

Part I

Towards Maintenance, Management and Renewal of Future Social Infrastructures

**- Social Infrastructures That Are Passed on
from Aged to Age -**

Chapter
1Social Infrastructures To Date and
Challenges Open for the Future

Section 1 History of Social Infrastructures and Their Roles

1 Development of Infrastructures Viewed in Chronological Order

The history of infrastructure development is long in Japan as well. Here is a retrospective review of the history of infrastructure development in Japan, starting from the ancient times (to the late Heian Period), through the medieval times (from the Kamakura Period to before the formation of the Edo Shogunate Government), to the modern times (Edo Period), modern age (from the Meiji Period to prewar years) and present age (from postwar years to the present time), along with discussions of how the infrastructures developed have been maintained and managed.

(1) Ancient times - Budding infrastructures in Japan -

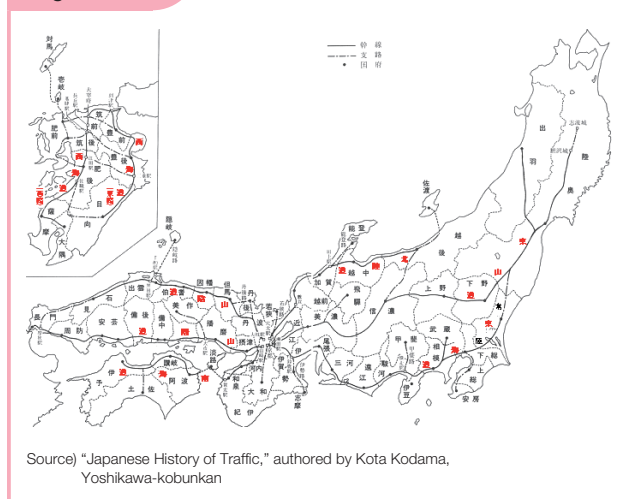
A documented account of infrastructures in the prehistoric days of Japan can be found in a Chinese book of history written in the third century, titled “Gishi-wajin-den.” An envoy from the Chinese country of Wei visiting Tsushima and the northern part of Kyushu in those days described the roads there as being no better than “animal trails” and remarked that he could not see people walking ahead of him because of gross vegetation. With the subsequent opening of the Tumulus Period, tumuli came to be built everywhere. Huge dimensions of these architectural structures attest to the advanced level of the civil-engineering technology in those days. According to Japan’s legendary history, the 16th generation Emperor Nintoku, the founder of the capital in Nanba, allegedly built Manda-no-tsusumi (Manda Levee) alongside Yodogawa River and a bridge across Ikaizu^{Note 1} and opened a highway from the capital of Nanba to Tajihino-mura^{Note 2}.

In 645, a political reform known as “Taika Reform” began to accelerate the pace of formation of a nation of centralized governance based on “Ritsuryo” (system of code and ordinance), enforcing a system of complete state ownership of land and citizens and marking off local administrative districts. The Capitals of Fujiwara-kyo and Heijo-kyo, built in succession, were furnished with large networks of roadside ditch nets as drainage. In the river traffic-rich nation of Japan, there had been ports called “Tsu” or “Tomari” from the ancient times, but state-run ports called “Kunitsu” were newly developed from province to province from which to ship tributes to the government during the Ritsuryo period.

Road development was commenced from a military viewpoint for unifying warring provinces. The prototype of roads had already been formed before Taika Reform (645), but roads entered a stage of full-scale development about during the reigns of Emperor Tenchi and Tenmu (668-686), and seven trunk roads (Tokai-do, Tosan-do, Hokuriku-do, Sannin-do, Sanyo-do, Nankai-do and Saikai-do) were collectively called the “Seven Post Roads.”

Regarding the maintenance and management of infrastructures in those days, the Building and Repairs Statutes of the Yoro Code compiled in 718 dictated that ports, bridges and roads in each district be repaired from mid-September to October and that, whenever an important road was broken to deny passage, it be fixed at all times. The statutes proceeded

Figure 1-1-1 Schematic of the Seven Post Roads



Note 1 Presumably part of the districts of the Higashinari-ku and Ikuno-ku of the present-day City of Osaka.

Note 2 Presumably part of the Cities of Matsubara, Habikino, Sakai, etc. of the present-day Osaka Prefecture.

to require provincial governors and local magistrates to patrol embankments close to a big river and renovate them after the fall harvest if they needed repairs or do so whenever they were found wrecked.

Column

Public Works Undertaken by Gyoki

In the ancient days of Japan, religious practitioners played a dominant role in the development of the nation's infrastructures. In those days, the Japanese Buddhist priests who had sailed as an envoy to Tang Dynasty China not only acquired the latest doctrines of Buddhism in the continent but brought back the then state-of-the-art concepts and expertise of civil engineering as they came home to Japan. As an example, Dosho (629 to 700), who visited Tang Dynasty China in 653, is said to have learned the Ritagyo (altruistic practices) of Mahayana (Greater Vehicle) Buddhism from Genjosanzo (Xuanzang), purportedly a model of Sanzo Hoshi appearing in Hsi-yu-chi (Journey to the West). Ritagyo is the way of the Buddha who not only pursued his own state of enlightenment but is dedicated to self-annihilation for the benefit of others. Monks are said to have sought learning from their practices of civil-engineering works, which were in accord with their concepts as they provided labor to make for a better living environment in the interest of the public.

Figure 1-1-2 Seated Statue of Gyoki (duplicate)



Source) Picture courtesy of the Osaka Prefectural Sayamaike Museum.

Among them, Gyoki (668 to 749), a disciple of Dosho, is remembered as religious practitioner who had left the most brilliant achievements among all. Initially, Gyoki was accepted as a wicked monk who kept people astray and his missionary work was

suppressed by the imperial court^{Note}.

Figure 1-1-3 Infrastructures Developed by Gyoki

Kind	Number	Location
Ponds	15	Kawachi (1), Izumi (8), Settsu (6)
Ditches	6	Kawachi (1), Izumi (2), Settsu (3)
Dykes	4	Kawachi (1), Settsu (3)
Sluices ^(Note)	3	Kawachi (3)
Road	1	A road leading to Kawachi and Settsu
Bridges	6	Yamashiro (2), Settsu (4)
Funayasu (harbors)	2	Izumi (1), Settsu (1)
Fuseya	9	Yamashiro (2), Kawachi (2), Izumi (2), Settsu (3)

(Note) Watergates and tubes through which water is discharged from reservoirs or the like (sluiceways and sluice pipes)

Source) Developed by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) from a chronicle of Gyoki in "The Dictionary of Gyoki" authored by Kaoru Inoue.

Under an ancient system of centralized governance based on the Ritsuryo (law and code), when people were ordered to pay taxes, such as Yo (taxes in kind) and Cho (tributes) or provide labor, they had to travel to and from the capital by carrying their own supplies of food to fulfill their duties. Travelers would suffer from hunger and diseases and may fall dead along the way. For this reason, Gyoki built welfare facilities, called "Fuseya," to practice the Ritagyo, providing food and lodging to the travelers and thus save them. While propagating adherence to the Ritagyo, Gyoki led practiced his teachings by leading people to construct civil-engineering works with funding from local powerful families, digging irrigation reservoirs and ditches, opening roads, building bridges and more (Figure 1-1-3). These activities not only resulted in a growing number of people following Gyoki's teachings but also enriched the powerful families' land. In 723, the Sanze-isshin Law, or a law that endorses the ownership of reclaimed land for three generations, was enforced to revise the land system then based on public land ownership, to authorize those who had reclaimed land to owner for a certain period of time, encouraging voluntary reclamation. Such change to Japan's land system helped broaden

Note In Shoku Nihongi" (Chronicles of Japan, Continued) compiled in 717, Gyoki is mentioned as a Shaveling Gyoki" ("shaveling" meant to disgrace a monk).

Gyoki's sphere of activities, with his reputation rising higher. Gyoki's such social enterprises soon won recognition from the imperial court.

Figure 1-1-4 A scene from the upper volume "Gyoki Building a Bridge" of Gangoji Gokuraku-bo Engi Emaki (Handscroll of the Legends of Gokuraku-bo at Gango-ji Temple)



Source) Image courtesy of the Gangoji Institute for Research of Cultural Properties.

In the wake of a heightening chain of social anxieties, including an outbreak of smallpox, famine and political rivalry, Emperor Shomu issued an "Order to Construct a Statue of Birushana Buddha" in 743 as a token of his prayer for the nation's stability. Gyoki was chosen to drive the construction of the great image of Buddha in this project, because nobody else could have probably been equal to the task of undertaking such large-scale public works by raising a huge amount of money and getting an

innumerable number of workers to work. Two years later, Gyoki was promoted to the position of Japan's first Daisojo (a Buddhist priest of the highest order) by Emperor Shomu to top the official priests' hierarchy. Gyoki passed away in 749, when he was recorded as Gyoki Bosatsu (Bodhisattva) in Shoku Nihongi" (Chronicles of Japan, Continued) cites him as Gyoki Bosatsu (Bodhisattva) for the sake of his achievements, blessing and so on. The diverse trails Gyoki had left behind have survived many centuries since to tell us of a typical example of a private initiative to develop social infrastructures in the ancient days of Japan.

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(2) Medieval times - Opening of the era of the warrior class and the development of infrastructures -

Through the medieval times in which a warrior government came into existence, a nation of decentralized governance that built on feudalism lasted as distinct from one of centralized governance based on Ritsuryo. Accordingly, the nation's infrastructures trended more towards regional development rather than uniform, nationwide deployment.

The Kamakura shogunate government worked to turn the capital of Kamakura into a large fortress not found in the ancient times. It built Kirigishi (bluffs), Horikiri (water-filled moats) and Kiridoshi (paths cut through mountains), roads with guttering and rivers with revetments. Wakaejima Island built at the proposal of a Buddhist priest, O-amidabutsu, is well known as the oldest port left to date. As a road policy, Minamoto no Yoritomo enforced the Law

of Post Roads in 1185 to lay the Tokai-do Road between Kamakura and Kyoto. Further, Kamakura Roads were developed for local warriors to rush to Kamakura in times of emergencies often expressed in the saying "Iza Kamakura." Further, officials known as "Hobugyonin" were appointed to manage lands and roads in the city of Kamakura, fix bridges and clean up roads.

As the period of warring states sets in, leading warring lords appeared. These lords embarked on programs to develop infrastructures in their own territories in an effort to boost their national power. A typical example is the repair works of the merging section of Kamanashi River and Midai River flowing Kofu Basin undertaken by Shingen Takeda. Generally

Figure 1-1-5 Shingen Zutsumi (Shingen Banks)



Source) Ministry of Land, Infrastructure, Transport and Tourism (MLIT)

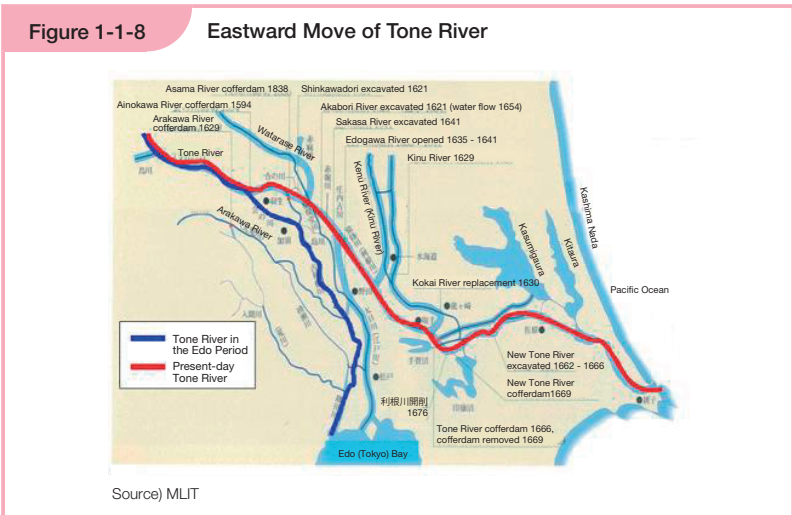
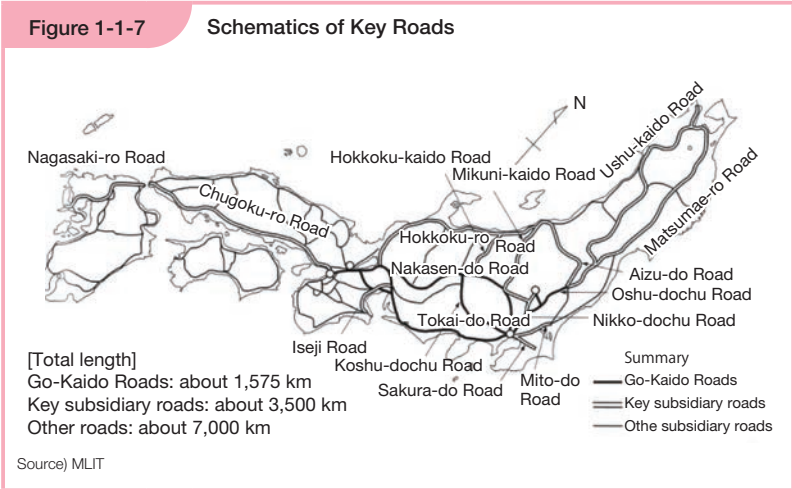
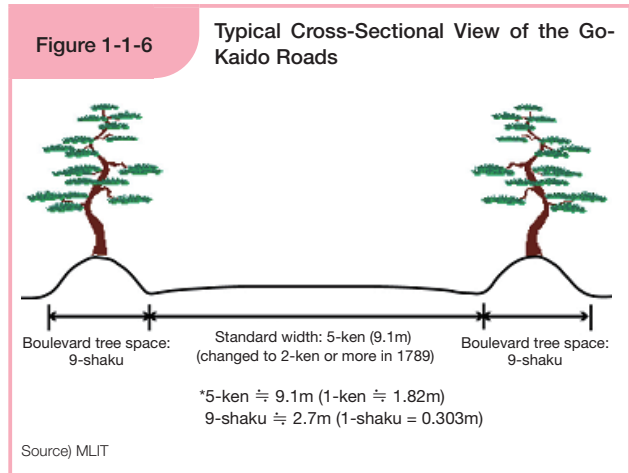
known as “Shingen Zutsumi (Shingen Banks),” the works encompassed a broad suite of flood control techniques, including embankment, water sharing, open levees and retardation. A Shinto shrine was built on the banks, where festivals were purportedly held to attract visitors to let them tread on and consolidate the banks (Figure 1-1-5).

