki KUBO, Leader, Pavement Team
Iwao SASAKI, Advanced Materials Team

Public Works Research institute
Japan

1

## Environmentally-friendly Pavement

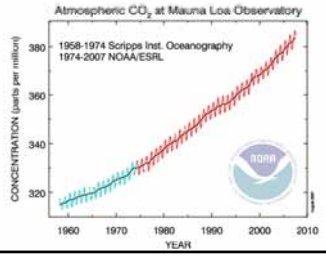
- Recycle use
  - Asphalt pavement
  - Byproduct
- Warm mix asphalt
- Cool pavement
  - Water retention pavement
  - Heat shield pavement
- Low noise pavement
- etc.

2

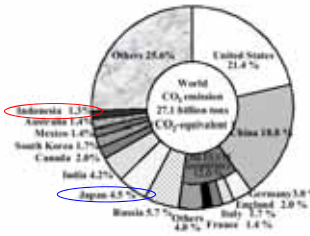
# Global Warming

- **IPCC Report**
  - **"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."**

$CO_2$ Monitoring in Hawaii

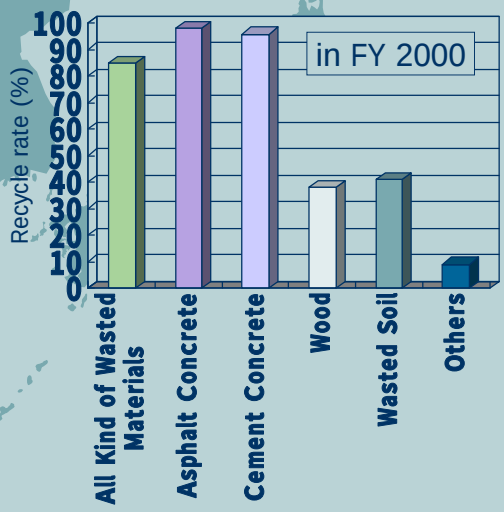



$CO_2$ Emission in each Country (2005)




3

# Percentage of Recycling of Wasted Materials in Japan




4

# Pavement Recycling Methods

- Plant recycling method
  - Surface (HMA), Base
- In-place base recycling method
- In-place surface recycling

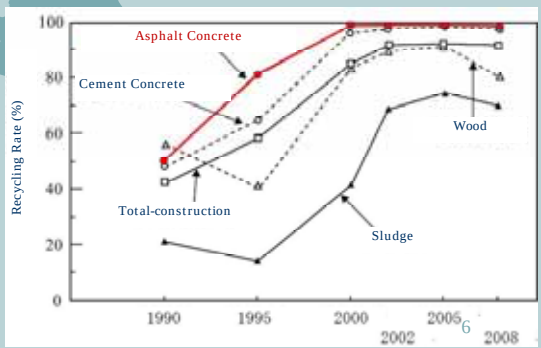

Plant recycling

In-place recycling

5

# Current Status: Asphalt Mixture Recycling in Japan

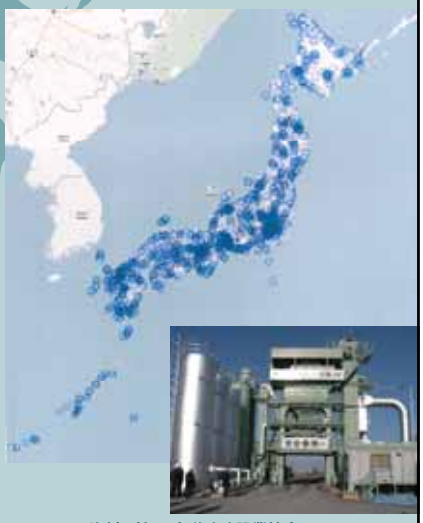
- Recycling techniques of RAP have spread.
  - Since 1970s
  - Technical guidelines
  - Law on Promoting Green Purchasing
- Recycling rate : 98 - 99 %




6

# $CO_2$ Emission in Pavement Field in JAPAN

- Total amount of CO2 emission in Japan was 1.3 billion tons in FY2000.
- The amount emitted from road relating field was about 2%.
  - Mainly from material production process
- Asphalt Mixtures
  - The share of asphalt pavements : 95%
  - The number of facilities : 1,223 (2006)
  - The amount of asphalt mixtures : 58million tons (2006)



資料:(社)日本道路建設業協会、
全国アスファルトプラント(20kmサービス圏)地図

7

# In-place Base Recycling Method

- At a roadwork site, crushing existing asphalt mixtures and mixing the product of this operation with existing granular base material and stabilizing agents such as cement and/or emulsified asphalt, then compacting this mixture to form a new base course.

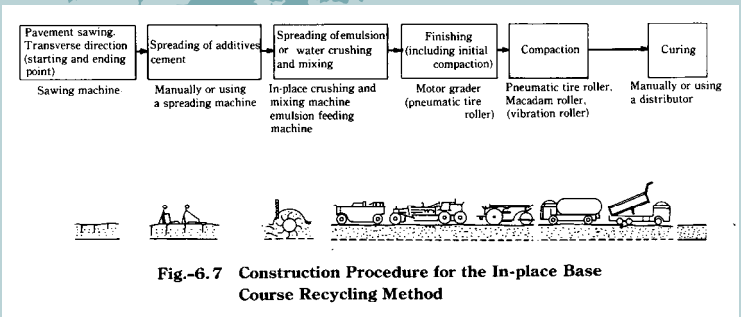



Fig.-6.7 Construction Procedure for the In-place Base Course Recycling Method

8

# In-place Surface Recycling

- At a roadwork site, heating the existing asphalt mixture, scarifying it to loosen the material, adding new asphalt mixture and/or rejuvenators as necessary, spreading and compacting it to create a new surface course or binder course.

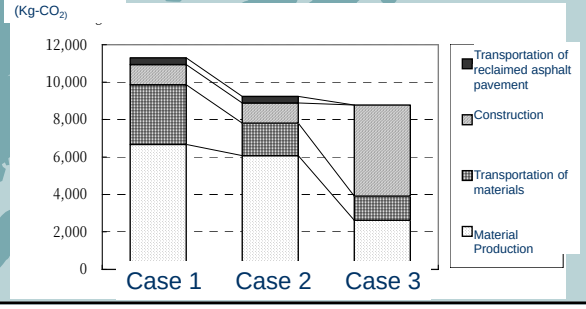
# Simulation of $CO_2$ emission in case of plant recycling and in-situ recycling

-Case 1: Cut and overlay (new aggregates)
-Case 2: 〃 (Plant recycling 60%)
-Case 3: In-situ recycling


Plant recycling

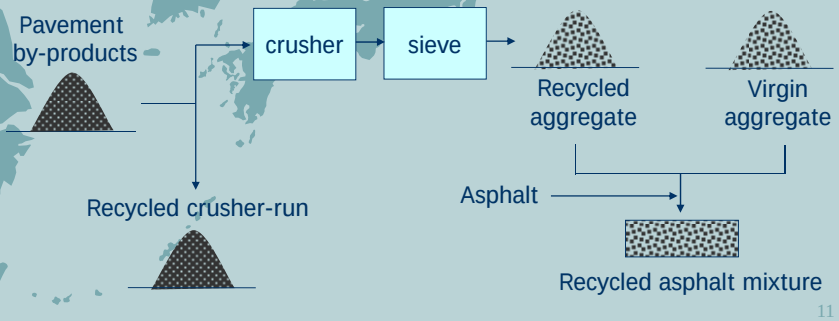
In-situ recycling

## Results



# Plant Recycling Method

- Recycling pavement material etc. at a stationary mixing plant (recycling mixing plant), and using it as pavement material.




11

# Recycled aggregate production, QC/QA

- Crushing

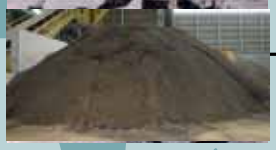
- Recycled aggregate

Density, asphalt binder content, asphalt penetration etc.

12

# Asphalt concrete recycling procedures

Recycled aggregate
(Used pavement)



Asphalt Mixture Recycle Plant

Rejuvenator

Recycled HMA

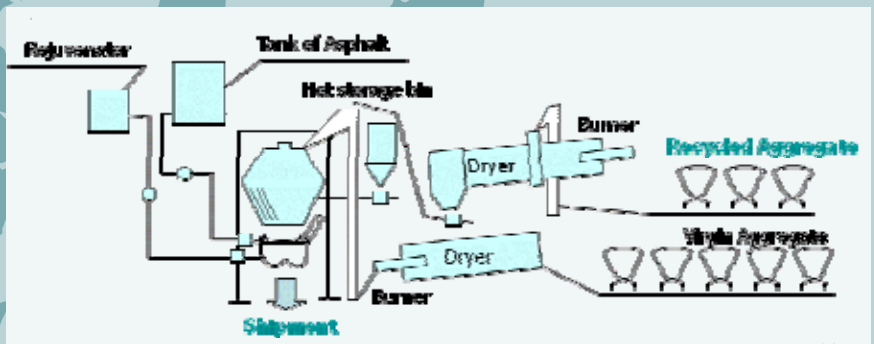
Virgin aggregate
Virgin Asphalt

13

# Asphalt concrete recycling plant

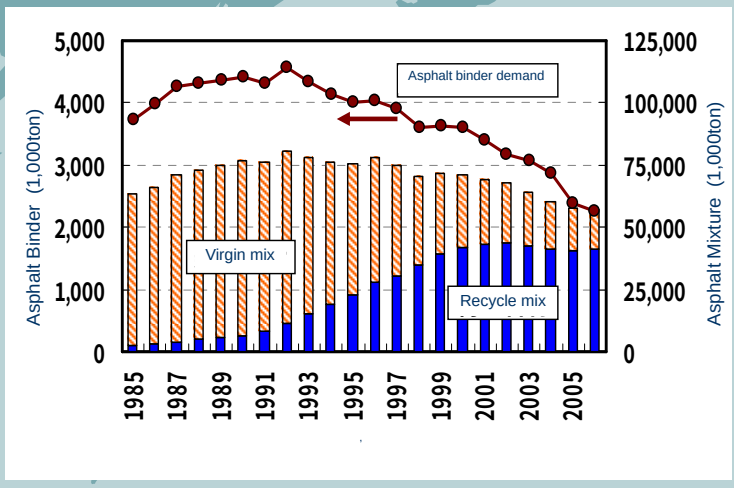
## - Twin dryer heating system -

- Drum dryer system
- Twin (attached) dryer system <- Most popular in Japan
- Single dryer (indirect-heating) system




14

# Plant Recycling




15

# Problems

- **Decline of penetration of aged asphalt contained in RAP.**

  **Pen＜20 : can not use**

  **Pen≧20 : OK**

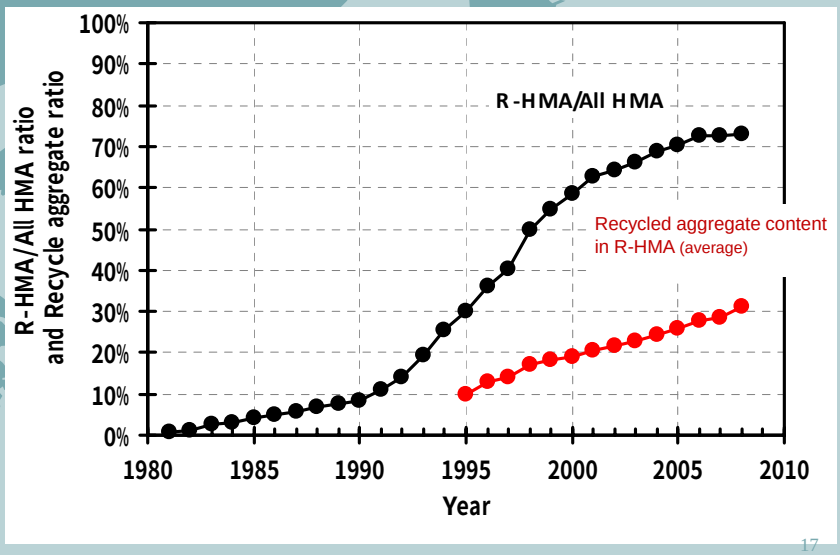
**1. Repeatedly recycled RAP increases**

**2. Polymer modified asphalt increase.**

- **Recycled asphalt mixture has already been promoted to use according to the following law**
  - **Law Concerning the Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (*Law on Promoting Green Purchasing*), enacted in FY2000**

