

Introduction of JST-JICA Technical Cooperation Project on Construction Waste in Vietnam and Construction Management and Recycling in Japan

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Field Survey on Solid Waste Landfills



*Maharagama, Sri Lanka
(2008-2009)*



*Udapalatha/ Gampola/Hambantota,
Sri Lanka (2009 - 2016)*



*Kataragama/Kurunegala,
Sri Lanka (2017 - 2018)*



*Payatas landfill site, Quezon City,
Philippines (2008-2009)*



*Vientiane, Laos
(2012)*



*Hanoi/Haiphong/Da Nang,
Vietnam (2016-)*

Training on Solid Waste Management in Japan: Capacity development of WM officers/engineers/researchers

- *Sri Lanka (Oct, 2011): 14 trainees*
- *Mongolia (Nov, 2011): 14 trainees*
- *Sri Lanka (Oct, 2012): 16 trainees*
- *Sri Lanka (SATREPS 2012~2016): > 50 trainees*
- *Laos (May 2013) : 11 trainees*
- *Iran (Aug, 2015): 10 trainees*
- *Vietnam (SATREPS 2018~2019): > 30 trainees*



SATREPS Training program of Vietnam counterparts in Japan

What is SATREPS?

SATREPS (Science and Technology Research Partnership for Sustainable Development) is a Japanese government program that promotes international joint research targeting global issues. Global challenges cannot be met by a single country or region acting on its own, so engagement by the international community is essential. To address these issues, SATREPS works through three- to five-year projects involving partnerships between researchers in Japan and researchers in developing countries. SATREPS projects are expected to lead to outcomes with potential for practical utilization, and to enhance research capacity in the developing country.

The program is collaboration between two Japanese government agencies: the Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA).



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Environment/Energy : Climate Change	-	-	-	-	-	-	-	-	-	-	-	-
Environment/Energy : Low carbon society	4	3	2	1	2	2	2	2	2	2	2	2
Environment/Energy : Global-scale environmental issue	4	1	2	3	1	3	4	2	2	3	2	3
		<i>Sri Lanka</i>						<i>Vietnam</i>				
Bioresources	5	2	3	1	2	4	4	2	2	3	3	3
Natural disaster prevention	2	2	1	2	2	3	2	2	1	2	3	2



Past and On-Going SATREPS Projects in Vietnam

	FY	Category	Project title	Primary Institute in JP / Program Manager	Collaborators in JP	Counterpart Institute in Vietnam
1	2009-2013	Bioresources	Sustainable Integration of Local Agriculture and Biomass Industries	The University of Tokyo / Prof. SAKODA Akiyoshi	National Agriculture and Food Research Organization (NARO)	Hochiminh City University of Technology (HCMUT), etc.
2	2010-2014	Environment/Energy (Global-scale environmental issues)	Establishment of Carbon-Cycle-System with Natural Rubber	Nagaoka University of Technology / Prof. FUKUDA Masao	National Institute for Environmental Studies (NIES)	Hanoi University of Science and Technology (HUST) / Rubber Research Institute of Vietnam (RRIV)
3	2010-2014	Bioresources	Development of Crop Genotypes for the Midlands and Mountain Areas of North Vietnam	Kyusyu University / Prof. YOSHIMURA Atsushi	Nagoya University	Hanoi University of Agriculture (HUA), etc.
4	2011-2015	Environment/Energy (Low carbon society/energy)	Multi-beneficial Measure for Mitigation of Climate Change in Vietnam and Indochina Countries by Development of Biomass Energy	Osaka Prefecture University / Prof. MAEDA Yasuaki	Ehime University / Osaka City University / Japan International Research Center for Agricultural Sciences (JIRCAS)	Vietnam National University, Hanoi (VNU-Hanoi), etc.
5	2011-2015	Disaster Prevention and Mitigation	Development of Landslide Risk Assessment Technology along Transportation Arteries in Vietnam	International Consortium for Landslides (ICL) / Executive Director, Dr. SASSA Kyoji	Tohoku Gakuin University (TGU) Forestry and Forest Product Research Institute (FFPRI)	Institute of Transport Science and Technology (ITST), Ministry of Transport, MOT
6	2011-2015	Infectious Diseases Control	Determine the Optimal Mechanism and Development of Surveillance Model for Multi-Drug Resistant Bacteria	Osaka University / Prof. YAMAMOTO Masahisa / YAMAMOTO Masahisa	Osaka Prefecture Institute of Public Health / Osaka Prefecture University / University of the Ryukyus	National Institute of Infectious Diseases (NIN), etc.
7	2014-2018	Bioresources	Establishment of Cryo-bank System for Vietnamese Native Pig Resources and Sustainable Production System to Conserve Bio-diversity	National Institute of Agricultural Sciences / Senior Researcher KIKUCHI Kazuhiro	Tokushima University / Tokushu Feed Mills Co., Ltd. (IFM)	National Institute of Animal Husbandry, Ministry of Agriculture and Rural Development
8	2014-2018	Environment/Energy (Low carbon society/energy)	Sustainable Development of Rural Area by Effective Utilization of Bio-wastes with Highly Efficient Fuel Cell Technology	Kyushu University / Assoc. Prof. SHIRATORI Yusuke	-	Laboratory for Nanotechnology (LNT), Vietnam National University - Ho Chi Minh City (VNU-HCM)
9	2015-2019	Bioresources	Development and Dissemination of Sustainable Production System Based on Invasive Pest Management of Cassava in the Greater Mekong Subregion	Kyushu University / Prof. TAKASU Keiji	Tokyo University of Agriculture / The University of Tokyo / RIKEN / Nagoya University	Agricultural Genetics Institute(AGI)
10	2017-2022	Environment/Energy (Global-scale environmental issues)	Establishment of Environmentally Sound Management of Construction and Demolition Waste and Its Wise Utilization for Environmental Pollution Control and for New Recycled Construction Materials in Vietnam	Saitama University / Prof. KEN Kawamoto	Center for Environmental Science in Saitama, National Institute for Environmental Studies	Hanoi University of Civil Engineering (HUCE), HUST, MOC, ISPONRE, Hanoi DOC, Hanoi URENCO, Haiphong DONRE

First SATREPS project targeting Waste Management and Recycling in Vietnam

Establishment of Environmentally Sound Management of Construction and Demolition Waste and Its Wise Utilization for Environmental Pollution Control and for New Recycled Construction Materials in Vietnam (Since 2018 ~)

Project Manager in Japan: Ken Kawamoto / Saitama University



Project Manager in Vietnam: Nguyen Hoang Giang

/ Hanoi University of Civil Engineering (HUCE)





Waste management problems are “Global Environmental Issues”

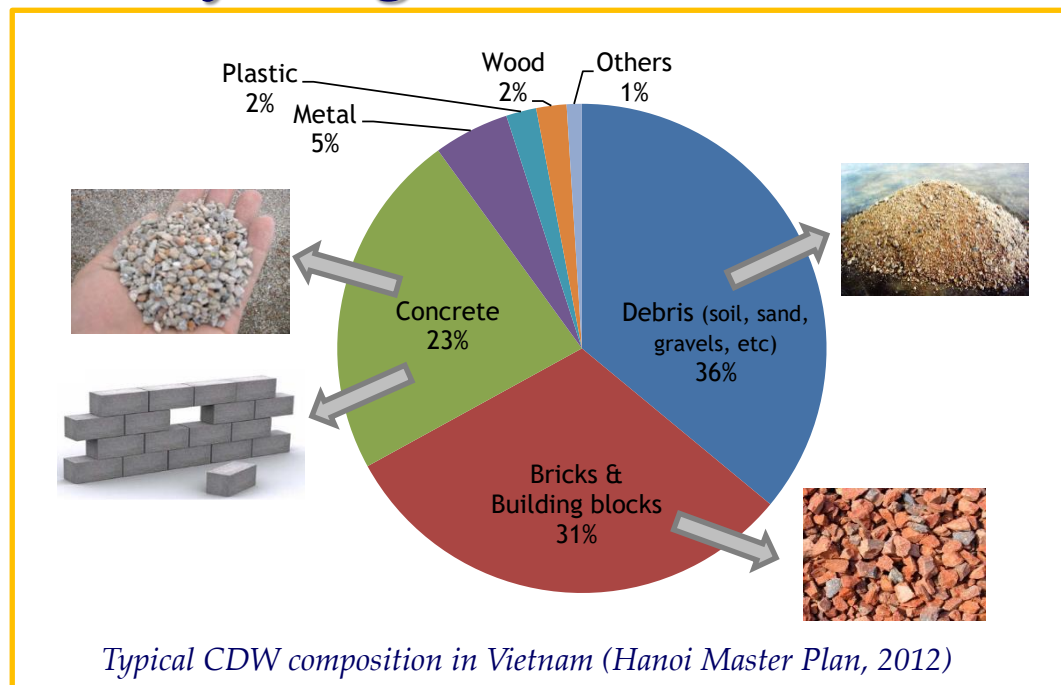
- ✓ *Waste management problems should be solved in the modern society.*
- ✓ *Proper and environmental sound waste management is an essential element for sustainable development.*
- ◆ Damage to human health and environmental pollutions caused by unregulated waste management and disposal
- ◆ Increase in Construction and Demolition Waste (CDW) due to rapid urbanization and population increase

