Wise adaptation measures for climate change in the water sector

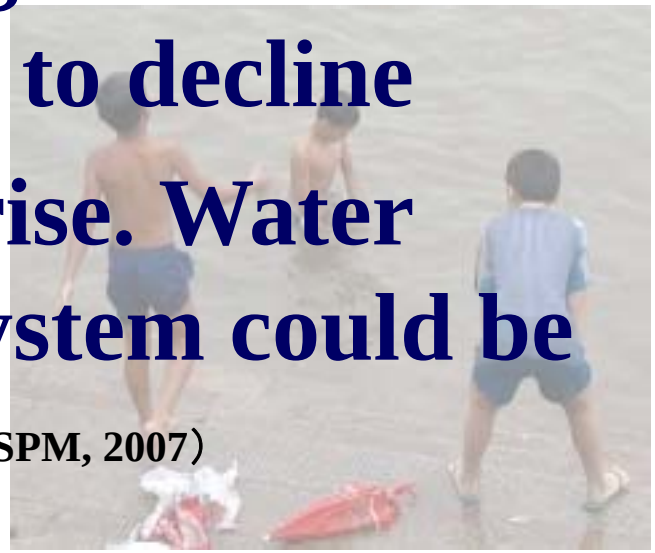
Taikan Oki

Institute of Industrial Science, The University of Tokyo

International Symposium on Construction and Environment
Mandarin Oriental Hotel Tokyo, Japan, February 4th, 2010

Impacts of climate change on freshwater resources (1)

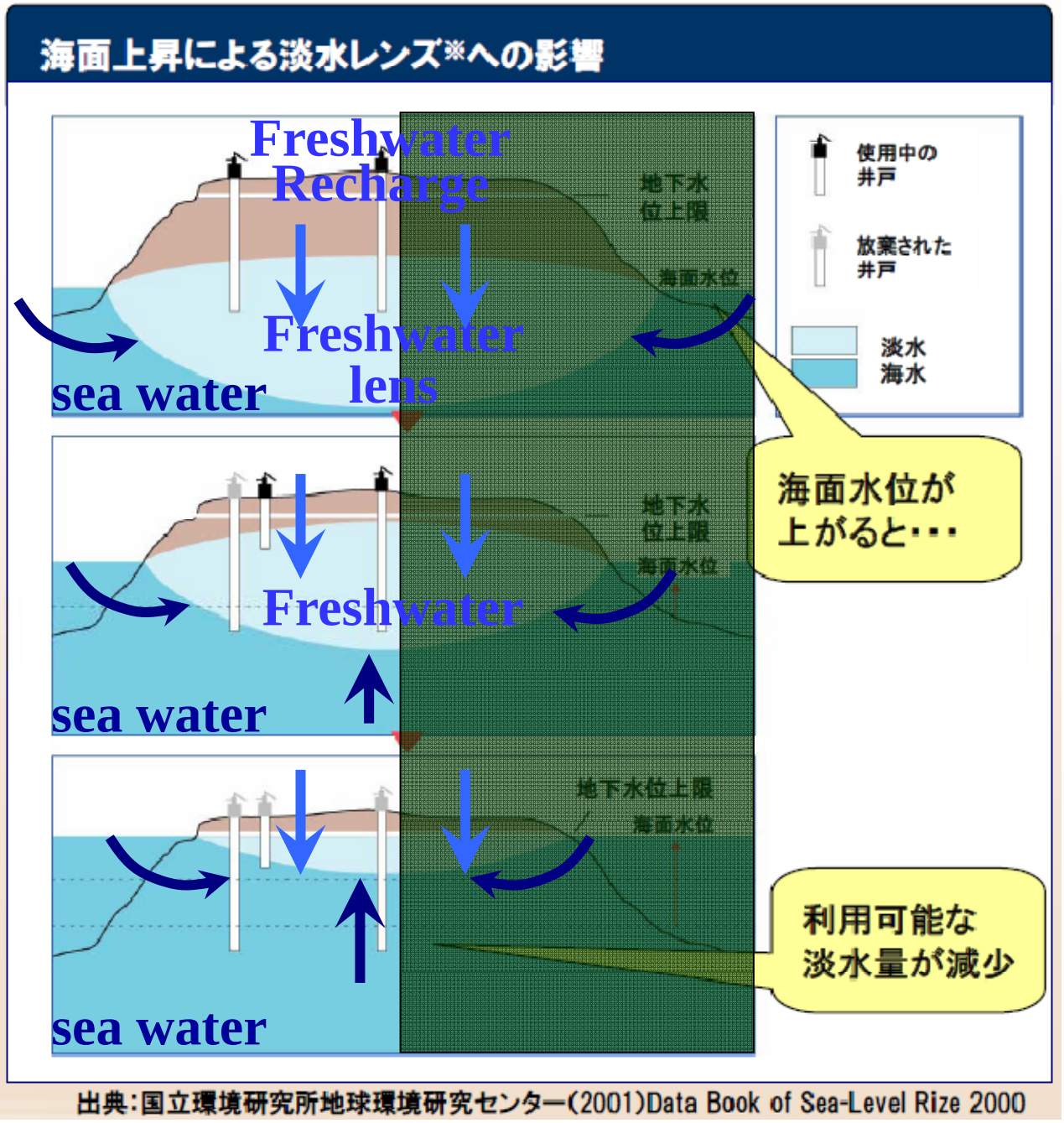
- **Temperature will increase:**
  - ❄ **Snow melt runoff will be changed in timing and the peak volume**
  - ❄ **water supplies stored in glaciers and snow cover are projected to decline**
  - ❄ **Water temperature will rise. Water quality and aquatic ecosystem could be deteriorated.** **(IPCC AR4, WGII, SPM, 2007)**



Impacts of climate change on freshwater resources (2)

Sea level will rise:

- Sea water intrusion to ground water near coastal region



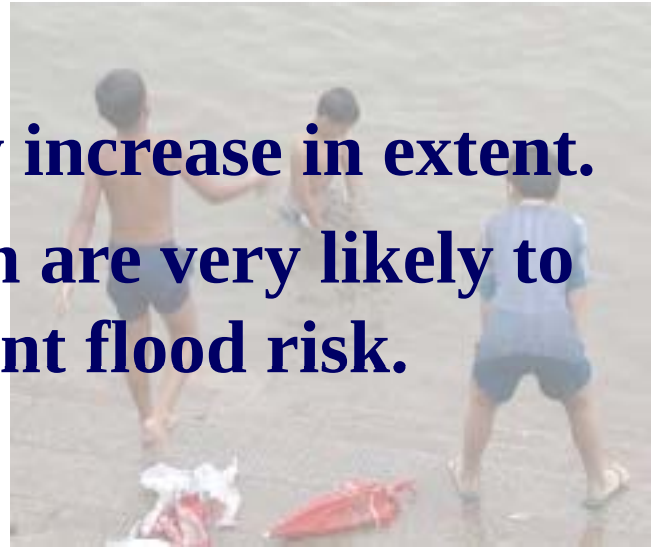
Coastal Mega Cities are Vulnerable

Figure TS.8. *Relative vulnerability of coastal deltas as indicated by estimates of the population potentially displaced by current sea-level trends to 2050 (extreme >1 million; high 1 million to 50,000; medium 50,000 to 5,000) [B6.3]. Climate change would exacerbate these impacts.*

（IPCC AR4, WGII, SPM, 2007）

Impacts of climate change on freshwater resources (3)

