Keio University Yamaguchi seminar

Water Resource Group

Impacts of Climate Change on Water Resource in Japan, and Adaptation Options

Shiori Arai Yohei Kudo Akiko Shimizu
Susumu Segawa Yoko Nobuoka

How to adapt to this problem?

Summary

Increase in Water Demand

Reduction Potential of Water Withdrawal

Chapter 1

Water as a Resource

Yohei

Chapter 2

Prospect of Water Resource in the World

Yohei

Chapter 3

Impacts of Climate Change on Water Resource in Japan

Akiko & Yohei

Chapter 4

Adaptation Options

Yoko & Akiko & Susumu

Conclusion

Reduction Potential of Water Withdrawal

Yohei

Annex

World Water Crisis and Japan

Yoko

Chapter 1. Water as a Resource

- **Life and Water**
- **Water resource on the Earth**
- **Water as a Resource**

Life and Water

indispensable

How much water is there on the Earth?

Water Resource on the Earth

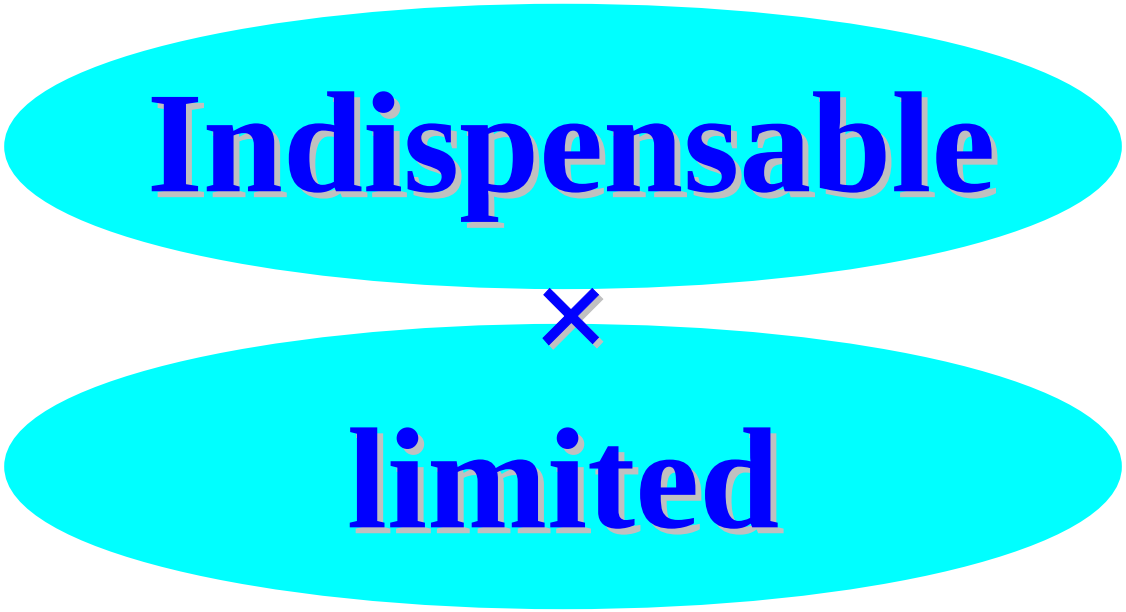
limited

Groundwater

0.01%

0.8%

Water as a Resource



Chapter 1

Water as a Resource

Yohei

Chapter 2

Prospect of Water Resource in the world

Yohei

Chapter 3

Impacts of Climate Change on Water Resource in Japan

Akiko & Yohei

Chapter 4

Adaptation Options

Yoko & Akiko & Susumu

Conclusion

Reduction Potential of Water Withdrawal

Yohei

Annex

World Water Crisis and Japan

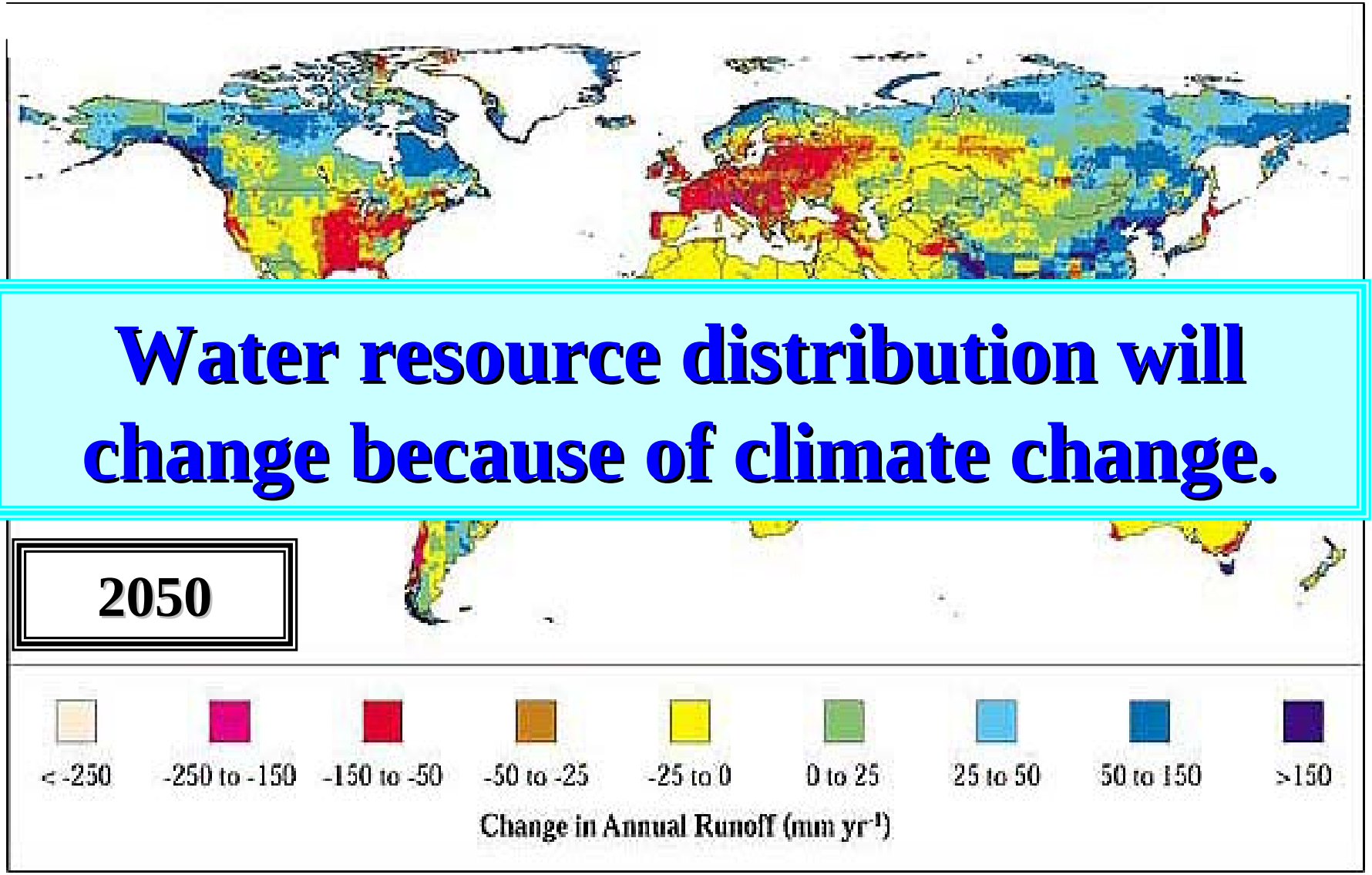
Yoko

Chapter 2. Prospect of Water Resource in the World

2-1. Change in Water Supply

2-2. Change in Water Demand

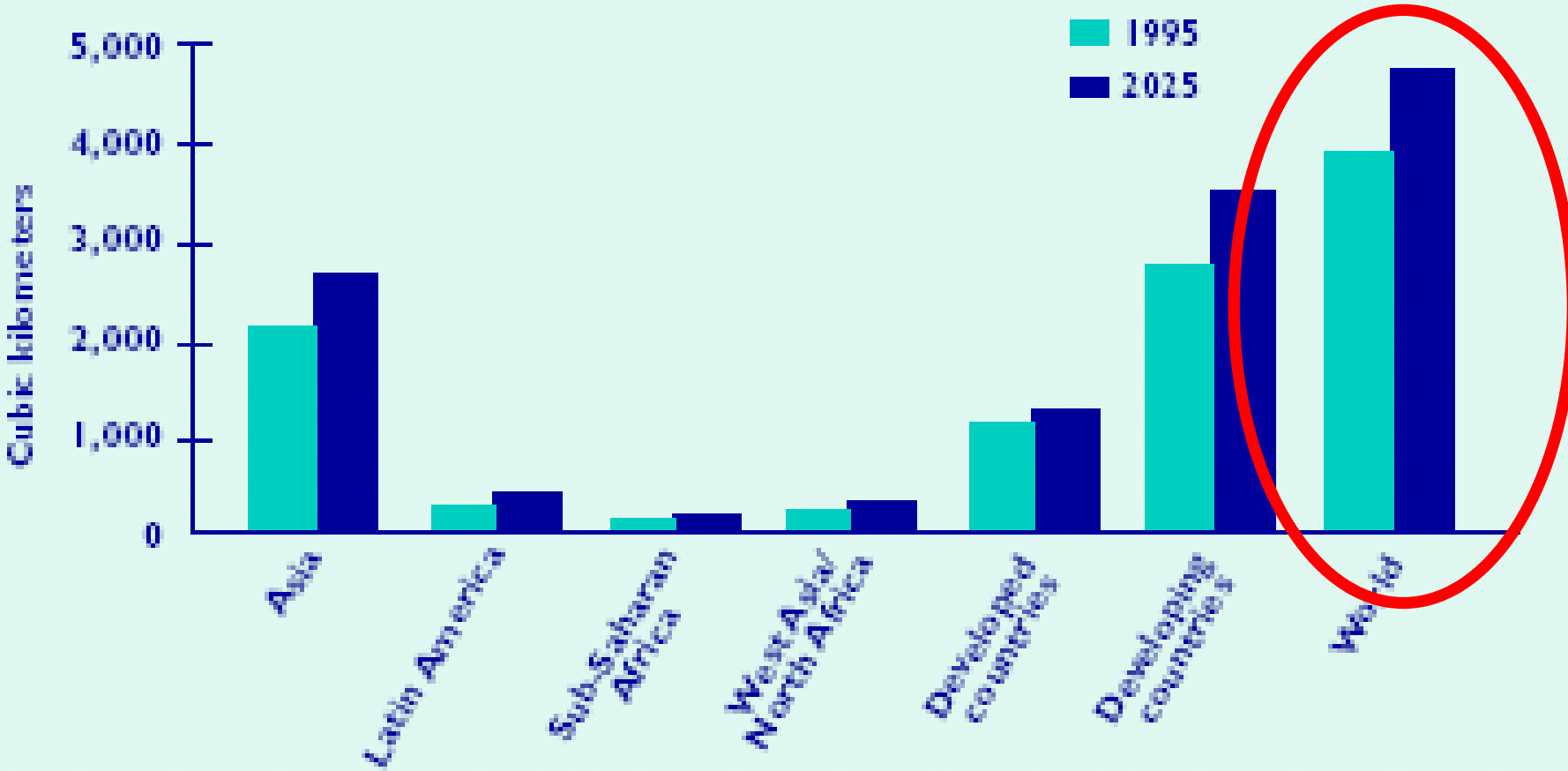
2-1. Change in Water Supply



Source:IPCC Third Assessment Report “Climate Change 2001

2-2. Change in Water Demand in the World

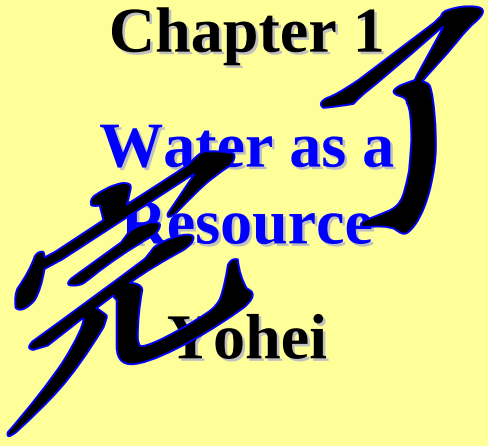
Figure 1 Total water withdrawal by region, 1995 and 2025



SOURCE: Authors' estimates and IMPACT-WATER projections, June 2002.
NOTE: Projections for 2025 are for the business as usual scenario.

Chapter 1

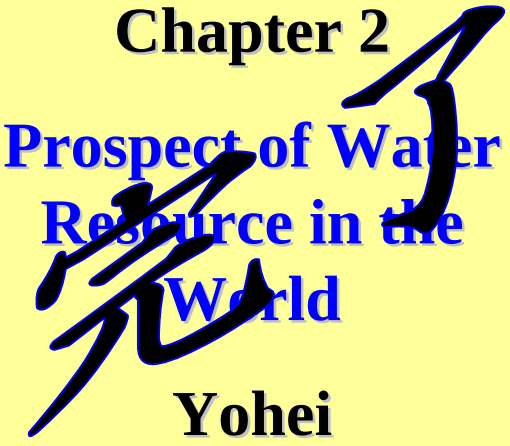
Water as a Resource



Yohei

Chapter 2

Prospect of Water Resource in the World



Yohei

Chapter 3

Impacts of Climate Change on Water Resource in Japan

Akiko & Yohei

Chapter 4

Adaptation Options

Yoko & Akiko & Susumu

Conclusion

Reduction Potential of Water Withdrawal

Yohei

Annex

World Water Crisis and Japan

Yoko

Chapter 3. Impacts of Climate Change on Water Resource in Japan

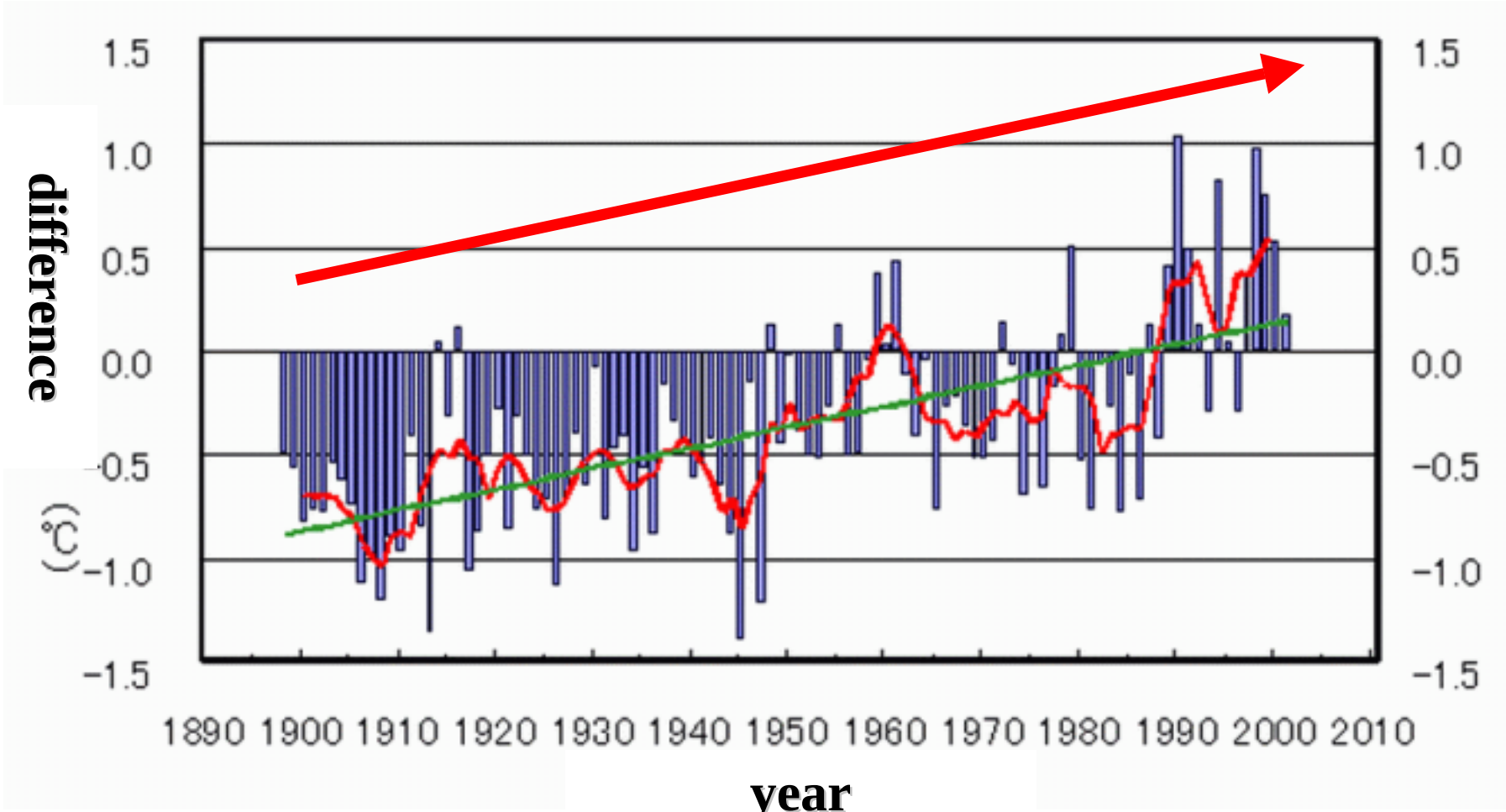
- 3-1. Impacts on Water Resource
  - 3-1-1. Current Situation
  - 3-1-2. Prospect
- 3-2. Impacts on Water Availability