+ CDW generation: 1.9 Mil tons/year (2010) to 2.5 Mil tons /year (2015)
+ Daily CDW generation exceeds 3000 tons/day in Hanoi and Ho Chi Minh City
+ % of CDW to total solid waste exceeds 30 in urban area



Treatment and Recycling of CDW

- ✓ **Illegal dumping and unknown treatment**
- ✓ **Insufficient recycling systems of CDW**



Country / Region	Waste Generation (million tons /year)	Recycle Rate (%)	Treatment	Reference
Thailand	1.9	~ 0	Dumped and landfill	Chinda et al. (2013)
Vietnam	1.9	1-2	Dumped and landfill	MONRE (2011)
Malaysia	6.9	5	Reuse and recycle, landfill	Papargyropoulou et al. (2011)
Korea	67	36 (Concrete)	Reuse and recycle	Bansal and Singh (2014)
Hong Kong		40	Reuse and recycle	Gao (2006)
Denmark	3 (Hard)	81	Reuse and recycle	
Netherlands	11 (Hard)	90	Reuse and recycle	
Japan	72.7	99 (Concrete, Asphalt) 85 (sludge)	Reuse and recycle	Ministry of Land, Infrastructure, Transport and Tourism (2012)



National strategies on waste management and environmental protection in Vietnam

- *National Strategy for Solid Waste Management in Industrial and Urban Areas until 2020 (1999)*
- *National Strategy for Environmental Protection (2003)*
- *Vietnam Agenda 21 (2004)*
- *Decree No. 23/2005/CT-TTg dated June 21, 2005 of the Prime Minister on Strengthening the Activities on Solid Waste Management in Urban Areas and Industrial Zones (2005)*
- *National Strategy on Environment Protection to 2020, with Visions to 2030 (2012)*
- ...

Decision No 2149/QĐ-TTg National strategy for management of solid waste up to the year 2025 and Vision to 2050 (2009; amended in 2018)

Vision to 2050: all solid waste is collected and re-used, recycled and thoroughly treated with advanced technology, environmentally friendly and in accordance with the actual conditions of each locals, restrict solid waste to landfill up to a minimum.

General target up to the year 2025: Improving efficiency of management system, community awareness on the management solid waste

Targets		in 2015	in 2020	in 2025
Ratio of cities that have solid waste recycling system %		50	70	100
Urban house Solid Waste	% Collected	85	90	100
	% Recycled	60	85	90
Construction and Demolition waste				
	% Collected	50	80	90
	% Recycled	30	50	60
Hazardous Industrial SW	% Collected	60	70	100
	% Recycled	0	0	0

Problems and Issues from **Improper CDW Management** and **Insufficient Recycling System**

Illegal dumping of CDW

+ e.g, Improperly treated or unknown amount of CDW: 1700 tons/day out of total CDW generation of 3000tons/day in Hanoi

Risks to human health and environment

- + Soil, surface and groundwater pollutions (mixing with unspecified hazardous waste)
- + Toxic materials in CDW (gypsum, asbestos, etc)
- + Transportation obstacles (roadside dumping), air pollution due to dust, degradation of infrastructure (e.g., blocking sewers), impact on urban landscape, waste of land, ...

Depletion of natural resources and energy

- + Destruction of natural environment at resource mining sites
- + Reuse/Recycling of CDW, Green Procurement



Overall goal

Achievement of a CDW collection and recycling rates of more than 50%, which meets the Vietnam national strategy for management of solid waste up to the year 2025, in Hanoi City



Project purpose

To develop environmentally sound CDW management and resource recycling systems in Hanoi City

Activity 1: Development of **Guidelines** for establishing environmentally sound management system for CDW

CESS

MOC (ATI) • HUCE

Hanoi DOC • Hanoi URENCO
Haiphong DONRE

** Guideline committee*



Activity 2: Development of **Technical instructions and standards** for evaluation and quality control of recycled materials from CDW

SU • NIES

HUCE

MOC (DST)

** Technical standard committee*



Activity 3: Development of **New technologies** for environmental pollution control and for infrastructure construction by utilizing recycled materials in Vietnam

SU

HUCE • HUST

MOC (ATI, DST, DCM)



Activity 4: Proposal of strategic **Business models** for promoting CDW recycling and practically effective promotion measures for environmental sound CDW management and recycling in a model city