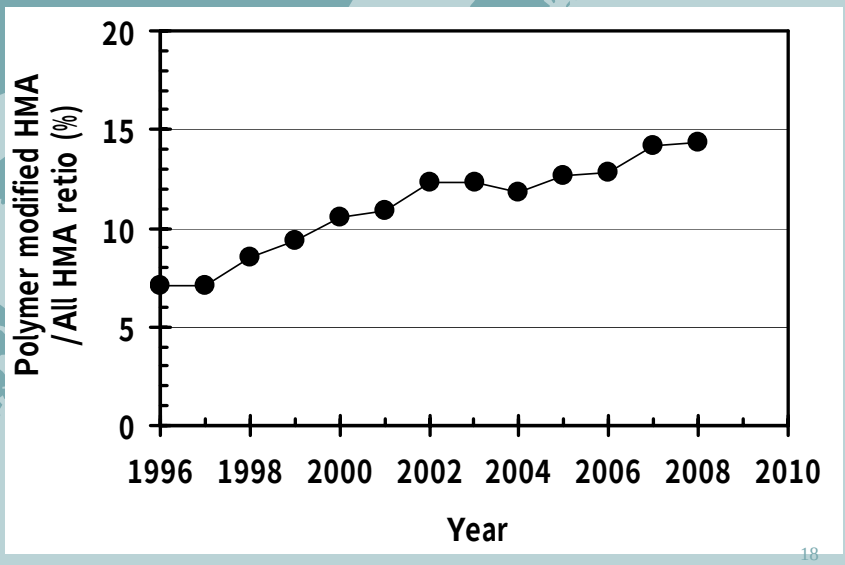
16

## Changes in R-HMA / All HMA ratio and RAP content in Japan



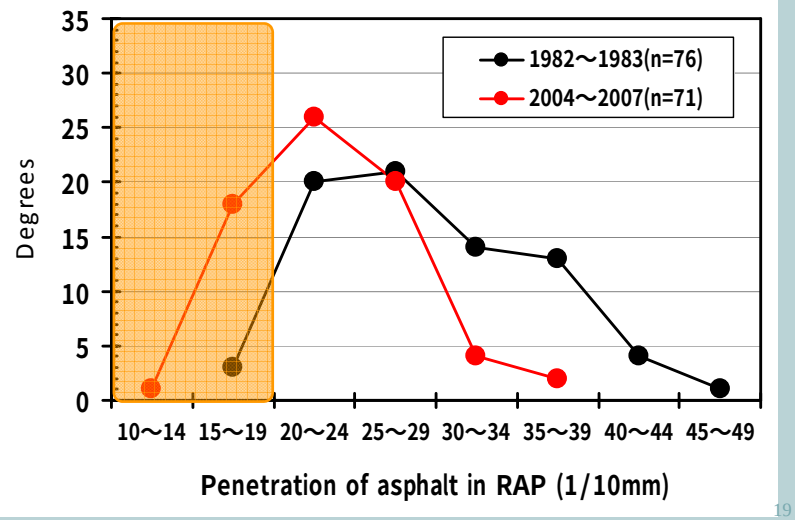

17

## Production of polymer modified asphalt mixture




18

## Penetration decline of asphalt in RAP (histogram)

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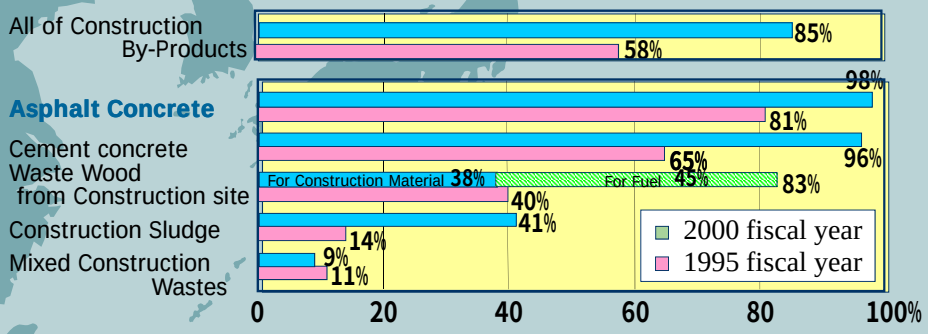
## Environmentally-friendly Pavement

- **Recycle use**
  - Asphalt pavement
  - **Byproduct**
- **Warm mix asphalt**
- **Cool pavement**
  - **Water retention pavement**
  - **Heat shield pavement**
- **Low noise pavement**
- **etc.**

20

# Recycling Ratio of Construction By-Products

- Recycling Ratio of Asphalt Concrete is Over 98%




21

# Typical wastes from other areas

Wood

Molten slag made from municipal waste and sewer sludge

Glass

Steel slag

Used tire rubber

Fly ash from electric power stations

22

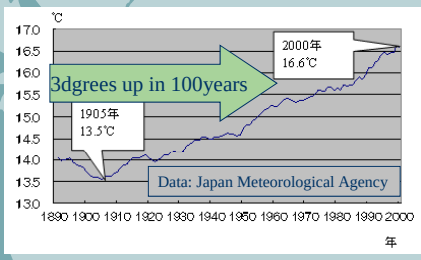
# Attention to use waste from other areas

- **Environmental Safety**
  - No seeping out of any harmful materials such as lead, chrome, etc.
- **Durability**
  - Equal strength with natural aggregate, such as hardness, wear-resist, etc.
- **Economical**
  - Not so expensive rather than natural aggregate
- **Stable supply**
  - Can be supplied with constant quantity and uniform quality
- **Sustainability**
  - Can be recycled in several times

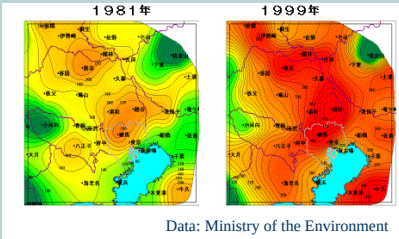
23

# Heat Island Effects in Japan

- **Caused by**
  - Increasing artificial land surface area (pavements etc.)
  - Increasing heat generated by our daily life (waste heat)
  - Decreasing water surface area
  - Others
- **Causes**
  - Heavy rainfall in very narrow urban area
  - Damage on human life




Annual Mean Temperature of Tokyo




Data: Ministry of the Environment

Days of Maximum Daily Air Temperature over 30 degree C

24

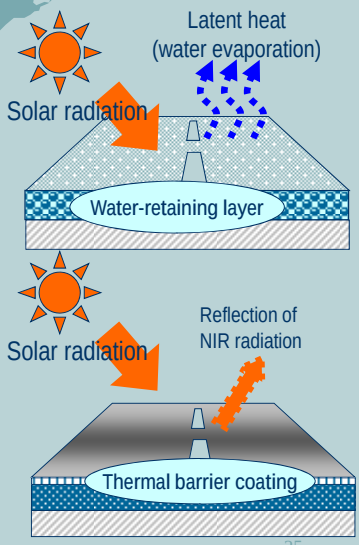
# Cool Pavement to mitigate the heat island effect

## Water retention pavement

- Store water inside pavement
- Uses the mechanism of latent heat

## Heat shield pavement

- Paint special coating
- Reflection of near-infrared ray (NIR)

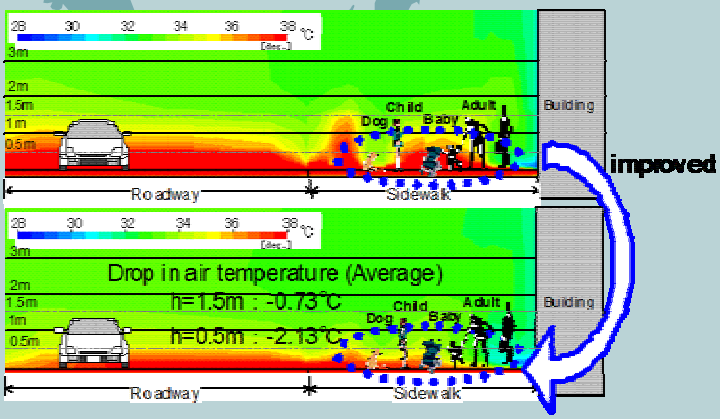



25

# Simulation Result

Compare with general pavement

- Maximum surface temperature … about -10℃
- Maximum air temperature … about -1 ℃(at 1.0m height)

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# Summery

- In Japan, the recycling ratio of reclaimed asphalt concrete is very high.
- Recycling is one of the most effective method to reduce CO2 emission in pavement field.
- In situ recycling is more effective than plant recycling.
- Recycle use of wastes from other areas is strongly expected, while there should be enough consideration about environmental safety.
- There are some challenging technologies such as cool pavement, which can drop the maximum road surface temperature.

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# Ⅴ-11. Lecture

# “The external force estimation for adaptation measures of storm surge protection in Japan”

Mr. Kenzi NOGUCHI

# The external force estimation for adaptation measures of storm surge protection in Japan

Yoshio Suwa
Head
Coast Division River Research Department
National Institute Land Infrastructure Management
Ministry of Land, Infrastructure, Transport and Tourism
Government of Japan

1

## Introduction

The reason why coastal protection are important in Japan.

2

**Overtopping by wind-blown waves in winter**

**(Itoigawa Coast, Itoigawa City, Niigata Pref.)**

Beach reclaim for road & Coastal erosion

3

Wave-induced damage to JR Hokuriku Line
(Omi Coast, Omi City, Niigata Pref.)

Coastal erosion

4

**Beach cliff immediately after the passage of typhoon**

**(Kita-kujukuri Coast, Asahi City, Chiba Pref.)**

5

**Beach cliff formed by coastal erosion**

**(Kaike Coast, Yonago City, Tottori Pref.)**

6

**Seawall damaged by Typhoon No. 23**

**(October 20, 2004; Nabae Coast, Muroto City, Kochi Pref.)**

Every year, 160 ha of beaches are lost to coastal erosion

7

# Use of coasts (1)

Marine activities

Jet ski
(Tei Coast, Yasu-cho, Kochi Pref.)

Clam digging
(Tsuyazaki Coast, Tsuyazaki-machi, Fukuoka Pref.)

Windsurfing
(Numazu Coast, Numazu City, Shizuoka Pref.)

8

# Use of coasts (2)

Tourism Events

T-shirt Fair
(Irino Coast, Ogata-cho, Kochi Pref.)

Sand art
(Irino Coast, Ogata-cho, Kochi Pref.)

9

# Use of coasts (3)

Culture & Education

Gatalympics
(Nanaura Coast, Kashima City, Saga Pref.)

Seaside summer school
(Yomiyama Coast, Tomiyama-machi,Chiba Pref.)

10

**Natural environments of coastal zones**

Sea turtle laying eggs (Moto Coast, Muroto City, Kochi Pref.)

Horseshoe crab (Tenjin Coast, Kasaoka City, Okayama Pref.)
(taken from Soji, N. and Sato,
Y., *Kabutogani*, Sanyo Shimbun, 1993)

Small fish gathering around artificial reef
(Kanezaki Coast, Genkai-machi, Fukuoka Pref.)

11

# Coastal conservation facilities

Revetment integrated with a park
(Kitamae Coast, Chatan-cho, Okinawa Pref.)

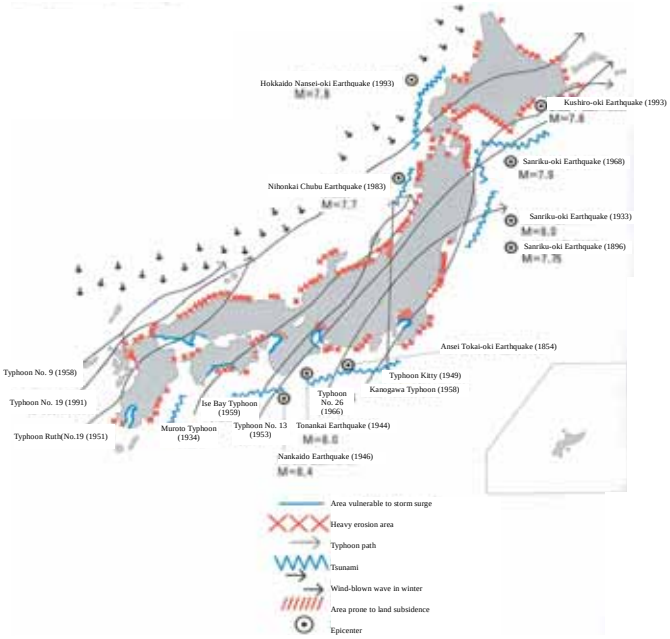
Gentle-slope levee
(Arao Coast, Arao City, Kumamoto Pref.)

Barrier-free slope
(Hoko Coast, Higashiura-cho, Hyogo Pref.)

Artificial Levee
(Ariake Coast, Higashiyoka-cho, Saga Pref.)

