The 5th International Forum on Sustainable Future in Asia
The 5th NIES International Forum, Yangon, Myanmar, Jan. 21-22, 2020

How Should We Design Our Sustainable Environment in an Uncertain World?

OHGAKI, Shinichiro
Prof. Emeritus, The Univ. of Tokyo
Former President, Japan Water Research Center (JWRC)
Former President, National Institute for Environmental Studies (NIES)

Global issues for sustainable development :

- The United Nations adopted **SDGs** on September 25, 2015
- 17 Goals and 169 targets

In order to achieve the SDGs' goals as a whole, water system is one of the most important subject. Because water is the essential resource for life and society, but it is also the vulnerable resource.

So I would like to talk here on sustainable development related to water issues.

Goal 6: Ensure access to water and sanitation for all

-By 2030, achieve universal and equitable access to safe and affordable drinking water for all

-By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

-By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

- - - - - - -

Goal 3: Ensure healthy lives and promote well-being for all at all ages

-By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programs

-By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

- - - - - -

(comment: "for all" = any countries/regions of any economic development stages, and people even during disasters)

Vulnerability of Water System

- Natural Vulnerability

- Social Vulnerability

Natural vulnerability

- Uncertainty of rainfall and snowfall

- Uneven distribution of fresh water

- Ecological system is sensitive to water quality and quantity.

- The impact on elements of a part of the water cycle affects all water elements.

Social vulnerability

-Water is an essential material for maintaining a sanitary environment, but it is also a vehicle for transmitting disease.

-In each region, the water use system basically deals only with the required amount. The ability to adapt to external fluctuations such as sever drought is small.

-Water is susceptible to natural disasters (earthquakes, floods, droughts, tsunamis, volcanic eruptions, etc.).

-Water conflicts are likely to occur between stakeholders over the same water resources. It is a source of international conflicts.

The world is changing.

We live in an uncertain world.

Two Major Changes of our World

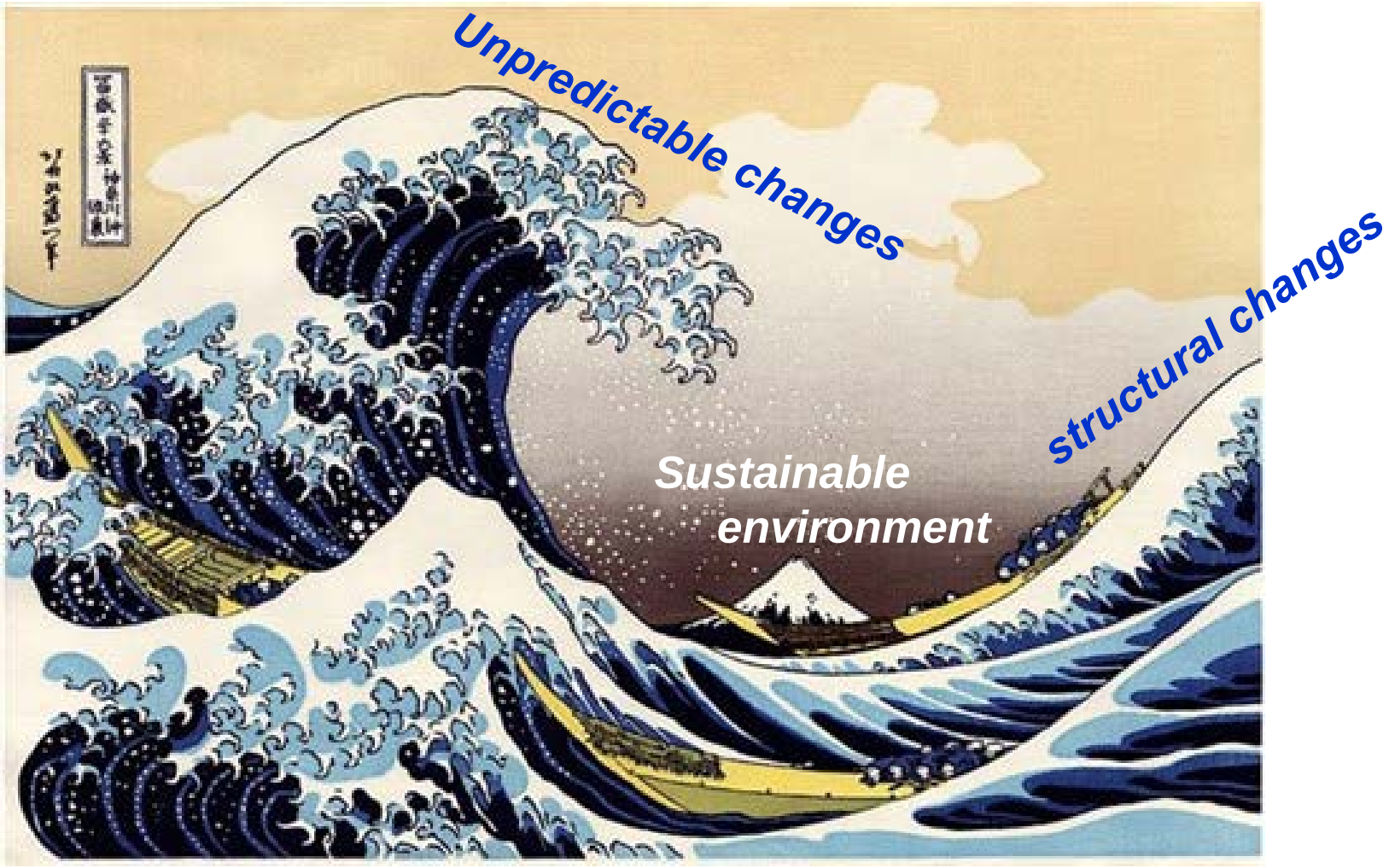
Structural Change

-dynamics of population
-urbanization
-global climate change

Unpredictable Change

-natural disasters
(earthquake, tsunami, drought, flooding, volcanic eruption,---)

The sustainability lies beyond getting through various changes.

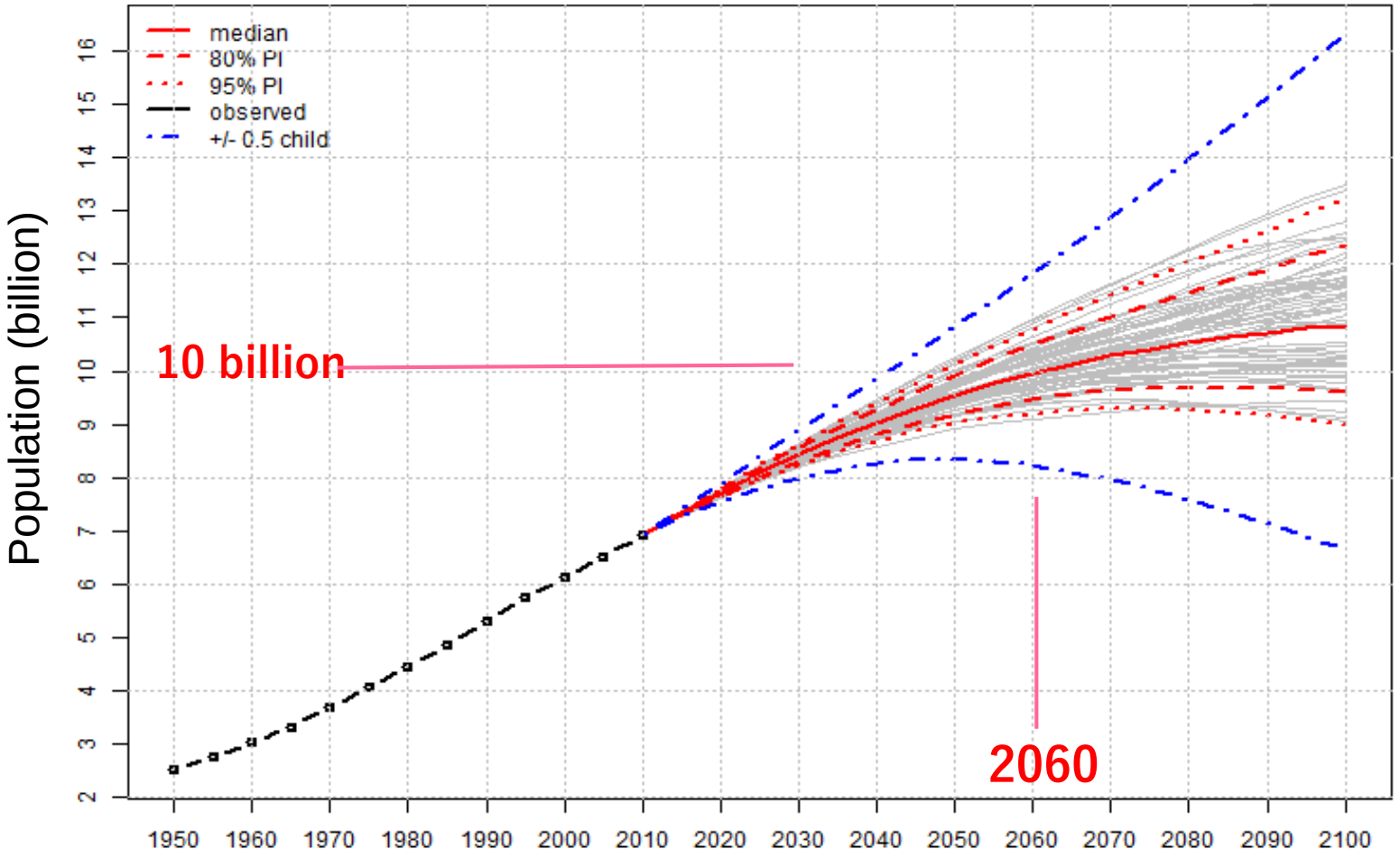


Graffiti on Katsushika Hokusai woodblock print “Kanagawaoki-namiura”

Structural change 1:

dynamics of population

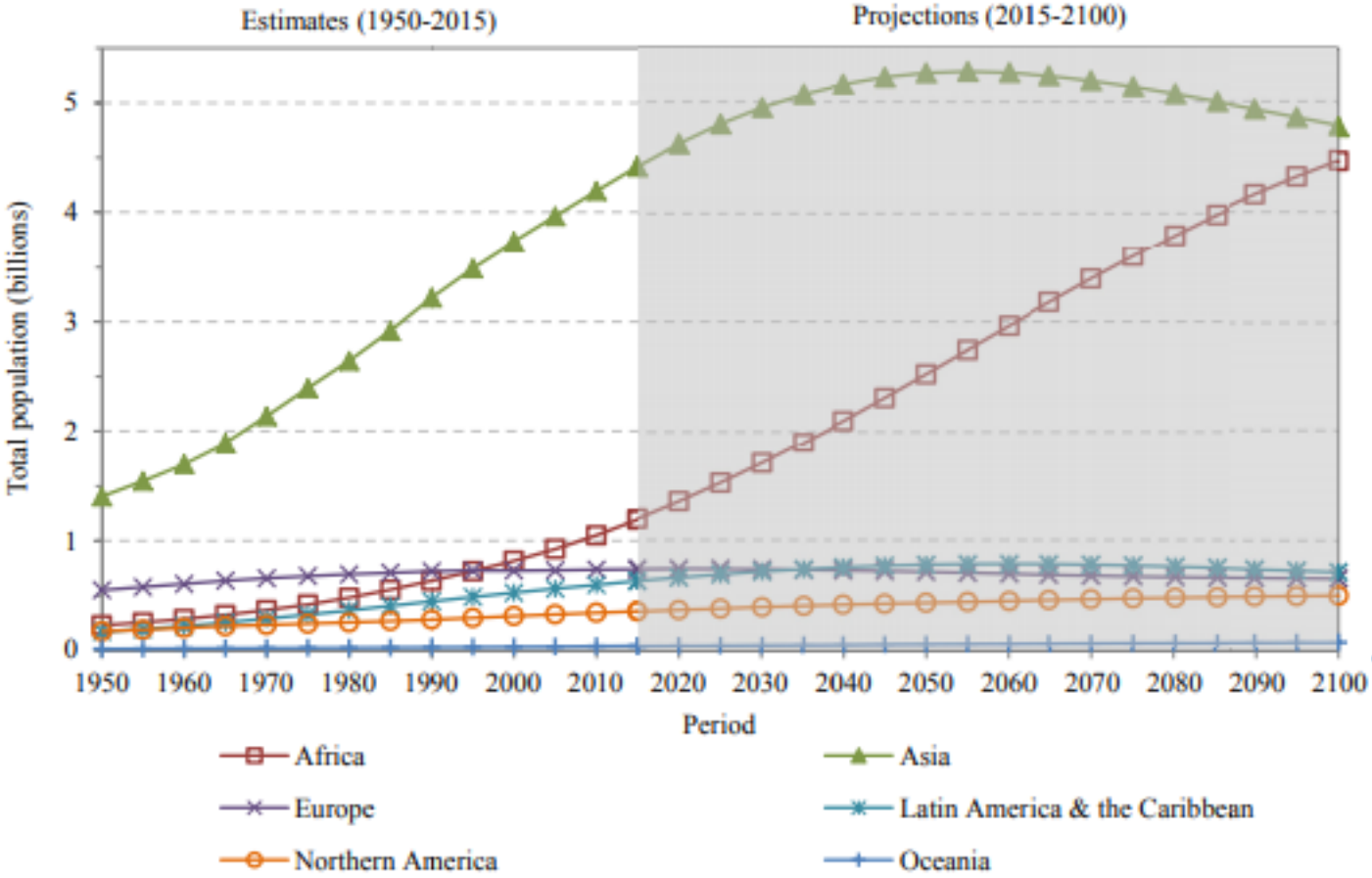
World: Probabilistic Population Projections



Source: United Nations (2014). Probabilistic Population Projections based on the World Population Prospects: The 2012 Revision. Population Division, DESA. ST/ESA/SER.A/353. http://esa.un.org/unpd/ppp/

Regions: Probabilistic Population Projections

Figure 3. Population by region: estimates, 1950-2015, and medium-variant projection, 2015-2100



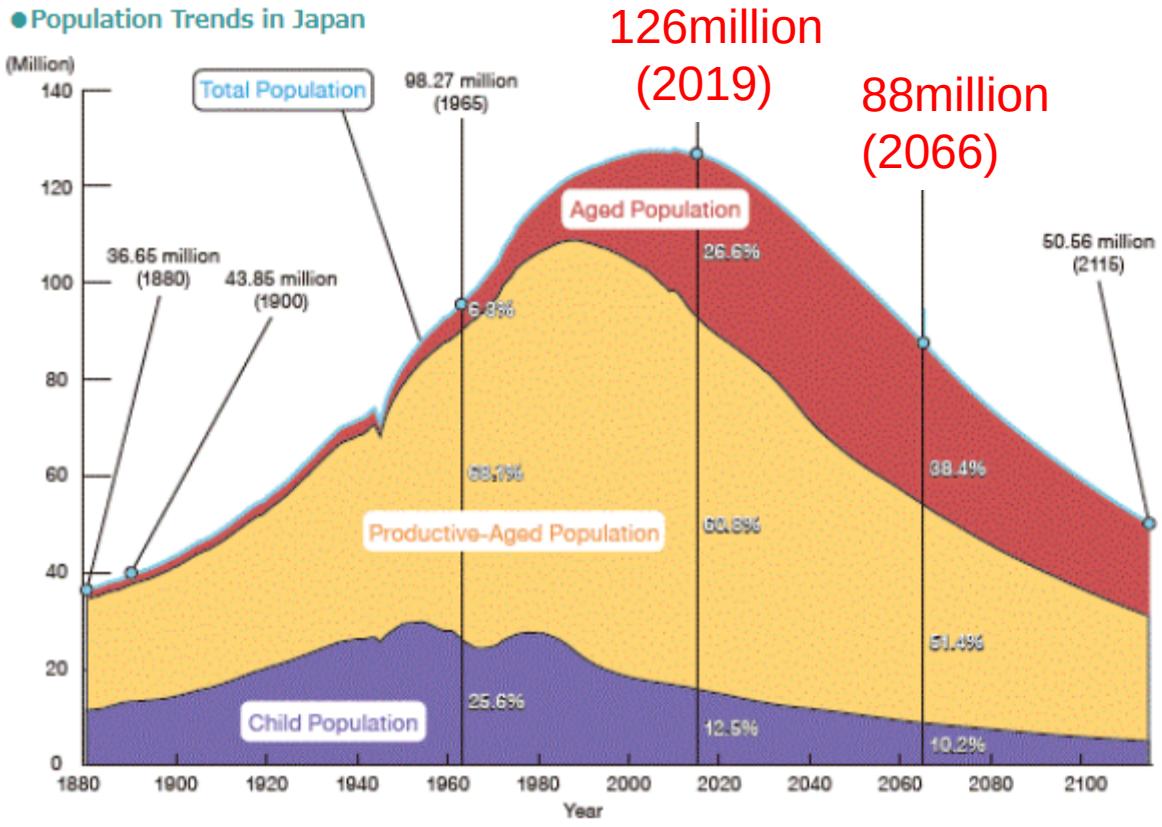
Asia
Africa
Latin America & the Caribbean
Europe
North America
Oceania

Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.