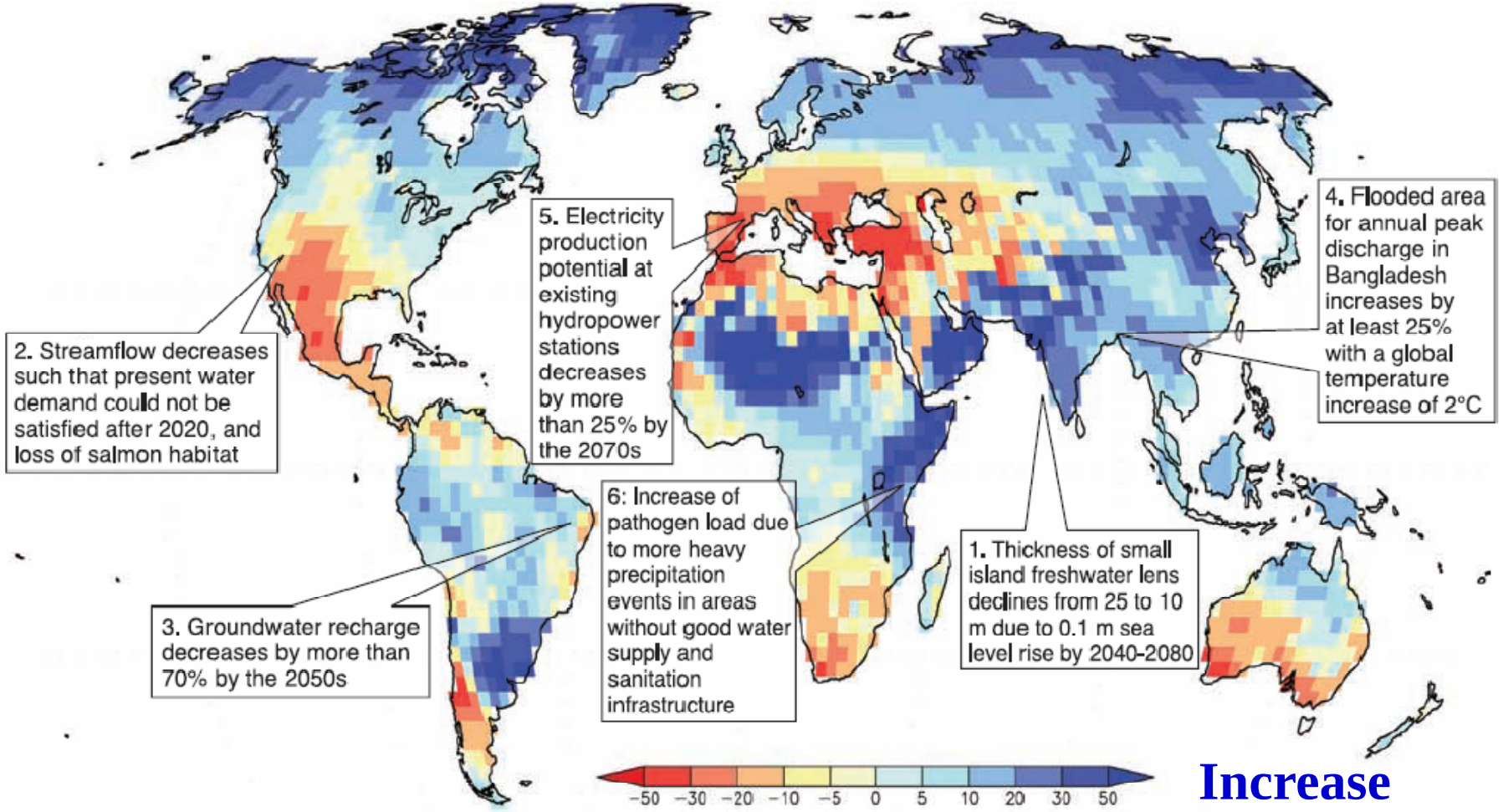
- **Hydrological cycle will be changed ("intensified")**
  - ❄ **10-40% increase of available water resources at high latitudes and in some wet tropical areas, and 10-30% decrease over some dry regions at mid-latitudes and in the dry tropics**
  - ❄ **Drought-affected areas will likely increase in extent.**
  - ❄ **Heavy precipitation events, which are very likely to increase in frequency, will augment flood risk.**



（IPCC AR4, WGII, SPM, 2007）

Changes in Annual River Discharge

---Ensemble Mean of 15 GCM results for IPCC AR4 ---



(A1B)

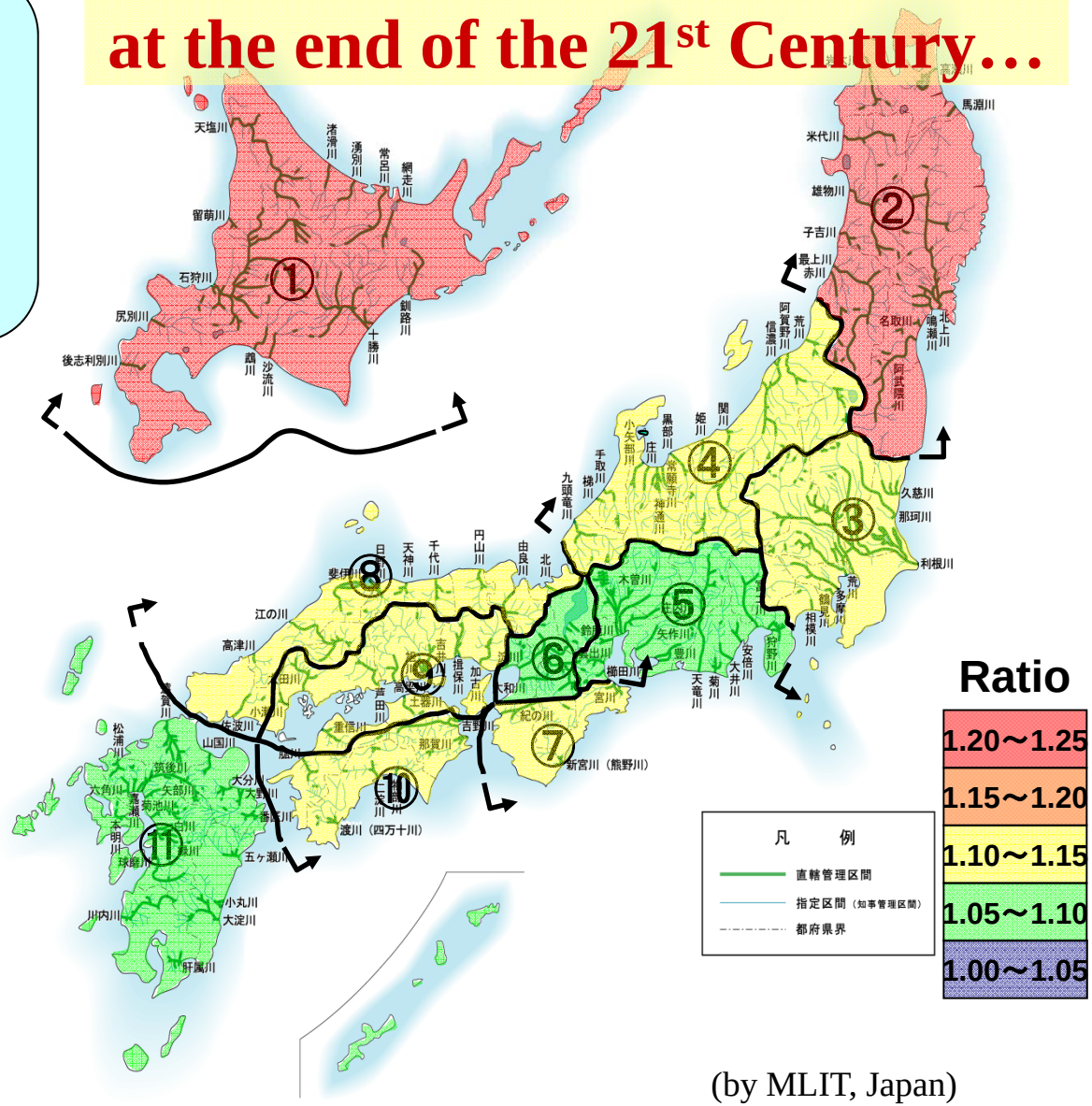
（IPCC AR4, WGII, 2007）

Mean Increase of the annual maximum daily rainfall

Ratio of the means of the annual maximum daily rainfall estimated by GCM20(A1b scenario) for 2080-2099 over 1979-1998

