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世界交通学会前会長

# Transforming Asia through Smart Cities and Sustainable Urban Development: Towards New Normal Mobility

**UNCRD Training Workshop on Smart Cities**

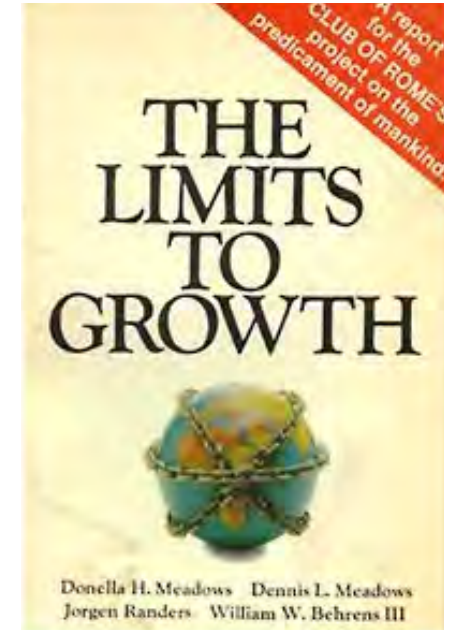
**28 August 2023, Nagoya**



Lessons from “The Limits to Growth”

# 1<sup>st</sup> Club of Rome Report 1972

## “The Limits to Growth” (3 million seller)

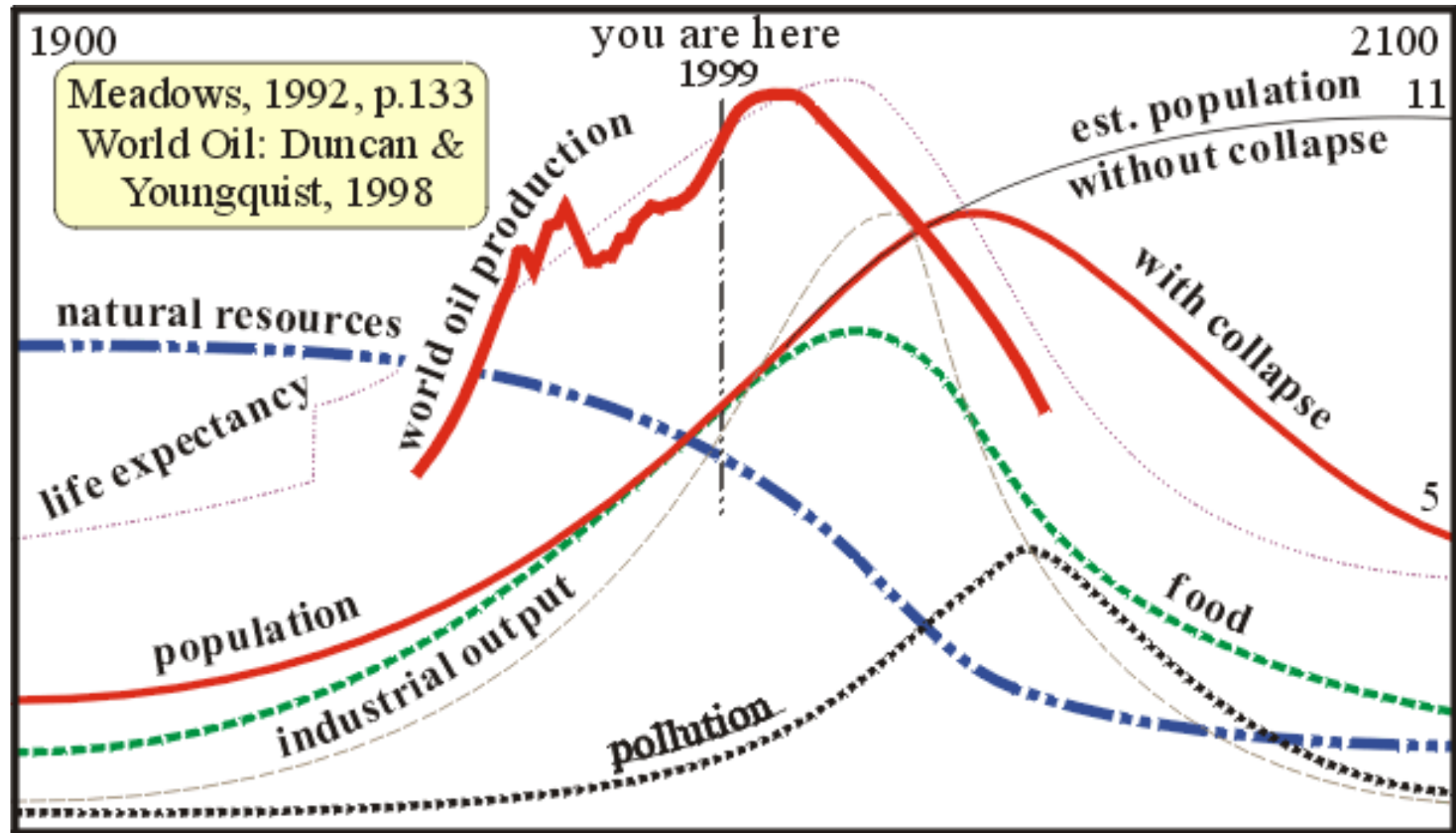


**Jorgen Randers, J. W. Forester, Donera Meadows, Denis Meadows, William Behrens**

**Source: [raunerlibrary.blogspot.com](http://raunerlibrary.blogspot.com)**

# The Limits to Growth (1972)

- A System Dynamics Simulation -



Source: [BEYOND THE LIMITS](#), Meadows, et al.;  
Chelsea Green Publishing Company, 1992. ISBN 0-930031-62-8.  
Phone: 800-639-4099 or 603-448-0317; FAX: 603-448-2576.

# Lessons from “The Limits to Growth”

## ➤ Club of Rome

- Established in 1968 by Aurelio Peccei (Vice-Chair of Olivetti & Exec. of FIAT)
- 100 full members, operated by 12 Executive Committee members

## ➤ “The Limit to Growth (1972): Club of Rome 1<sup>st</sup> report

### Lesson from “daily doubling Water Lotus”

- Today may be “The Last Day to Recover” → *“Resilience”*

## ➤ Origin of SDGs

- Saburo Okita, CoR member proposed to United Nations to establish WCED (World Commission of Environment and Development=Brundtland Com.)
- Report “Our Common Future (1987)” → *“Sustainable Development”*
- “Erath Charter” (2000)
- “SDGs” (2015)

# The Limits to Growth in “Mobility”

# Extreme Life in a City of “8hrs Commuting a Day” - Bangkok 1993 -



A School Boy waiting for Bus at 20km Suburb at 4:30 am (1993)

Extracted by Hayashi from “Bangkok Post 4 Sept 1993”

# Understanding "The Limits to Motorization" along Economic Development Stages

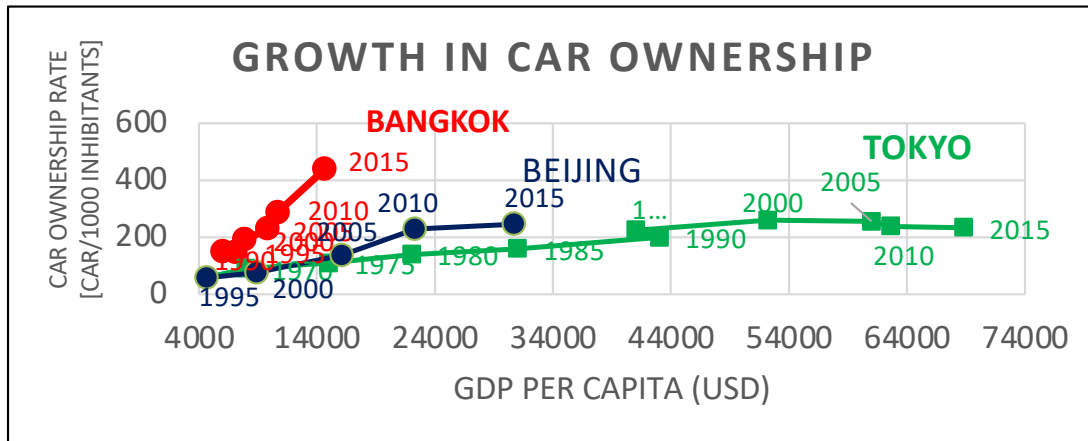


Photo by Hayashi(1993)

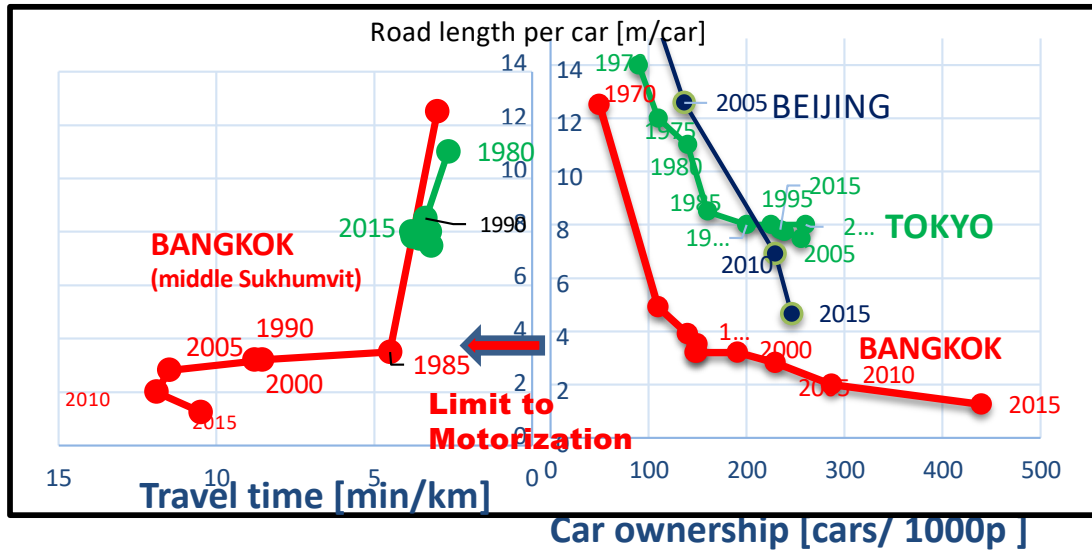


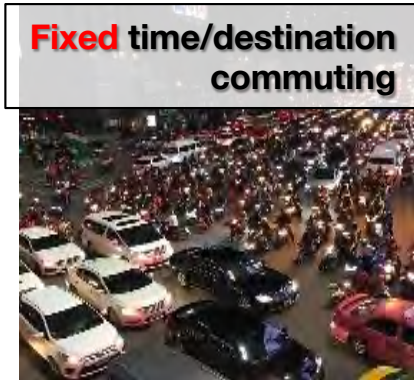
Photo by Hayashi(2018)