Japan: Population Projection for Japan

Population Projection for Japan

"Population Projection for Japan" is a projection of the overall size and the age-sex breakdown of the future population in Japan, used widely as an important reference by the national and local governments and in other various fields. This projection is based on information from the Census, vital statistics, as well as research developed from various national representative surveys on population and social security problems conducted as the Institute.

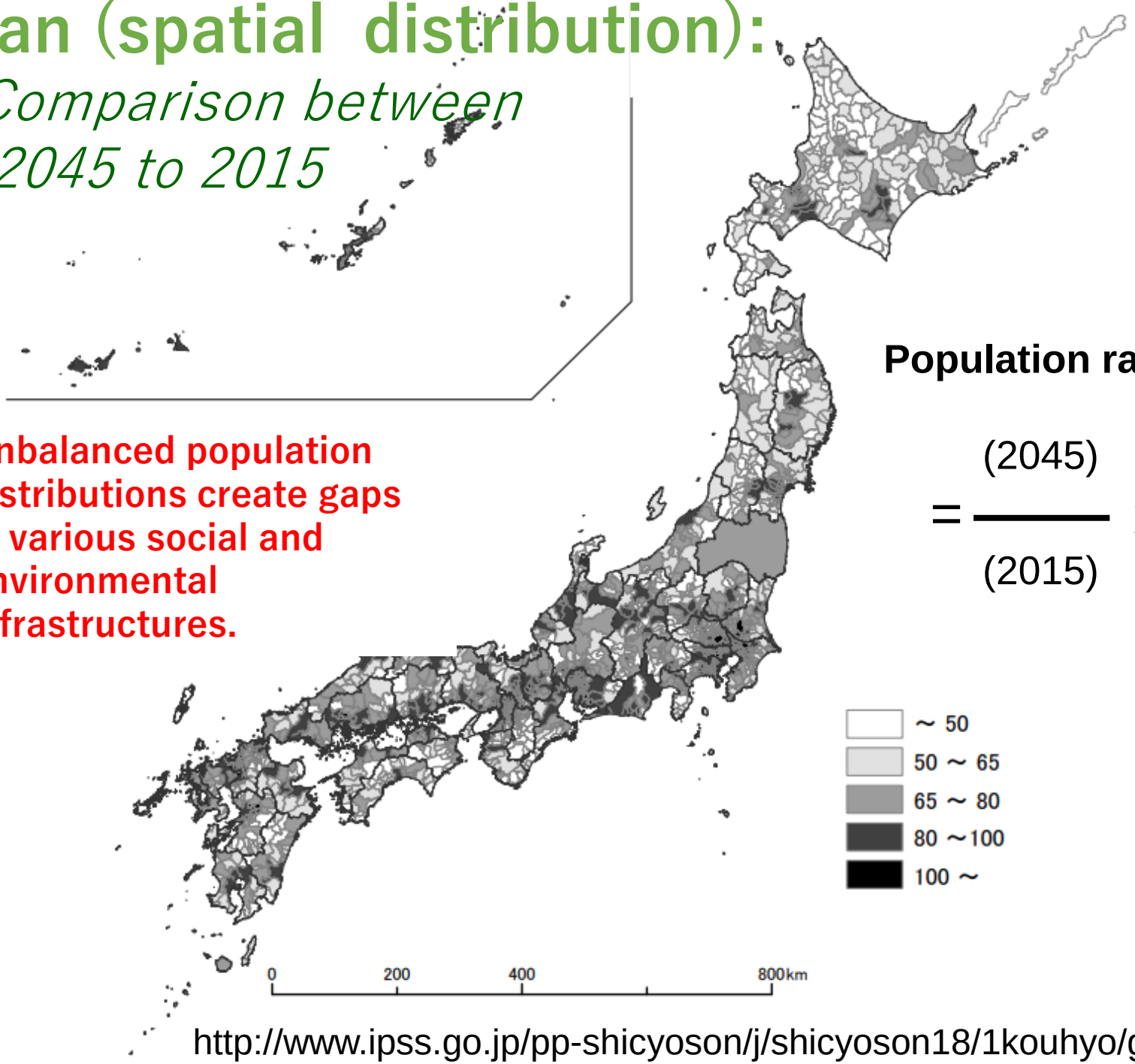


Sources: Population Estimates by the former Statistics Bureau, "Population Census of Japan", "Population Estimates", by Statistics Bureau, Population Projections for Japan: 2017-2065 (Medium Variant)

http://www.ipss.go.jp/pr-ad/e/eng/03.html

Japan (spatial distribution):

Comparison between 2045 to 2015



Population ratio

$$= \frac{(2045)}{(2015)} \times 100$$

Unbalanced population distributions create gaps in various social and environmental infrastructures.

http://www.ipss.go.jp/pp-shicyoson/j/shicyoson18/1kouhyo/gaiyo.pdf

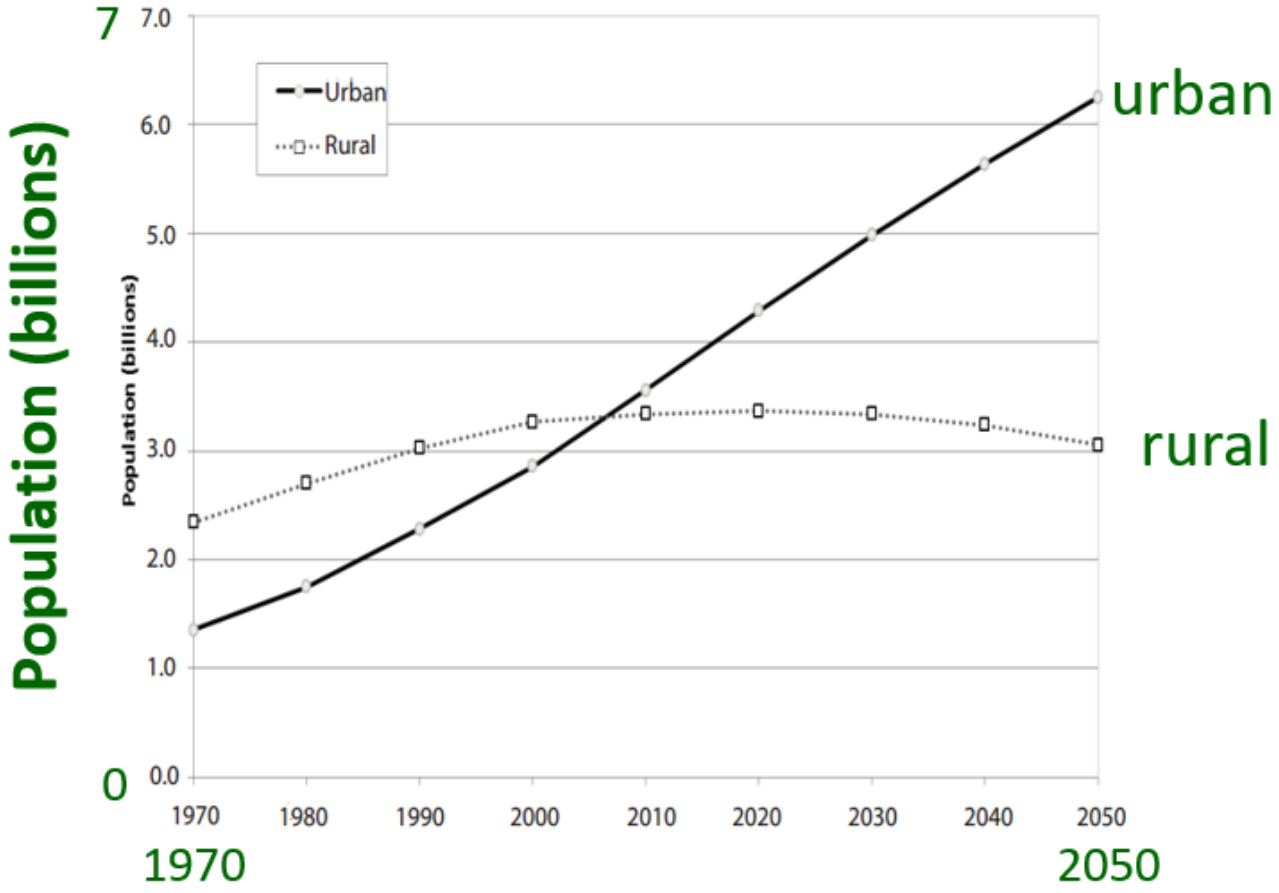
Structural change 2:

Urbanization

World urban and rural population, 1970-2050

(UN)

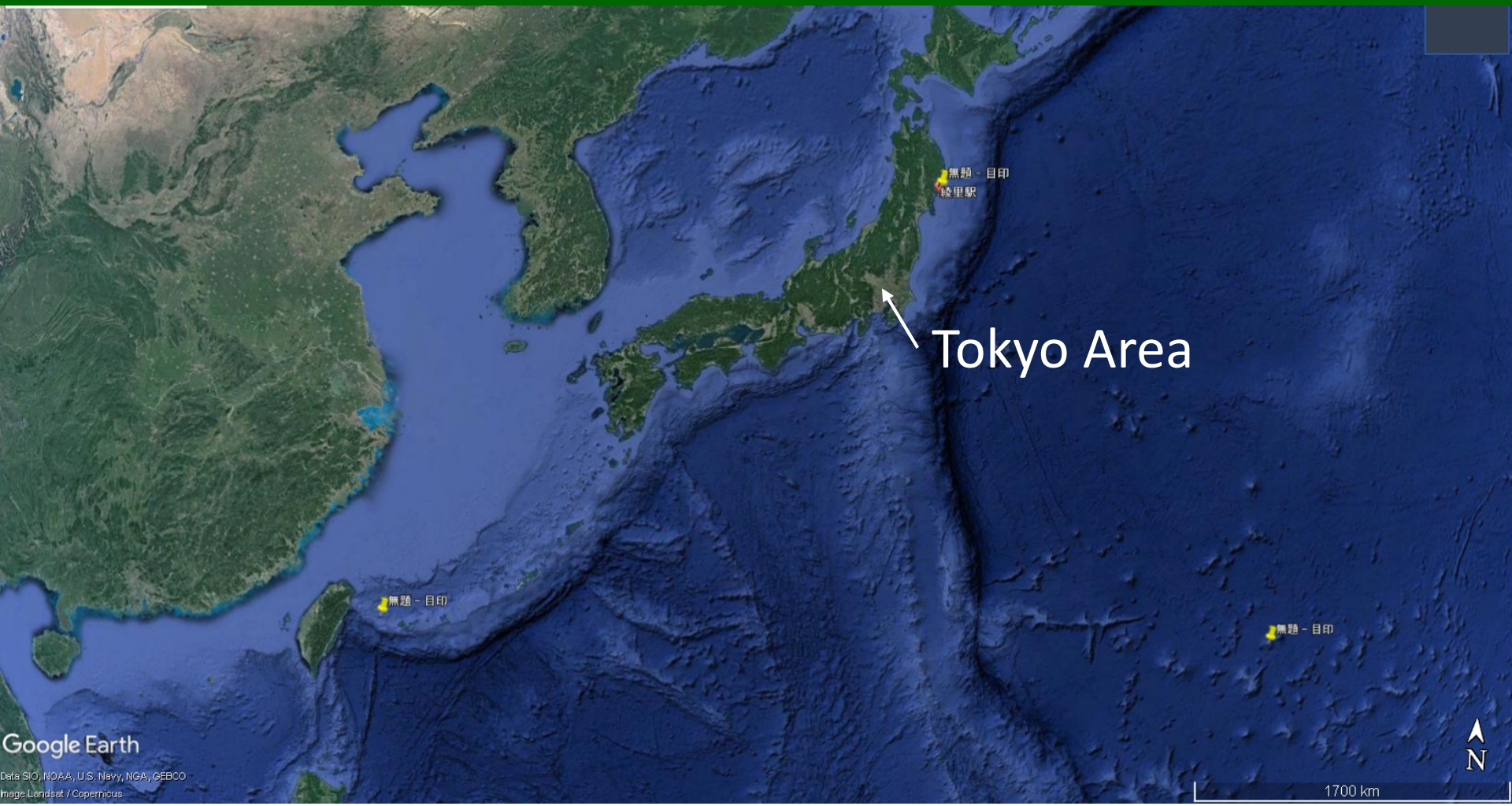
World is faced with rapid population increase in urban areas.



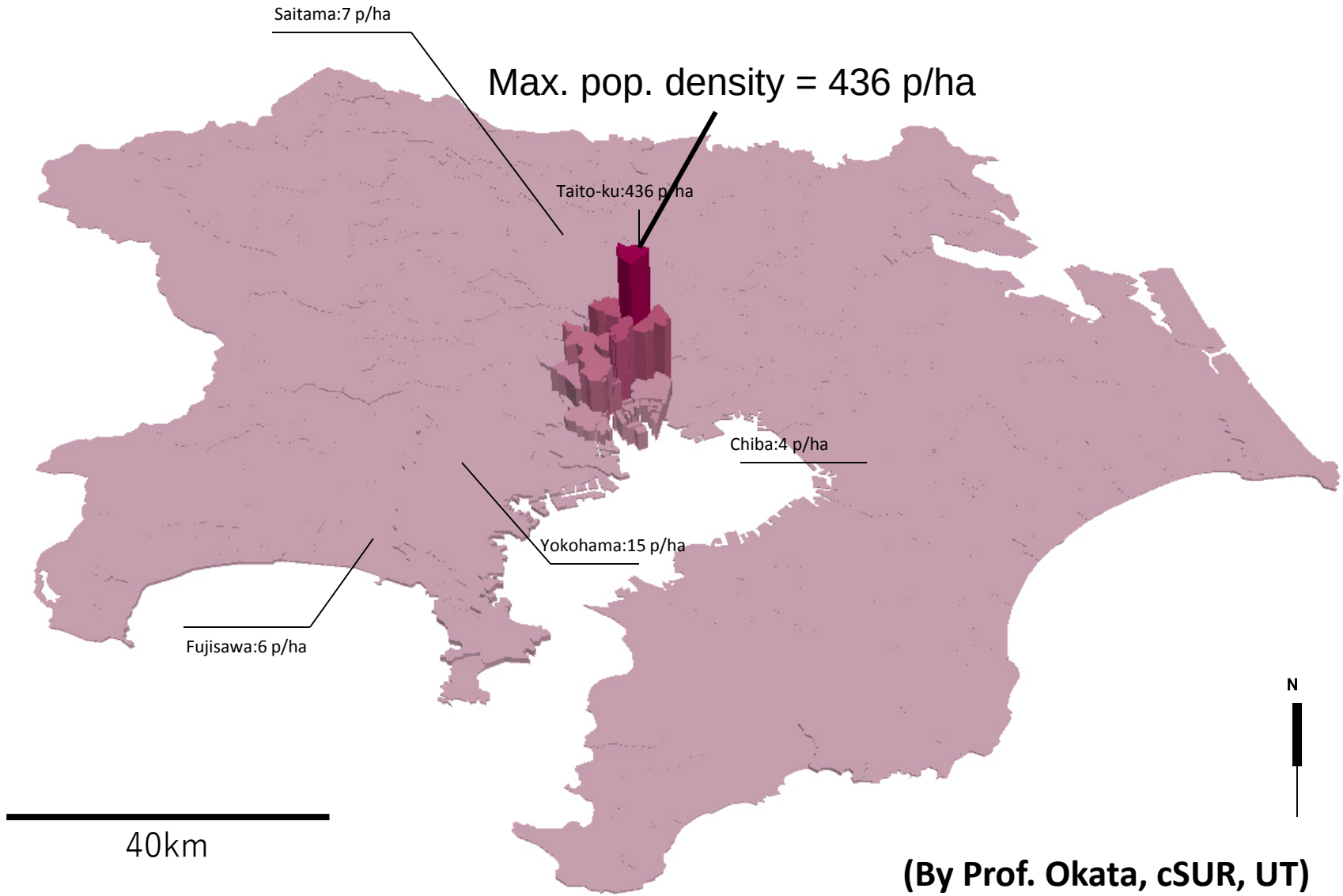
www.un.org/en/development/desa/population/publications/pdf/trends/Concise%20Report%20on%20the%20World%20Population%20Situatio

History and Prediction of Tokyo on population density and spatial distribution

(facts of 100 years from 1920 and 2050 prediction)