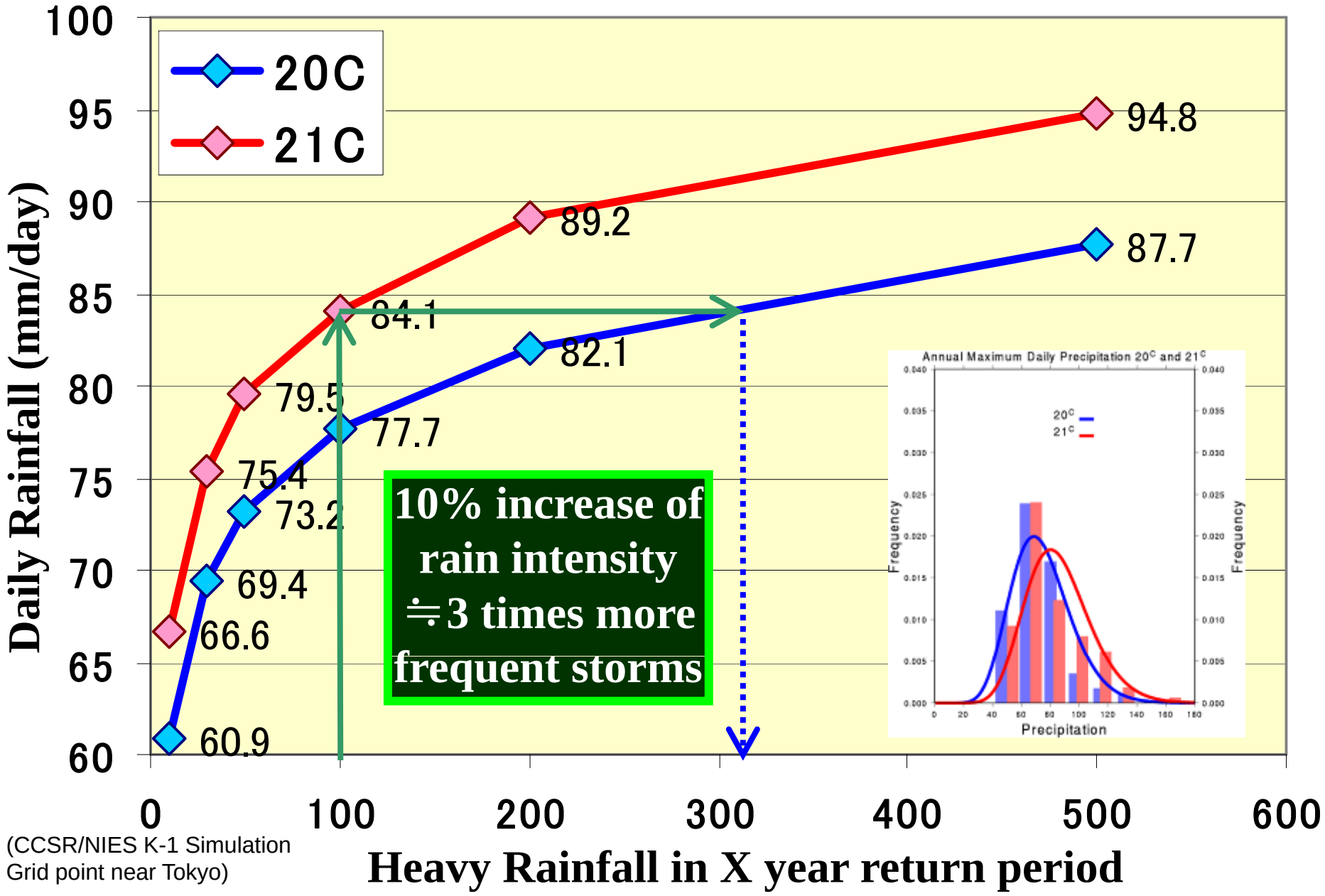
①	Hokkaido	1.24
②	Tohoku	1.22
③	Kanto	1.11
④	Hokuriku	1.14
⑤	Chubu	1.06
⑥	Kinki	1.07
⑦	Kii-nanbu	1.13
⑧	San-in	1.11
⑨	Setouchi	1.10
⑩	S-Shikoku	1.11
⑪	Kyushu	1.07

At most 1.2 times at the end of the 21st Century…



(by MLIT, Japan)

Expected Annual Maximum Daily Rainfall in X year return period

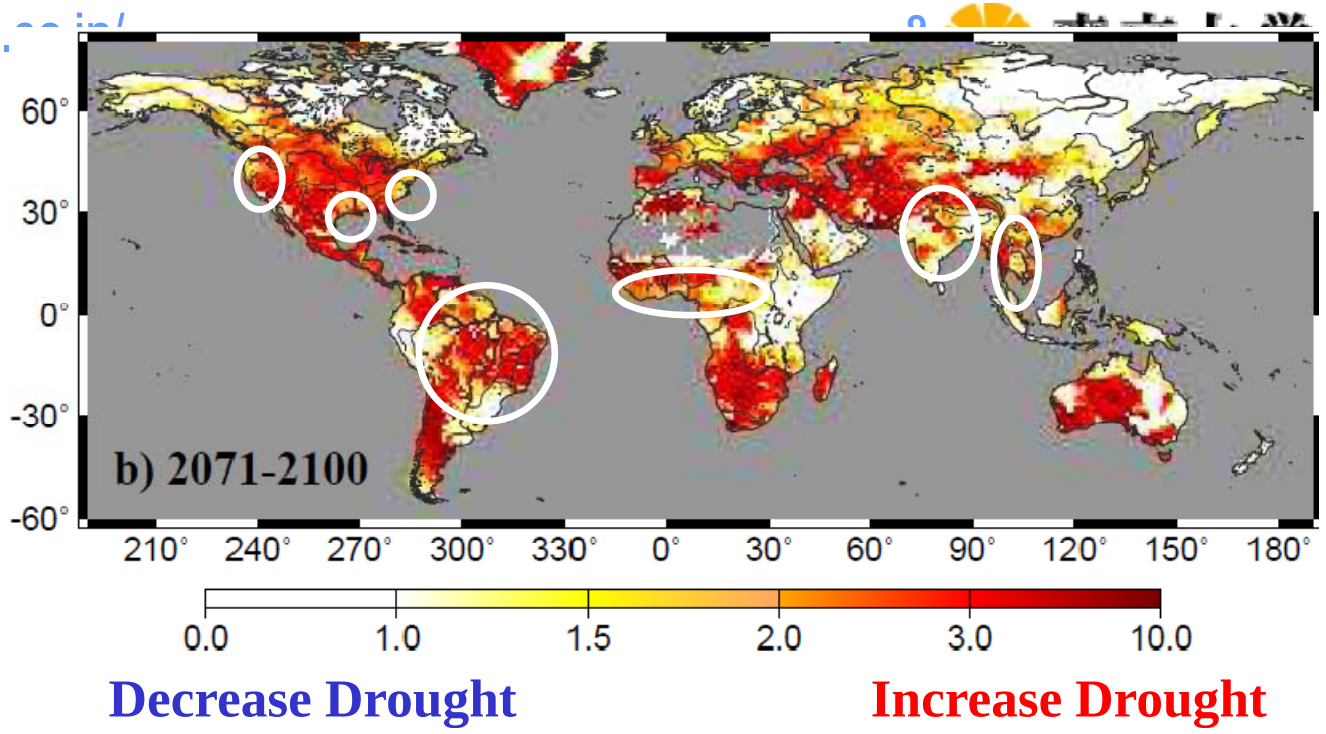


(CCSR/NIES K-1 Simulation
Grid point near Tokyo)

Change in Drought Frequency

End of 21st century compared with 20th century

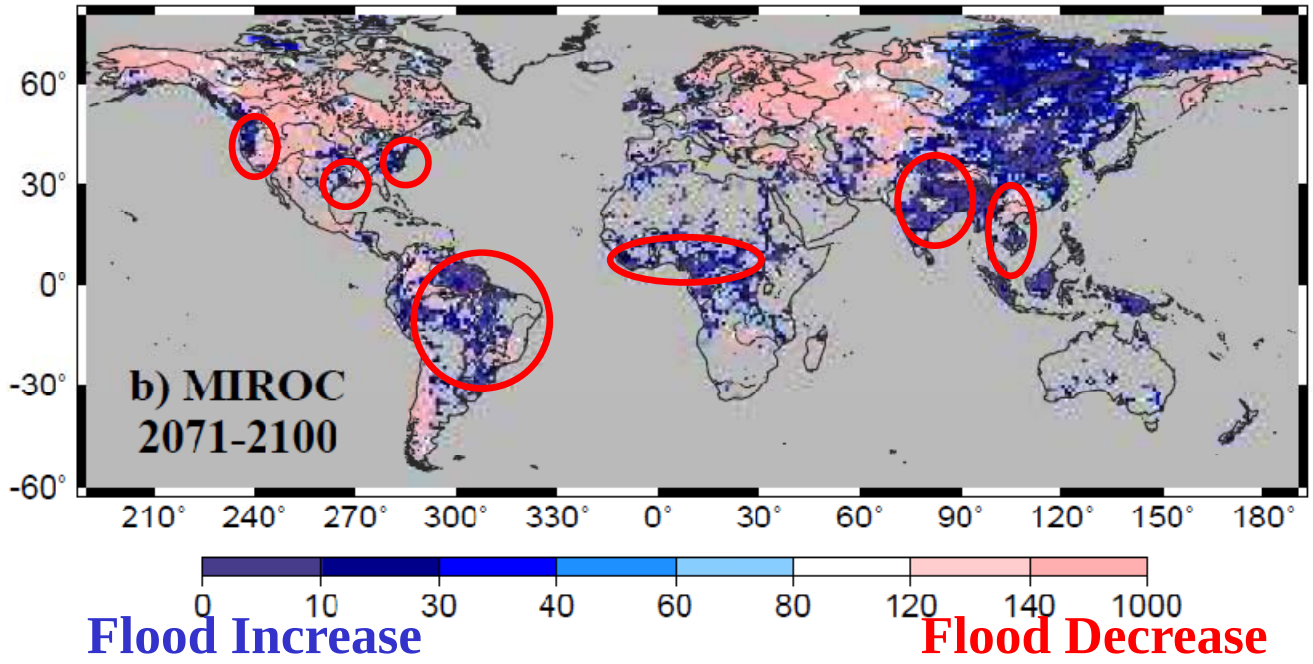
Drought: daily river discharge is below threshold of 10% percentile