(3) Modern times - Development of infrastructures in times of peace -

In the Edo Period in which the Tokugawa shogunate regime was in firm position, a state of national tranquility lasted about 270 years to encourage the regional, as well as nationwide, development of infrastructures. The shogunate government of Edo was a centralized entity but had power to reshuffle, diminish or divide the feudal lords’ territories at its discretion and imposed obligations on the feudal lords to provide the money and labor needed to help it build infrastructures on its own in the civil-engineering and construction works called “Otetsudai-bushin.”

Go-Kaido Roads, or the five key roads, are typical of the highways developed during the Edo Period. The five land routes starting from Edo were kept under direct supervision from the Tokugawa shogunate government - Tokai-do Road, Nakasen-do Road, Nikko-dochu Road, Oshu-dochu Road and Koshu-dochu Road. Each of these roads had post stations set up at fixed intervals and each station was required to keep horses available at all times under a Tenma-sei, or transportation system. The Go-Kaido Roads were managed by Road Magistrates, who regulated post stations, repaired roads and bridges, preserved boulevard trees and milestones and more. Day-to-day maintenance and management tasks were undertaken by roadside post-station townsmen and villagers, while larger works were carried out by daimyo, or feudal lords, and daikan, or local governors. Because the roads were treaded not only by daimyo traveling to and from Edo to fulfill their duty for alternate year-attendance at the Tokugawa shogunate government but also by merchants and the general public, the roadside amenities were frequently maintained and fixed.

Flood control projects continued to grow in scale and technologies advanced. In the Kanto Plains, Kanto Region Magistrate Ina Bizennokami Tadatsugu and his descendents changed the course of Tone River then flowing into the present-day Tokyo Bay eastwards to flow into Choshi on the coast of Pacific Ocean in an effort to defend Edo from recurring flood damages in a 60-year major flood control project known as “Eastward Move of Tone River” (Figure 1-1-8). Flood control works conducted during the Edo Period were



supervised by the shogunate government, with their expenditures being shared among the shogunate government, clans, villages and so on in the ratios predetermined according to the scale of the works, such as governmental, public, lord and private works.

As for sewage systems, stone-built sewer ditches, called “Taiko (or Sewari) Gesui,” allegedly built by Hideyoshi Toyotomi in the late days of the medieval times in Osaka, were expanded in the Edo Period as they were maintained and managed at the responsibility of townspeople from different districts. Records state that ditch cleanup work, called “Suido Sarae,” was carried out jointly by townspeople from these districts and the ditches repaired at their expenses. The Taiko Gesui was later transferred to the Meiji Government, and part of the system is still used at present.

The prototype of the modern urban park in Japan is said to date back to the Edo Period. Yoshimune, the eighth shogun, planted cherry trees in Asukayama Hill near Oji Gongen Shrine to make it a place for viewing cherry blossoms. In addition, the present-day guidebooks were published, including “Edo Meisho-zue” (a pictorial guide to the sights of Edo). Thus, there were places like the modern parks in the Edo Period, where people would gather and feel the nature of the four seasons.

Column

Private Management of Eitai Bridge in the Edo Period

In the winter of 1657, a large-scale blaze, generally known as the “Great Fire of Meireki” set Edo on fire, reportedly burning down about 60% of all the towns of Edo. Later, Daimyo’s residences, Buddhist temples and Shinto shrines were distributed in a wider area and broad streets built from a disaster preparedness viewpoint, with densely populated towns spreading into locations, such as Honjo and Fukagawa, in the Koto District then in the outskirts of Edo. In line with the expanding sphere of Edo, Ryogoku Bridge was built across Sumida River in 1660, followed by Eitai Bridge in 1698, spurring the metropolitan Edo to grow into the so-called “Eight Hundred and Eight Towns of Edo. Eitai Bridge was first built at the Big Ferry of Fukagawa, about 200m downstream from the present bridge location. The huge wooden bridge was 207 meters long and 6.8 meters wide, with clearances of at least 3 meters to allow vessels to pass even in times of spring tides.

Eitai Bridge is widely known as a passage way for the forty-seven ronin en route to Sengakuji Temple in Takanawa after they had broken into Kira’s residence to take their vengeance and is also reputed as a privately managed bridge in the Edo period.

While both Ryogoku Bridge and Eitai Bridge were built by the Edo shogunate government, maintaining and managing multiple long and large bridges could have imposed a heavy burden upon the

governmental finance. The removal of Eitai Bridge was decided in 1719 in the Kyoho Period as its pace of decay aggravated significantly. But as local townspeople filed a petition for continued existence of Eitai Bridge, the shogunate government authorized its survival, but subject to the bridge being maintained and managed by the townspeople on their own.

Then, the maintenance and management of the bridge by townspeople began, but it often suffered breakage as the piles were decayed by seawater and also under the influence of rainstorms and so on. In the circumstances, the shogunate government recognized that burdening the townspeople with all of the maintenance and management expenses incurred was no longer practicable and decided to authorize the collection of 2-mon per capita from the passengers, except for samurai, for a limited period of seven years from 1726. This was when the administration of the bridge, as well as its maintenance and management, by the townspeople began. The bridge toll thus collected financed the reconstruction of the bridge as early as in 1729. The shogunate government authorized the collection of bridge tolls by 1-mon and also as necessary to finance its renovations incurred by its destruction by fire, washout and so on for 10 years from 1736.

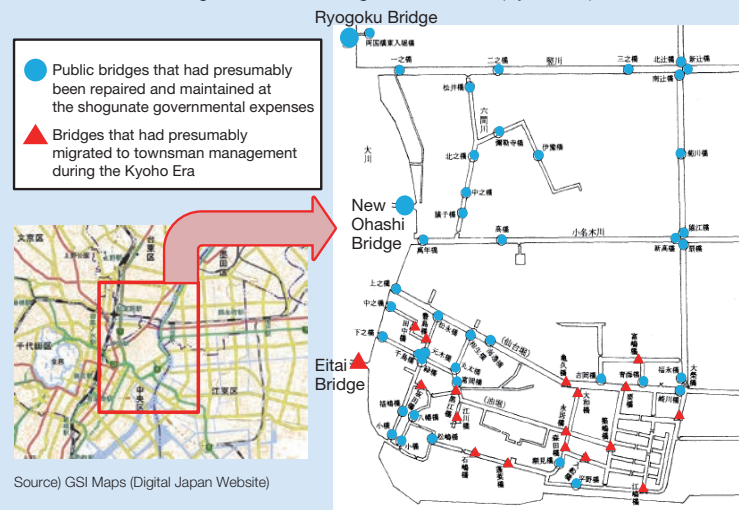
In 1807, Eitai Bridge collapsed, leaving more than 500 dead reportedly on the date on which a festival

of Tomioka Hachiman Shrine in Fukagawa was held. The following year, the shogunate government rebuilt Eitai Bridge in its entirety, putting an end to the period of bridge maintenance and management by the townspeople. This story should tell that bridges had been recognized as an essential urban infrastructures in the Edo Period as well and as such were kept under government-private management.

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Figure 1-1-9 Status of Privatization of Bridges in the Honjo and Fukagawa Districts during the Edo Period (Kyoho Era)



Source) GSI Maps (Digital Japan Website)

Source) Hiroshi Matsumura, “Privatization of Edo Bridges during the Kyoho Era,”
Proceedings of Lectures on the History of Civil Engineering

Figure 1-1-10 Eitai Bridge in the Edo Period



Source) National Diet Library

(4) Modern era - Development of infrastructures in the course of Japan's steps towards modernization -

Founded in 1868, the Meiji Government returned lands and people to the Emperor, and abolished feudal domains and inaugurated prefectures and moved ahead with its goal of forging a new nation through the concepts of enriching the nation and fortifying its military strength and promoting new industry. In developing infrastructures, the government was active to introduce technologies from the U.S. and European nations, which had been progressively modernized through the Industrial Revolution, to achieve drastic leaps. The central and local governments were supposed to assume their own shares of the workload and spending needed to develop, maintain and manage infrastructures as stipulated in “River, Port and Road Repair Rules” promulgated in 1873. Examples of private capital leveraged to develop, maintain and manage infrastructures can also be found.

(Development of Traffic Infrastructures)

While the government opened the nation's first railway between Shinbashi and Yokohama (about 29 km) in 1872, the finance tightened gradually in the wake of the Seinan War or other conditions. Railway construction stalled after opening of the railway between Kyoto and Kobe in 1877. The construction of private railways financed by private capital gained more impetus subsequently. When Nippon Railways was incorporated with a view to laying private railways in 1881, the advantages of railway investment won recognition, and a private railway boom came around 1887. The Railway Construction Law enacted in 1892 consolidated a policy for driving the construction of railways in the primary initiative of the central government. As the Railway Nationalization Law was enacted in 1906, state-run railways came to command a little more than 90% of the nation's railways towards the end of the Meiji Period. With the opening of the Showa Period,

suburban train networks came to be developed keeping pace with the progress of urbanization. In 1927, Japan's first subway run by Tokyo Underground Railway came into service between Asakusa and Ueno by Tokyo Underground Railway.

When Yokohama Port opened in 1859, it was furnished with two docks eastward and westward. Main ships would stay at anchor offshore, and smaller barges would reciprocate between the docks and the main ships to carry freight and passengers. Opening of the railway between Yokohama and Shinbashi resulted in a bulking volume export and import freight at Yokohama Port, urging the development of facilities that allow direct mooring of larger main ships, but harbor works was not commenced instantly because of financial difficulties. It was not until 1889 when Japan's first harbor renovation works set into full motion. Through the implementation of the first phase of the renovation works (1889 to 1896) and the second phase (1899 to 1916), the construction of general-purpose harbor facilities furnished with railway sidings came to completion with berthing and cargo handling made easier, turning Yokohama into one of the world's leading ports. Following the Sino-Japanese War and the Russo-Japanese War, an accelerating transition of Japan's industrial structure, with its heavy industries progressing, dictated the nation to launch a political package aimed at ports and harbors to respond to the needs of the changing times. Then, the Port and Harbor Council was inaugurated under the jurisdiction of the Minister of Internal Affairs as an advisory body concerning the construction and planning of ports and harbors. The council submitted its recommendation titled "Policy for Selecting and Constructing Key Ports and Harbors" to the government in 1907 and designated four ports as Class 1 key ports and eight as Class 2 key ports to qualify for treasury subsidization. More key ports were added in pace with the growth of domestic industries.

Japan's history of airport building dates back to the construction of a military airfield in Tokorozawa, Saitama Prefecture 1911. In 1931, a state-run airport dedicated to civil aviation opened as "Tokyo Airport" (later "Haneda Airport"), furnished with one runway 300 m long and 15 m wide. Osaka Itami Airport completed in 1939 but, with the subsequent outbreak of World War II, air transportation was no longer available to civilians for private use as the nation moved into a war regime.