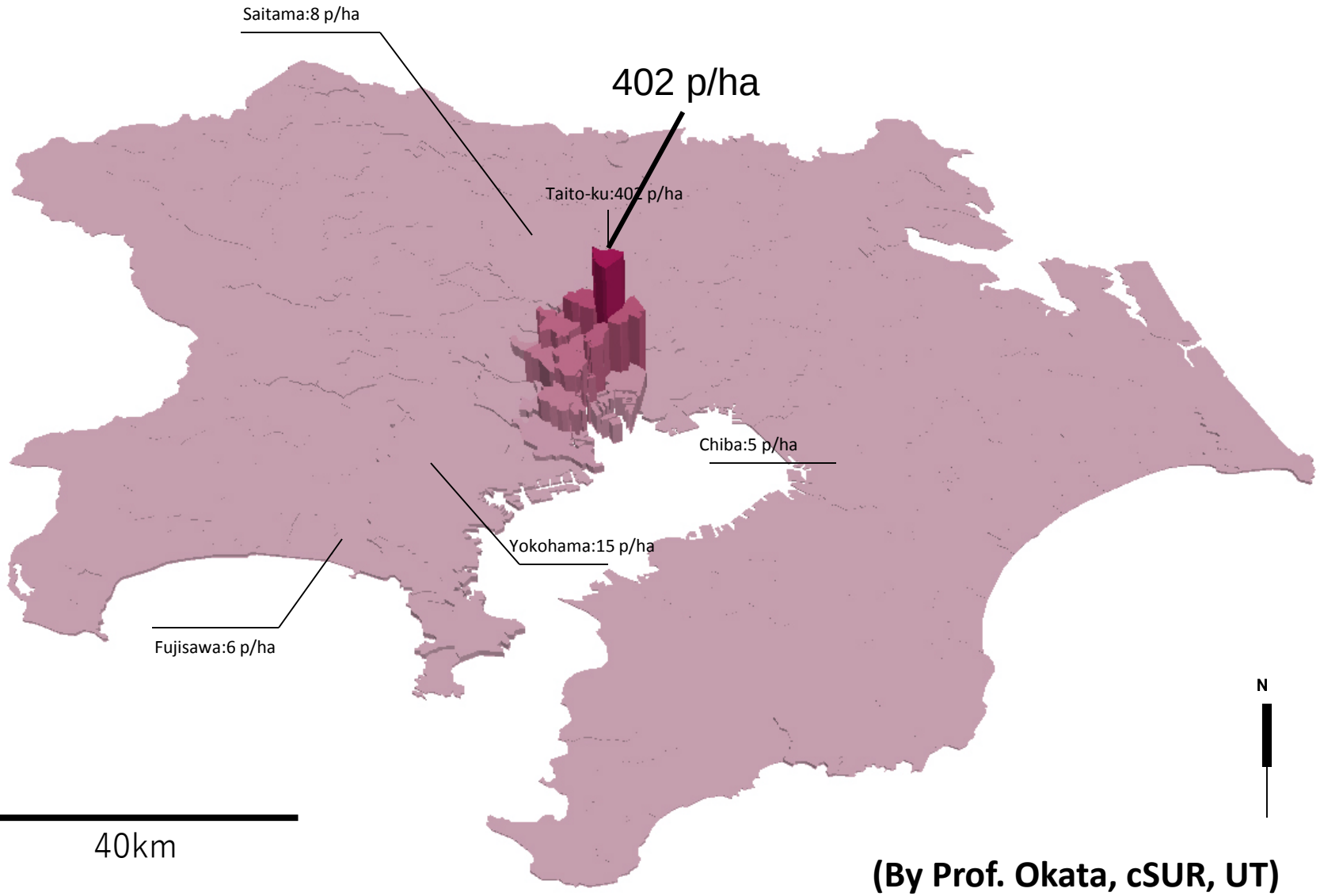
1920 **8.2 million** (Total population in this area)



(By Prof. Okata, cSUR, UT)

1925 **9.3 million** (Total population in this area)

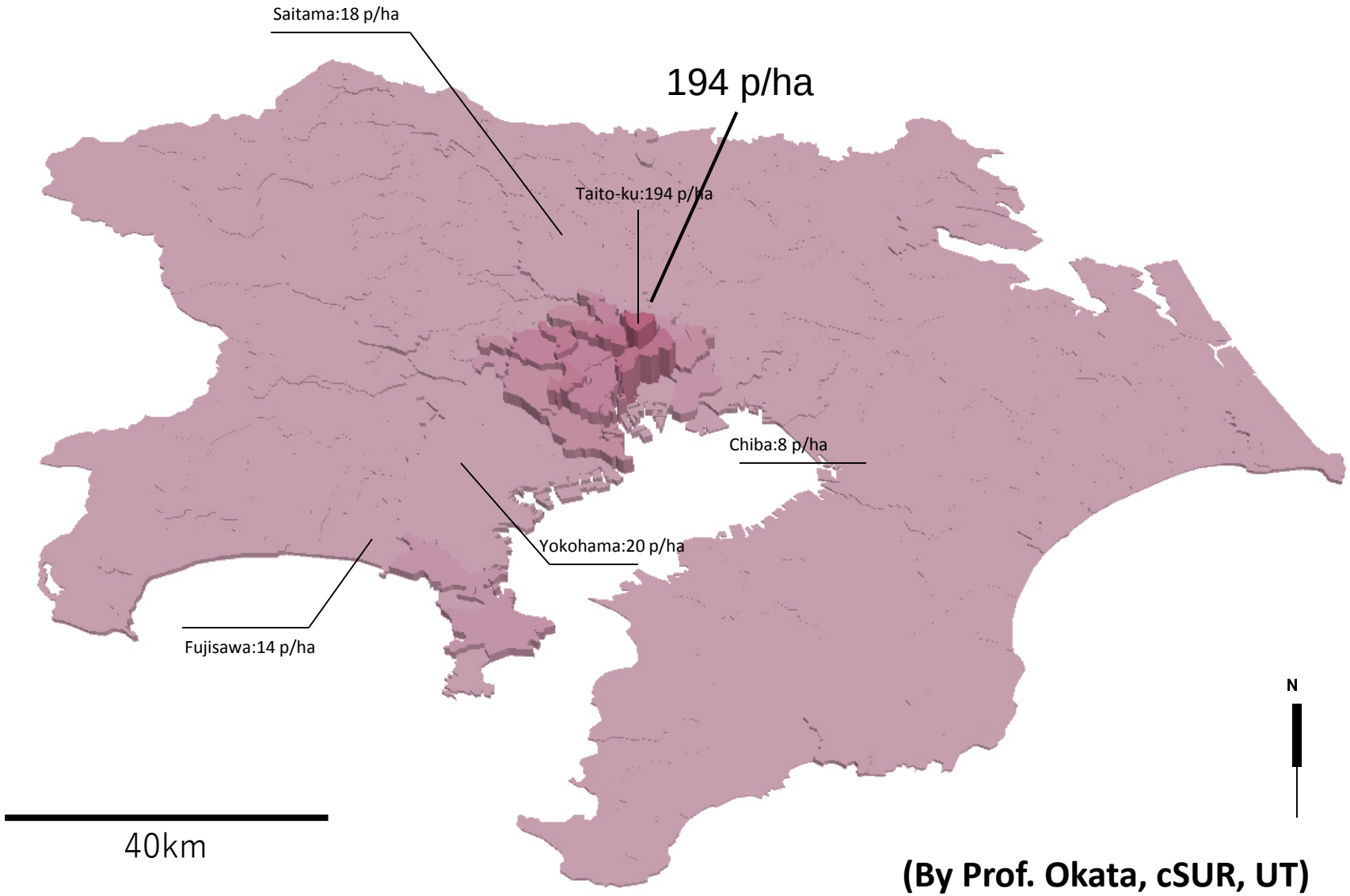
(a tremendous earthquake in Tokyo in 1923)



(By Prof. Okata, cSUR, UT)

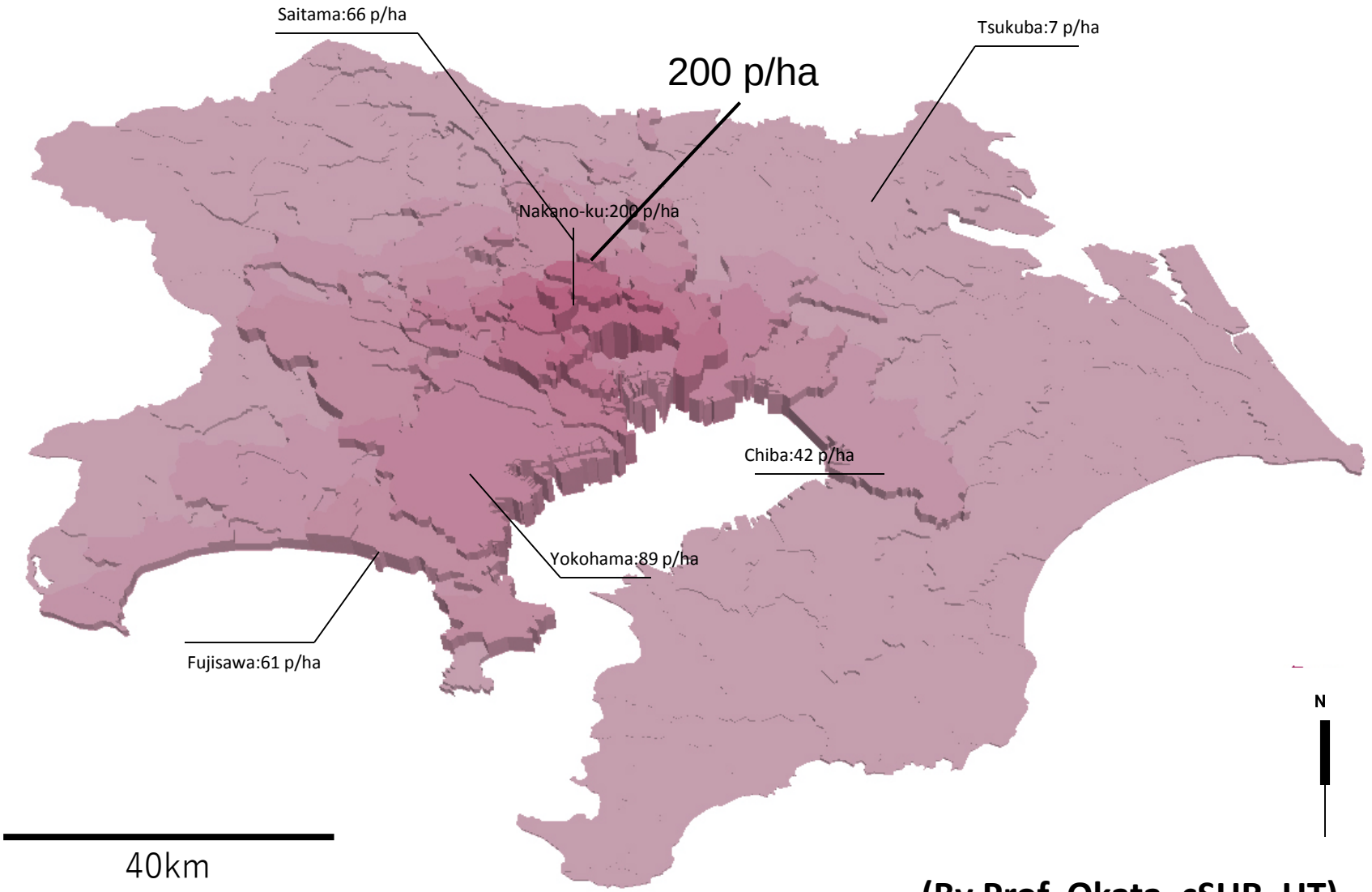
1947 **12.3 million** (Total population in this area)

(heavy bombing to Tokyo-downtown at 1945 in World War II)



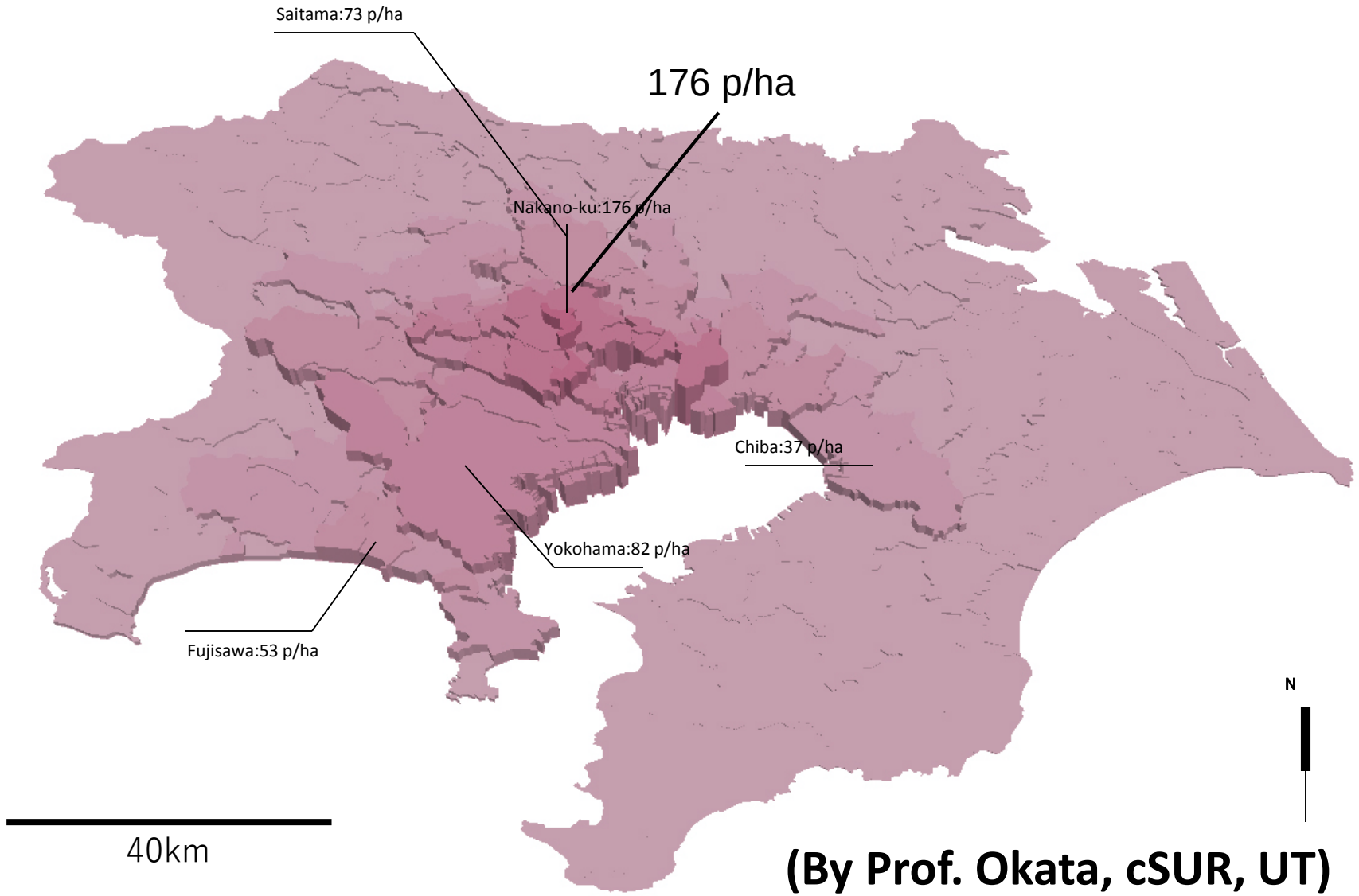
(By Prof. Okata, cSUR, UT)

2005 **35.6 million** (Total population in this area)



(By Prof. Okata, cSUR, UT)

2050(prediction) **31.2 million** (Total population in this Area)



(By Prof. Okata, cSUR, UT)

Structural change 3:

Global Climate Change

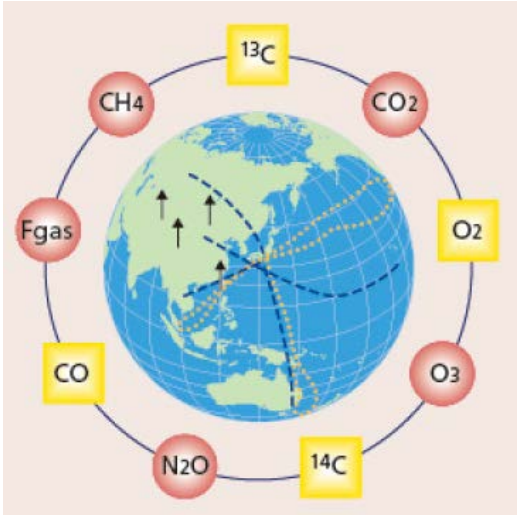
GHG Monitoring System with Satellite, aircraft, ship and observation tower (NIES)