# Mobility Transformation

- Emergence from 20 Century's Stupid Habits -

20<sup>th</sup> century **Stupid Mobility** → for **Mass Economy** with **High Carbon**



21<sup>st</sup> century **Smart Mobility** → for **People** with **High QOL/Low Carbon**

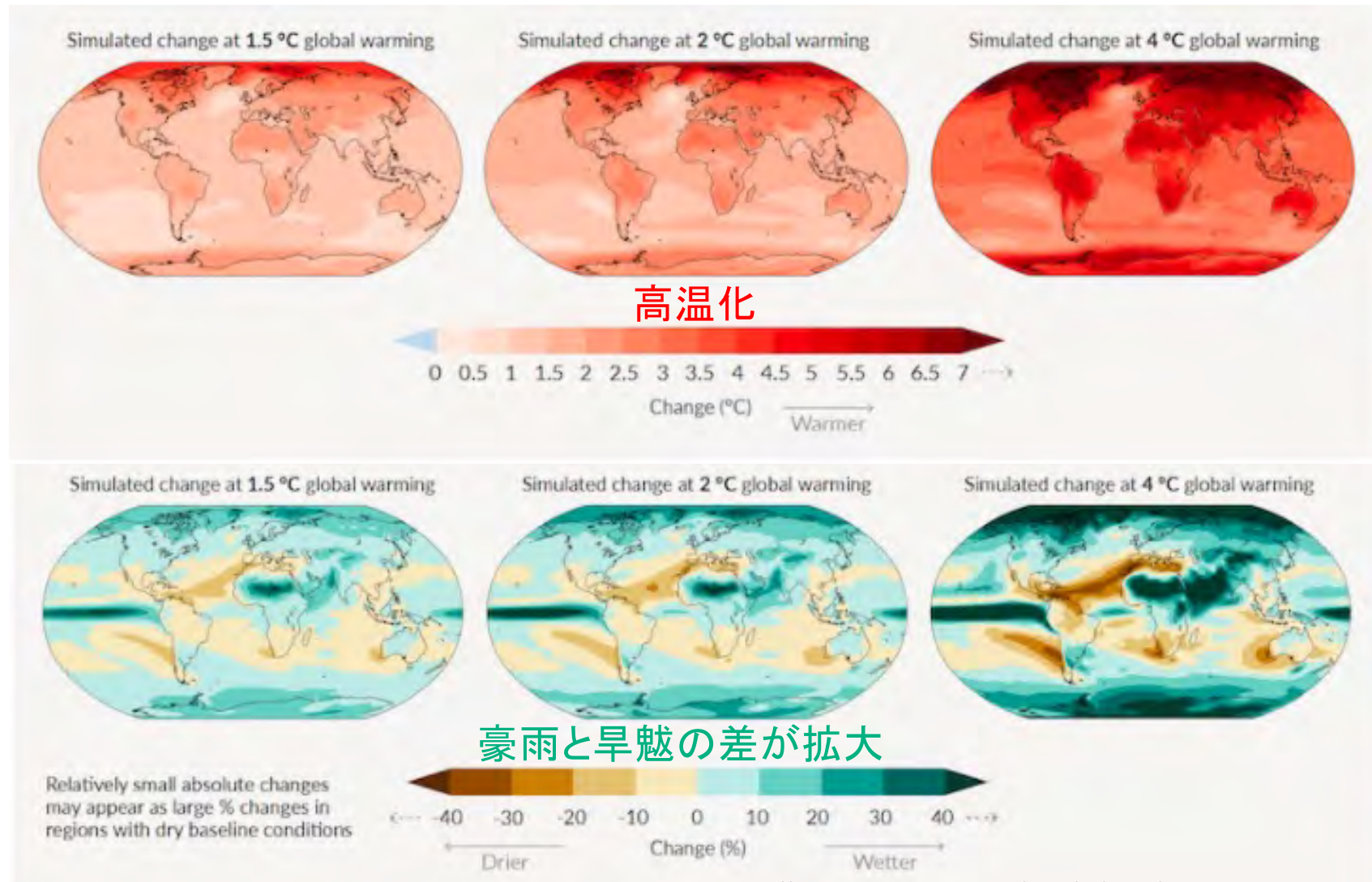
# Damages caused by Mobility (World, Thailand)

## - Effects on Mortality, Health & Well-Being -



# Carbon Neutral

# Change in Temperature resulting in damages as Heat Wave, Heavy Rainfall, Drought

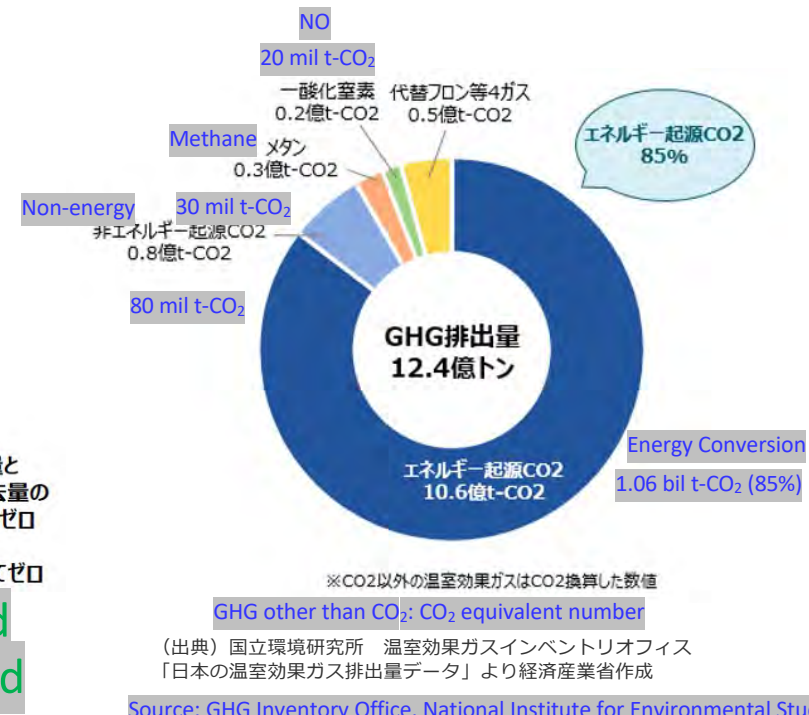
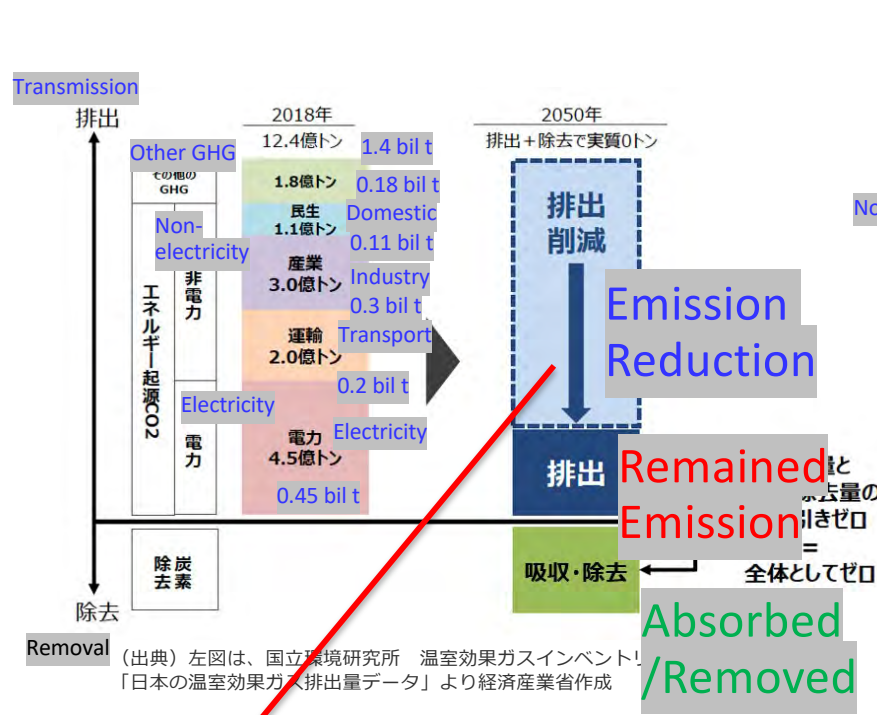


# Paris Agreement (← IPCC 5<sup>th</sup> report)

– Difference in damages between 1.5 °C and 2.0 °C rise –

	1.5°C	2°C	2°C/1.5°C
Population hit by serious heat-wave at least once 5 years	14%	37%	2.6 times
Summer without Ice in the North Pole	at least once in 100 years	at least once in 10 years	10 times
Sea level rise by 2100	0.40 meters	0.46 meters	0.06 meters rise
Land area is changed to a New Biotic Formation (BIOM)	7%	13%	1.86 times
Crop reduction of Corn in Tropical zones	3%	7%	2.3 times
Coral reef further reduction	70–90%	99%	29%+ worsen
Reduction in marine fisheries	1.5 mil-ton	3 mil-ton	2 times

# Can Japan achieve 2050 Carbon Neutral ?



- 80% (2050/2020) → - 42% (2030/2020) → Keeping -5.23%/yr for 30 yrs Possible ?

c.f.) - 8%/yr (2019→2020) under City Lockdown, Stopping Air transport

Strategy of “Mobility”  
toward “Carbon Neutral”

# Policy/Technology Solution Options for De-Carbon & Anti-Pollution

(CUTE Matrix)