Road development lagged behind railway development as a whole, because the Meiji Government had a policy of prioritizing railways.

Japan's first road legislation is said to have been the stipulation that reads "those who undertake to execute projects for flood control, road repairs, etc. for convenience's sake shall be authorized to collect dues" issued in December 1871 as Grand Council of State Edict No. 648. This edict encourages private development of roads and bridges in return for granting a right to collect dues. It helped renovate Sayo-no-Nakayama Pass on the Tokai-do Road and lay a bridge across Tenryu River. In 1876, Grand Council of State Edict No. 60 was issued to classify all roads into three categories: national roads, prefectural roads and vicinal roads. In 1885, 40 national road routes were authorized. Later, the Road Bill was debated at the Imperial Diet starting from 1896. The former "Road Law" was established in 1919, which had played a central role in Japan's road administration until the present Road Law was enacted in 1952.

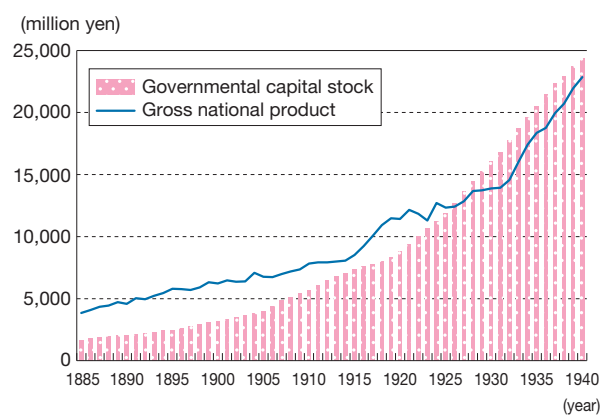
(Development of Infrastructures in Daily Livelihood)

As for river control, low-water river works were conducted to rectify and dredge channels and thus to animate river traffic, then a primary means of mass-transportation. The development of railway networks since the middle of the Meiji Period, however, eroded river traffic, with the result of the significance of low-water river works shrinking. In the meantime, flood damages occurred frequently on large rivers, such as Yodo River, Tone River and Kiso River, arousing a need to put drastic flood control measures into action. A subsequent transition to high-water works by embankment was instrumental in gradually diminishing flood damages.

Arakawa Discharge Channel was one of these. Its master plan was formulated as a drastic measure to protect downtown Tokyo from flood damages in the wake of a catastrophic flood in 1910. Its construction was commenced in 1911, the following year. The works was pursued by making maximum use of manual excavation, mechanical excavation,

Figure 1-1-11

Gross National product and Governmental Capital Stock in Modern Japan



(Note) Values are based on the 1934 to 1936 prices.

Source) Developed by the MLIT from "Economic Growth of Modern Japan" authored by Kazushi Okawa and Ryoshin Minami and from "National Income (Long-Term Economic Statistics 1" authored by Kazushi Okawa, Nobukiyo Takamatsu and Yuzo Yamamoto.

mechanical dredging and so on but its progress was made most difficult by the Great Kanto Earthquake in 1923 and the like. The construction of the channel came to completion in 1930 after a 20-year period. Arakawa Discharge Channel has curbed flooding from Arakawa River or else, adding to the disaster preparedness of the surrounding areas.

With the progress of urbanization, inundation damages from heavy rainfalls and outbreaks of infections induced by stagnant sewage systems prompted the construction of European-style modern sewage systems capable of removing sewage, such as the brick-made large sewage system in Yokohama whose construction started in 1881 and the Kanda sewage system in Tokyo whose construction started in 1884. Later, the Sewage System Law was enacted in 1900, followed by Mikawajima Sewage Treatment Plant coming into service in 1922 to mark the beginning of Japan's history of sewage disposal. But such sewage systems were short of nationwide dissemination because the development of water works was prioritized over sewage systems when it came to developing a hygienic environment.

Japan's history of urban park development began in 1873, when Grand Council of State Proclamation No. 16 was released to convert those places where people would get together and amuse themselves, as by viewing green vegetation as they did during the Edo Period, to public land for use as "parks" and make them accessible to the public. In the then Prefecture of Tokyo, Asakusa Park, Ueno Park and others were designated "parks." Hibiya Park, which opened in 1903, was Japan's first modern urban park built on a planned basis. Modeled after a Western park, Hibiya Park offered a design prototype for the urban parks that were subsequently developed in various parts of Japan.

(5) From the postwar years to the present day

Emerging from a period of revitalization, Japan entered a period of rapid economic growth around 1955 and moved on to settle in a period of stable growth since the oil-triggered crises in 1973. Since the economic bubbles collapsed in the early 1990, Japan has found itself in a period of low economic growth to date.

Regarding the total usage, development and preservation of national land, a chain of five Comprehensive National Development Plans have been formulated since 1962 in accordance with the Comprehensive National Development Law to define the futures of comprehensive national land development from long-term and national economic perspectives. Regional promotion policies, social capital development programs and the like have been put into action pursuant to these plans (Figure 1-1-14). The development of infrastructures by category has been driven by formulating infrastructure-specific long-term plans, including the Five-Year Road Development Program of 1954, to define guidelines from long-term perspectives (Figure 1-1-15).

Figure 1-1-12

Former Iwabuchi Watergate at the Time of Completion



Source) MLIT

Figure 1-1-13

Large Sewage Works Made of Bricks in Yokohama



Source) MLIT

Figure 1-1-14 Comprehensive National Development Plans Developed To Date

	First Comprehensive National Development Plan	New Comprehensive National Development Plan	Third Comprehensive National Development Plan	Fourth Comprehensive National Development Plan	Grand Design for National Land for the 21st Century
Cabinet Council Decisions	October 5, 1962	May 30, 1969	November 4, 1977	June 30, 1987	March 31, 1998
Background	1 Migration to rapidly growing economy 2 Escalating overpopulated city issues and income gaps 3 Income doubling plan (Pacific Belt Zone Initiative)	1 Rapidly growing economy 2 Concentration of population and industries in major cities 3 Progress of computerization, internationalization and technical innovation	1 Consistently growing economy 2 Signs of decentralization of population and industries 3 Evidence of limited availability of national land resources, energies and so on	1 Centralization of population and facilities in Tokyo 2 Worsening of employment problems in rural areas due to rapid changes in the industrial structure, etc. 3 Progress of full-scale internationalization	1 Era of the Earth (global environmental issues, stiffening competition, exchange with Asian nations) 2 Era of depopulation and aging 3 Era of advanced computerization
Target year	1970	1985	About 10 years from 1977	About 2000	2010 to 2015
Basic goal	Balanced inter-regional growth	Rich environment creation	Development of an integrated human living environment	Multipolar distributed national land building	Laying of groundwork for multiaxial national land structure formation
Development method, etc.	Site-based development method In the light of the necessity to decentralize industries to achieve goals, lay out development sites in conjunction with existing major industrial complexes, such as Tokyo, and interconnect these sites by means of traffic and communication facilities. At the same time, drive development activity on a chain reaction basis while taking advantage of characteristics of the neighboring areas to achieve balanced inter-regional growth.	Large-scale development project initiative Develop networks of Shinkansen, expressways and the like to propel the implementation of large-scale projects, correcting biased patterns of land usage and dissolving the problems of overpopulation, underpopulation and inter-regional gaps.	Settlement initiative Promote regional development while curbing the concentration of population and industries in major cities, and keep national land usage balanced to form a human-oriented integrated living environment.	Exchange network initiative To build a multipolar decentralized land: (1) Drive regional development through originality and ingenuity while taking advantage of regional characteristics. (2) Drive the development of vital systems of transportation and information and telecommunications on the central government's own or pursuant to its leading guidelines. (3) Form various exchange opportunities through partnership among the central and local governments and private sector groups.	Participation and Partnership - National Land Planning through Participation of Various Entities and Regional Partnership - (Four Strategies) 1 Create nature-oriented living areas (small cities, agricultural and fishing villages, intermediate mountainous areas, etc). 2 Renovate major cities (fix, renew and utilize urban spaces) 3 Develop axes of inter-regional partnership (as a core of inter-regional partnership linked in an axial form) 4 Broad-area international zones (spheres of global exchange)

Source) MLIT

Figure 1-1-15 Long-Term Development Programs in Respective Fields

Name	Five-Year Road Development Program	Seven-Year Harbor Facility Development Program	Seven-Year Sewage Works Development Program	Seven-Year Airport Facility Development Program	Seven-Year Development Program for Urban Parks, etc.	Seven-Year Flood Control Program
Governing law	Emergency Measures Law for Road Development	Emergency Measures Law for Port and Harbor Development	Law on Emergency Measures concerning the Construction of Sewerage Systems	-	Emergency Measures Law for Development of Urban Parks, etc.	Emergency Measures Law for Flood Control and Forest Conservation
Planning period	First (FY1954-FY1958) Second (FY1958-FY1962) Third (FY1961-FY1965) Fourth (FY1964-FY1968) Fifth (FY1967-FY1971) Sixth (FY1970-FY1974) Seventh (FY1973-FY1977) Eighth (FY1978-FY1982) Ninth (FY1983-FY1987) 10th (FY1888-FY1992) 11th (FY1993-FY1997) New (FY1998-FY2002)	First (FY1961-FY1965) Second (FY1965-FY1969) Third (FY1968-FY1972) Fourth (FY1971-FY1975) Fifth (FY1976-FY1980) Sixth (FY1981-FY1985) Seventh (FY1986-FY1990) Eighth (FY1991-FY1995) Ninth (FY1996-FY2002)	First (FY1963-FY1967) Second (FY1967-FY1971) Third (FY1971-FY1975) Fourth (FY1976-FY1980) Fifth (FY1981-FY1985) Sixth (FY1986-FY1990) Seventh (FY1991-FY1995) Eighth (FY1996-FY2002)	First (FY1967-FY1971) Second (FY1971-FY1975) Third (FY1976-FY1980) Fourth (FY1981-FY1985) Fifth (FY1986-FY1990) Sixth (FY1991-FY1995) Seventh (FY1996-FY2002)	First (FY1972-FY1976) Second (FY1976-FY1980) Third (FY1981-FY1985) Fourth (FY1986-FY1990) Fifth (FY1991-FY1995) Sixth (FY1996-FY2002)	First (FY1960-FY1964) Second (FY1965-FY1969) Third (FY1968-FY1972) Fourth (FY1972-FY1976) Fifth (FY1977-FY1981) Sixth (FY1982-FY1986) Seventh (FY1987-FY1991) Eighth (FY1992-FY1996) Ninth (FY1997-FY2003)
Target facility	Roads	Breakwaters, sear routes, berths, etc.	Sewage systems	Airport and aeronautical navigation aids	Urban parks	embankment, dams, etc.

Source) MLIT

Categorized long-term plans have been integrated into Prioritized Social Capital Development Plans to consolidate cross-sectional inter-business collaboration and spurt the development of infrastructures in a more prioritized, effective and efficient manner. In addition, the Comprehensive National Land Development Law was refurbished in its entirety as the National Spatial Planning Law in 2005 to allow National Development Plans to respond to the needs of an increasingly

mature society while valuing more of the aspects of “preservation,” such as existing stock utilization and harmony with natural environments. Responsive to this move, National Spatial Strategies^{Note 3} were formulated in 2008, which have been enforced to date.

Because the work of developing, maintaining and managing infrastructures generally is not compatible with market principles, it has been carried out at the primary initiative of public offices, but a review of the shares of the responsibility between the governmental and private sectors has been underway to reflect continuing global trends towards privatization. In railways, for example, a JNR privatization reform that took place in 1987 put an end to the 115-year-long history of national railways that had been owned and run by the nation since 1872, passing over the railway services to a newly incorporated JR. The New Tokyo International Airport Authority dissolved in 2004 to launch Narita International Airport Corporation.

As a scheme of infrastructure development, maintenance and management, PFI has launched since 1999 pursuant to the provisions of the Act on Promotion of Private Finance Initiative since it came into being first in the U.K. In 2011, efforts followed to encourage further PFI usage, which included expanding the scope of facilities that qualify for PFI and inaugurating a system of suggestion by private entrepreneurs and a right to administer public offices, etc.

Thus, Japan has such a long history of infrastructures development, maintenance and management dating back to the ancient times that its infrastructures have been developed, maintained and managed to suit the social situations of the times, as well as the relationships between the nation and locals and between the governmental and private sectors. The process of plotting the futures of infrastructures maintenance and management should be pursuing the most efficient, most effective way of management to address the challenges of the times with due regard given to such historical changes.

2 Roles of Social Infrastructures

As reviewed above, the lasting development of infrastructures from the olden days afterward has been motivated by expectations of their effects to revitalize our economic activities and enrich our living for long periods. While the effects of treasury disbursements are often discussed with regard to the flow effects^{Note 4}, their stock effects are reviewed below.