3-1. Impacts on Water Resource

3-1-1. current situation of climate change

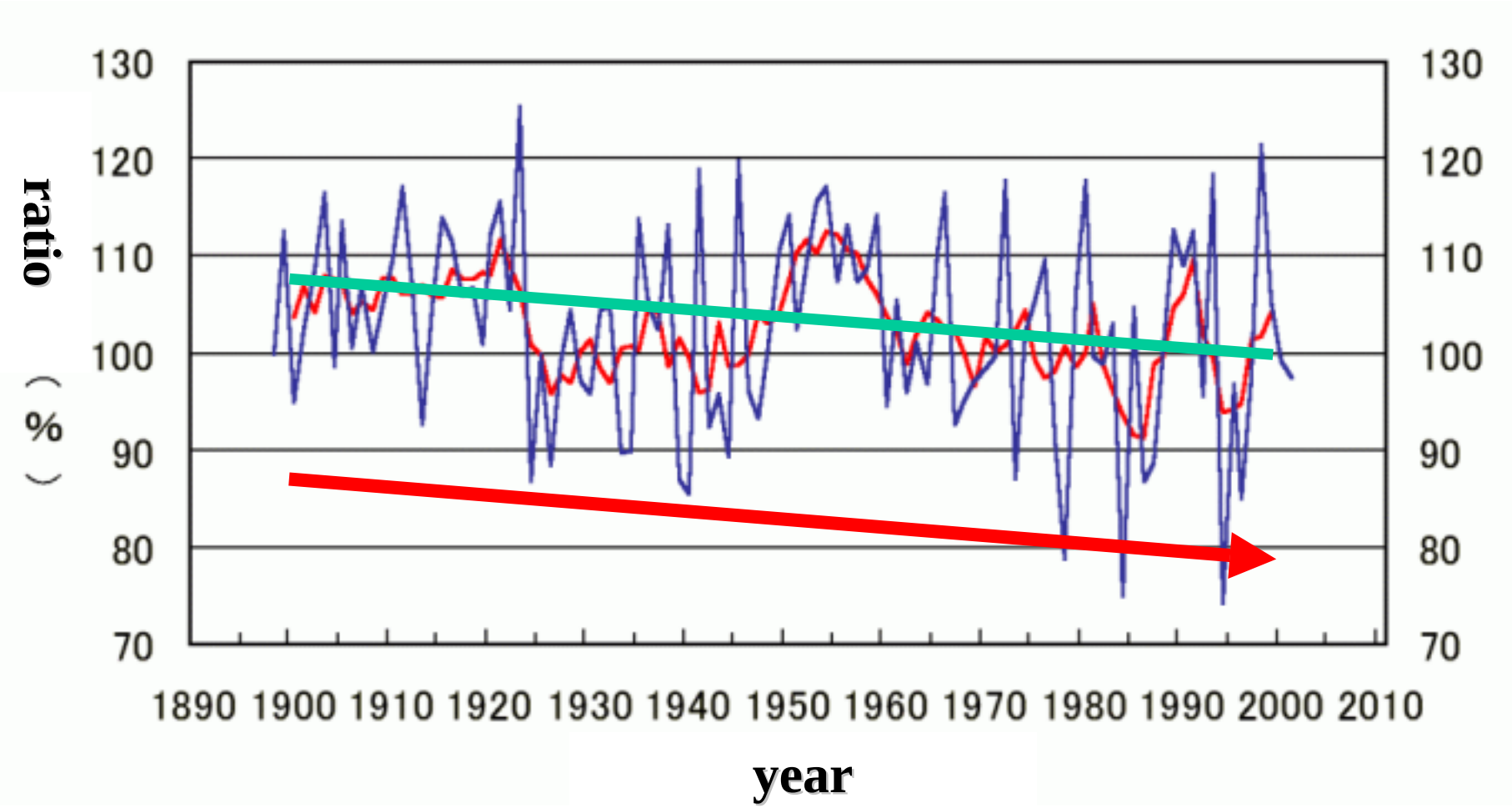
- Temperature
- Precipitation
- Abnormal Weather

Temperature



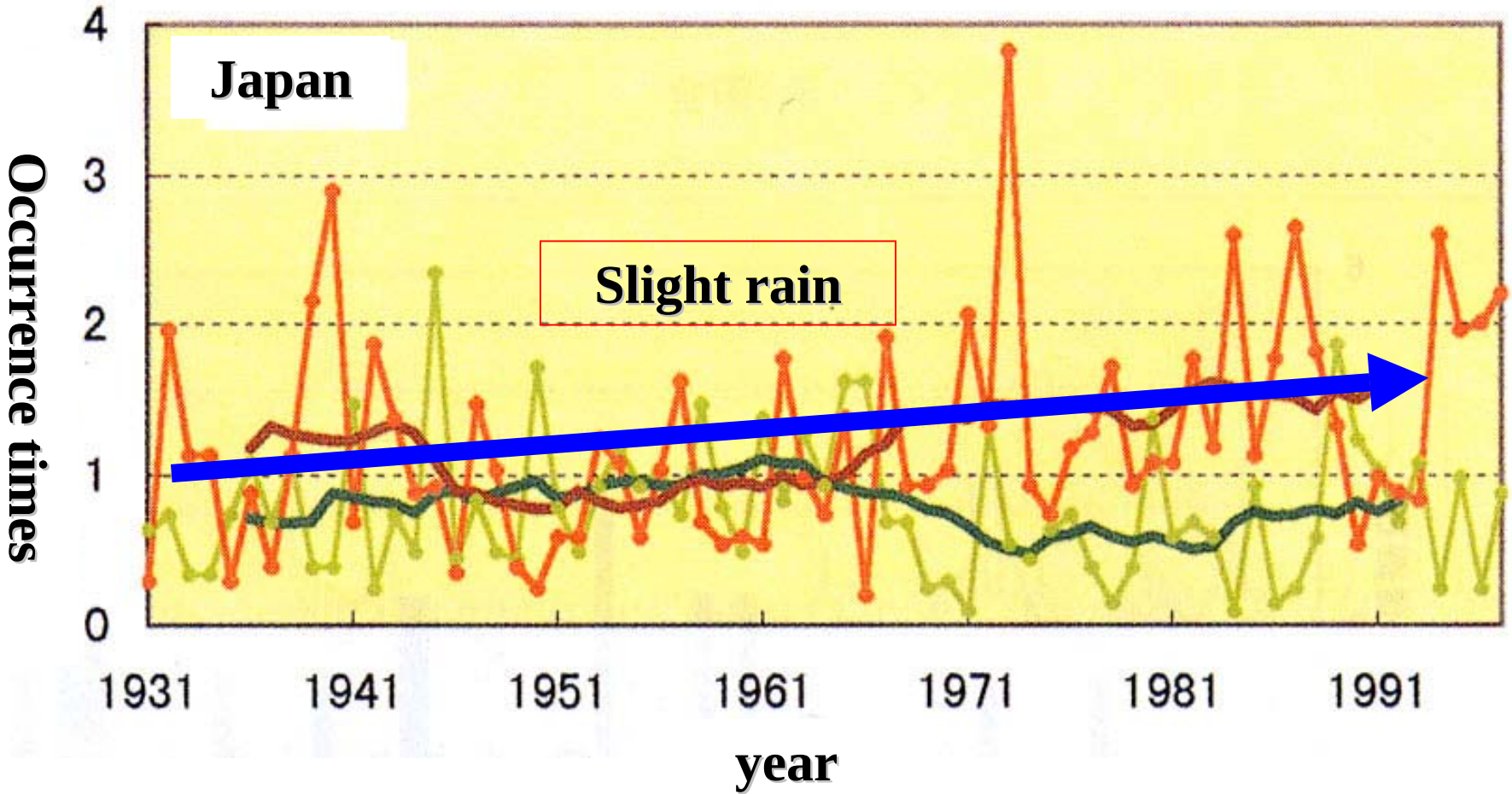
Source:Japan Meteorological Agency

Precipitation



Source:Japan Meteorological Agency

Abnormal Weather



Source:Japan Meteorological Agency

3-1. Impacts on Water Resource
3-1-2. Prospect

- Increase in evaporation
  (Decrease in river flow)

- Frequent abnormal weather

How about impacts on water availability?

3-2. Impacts on Water Availability

Impacts on Water Resource

- Increase in evaporation

  (Decrease in river flow)
- Increase in abnormal weather

Water supply and demand will be tight !

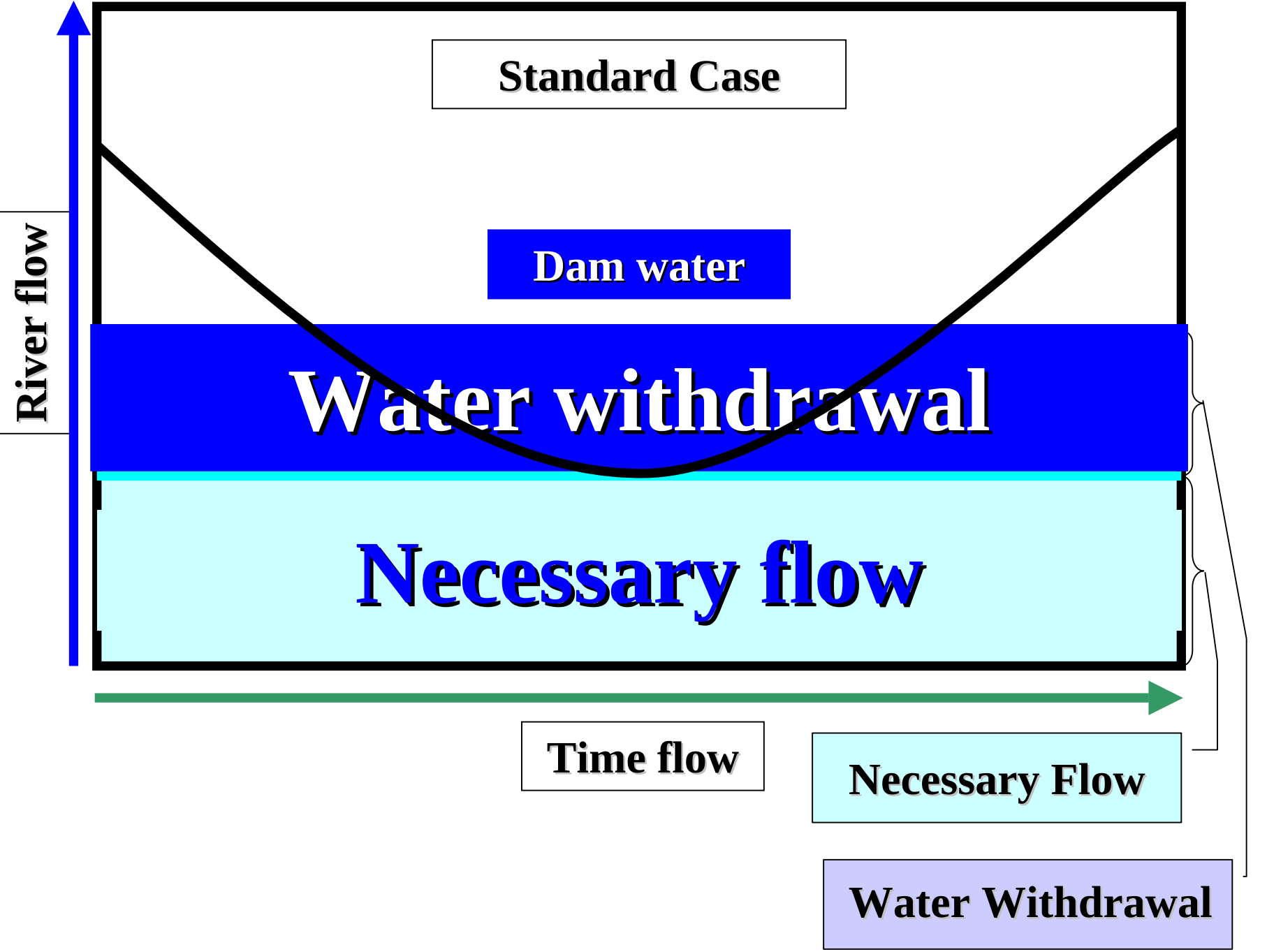
Background

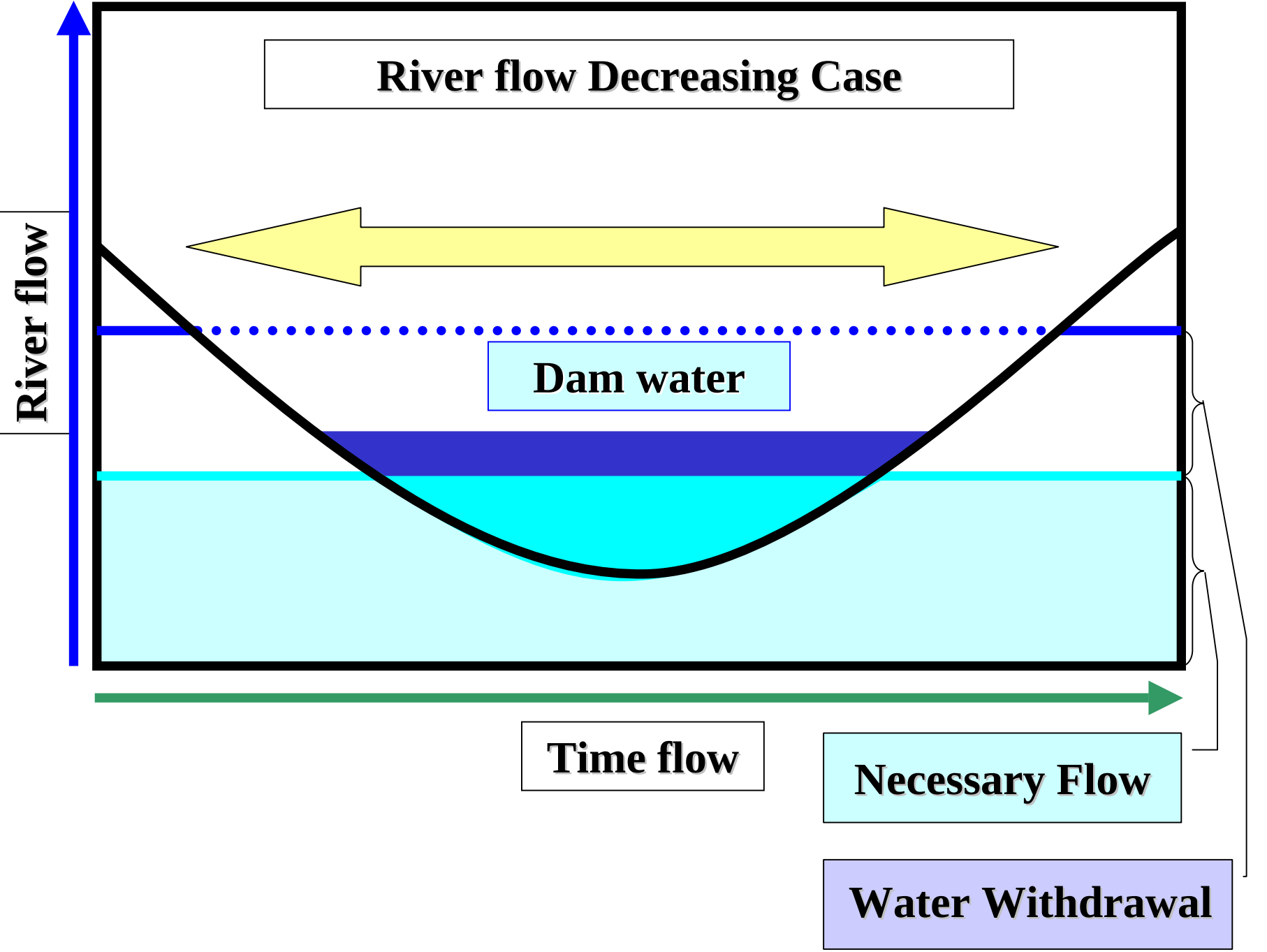
Water resource development in Japan depends on dams!

Water storage⇒12billion m

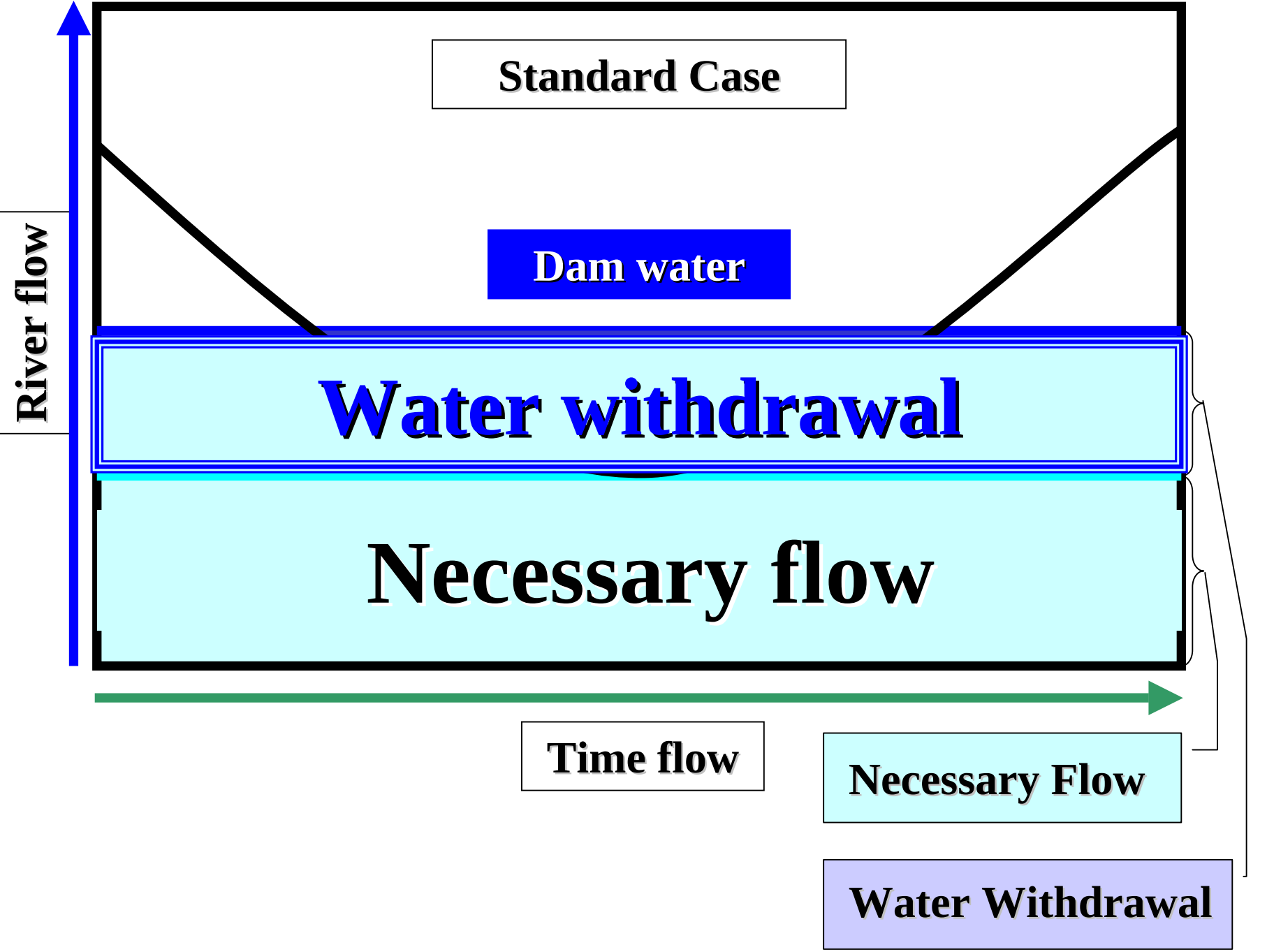
Water withdrawal in Japan is supported by dams!