NIES

ISPONRE • HUCE

MOC • Hanoi DOC
Hanoi URENCO

Research & Development

Administration & Implementation

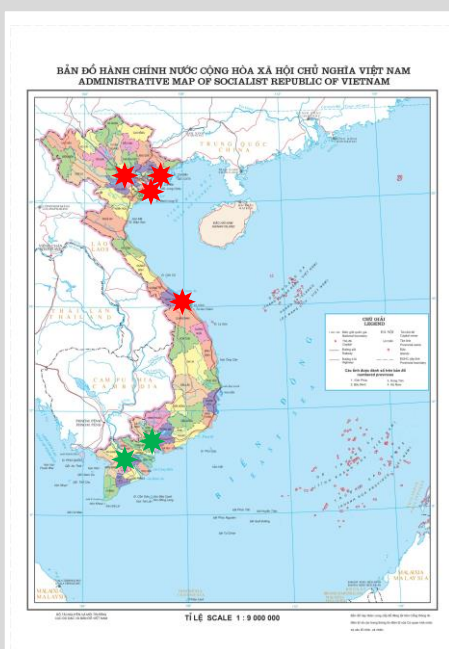


Quản lý và xử lý CTRXD tại Việt Nam

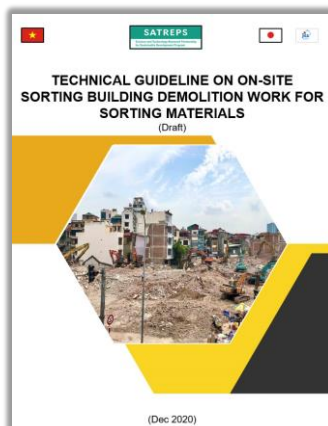
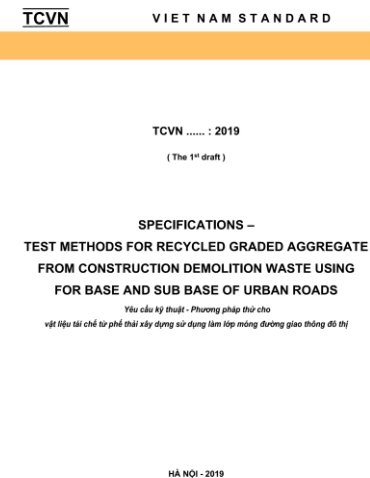
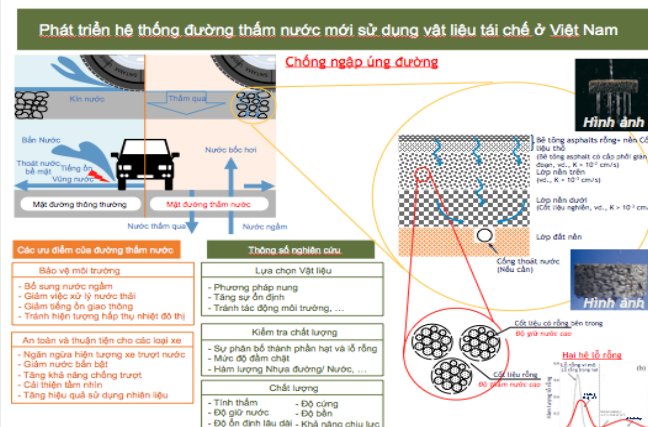
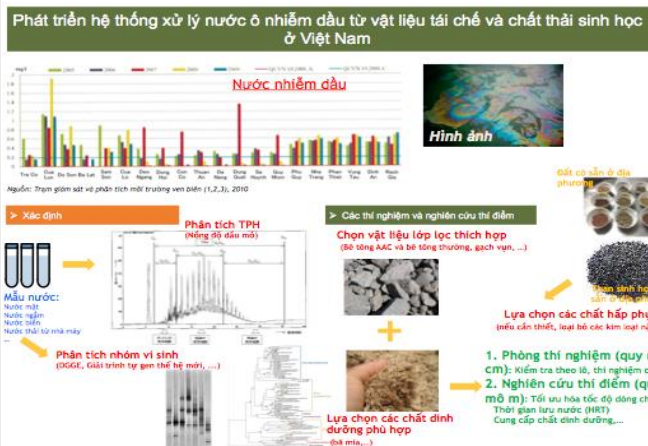
5 TP trực thuộc TW

Công nghệ xử lý CTRXD

Kết quả



<https://www.invert.vn/media/uploads/files/ban-do-hanh-chinh-viet-nam.jpeg>



Khảo sát thực trạng CTRXD tại các địa phương của Việt Nam

National University of Civil Engineering (NUCE), Ministry of Construction (MOC), Hanoi Department of Construction (Hanoi DHC) in
Hanoi, Salween University, The Center for Environmental Science in Salween (CES) in Japan

Baseline Survey Report on Construction and Demolition Waste Landfills in Hanoi, Vietnam

October 2019



Viet Nam Solid Waste Treatment and Recycling
Joint Stock Company



FINAL REPORT

INVESTIGATION ON THE CURRENT STATE OF CONSTRUCTION AND
DEMOLITION WASTE MANAGEMENT IN HAI PHONG, VIETNAM

Hanoi, 10 January 2020

Final Report
Investigation into the economic feasibility of CDW recycling
in Hanoi, Vietnam

February 2020

Vietnam Waste Planning

Ramot University of Civil Engineering (RUCE), Da Nang Environmental Protection Agency, The University of Da Nang – University
of Science and Technology (DUT), and Salween University

JST-JICA SATREPS Report on Construction and Demolition Waste Management in Da Nang, Vietnam

November 2021



(a)



Khảo sát tại 05 thành phố lớn: Hà Nội, Hải Phòng, Hồ Chí Minh, Quảng Ninh, Đà Nẵng



Article

Current Management Condition and Waste Composition Characteristics of Construction and Demolition Waste Landfills in Hanoi of Vietnam

Hoang Giang Nguyen ¹ , Dung Tien Nguyen ² , Ha Tan Nghiem ² , Viet Cuong Tran ¹, Akira Kato ³, Akihiro Matsuno ⁴, Yugo Isobe ⁵, Mikio Kawasaki ⁵ and Ken Kawamoto ^{1,4,*}

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check for updates

Citation: Nguyen, H.G.; Nguyen, D.T.; Nghiem, H.T.; Tran, V.C.; Kato, A.; Matsuno, A.; Isobe, Y.; Kawasaki, M.; Kawamoto, K. Current Management Condition and Waste

Abstract: This study collected basic information and conducted the present management condition of construction and demolition waste of Vietnam and to characterize waste composition and grain size at landfills. Basic information on seven CDW landfills under investigation was collected, and the waste composition and the grain size distribution

A Circular Economy: Promotion of Construction and Demolition Waste Management in Vietnam

Nguyen Hoang Giang¹, Tran Thi Viet Nga¹, Tong Ton Kien¹, Nghiem Ha Tan¹, and Ken Kawamoto²

Abstract Decision No. 491/QĐ-TTg Approving Adjustments to the National Strategy for Integrated Management of Solid Waste, and Directive No. 41/CT-TTg on Urgent Solutions to Enhance Solid Waste Management in Vietnam were issued by the Prime Minister in May 2018, and December 2020, respectively. Following those incentive policies, all cities and provinces were immediately ordered to invest in, and operate advanced solid waste treatment plants to reduce the land-filled waste to less than 20% for the five largest cities, and to less than 25% for the rest of the country. These policies are crucial to promote reducing, reusing, and recycling of solid waste in Vietnam in general, and of construction and demolition waste (CDW) in particular. Further sustainable and effective approaches include promoting new guidelines and standards, establishing provincial CDW management systems and supporting CDW recycling businesses that are attractive to private sectors.

Book Chapter on "Circular Economy and Waste Valorization: Theory and Practice from an International Perspective" published by Springer in 2022

SATREPS Stationary-type crushing machine for manufacturing recycled materials from waste concrete





Life of World (9): Vietnam
(POPLAR Publishing Co., Ltd., Apr 2020)

Book in School Library List in Japan



▲廃主業の環境問題や廃棄物業者が、日本の建設廃棄物のリサイクルの取り組みをつたえるワークショップをハノイ市で開催。



▶ 道に不法投棄された建設廃棄物。

ベトナム-日本の協力で ごみの地産地消を目指す

ごみの増加による環境汚染は世界じゅうの問題です。ベトナムでも経済や社会の発展にともない、ごみが増え続けています。

ビルや住宅の建築と解体にともなう、建設廃棄物も増えています。廃棄物の多くはごみ捨て場にうめられたり、空き地や道に不法投棄されたりしています。

ハノイでは、分別とリサイクルによってごみの量をへらす取り組みがはじまっています。限りある資源をどのように活用するのか、ベトナムと日本の大学などが協力し、リサイクルの技術向上の計画が進みます。ごみの地産地消をきっかけ、2025年までに建設廃棄物のリサイクル率を50%以上にするのが目標です。

インタビュー

まずは意識改革を!

天然資源の豊富なベトナムでは、リサイクルの取り組みはまだこれからです。日本の経験や情報を両国で共有して、ベトナムでも運用しやすい形のリサイクルを実現したいと計画しています。まずはリサイクルしよう、再生しよう、ごみに役割をあたえよう、という意識改革からはじめます。



◀ワークショップで発表する、プロジェクトリーダーの埼玉大学の川本健先生。

Collaboration with MOE Project in Vietnam



FY 2020-2021 環境省「我が国循環産業の海外展開事業化促進業務」

事業名：ベトナム国での建設廃棄物によるリサイクル骨材及び機能性舗装事業
の展開可能性調査(エコシステム、オリエンタルコンサルタント)

SATREPS

Science and Technology Research Partnership
for Sustainable Development Program

Structural design of
permeable pavement system



Recycling of waste Clay brick

Awarded “METI Good Practice” in 2021

Climate Change Adaptation Good Practices by Japanese Private Sector

March 2021



8. Functional paving materials made from waste roof tiles and bricks to reduce urban flooding and heat island effect

ECOSYSTEM Inc. http://eco-system.ne.jp/index_eng.html

Adaptation Challenge Torrential rains, typhoons and hurricanes have been occurring more frequently due to climate change. In urban areas, ground surfaces are paved with asphalt and concrete, making it difficult for water to seep into the ground and be absorbed. Therefore, urban flooding occurs when rainfall and water levels exceed sewage treatment capacity. Moreover, rising temperatures will exacerbate the heat island effect, causing health problems and ecological changes.