Strategies Means	AVOID	SHIFT	IMPROVE
Technologies	<ul style="list-style-type: none"> <li>• Transport oriented development (TOD)</li> <li>• <b>Poly-centric development</b></li> <li>• Efficient freight distribution</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Railways and BRT</b></li> <li>• Interchange improvement among railway, BRT, bus and para-transit modes</li> <li>• <b>Facilities for small mobility and pedestrians</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>HB,PHB</b> vehicle</li> <li>• <b>E-vehicle</b></li> <li>• <b>Fuel cell/Hydrogen</b> vehicle</li> <li>• Biomass fuel</li> <li>• Autonomous driving</li> <li>• "Smart grid" development</li> </ul>
Regulations	<ul style="list-style-type: none"> <li>• Land-use control</li> </ul>	<ul style="list-style-type: none"> <li>• Separation of bus/para-transit trunk and feeder routes</li> <li>• Local circulating service</li> <li>• Control on driving and parking</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Emissions standards</b></li> <li>• "Top-runner" approach</li> </ul>
Information	<ul style="list-style-type: none"> <li>• <b>Teleworking</b></li> <li>• Online shopping</li> <li>• Lifestyle change</li> </ul>	<ul style="list-style-type: none"> <li>• <b>MaaS</b></li> </ul>	<ul style="list-style-type: none"> <li>• "Eco-driving"</li> <li>• ITS traffic-flow management</li> <li>• Vehicle performance labeling</li> </ul>
Economy	<ul style="list-style-type: none"> <li>• Subsidies and taxation to location</li> </ul>	<ul style="list-style-type: none"> <li>• Park &amp; ride</li> <li>• Cooperative fare systems between modes</li> </ul>	<ul style="list-style-type: none"> <li>• Fuel tax/carbon tax</li> <li>• Subsidies and taxation to low-emissions vehicles</li> </ul>

Hideo Nakamura, Yoshitsugu Hayashi and Anthony D. May eds (2004)

Urban Transport and The Environment – An International Perspective, Elsevier



# Goals for new Car Sales

	目標年度	目標	FCV	EV	PHEV	HEV	ICE
日本 	2030	HV : 30~40% EV・PHV : 20~30% FCV : ~3%	~3%	20-30%		30~40%	30~50%
	2035	電動車(EV/PHV/FCV/HV) 100%	100%				
EU 	2035	EV・FCV : 100% (注) 欧州委員会提案	100%		対象外		Not allowed
米国 	2030	EV・PHV・FCV : 50%		50%		50%	
中国 	2025	EV・PHV・FCV : 20%		20%			
	2035	HEV50% EV・PHV・FCV : 50% (注) 自動車エンジニア学会発表		50%		50%	対象外 Not allowed
英国 	2030	ガソリン車 : 販売禁止 EV:50~70%		50-70%			対象外 Not allowed
	2035	EV・FCV : 100%	100%		対象外		Not allowed
フランス 	2040	内燃機関車 ; 販売禁止	100%		対象外		Not allowed
ドイツ 	2030	EV : ストック1500万台		ストック 1500万			

出典 : 公表情報を元に経済産業省作成

Stock:15mil cars

Stock:15mil cars

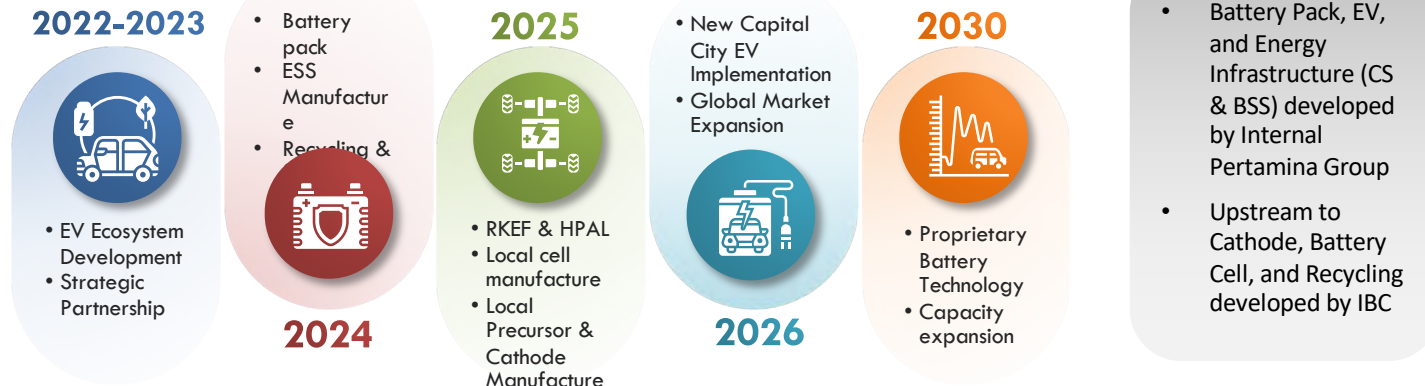
[https://www.enecho.meti.go.jp/about/special/johoteikyo/xev\\_2022now.html](https://www.enecho.meti.go.jp/about/special/johoteikyo/xev_2022now.html)

# Importance of Shift to EV but The Barriers

- EV shift is important for decarbonization of road transport that shares 50% of world Oil consumption, 170EJ (exajoule=10<sup>18</sup>J).
- Is EV the best solution?
- EV emit more emission till water, solar, wind electric generations will be dominant → From Well to Wheel Life-cycle Energy management
- 50% more total Electricity Demand if all vehicles are replaced by EV
- Can we build many more electricity generation, power storage and transmission systems?
- Competitor: Electricity demand for Data Center is estimated to be 100% more total electricity in 2030
- Waste of lithium-ion battery contains chemical and nuclear matters  
→ CO<sub>2</sub>/km Fuel Efficiency based Regulation + Top Runner System

# Development of EV Ecosystem

## Battery Business Roadmap



## Pertamina EV Ecosystem Initiative



Note: 14 BSS spread over 7 Pertamina gas stations to serve 500 E2W

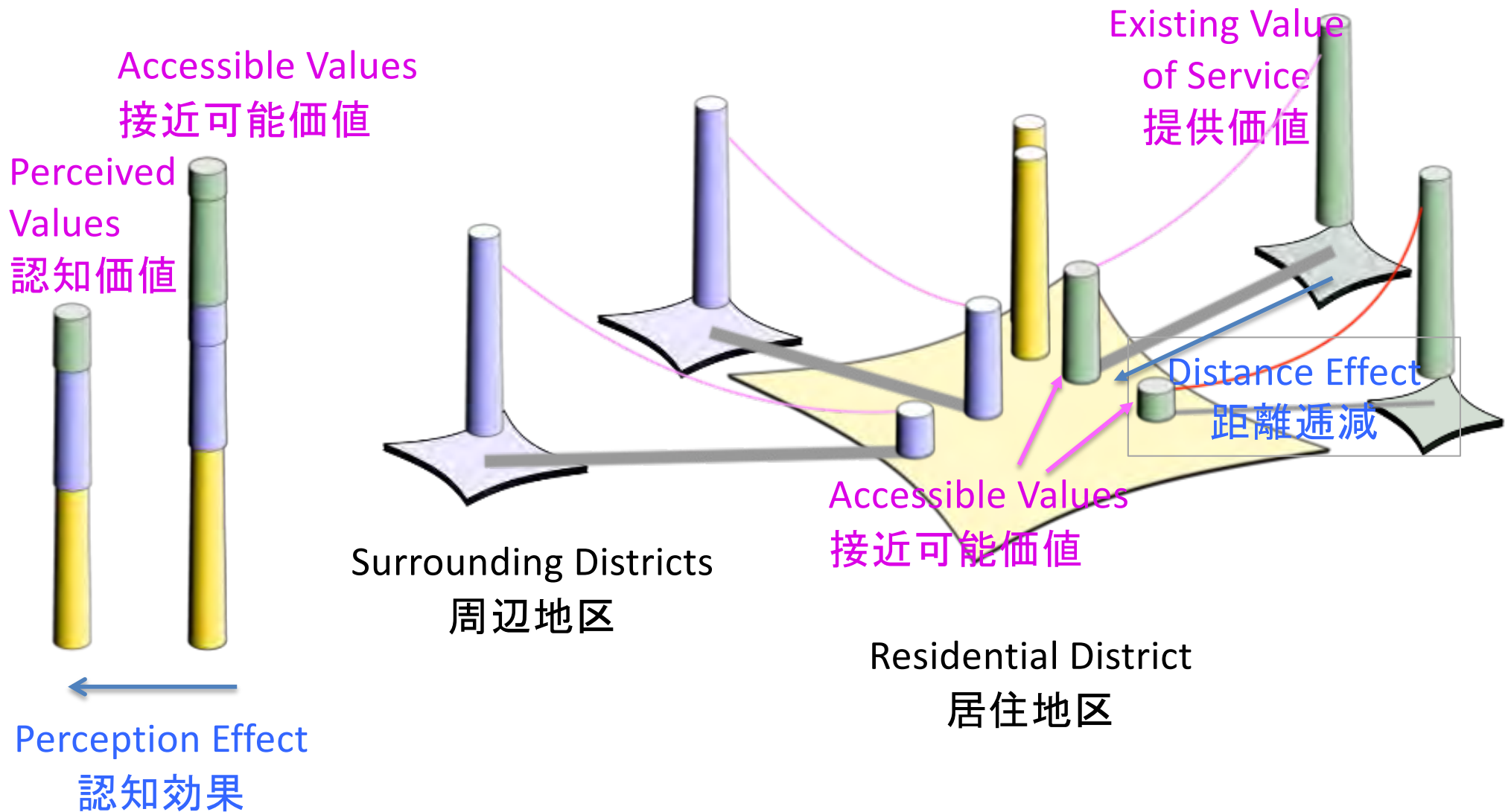
Courtesy by Andianto Hidayat (Pertamina, Indonesia)

Beyond Carbon Neutral  
– Wellbeing –

# QOL mainstreaming in Transport Planning

- From Mass Economic **Efficiency** to Individual's **Sufficiency**
- From **Cost-Benefit** Analysis to **QOL Accessibility Model (Hayashi model)**
  - by different Age, Gender, Income level
- Towards **SDGs: No one left behind**

# Hayashi's QOL Accessibility Model



# Hayashi's QOL Accessibility Model

## Accessible Value

$$A_{ij}^m = V_j^m \cdot e^{-\alpha c_{ij}}$$

- $m$ : QOL factor
- $i$ : Mesh block with residents living in
- $j$ : Mesh block with objective value of QOL factor  $m$
- $\alpha^m$ : Impedance parameter for traveling from mesh block  $i$  to mesh block  $j$
- $c_{ij}$ : Travel cost between mesh block  $i$  and mesh block  $j$
- $V_j^m$ : Existing value of QOL factor  $m$  exists in mesh block  $j$
- $A_{ij}^m$ : Accessible Value of  $V_j^m$  for residents living in mesh block  $i$ .