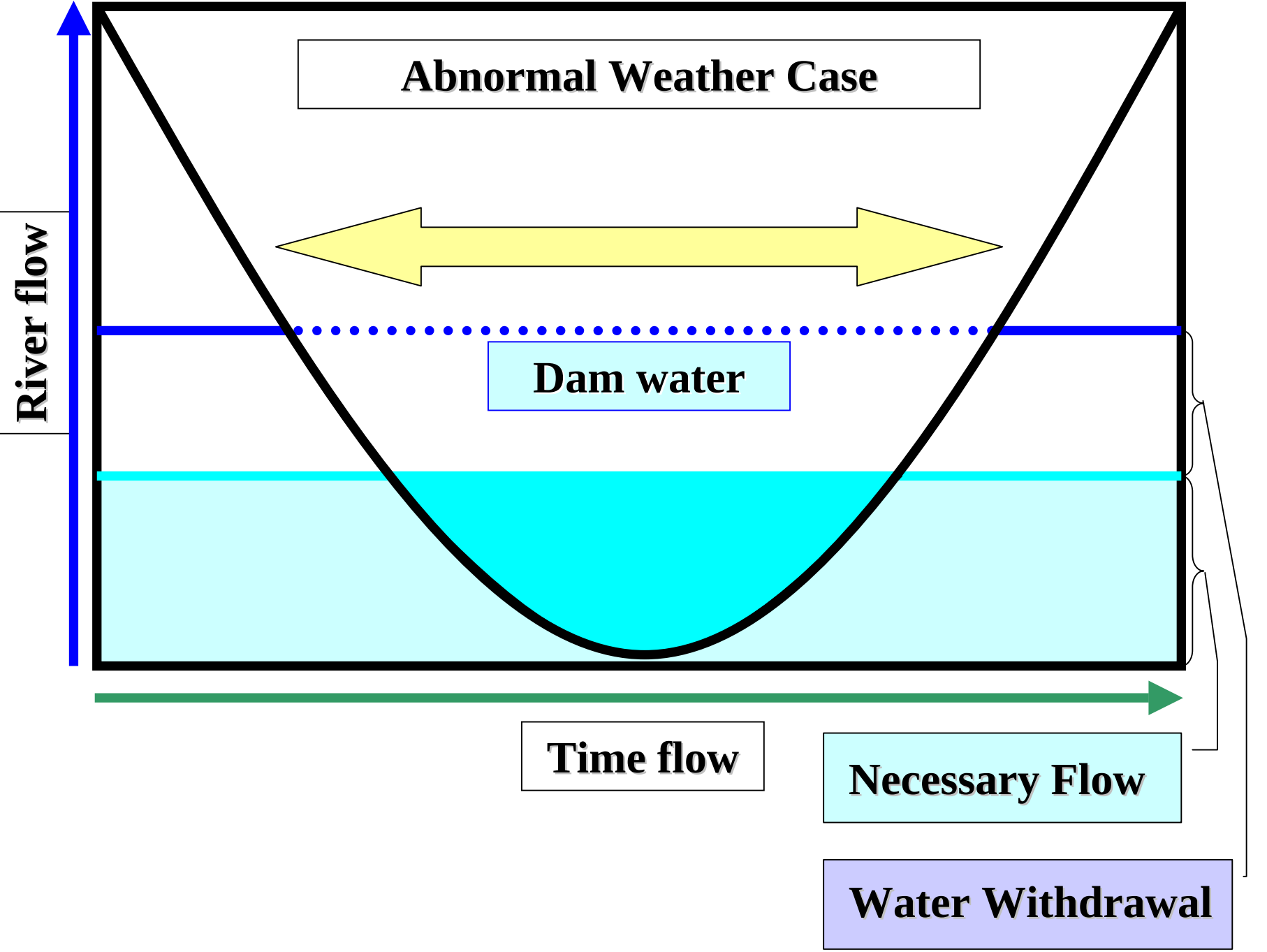
Decrease in river flow causes decrease in water withdrawal


Standard Case
River flow
Dam water
Water withdrawal
Necessary flow
Time flow
Necessary Flow
Water Withdrawal


River flow Decreasing Case
River flow
Dam water
Time flow
Necessary Flow
Water Withdrawal

Frequent abnormal weather causes decrease in water withdrawal


Standard Case
Dam water
River flow
Water withdrawal
Necessary flow
Time flow
Necessary Flow
Water Withdrawal


Abnormal Weather Case
River flow
Dam water
Time flow
Necessary Flow
Water Withdrawal

3-2. Impacts on Water Availability

- Decrease in river flow
- Frequent abnormal weather

⇒Decrease in water supply

Furthermore…..

- Rise in temperature

⇒Increase in water demand

Water supply and demand will be tight !

How to adapt to this problem?

Chapter 1

Water as a Resource

Yohei

Chapter 2

Prospect of Water Resource in the World

Yohei

Chapter 3

Impacts of Climate Change on Water Resource in Japan

Akiko & Yohei

Chapter 4

Adaptation Options

Yoko & Akiko & Waccho

Conclusion

Reduction Potential of Water Withdrawal

Yohei

Annex

World Water Crisis and Japan

Yoko

4. Options for adaptation

For Japan to secure sufficient water resources……

1. Increase water supply by dams
2. Decrease water demand by improving efficiency

4-1. Dams

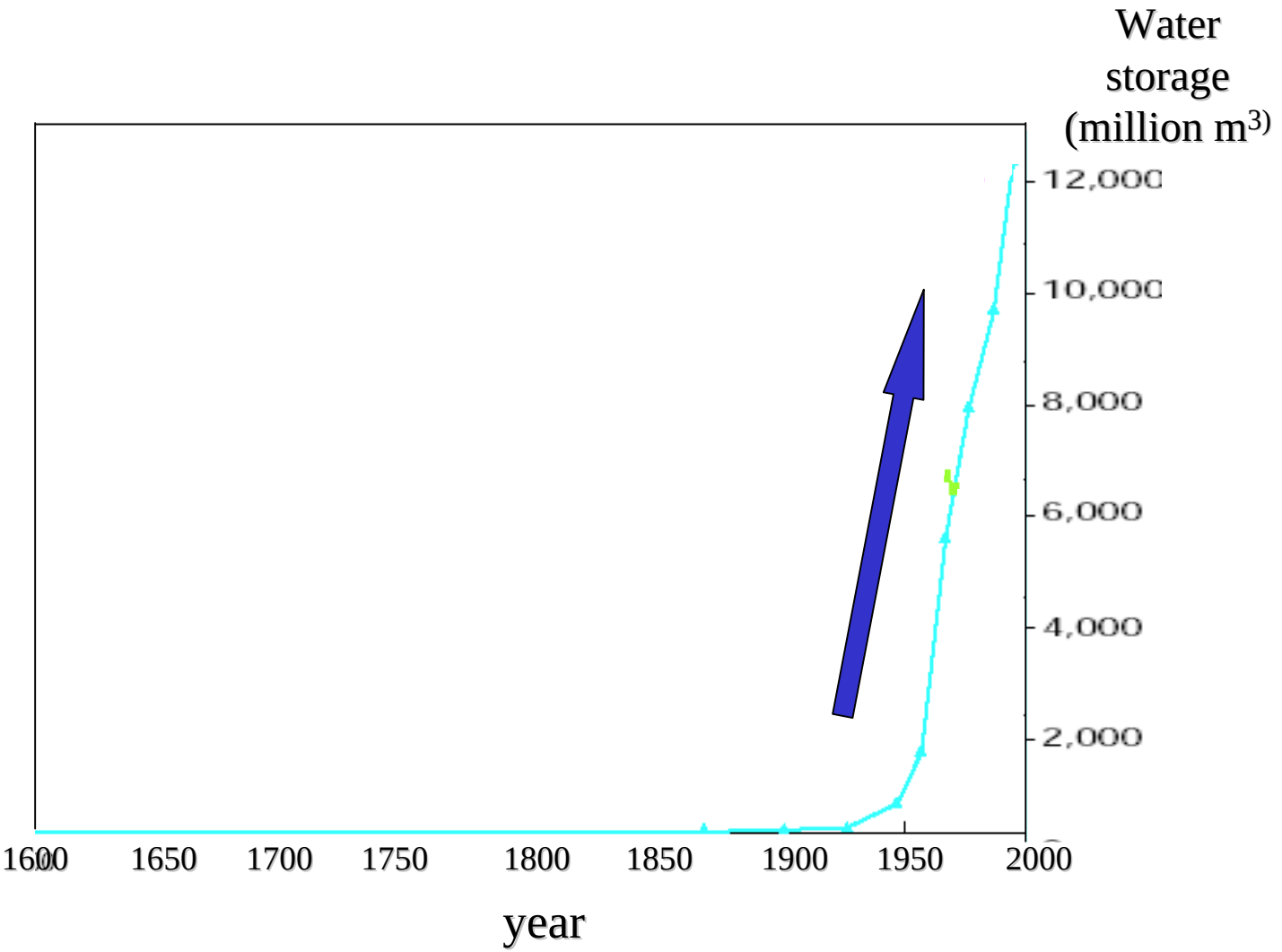
About 2700 dams in Japan

The main policy of Japan’s water resource development

Roles of dams

- **Stable water supply**
- **Water resource security**

Dams


Water storage (million m3)
12,000
10,000
8,000
6,000
4,000
2,000
1600
1650
1700
1750
1800
1850
1900
1950
2000
year

How effective are dams to secure water resources?

Dams' effectiveness (Water shortage)

- Effective method for water shortage

ex.: Around Tokyo area (m^3)

	1963-64	1996
City water use	1billion	1.6billion
Water storage (dams)	0.18billion	0.37billion
Restriction of the water supply	513days	44days

Moreover…

- In the past….dams were considered to bring tremendous positive effects

ex. Increasing demand for water in industrial and households sectors

Creation of employment

There has been strong resistance to constructing more dams to control water resources.

3.Why cannot we build more dams?

1. Higher concern for the environment

(Dams destroy biodiversity)

3.Why cannot we build more dams?

2. Anti-public works projects

especially since introduction of Public Works Assessment System in 1997

(Dams guzzle a tremendously large sum of taxpayers' money)

In view of these arguments, it is becoming more difficult to construct more dams.

Anti-dam!!

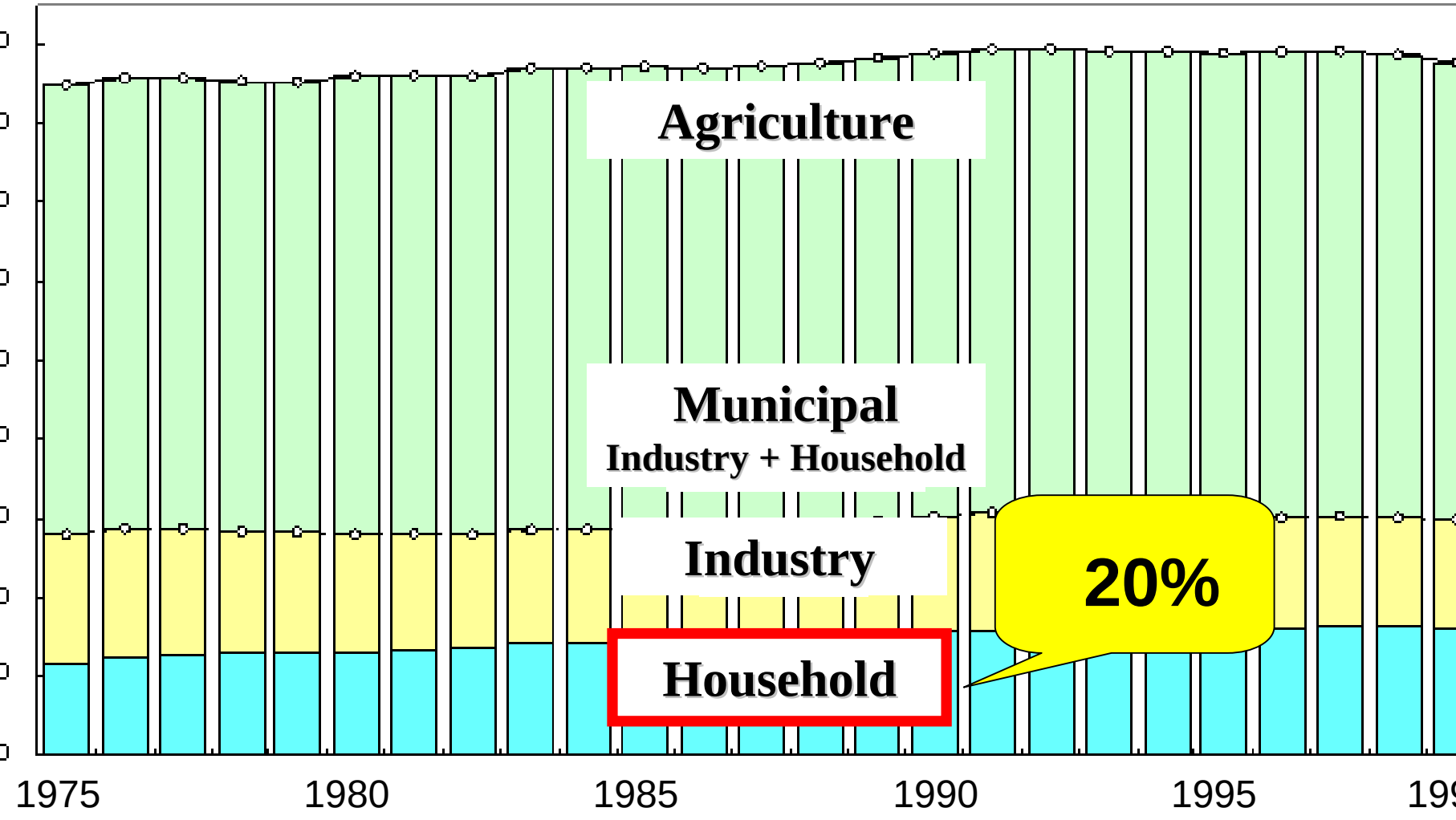
4. Options for Adaptation

1. Increase water supply by dams
2. Decrease water demand by improving efficiency

Decrease water demand

Reduction
of
water withdrawal

4-2. Reduction potential of water withdrawal



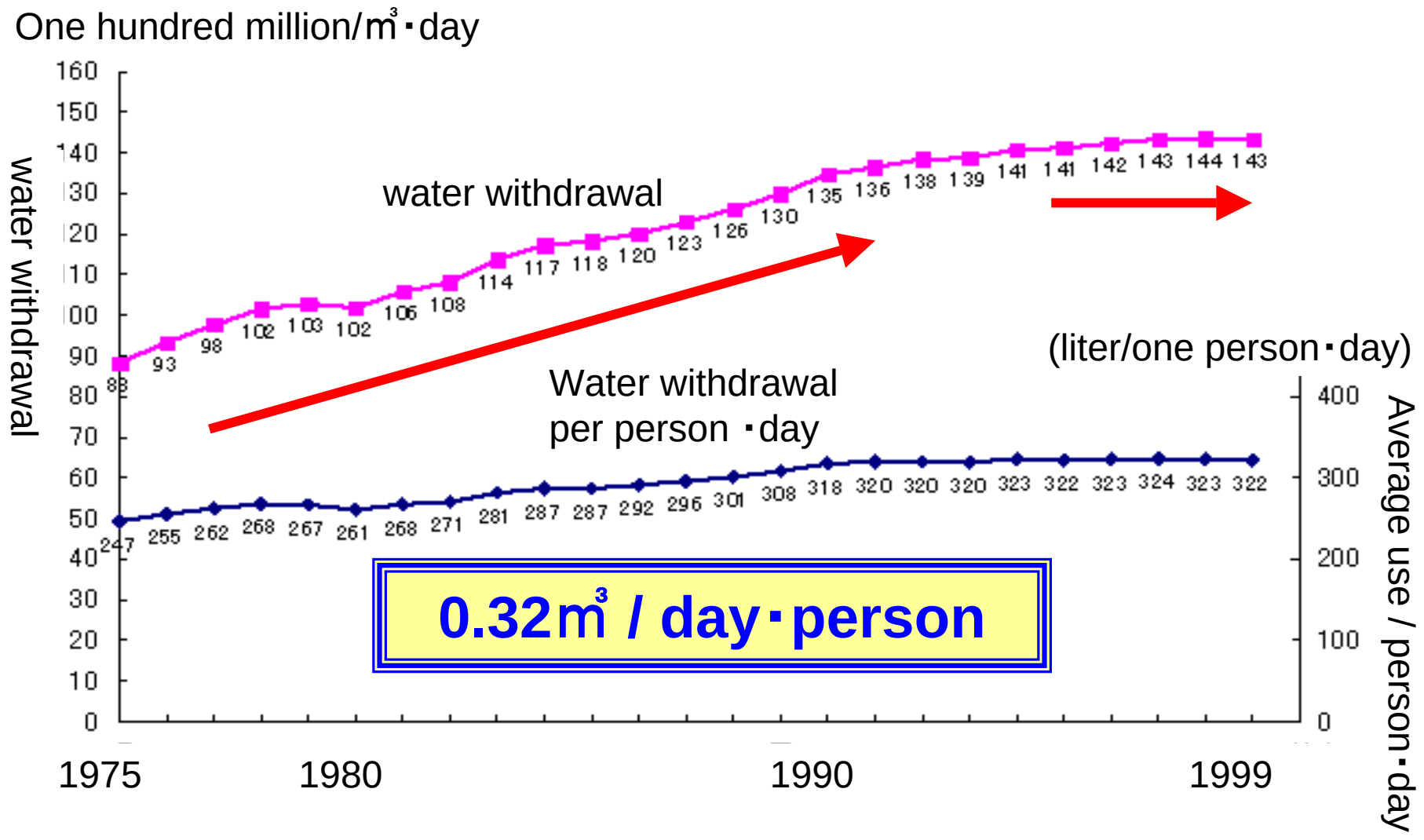
Source:Ministry of Land, Infrastructure and Transportation