12

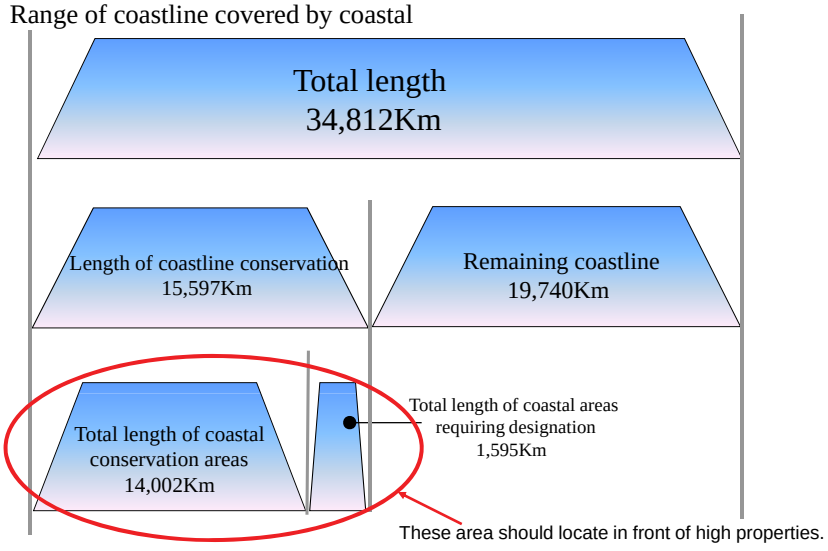
# Characteristics of coastal disasters




13

# Purpose and scope of coastal projects

■ Range of coastline covered by coastal




14

# Climate Change Adaptation Action
# by
# Coast Area by Coast Division, River Bureau

- To raise crown height of sea wall

To cope with sea level rise and intensified typhoons, concrete storm surge barriers should be rebuilt higher to enhance their protection capacities against intensified external forces, especially at a time of renewal, so that inundation occurs less frequently. In practice, barrier heights should be raised in stages in step with the progress of research on sea level rise and intensified typhoons:

Phase 1: The increased sea level is taken into account.

Phase 2: In addition to increased sea level, sea level rises expected in the future are taken into account based on the trend in sea level rise and prediction calculation. The service life of facilities in also taken into account.

Phase 3: In addition, the height of storm surges expected to increase due to more intense typhoons is taken into account.

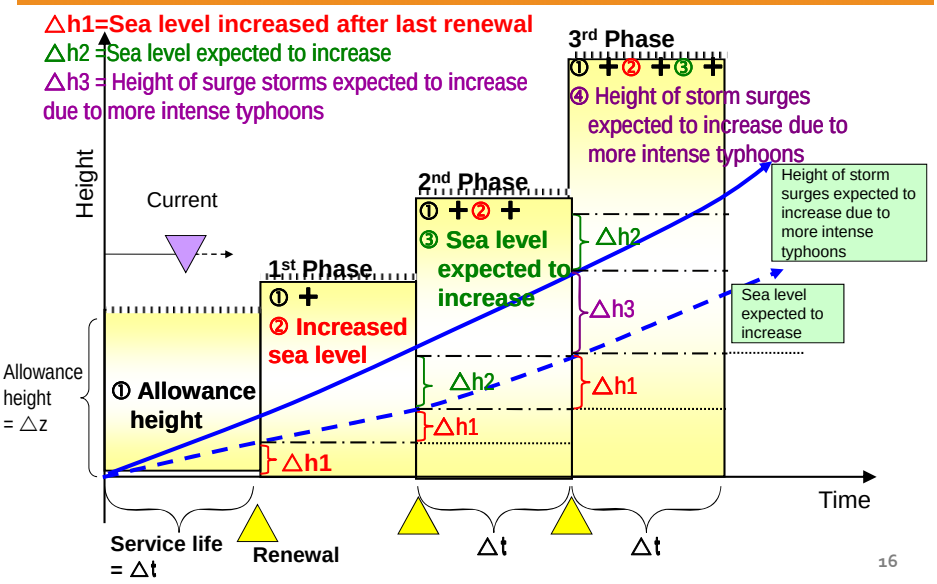
Storm surge barriers should be designed so that they are hard to breach even if external forces are more powerful than expected due to sea level rise.

- Promotion of comprehensive sediment management

Comprehensive sediment control should also be promoted to cope with coastal erosion in progress.

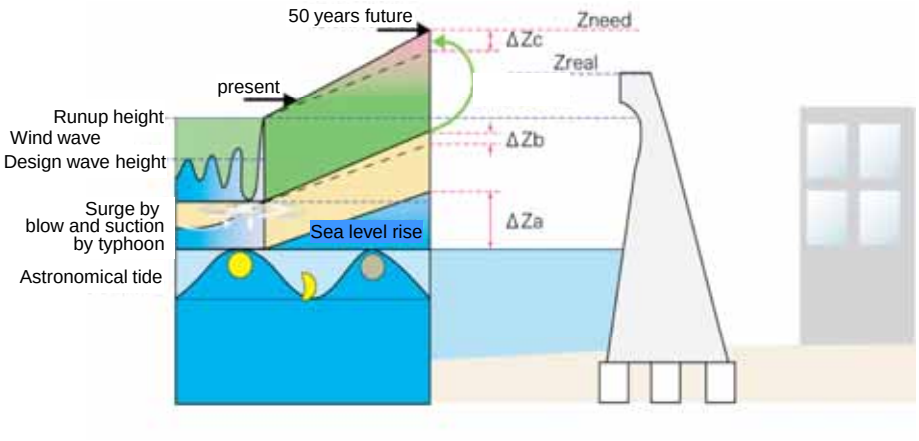
15

# Adaptation to increased external forces : Staged measures for storm surges



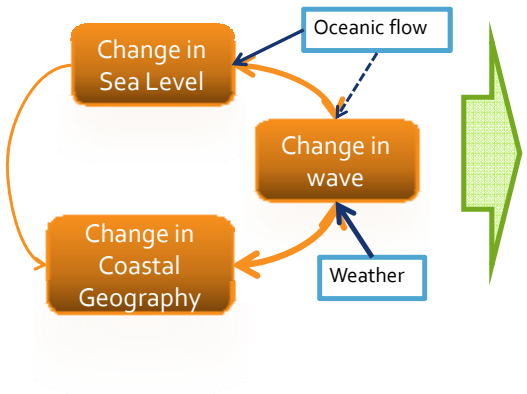

16

# Parameter of crown rise




17

# Will the change makes new "Waves"?




But tough to simulate

Simple Variation

Change in predominant wave

Rate of change in wave height

Mode Sift

Long waves

Coriolis transportation

Nonlinear interactions

Typhoons and Depressions

Changes in course or alignment

18

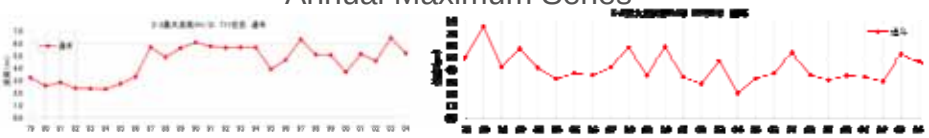
# Changing of "Wave Climate"

Detect signals !

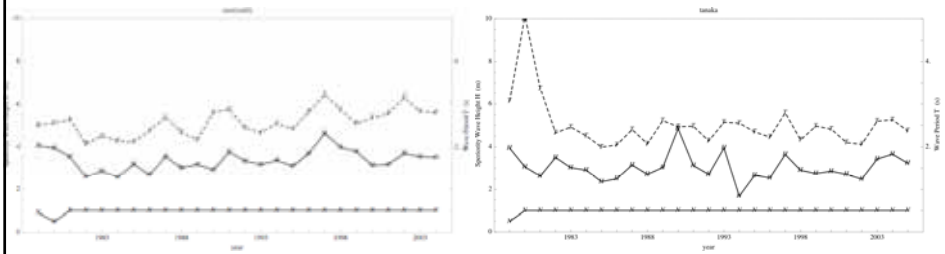
19

# Detecting signal in Large waves

Annual Maximum Series



Average of Top Group

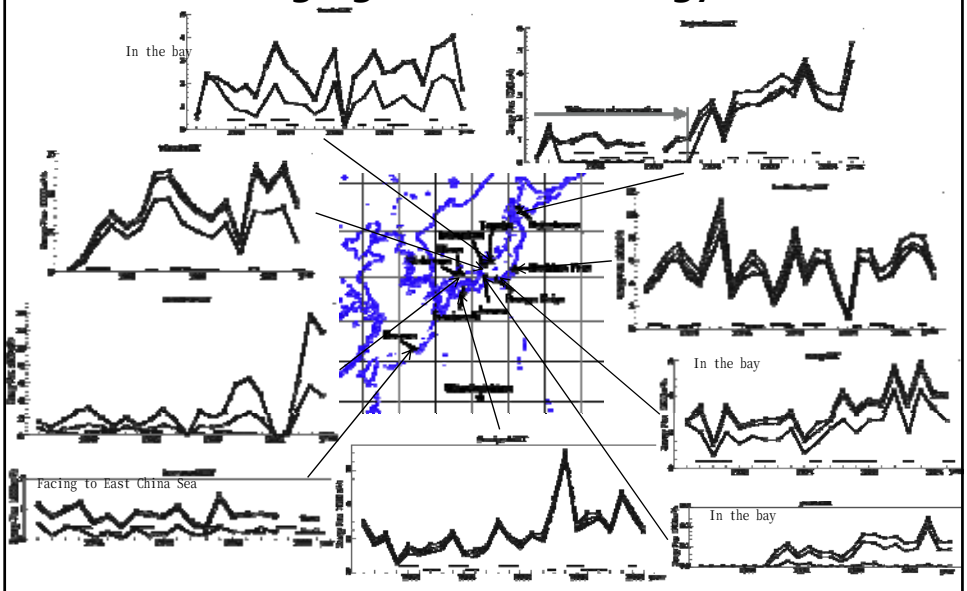


Sumiyoshi Coast

Shimoniikawa Coast

20

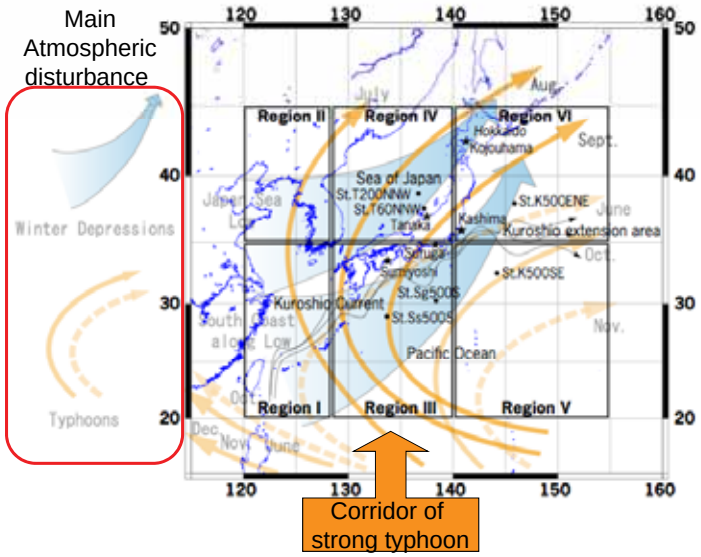
## Detecting signal in wave energy fluxes