Change in Flood Frequency

End of 21st century compared with 20th century

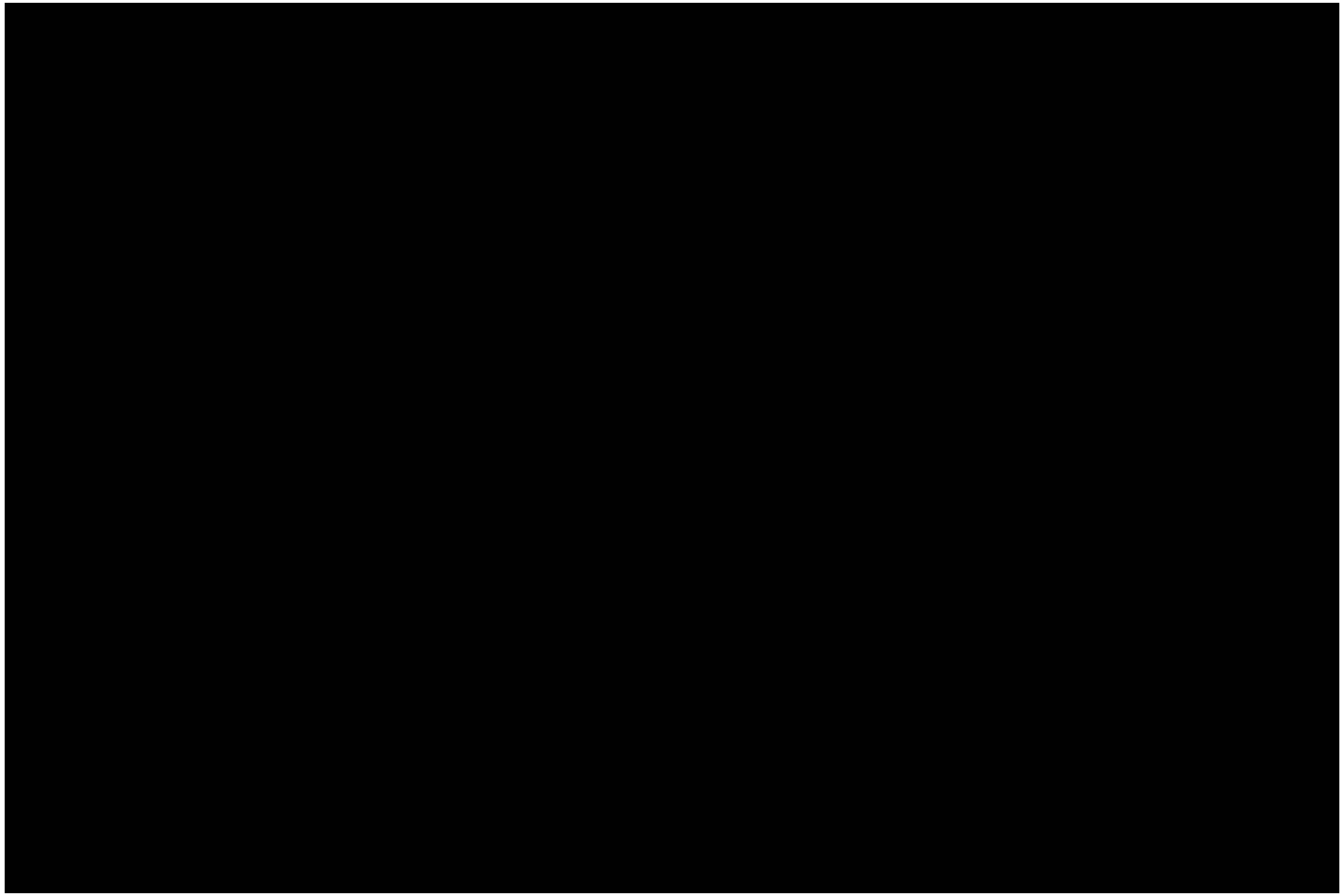
Frequency in the 21st century of 100-year flood in the 20th century



Hirabayashi et al., (*HSJ*, 2008)
Based on CCSR-NIES AOGCM

Japan Pavilion of EXPO Zaragoza (Spain)
Main Theme: Water and Sustainable Development

Changes in the Occurrence of Extreme Events in River Discharge



Hirabayashi et al., (*HSJ*, 2008)
Based on CCSR-NIES AOGCM

Impact of human activities on freshwater resources and their management, with climate change being only one of multiple pressures

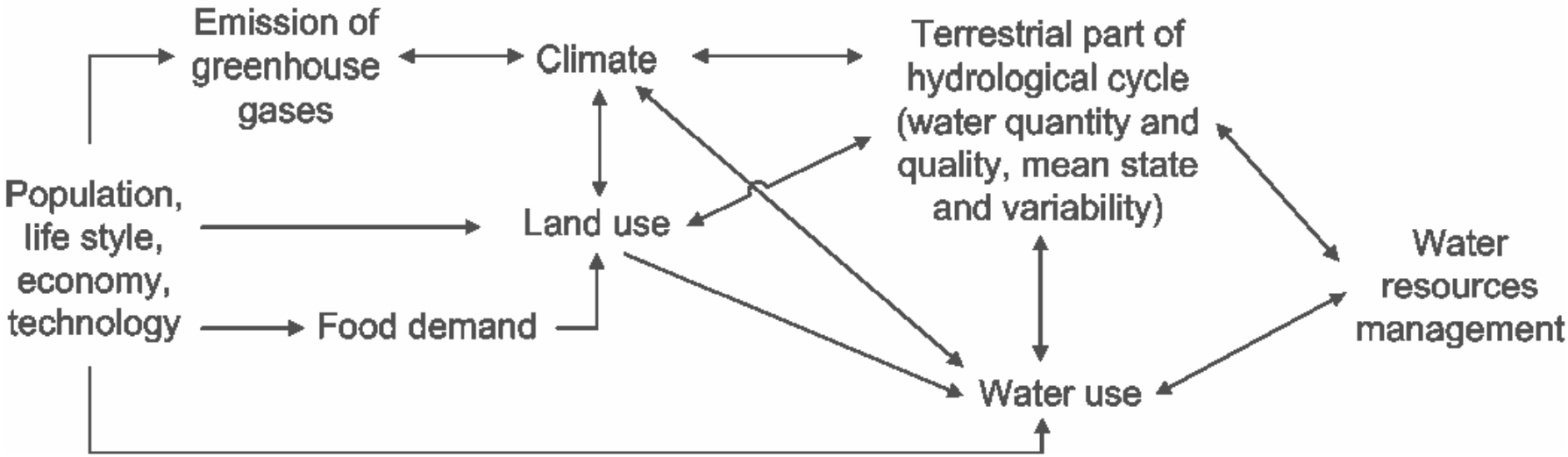
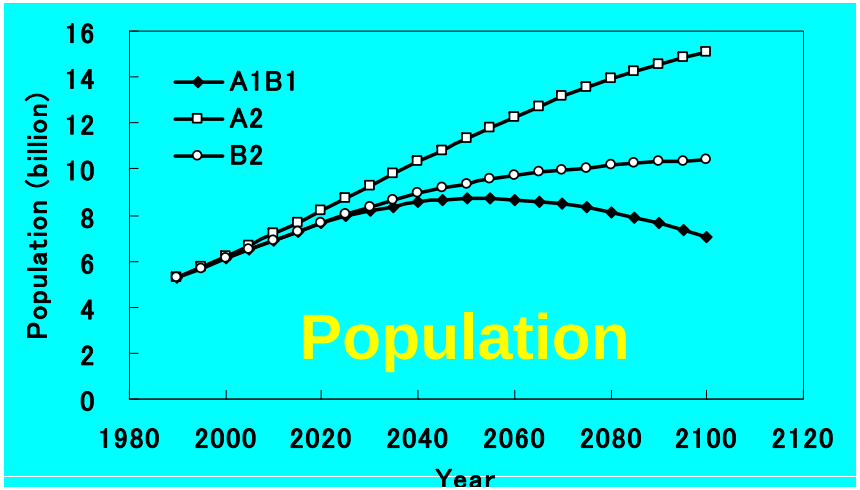


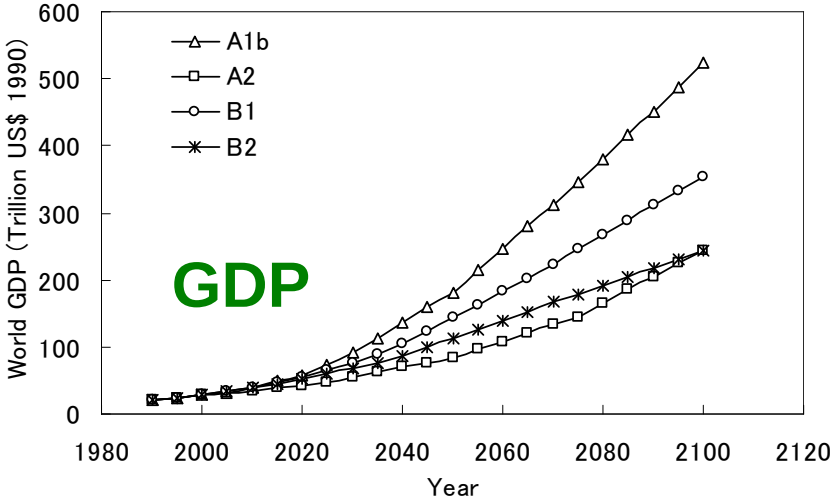
Figure 3.1: Impact of human activities on freshwater resources and their management, with climate change being only one of multiple pressures (modified after Oki (2005)).