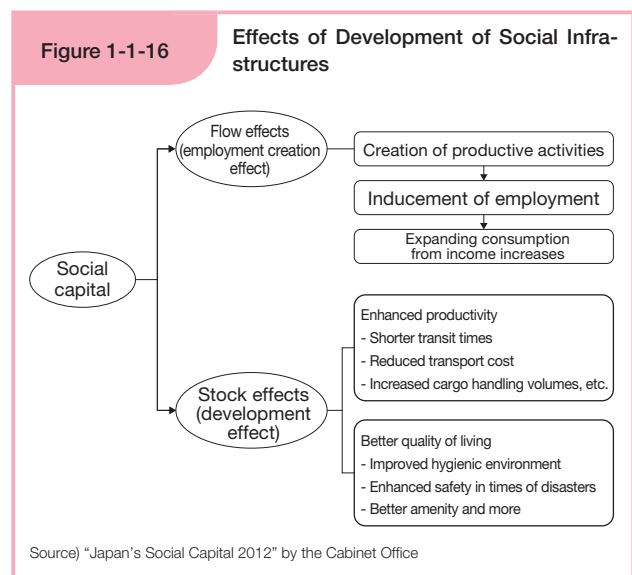
(1) Stock effects of social infrastructures

The stock effects of social infrastructures can be broken down into two categories (Figure 1-1-16):

- ① Productivity effect - Social infrastructures boost the productivity of economic activities by cutting transit times, reducing transport costs and so on, encouraging economic growth.
- ② Welfare effect - Social infrastructures help augment the quality of life by enhancing amenity, improving the hygienic environment, furthering safety in times of disasters and so on, making for better economic welfare.

Various studies have dealt with the stock effect so far. Particularly, a number of studies have focuses on the productivity effect. Productive factors that create economic growth can be classified into labor force, capital and all other productive factors (TFP^{Note 5}). Studies on productivity

effects grabbed attention when the possibility of explaining the fall in the rate of rise of TFP in the 1970s and after from its level in the 1960s with reference to the then disquieting issues of aging social infrastructures and their slow development



Note 3 The planning period is about 10 years from 2008.

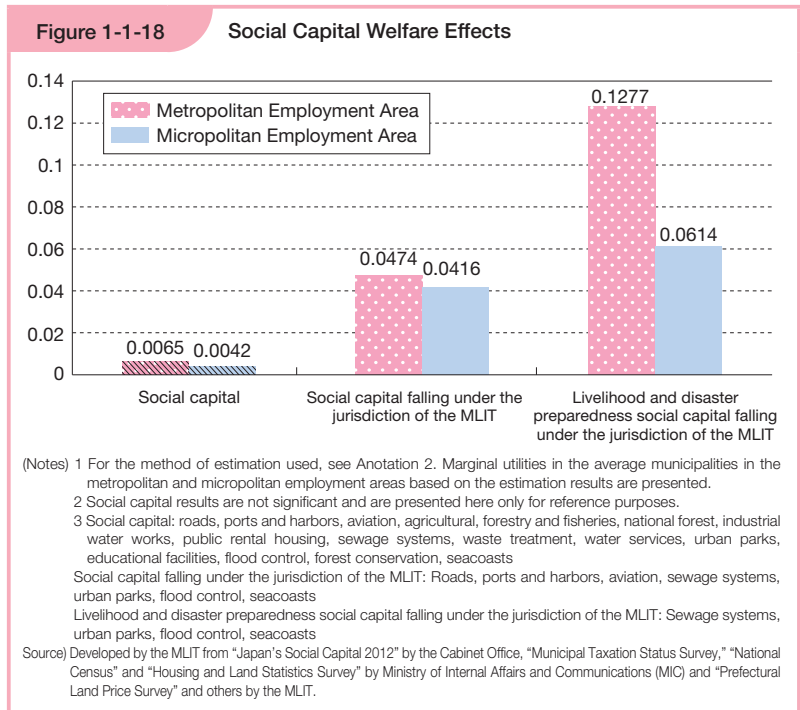
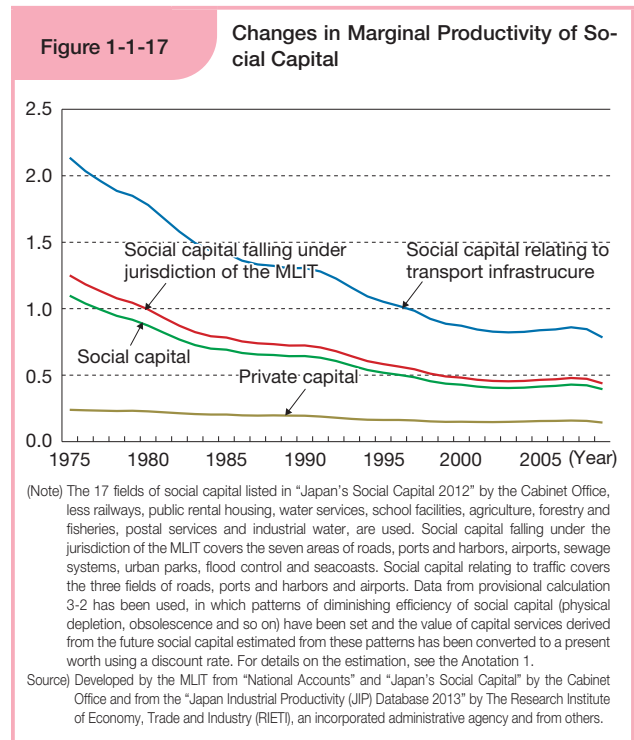
Note 4 The effects the implementation of a project aimed at developing a social infrastructure may have upon expanding consumption, as by purchasing raw materials, stimulating ripple demand for machinery and the like and inducing employment. Examples are the multiplier effect and inducement effect.

Note 5 Total factor productivity, or productivity that allows for all the factors that contribute to production, except for the quantity of labor input and the capital stock. Total factor productivity is considered to be enhanced by better productive efficiency and factors that encourage increased production, such as technical innovations.

was realized. Various kinds of empirical studies have been initiated in Japan as well^{Note 6}.

Figure 1-1-17 plots the results of a verification of the productivity effects of social capital using data from 1975 to 2009. A look at changes in the marginal productivity of social capital (a measure of to what extent production will increase when one additional unit of social capital is added) suggests that both private capital and social capital have diminished in marginal productivity in pace with the accumulation of capital but moved consistently with the onset of the 2000s. This is considered attributable to the effect of infrastructures that have been efficiently developed through cost-effective and other analyses since the beginning of the 2000s. Marginal productivity comparisons by social capital category indicate that social capital has high marginal productivity in those fields of transportation that presumably contribute directly to productive activities, such as roads, ports and harbors and airports. The extent to which infrastructures contribute to production is thus found to vary depending on characteristics of their categories.

Some prior studies attempted to verify the latter welfare effect. Figure 1-1-18 summarizes the results of verification of the welfare effects of social capital by using data classified by urban employment area^{Note 7}. Here, the welfare effect was verified in accordance with the concept of the capitalization hypothesis, whereby the benefit of an infrastructure developed in a given area is ascribed to the land rent (land price) as a result of increased demand for residential grounds in that area triggered by enhanced comfort and convenience. On the basis of the results of such verification, the marginal utility (a measure of to what extent the average land price will change when one unit of social capital is added) was calculated. According to information available from this website, if infrastructures are developed in a given area, the comfort and convenience of that area would be augmented and the effects of those infrastructures manifest



Note 6 Work, etc. presented by Aschauer, D.A. (1989) in "Is Public Expenditure Productive?" Journal of Monetary Economics, vol.23, pp.177-200 are said to be the first of such studies. Summaries of empirical studies in Japan so far include "Productivity Effects of Social Capital: Survey of Empirical Studies" authored by Osamu Murata and Taishi Ono (2001), "Public Investment and Road Policy" compiled by Junichi Nagamine and Taisuke Katayama, Keisoshobo and "Economic Analysis of Social Capital: Prospects" by Yasushi Iwamoto (2002) and Grant-in-Aid for Scientific Research on Priority Areas "Empirical Analyses of Programs" Discussion Paper No. 3.

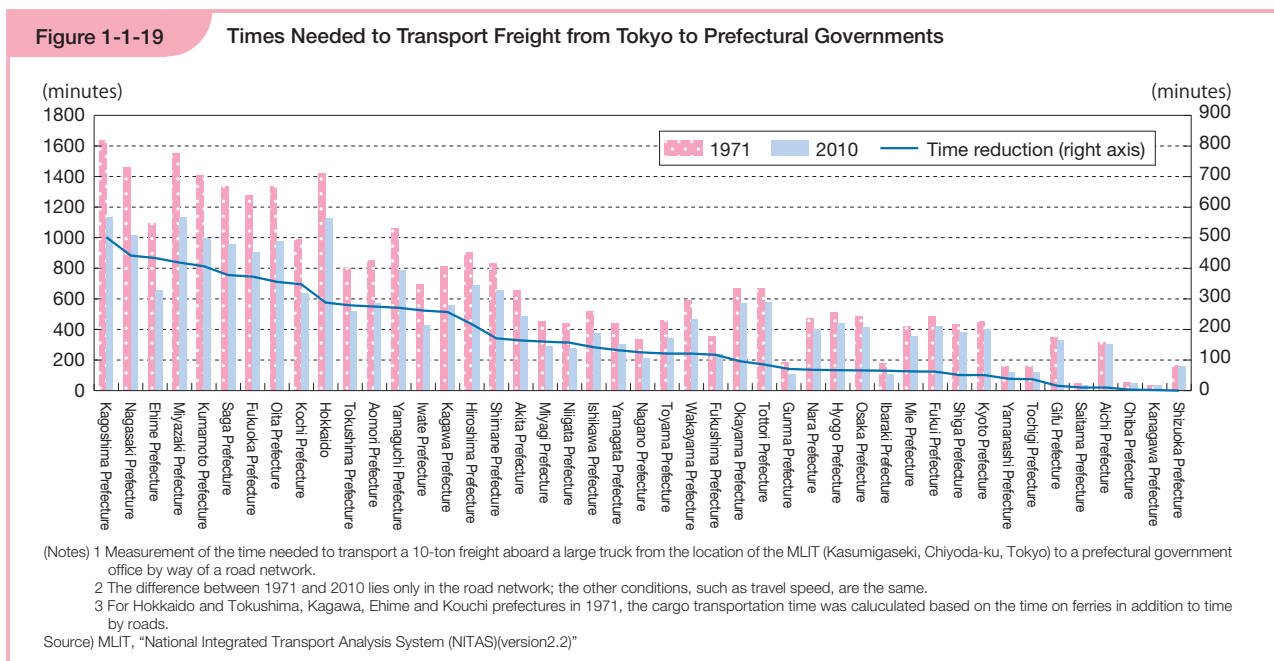
Note 7 An urban area is set by:(1) Locating central cities on the basis of a DID population, (2) Designating those municipalities having a commuting rate of 10% or more to travel to and from a central city as "urban cities" and (3) Allowing multiple central cities within each urban area. Urban employment areas are the concept of urban areas that have been suggested in "Japan's Urban Area Setup Criteria"(Yoshitsugu Kanamoto, Kazuyuki Tokuoaka (2002)), and the scope of each urban area has been published at the University of Tokyo Center for Spatial Information Science website (http://www.csis.u-tokyo.ac.jp/UEA/uea_code.htm).

themselves as rises in the land prices. Infrastructures in the fields of living and disaster preparedness are no exception to these effects. Infrastructures relevant to livelihood, such as sewage systems and urban parks, and those relevant to disaster preparedness, such as flood control and seacoasts, are found to help enhance comfort and convenience by improving local living environments and disaster preparedness.

Because such positive analyses more often than not yield different results depending on the data and the analysis method used, the results should be interpreted with some latitude taken into account. These findings suggest that the development of social infrastructures has positive effects from both economic and welfare aspects and stimulates greater simplicity in the flow of economic activity, making for added regional comfort and convenience.