21

## Definition of Regions

Main Atmospheric disturbance

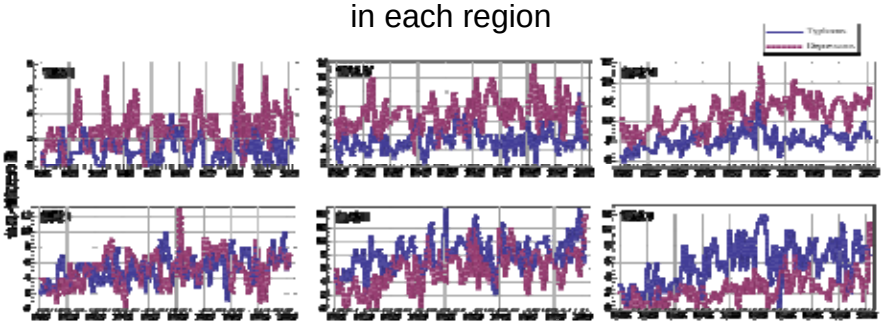



*Present routes*

Corridor of strong typhoon

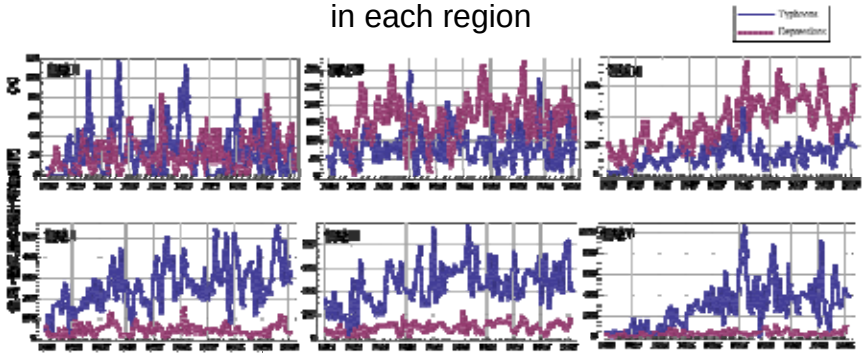
22

Annual track numbers typhoons and depressions thru in each region




23

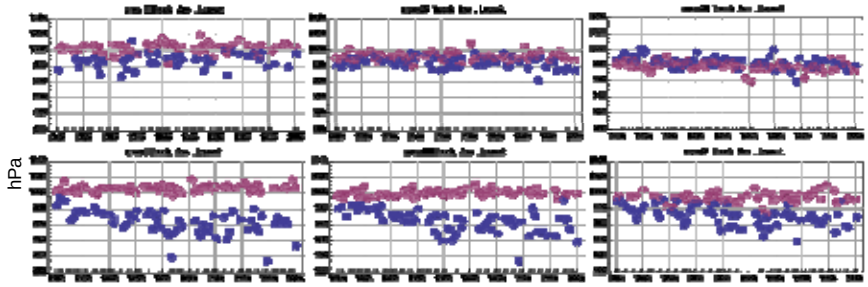
Annual total residence time of typhoons and depressions in each region




24

Annual average of the lowest pressure

of typhoons and depressions during each region

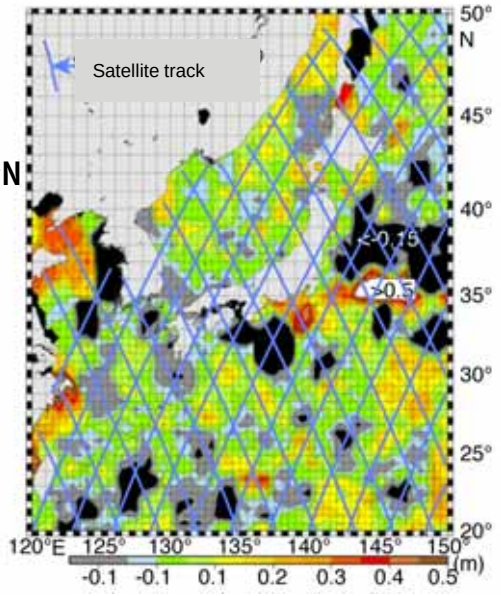




25

satellite altimeter

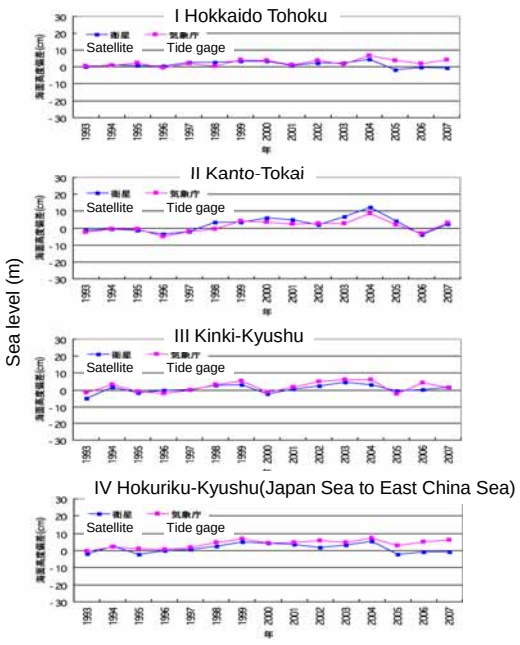
Topex/POSEIDON




**験潮場が近隣にない場合はどう考えるか**

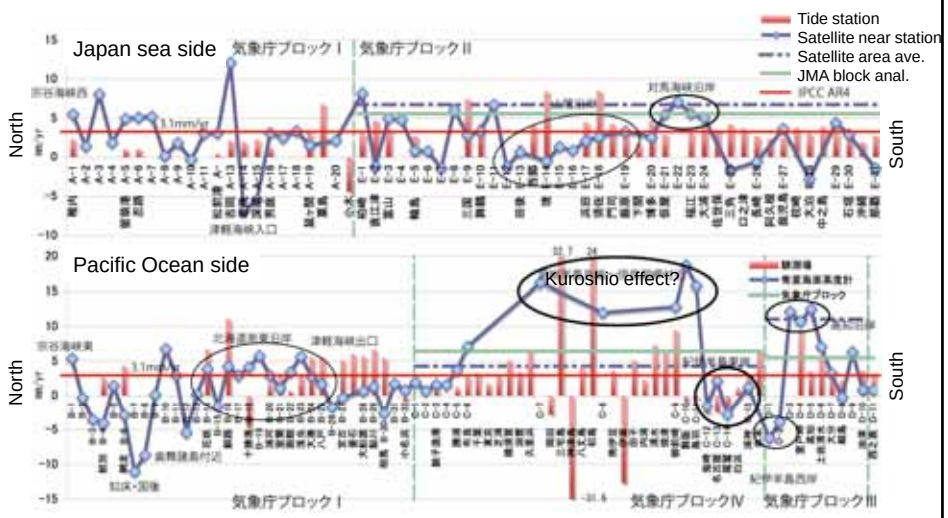
26

## Area average of Satellite altimeter vs. Tide gage (Japan Metrological Agency)



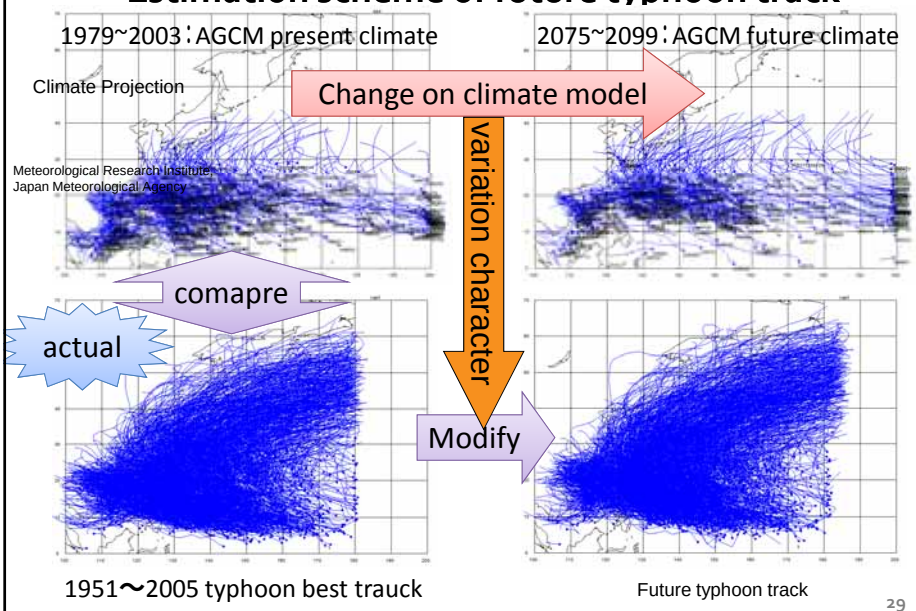

27

## Anduration of sea level rise speed around Japan



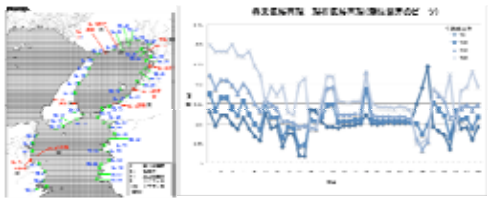

28

## Estimation scheme of future typhoon track

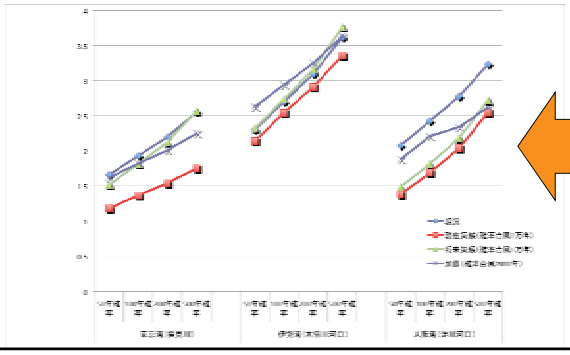



29

## Estimation of future typhoon surge



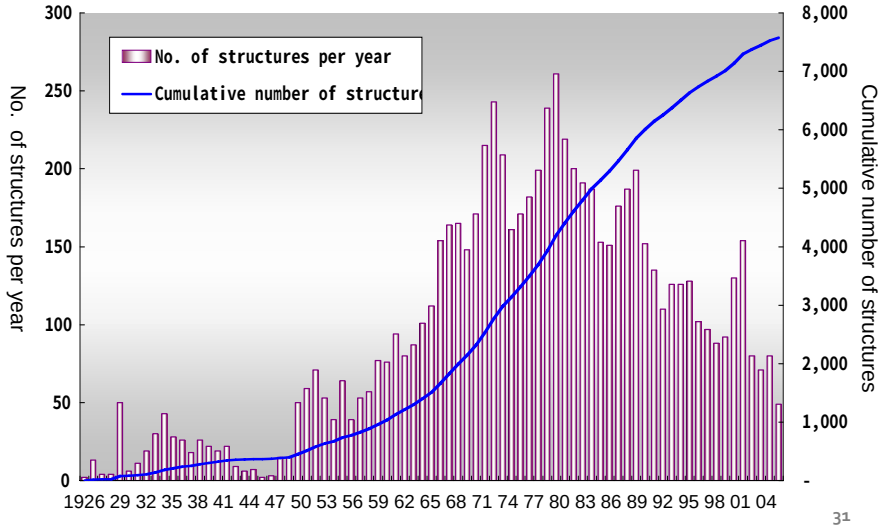
Example of result on Osaka bay



We need more trustful typhoon model.

30

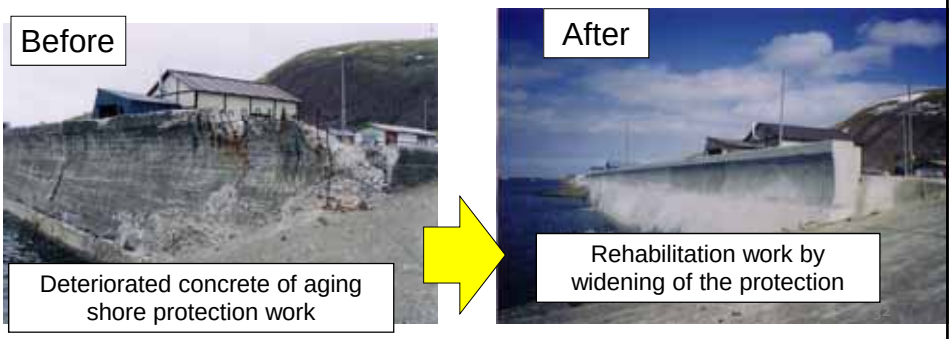
**Maintenance/renewal cost is expected to increase for existing structures extensively built during the economic growth in the 1960s (1926-2004)**



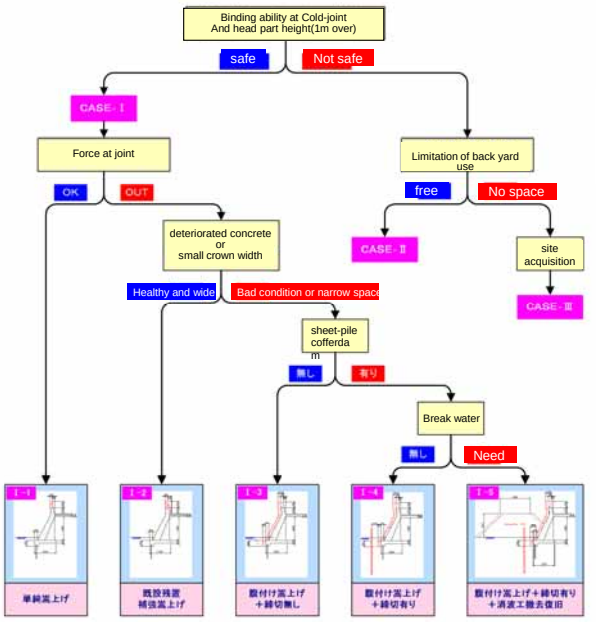

31

## Maintaining and improving the reliability of existing structures: response to aging revetments

To avoid financial concentration on renewing structures, they should be inspected and assessed in terms of reliability, and maintained and managed systematically by taking preventive measures to prolong their service lives.