4-2-1 water for household

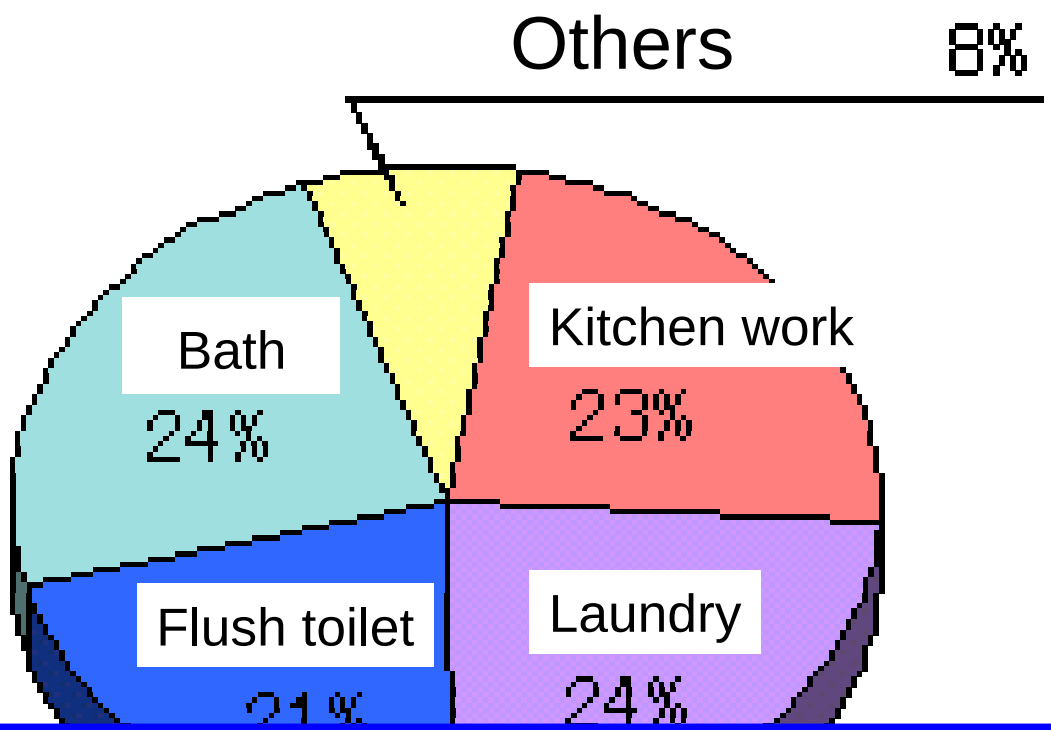
Water for household contains

- Drinking water
- Kitchen work, washing, bath, cleaning, flushing toilet, watering etc.
- restaurant, fountain, public toilet, water for extinguishing fires etc.

Change in water for household



Breakdown of uses



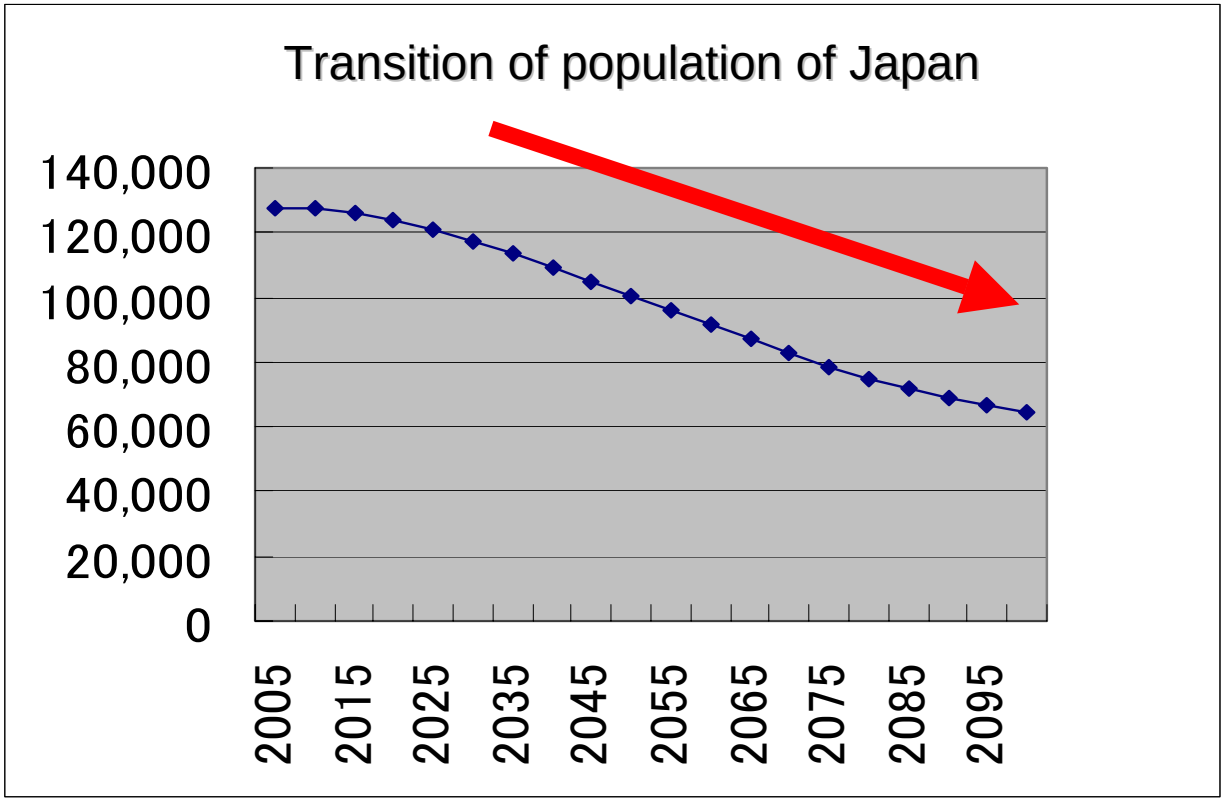
When the period of water shortage,

those kinds of water use are influenced!

How to reduce?

Water for household

= (Average use / person･year) × (population)



Reduction Potential in Withdrawal ～ water for household

- Water saving

  ①Prevention of water leakage

  ②Equipment

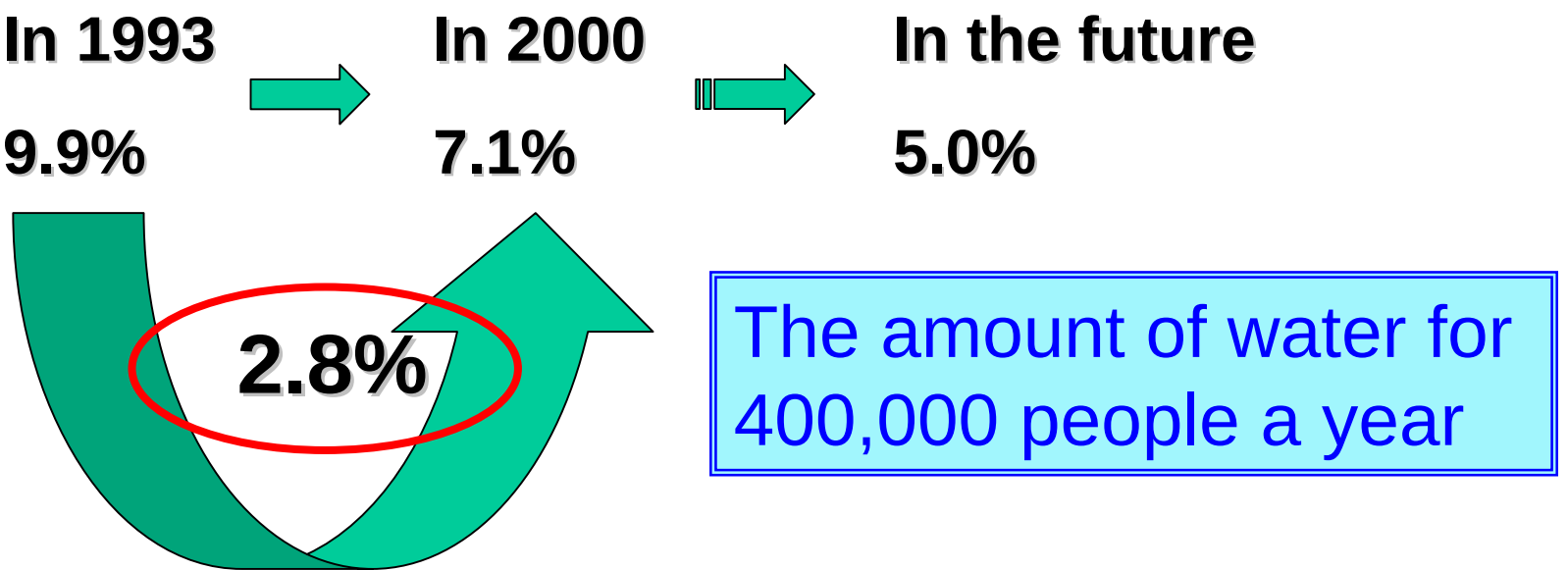
  ③The way of use

- Water for miscellaneous use

Water saving
① Prevention of water leakage

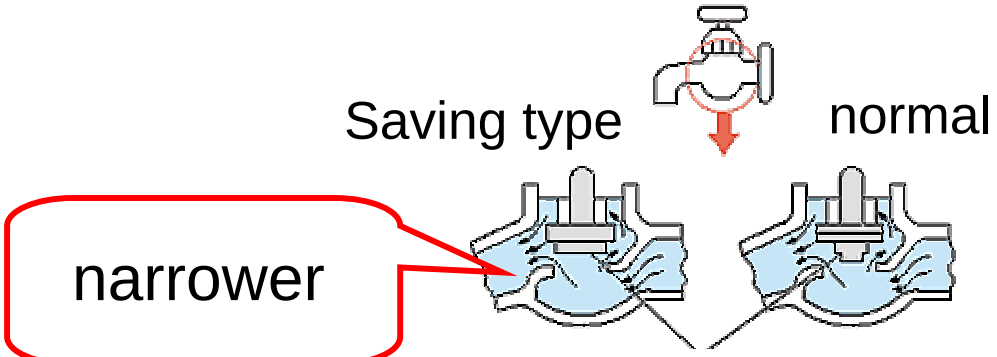
e.g. Repair of water pipes

In Tokyo area ~ Water leakage rate



The amount of water for 400,000 people a year

Water saving ②Equipment



Water saving faucet

6ℓ of water save
in 1 minute

Water saving type flushing toilet

12ℓ of water save
at the maximum

Water saving type washing machine

55ℓ of water save

Water saving ③ The way of use

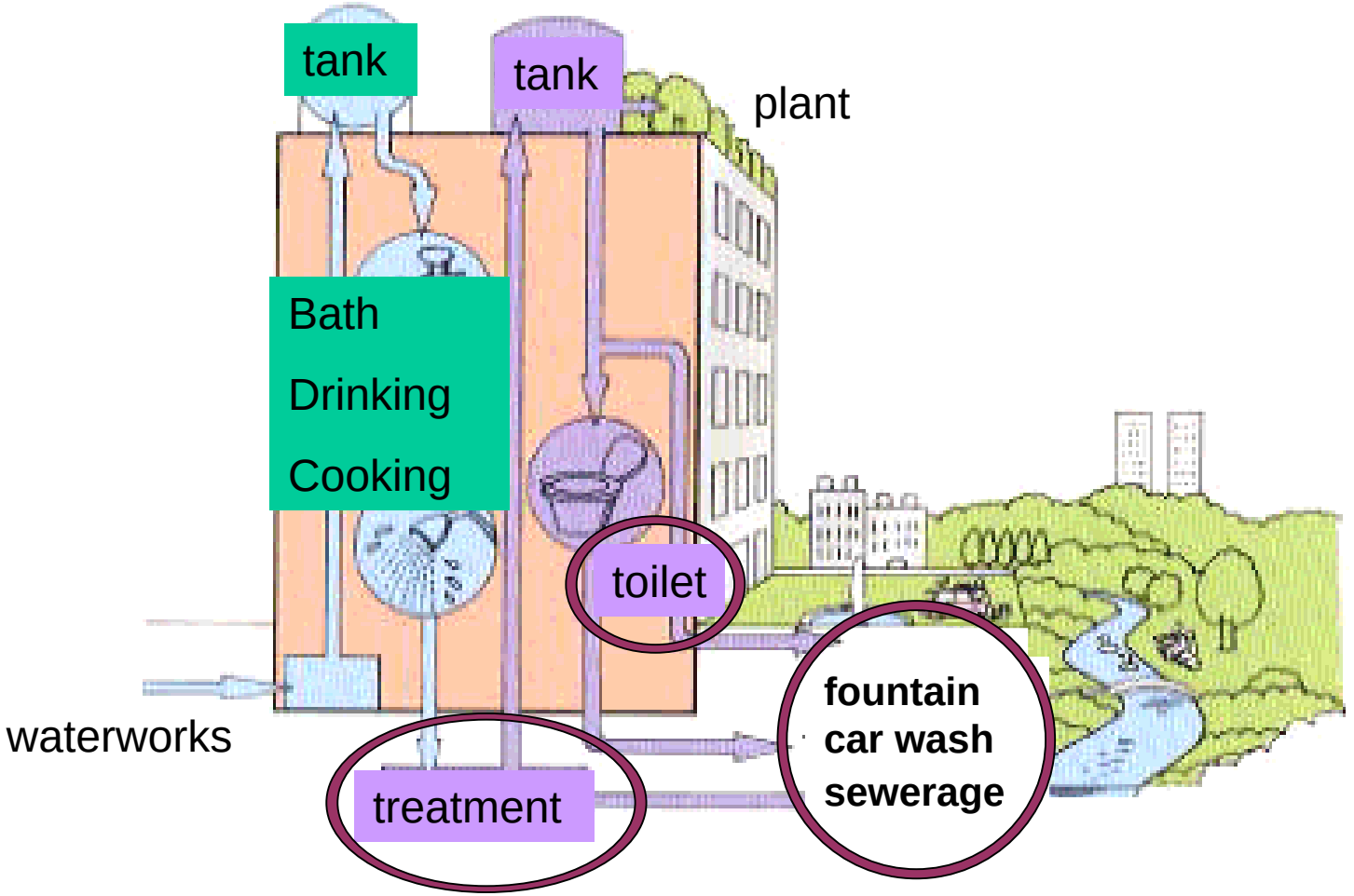
Turn a tap off when you brush your teeth

Use a bucket when you wash your car

Water for miscellaneous use

- Recycling
- Rain water use

The system of water for miscellaneous use



www.prof-akayama.jp/kikaku/ tochi/image/mizusigen7.gif

Example of the water saving on this system

Government office building	**503 ㎥/day**
City office building	**34 ㎥/day**
Hotel	**300 ㎥/day**
Hospital	**83 ㎥/day**
Private company office building	**156 ㎥/day**