## Perceived Value

$$QOL_i^k = \sum W^{mk} A_{ij}^m$$

- $k$ : Population group  $k$  with certain social-economic attributes
- $W^{mk}$ : Weight of QOL factor  $m$  for person  $k$  among all factors
- $QOL_i^k$ : Perceived Value=Quality of life for person  $k$  living in mesh block  $i$

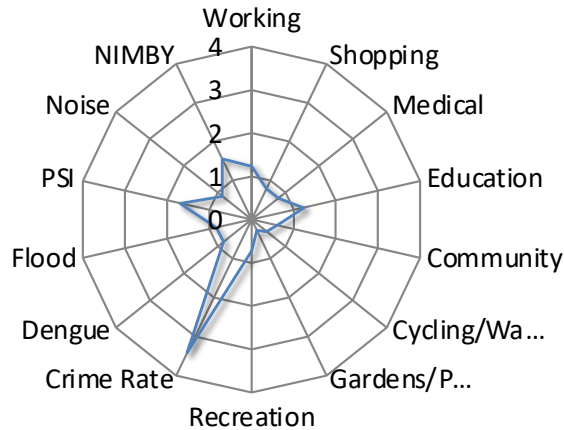
## Gross Regional Happiness

$$GRH^k = \sum_i P_i^k \cdot QOL_i^k$$

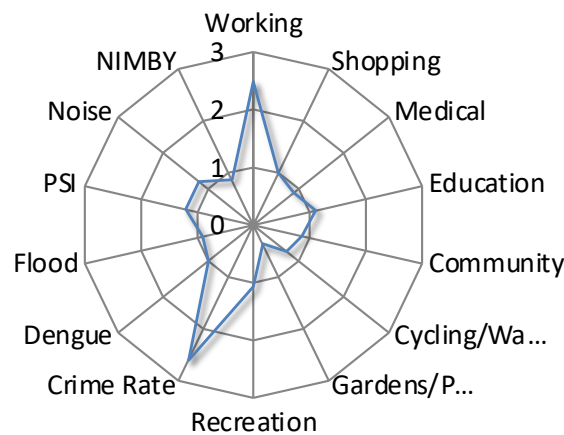
$$GRH = \sum_k GRH^k$$

# Weights between QoL Factors (Singapore)

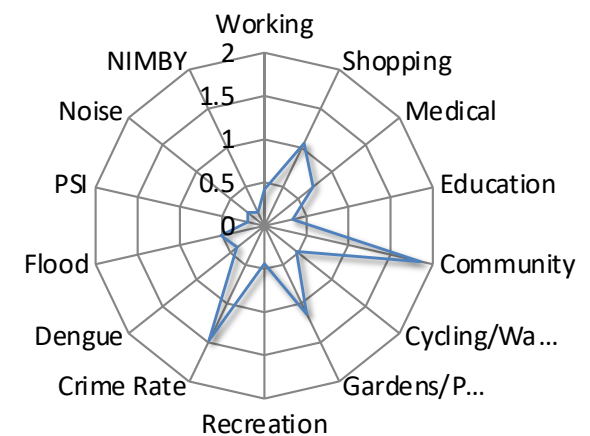
**Young / Female**



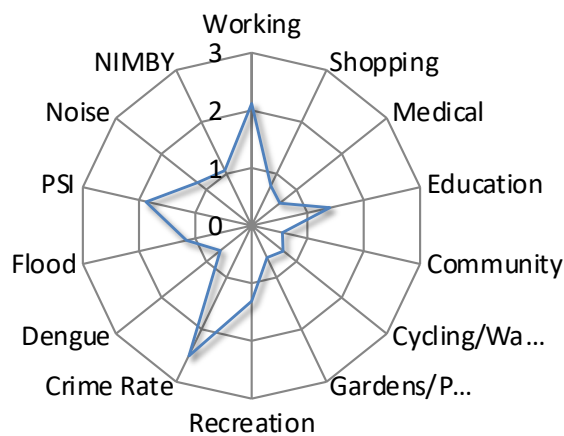
**Middle-aged / Female**



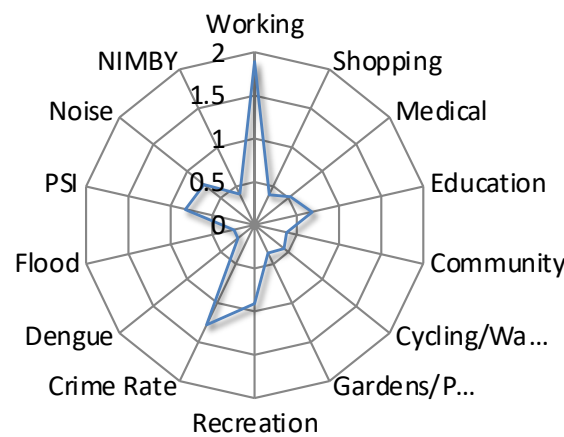
**Aged / Female**



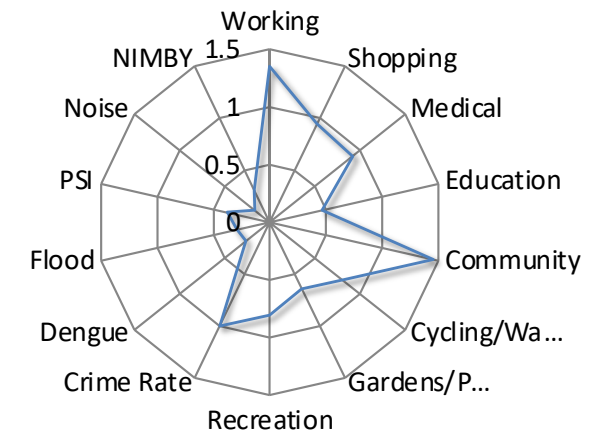
**Young / Male**



**Middle-aged / Male**

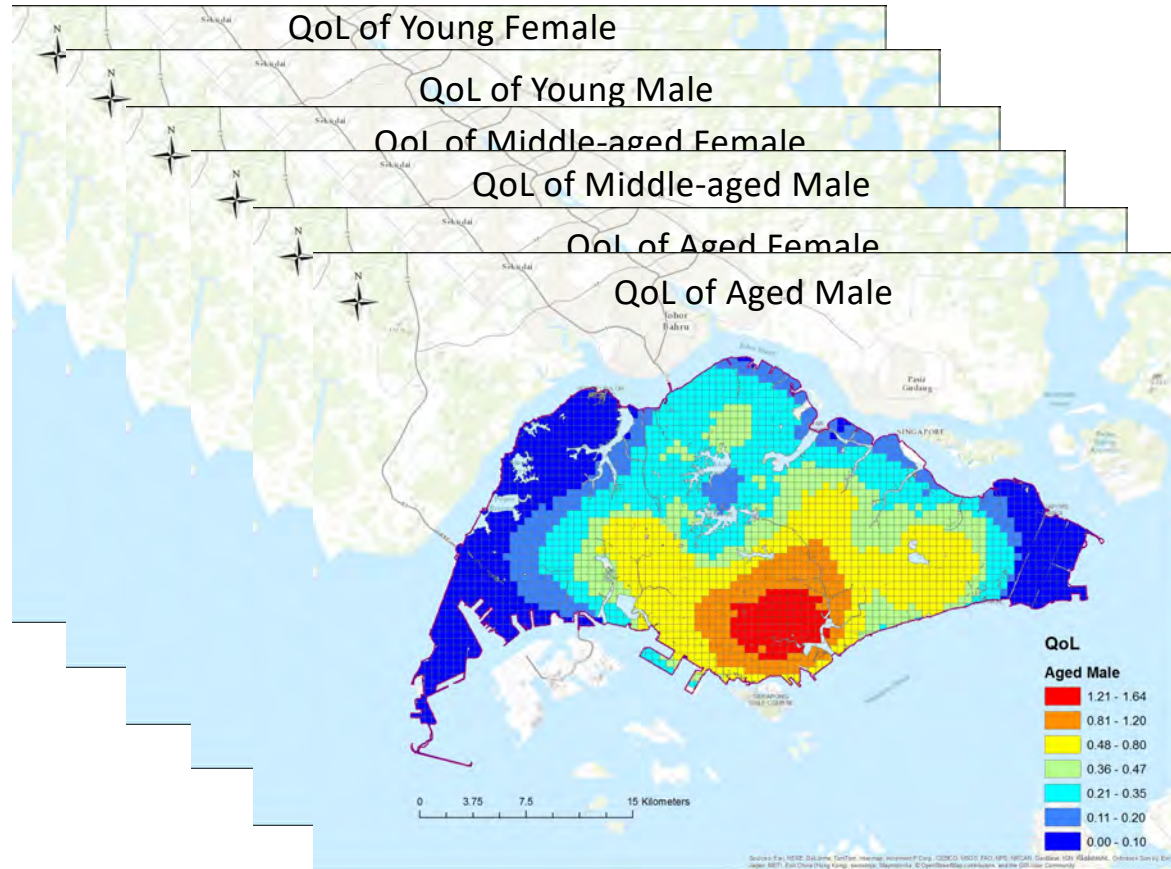


**Aged / Male**



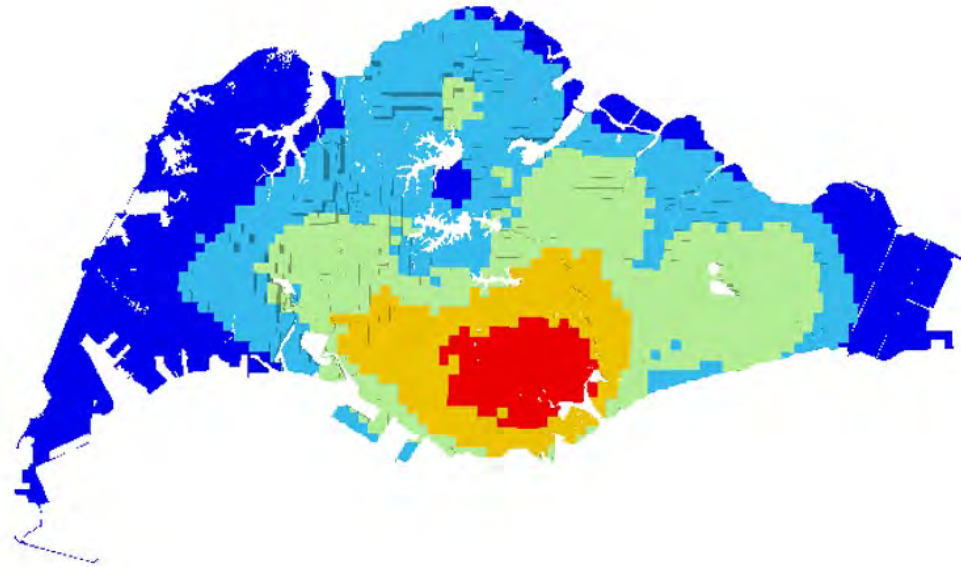


# QoL Spatial Distribution in Singapore (by age, gender)



# *Policy Options*

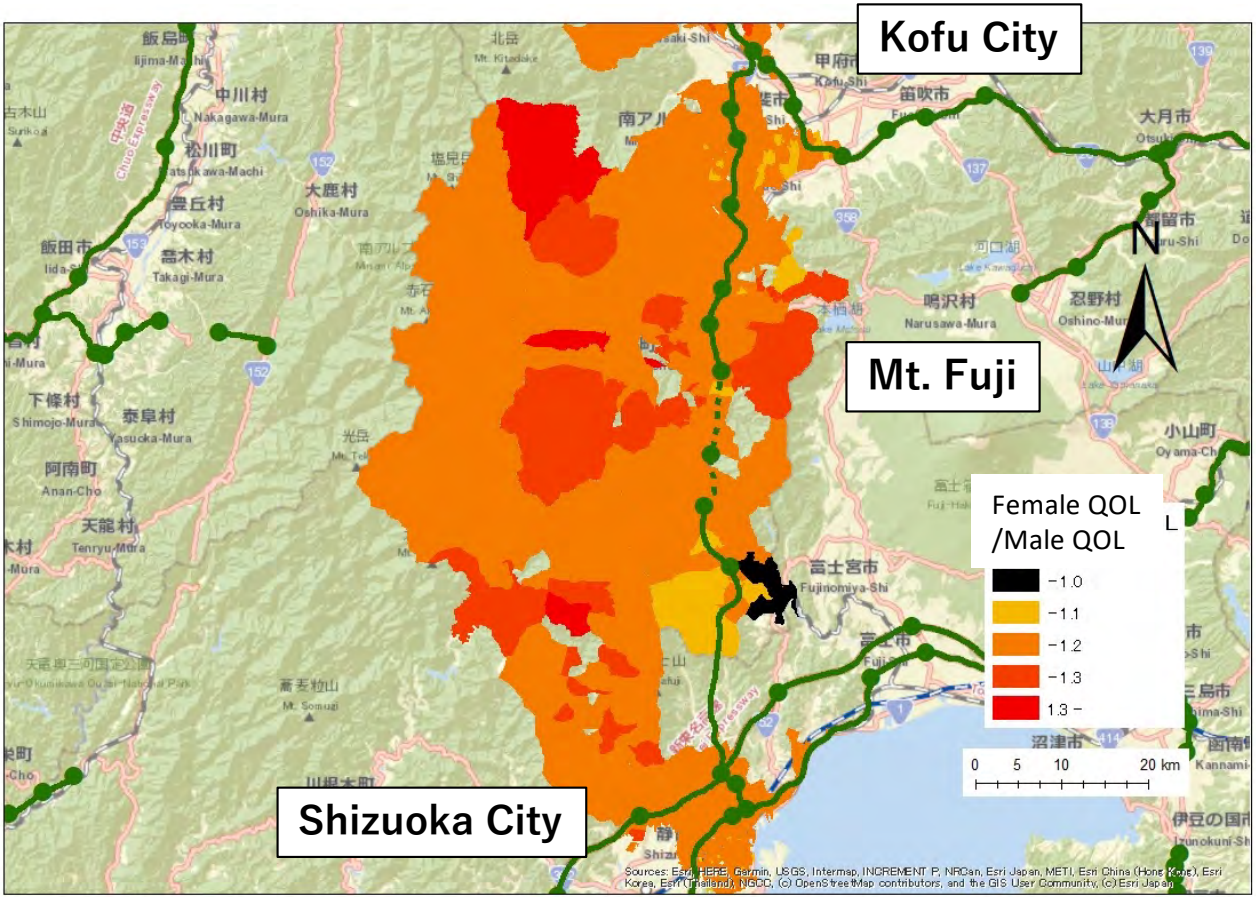
## *- Transport Network or Compact City -*



**Total Volume = GRH (Gross Regional Happiness)**

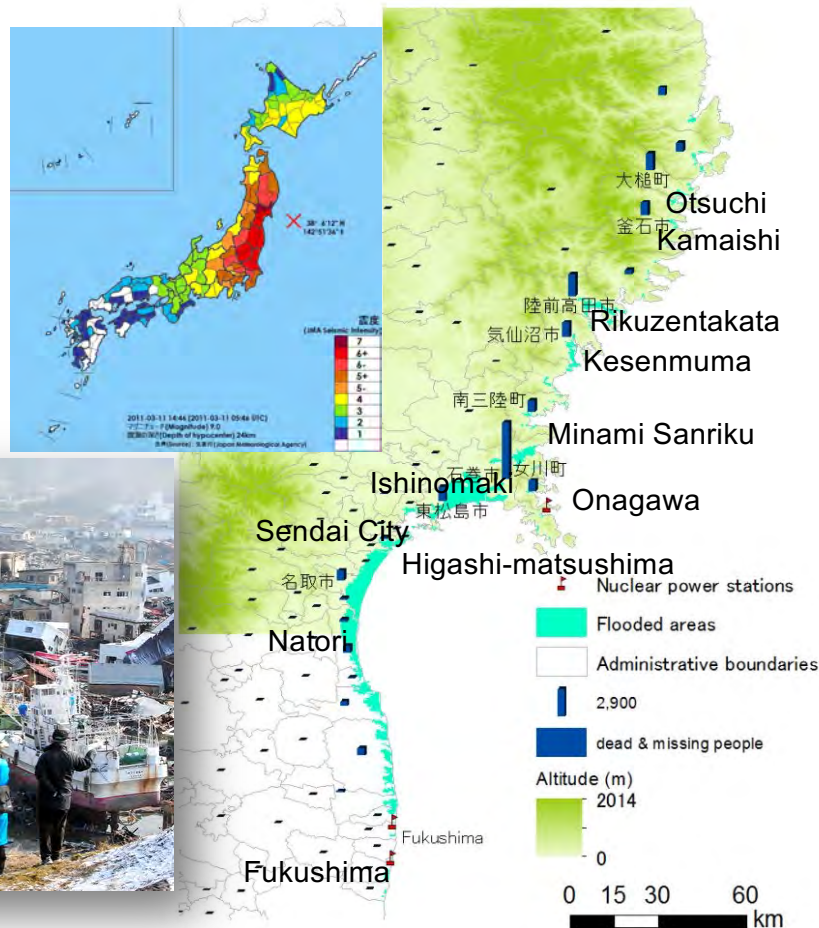
Source: Master Thesis of Yong Jian Khoo,  
supervised by Yoshitsugu Hayashi, Graduate School of Environmental Studies, Nagaya University, 2015

# QOL Comparison: Female / Male (Motorway Opening near Mt.Fuji, Japan)



**Resilience against  
Natural Disasters and Pandemics**

# Damages by The Great East Japan earthquake, 2011



Source : asahi.com

Time & Date	14:46 11/03/11
Magnitude	9.0
Earthquake type	Undersea mega-thrust
Death	14,907 (19/05/2011)
Missing	9,041
Injuries	4,799
evacuees	160,672
Tsunami area (km <sup>2</sup> )	561
Completely destroyed residential buildings	91,150

(Source: Ministry of Internal Affairs  
and Communications, Statistics  
department, Japan)