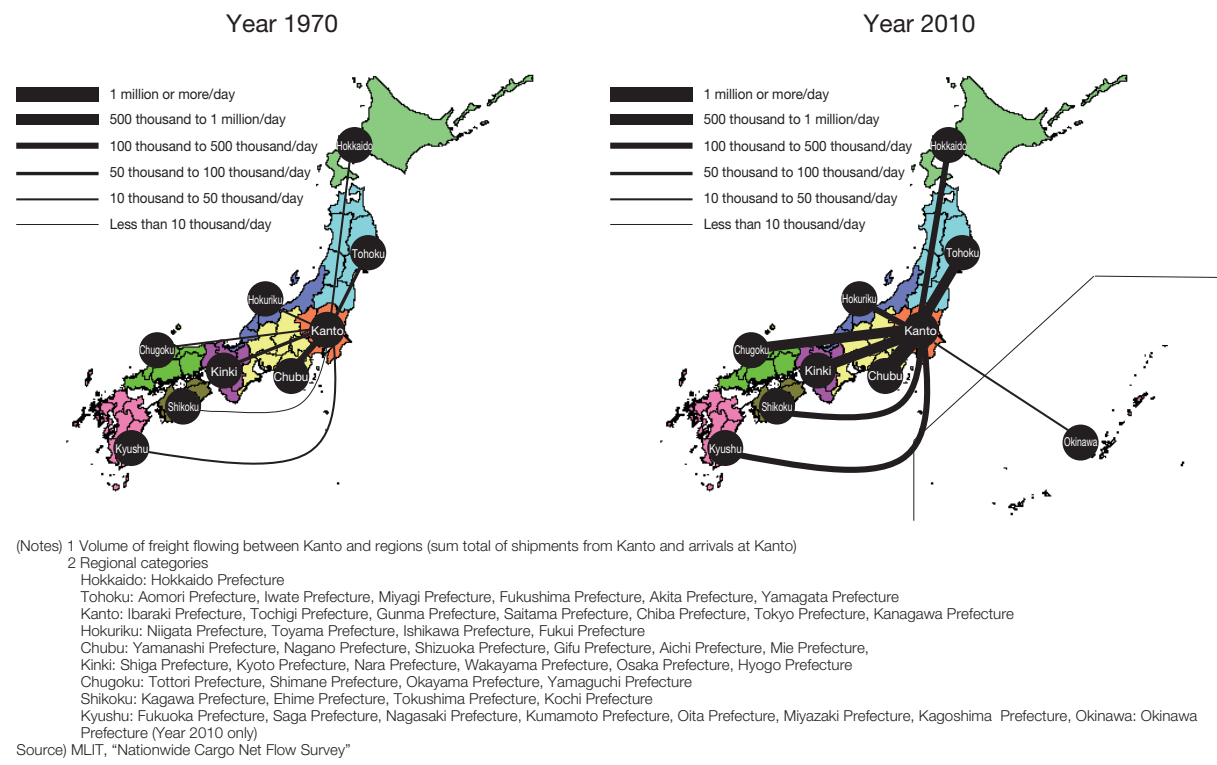
(2) Practical example of stock effects

Transit times trimmed by the development of transportation networks offer an intelligible example of the productivity effect. Figure 1-1-19 compares the times needed to transport freight to prefectural governments on roads starting from the location of the MLIT in 1971 and 2010. Obviously, enhanced transportation networks resulting from the development of expressways, etc. have cut the transit times drastically.



Comparisons of the volumes of freight flow nationwide in 1970 and 2010 indicate that inter-regional transport has animated (Figure 1-1-20). Various factors, such as changes in the nation's industrial structure, are conceivable, but business activities simplified through the development of transport networks to cut on the costs of transporting raw materials, finished products and so on may be responsible in part.

Figure 1-1-20 Comparisons of the Volumes of Freight Flow Arriving at and Leaving Kanto



Enhanced disaster preparedness and improved hygienic status are among the typical welfare effects.

As for disaster safety, water damages have been reduced steadily through the development, etc. of social infrastructures designed to control flooding from dams, riverbanks and so on (Figure 1-1-21). Although simple year-by-year comparisons are difficult to make because torrential rains, typhoons, etc. vary in their scale from year to year, the 10-year average of the flood damage-affected areas is found to have fallen in the 2000s to about one seventh of its level in the 1970s.

By prefecture, the scale of flood damages is found to have shrunk nationwide in the 2000s from the 1970s (Figure 1-1-22).

Next, let us look at an example of how the hygienic status has improved.

A growing stock of sewage systems, coupled with appropriate practice of their maintenance and management, has contributed greatly to the improvement of the water environment. A look at changes in the river BOD (river environmental

Figure 1-1-21 Changes in Flood Damage-Affected Areas (Nationwide)

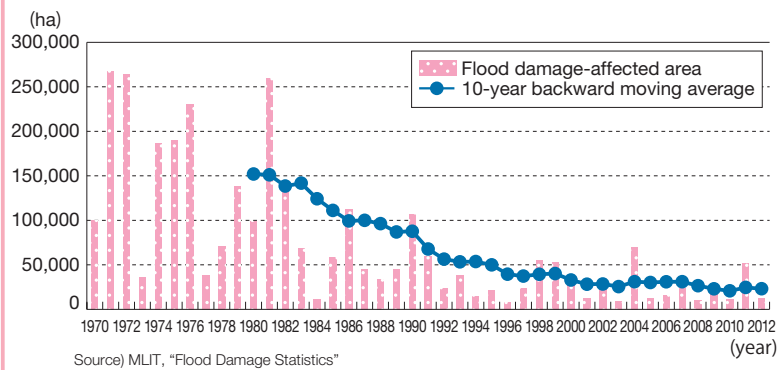
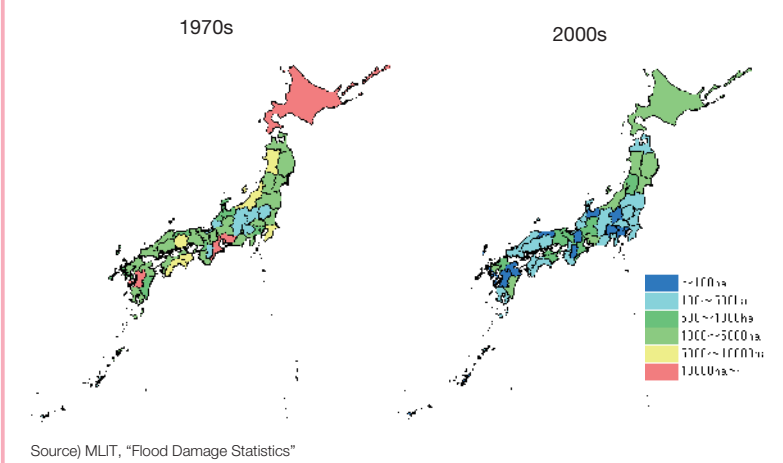


Figure 1-1-22 Flood Damage-Affected Area Comparison

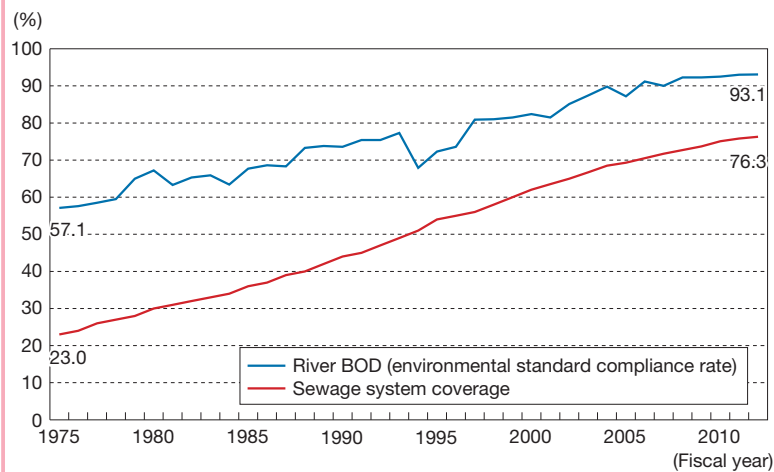


standard compliance rate^{Note 8}) and the sewage system coverage show that both have risen with time (Figure 1-1-23).

In addition, as the quality of public water improves, the estimated number of ayu (Japanese trout) running up Tama River flowing through Yamanashi, Tokyo and Kanagawa Prefectures and the catches of shijimi (Japanese freshwater clam) along the river have increased rapidly (Figure 1-1-24).

Figure 1-1-23

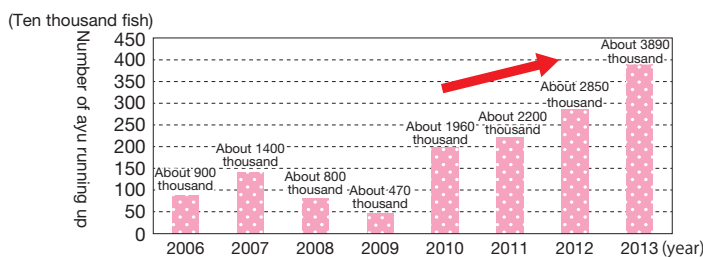
Changes in River BOD (environmental standard compliance rate), Sewage System Coverage, etc.



Source] Developed by the MLIT from "Public Water Quality Measurement Results" compiled by the Ministry of the Environment and from MLIT materials

Figure 1-1-24

Time-Related Changes in the Number of Ayu (Sweetfish) Running Up Tama River (Chofu Intake Weir)



Source] MLIT



The development of social infrastructures has contributed significantly to revitalization of the nation's economic activity and betterment of the national life. Such contribution has depended solely on perfection of their maintenance, management and upgrade. Continued efforts directed at the maintenance, management and upgrade of these social infrastructures should be a key to their successful functioning.

Section 2 Climate of the Economic Society Surrounding Social Infrastructures

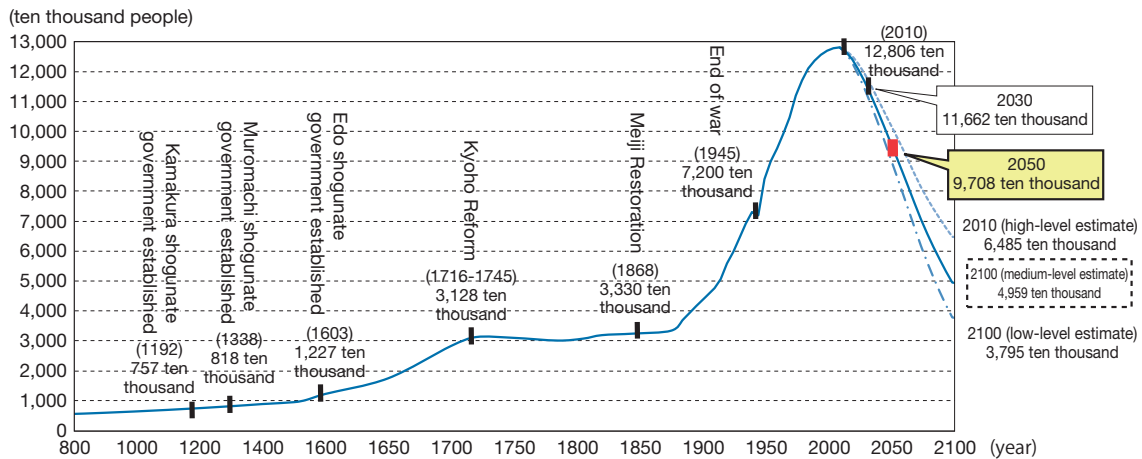
While social infrastructures have evolved in the course of a long history as reviewed in the foregoing section, the economic social status surrounding them has been changing drastically as the nation slips into a society of dwindling population, experiences tight financial positions and faces evolving disaster and other risks associated with climate changes.

1 Slipping into a Society of Sheer Dwindling Population

Japan's total population had yearly increased at an average rate of per annum since the Meiji Era but has now shifted into a period of long-term decline; it is predicted to revert to a size some 50 years ago (1965) in 2050 over a period of about 40 years from 2010 (Figure 1-2-1).

Note 8 The ratio of the number of water areas that meet the environmental criteria for BOD (biological oxygen demand), a typical water quality index of the organic contamination of rivers.