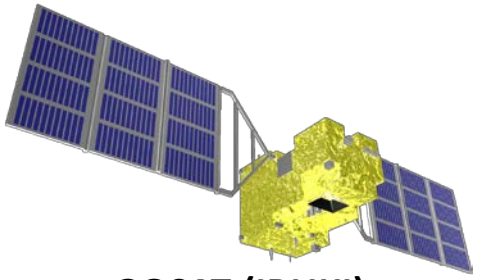
Commercial Ocean Line

Commercial Air Liner (JAL)

Pasoh
(Malaysia)

(CO_2 Flux)





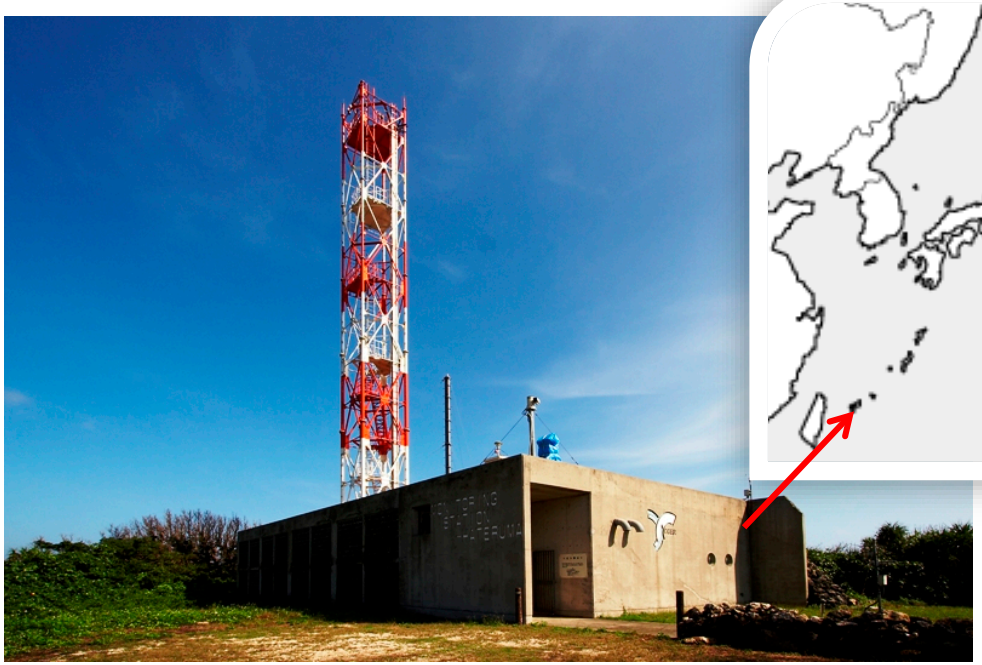
GOSAT (IBUKI) or

GOSAT 2

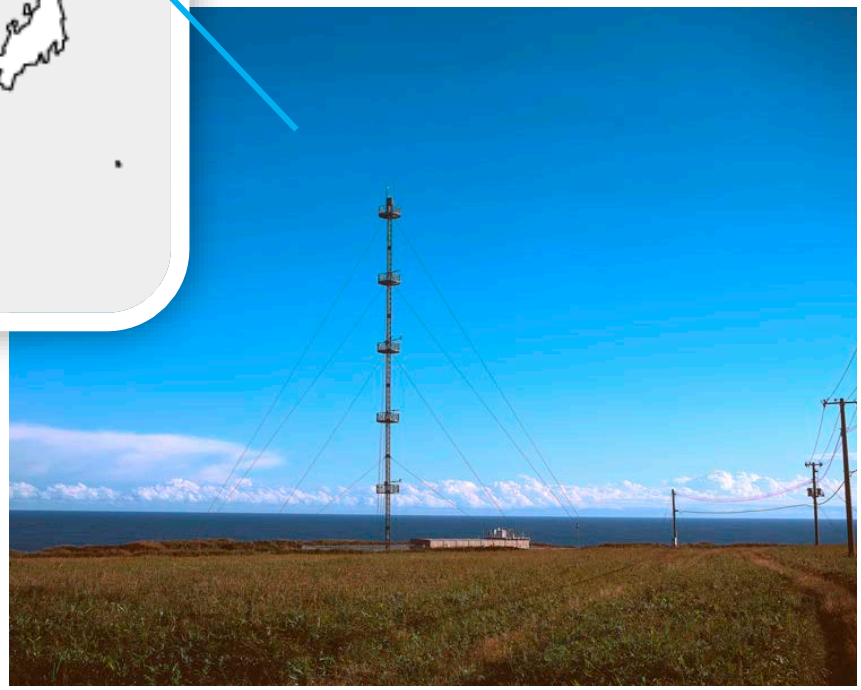
Monitoring Network over Ocean, Land, Atmosphere and Space

(2016 Original graph by NIES)

Greenhouse Gases Monitoring in Japan by National Institute for Environmental Studies



(Ref. Yangon 16°48’N)



Hateruma monitoring station

24°3’14”N, 123°48’39”E

Tower height 39m

Air intake height 46.5m(GL)

Cape Ochi-ishi monitoring station

43°9’34”N, 145°30’5”E

Tower height 55m

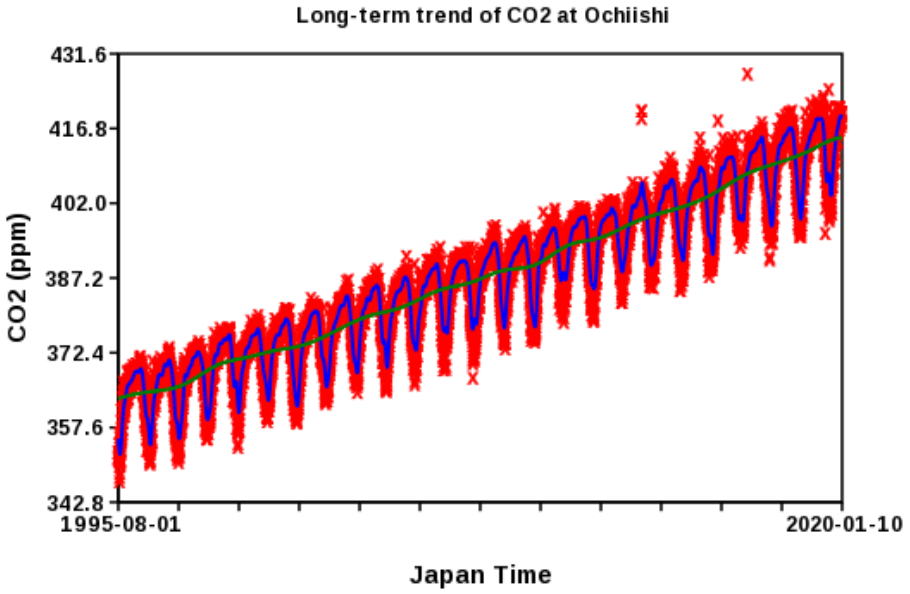
Air intake height 96m(GL)

(©2020 Ohgaki. Original photo by NIES)

Long-term CO_2 trend in Japan (Greenhouse Gases Trend Update, NIES)

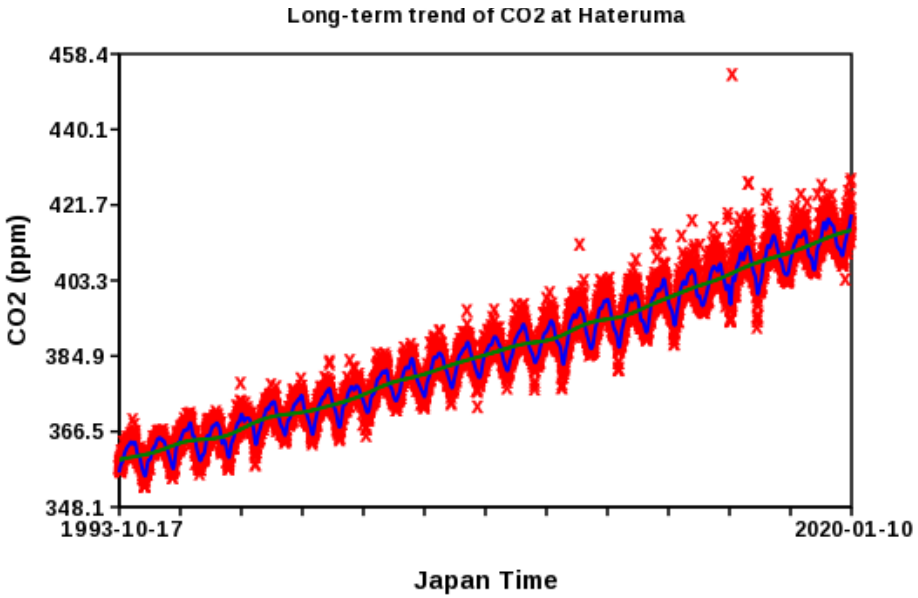
Ochi-ishi Station

http://db.cger.nies.go.jp/api/ggtu/images/Ochiishi.CO2.trend.png



Hateruma Station

http://db.cger.nies.go.jp/api/ggtu/images/Hateruma.CO2.trend.png



(IPCC WG1 AR5) Sep. 2013

E.2 Atmosphere: Water Cycle

Changes in the global water cycle in response to the warming over the 21st century will not be uniform.

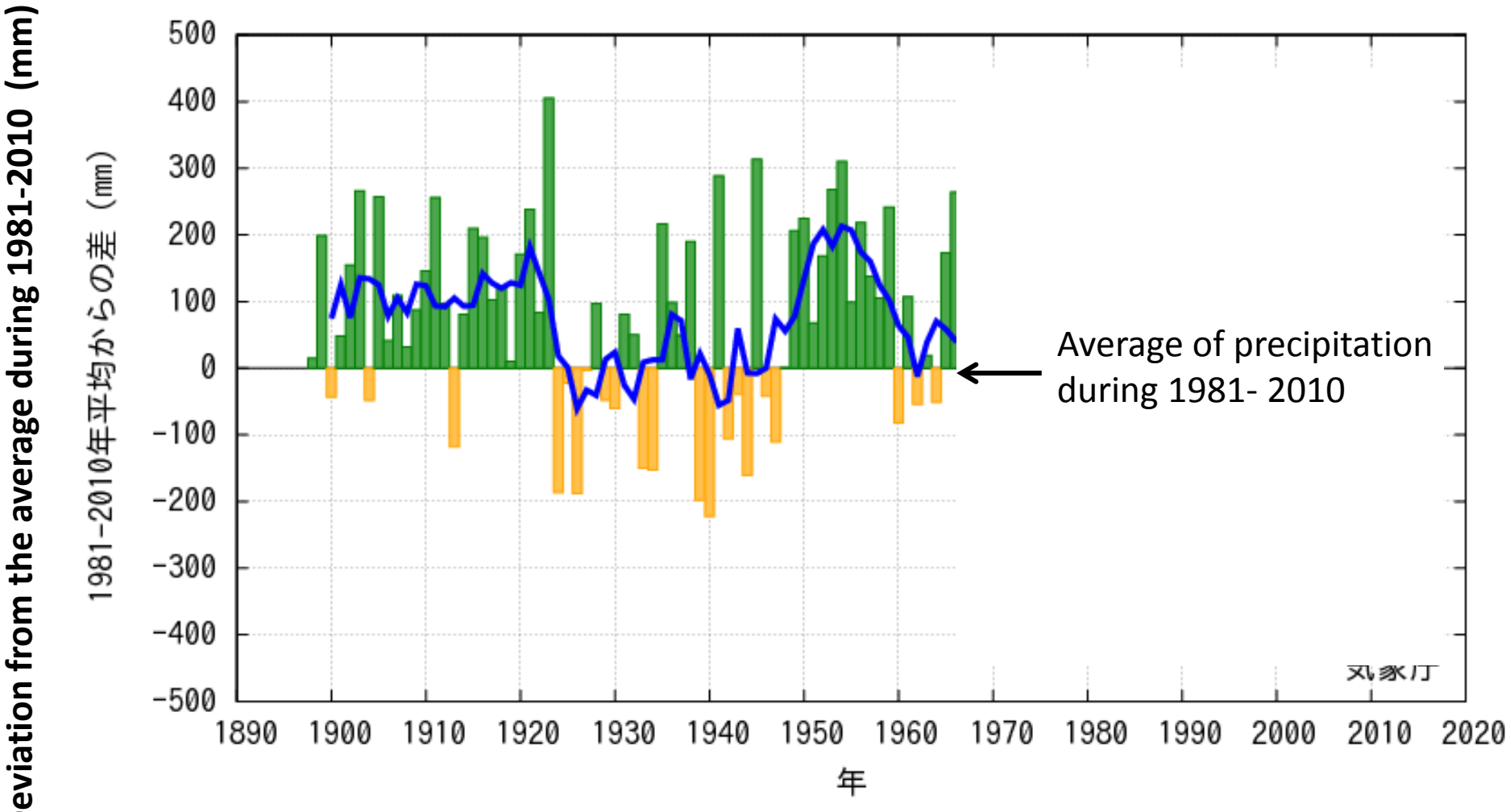
The contrast in precipitation between wet and dry regions and between wet and dry seasons will increase, although there may be regional exceptions (see Figure SPM.8). {12.4, 14.3}

Extreme precipitation events over most of the mid-latitude land masses and over wet tropical regions will *very likely become more intense and more frequent by the end of this century, as* global mean surface temperature increases (see Table SPM.1). {7.6, 12.4}

- Globally, it is *likely that the area encompassed by monsoon systems will increase*

(Red colored by Ohgaki)

Annual precipitation of Japan (Meteorological Agency, Japan)

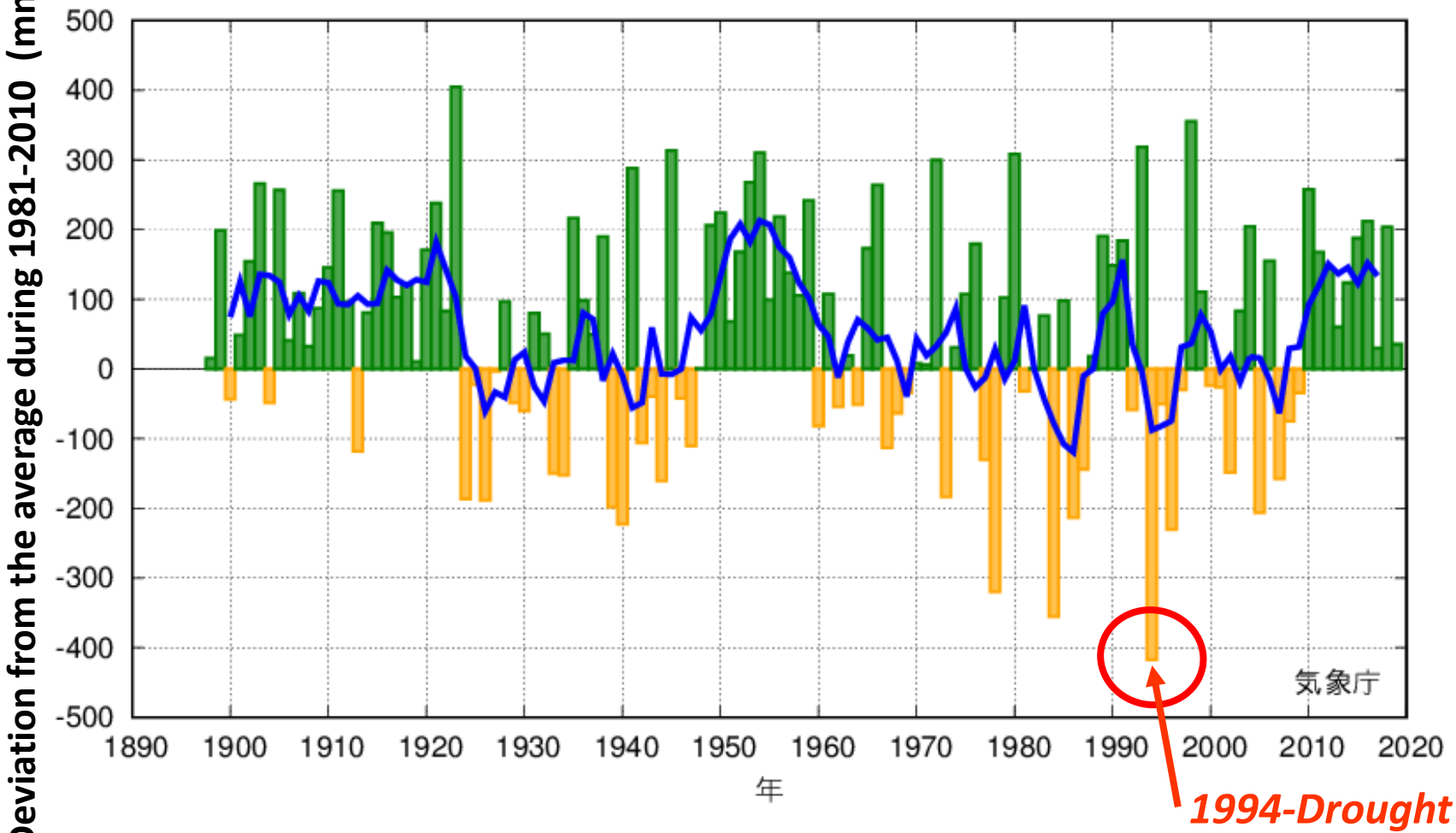


国内51地点での年降水量偏差（基準値に対する偏差で、mmであらわす）を平均した値、太線（青）：偏差の5年移動平均。基準値は1981～2010年の30年平均値。
出典：http://www.data.jma.go.jp/cpdinfo/temp/an_jpn_r.html