# Disaster Resilience

## 2011 Bangkok Flood Central Region and Industries Submerged for Months



**Duration: 149 days**

**Life Loss: 813 deaths**

**Economic Loss: 48,185 mil US\$**

**Elevated/Underground Rails are Resilient**

Courtesy by Varameth Vivhiensan

# Lack of Emergency Management

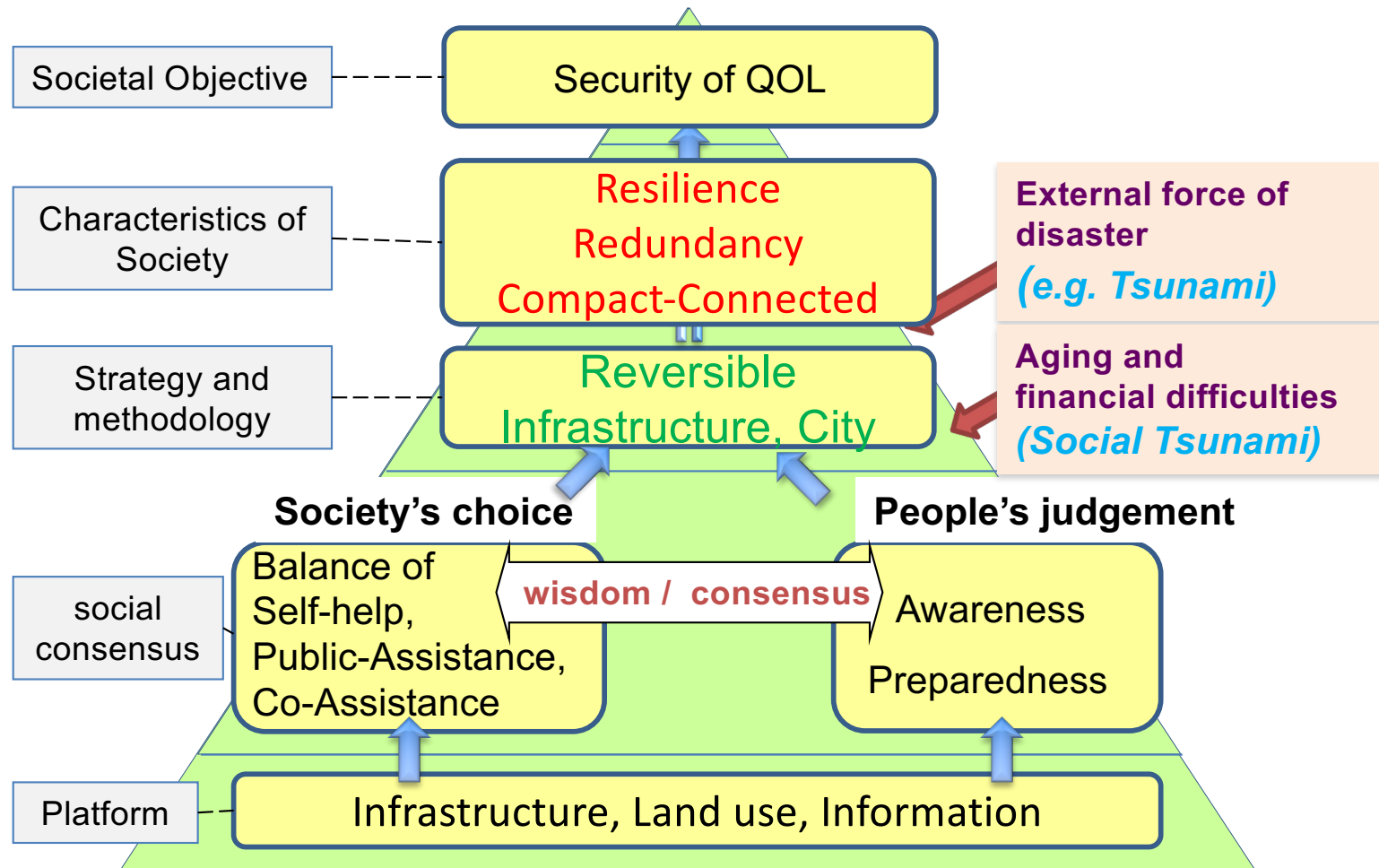
- Stuck in Traffic on Route 43 after Kobe Earthquake, 1995 -

Emergency Vehicles could not Move  
(Failure in Management)

Collapse as a result of  
Slender Pier Design  
for Better Landscape  
(Failure in Hardware)