Figure 1-2-1 Long-Term Changes in Japan's Population

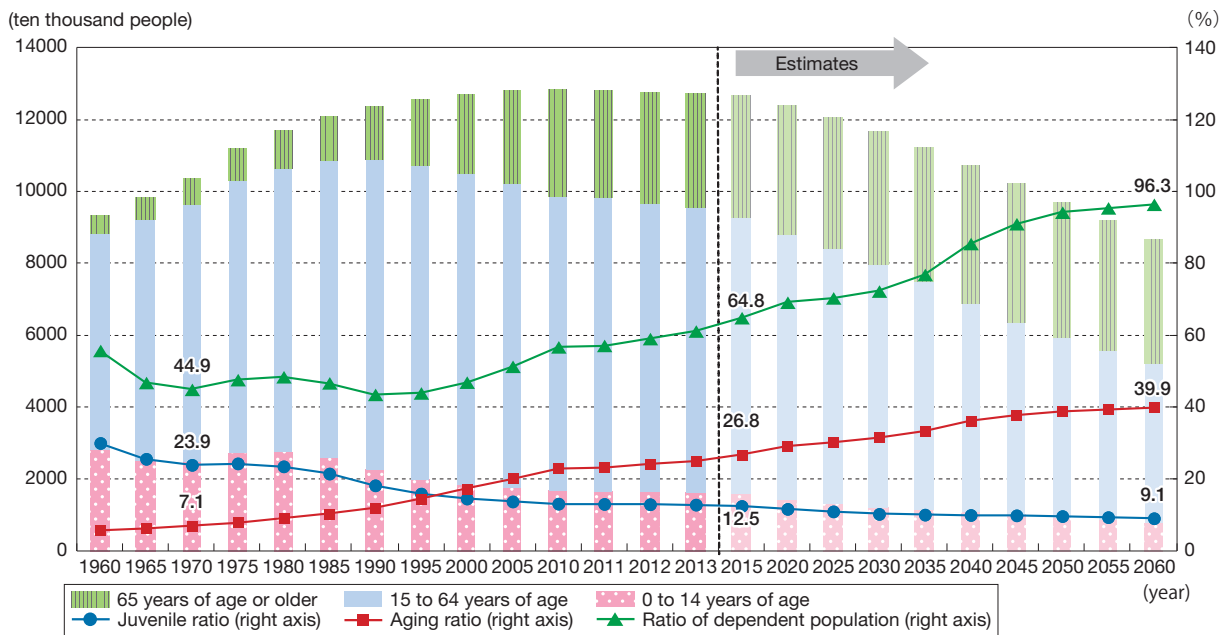


Source) Statistics for 2010 and earlier Developed by the MLIT from a "National Census" and "Basic Tallies of Population, etc. from 2010 National Census" by the MIC and "Long-Term Time Analyses of Population Distributions in the Japanese Archipelago" (1974) by the National Land Agency and statistics for 2015 and later from "Estimates of Japan's Future Population (January 2012 Estimates)" by the National Institute of Population and Social Security Research (NISS).

To view population changes in structural terms, apart from scales, the ratio of dependent population (sum total of the young population (14 years of age or younger) and elderly population (65 years of age or older) divided by the productive population (15 years of age or older but younger than 64 years of age), with the quotient being multiplied by 100) was calculated. From 1960 to the first half of the 1970s, or a period of rapid economic growth that sparked the wholesale development of social infrastructures, the ratio of dependent population remained low but started soaring from the latter half of the 1990. It is forecast to top 64.0 in 2015 and even reach 96.3 in 2060, when we brace for a society in which each worker supports one child or elderly individual.

After all, populations will continue to decline from now on a scale similar to that 50 years ago but in totally different age compositions (Figure 1-2-2).

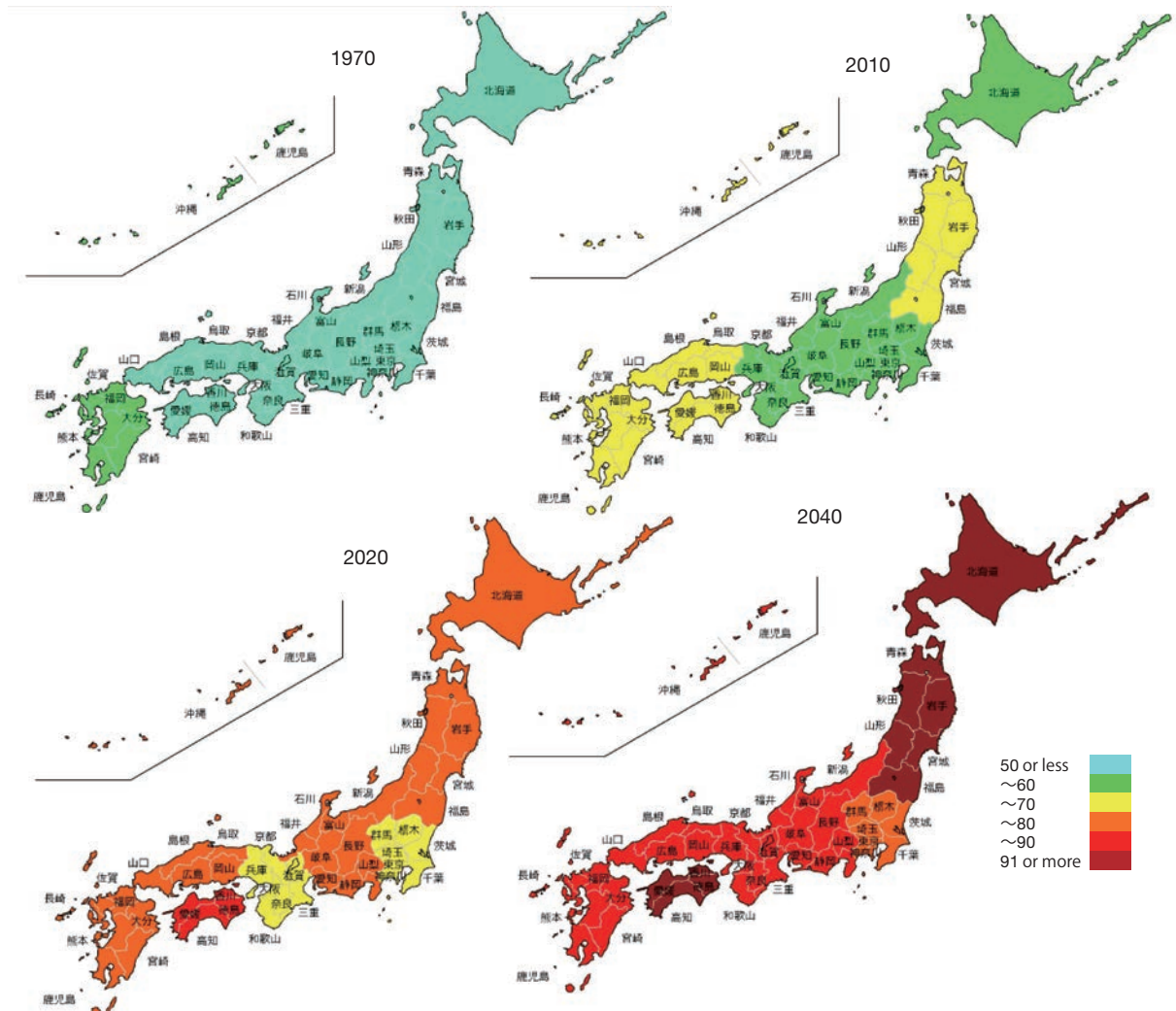
Figure 1-2-2 Changes in Population Age Compositions



Source) Developed by the MLIT from a "National Census" and "Population Estimates" by the MIC and medium-level estimates in "Estimates of Japan's Future Population (January 2012 Estimates)" by the NISS.

When looking at changes in the ratios of dependent population by region, the Kyushu region had the highest ratio of dependent population in 1970, each individual was supported by two. The Tokyo metropolitan area is predicted to have the lowest ratio of dependent population in 2040, in which each will be supported by 1.2 (Figure 1-2-3).

Figure 1-2-3 Changes in the Ratios of Dependent Population (by Region)



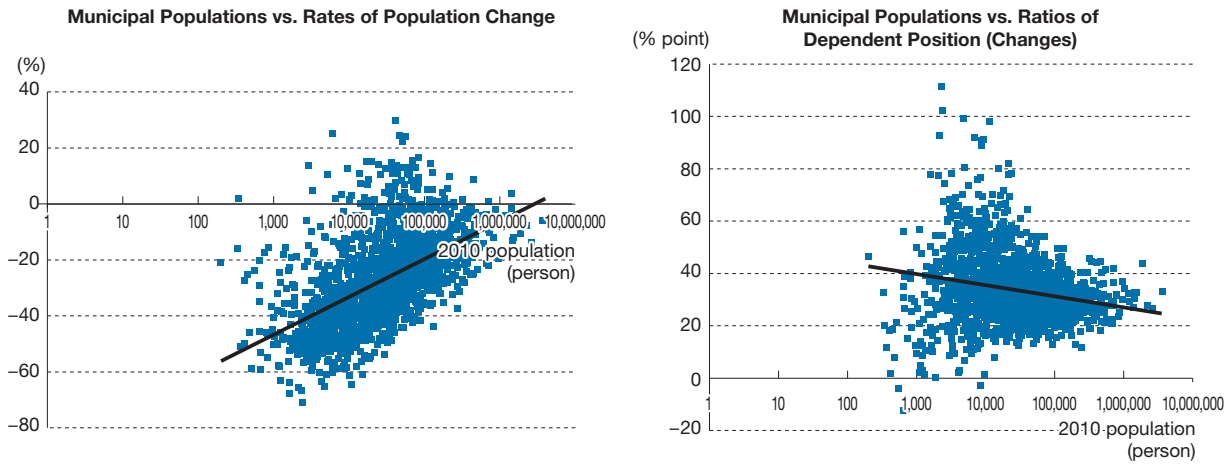
Source) Developed by the MLIT from the "National Census" for the population before 1970 by the MIC and "Estimates of Japan's Future Population (March 2013 Estimates)" for the population after 2010 by the NISS.

A look into the relationships between the municipal populations in 2010 and the anticipated rates of population rise/fall from 2010 to 2040 reveals that the less a municipality is populated, the higher its rate of population tends to get (Figure 1-2-4).

Further, in 63% of the total number of points (every 1 km²) nationwide, populations are predicted to slip more than 50% in 2050 from their 2010 levels, with about 20% of them being left uninhabited (Figure 1-2-5).

Figure 1-2-4

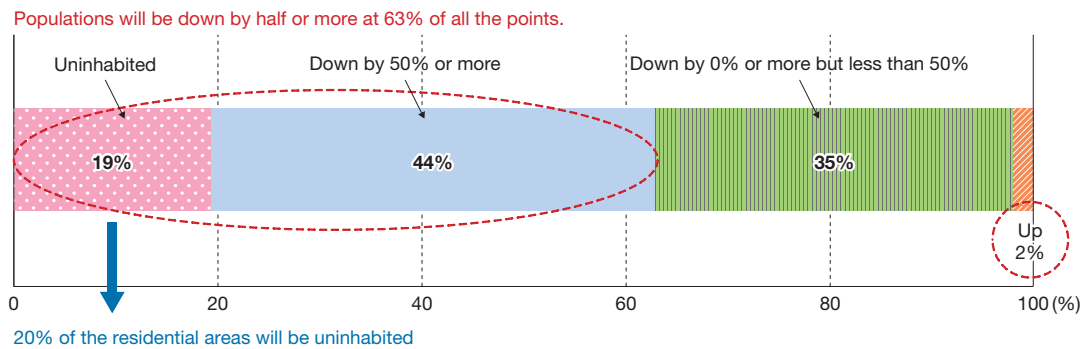
Relationships between Municipal Populations and Rates of Population Change and Ratios of Dependent Population (Changes) (from 2010 to 2040)



(Note) Excluding data from Fukushima Prefecture.
 Source) Developed by the MLIT from "Estimates of Japan's Future Population (March 2013 Estimates) by the NISS.

Figure 1-2-5

Number of Points Classified by Rate of Population Rise/Fall



Source) "Reference material relating to the blueprint of "New National Grand Design," MLIT.

The upcoming phase of depopulation will be characterized by smaller generations working to support larger populations of elderly people. This trend will be more pronounced in rural cities holding smaller populations. It would be necessary to remember this fact in exploring the way our economic society should be.

2 Sagging Economy and Stiffening International Competition

As explained earlier, Japan's population is forecast to dwindle in the future, exerting various effects of concern on our economic society. One of such concerns is the shrinking scale of the nation's economy in pace with diminishing population.

Trends in Japan's GDP suggest the growth rates in recent years have fallen from the 1980s (Figure 1-2-6). A look into the growth rates and shares of the nominal GDPs of member nations of the OECD also tells that our growth rate and share are on a downward trend (Figure 1-2-7).