(Original graph by JMA)

Increasing extreme cases of annual precipitation

(気象庁HPより)



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出典：http://www.data.jma.go.jp/cpdinfo/temp/an_jpn_r.html

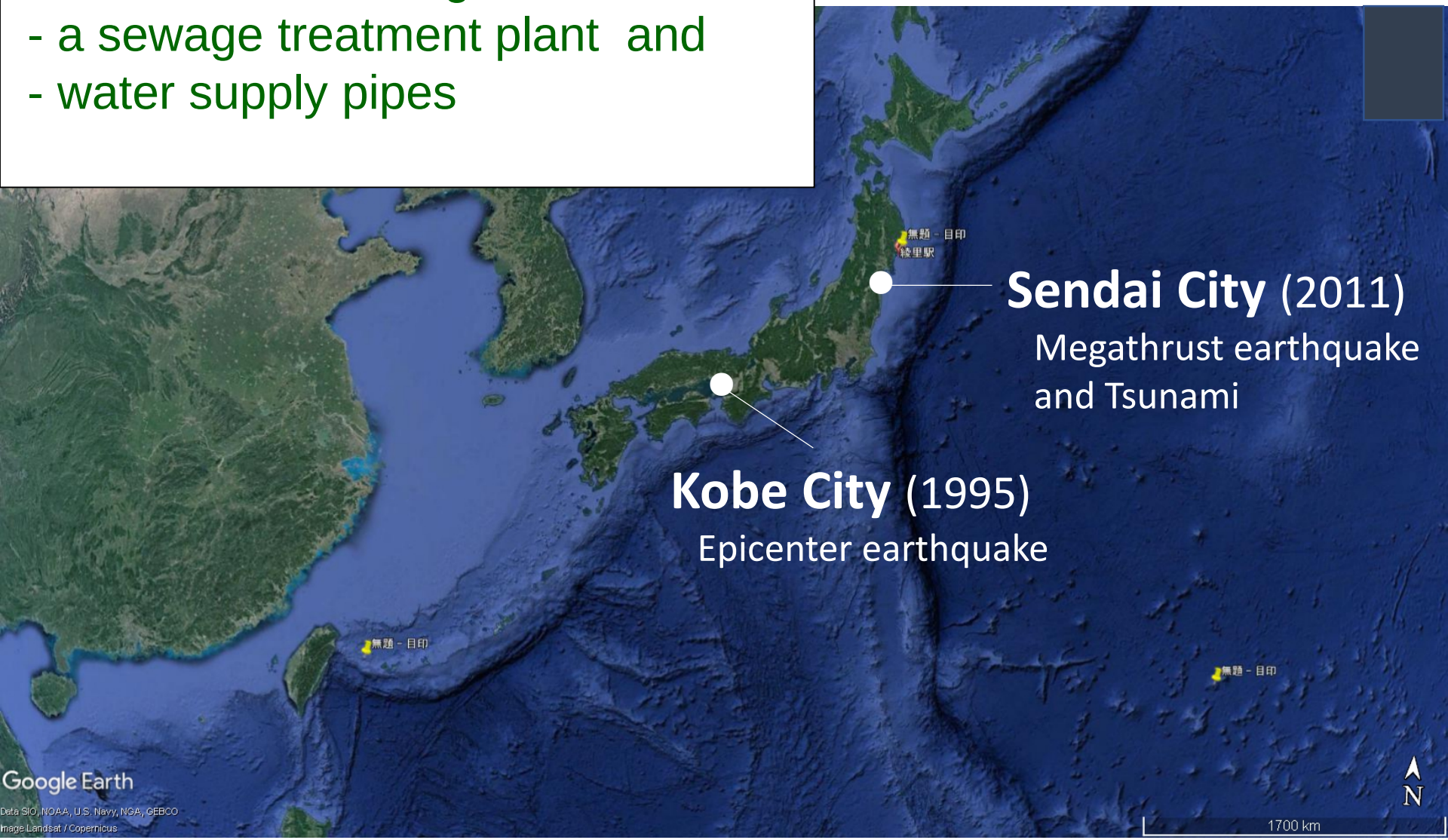
(Original graph by JMA)

Unpredictable change:

Natural Disasters

- *tsunami*
- *earthquake*

Two cases on damages to
- a sewage treatment plant and
- water supply pipes



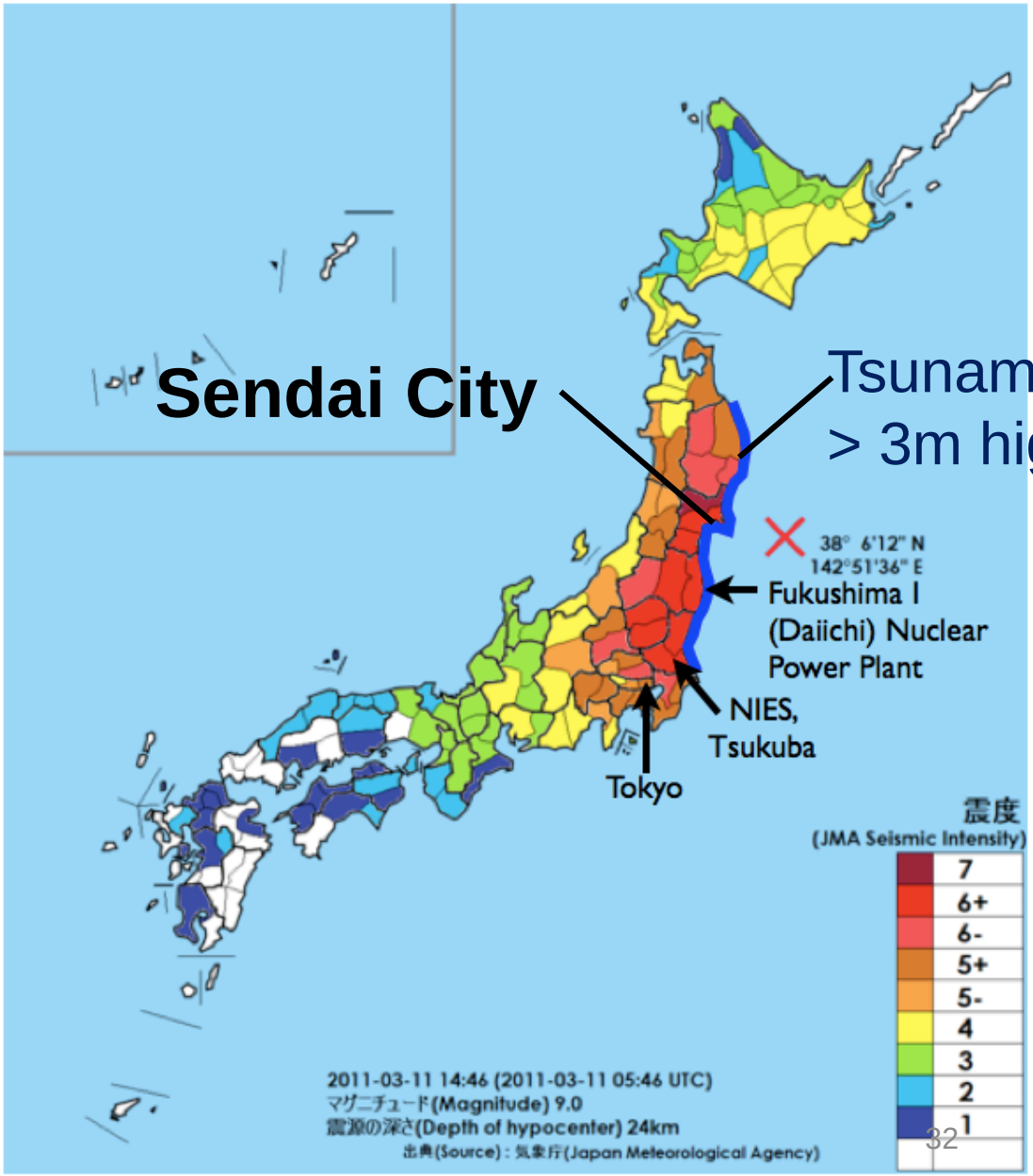
Great East Japan Earthquake

(NIES)

14:46, March 11, 2011:
Magnitude 9.0 (Mw)

Tsunami (Huge Tidal Wave):
Blue line indicating more than 3 m high

Fukushima Daiichi nuclear disaster:
Power failure,
Equipment failures,
Nuclear meltdowns,
Releases of radioactive materials



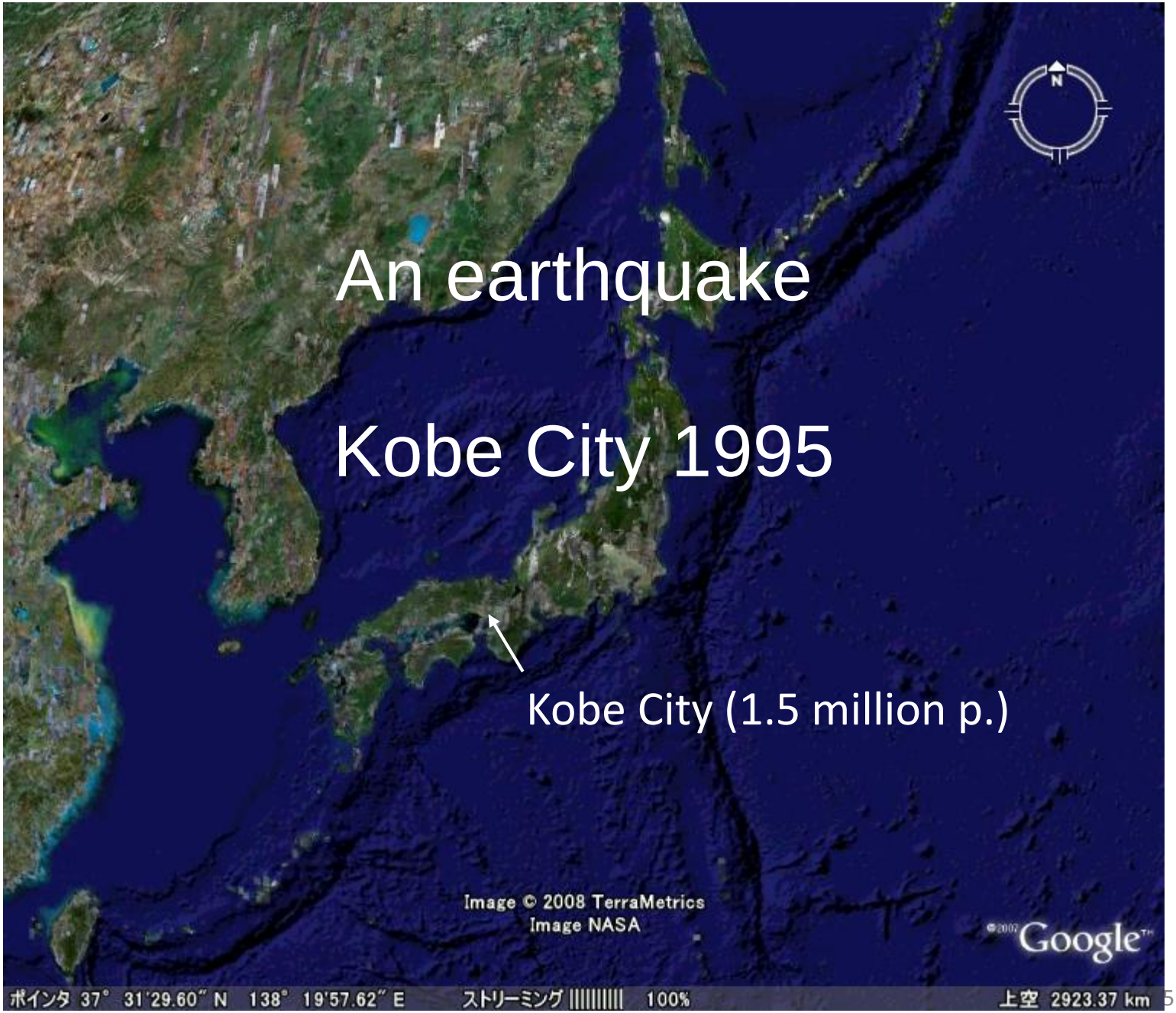
32

Tsunami struck Minamigamo Sewage treatment plant.
Photo at 16:01, 2011/3/11

https://www.city.sendai.jp/shiminkoho/shise/daishinsai/zenkoku/photoarchive/engan/index.html

After Tsunami

(Minamigamo Sewage treatment plant)


An earthquake
Kobe City 1995
Kobe City (1.5 million p.)
Image © 2008 TerraMetrics
Image NASA
©2007 Google
ポインタ 37° 31'29.60" N 138° 19'57.62" E
ストリーミング 100%
上空 2923.37 km

HANSHIN-AWAJI EARTHQUAKE 1995.1.17

(An earthquake directly above its epicenter)

(by courtesy of Mr. Matsushita, Kobe City)

Damage of water supply pipes due to the earthquake, Kobe City 1995

damage points: more than 1757 in the City

Cast iron pipes (CIP)

垂水区内φ800 CIP

(by courtesy of Mr. Matsushita, Kobe City)

Ductile iron pipes (DIP)

市役所前φ800 DIP

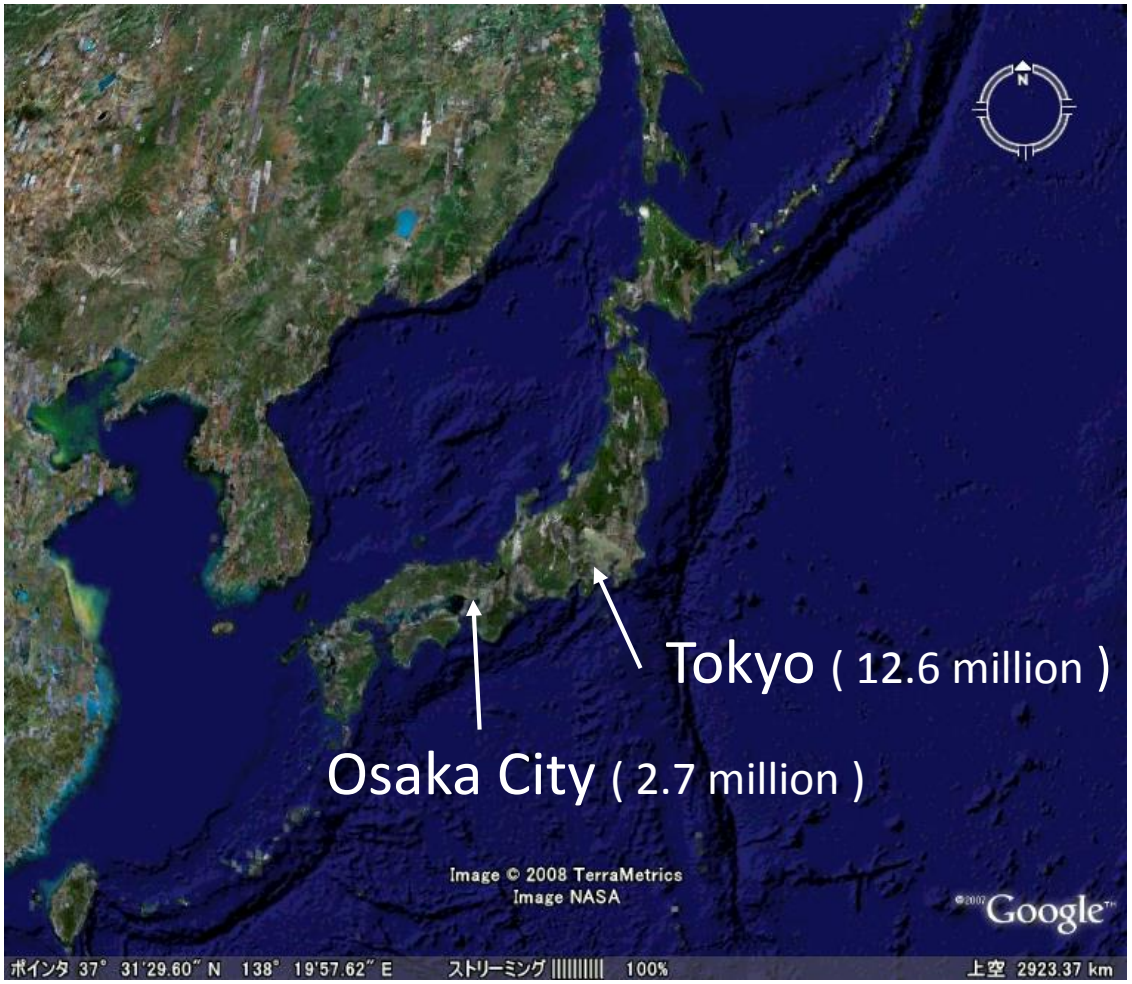
What occurred in urbanized area due to rapid urbanization?