# Resilient Cities and Communities

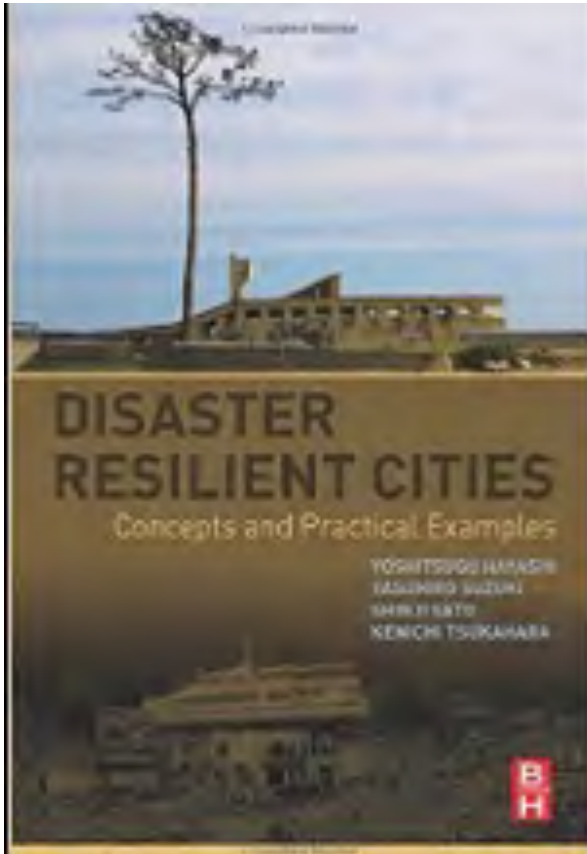




# Regeneration of Community Bonds (Shanghai)



# Books: Disaster Resilient Cities



Elsevier, 2016



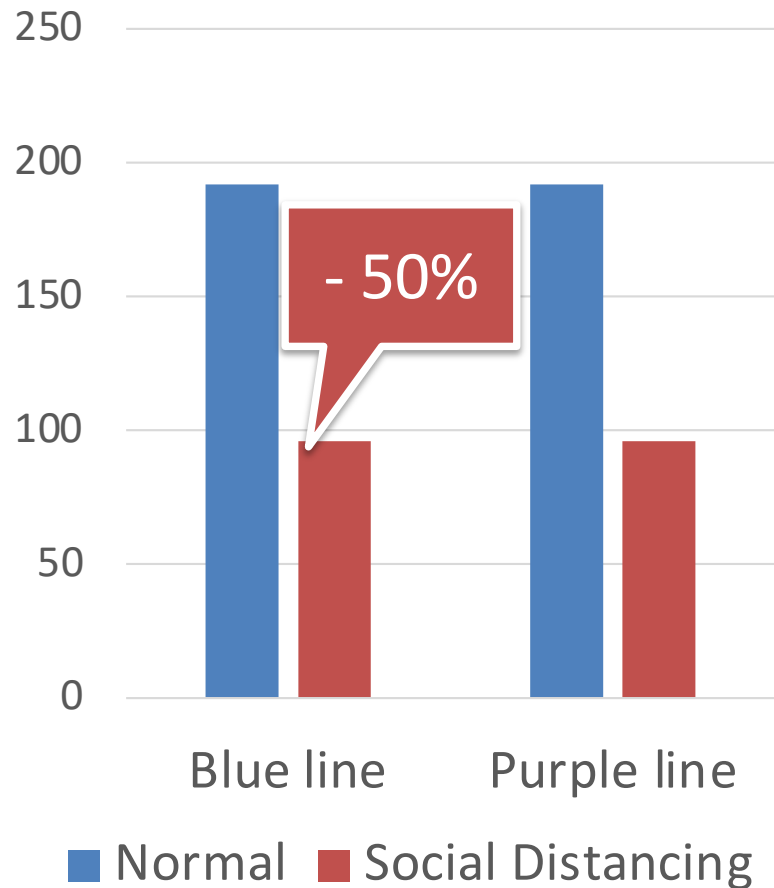
Akashi 明石書店, 2015



Tsinghua University Press, 2015

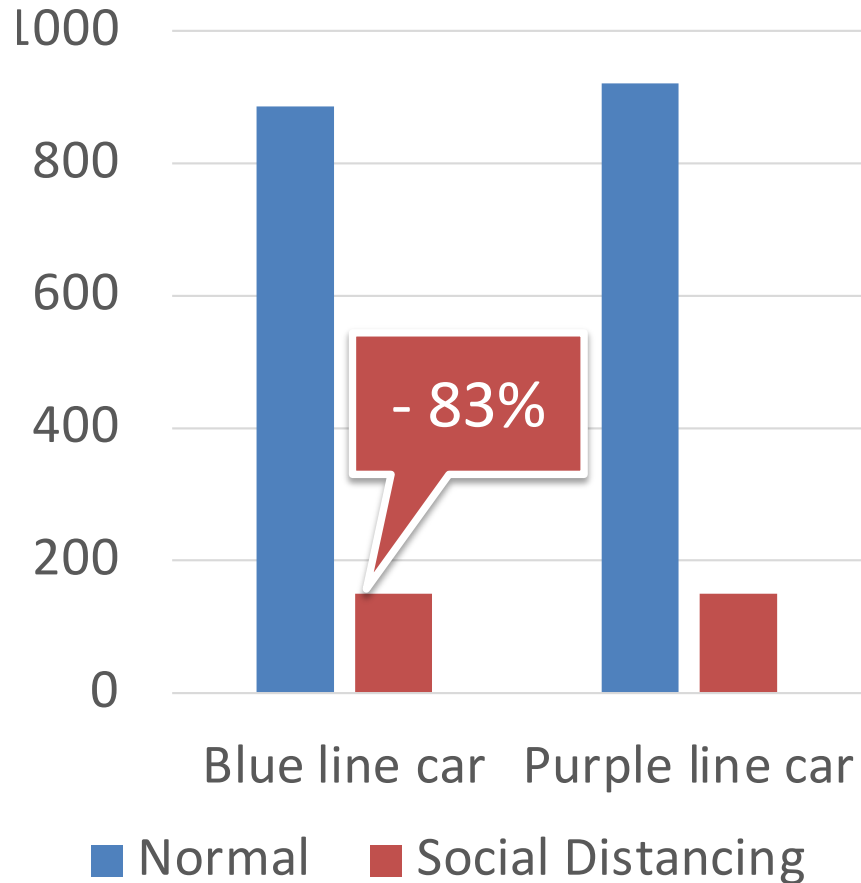
# Social Distancing

## Reduced Platform Capacity



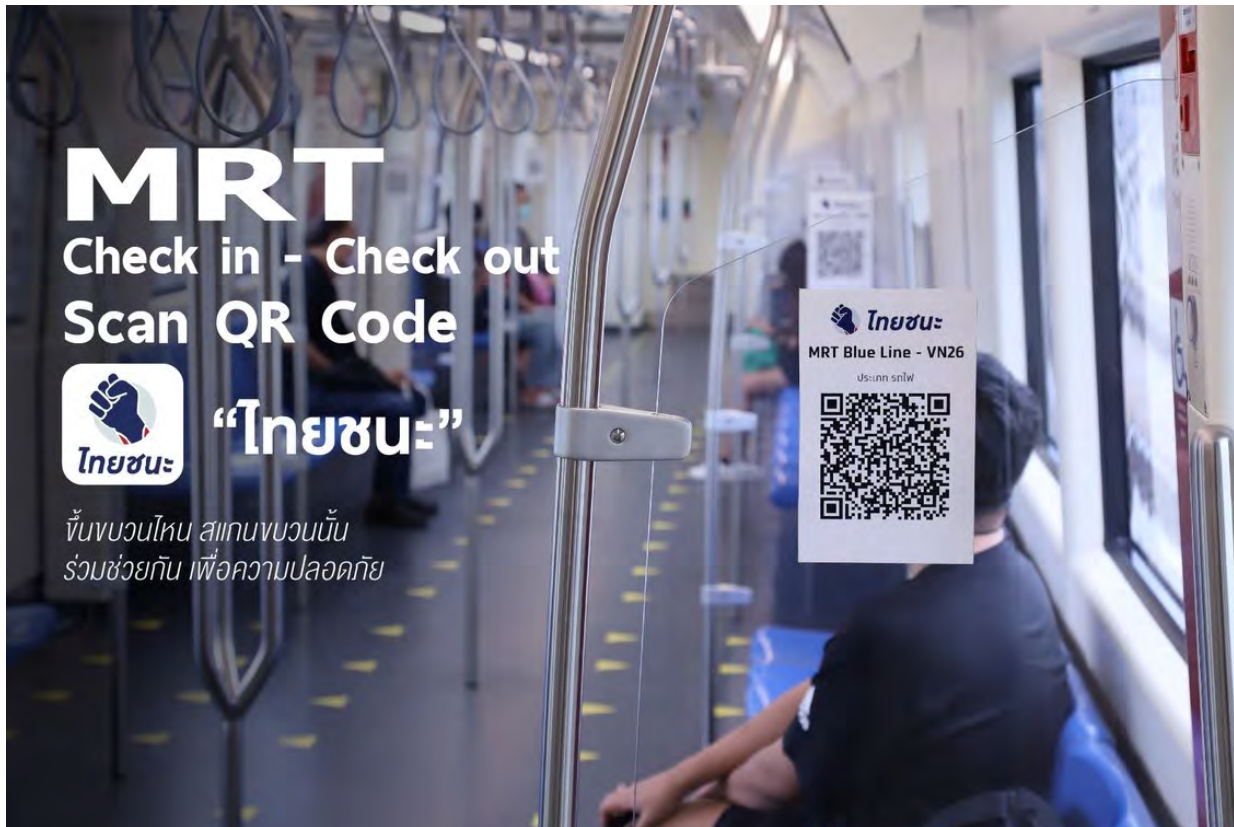
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# Social Distancing Reduced Train Capacity



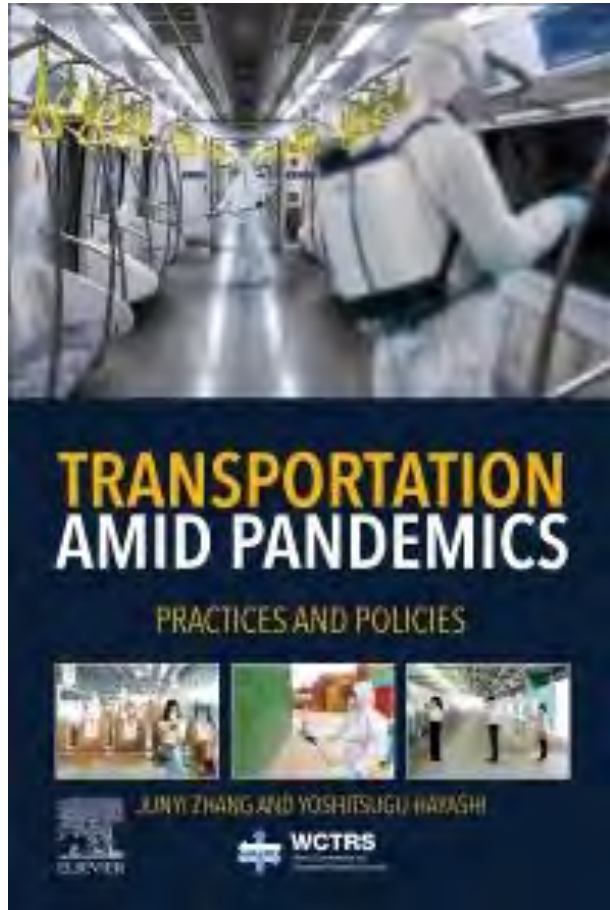
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# “Thais Win” Application



# Pandemic Resilience: Learning from COVID-19

## COVID-19 Handbook

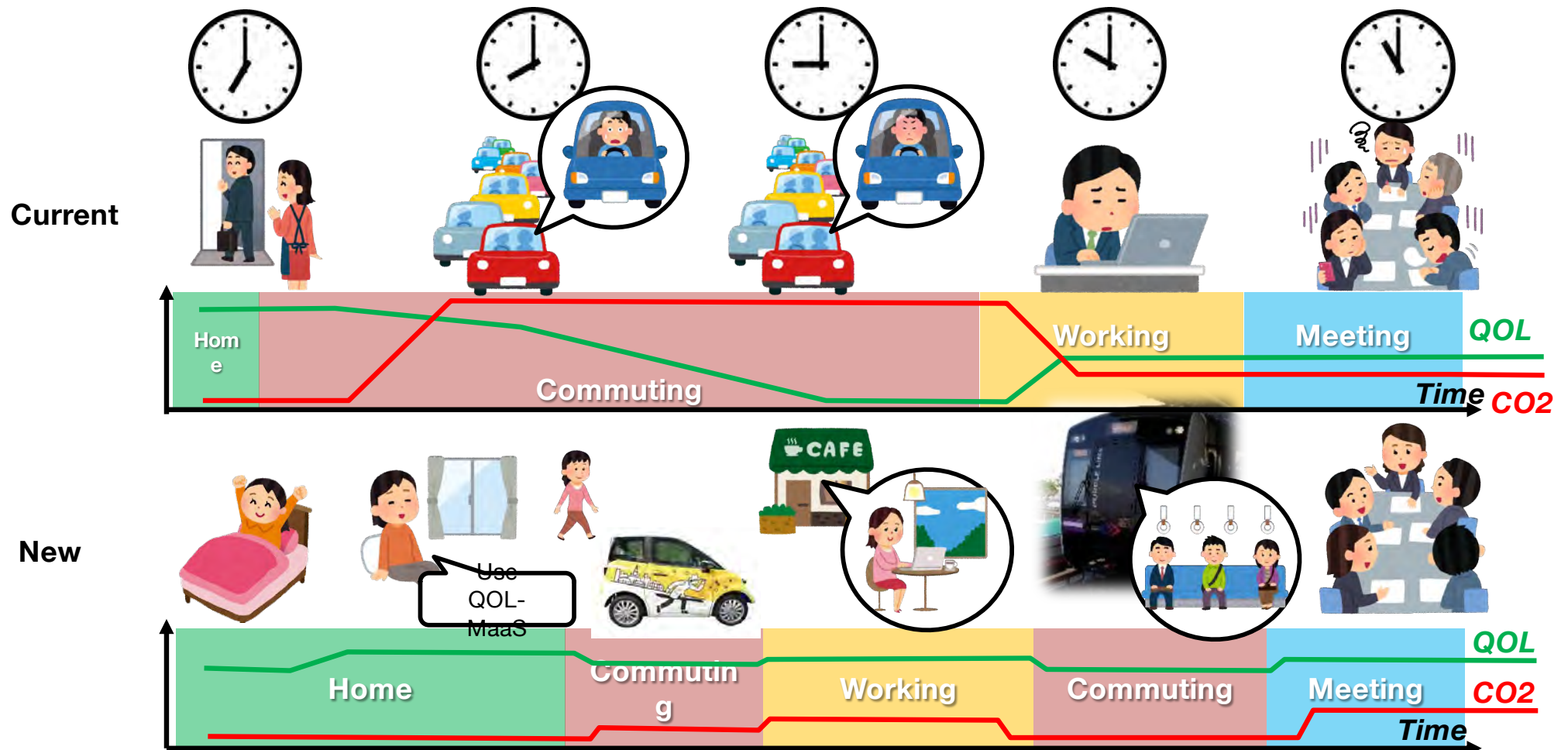