Contribution ECOSYSTEM contributes to reducing urban flooding and the heat island effect by paving the ground with waste roof tiles and bricks that have permeability and water retention properties.

Project Details

Background

Country | Vietnam

Ceramic products such as roof tiles and fired bricks, which are used as raw materials for pavement, are found in many parts of the world, especially in Europe, Southeast Asia, and South America. In order to capture this market, ECOSYSTEM is considering expanding overseas. In Vietnam, it is conducting a feasibility study with support from the Ministry of the Environment, Japan.

Business Model of the Project

In Vietnam, construction waste materials and substandard products from tile and brick factories are disposed of as industrial waste in landfills or illegally dumped. However, local partners will contract with ECOSYSTEM to purchase plants manufacturing paving materials, procure waste tiles and bricks, reuse them, and sell them to private companies and public organizations. Since plants manufacturing paving materials can be assembled locally, ECOSYSTEM plans to contract with a local company for local plant assembly and maintenance in the future.



▲ Discarded roof tiles and bricks

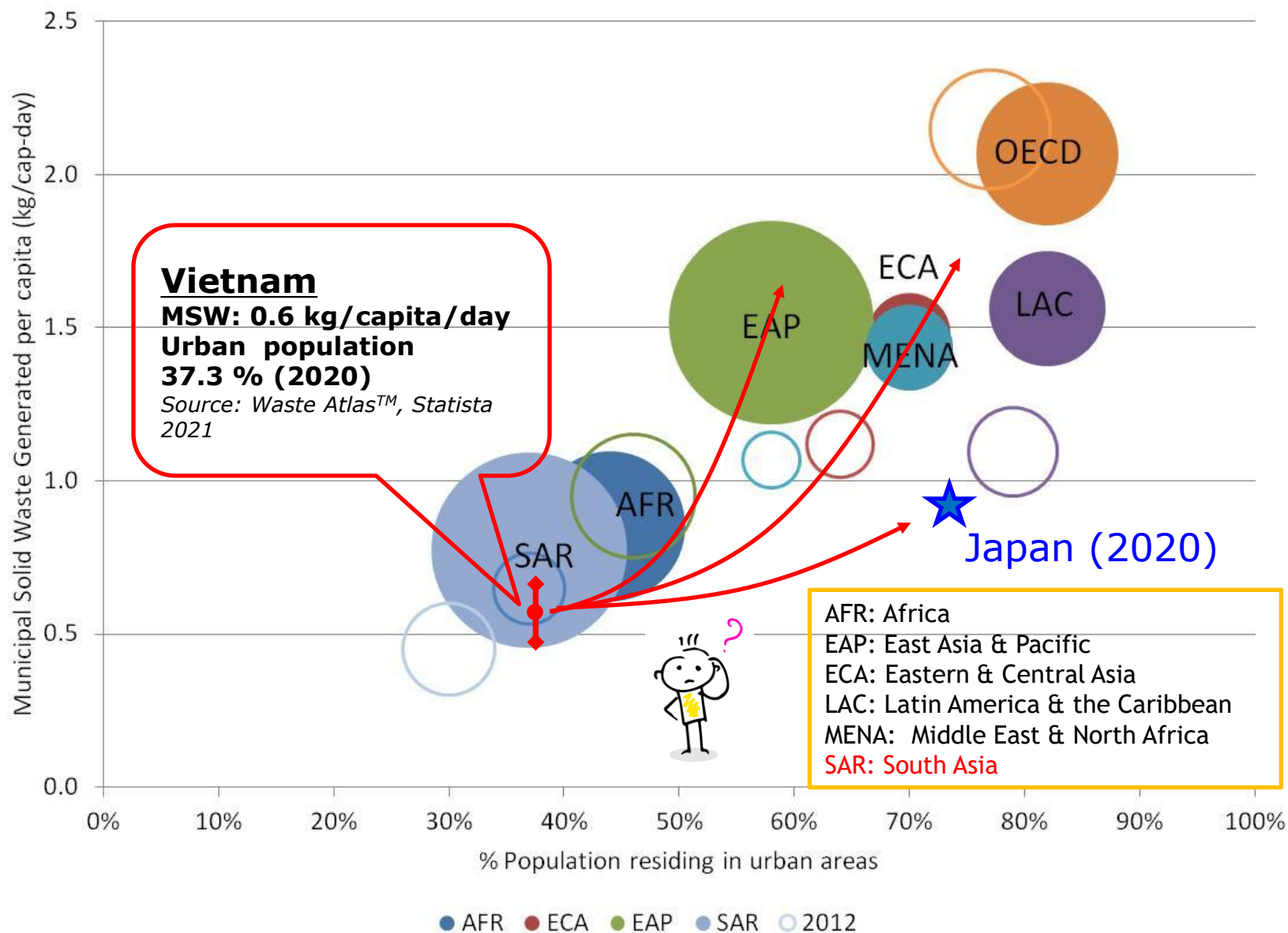


▲ Waste roof tiles and bricks

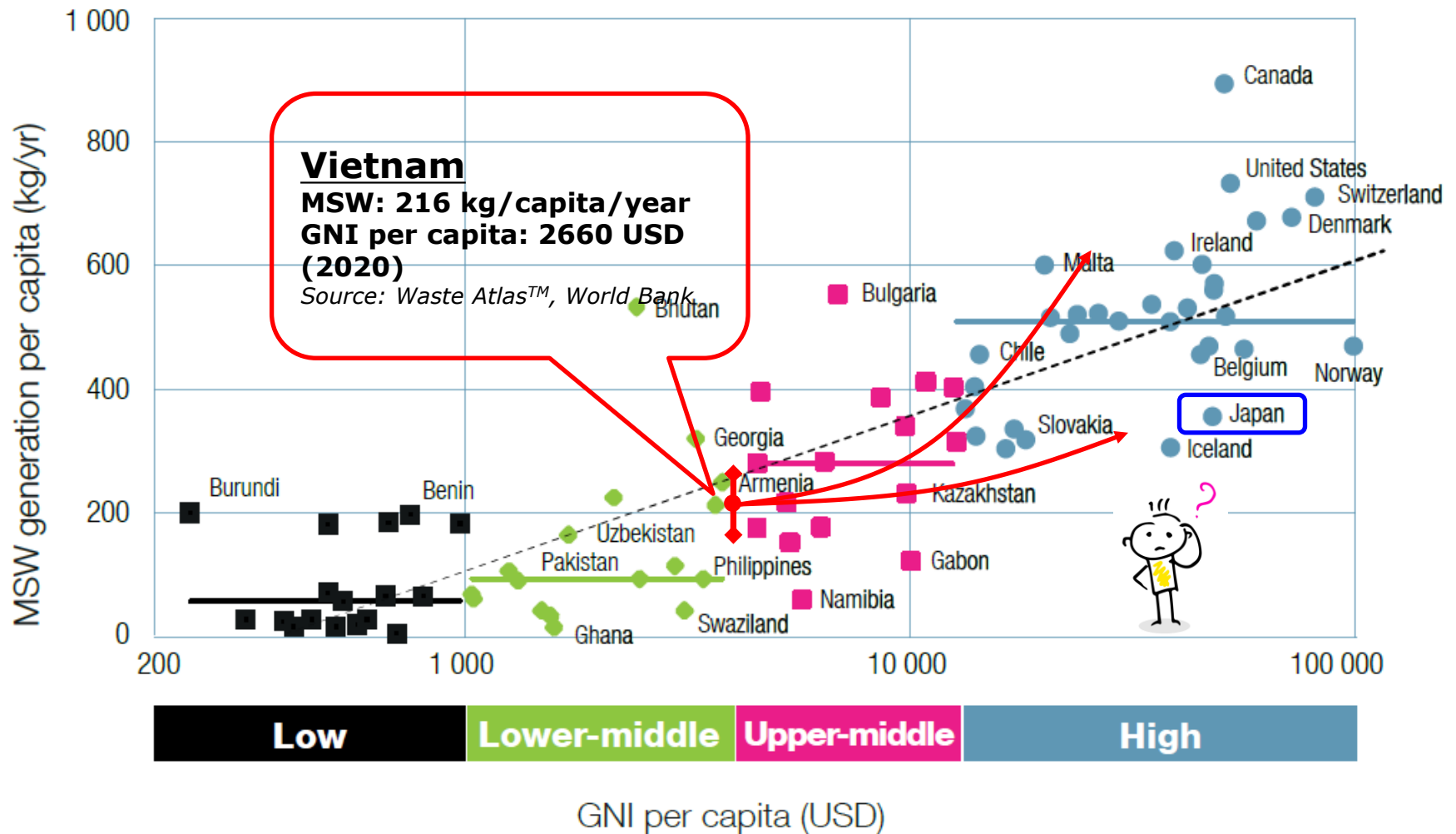
Photo credit: SATREPS Vietnam Project (Dr. Kawamata, Saitama University)

What is Solid Waste?