What measures against the uncertainty of climate and disasters are taken?

some experiences:

- land subsidence and groundwater in Tokyo and Osaka
- Wastewater reuse in Tokyo
- Measures against earthquake in Tokyo and Kobe

Groundwater and subsidence in Tokyo and Osaka City



Urbanization causes land subsidence

-Urbanization means increase of water demand for households, industries and business activities.

↓

-As the first stage of urbanization , groundwater is most convenient water resources for all demand.

↓

-In the case of geological alluvial plain like Tokyo area or Yangon, **excess drawing from groundwater causes land subsidence.**

1950

2000

History of Groundwater level in Tokyo

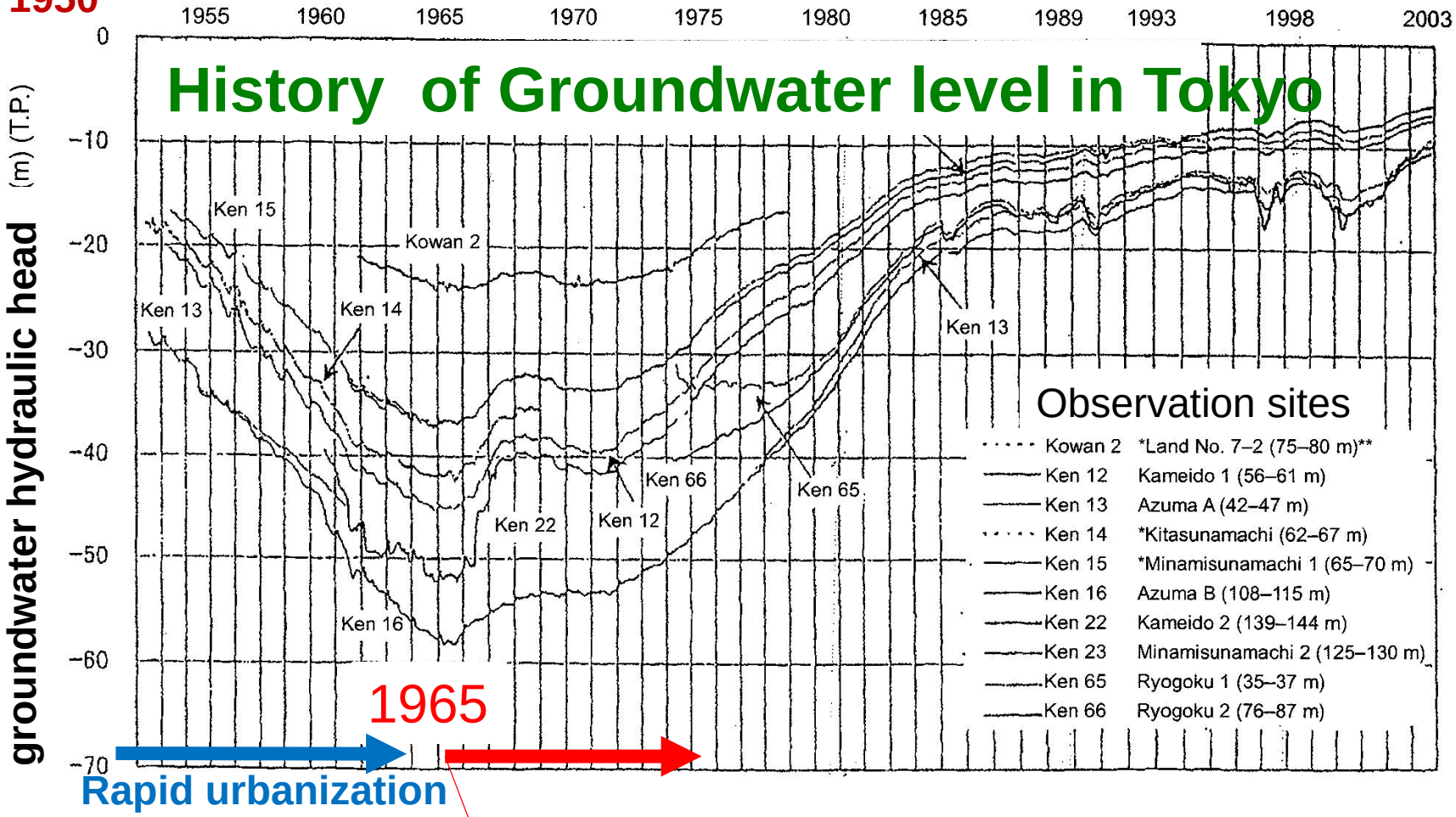


Figure 2. Variation in groundwater level in wells in Koto-ku and Sumida-ku

Source: Tokyo Metropolitan Research Institute for Civil Engineering Technology 2004.

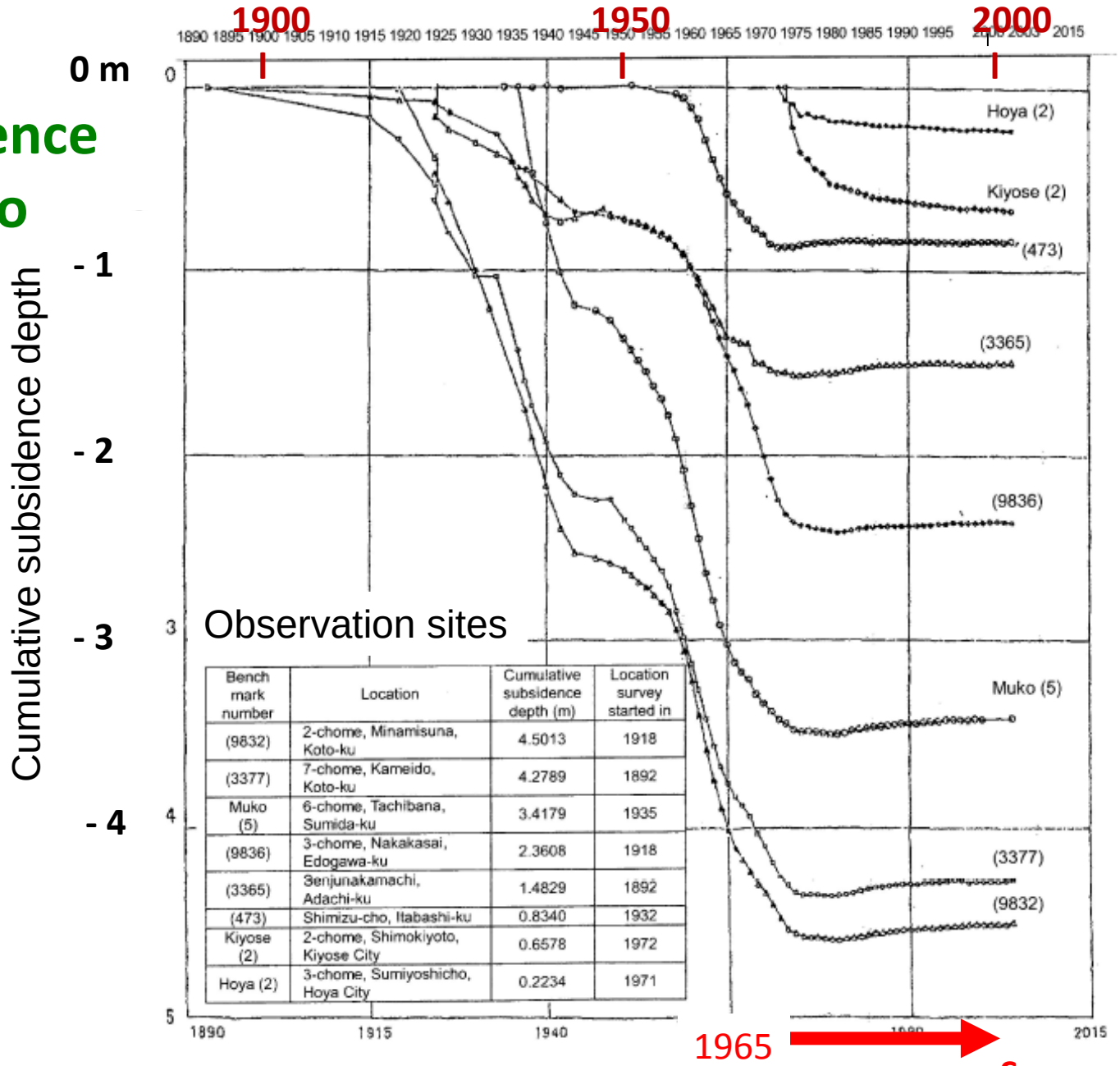
Note: The water level of a well installed in the confined aquifer is higher than the upper surface of the aquifer in the stratum because the well water is pressurized.

*Single asterisk indicates former site of a well.

**Figures in parentheses represent strainer depths.

- Control of the drawdown of groundwater level by Industrial Law and Building Law
- Alternative water from Industrial Water Works

Land subsidence In Tokyo

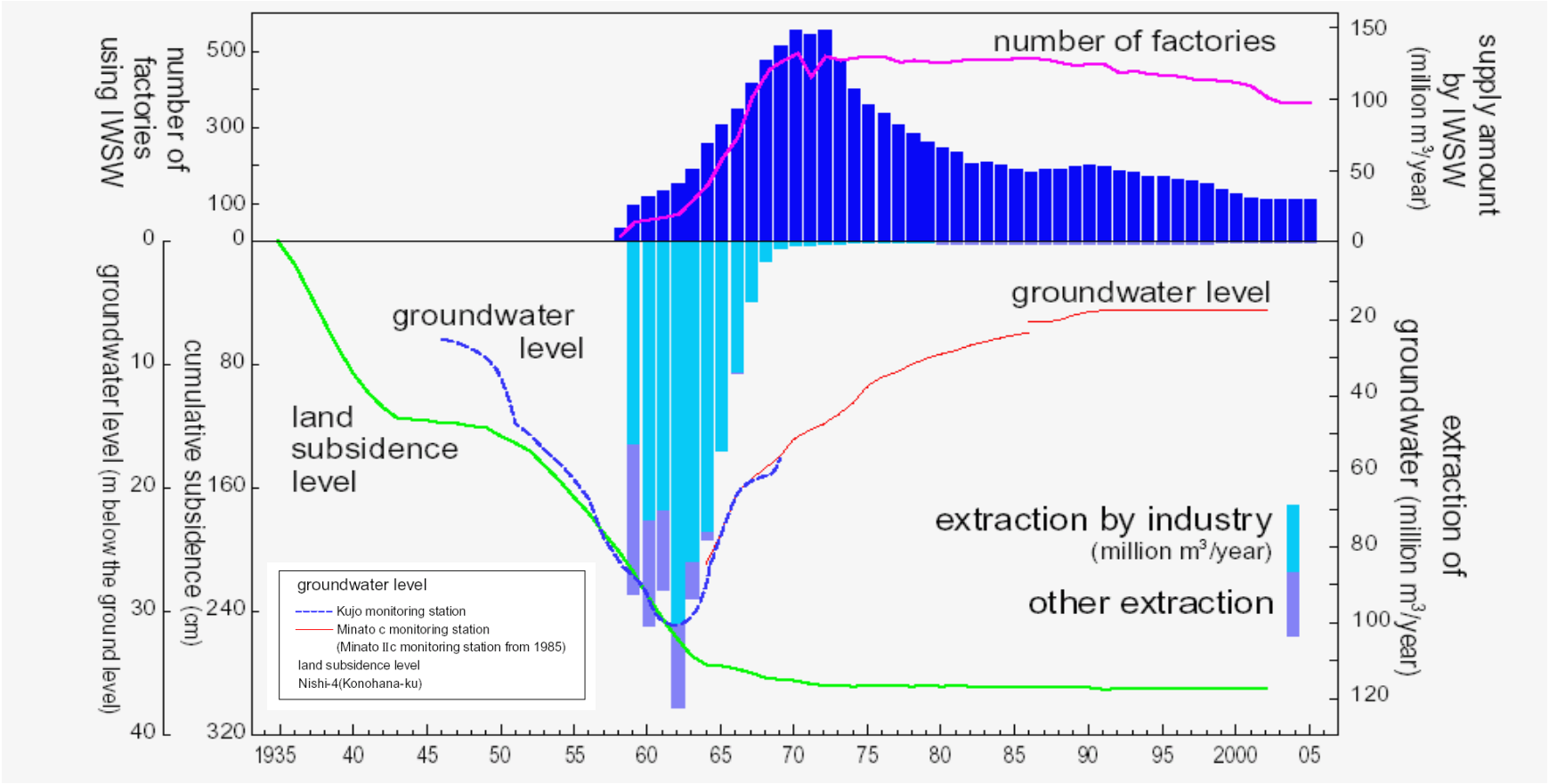


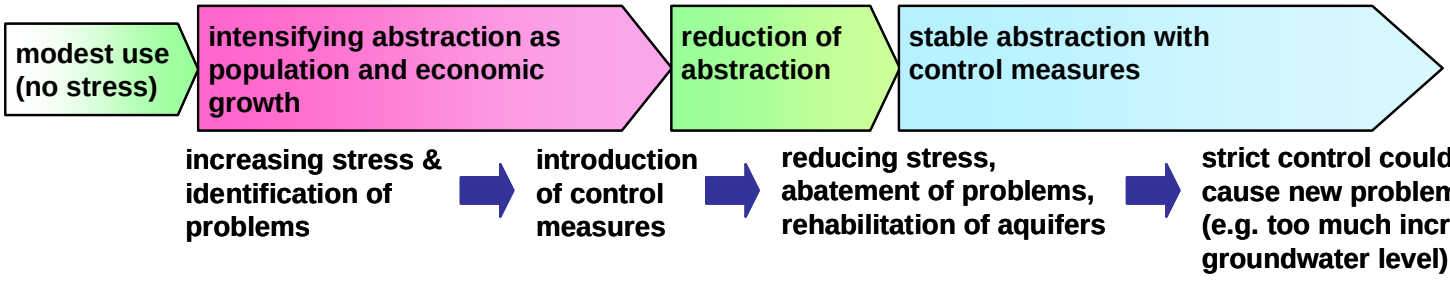
Bench mark number	Location	Cumulative subsidence depth (m)	Location survey started in
(9832)	2-chome, Minamisuna, Koto-ku	4.5013	1918
(3377)	7-chome, Kameido, Koto-ku	4.2789	1892
Muko (5)	6-chome, Tachibana, Sumida-ku	3.4179	1935
(9836)	3-chome, Nakakasai, Edogawa-ku	2.3608	1918
(3365)	Senjunakamachi, Adachi-ku	1.4829	1892
(473)	Shimizu-cho, Itabashi-ku	0.8340	1932
Kiyose (2)	2-chome, Shimokiyoto, Kiyose City	0.6578	1972
Hoya (2)	3-chome, Sumiyoshicho, Hoya City	0.2234	1971

Figure 1. Cumulative subsidence depths at major benchmarks, 1890–2003

Source: Tokyo Metropolitan Research Institute for Civil Engineering Technology 2004.