Figure 1-2-6 Changes in Japan's GDP

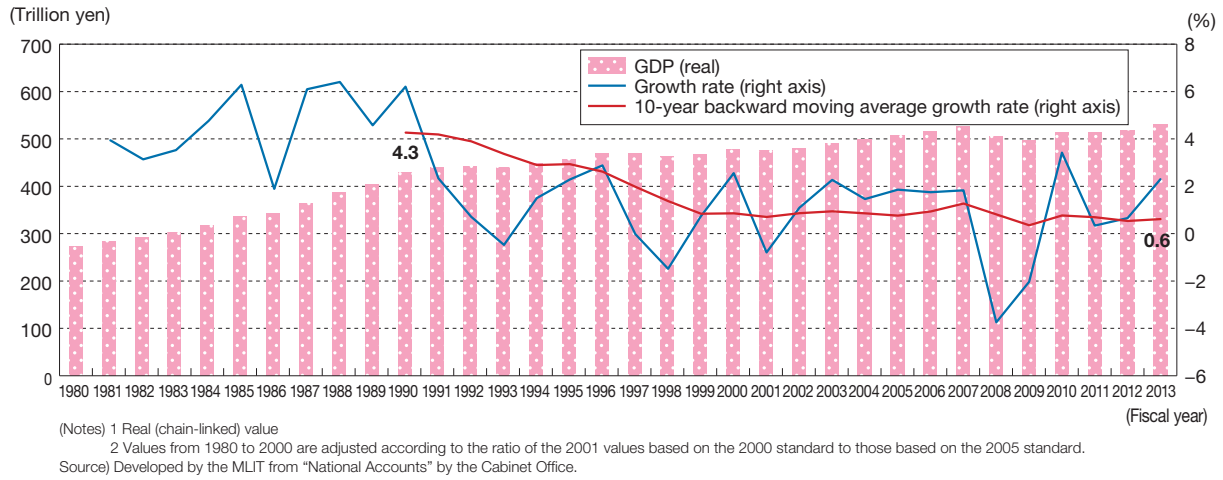
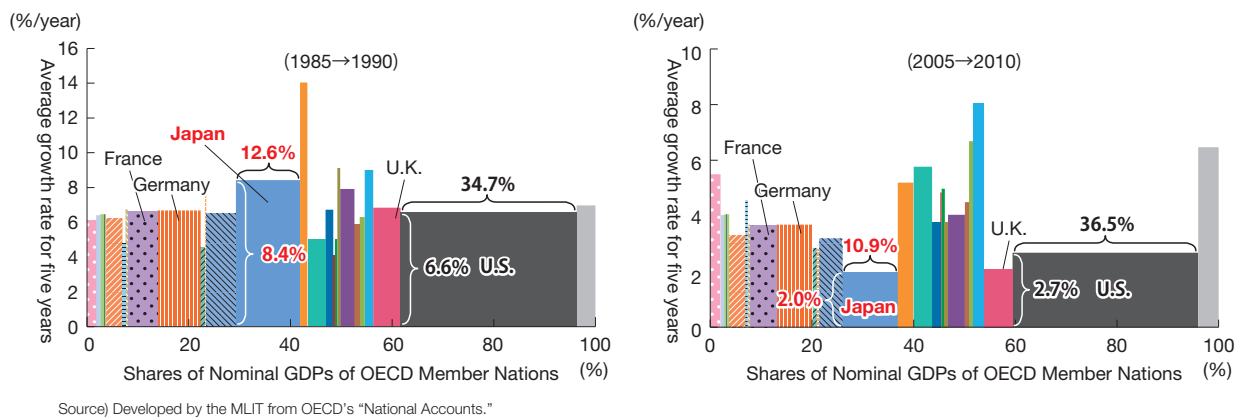
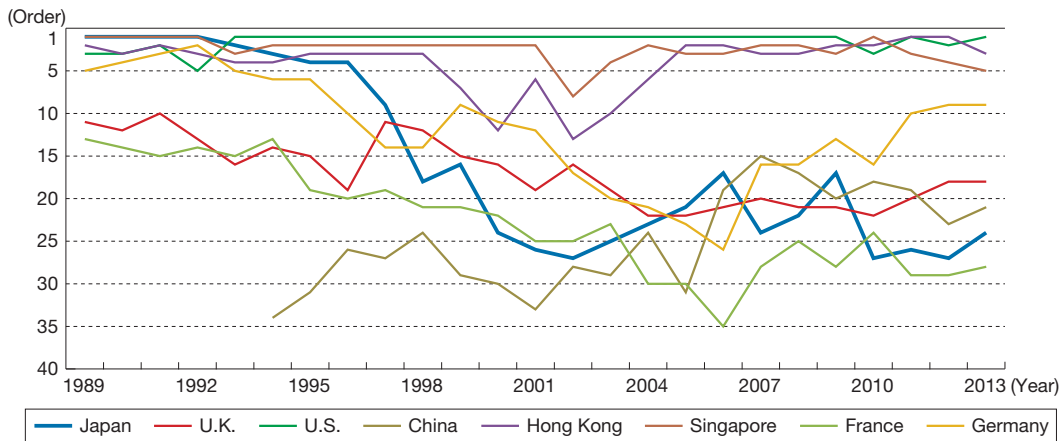


Figure 1-2-7 Growth Rates and Shares of Nominal GDPs of Member Nations of the OECD



Japan's international competitiveness is also on the decline amid sluggish economic activity. The International Institute for Management Development (IMD) defines competitiveness in its own terms on the basis of indexes that represent economic standing, governmental efficiency and so on and releases a competitiveness ranking of countries and regions each year. Japan used to rank high in this list in the early 1990s in the world, but slipped down from the latter half of the 1990s to move sideways on the 20th rank level in recent years (Figure 1-2-8).

Figure 1-2-8 Changes in International Competitiveness

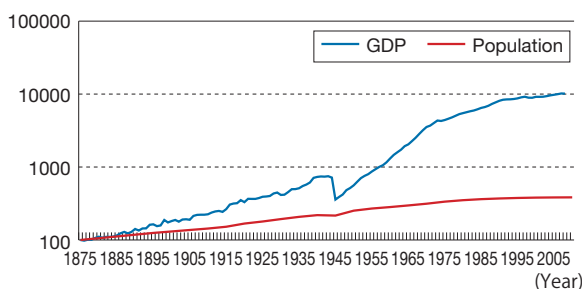


(Note) For 1989 and 1992, the orders have been published separately for the member nations (22) of the OECD and other regions (15).
 Source) Developed by the MLIT from "World competitiveness report 1995" for 1989 to 1992, "The competitiveness yearbook 1997" for 1993 to 1997 and its "The world competitiveness yearbook 1999" for 1998 to 1999, "The world competitiveness yearbook 2001" for 2000 to 2001, "IMD world competitiveness yearbook 2006" for 2002 to 2006, "IMD world competitiveness yearbook 2011" for 2007 to 2011 and "IMD world competitiveness yearbook 2013" for 2012 to 2013, all compiled by IMD.

It is true that economic growths are driven in one way by population increases (growing labor population), but analyses of the nation's long-term economic growth tell that the growth of its real GDP has by far outpaced the rate of population increases (Figure 1-2-9). This fact suggests that Japan's economic growth has been intensely influenced by factors other than population increases^{Note 9}.

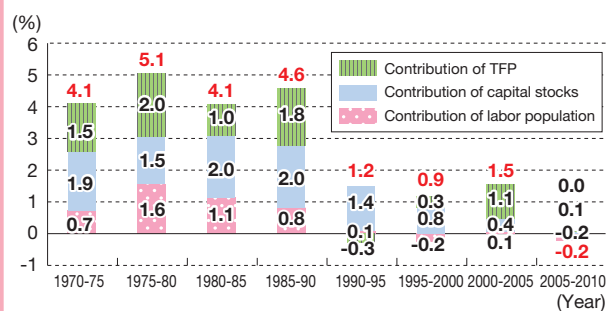
Taking a closer look at Japan's economic growth in the 1970s and after using a technique called "growth accounting"^{Note 10}, increasing labor population has had a relatively small share of contribution to the nation's economic growth, but it had its prime impetus derived more from increases in the capital stock and higher TFP up until 1990. In the 1990s in which the economic bubbles had burst, and after, the capital stock had a narrowing share of contribution to the nation's economic growth, when compared with a negative share of contribution of TFP from 1990 to 1995 and a zero share from 2005 to 2010 (Figure 1-2-10).

Figure 1-2-9 Japan's Population and Real GDP (1875 = 100)



Source) Developed by the MLIT from Angus Madison's "Historical Statistics of the World Economy: 1-2008 AD," a "National Census" and "Basic Tallies of Population, etc. from 2010 National Census" by the MIC and "Long-Term Time Analyses of Population Distributions in the Japanese Archipelago" (1974) by the National Land Agency.

Figure 1-2-10 Changes in Growth Accounting



Source) Developed by the MLIT from the "Japan Industrial Productivity (JIP) Database 2013" by The Research Institute of Economy, Trade and Industry (RIETI), an incorporated administrative agency.

Note 9 Refer to "Deflation" by Hiroshi Yoshikawa (2013).

Note 10 Growth accounting is a technique by which the sources of an economic growth are broken down into an increased capital stock, increased labor population and higher TFP to determine quantitatively which of the three sources contributes most to the economic growth. Assuming a Cobb-Douglas production function based on Y: GDP, A: technology level, K: capital stock, L: labor quantity, α: capital share and 1-α: labor share, GDP can be stated in an equation as $Y = AK^\alpha L^{1-\alpha}$. If logarithms of both sides of the equation are taken and differentiated with respect to time Y4, the following is derived:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha \frac{\dot{K}}{K} + (1-\alpha) \frac{\dot{L}}{L}$$

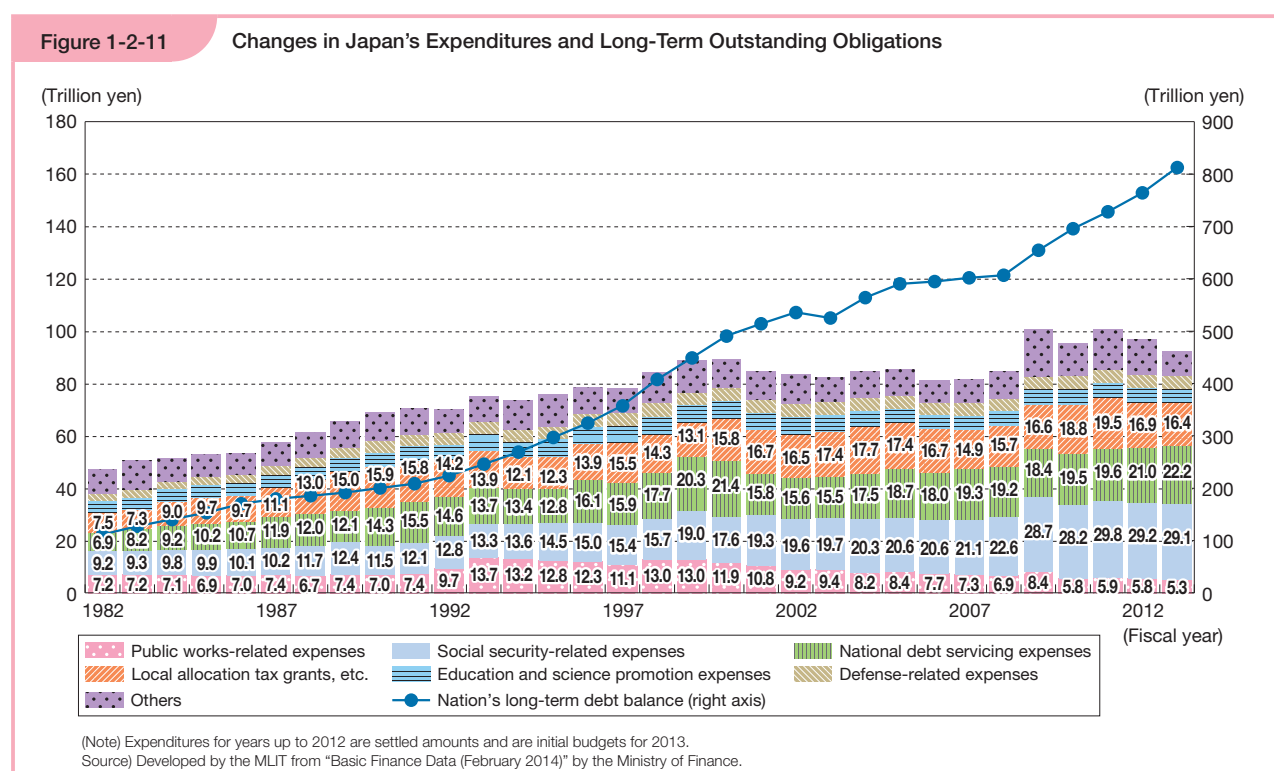
(where Y, A, K, and L are Y, A, K and L differentiated with reference to time, respectively.) Thus, the growth rate of GDP can be broken down into a technological advance, an increased capital stock, and an increased labor population.

Summing up, there is no doubt that dwindling labor population has a dampening effect on the nation's economic growth, but the way other contributing factors work should deserve equal notice in weighing the future course of our economic growth. The impact of shrinking labor population may be mitigated to some extent by pursuing a continuing program to promote the employment of women and elderly people and enhance individual workers' capabilities, but keeping up economic growth should dictate more than that, building up a capital stock and boosting TFP^{Note 11, Note 12}.

Namely, labor productivity needs to be boosted through higher productive efficiencies, technological innovations and so on. Social infrastructures would lead to higher productivity if they can demonstrate their utilities successfully. Making intelligent use of social infrastructures would be required to revitalize our flagging national economy.