Reduction Potential in Withdrawal ~ water for household

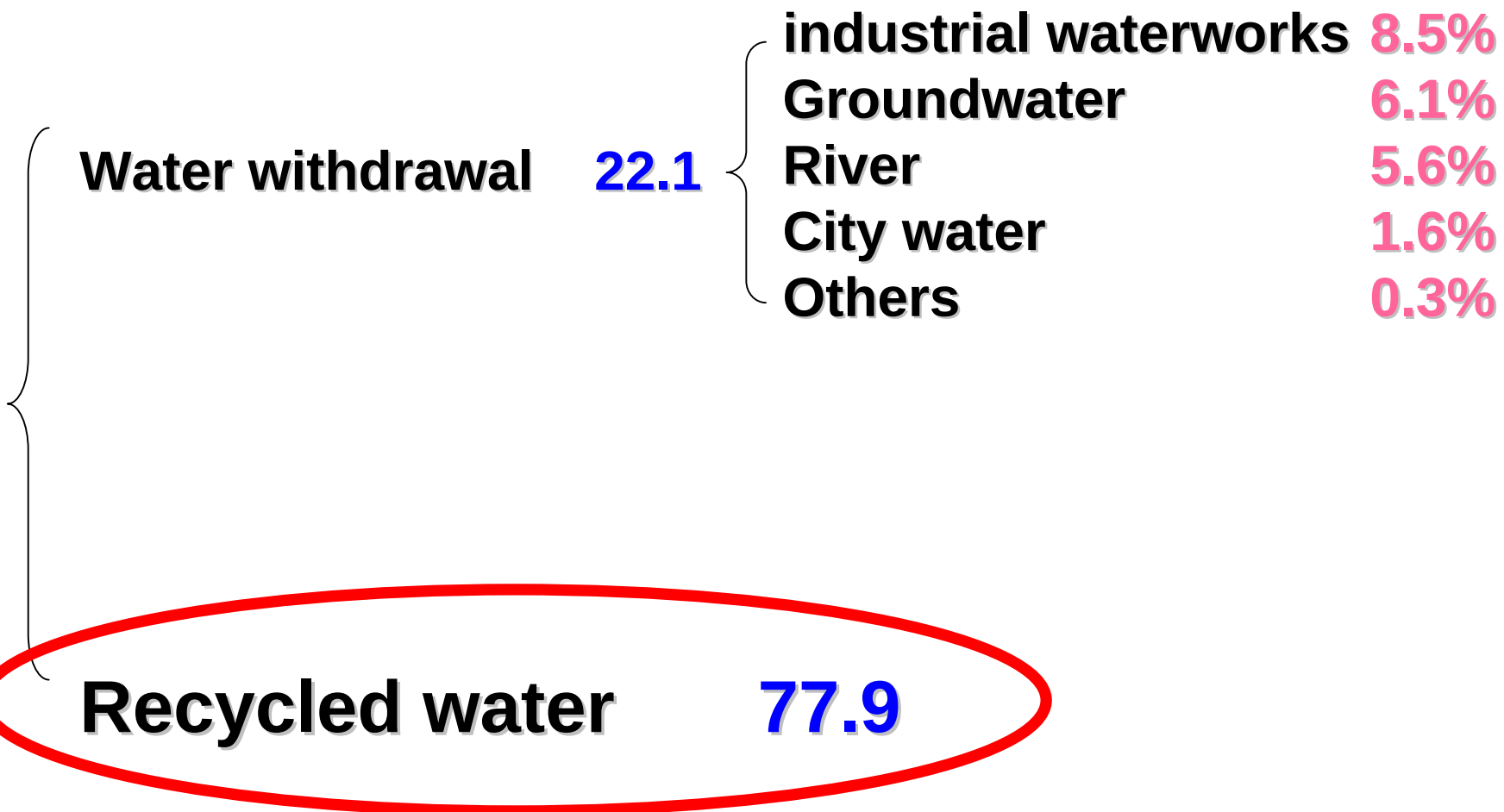
★ Water saving
Miscellaneous use

★ Population starts decreasing in 2006

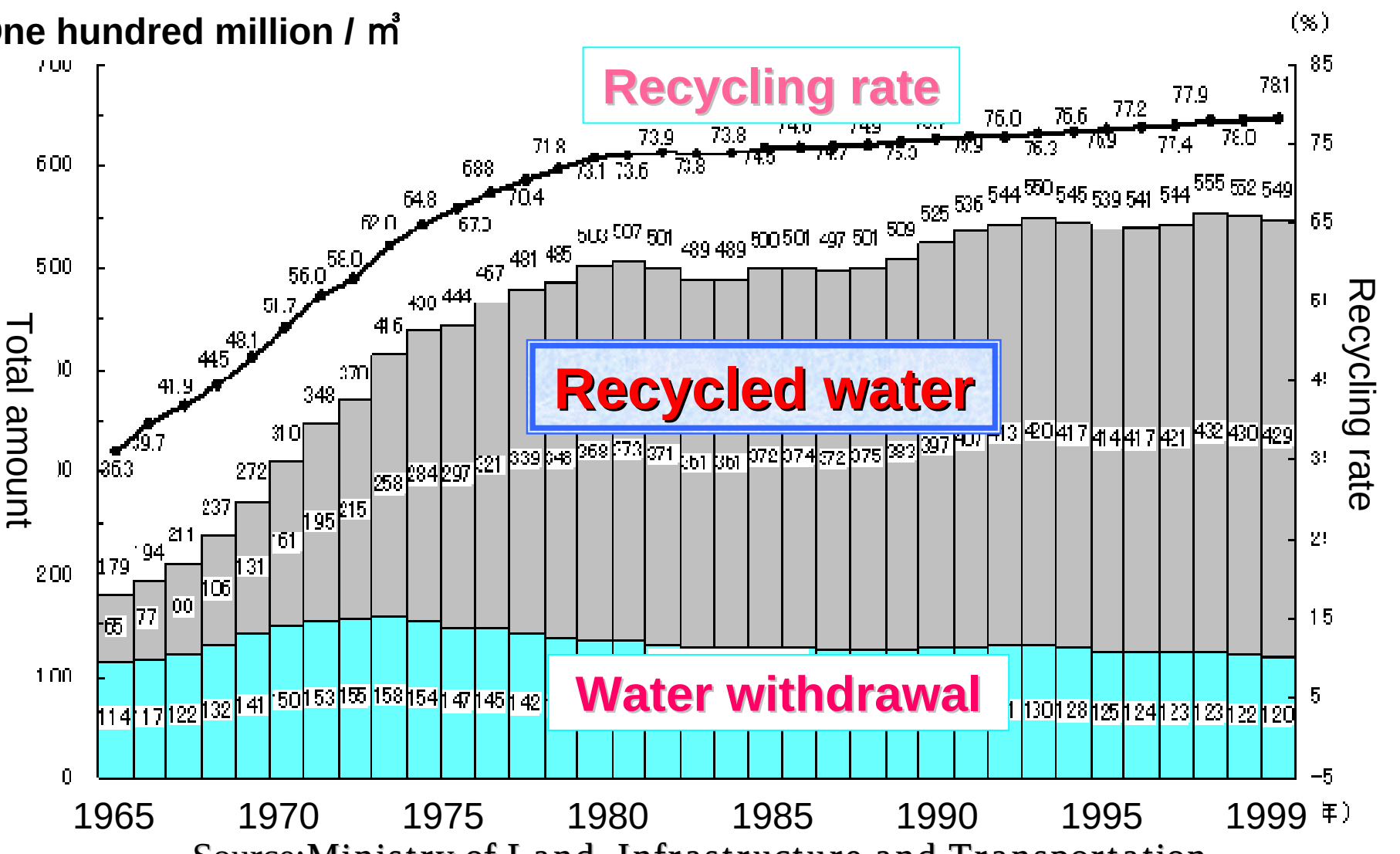
There is Reduction potential
in withdrawal for household

4-2-2 Water for Industry

What is water for industry?



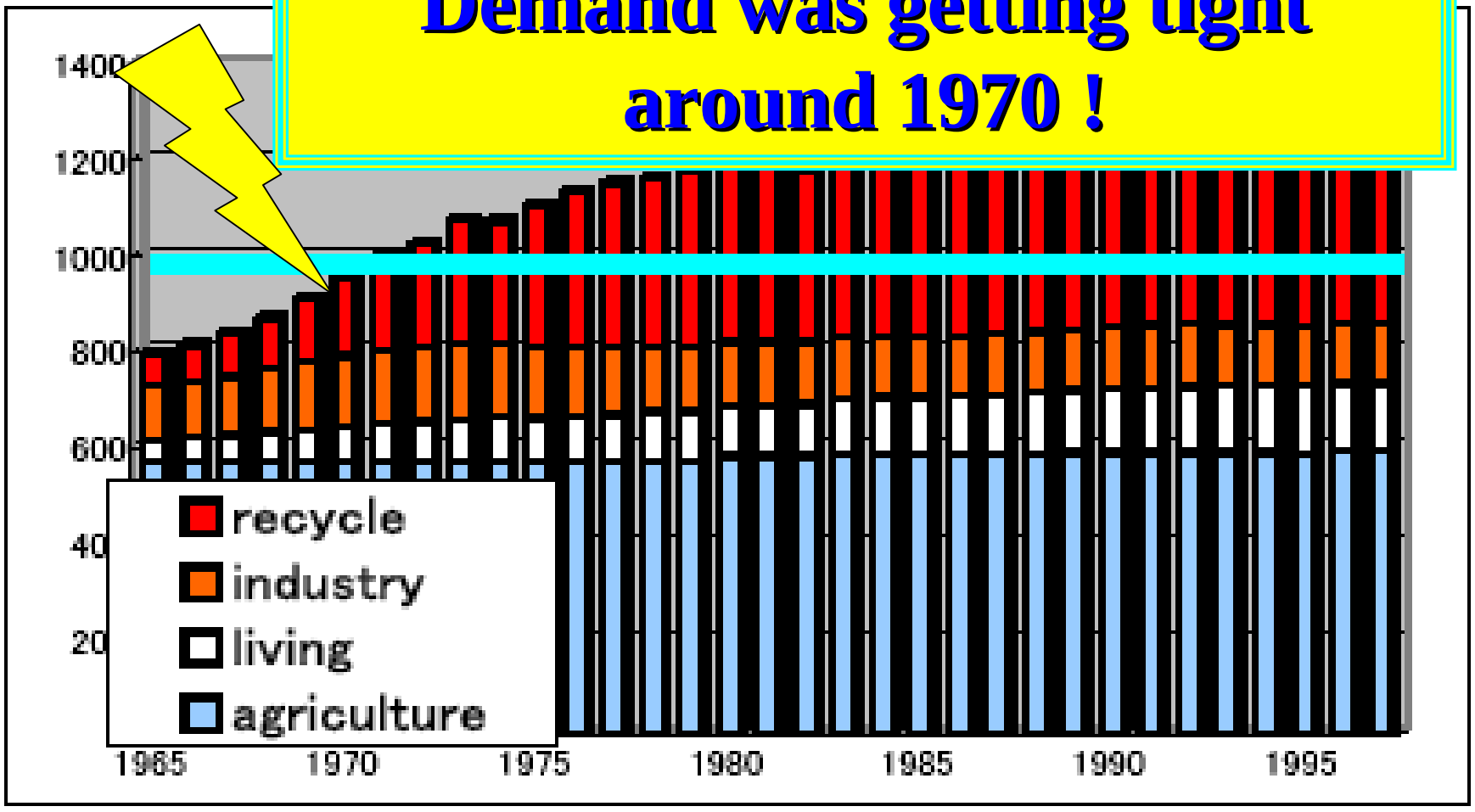
Change in water for industry



Source:Ministry of Land, Infrastructure and Transportation

Contribution of Recycled Water

Demand was getting tight around 1970 !

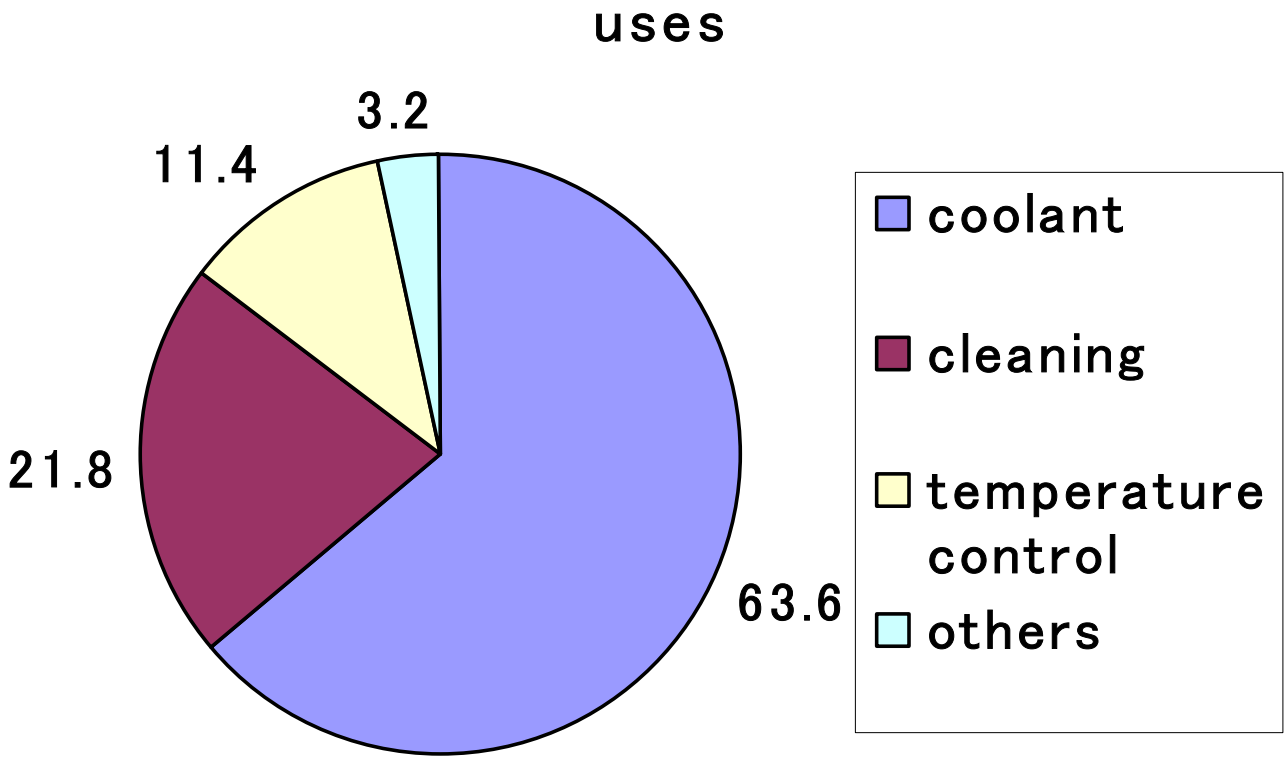


Increase in use of recycled water

- Uses of water for industry
- Increase in unit price
- The regulation of drainage

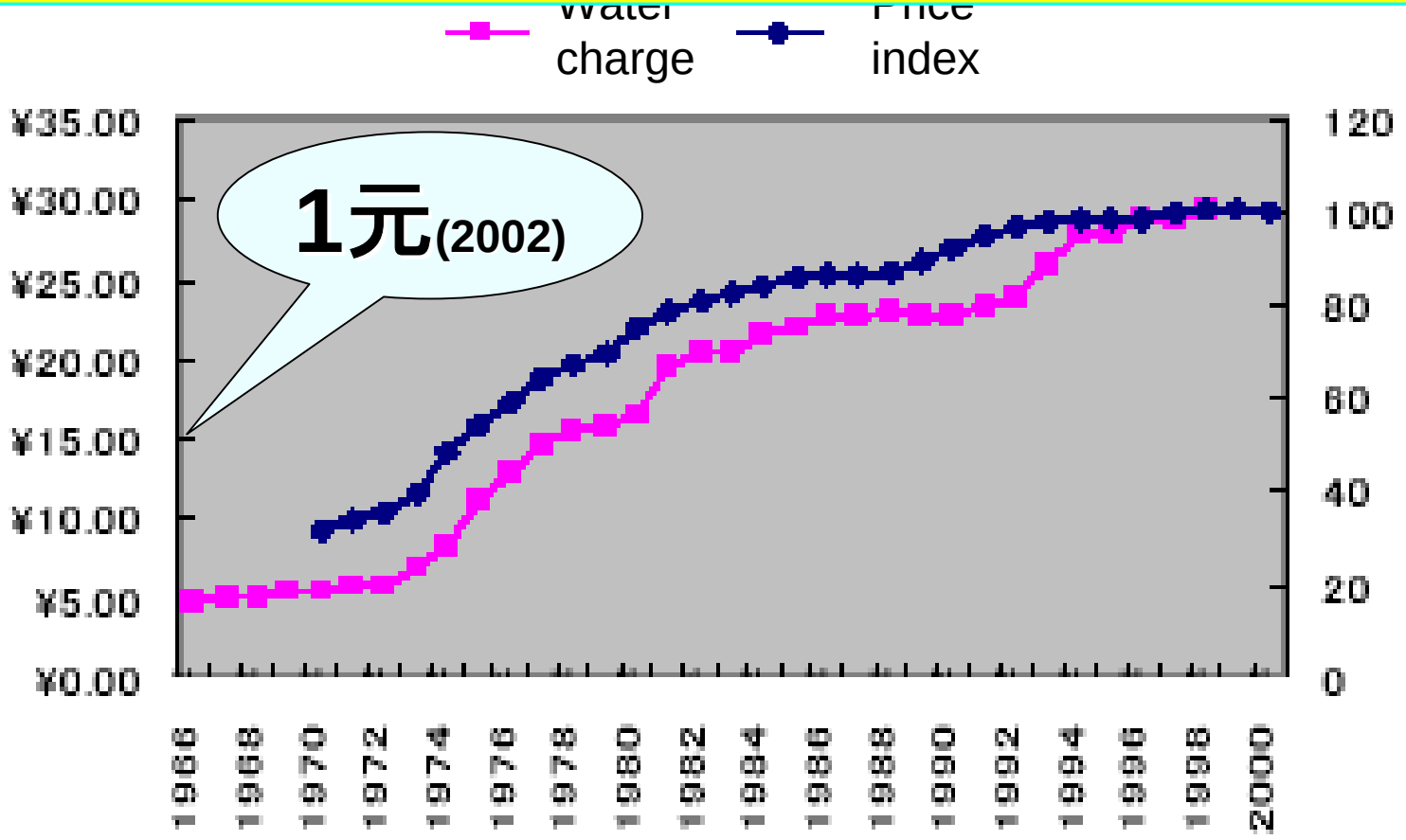
Uses of water for industry

Most of used water was easy to recycle!



Water charge and Price index

In real terms, water charge was doubled!



The regulation of drainage

The regulation of drainage

introduce purification equipment

The cost of purification is determined not by quality but by quantity of water

To reduce the amount of waste water is cost effective!

There is a room for more efficient use!