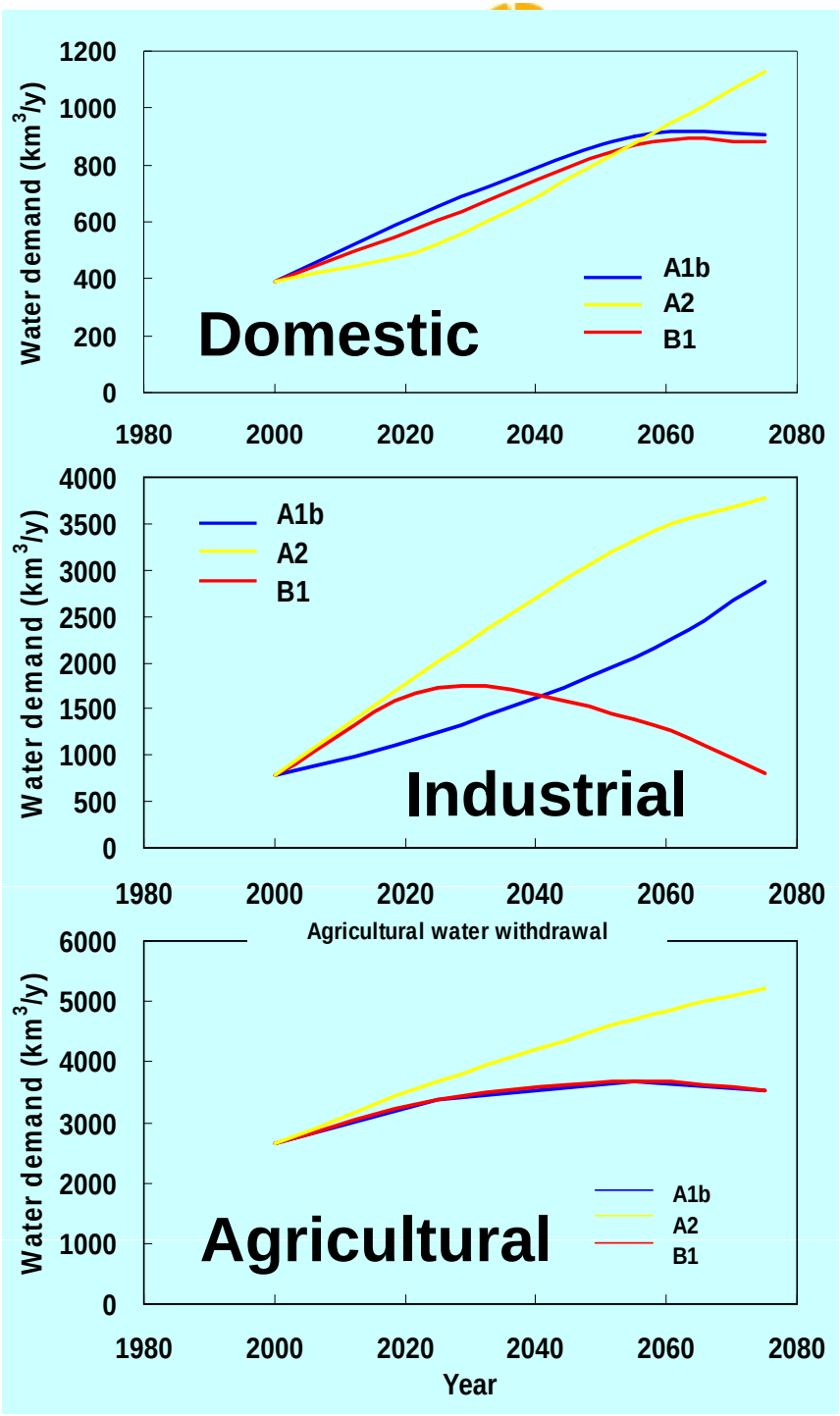
(IPCC AR4, WGII, Chapter 3, "Freshwater Resources and their Management", 2006)

Future Projection

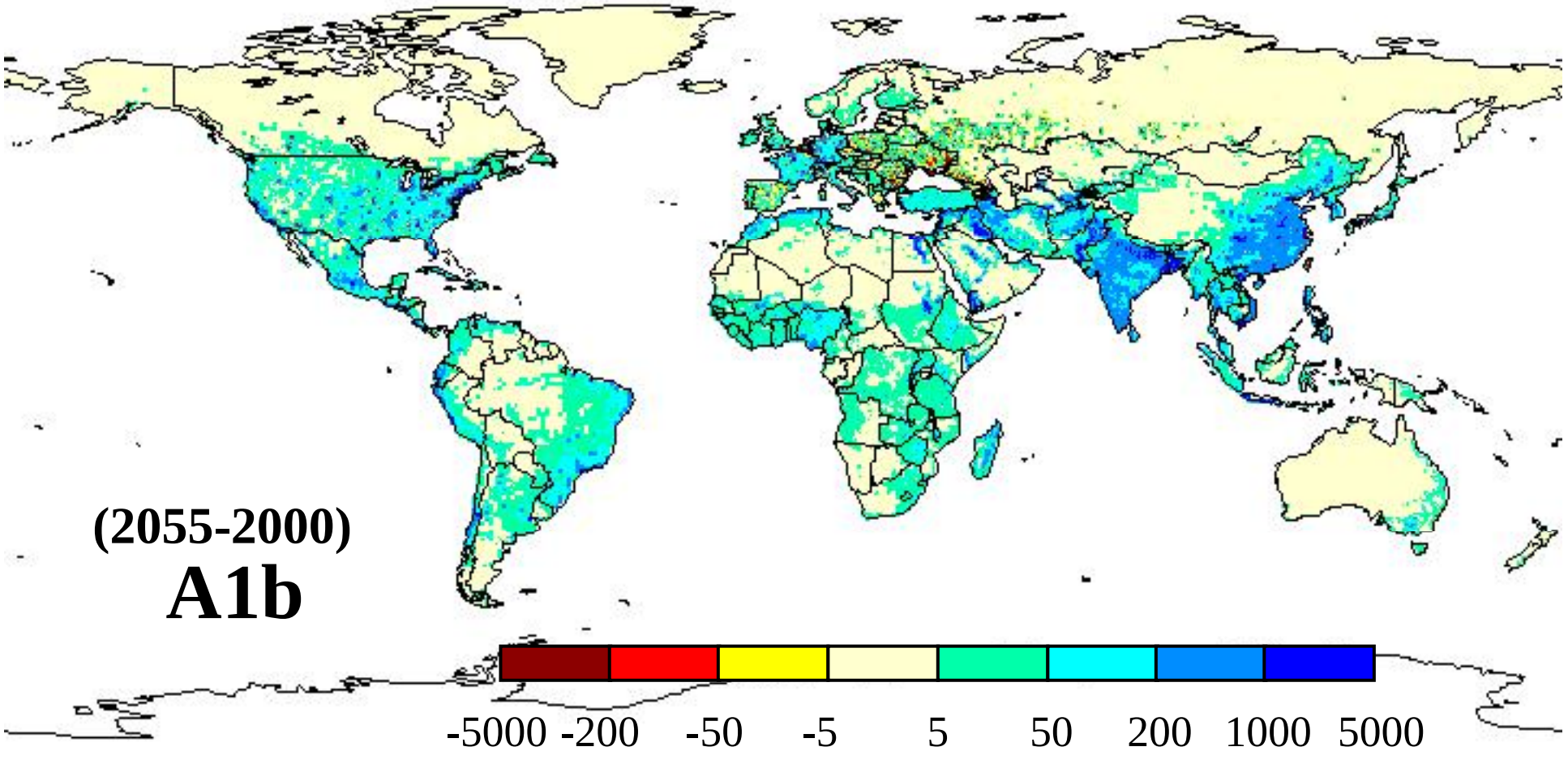
- SRES based
  - Population (urban & rural), GDP, efficiency
  - Climate change
- Global 0.5 degree grid distribution based







Total Water Withdrawal ($10^6 m^3/y$) in 2050 (difference to Year 2000)



(Shen, et. al, 2008, HSJ)

The ultimate objectives of future-oriented world water resource assessments are to show the international community the "*Projection*," what will happen if we continue to manage our water resources as we do today but not "*Prediction*," and to indicate what actions may be needed to prevent undesirable outcomes. In that sense, studies of future world water resources are successful if their predictions based on business-as-usual are proven wrong.