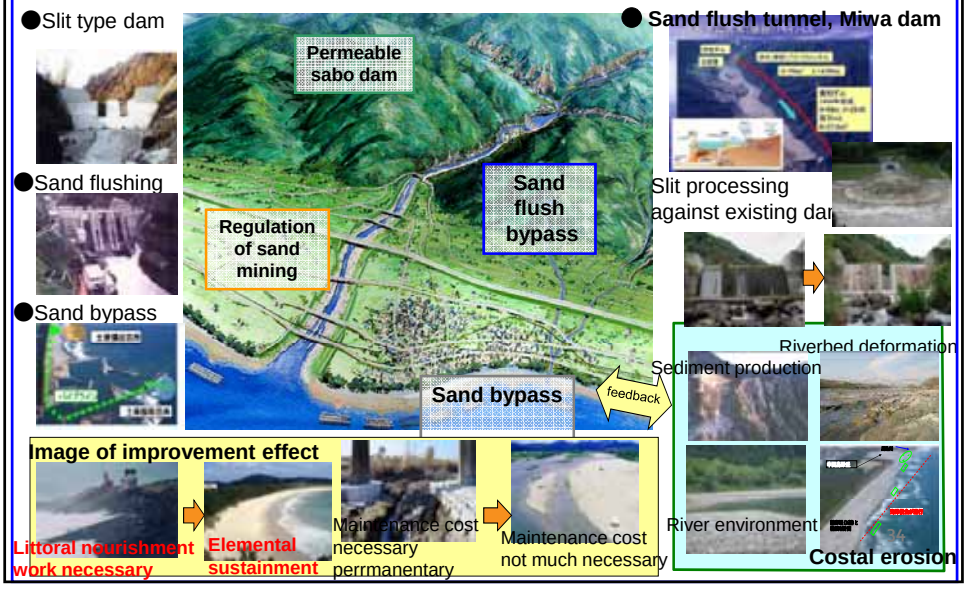
An example of trees to select HOKYOU method




33

# Promotion of comprehensive sediment management

Comprehensive sediment management should be promoted to take measures for sabo, dam sedimentation, river-bed deformation, and costal erosion.



# Ⅴ-12. Lecture

# “Water Quality Improvement and Change of Environmental Concern for Rivers in Japan”

Mr. Kunihiko AMANO

# Water Quality Improvement and Change of Environmental Concern for Rivers in Japan

Dr. Kunihiko Amano

National Institute for Land and Infrastructure Management

1

## Beginning of Environmental Concern

- ’70s Decade of Public Nuisance by Industry
- Outbreaks of Red tide in Coastal Sea
- Pollution of fish by Hazardous materials such as PCB

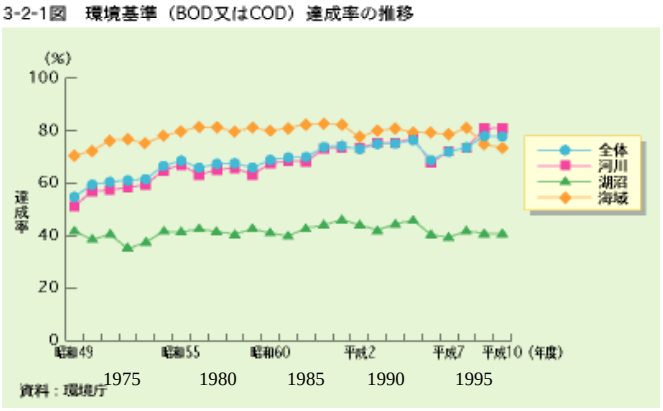
2

# Legislation of Environmental Laws Regarding Aquatic Environment

- 1971 Water Pollution Control Law
- 1971 Environmental Quality Standards for Water Pollution
- 1978 Total Pollutant load Regulating Standards
- 1982 N, P Standards for Lakes
- 1984 Lake Water Quality Conservation Law
- 1993 THE BASIC ENVIRONMENT LAW
- 1997 ENVIRONMENTAL IMPACT ASSESSMENT LAW

3

# Achievement Rate of Environmental Standards (BOD/COD)

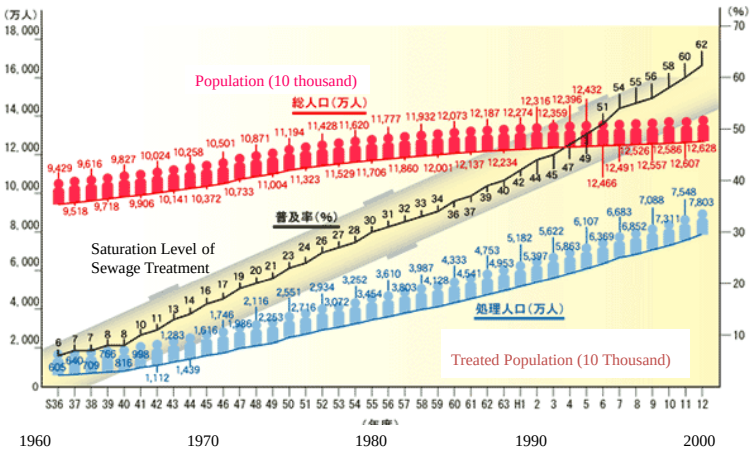



Total
Rivers
Lakes
Coastal Waters

Good Achievement in Rivers; Poor Achievement in Lakes

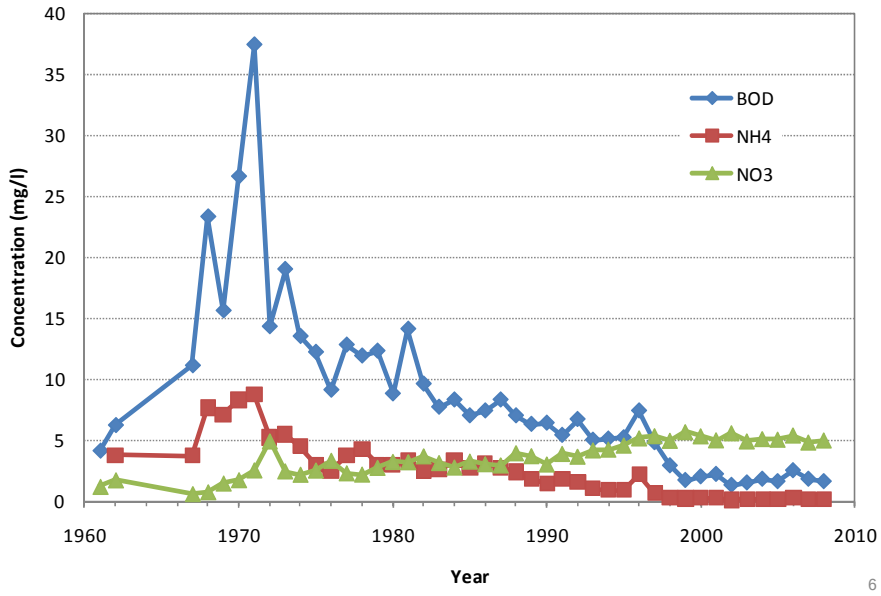
4

# Progress of Sewage Treatment Works



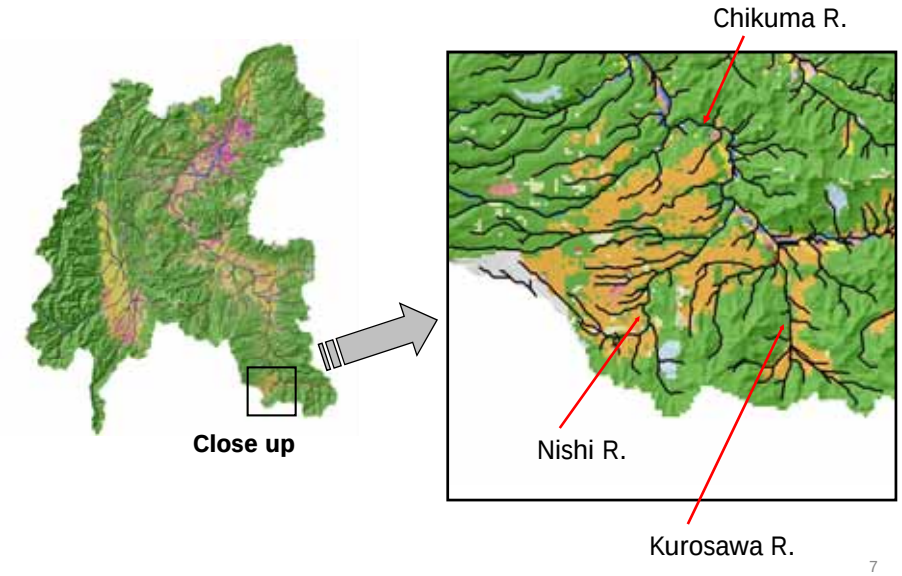

5

# Water Quality Change in Tama River (Tokyo)



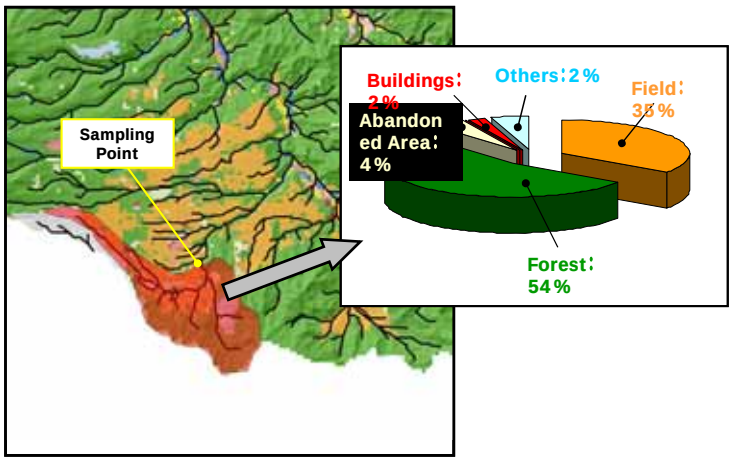

6

## Water Quality of River and Basin Character



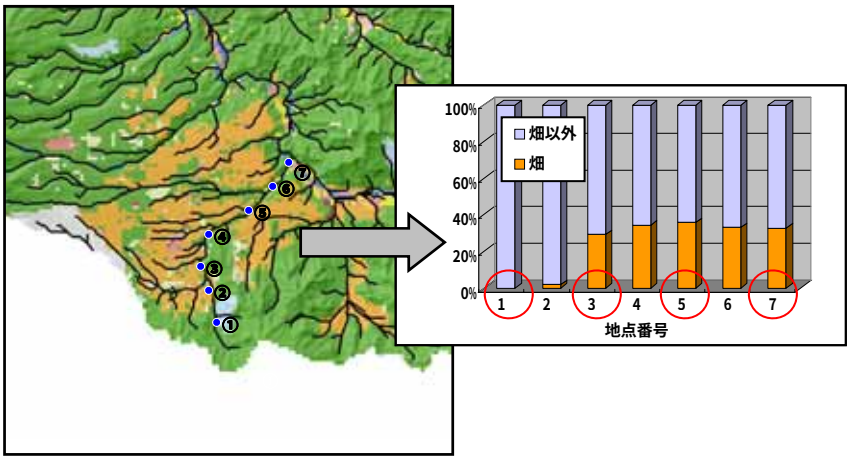

7

## Land Use Effect on River Water Quality




8

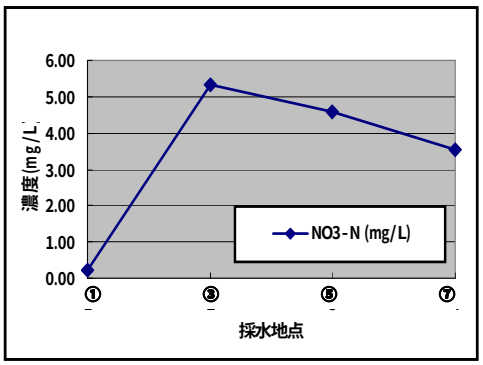
## Land Use Effect on River Water Quality