Reduction Potential of Water Withdrawal ～ water for industry

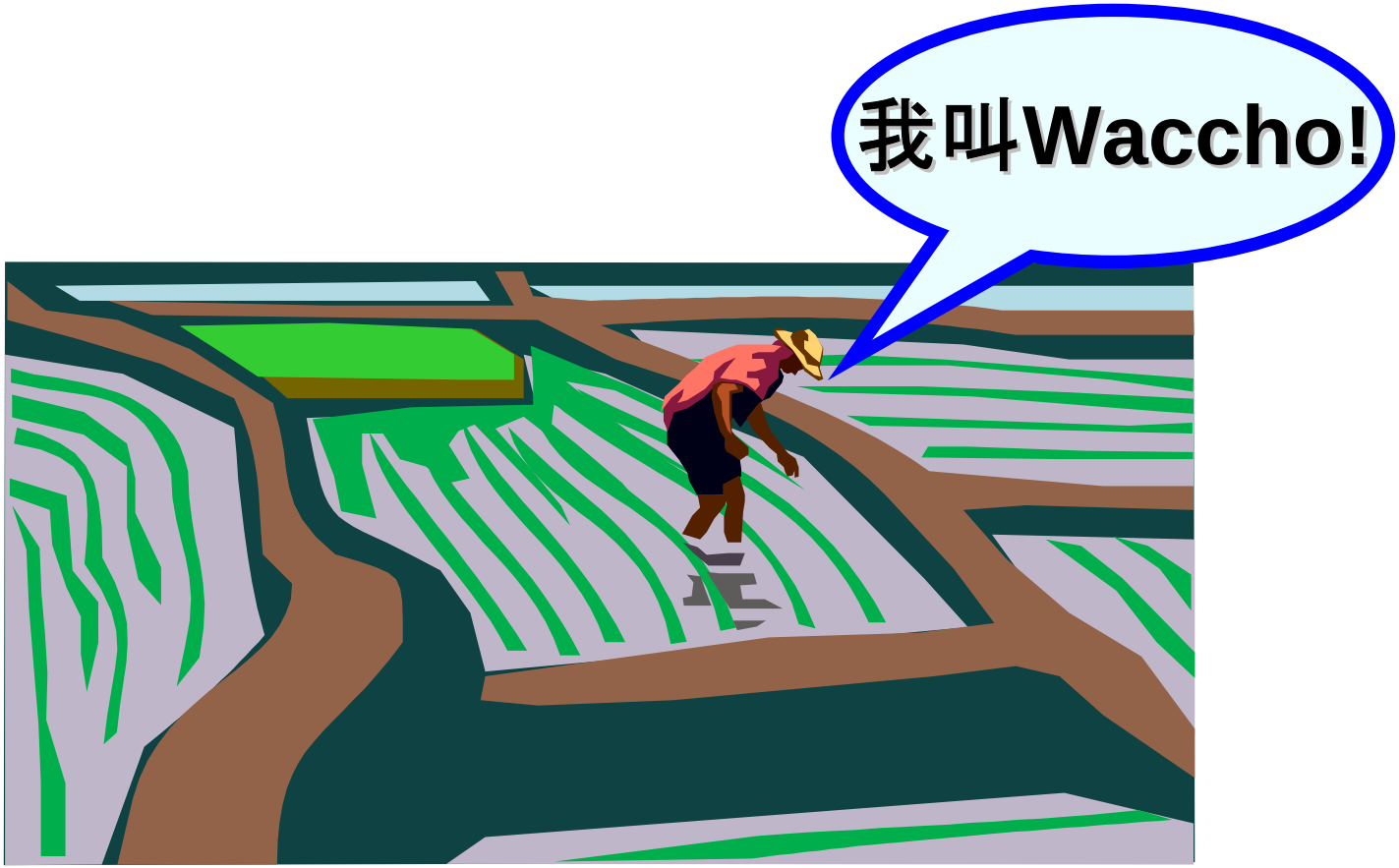
For further use of recycled water･･･

- Increase in unit price
- The regulation of drainage

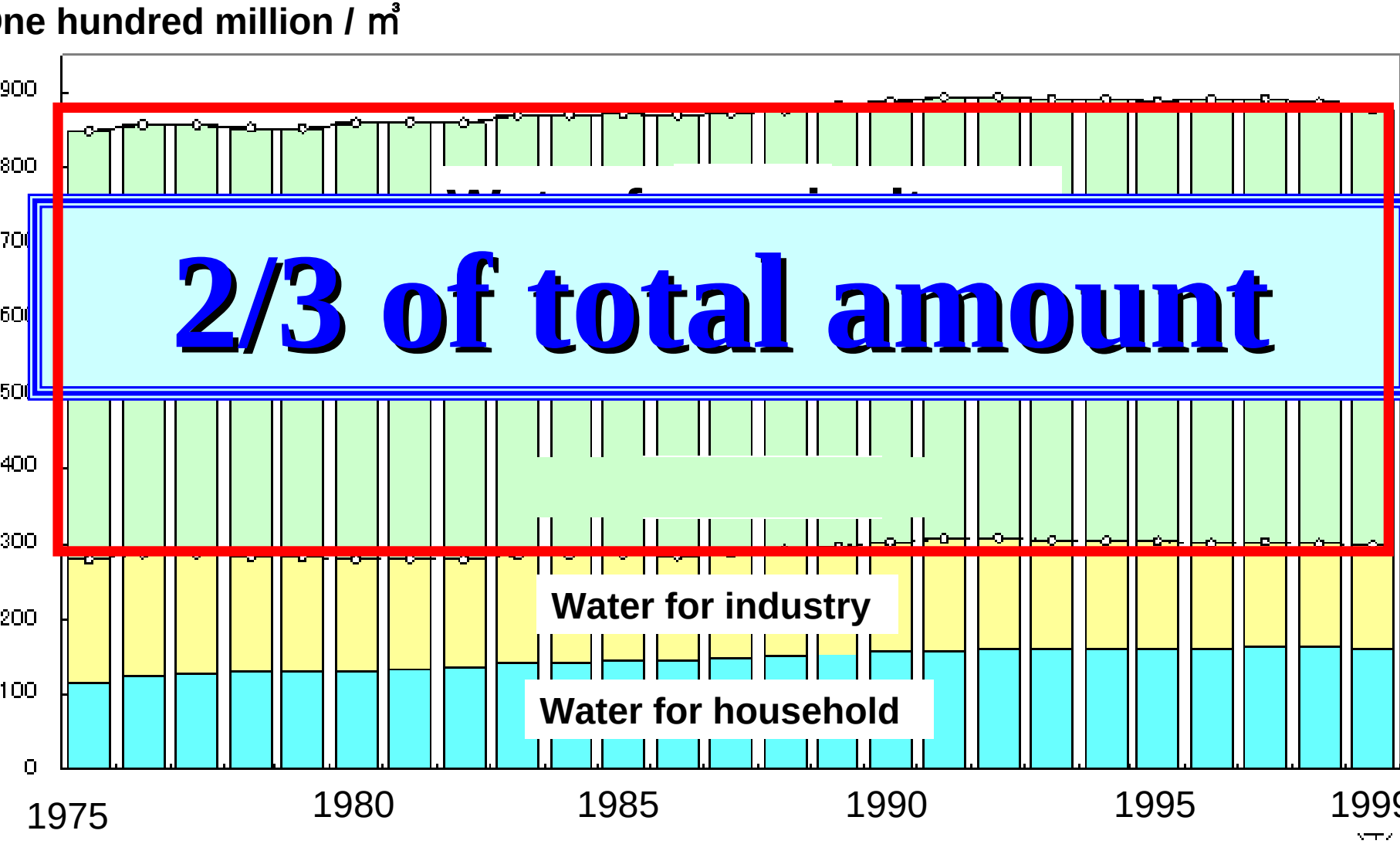
However

It seems difficult to reduce water withdrawal any more.

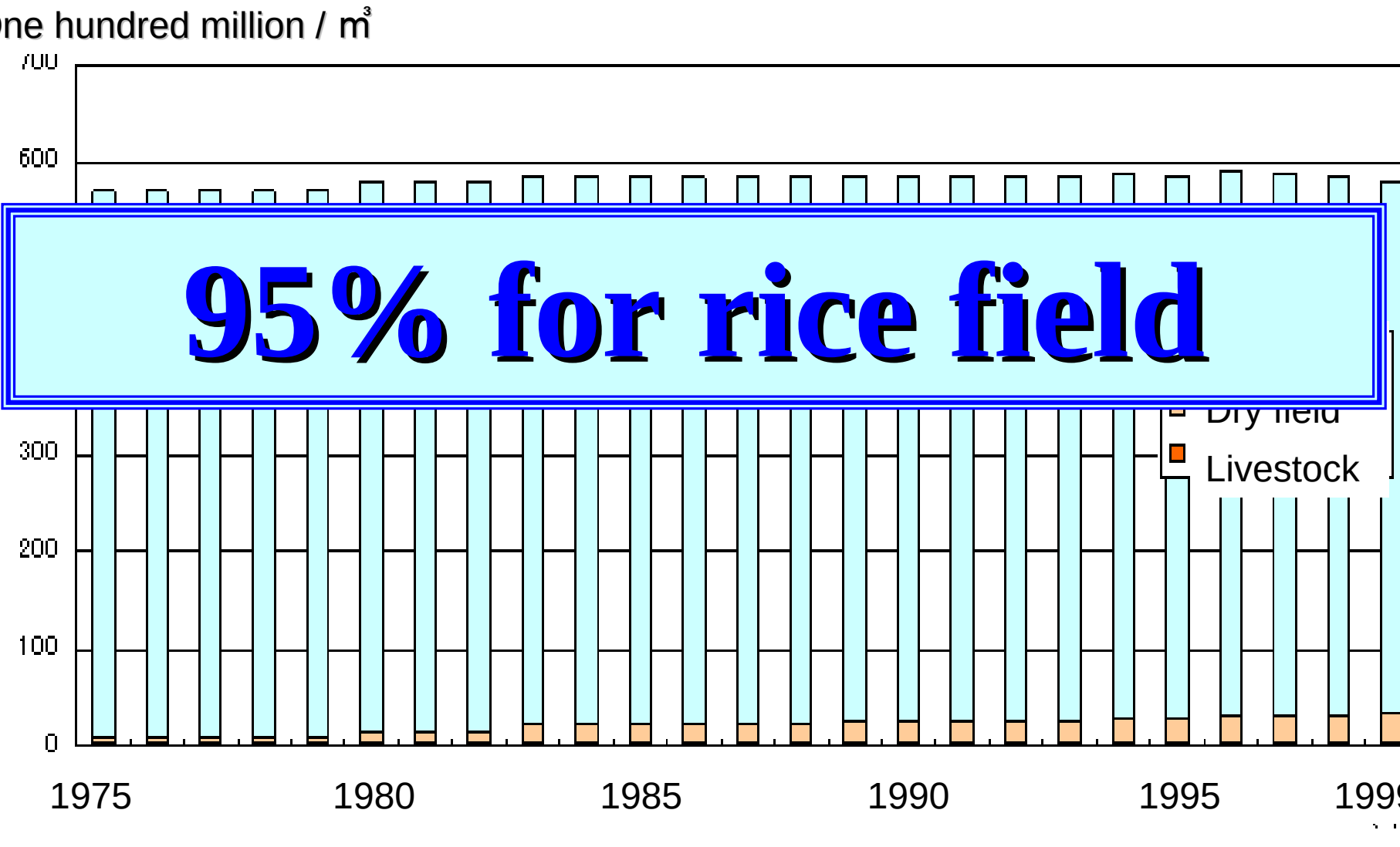
4－4 Water for Agriculture



Change in Water Withdrawal in Japan

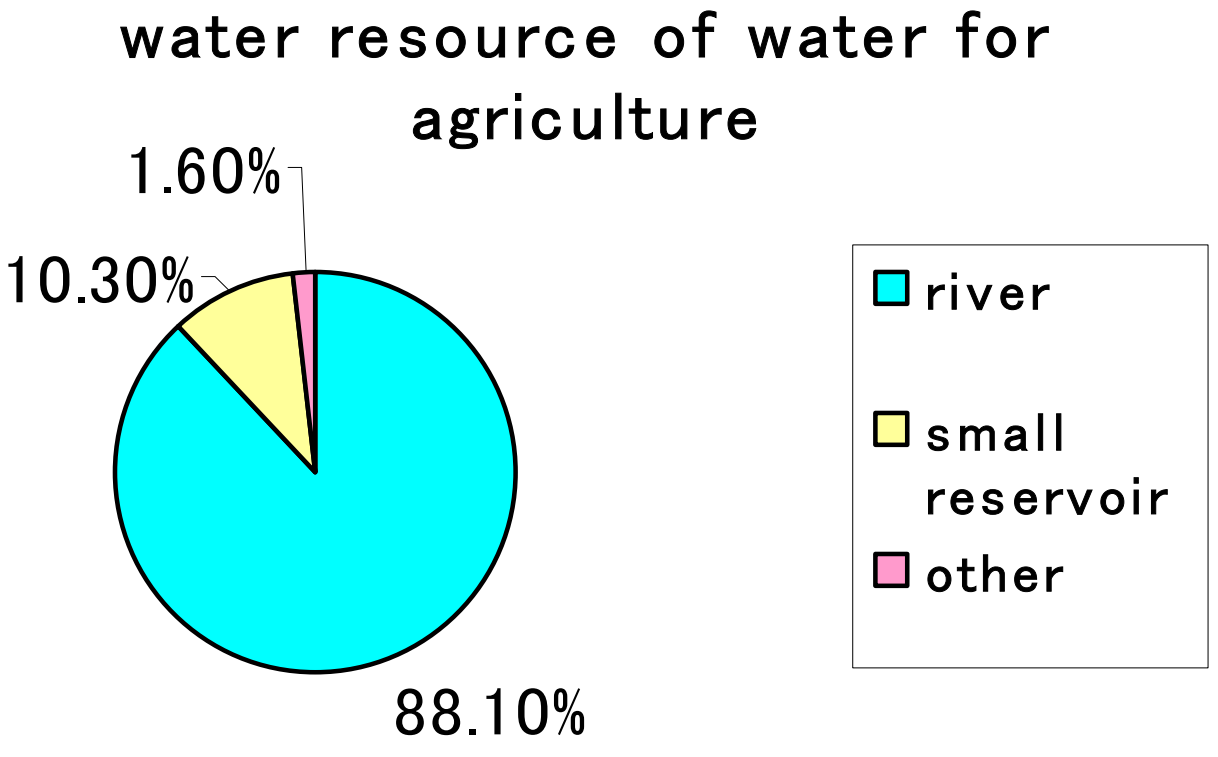


Change in Water for Agriculture



95% for rice field

Source of Water for Agriculture



Affected directly by decrease in river flow

Mechanism of Water Withdrawal in Agriculture

- Withdrawal in agriculture is based on two kinds of water rights.

①Old water rights (Traditionally)

②New water rights (By permission)

Water use with grandfathering water rights is unclear.

How to reduce?

1. **Shifting from old water rights to new water rights**
2. **Stop inefficient use**
3. **Extend existing efficient use**

1. Shifting water rights

- Water use with old water rights is unclear.

Shifting from old water rights to new water rights.

The amount of water withdrawal become clear!

2. Stop inefficient use

- **Reduction by renewing agricultural irrigation systems**

Prevent water leakage

Stop inflow water to unnecessary rice field

Until now, 315 million m^3/year was reduced

3. Extend existing efficient use

(Ex) BANSUI, reuse, etc

- In 1999,

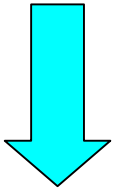
  Agricultural water is diverted to water for household.

⇨ Diversion estimated as 703,000 people's water for household at T-river.

Agricultural water can correspond to water shortage flexibly

Reduction Potential of Water Withdrawal ~ water for agriculture

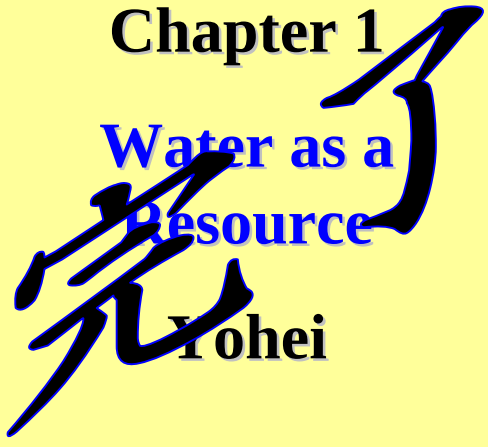
- Extend established efficient use
- Shifting from old water rights to new water rights.
- Stop inefficient use



Water for agriculture can be used more efficiently!

Chapter 1

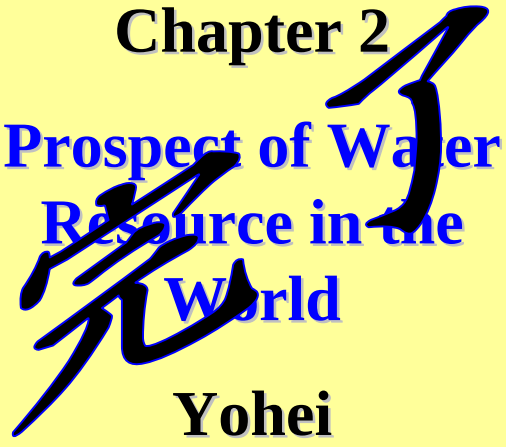
Water as a Resource



Yohei

Chapter 2

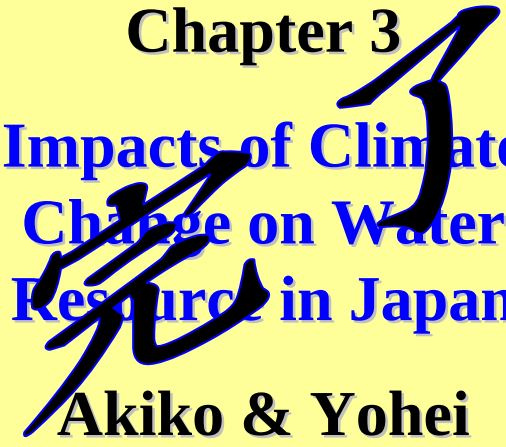
Prospect of Water Resource in the World



Yohei

Chapter 3

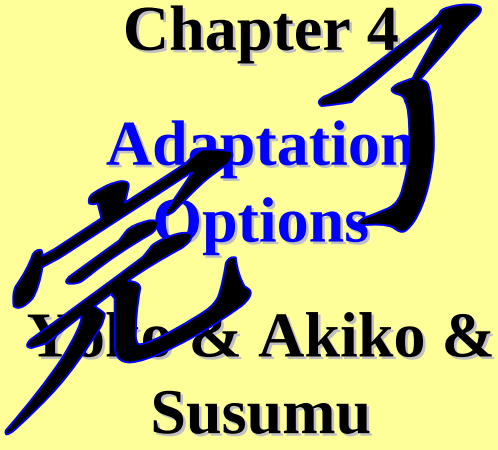
Impacts of Climate Change on Water Resource in Japan



Akiko & Yohei

Chapter 4

Adaptation Options



Yoko & Akiko & Susumu

Conclusion

Reduction Potential of Water Withdrawal

Yohei

Annex

World Water Crisis and Japan

Yoko

Conclusion

Adaptation Options

~~1. Water resource development by dams~~

2. Water withdrawal reduction

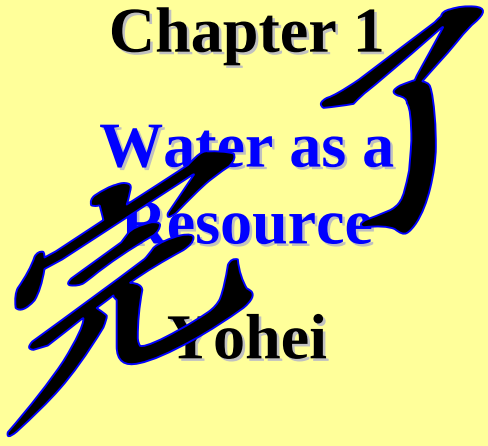
- **Household**
- **Industry**
- **Agriculture**

It is important to grasp reduction potential of water withdrawal.