- **Lockdown** → **2 hr-City** life is **not resilient** in emergency
- People **trust** whole metropolitan society less and **local community** more
- Need for **last mile** convenient mobility
- Need **3<sup>rd</sup> place** for co-working
- Need for **accessibility to service facilities** such as hospitals, shops, etc.

**Junyi Zhang & Yoshitsugu Hayashi eds., WCTRS-Elsevier Book Series, 715 pages**

# Transforming Work–Life Style for New Normal

# QOL-MaaS: Work-Life Style Changer for 21<sup>st</sup> Century

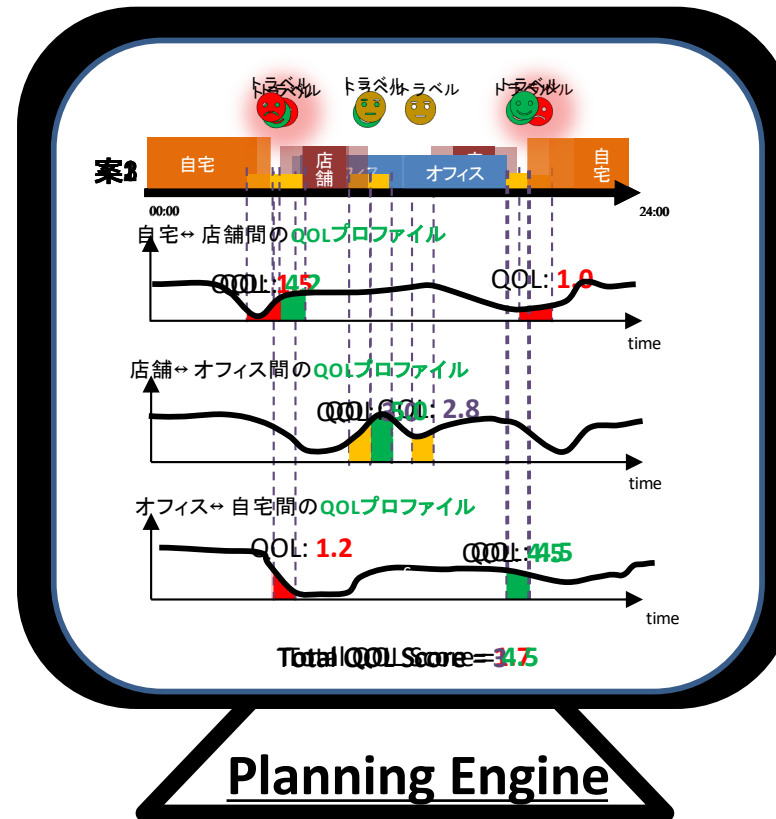


From JICA/JST SATREPS Project 2018-2024 "Smart Transport for Thailand 4.0" (Leader: Yoshitsugu Hayashi)