9

## Nitrate Concentration along Nishi R.

Samplings on Nov. 20, 2003




【point①】

【point③】

10

## Water quality in rivers in Japan

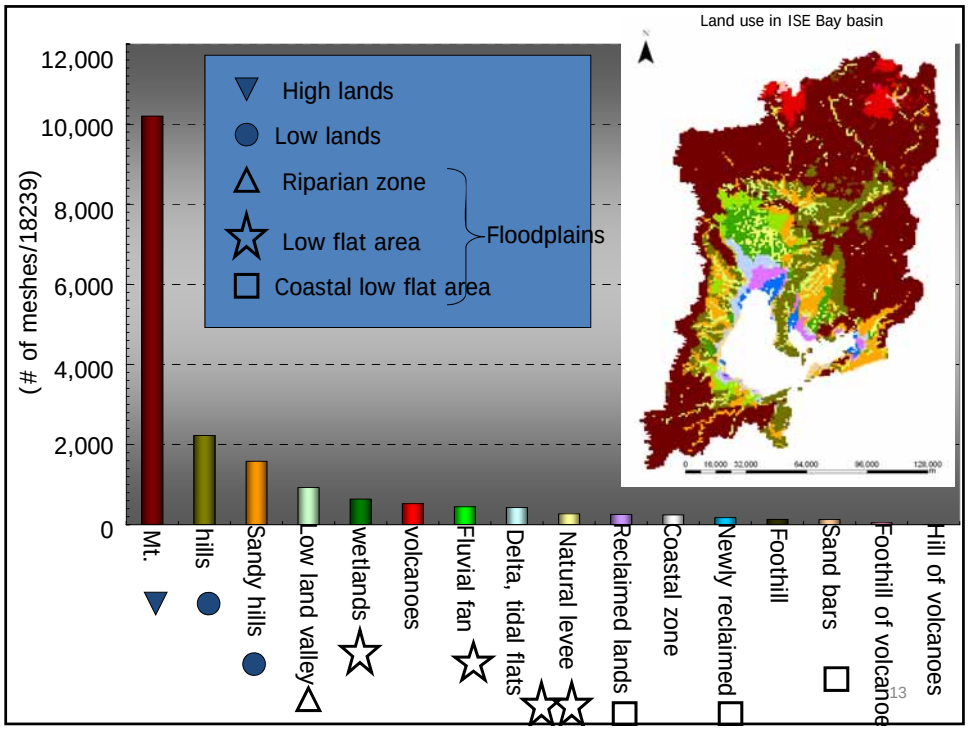
- Water quality has been improved significantly by the propagation of sewage treatment system (in rivers and in terms of BOD).
- Control of diffuse sources for nutrient control is still a major concern.
- Watershed management is the key for the success of water quality control.

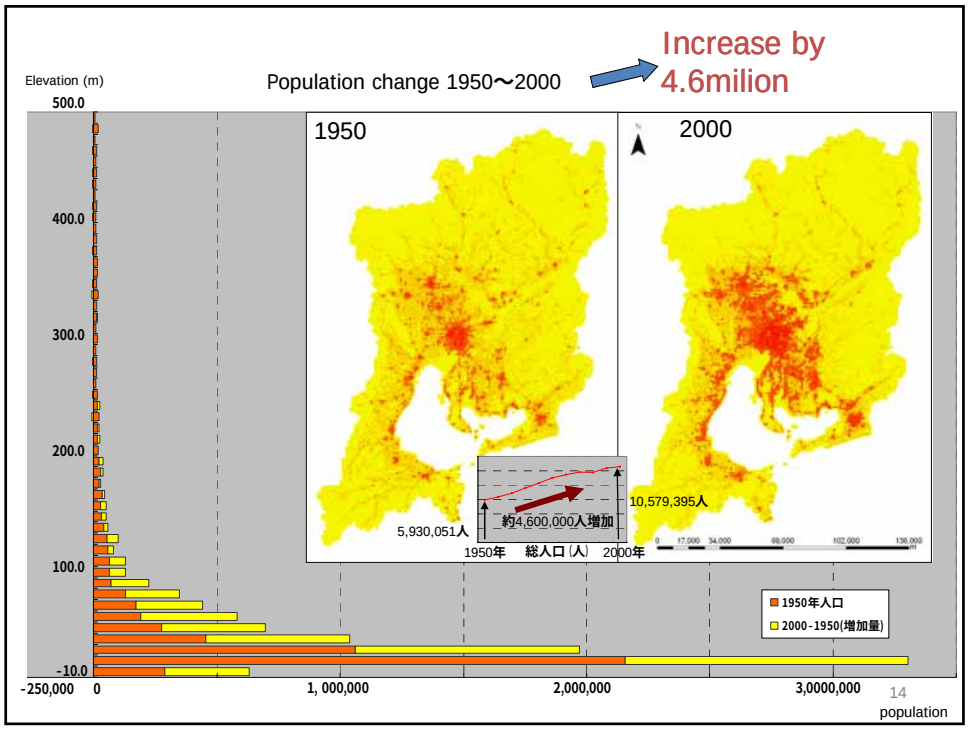
11

## Watershed change of Ise Bay

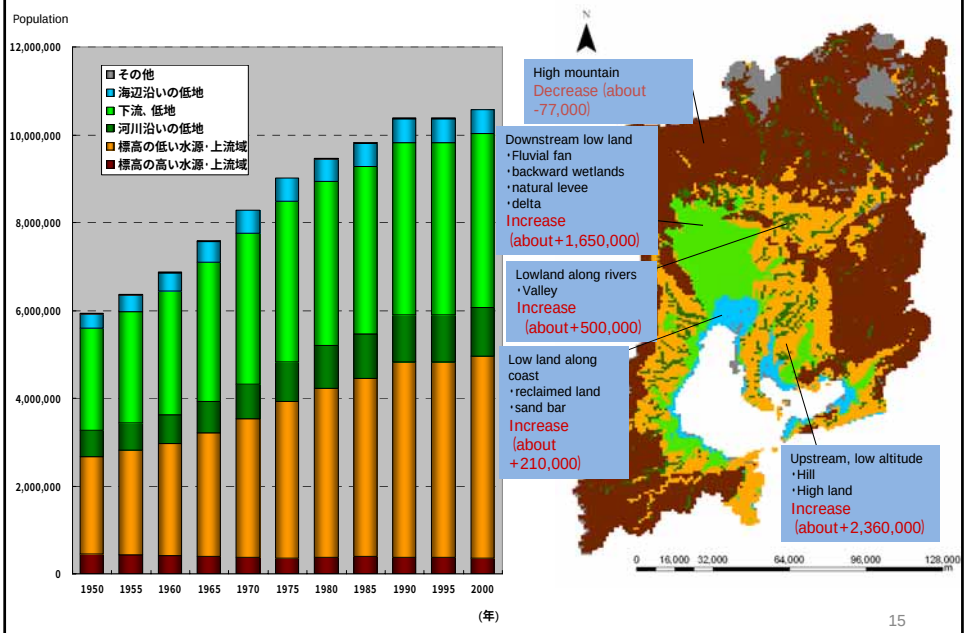
- Changes in population, land cover, water use, sediment supply and pollutant load were estimated from 1950 to 2000.
- Changes in ecological features were compared to those changes.

12


Land use in ISE Bay basin
12,000
10,000
8,000
6,000
4,000
2,000
0
(# of meshes/18239)
High lands
Low lands
Riparian zone
Low flat area
Coastal low flat area
Floodplains
Mt.
hills
Sandy hills
Low land valley
wetlands
volcanoes
Fluvial fan
Delta, tidal flats
Natural levee
Reclaimed lands
Coastal zone
Newly reclaimed
Foothill
Sand bars
Foothill of volcanoes
Hill of volcanoes
13

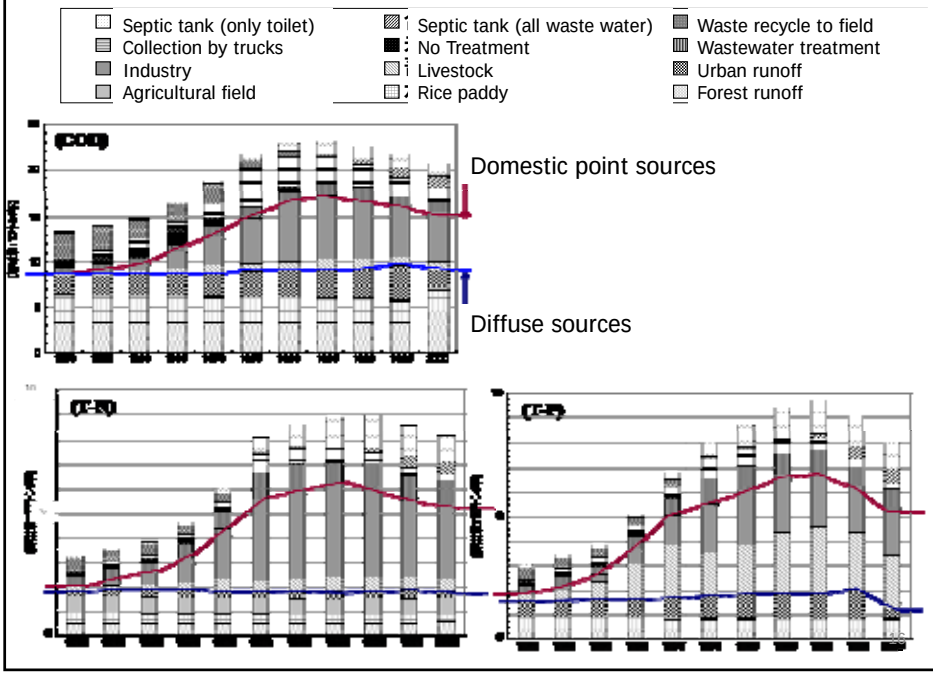

Increase by
4.6milion
Elevation (m)
Population change 1950〜2000
500.0
400.0
300.0
200.0
100.0
-10.0
1950
2000
5,930,051人
10,579,395人
約4,600,000人増加
1950年 総人口（人） 2000年
1950年人口
2000-1950(増加量)
-250,000
0
1, 000,000
2,000,000
3,0000,000
population
14