We need to think about adaptation options as well as mitigation options

Chapter 1

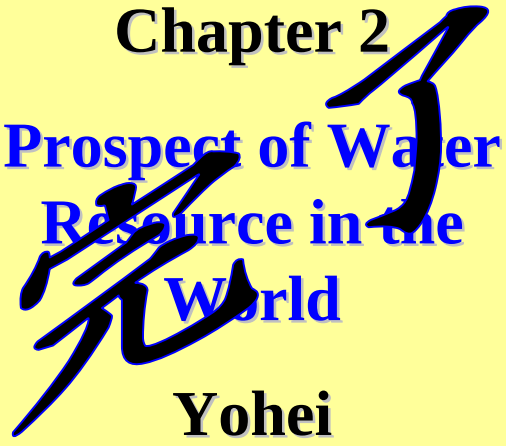
Water as a Resource



Yohei

Chapter 2

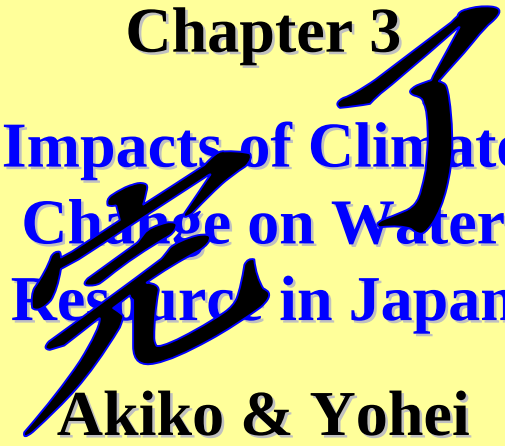
Prospect of Water Resource in the World



Yohei

Chapter 3

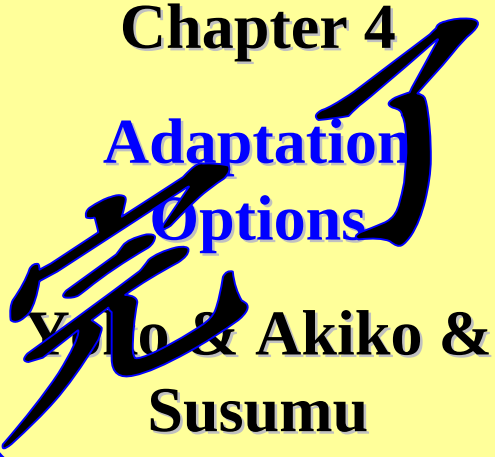
Impacts of Climate Change on Water Resource in Japan



Akiko & Yohei

Chapter 4

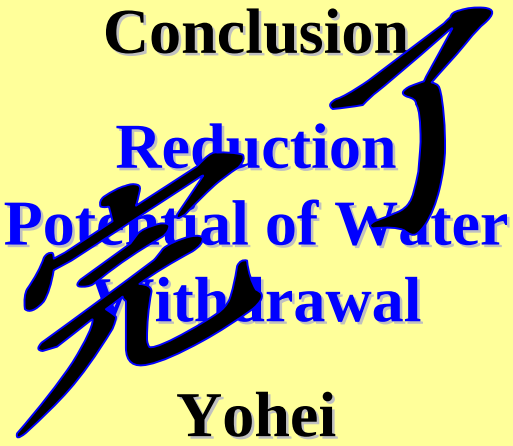
Adaptation Options



Yoko & Akiko & Susumu

Conclusion

Reduction Potential of Water Withdrawal



Yohei

Annex

World Water Crisis and Japan

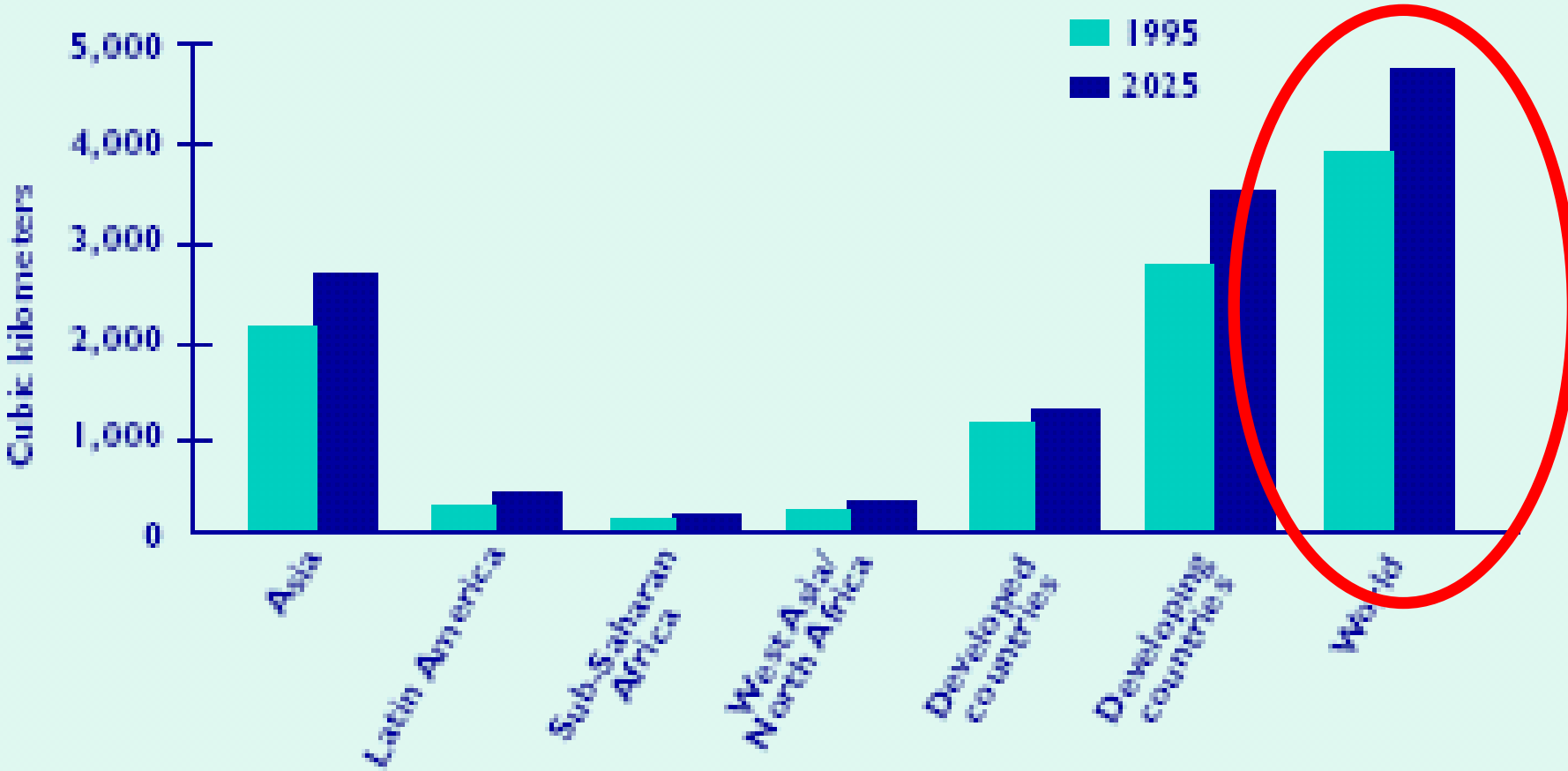
Yoko

ANNEX. World Water Crisis and Japan

- **World Water Crisis**
- **Virtual Water Withdrawal**

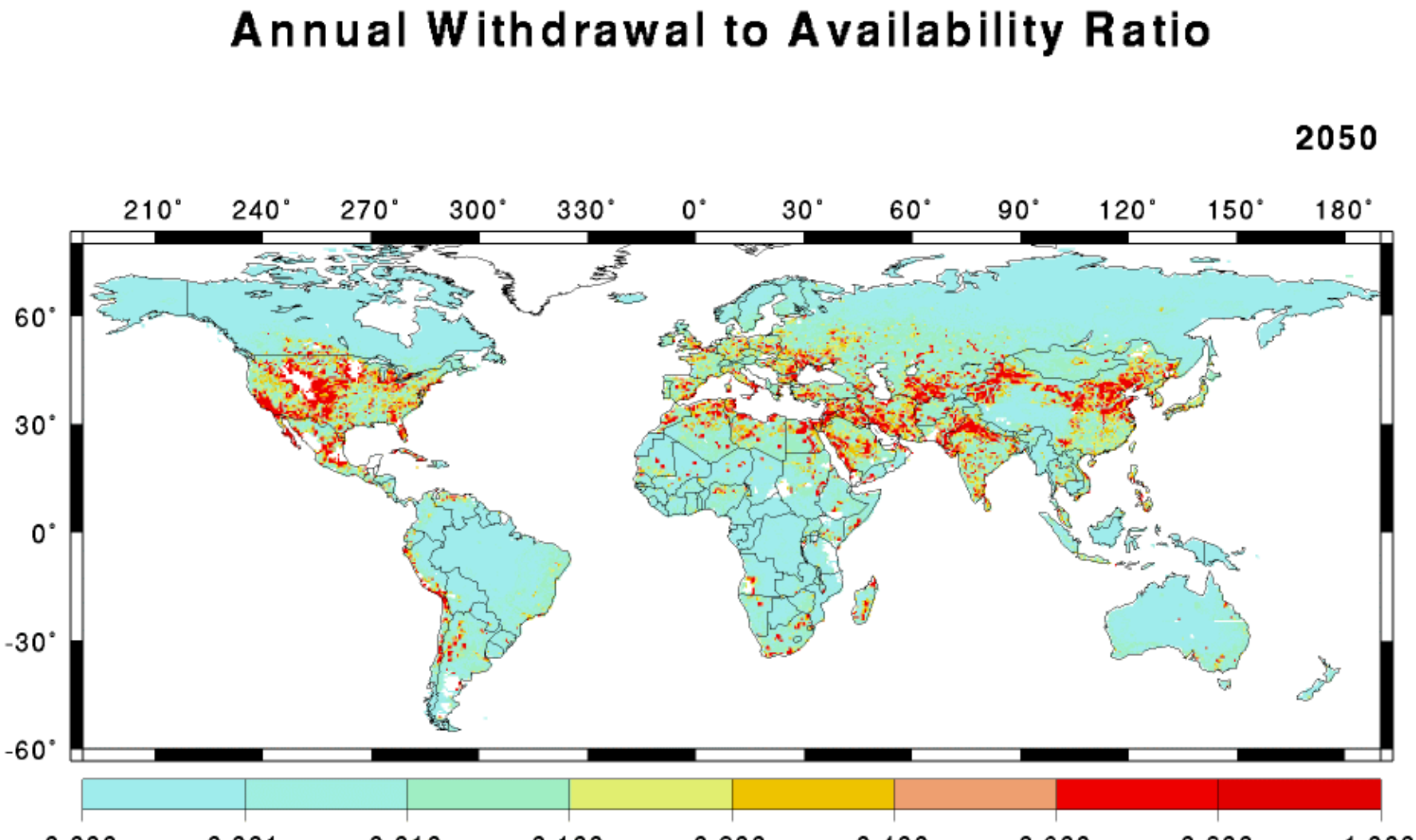
Total Water Withdrawal

Figure 1 Total water withdrawal by region, 1995 and 2025



SOURCE: Authors' estimates and IMPACT-WATER projections, June 2002.
NOTE: Projections for 2025 are for the business as usual scenario.

Water Stress



What does world water crisis have to do with Japan?