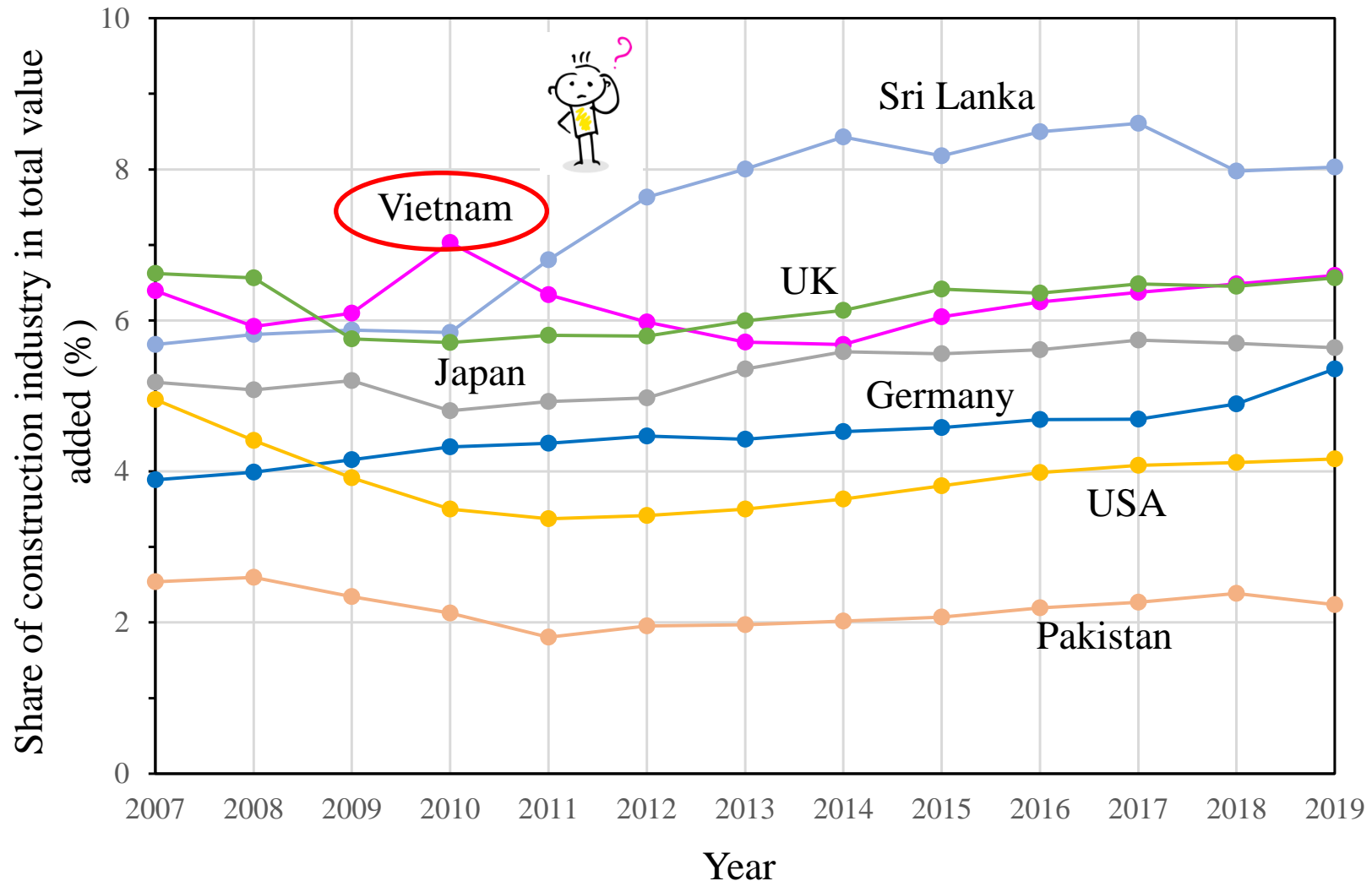
MSW Generation vs Urban Population



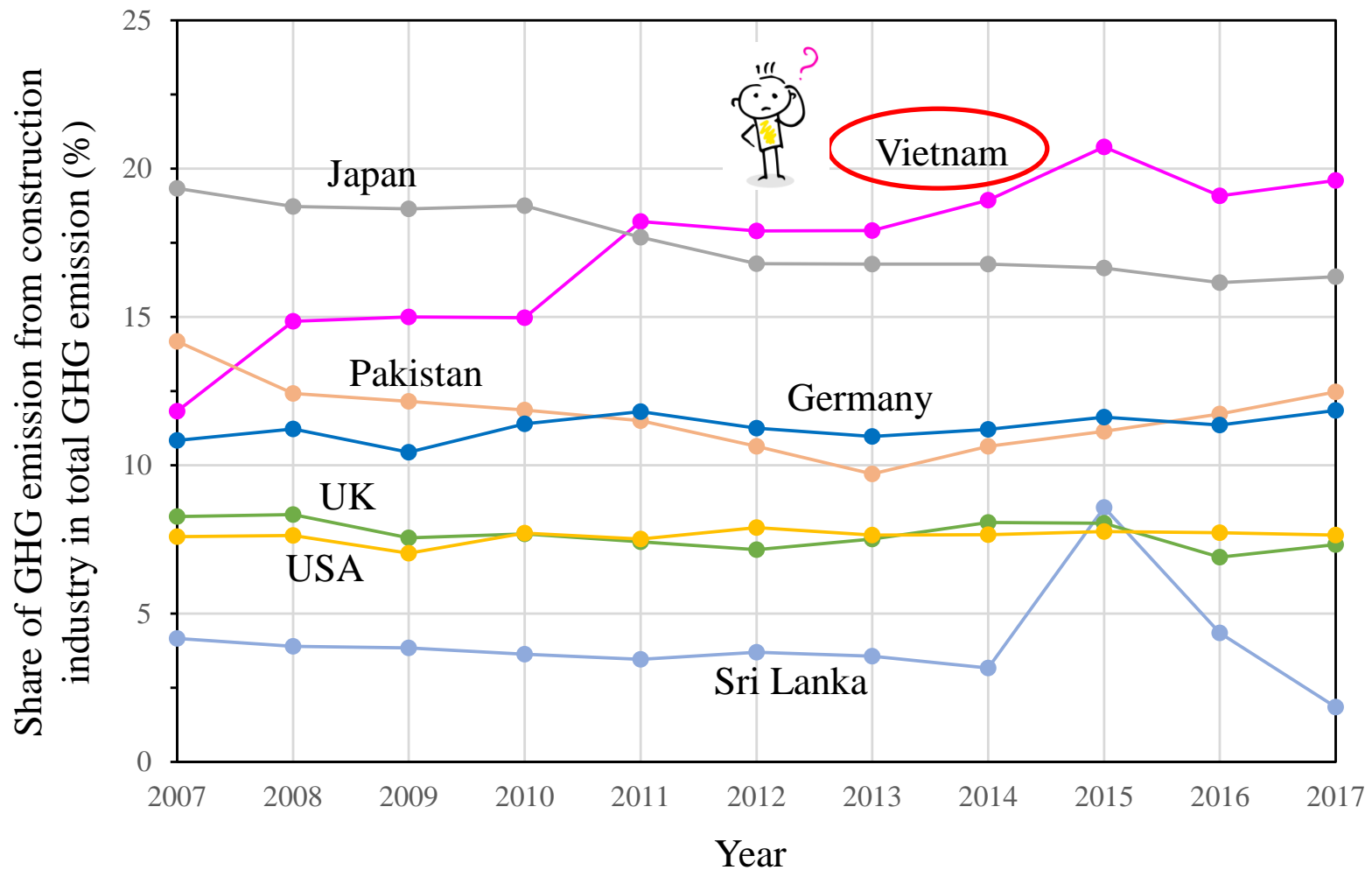
MSW Generation vs Income Level



Share of **construction industry** in total value added (%)