Q: How can we realize B1 society?

(Oki and Kanae, *Science*, 2006)

Counter Measures against CC

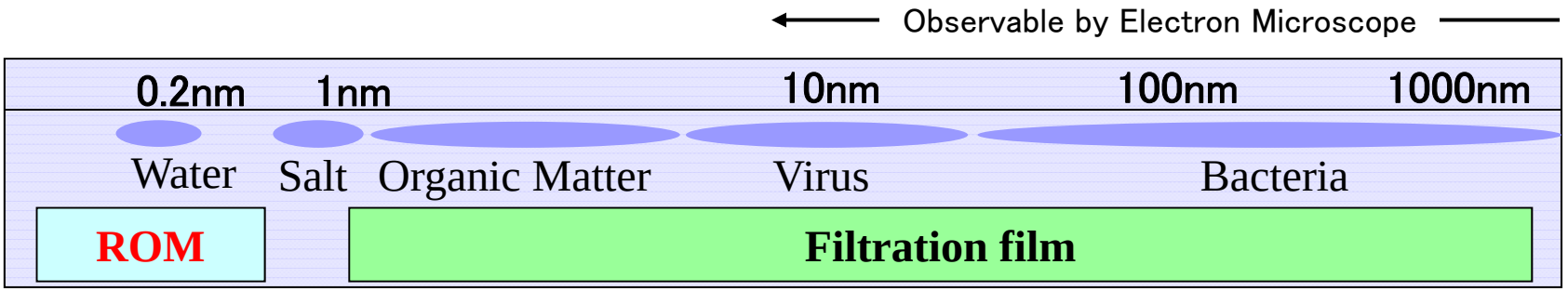
- Mitigation (slow down the speed of CC)
  - Reduce the emission of green house gases
  - Also good for energy saving, air pollution, energy security (⇔nuclear power), new industry (solar panel, eco-car, …)
- Adaptation (reduce disasters due to CC)
  - Enhance the resilience of the society
  - Also solves the existing social issues: poverty, vulnerabilities for natural disasters, sustainable energy, health, food and agriculture, ecosystem, transportation, …

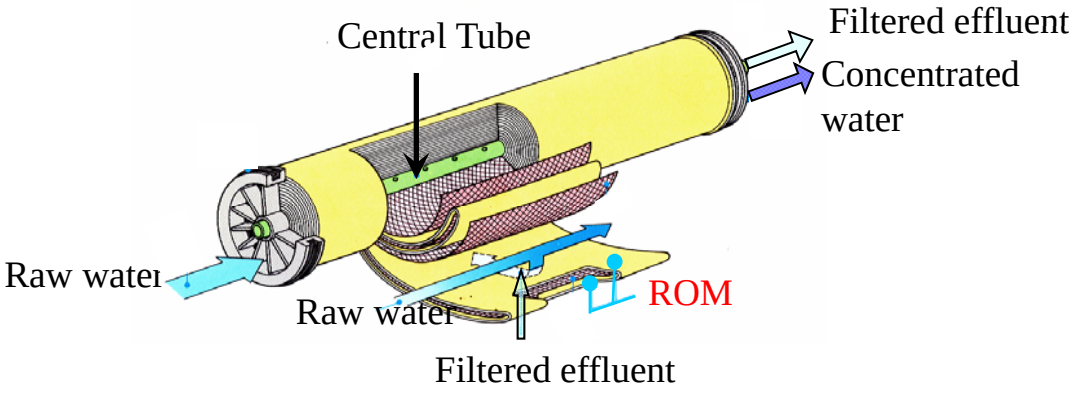
Adaptation Options

- **Supply-side/structural measures**
  - **Prospecting and extraction of groundwater**
  - **Increasing storage capacity by building reservoirs and dams**
  - **Desalination of sea water**
  - **Expansion of rain-water storage**
  - **Water transfer**
  - **construct flood embankments**

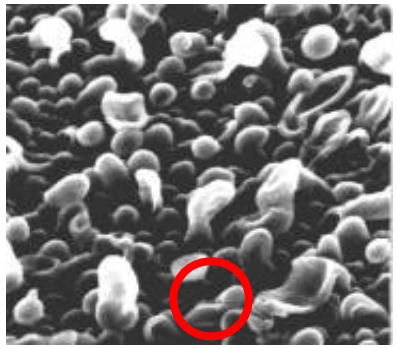
(IPCC AR4, WGII Ch3, 2007)