# DX → “QOL MaaS”

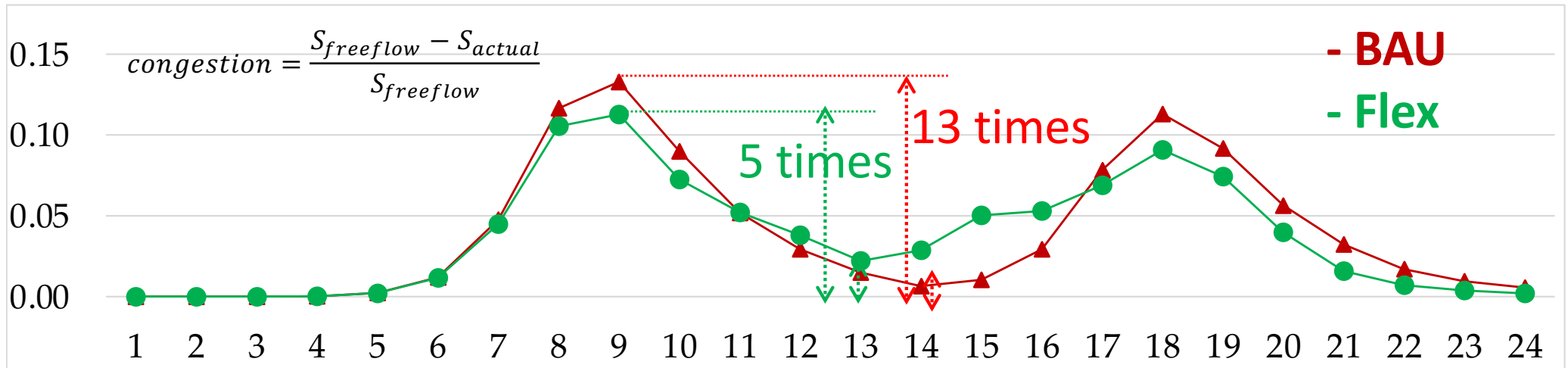
## Guiding to Max QOL Sequence Plan of Activity 6 Travel



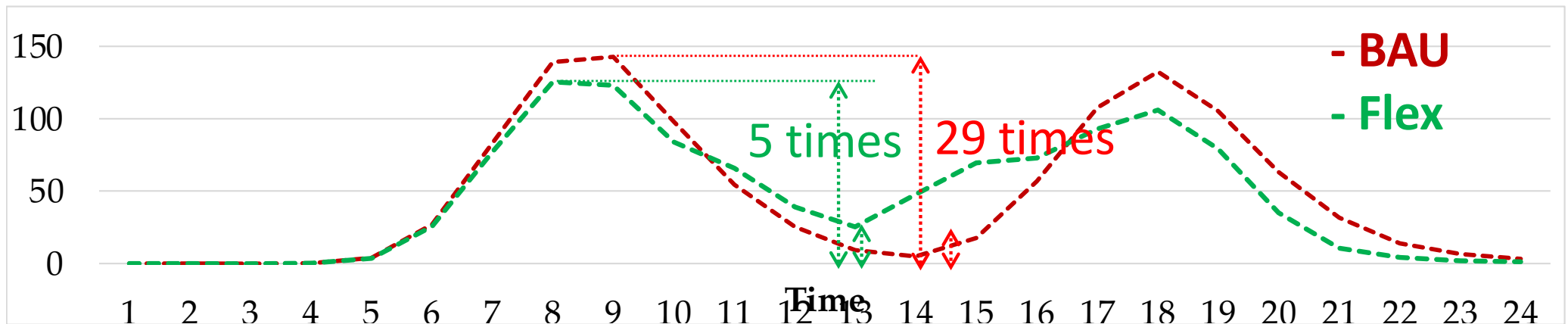
From JICA/JST SATREPS Project 2018-2024 “Smart Transport for Thailand 4.0” (Leader: Yoshitsugu Hayashi)

# Effects of Location – Time Shift of Activity & Travel

## 1. Daily Traffic Congestion



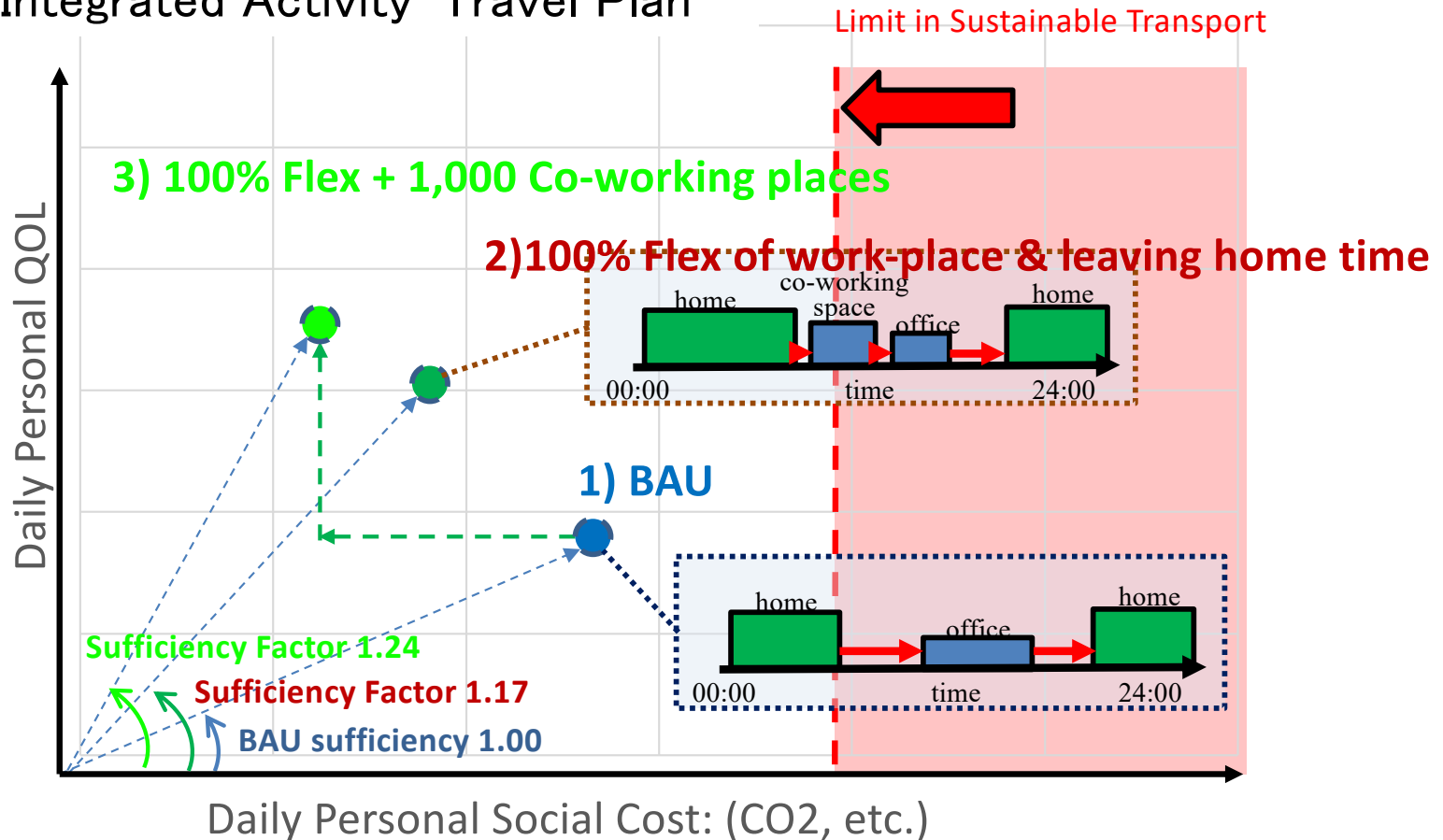
## 2. Hourly CO2 Emission (ton/ 100,000agents)



From JICA/JST SATREPS Project 2018-2024 "Smart Transport for Thailand 4.0" (Leader: Yoshitsugu Hayashi)

# "Sufficiency" Factor X

## Daily Integrated Activity-Travel Plan



From JICA/JST SATREPS Project 2018-2024 "Smart Transport for Thailand 4.0"  
(Chair: Yoshitsugu Hayashi)



## QUALITY OF LIFE ASSESSMENT IN URBAN DEVELOPMENT AND TRANSPORT POLICYMAKING



Edited by Yoshitsugu Hayashi, Hiroyuki Takeshita,  
and KE Seetha Ram



ASIAN DEVELOPMENT BANK INSTITUTE

# New Book

- Just Published, July 2023
- Asian Development Bank Institute Press
- e-Book: free download
  
- Editors: Yoshi Hayashi, Hiroyuki Takeshita, K.E.Seetharam
- Authors: include Yoshi Hayashi, Werner Rothengatter, Roger Vickerman, Yves Crozet, Jamie Leather

# Strategy for Mobility Transformation

- *Solution in Infrastructure Supply-side*
  - Railway Improvement
  - EV for Cars, FCV for Heavy Duty Trucks, e-Fuel
  - Generation, Power Storage, Charging of Electricity and Hydrogen
- *Solution in Behavior Demand-side*
  - Fixed Workplace & Commuting Timing → both Flexible
  - “New Normal Lifestyle” in Post COVID-19 Era
  - “QOL-MaaS”
- *QOL*
  - GDP (20<sup>th</sup> Century) → Personal QOL (21<sup>st</sup> Century)
  - GDP → GNH (Bhutan)
  - High Carbon → De-Carbon (CO<sub>2</sub>)
  - “Efficiency” (GDP/ Direct Cost) → “Sufficiency” (QOL/ CO<sub>2</sub>) → SDGs

# Sufficient and Inclusive Mobility and Life Better for Everyone !



Thank you for your attention !