Share of GHG emission from **construction industry** in total GHG emission (%)



Solid Waste Management for Sustainable Urban Development

Sustainable Cities



Practice in Japan: Construction recycling

Sakura Environmental Center, Saitama City, Japan (2015-)

Waste incineration and thermal recycling facility



MSW molten slag



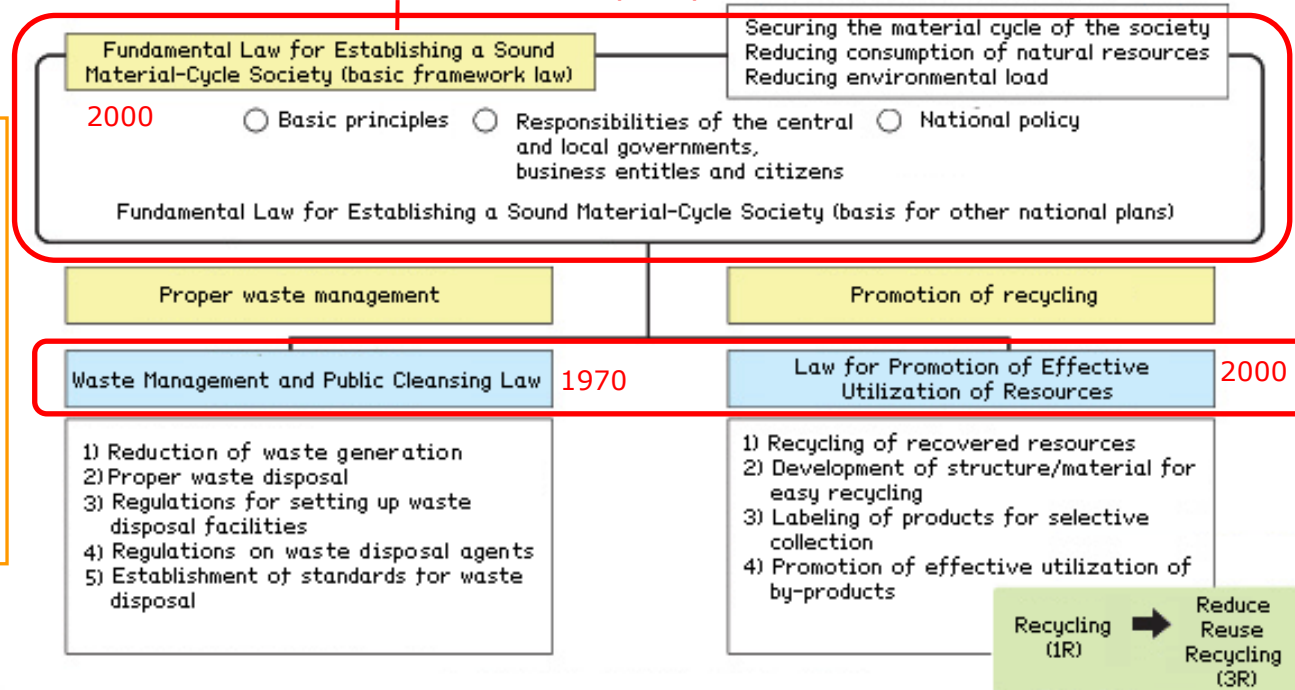
Saitama Environmental Management Center, Saitama Prefecture, Japan (2003-): *Complex facility combining recycling plants and engineered landfills*



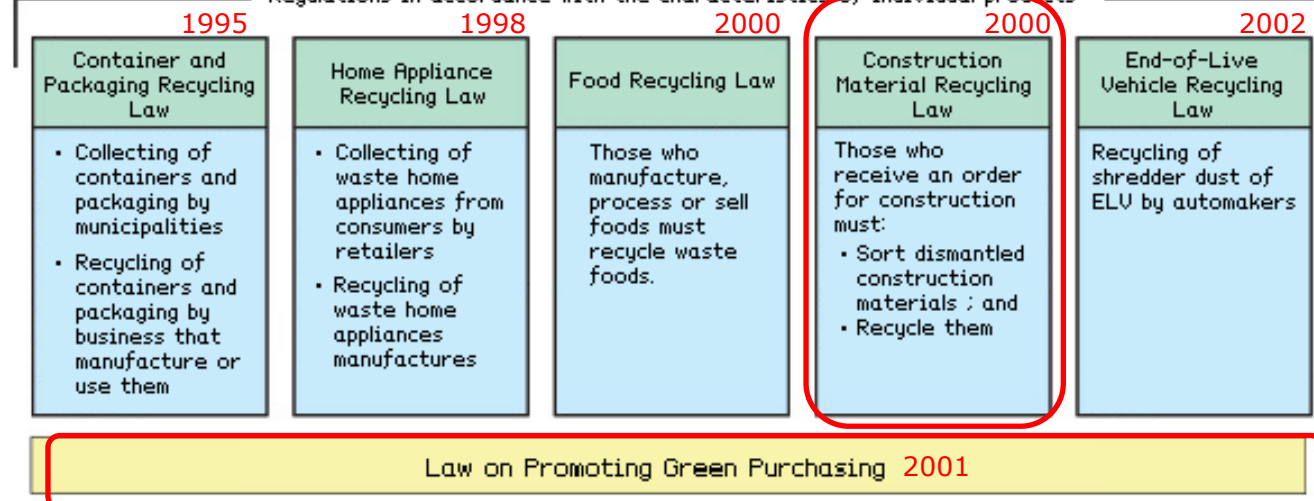
Legislative system and policies for proper waste management and sound material cycle society

“Sound Material-Cycle Society” means a society where the consumption of natural resources is minimized and environmental loads are reduced, first, by preventing products, etc. from becoming waste, etc.; secondly, by recycling discharged wastes appropriately into usable resources as much as possible; and lastly, by securing appropriate disposal of wastes when they cannot be recycled by any other means.

Basic Environmental Law (1993)



Regulations in accordance with the characteristics of individual products



(Reference) Ministry of Economy, Trade and Industry

Source: Technical Expertise of Japan in Solid Waste Management, JICA (2007)

Construction Material Recycling Law in Japan (2000)

Point 1

Obligation of sorting demolition waste or recyclables

- Construction/demolition work above a certain threshold
- Specified construction materials (concrete, asphalt & concrete, wood)