Reverse Osmosis Membrane

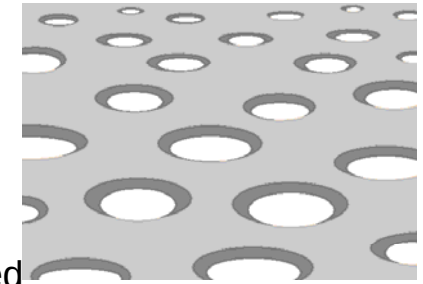




Surface of ROM



Expand



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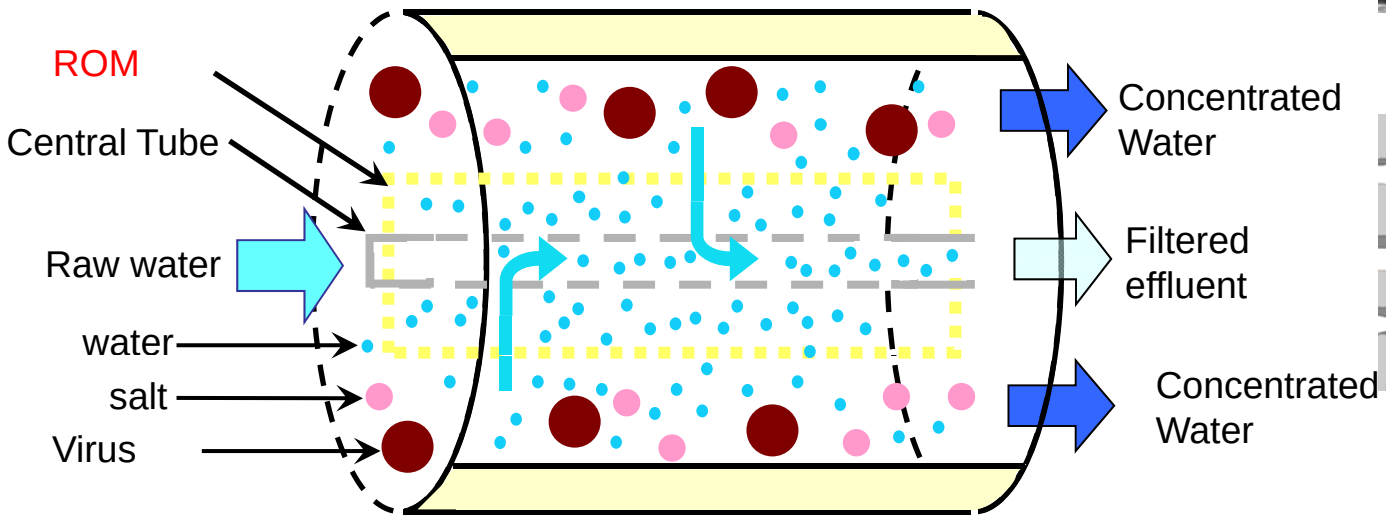
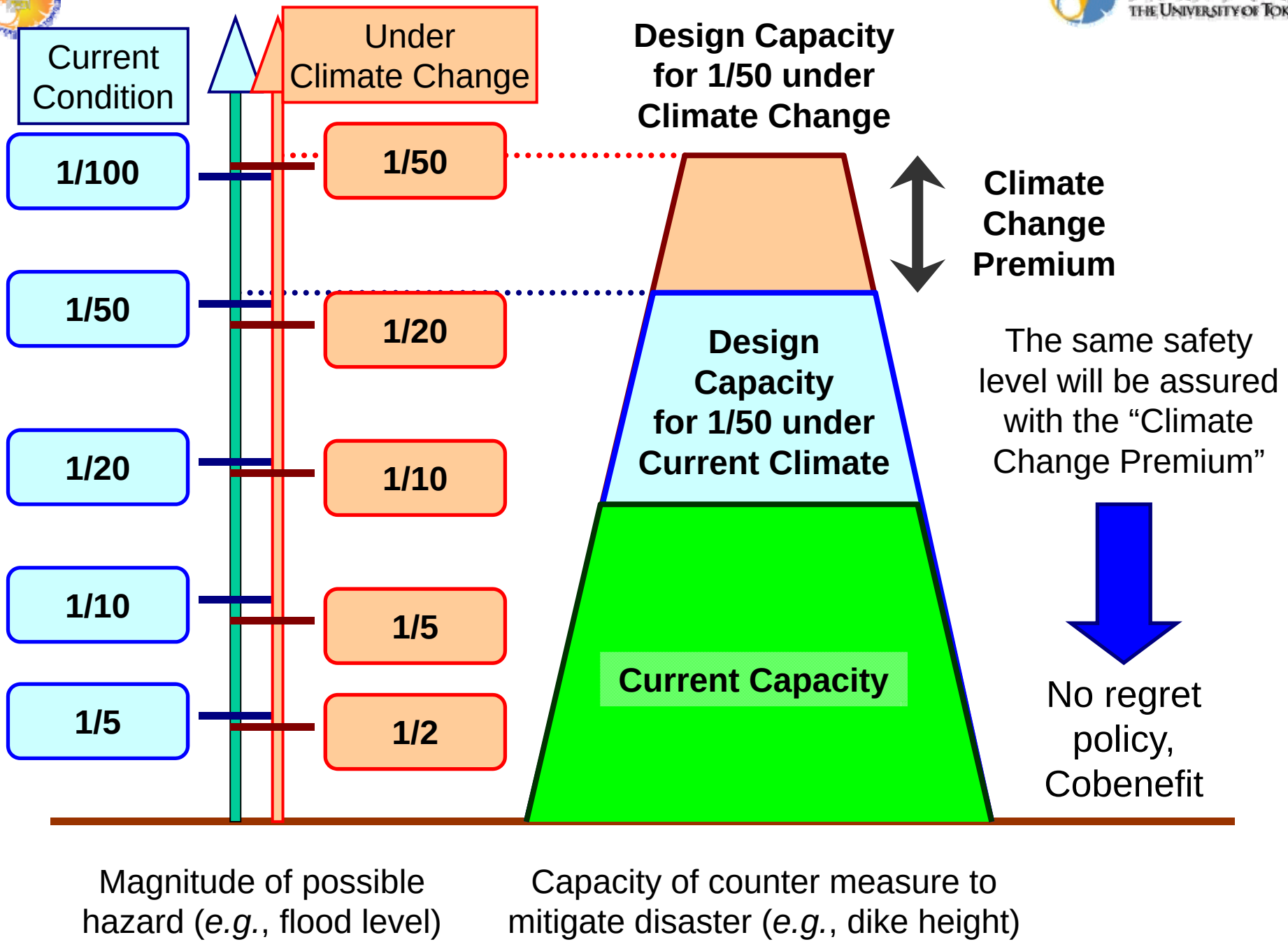
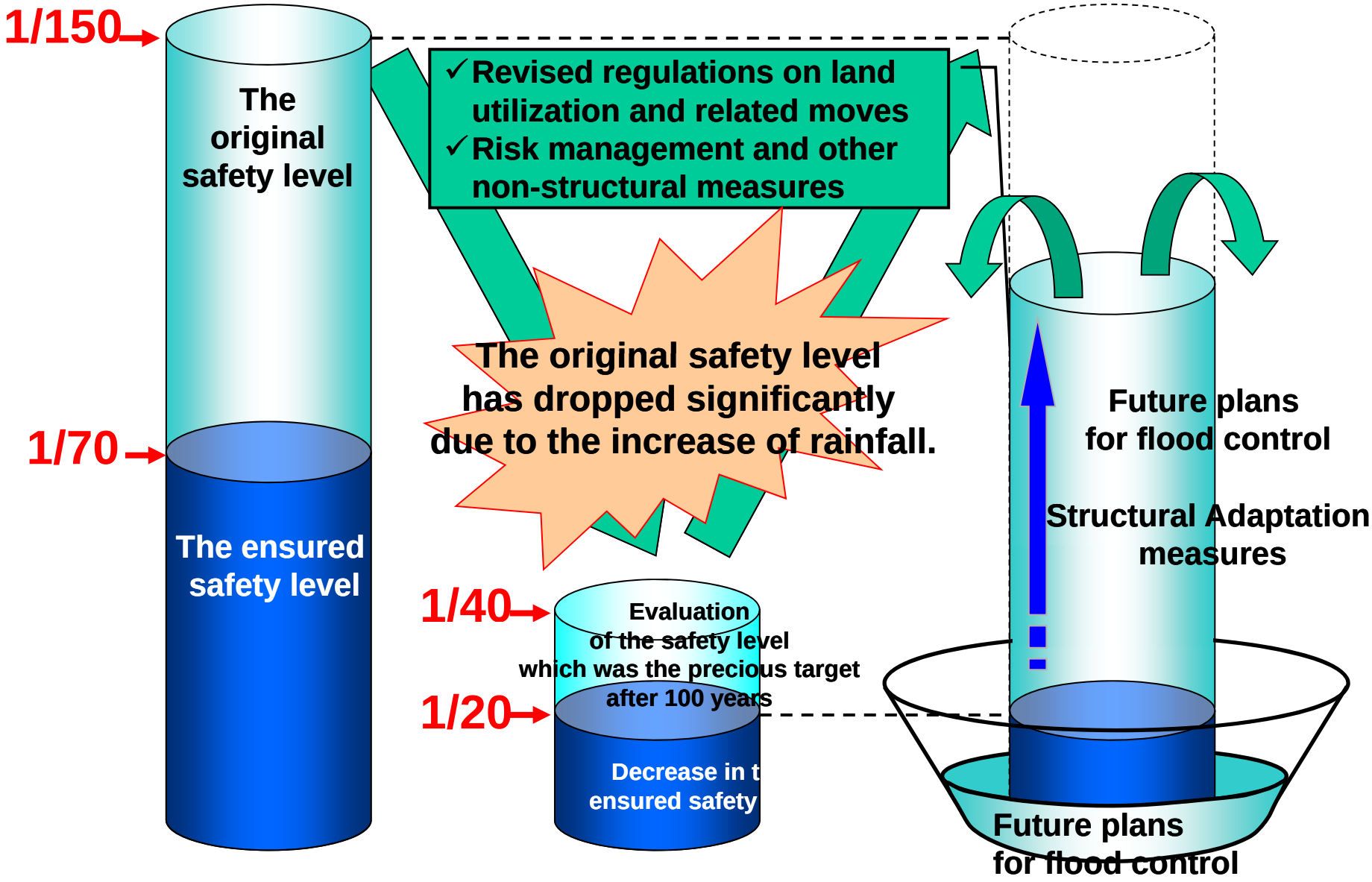



Current Condition
Under Climate Change
1/100
1/50
1/50
1/20
1/20
1/10
1/10
1/5
1/5
1/2
Design Capacity for 1/50 under Climate Change
Climate Change Premium
Design Capacity for 1/50 under Current Climate
Current Capacity
The same safety level will be assured with the “Climate Change Premium”
No regret policy, Cobenefit
Magnitude of possible hazard (e.g., flood level)
Capacity of counter measure to mitigate disaster (e.g., dike height)

Limitations on Adaptive Measures

(by MLIT)



Adaptation Options

- **Demand-side/soft measures:**
  - **Improvement of water-use efficiency by introducing water recycling system.**
  - **Expanded use of water markets and economic incentives to reallocate water to highly valued uses and conserve water.**
  - **Reduction in water demand for irrigation by enhancing agricultural skills, or by importing agricultural products, *i.e.*, virtual water trade.**

(IPCC AR4, WGII Ch3, 2007)

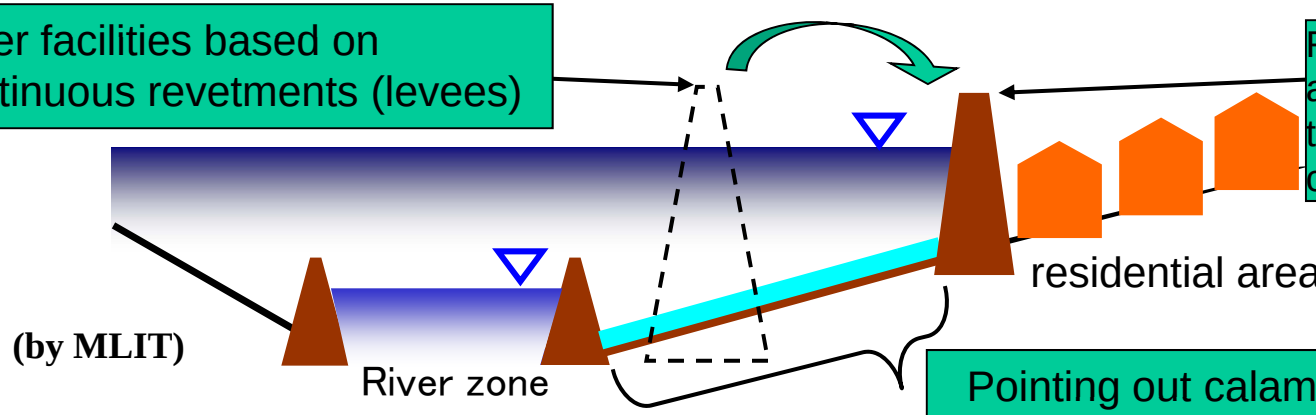
Measures Based on Regional Development that Incorporate Revised Regulations on land Use

Handling with large-scale floods that go beyond the level that can be managed by facilities alone, with land utilization and regional management that accommodate possible inundation.