## Population change among topological background

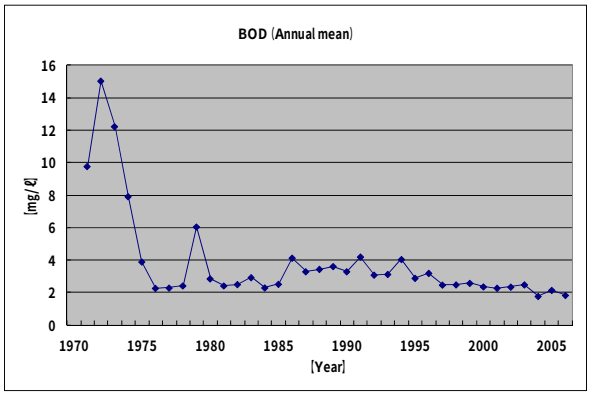


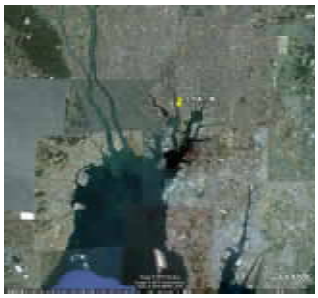

15

## Estimated Change in total pollutant load from different sources



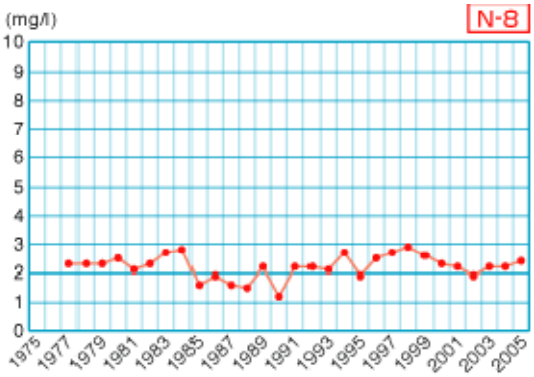
# Improvement of WQ in a river



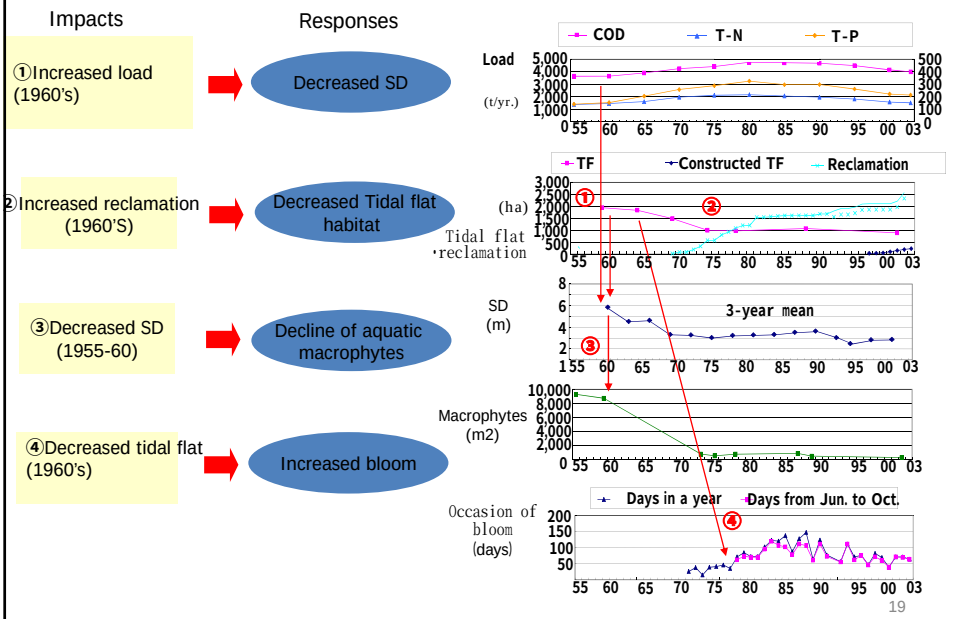
17

# COD in ISE Bay (No improvement)



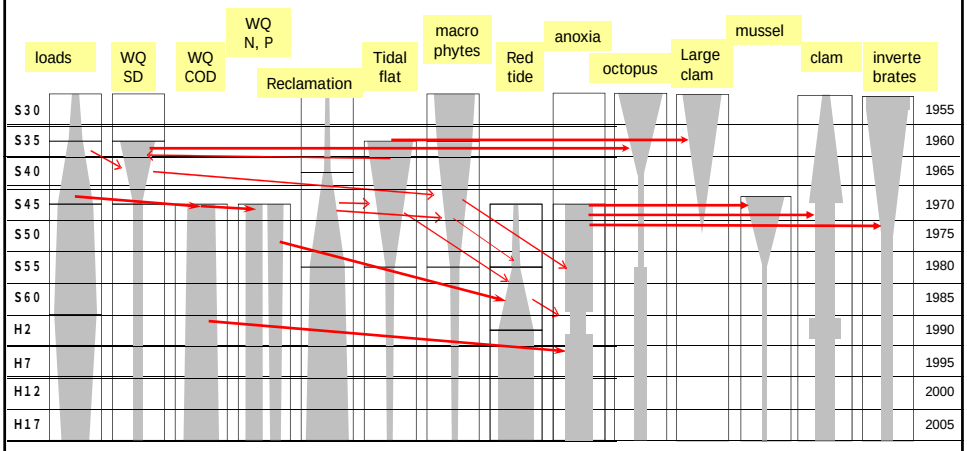

18

# Environmental change in bay (WQ・Habitat・Bloom)




19

# Assumed relationship between environmental change and ecosystems




20

## Historical Perspectives for River Environment

- Water Pollution by Industry (Point Sources) has been relatively well solved by the progress of waste water treatment.
- Progress of Sewage Treatment Works has improved River Water Quality in terms of BOD.
- Water Quality of Coastal areas and Lakes has not been improved well due to internal production caused by high nutrient loading. Thus, management of watershed became more important.
- Not only water quality but also ecosystem management has been paid much attention recently.

21

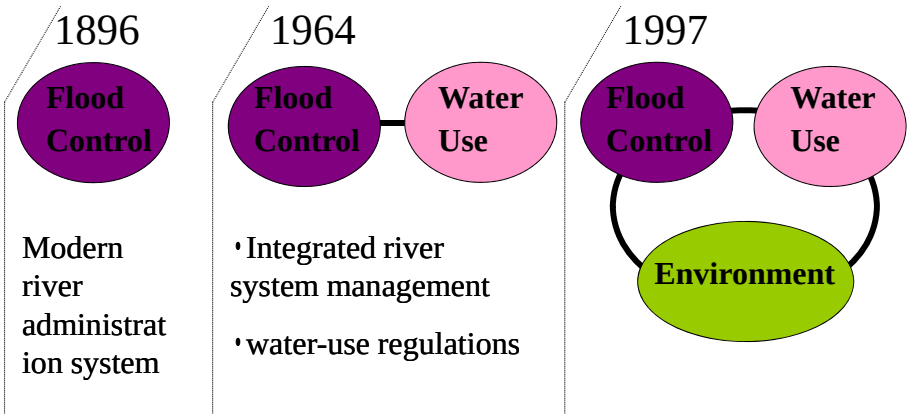
## River Restoration, A New paradigm

- 1990: Naturally-diverse river works, Japanese version river restoration project
- 1997: Amendment (on River Environment) of River Law and enactment of Environmental Assessment Law

- More attention began to be paid on aquatic biota.

22

# River Law for Environment




23

# Naturally-diverse river works (Japanese version of river restoration)

- Officially started in 1990 by MOC(MLIT)
- Purpose

  Ecosystem with high biodiversity

  Beautiful landscape

24

## Historical Progress in River Restoration

- Control of hazardous materials
- Control of organic pollutants
- Control of nutrients
- Improvement of environment in terms of habitat for wild lives and good landscape

25

## 5 Major Classes of Environmental Factors that Affect Aquatic Biota

- Energy Source ( Food for Organisms )
- Water Quality
- Habitat Quality
- Flow Regime
- Biotic Interactions

26

## Recent major human impacts on rivers in Japan

- Excavation and widening of low water cannel
- Change in sediment supply
- Decrease of flood discharge and frequency
- Construction of weirs and concrete shore protection
- Water quality change
- Invasion of exotic species

27

## Excavation and widening of low water cannel

- Large amount of river bed material (gravels and sand) was excavated to use as concrete aggregates and to enlarge flow capacity of rivers from 1950's to 1970's.
- Excess erosion which can damage the foundation of structures and lowering of groundwater table occurred as the consequences. To prevent this, strict regulation has been enforced.

28

## Change in sediment supply

- Construction of dams, check dams, and forest protection reduced the supply of sediments to downstream rivers.
- Otherwise, supply of fine silts increased in urbanized area.

29

## Decrease of flood discharge and frequency

- Although dams in Japan do not have enormous capacity for flood control, they have reduced peak discharge and frequency of floods.
- Also, variation of flowrate is smoothened during non-flood period.

30

## Construction of weirs and concrete shore protection

- Construction of weirs, shore protection, and dams have fragmented river networks and deteriorated the environment of river shore after 1960's.
- Construction of perpendicular concrete dikes has proceeded and it destroyed wildlife habitat of rivers in urban areas.

31

## Water quality change

- Impoundment in dams has changed water quality.
- Urban runoff contains large amount of pollutants.
- Development of sewage works sometimes reduce the flow in rivers and river water quality is controlled by that of effluent from water treatment works if the discharge from water treatment works is large.

32

## Invasion of exotic species

- Discharge of fishes which had been grown in other places (e.g. Sweet fish from lake Biwa) and invasion of exotic species such as large mouth bass endanger native species.
- Exotic plants such as pseud-acacia prevails in flood channel.

33

## Emerged responses in river environment (1)

(Deterioration of habitat quality in rivers)

- Enlarged gaps between low water channel and flood channel lessened the inundation frequency of flood channel and shores along rivers. This lead to the invasion of dry land trees to river shore.
- Loss of sand from bed material occurred and this deteriorated habitat quality for benthos.
- Fragmentation of river networks interrupted fish migration.

34

# Emerged responses in river environment (2)

(Changes following water quality and quantity change)

- Ecosystem shift due to water quality change (e.g. Species changes in periphyton, benthos, and fishes)
- Ecosystem shift due to water quantity change
  (e.g. Discontinuity of surface water in rivers and water quality deterioration due to longer retention time)

(Exotic Species)

- Exotic species accelerated the negative pressure on native species.

35

## Major recent anthropogenic impacts on rivers in Japan

(Flow rate and its fluctuation pattern)

- Flood control by dams -> Less disturbance
- Water use for agriculture, power, and domestic purposes
  -> Less water in rivers

(Water quality)

- Water quality deterioration by agriculture, industry and urbanization

(River morphology (Habitat))

- Enlargement of low water channel by bed material excavation and/or river channel alteration for flood control -> Different inundation pattern and habitat loss

(Sediment transport)

- Sediment flux decrease by erosion control and building dams

(Network connection and distribution pattern)

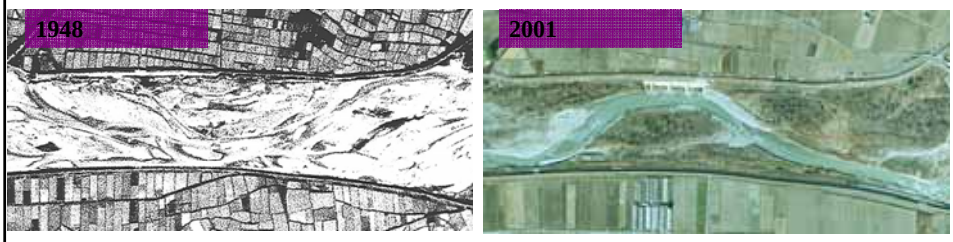
- Fragmentation of river system by weirs and bank protection
- Separation of rice field from river network by rice field reform

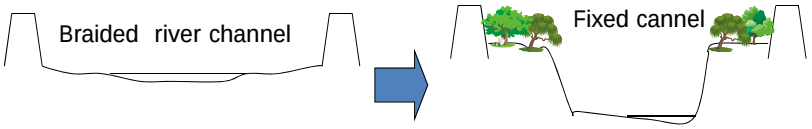
(Exotic species)

- Introduction of exotic species

36

## Typical River Alteration in Japan during recent 50 years




### Human Impacts

- Gravel extraction
- Construction of dams at upstream
- Use of exotic trees to stabilize slopes

- ■Fixation of low water channel
- ■Decrease of gravel bars
- ■Less inundation onto flood ways

### Environmental Responses

- Shift in plant communities (increase of high trees, decrease of plants depending on gravel bars)
- Less refuge for fishes during floods

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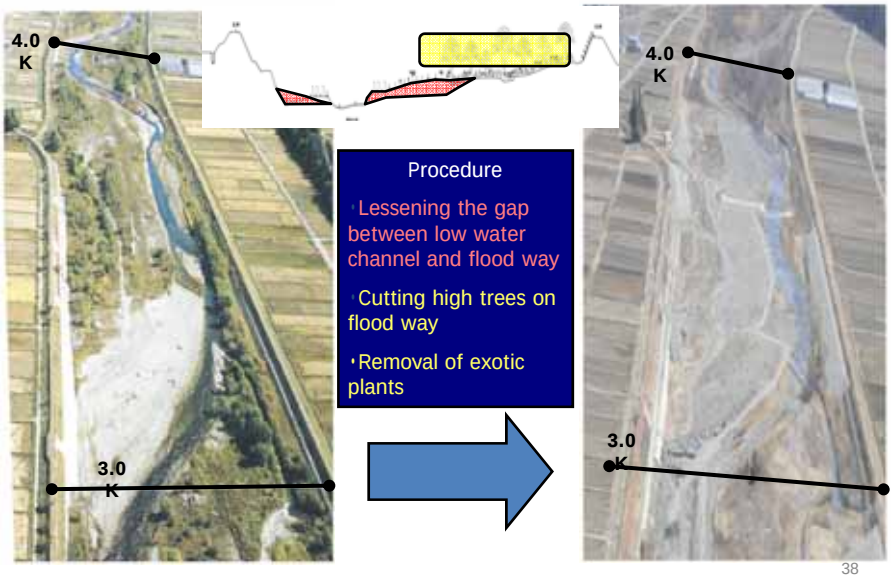
## Restoration project in Mibu River

Before restoration (2002) | Restoration project (2005)




**Procedure**

- Lessening the gap between low water channel and flood way
- Cutting high trees on flood way
- Removal of exotic plants

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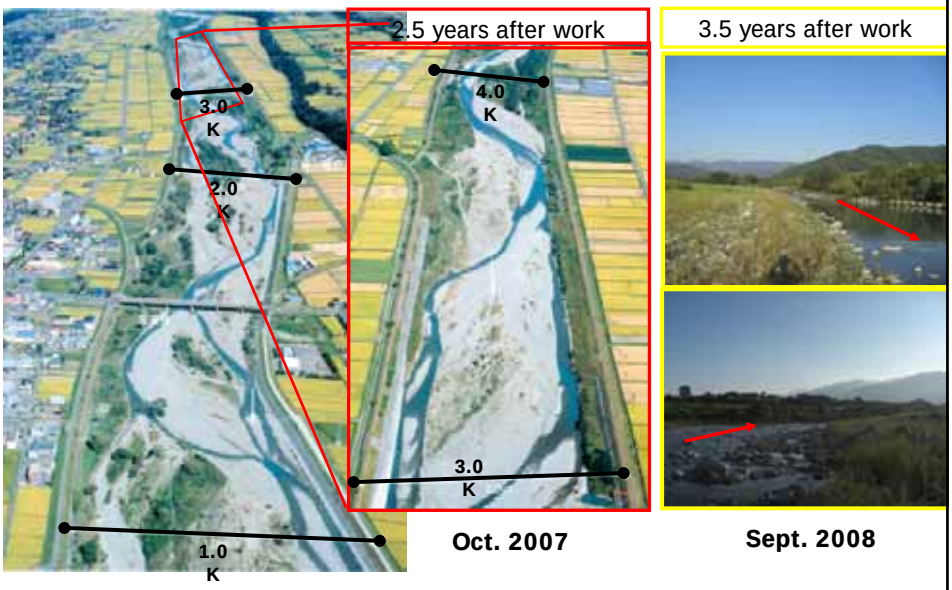
## Present status after restoration work

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## River Restoration, our approach

(Environmental situation)

- Pristine natural condition usually cannot be the goal of river restoration in Japan, since most rivers running through alluvial plains have been managed and altered by human society for hundreds of years (no pristine reference).
- The environment which had been managed in sustainable manners until modern economic development starts can be a candidate for the goal.