Point 2

Procedure and contract between clients and contractors

- Advance notification
- Appropriate payment for separation and demolition costs

Point 3

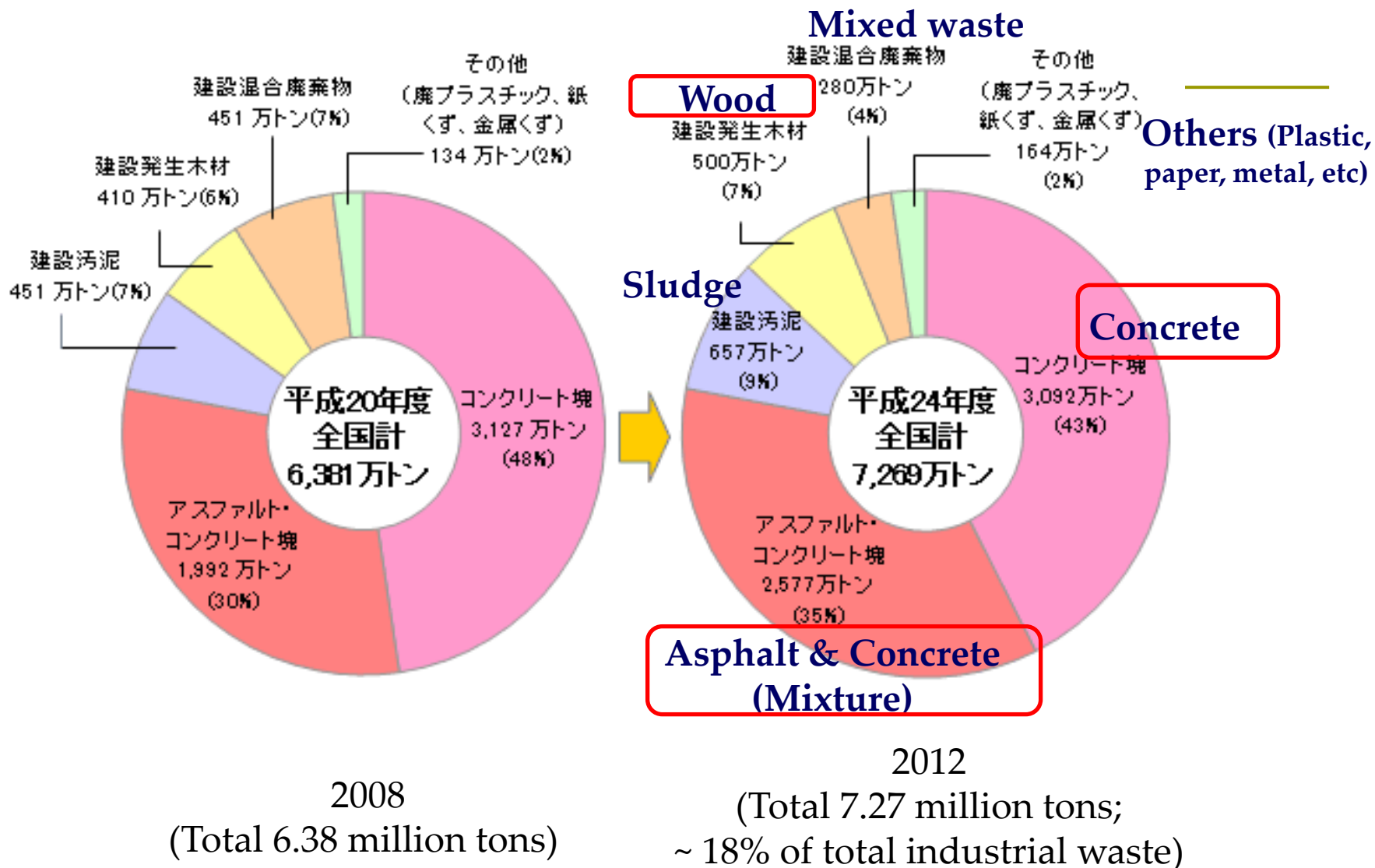
Registration system of demolition operators

- Implementation of appropriate demolition work
- Securement of construction technology

Planning of basic WM and Recycling policy

e.g., Targets on recycling %

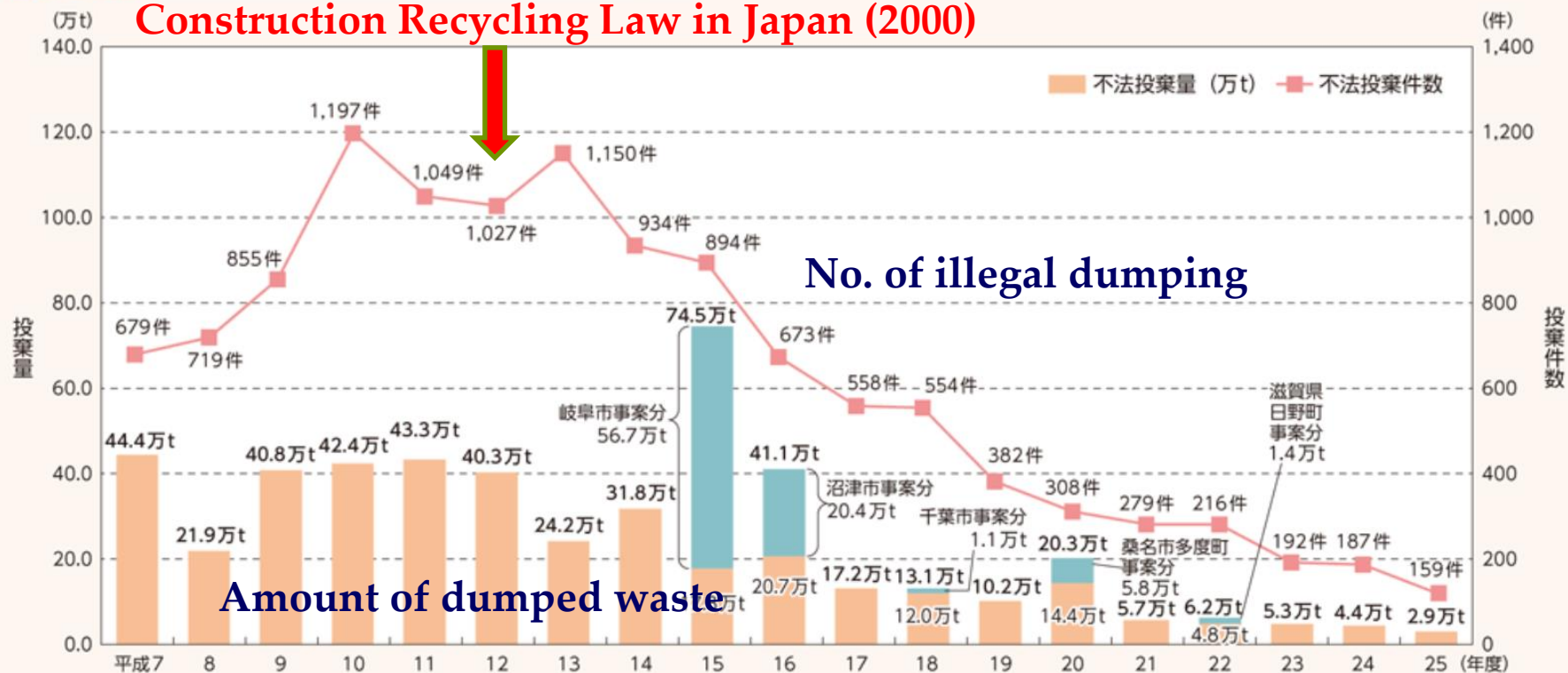
Generated CDW in Japan



Illegal dumping of CDW in Japan

図 3-2-22 産業廃棄物の不法投棄件数及び投棄量の推移

Construction Recycling Law in Japan (2000)



No of illegal dumping: 159
Total Amount: 29,000 tons

Recycling of CDW in Japan

	2002	2005	2008	2012	2018
Recycling rate (%)*					
CDW total	91.6	92.2	93.7	96.0	97.2
Asphalt & concrete (Mixture)	98.9	98.6	97.3	99.5	99.5
Concrete	97.6	98.1	96.8	99.3	99.3
Wood	90.2	90.7	89.4	94.4	96.2
Sludge	68.3	74.5	85.1	85.0	94.6
Recycled amount of mixed waste (million tons)	1.22	0.82	1.05	1.62 (Recycling =58.2%)	2.28 (Recycling =63.2%)
Reused Soil (million m ³)	256	187	116	198	290 (Recycling =79.8%)

Source: MLIT (2014, 2021)

* Including volume reduction

Typical concrete recycling plant in Japan



Typical asphalt recycling plant in Japan



Recycled aggregates for road construction in Japan



RC-40



Hot-asphalt stabilized aggregates



RM-30



MS-25

Typical construction soil recycling plant in Japan

(Tokyo Metropolitan Construction Waste Soil Recycling Center)



Concluding Remarks

- CDW recycling is a key activity to achieve sustainable urban development and to create circular economy in a sustainable society.
- Country/Region-specific characteristics of construction industry and CDW management/treatment/disposal techniques are fully considered to make action plan and to promote CDW recycling.