Conversion to minimize damage by regional development and revised land use regulations

River facilities based on continuous revetments (levees)

River facilities that surround a limited number of districts that must be protected with circular levees, etc…

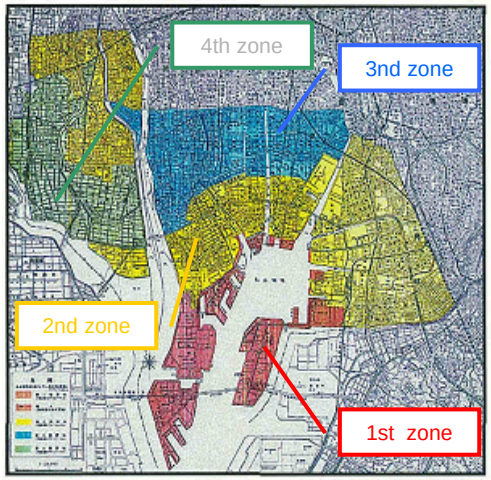


(by MLIT)

Pointing out calamity danger districts

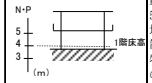
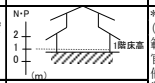
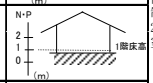
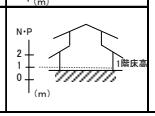
Revised regulation on land utilization by pointing out calamity danger districts

Conversion to regions with strong defense against inundation



Disaster prevention map in Nagoya city

Ex. Regulation on land utilization (on Nagoya city)

		1階の床の高さ	構造制限	図解	
第1種区域	市街化区域	N・P(+)4m以上	木造禁止		*建築物の建築禁止 範囲…海岸線・河岸線から50m以内で市長が指定する区域 制限…居住室を有する建築物、病院及び児童福祉施設等の建築禁止 木造以外の構造で、居住室等の床の高さをN・P(+)5.5m以上としたものについては建築可能
第2種区域	市街化区域	N・P(+)1m以上	2階以上に居室設置緩和：延べ面積が100㎡以内のものは避難室、避難設備の設置による代替可		*公共建築物の制限(第2種～第4種区域) 範囲…学校、病院、集会場、官公署、児童福祉施設等その他これらに類する公共建築物 制限…1階の床の高さN・P(+)2mかつN・P(+)3.5m以上の居室設置
第3種区域	市街化区域	N・P(+)1m以上	――		
第4種区域	市街化調整区域	N・P(+)1m以上	2階以上に居室設置		

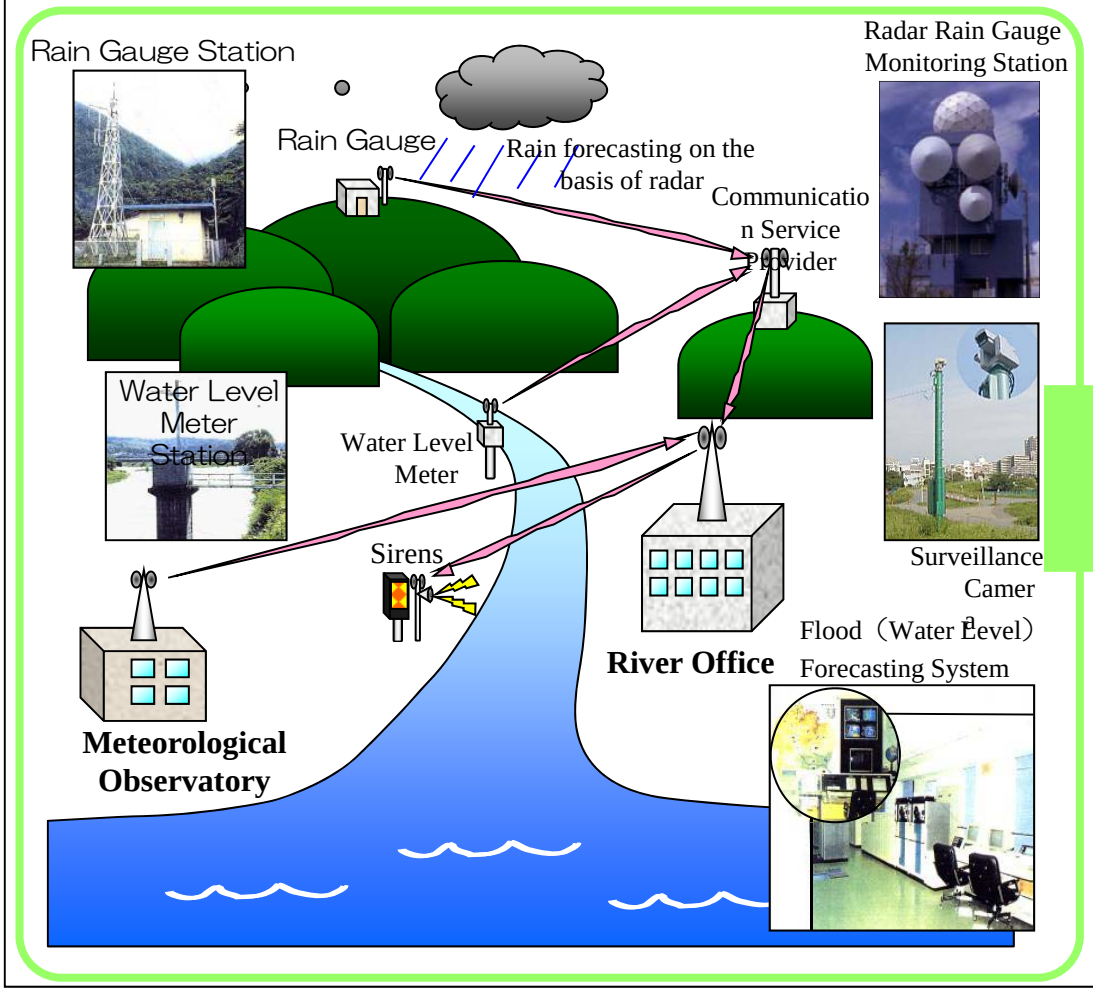
E.g. The piloti method (elevated-flood style) is used to minimize damage even if the building is inundated.

Adaptive Measures Centered on Risk Management

(by MLIT)

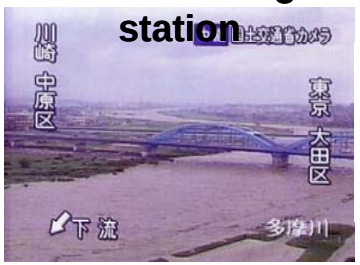
Sharing real-time information

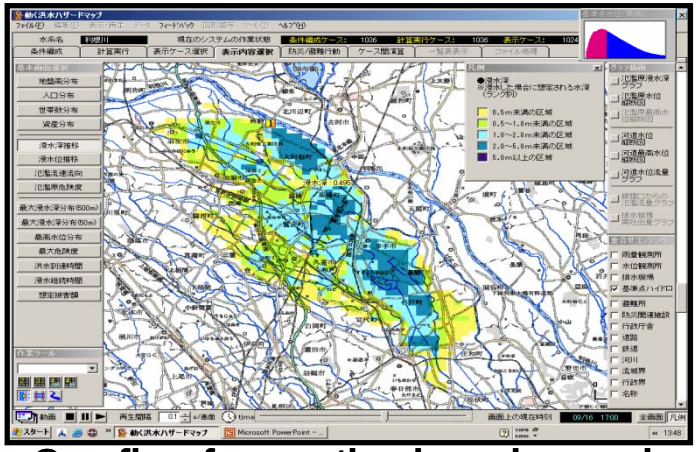
- Real time information on rainfall and water level provided to mobile phones, the Internet and radio network for disaster prevention, etc…
- Towards flood forecasting on the basis of real time simulations, etc…



Information provided to mobile phone / the internet

Video provided to broadcasting station





Overflow forecasting based on real time simulation

Messages

- **Concerned water scarce region in the future is basically where problems exist now.**
  - **More water stress in Mediterranean countries and Western part of NA due to climate change.**
  - **Social change gives more pressure in Middle East, West Asia, and South Asia.**
  - **Lack of social capacity in Sub-Saharan Africa and Latin America are concerned to be vulnerable.**
- **Serious changes in extreme events are also concerned.**
- **Coastal Mega Cities are/will be vulnerable.**
- ***Monitoring* changes → *Projections* of Social and Climatic Changes → Impact *Assessments* → Examine Adaptation *Options* → *Decision Making* → *Actions***