Land subsidence due to groundwater extraction in Osaka





(Kataoka,et al. IGES Policy Brief #4, March 2006)

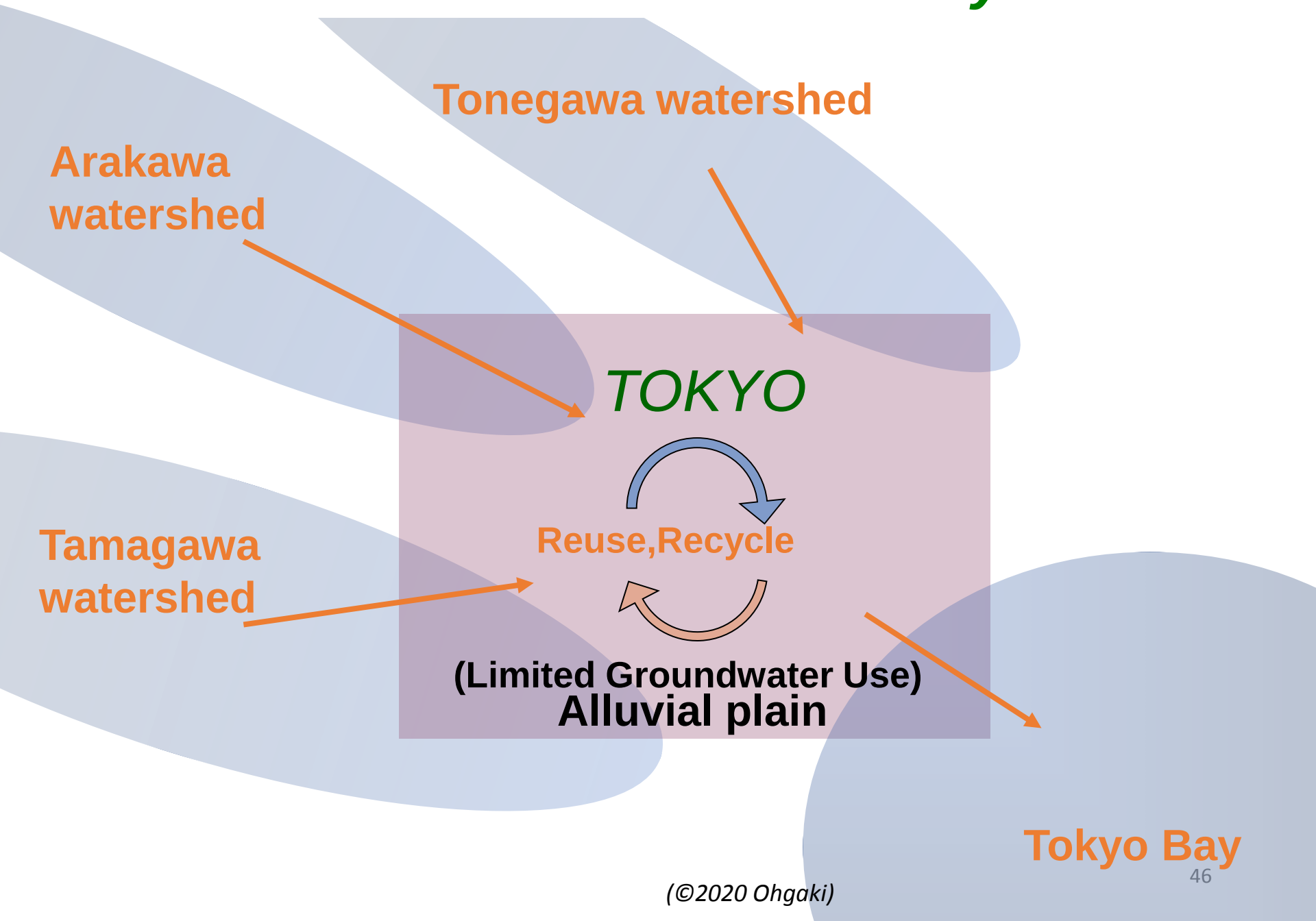
From this groundwater cases,

we can learn that
urban environmental systems
form complex relationships
between cause and effect.

Wastewater reuse in Tokyo

Measures against shortage of water resources

Structure of water flow in Tokyo



Daytime Population in Tokyo

Resident population	about	13,520,000
Daytime population*	about	15,920,000
		+ 2,910,000

Daytime /Resident = 1.18

* not including temporary visitors

(according to 2015-Census)

Shinjuku Skyscrapers and Tokyo City Hall

Reclaimed Wastewater Use for Toilet Flush in Skyscrapers and Tokyo City Hall, Shinjuku, Tokyo (since 1984)

(2016 S. Ohgaki)

Supply Destinations of Reclaimed Water from Shibaura Wastewater Treatment Plant

Osaki area

Shinagawa area

Shiodome area

Shibaura Sewage Treatment Plant
Membrane technology

Wastewater reuse (for toilet flushing) in urbanized area

Individual house --------*basically impossible*

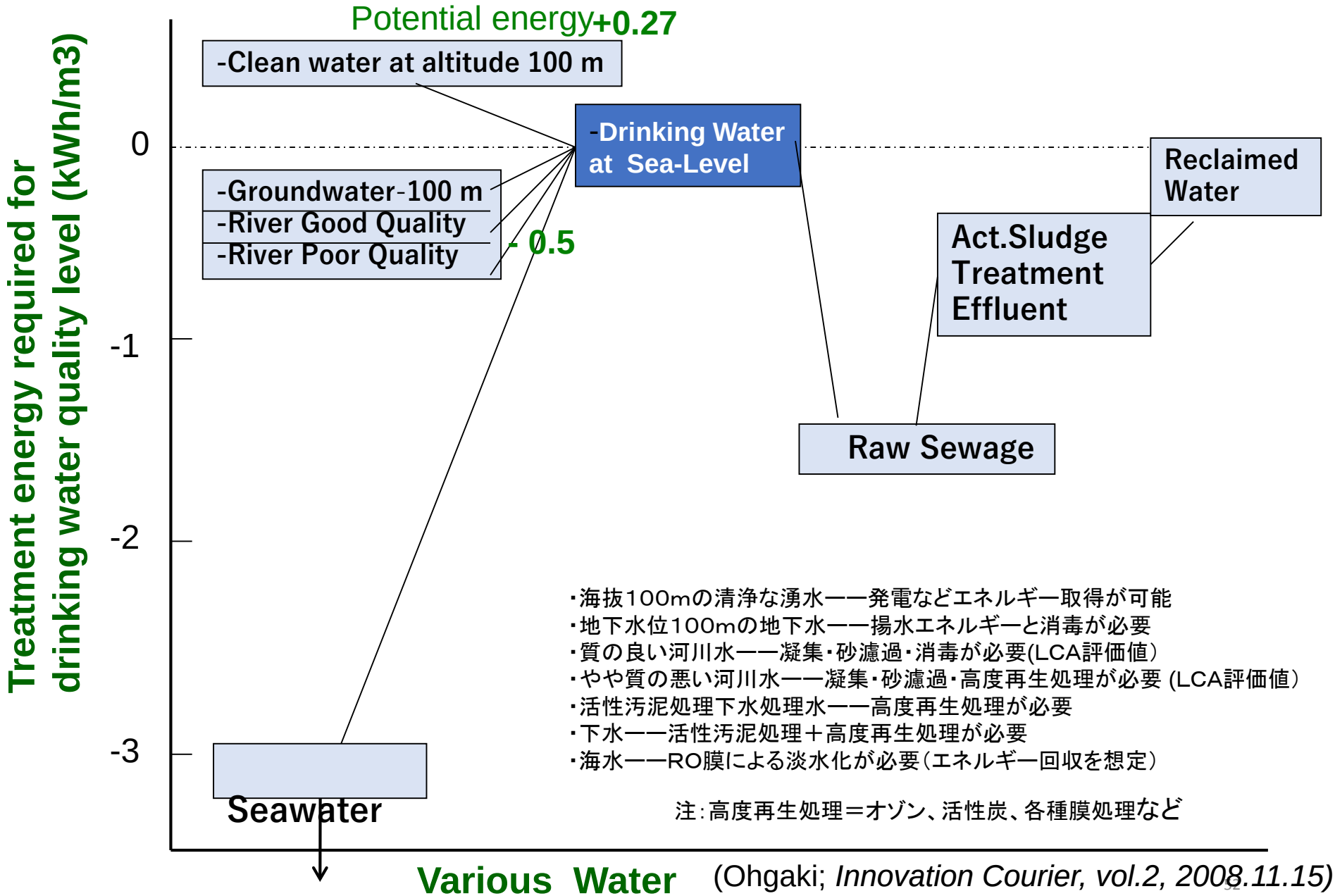
Condominium ----------*possible but not so popular*

Office/Commercial building

----regional recycle from Sewage Treatment Plants

----recycle inside in a big-building

Energy for Wastewater Reuse



・海抜100mの清浄な湧水――発電などエネルギー取得が可能
・地下水位100mの地下水――揚水エネルギーと消毒が必要
・質の良い河川水――凝集・砂濾過・消毒が必要(LCA評価値)
・やや質の悪い河川水――凝集・砂濾過・高度再生処理が必要 (LCA評価値)
・活性汚泥処理下水処理水――高度再生処理が必要
・下水――活性汚泥処理＋高度再生処理が必要
・海水――RO膜による淡水化が必要(エネルギー回収を想定)

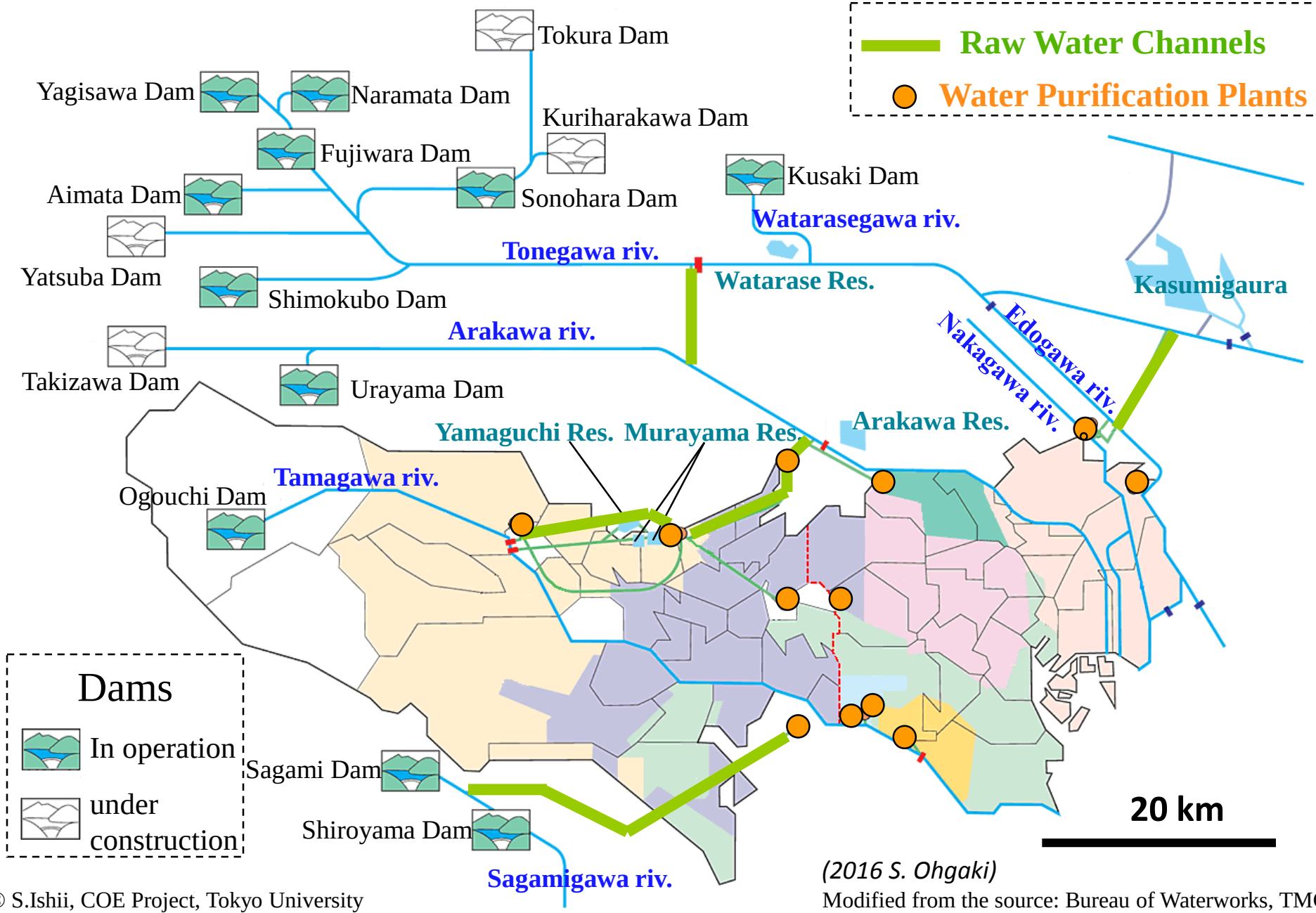
注:高度再生処理＝オゾン、活性炭、各種膜処理など

(Ohgaki; *Innovation Courier, vol.2, 2008.11.15)*

Measures against unpredictable changes
(earthquake, accidents,….)
for sustainable water supply

- ***Tokyo***
- ***Kobe City***

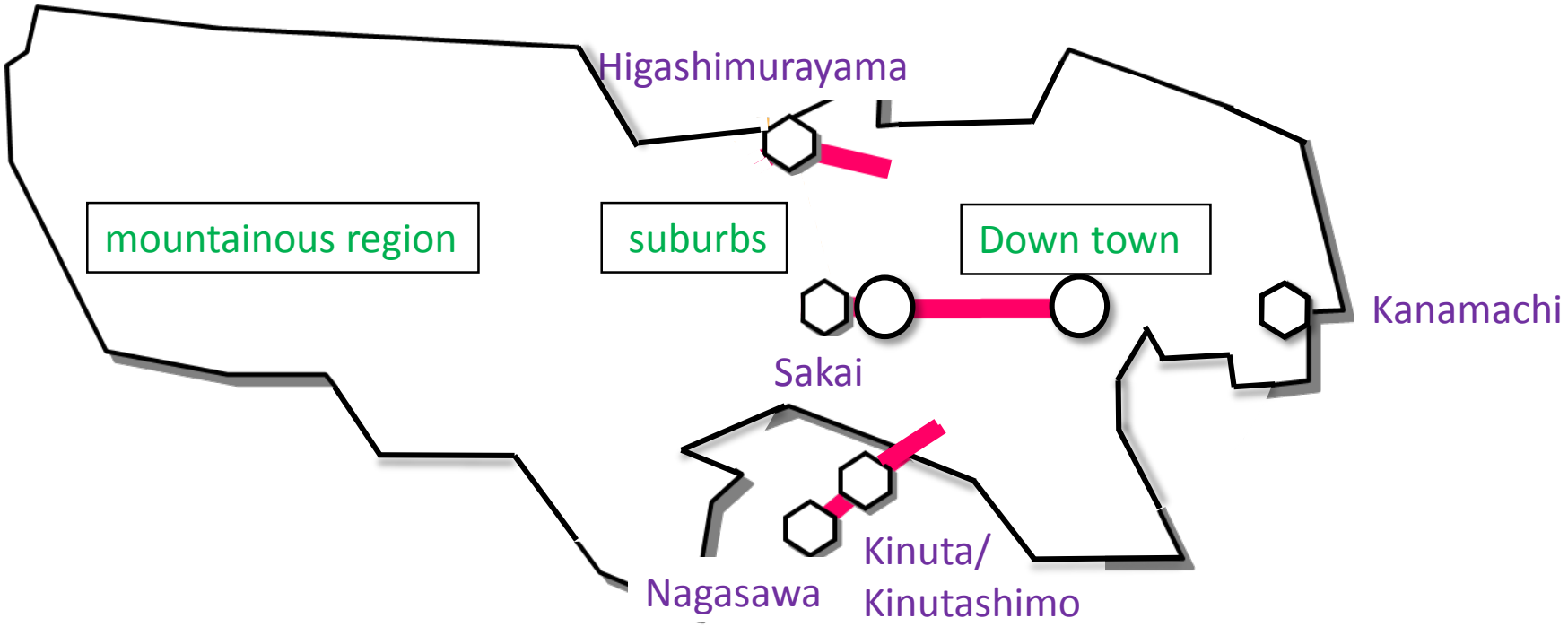
Water Supply Network in Tokyo



(2016 S. Ohgaki)