Virtual Water Withdrawal

- **Definition**

  VWW = the amount of water withdrawn for imported goods in exporting country

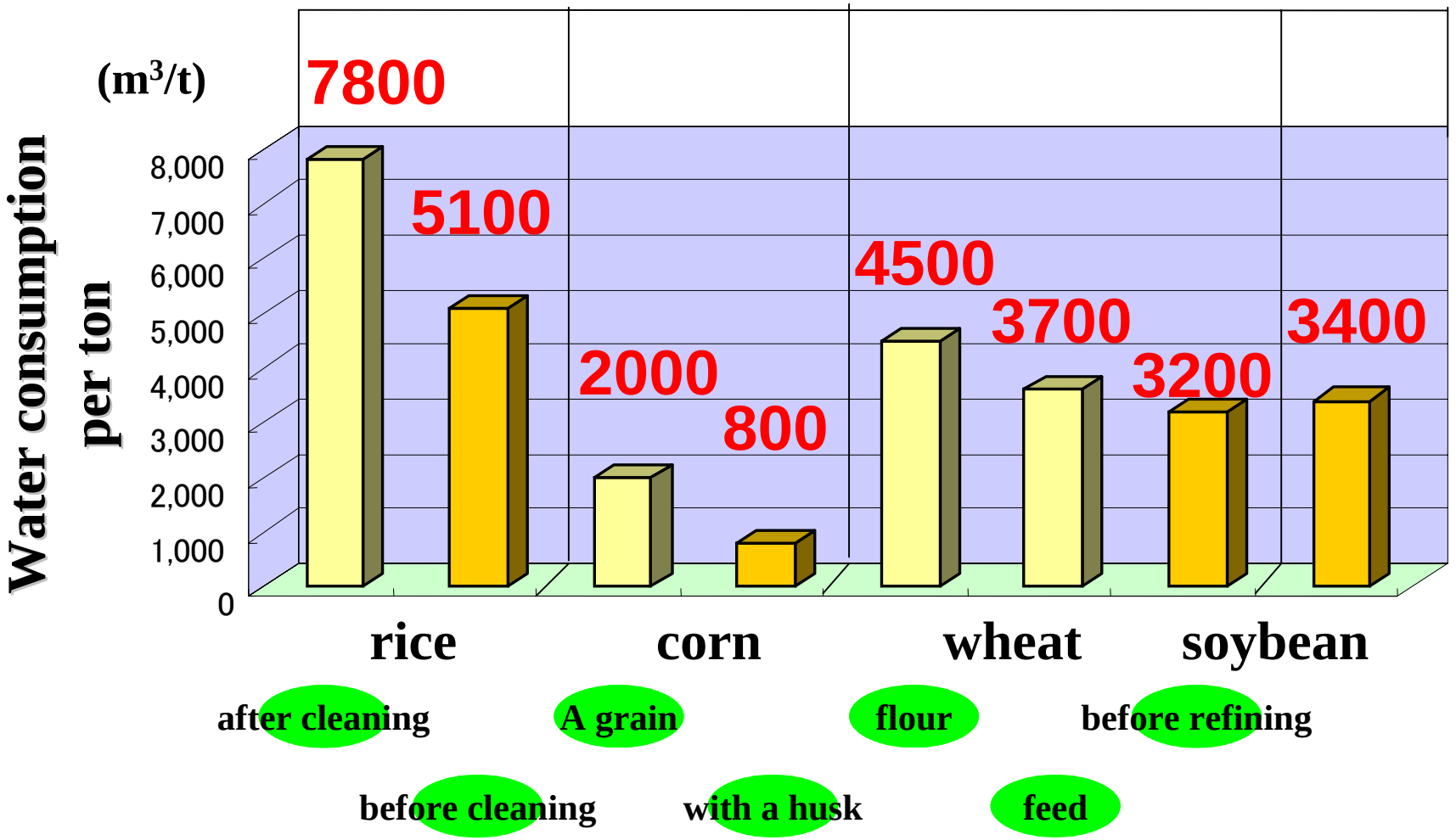
- **Calculation**

  farm products

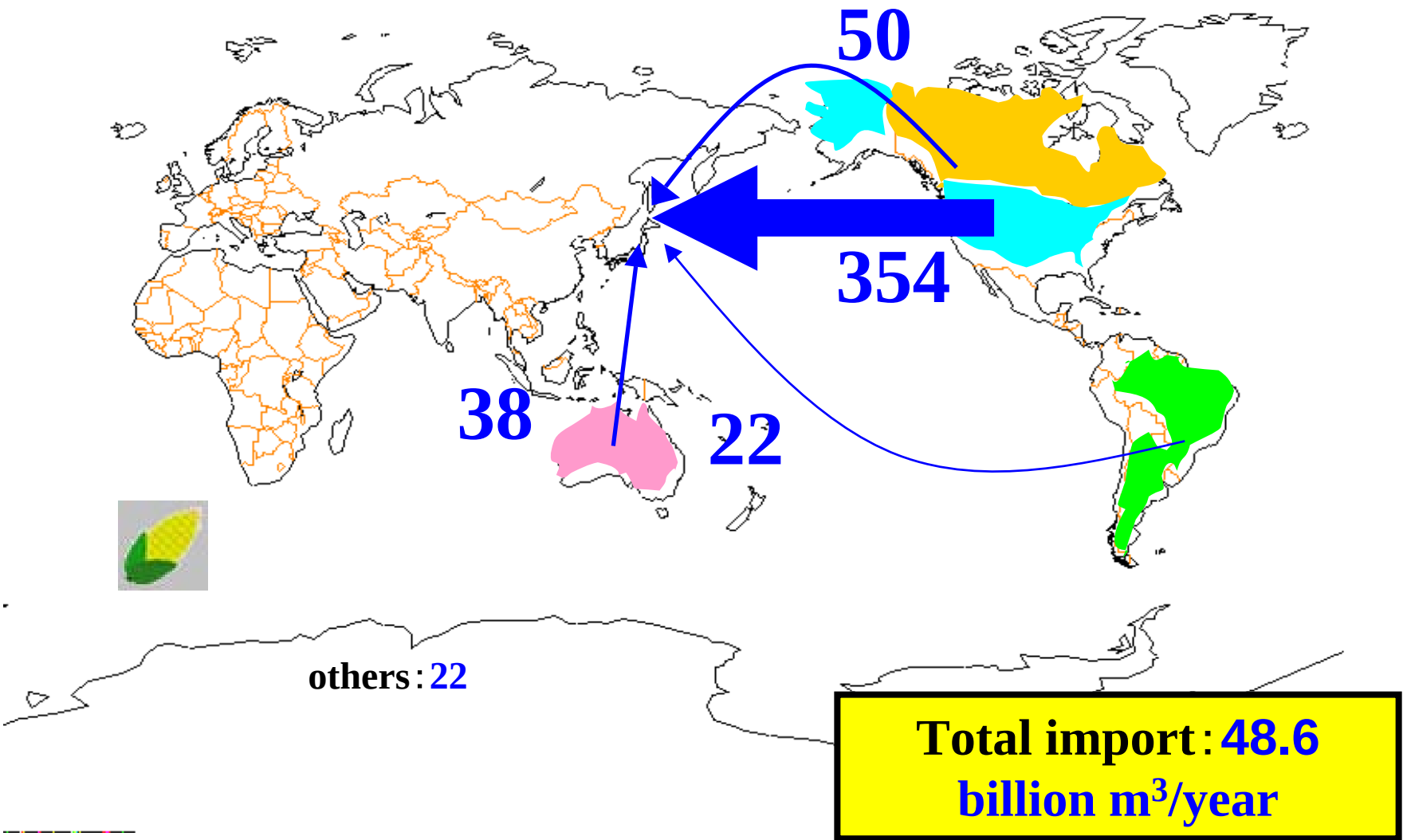
  stock farm products

  industrial products

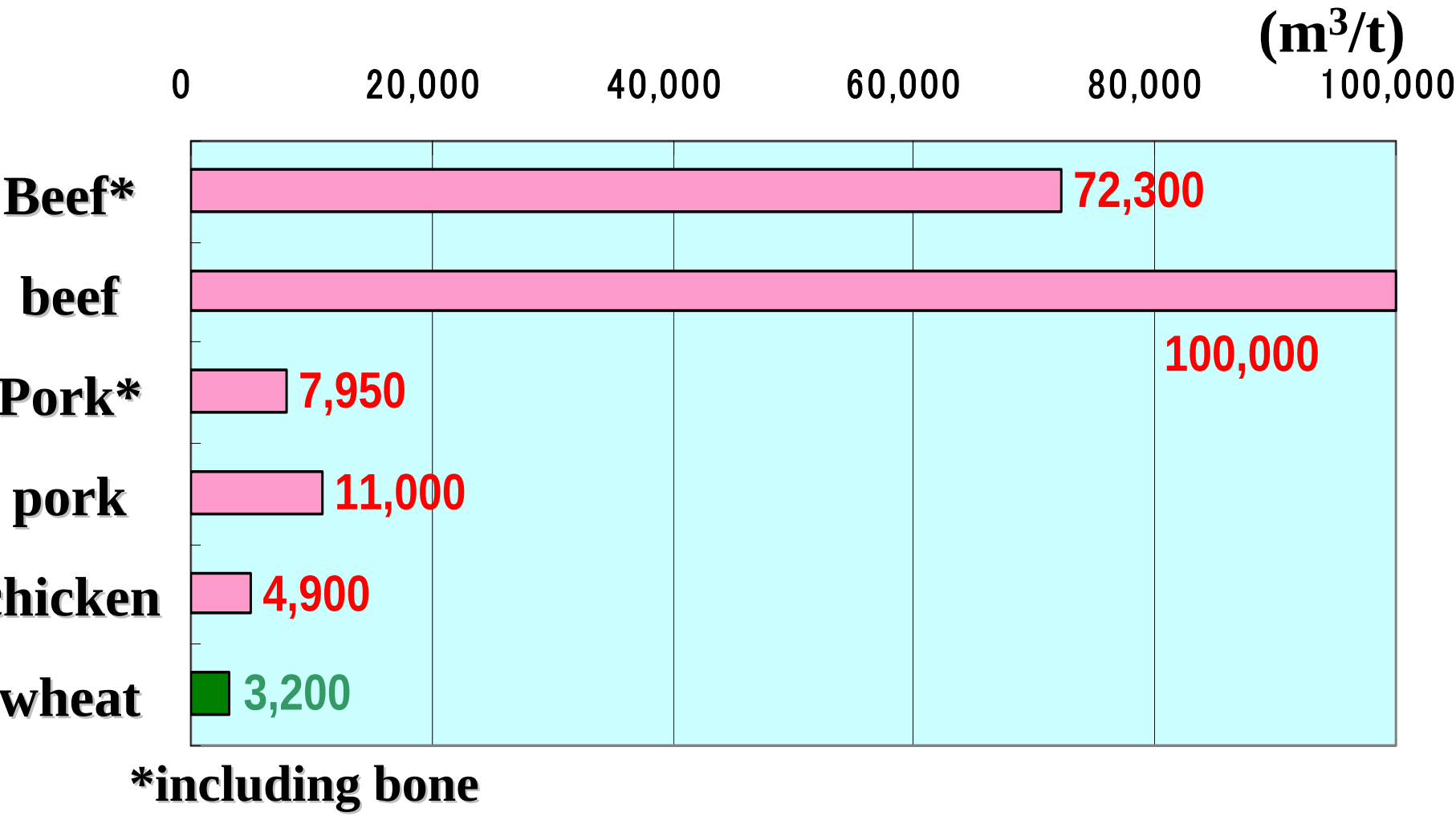
Water consumption per ton ~farm products~



virtual water withdrawal ~farm products~

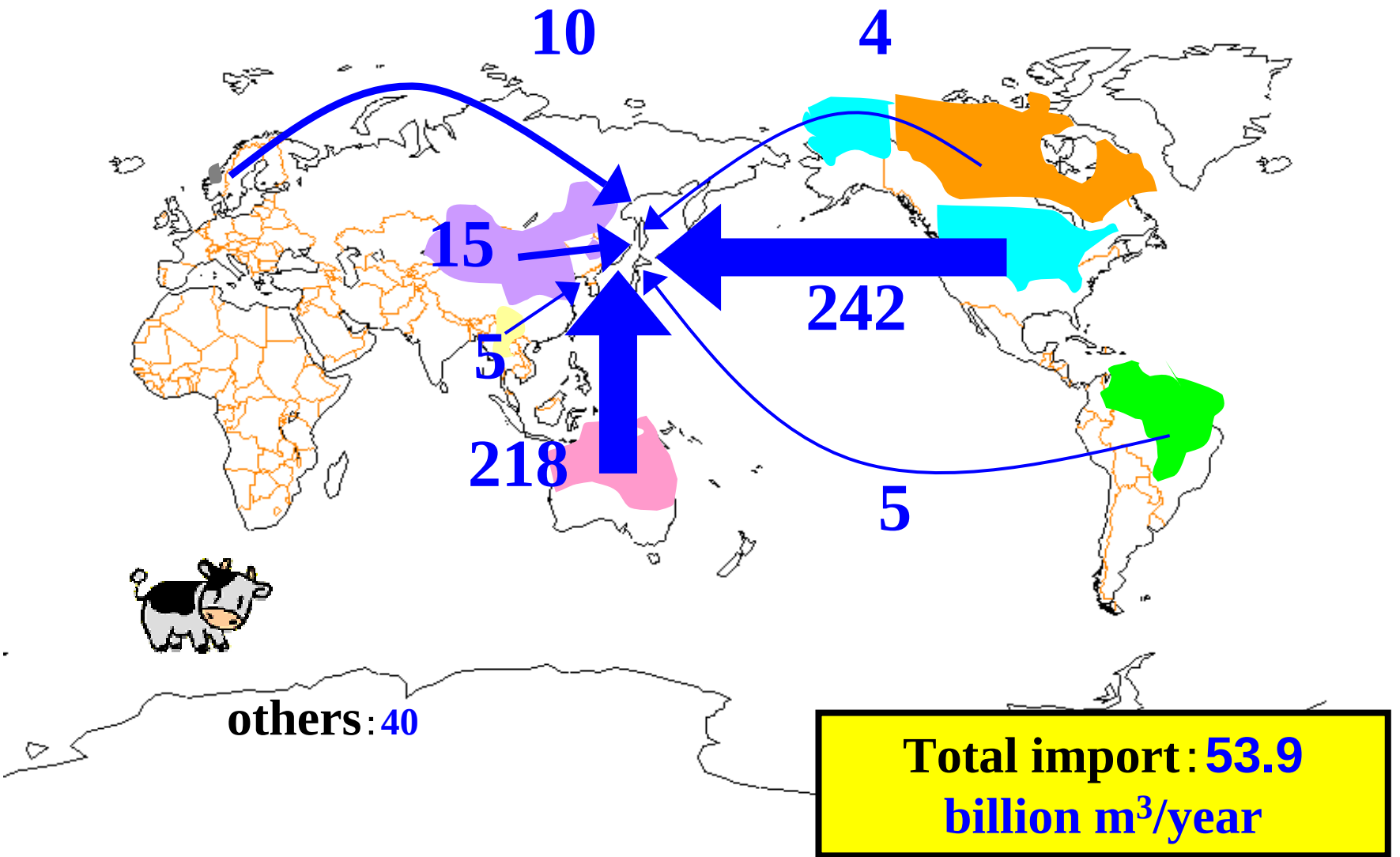


Water consumption per ton ~stock farm products~

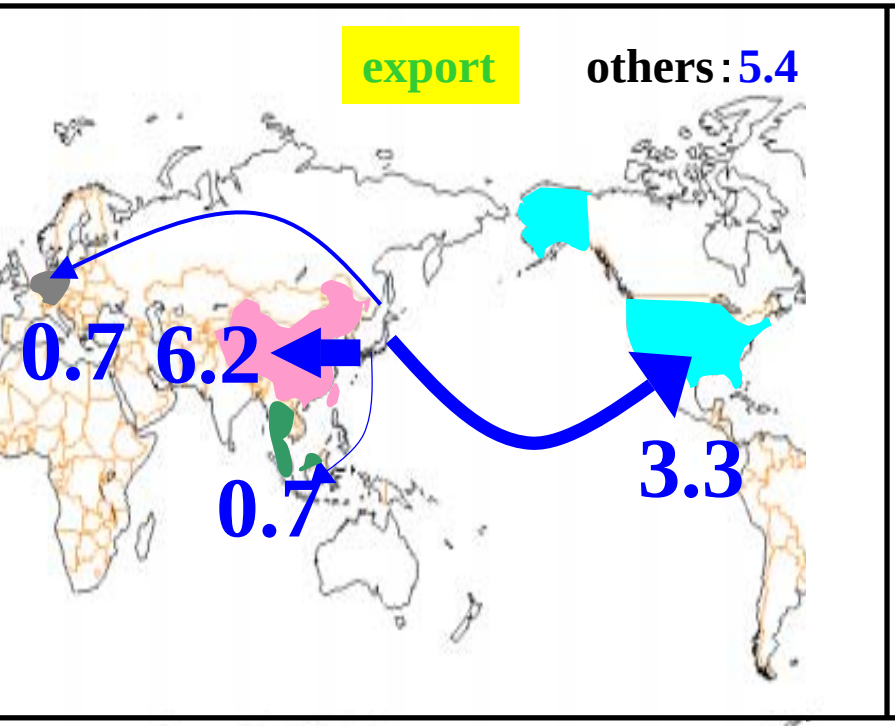


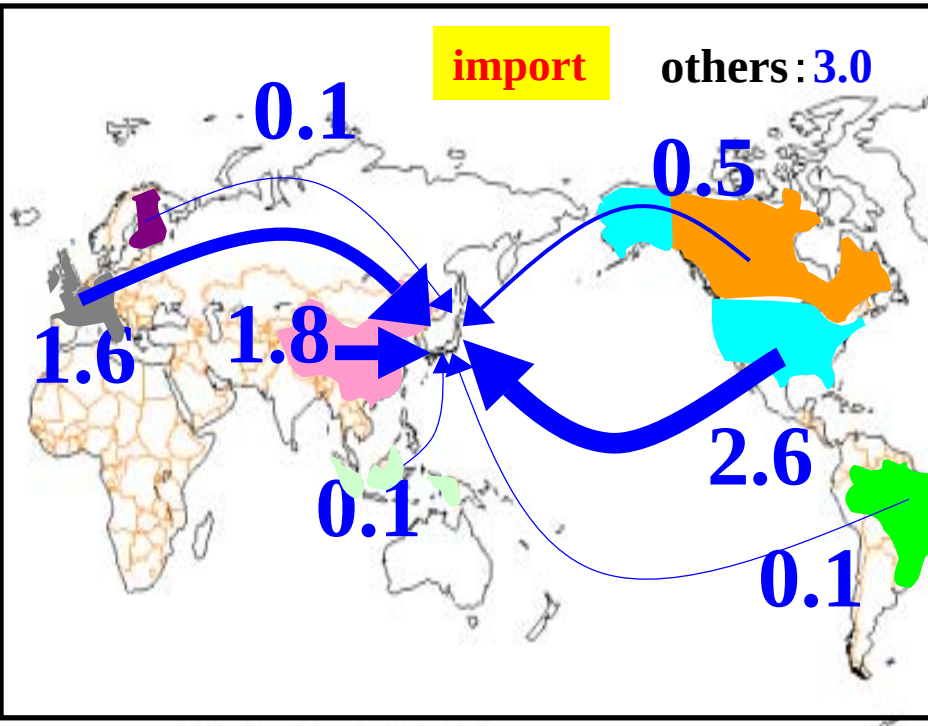
*including bone

virtual water withdrawal
~stock farm products~



virtual water withdrawal ~industrial products~





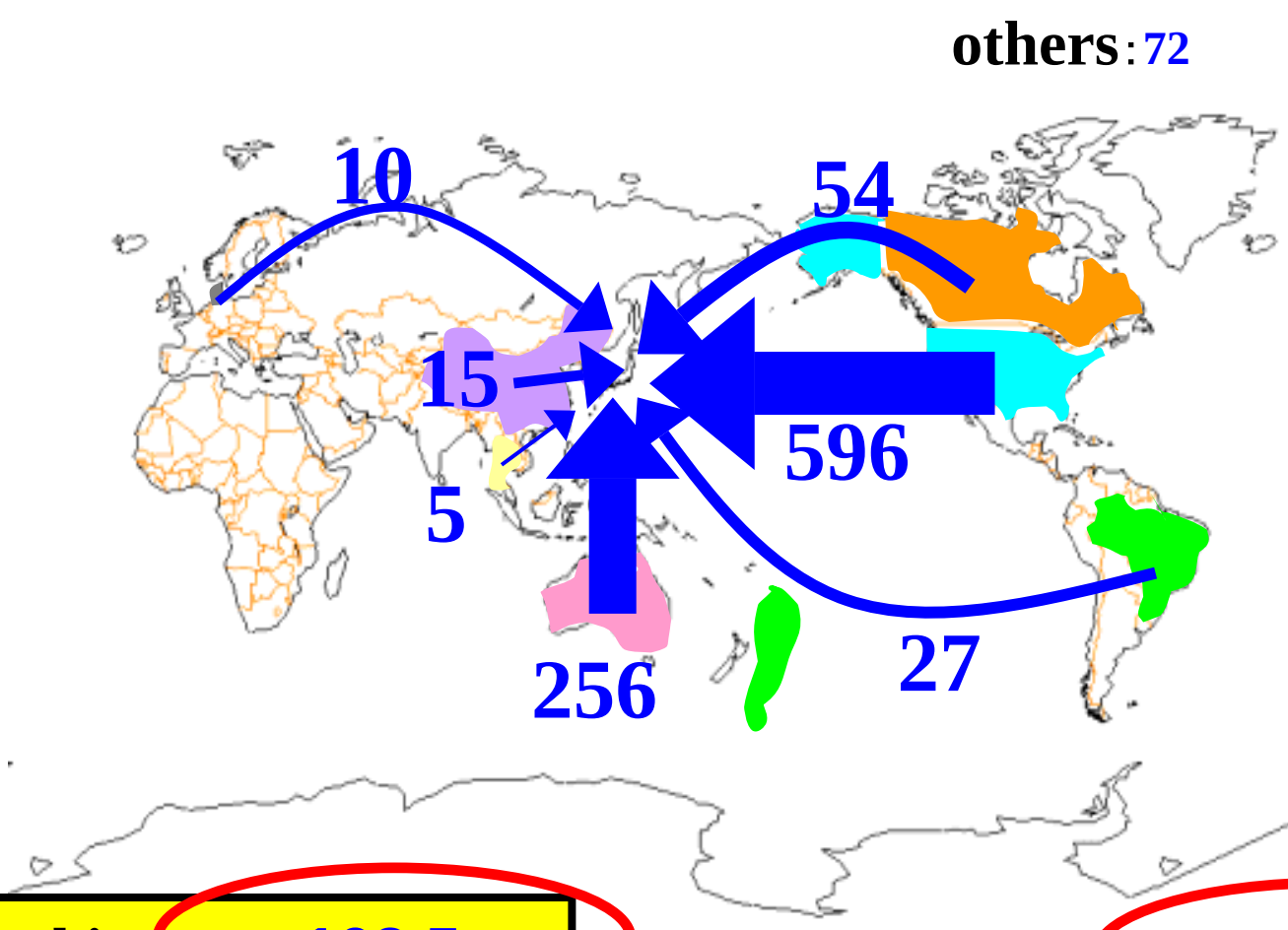
Total export : 1.6 billion m³/year

Total import : 1.0 billion m³/year

Water withdrawal for industry in Japan:

12.0 billion m³/year

Virtual Water Withdrawal ~ total import~



Total import : 103.5 billion m^3/year

Total Water Withdrawal in Japan : 89.0 billion m^3/year

taking virtual water withdrawal into account…

Net total virtual water withdrawal in the world : 103.5 billion m^3/year

Total Water Withdrawal in Japan : 89.0 billion m^3 /year

Japan will be hit by world water crisis

We need to think about world water crisis as well as water resource related problems in Japan

Water Resources Group

再見!