Acknowledgements

JST-JICA Science and Technology Research Partnership for Sustainable Development (SATREPS) in Vietnam FY2018-FY2022



Research grant from the Research Management Bureau, Saitama University (FY2009-FY2021)



Thank you very much

Saitama university: FACTs & figures



**NATIONAL
UNIVERSITY**

**Established
1949**

**MORE THAN
8,000 STUDENTS
ENROLLED
(as of May, 2017)**

**Undergraduate : 7000
Masters : 1200
Doctoral : 250**

** as of May, 2017*

**A TOTAL OF 760
UNIVERSITY
STAFF**

** as of May, 2017*

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UNESCO Chair



<http://jupiter.civil.saitama-u.ac.jp/international/sssv/>

LINKS



Graduate School of
Science and Engineering



Department of Civil and
Environmental Engineering

GLOBAL NETWORK OF SAITAMA UNIVERSITY



1992 – 2020 (No. of graduates as of March, 2020)

History of WM in Japan

1900 Dirt Removal Law (汚物掃除法)

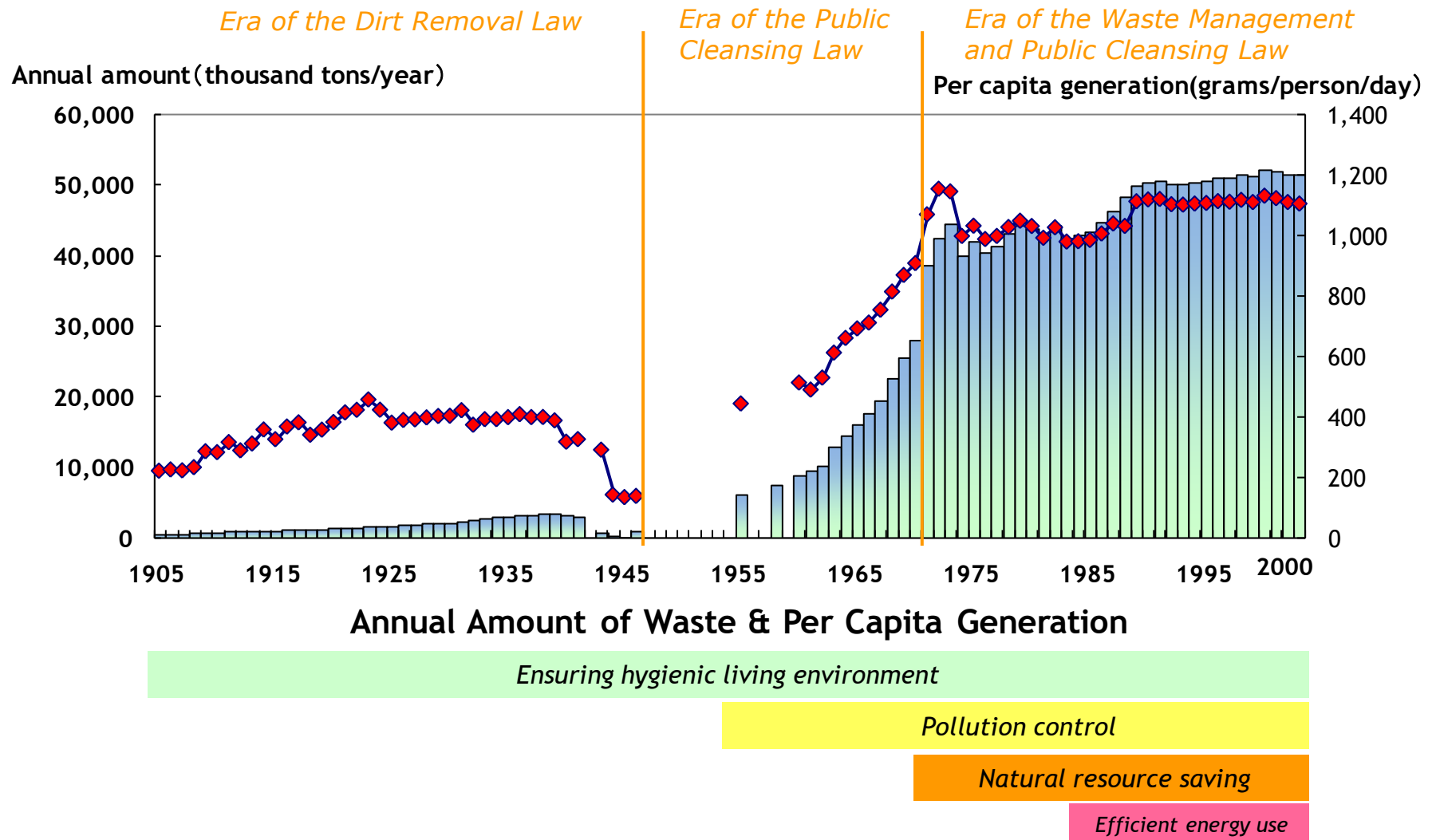
- ... Outbreak of infectious diseases and needs to ensure hygienic living environment

1954 Public Cleansing Law (清掃法)

- ... Rapid increase in waste amount accompanying with high economic growth, Environmental pollution

1970 Waste Management and Public Cleansing Law (廃棄物処理法)

- ... Legal and policy framework for pollution control, Steady economic growth



Era of the Dirt Removal Law

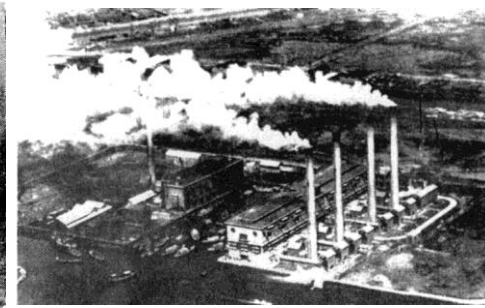
1887-1886 Repeated outbreak of infectious diseases

1900 Enactment of the *Dirt Removal Law*

1930- Waste collection by municipalities

Waste separation at generation source and
sorted collection

Solid waste incineration



Less attention to environmental countermeasures

Era of the Public Cleansing Law

1950- Rapid increase in waste amount accompanying with high economic growth, Serious environmental pollutions

1954 Enactment of the *Public Cleansing Law*

Financial and technical assistance to municipalities by the national government

Required hygienic treatment

Citizen responsibility in waste management

1954- Strong protest against construction projects

1960- Continuous high economic growth

More serious environmental pollutions (Asthma, etc)

Changing in waste (plastic, electronic, etc)

Changes in intermediate treatment (incineration)

Improvement in waste collection system,

From open dumping to sanitary landfills



*Needs much improvement in development of
(controlled) sanitary landfills*

Era of the Waste Management and Public Cleansing Law

- 1970- Legal and policy framework for pollution control
 - 1968 Air Pollution Control Law
 - 1970 Water Pollution Control Law
 - 1970 Enactment of the *Waste Management and Public Cleansing Law*
 - Industrial waste prescribed in the Law, Responsibility of businesses, waste disposal standards,...
 - Energy recovery and electricity generation from incineration plant
 - Environmental pollution caused by incineration (acid gas, heavy metals, ...)
 - Conflict over waste disposal and landfill siting
- 1980- Steady economic growth
 - Shortage of final disposal sites
 - Promotion of recycling by administrative body*
- 1990- Dioxins issues from incineration facilities, Increase in illegal dumping due to increasing disposal cost
 - Establishment of material-cycle society*, Change in building design (suits to surroundings)
 - Enhancement of engineered standards pertaining to final waste disposal site*



Products of natural aggregates (crushed stone) and recycled aggregate in Japan

Construction Recycling Law (2000)