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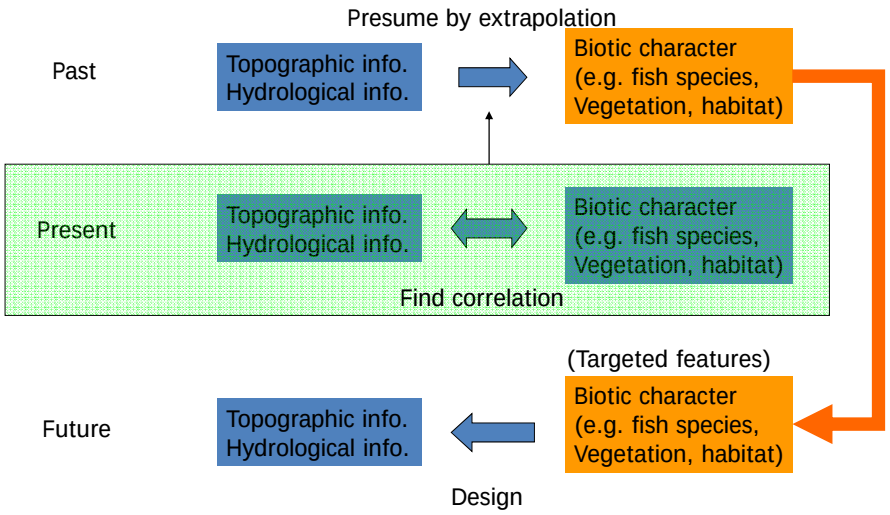
# Our approach to set goals

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# Our approach to set goals

- Past environment, which is supposed not to have faced significant modern environmental alteration should be estimated as quantitatively as possible.
- Since biotic information in the past is quite limited, we have paid attention on old geographical (topographical) and hydrological information.
- Based on the present correlation between local topographical and hydrological features and biotic characters found in rivers, we may be able to presume past environment in biotic sense.

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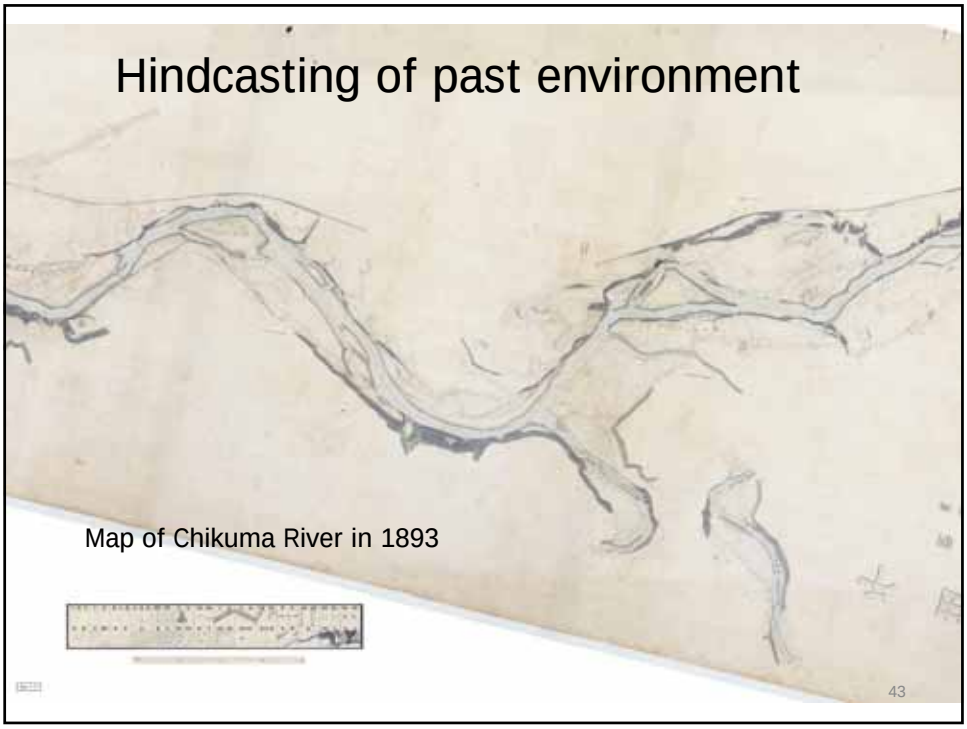
## Hindcasting of past environment



Map of Chikuma River in 1893

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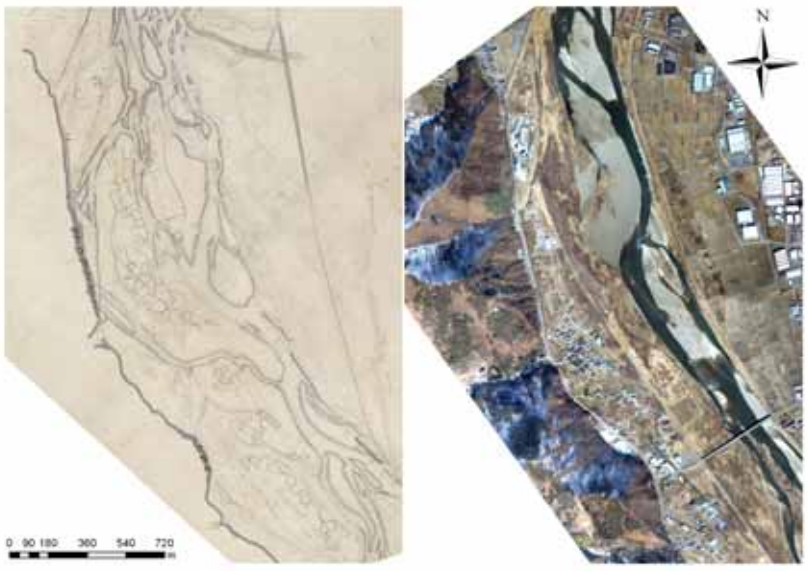
## Topographical alteration from 1893 to present

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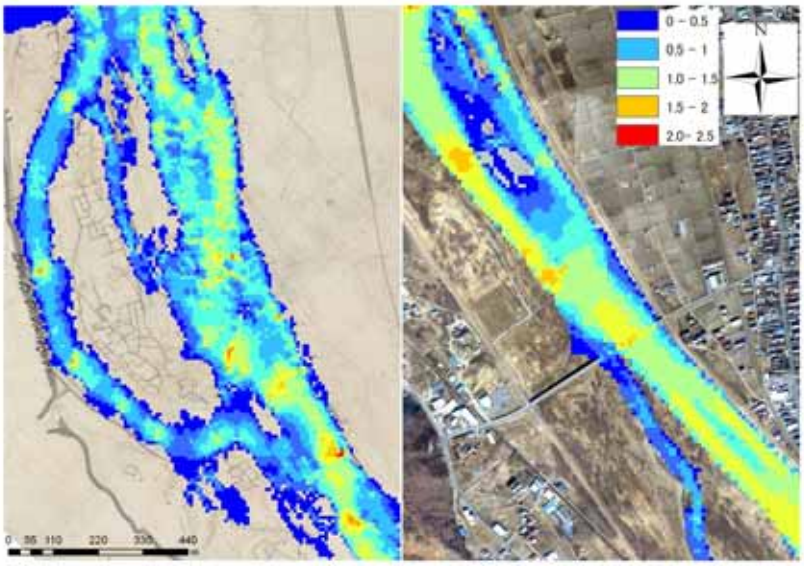
Hydrodynamic change due to topographical change

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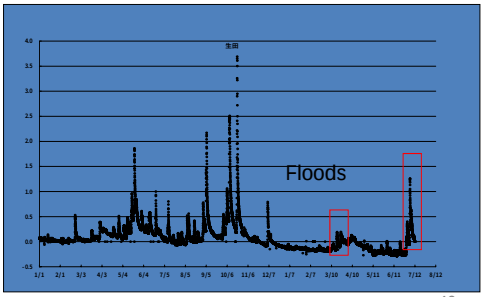
Tracking of fish behavior during
floods using
Advanced Telemetry System (ATS)

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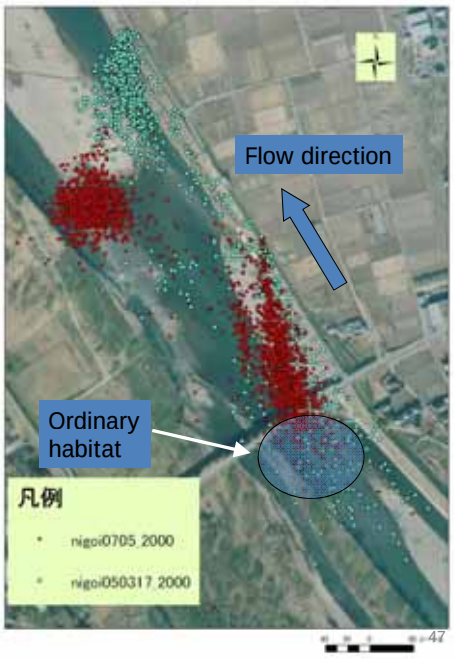
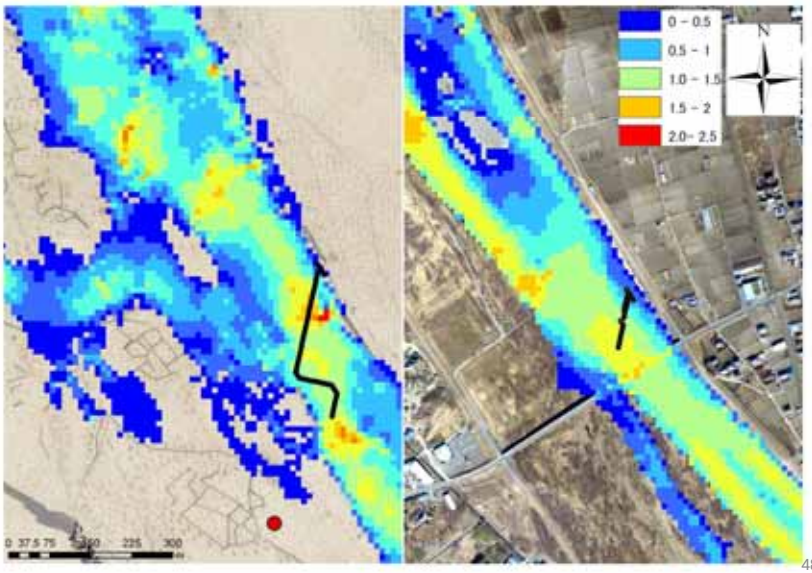
## Tracking results of tagged carp

Tagged carp was flushed downstream during flood. However, it avoided to be swept further downstream by finding places where velocity is low (refuge at flood).

Legend:
- blue circle shows location of tagged carp during flood in March
- red circle shows location of tagged carp during flood in July




Fish behavior model combined with hydrodynamic model can hindcast the effect of floods on fishes during flood



# Setting goal for river restoration

- Habitat evaluation based on present and past information must be proceeded in robust manners for quantitative estimation of restoration projects.
- Ecological monitoring for the restoration project of riparian environment should be performed in more detail (in particular, focusing on ecological function).
- Since traditional land use is a part of local environment in Japan, we have to take it into consideration in river restoration project.
- River ecology research groups which consist of civil engineers and ecologists have started joint study recently.

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# Conclusion

- Water quality seems to be the first concern when the river environment begins to be deteriorated by human impact because it is clear to notice the change and somehow easy to find the cause.
- Environmental factors other than water quality should be taken into consideration to restore river environment.
- Broader temporal and spatial consideration should be paid.
- Social agreement is an important issue in environmental management. Establishment of good stewardship by residents in river basins will be more important in the near future.

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