Modified from the source: Bureau of Waterworks, TMG

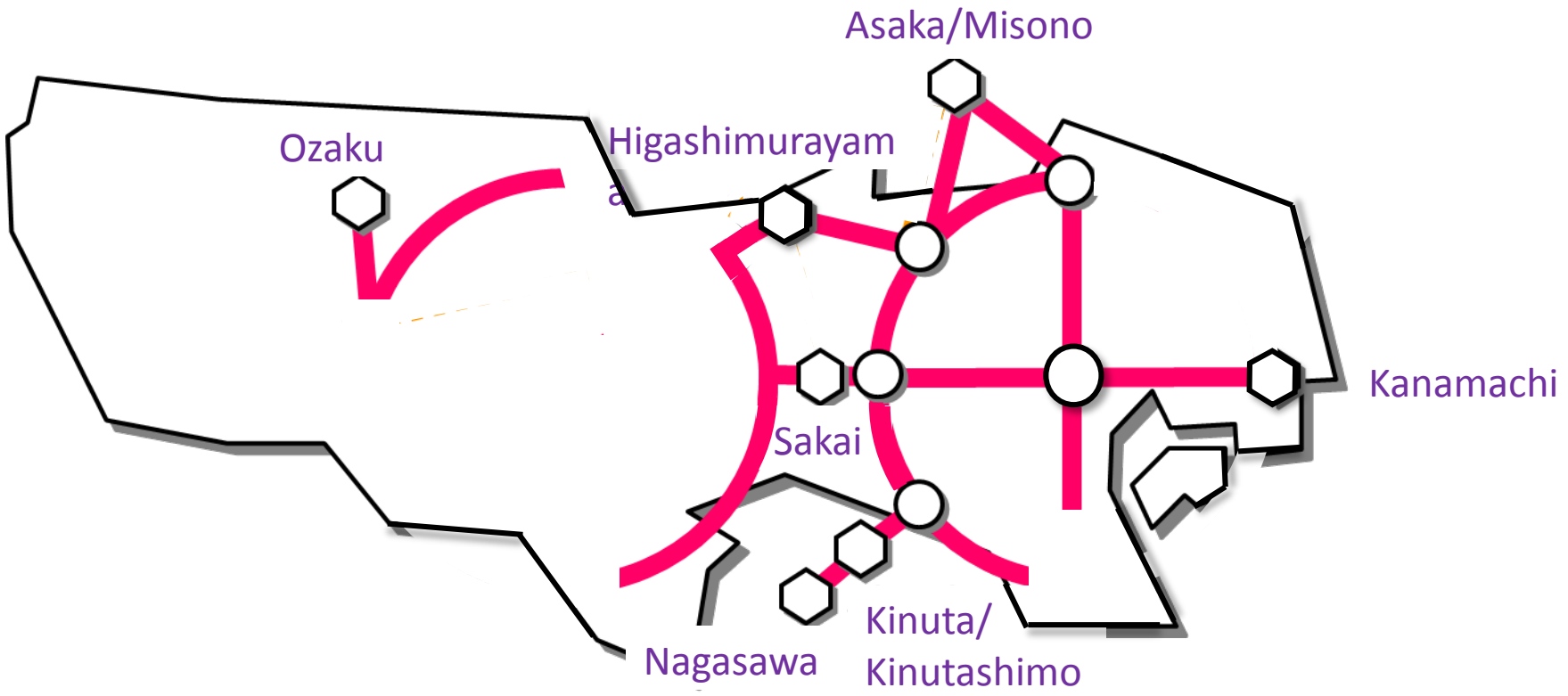
Re-Networking of Transmission Mains for Security and Rehabilitation in Drinking Water Distribution (around ϕ 1800 mm)



1960

(by courtesy of Sasaki, JWRC)

(2016 S. Ohgaki)



Purification plant

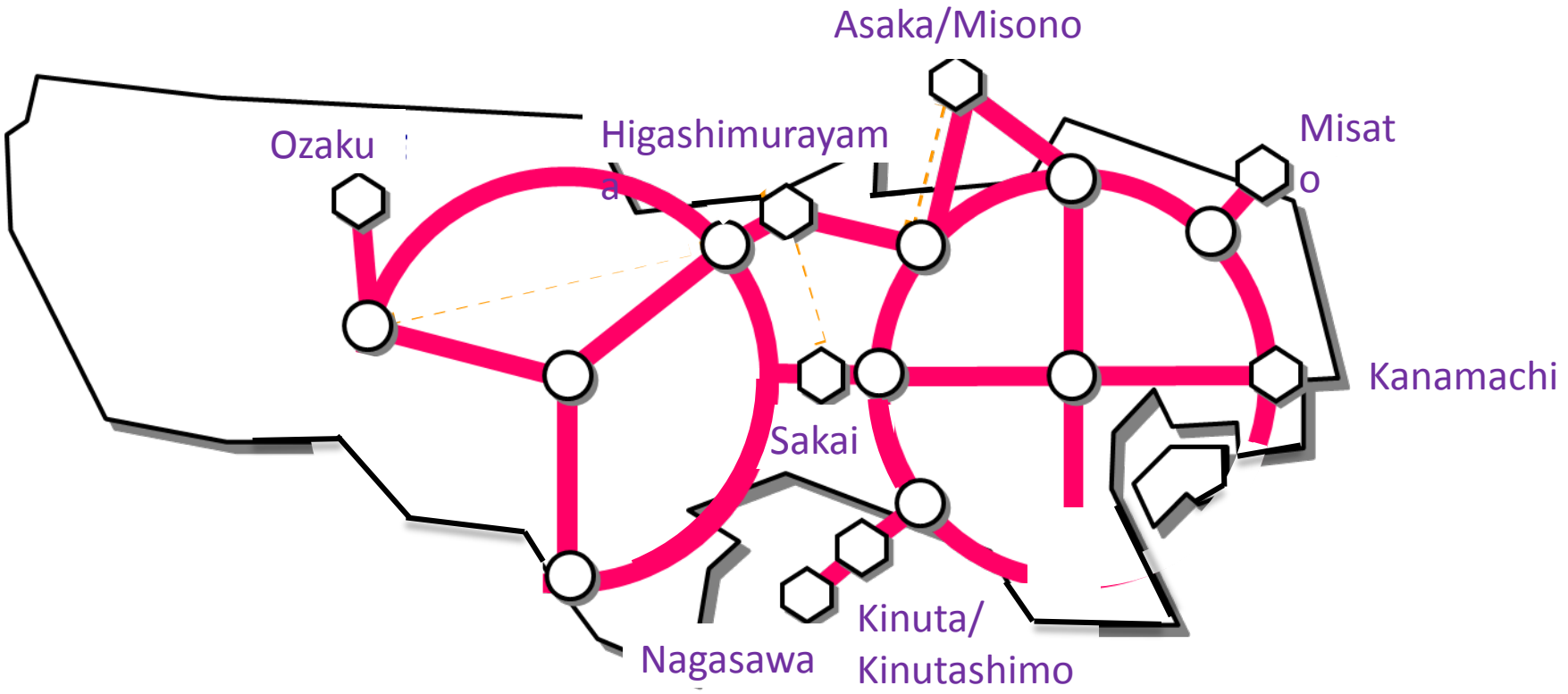
Water distribution station

Transmission main

1980

(by courtesy of Sasaki, JWRC)

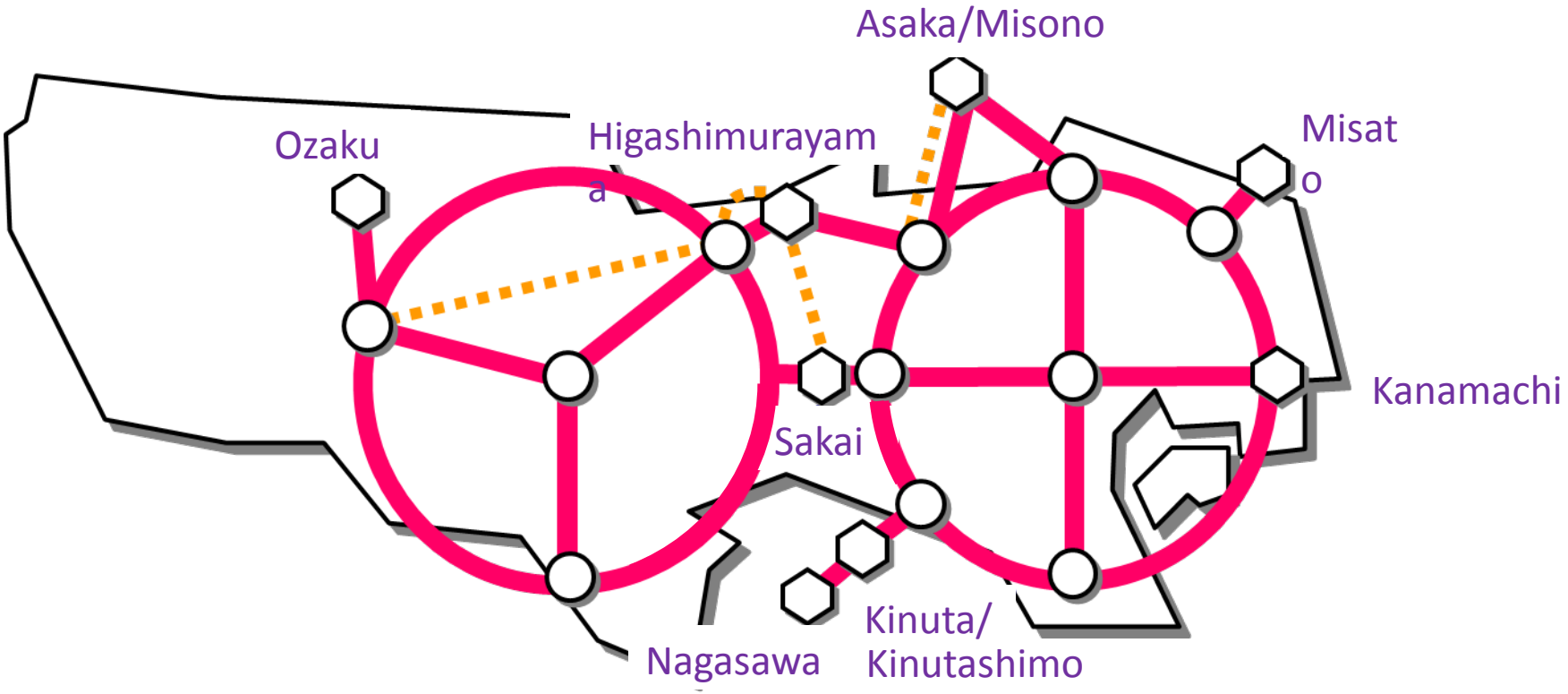
(2016 S. Ohgaki)



2000

(by courtesy of Sasaki, JWRC)

(2016 S. Ohgaki)



2015 (55 years after from 1960)

(by courtesy of Sasaki, JWRC)

(2016 S. Ohgaki)

Redundancy pipe network system for water supply in Kobe City

http://www.city.kobe.lg.jp/foreign/english/index.html

Third transmission main
(ϕ 2400 mm)
Kobe City

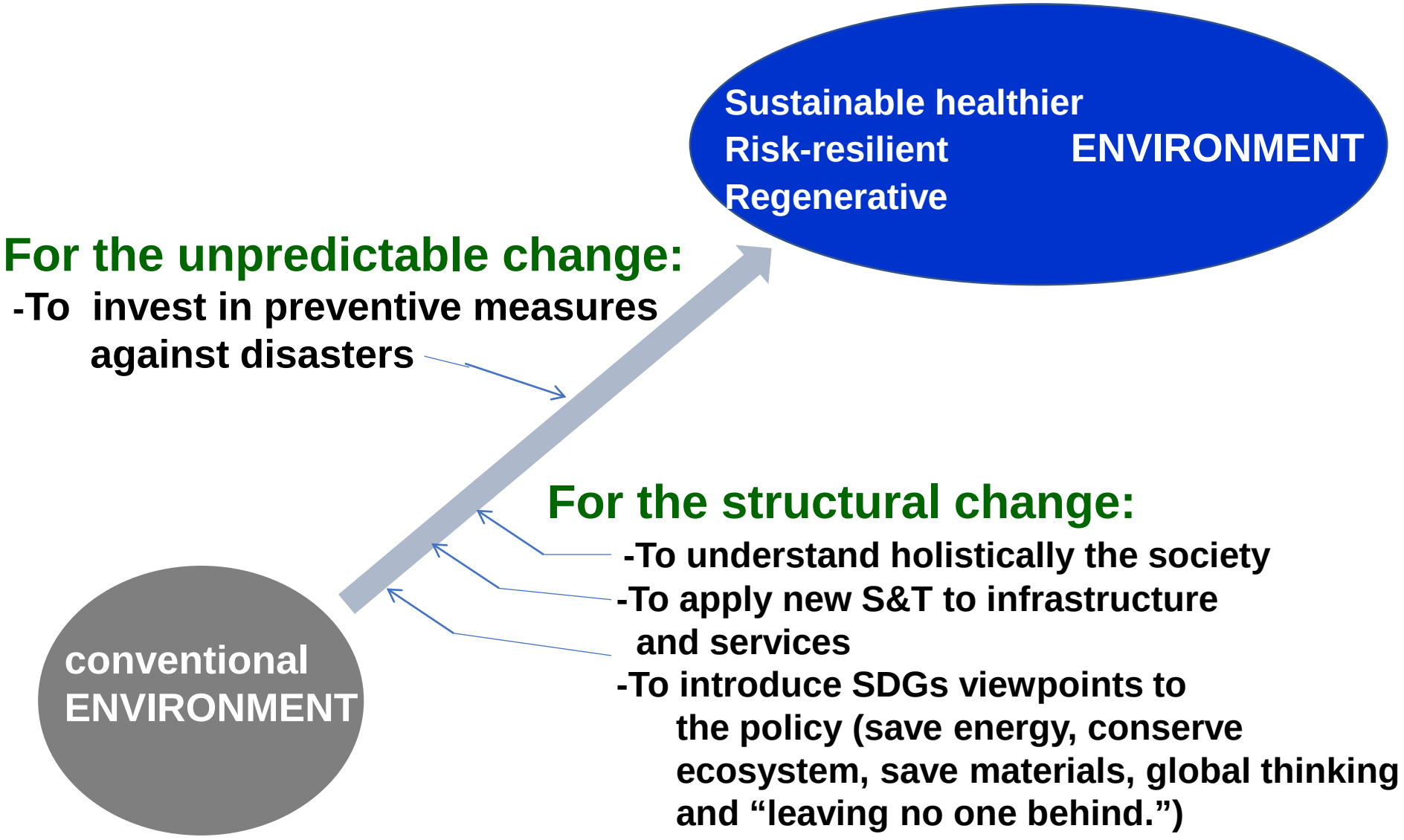
Over 60m depth

2km

(by courtesy of Mr. Matsushita, Kobe City)

(2016 S. Ohgaki)

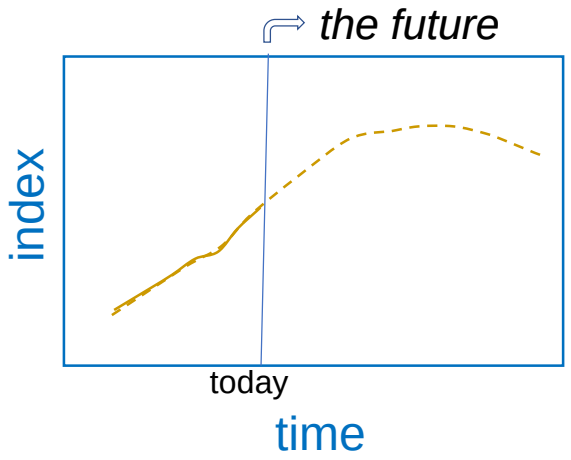
What we learn from these cases:



Structural Changes = long term phenomena

We need long term observation or historical evidence.

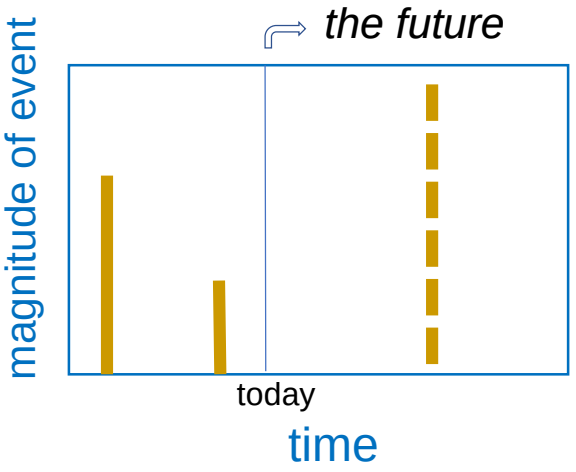
To learn historical experience
from other countries or regions



Unpredictable Changes = rare occurrence

No one country has frequent experience

To learn globally from experiences
in other regions



To deal with global issues like SDGs in an uncertain world,

we need to:

- ***learn** not only from indigenous events of individual countries but **from events of wider regions**.*
- *have **a holistic understanding** of society.*
- *have **a long-term perspective** beyond SDGs-2030 because construction of the actual social infrastructure takes time.*
- ***incorporate various science & technology** including new fundamental technology, ICT, bioengineering and others into practice without delay.*

For this purpose, ….

For this purpose, communication and cooperation between professionals is indispensable.

One mechanism to enable that is the international knowledge & information exchange like this forum.

ကျေးဇူးတင်ပါတယ်

Thank you for your attention