3 Tightening Financial Constraints

Under the influence of declining tax revenues from sluggish economic activity and increased budgetary spending incurred by a growing population of elderly people with falling birthrates and so on, Japan's financial standing has aggravated at a rapid tempo with its long-term balance of the government debt reaching 812 trillion (Figure 1-2-11).



The ratio of the amount of a nation's outstanding debt balances to its GDP provides a measure of the size of its debts, which is a key indicator of its financial soundness. By comparison, Japan remains at the lowest level, above that of countries with their financial crises surfacing, such as Greece and Portugal (Figure 1-2-12).

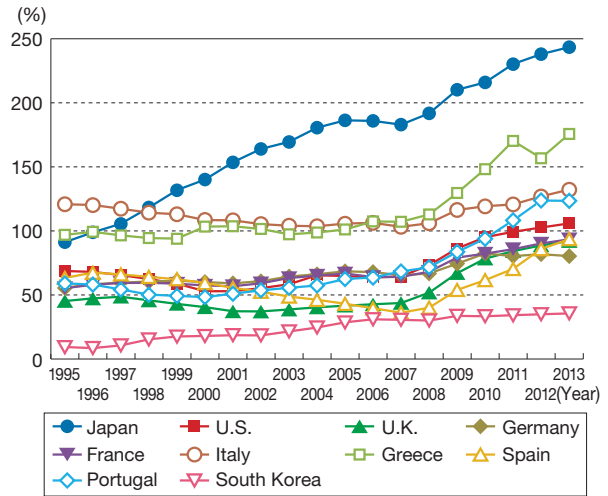
Note 11 According to estimates compiled by the Ministry of Health, Labour and Welfare (Employment Policy Research Group), the number of workers in 2030 will be down by 8,210 thousand (from its 2012 level) if economic growth and labor participation do not make proper progress or will remain 1,670 thousand down if they do.

Note 12 The life-cycle theory foresees that a growing population of elderly people to command a larger share of the population, with falling birthrates, will result in a reduced saving rate because elderly people often dip into their savings as they live. For this reason, the funds that are dedicated to investment will decline if no allowance is made for fund inflow from overseas sources.

It has been pointed out to date that Japan has a higher ratio of the amount of public investment to its GDP than other advanced nations. Public investment, while on a rising trend in other advanced nations, has been continuously declining in Japan to a level on a par with member nations of the OECD as the nation has trimmed public investment since the beginning of the 2000s (Figure 1-2-13, Figure 1-2-14). To proceed with the development of social infrastructures of true need or with the proper maintenance, management and upgrade of social infrastructures that have been developed so far, ensuring the appropriate allocation of the public works-related expenditures required would be necessary.

Figure 1-2-12

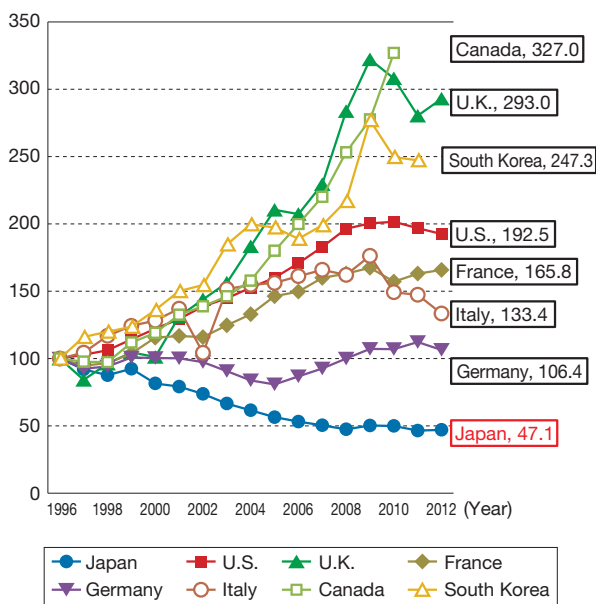
International Comparisons of Outstanding Debt Balances (in relation to GDP)



Source) Developed by the MLIT from "World Economic Outlook Database, October 2013" compiled by the OECD.

Figure 1-2-13

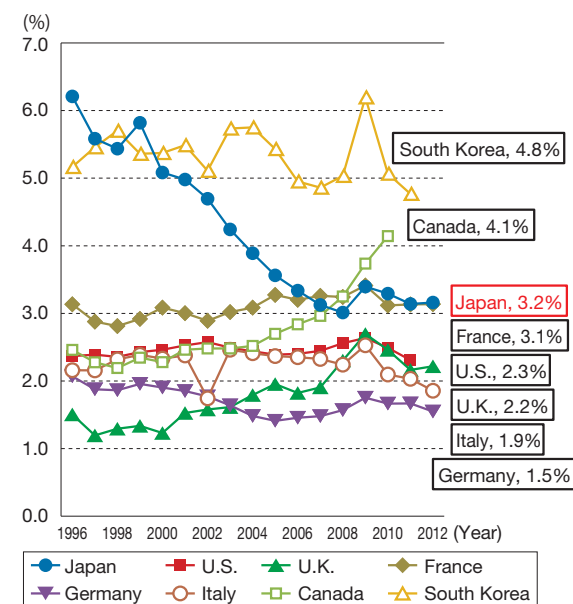
Changes in General Governmental Public Fixed Capital Formation (relative to 1996 as 100)



(Notes) 1 All values indicated are nominal.
 2 For the U.K. in 2005, the effects of the assumption of the assets and debts of British Nuclear Fuels Limited (BNFL) by the central government (approximately £1.4 billion) are excluded.
 3 Data based on O8SNA used since July 2013 for the U.S. and data based on 93SNA for other nations.
 Source) Developed by the MLIT from OECD Stat. Extracts "National Accounts" for countries other than Japan and from "Fiscal 2012 National Accounts (2005 basis, 93SNA)" (Authentic Information) compiled by the Cabinet Office for Japan.

Figure 1-2-14

Changes in the Ratio of Public Investment (I_g/GDP) in Major Advanced Nations



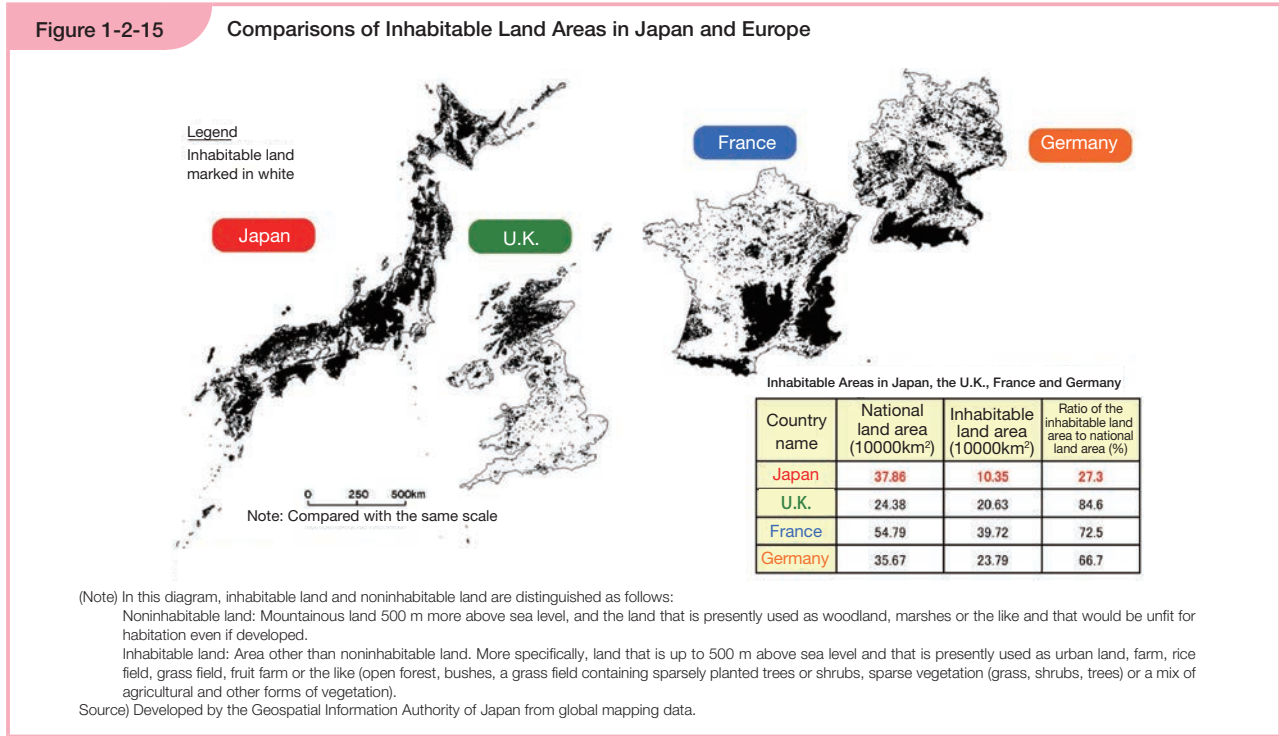
(Notes) 1 All values indicated are nominal.
 2 For the U.K. in 2005, the effects of the assumption of the assets and debts of British Nuclear Fuels Limited (BNFL) by the central government (approximately £1.4 billion) are excluded.
 Source) Developed by the MLIT from OECD Stat. Extracts "National Accounts" for countries other than Japan and from "2012 National Economic Accounting (2005 basis, 93SNA)" (Authentic Information) compiled by the Cabinet Office for Japan.

4 Fragile National Land and Heightening Disaster Risks

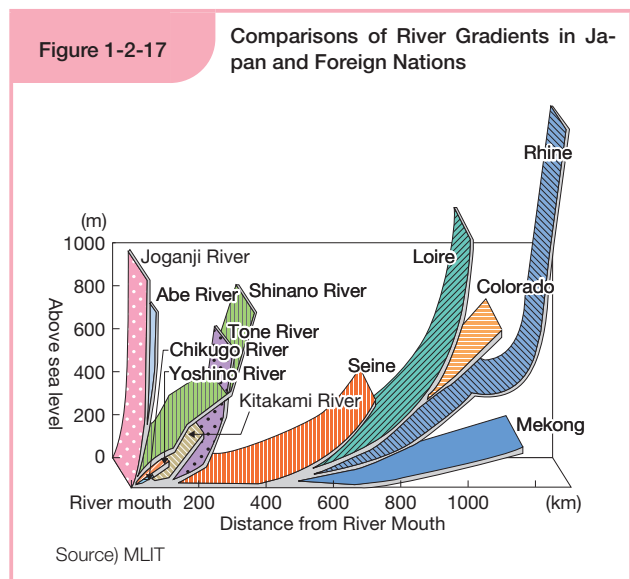
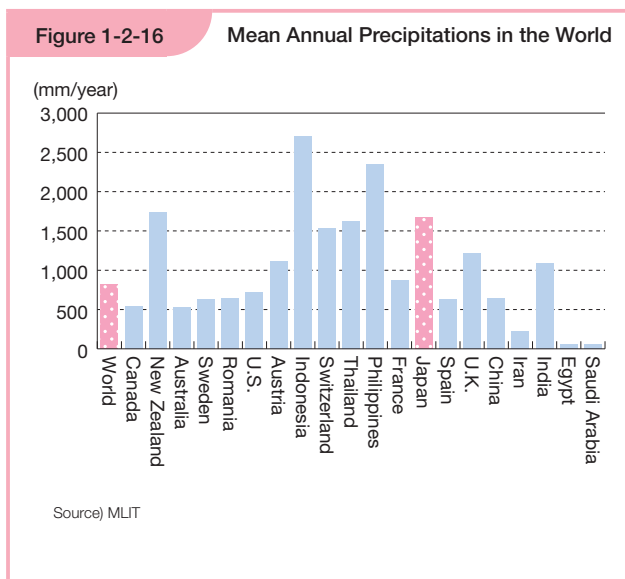
Exploring directions for the nation's social infrastructures, as well as its demographics and economic and financial status, should pay heed to characteristics of the national land as well.

(1) National land conditions and climate

Japan sits on a narrow strip of land covering 2000 km from north to south, with steep mountains traversing its middle part longitudinally. A greater proportion of the land is dominated by mountains, with inhabitable plains being scattered in small areas. The nation's ratio of the inhabitable land area to the total land area is 27%, by far lower than 60 to 80% in Europe (Figure 1-2-15).



Japan has about a two times higher rate of mean annual precipitation than the rest of the world, with rainfalls converging during on the nation's rainy or typhoon season (Figure 1-2-16). Rivers are so short and steep that, once a heavy rain falls, it would pour from mountains into the sea at once to threaten floods and landslide disasters (Figure 1-2-17). In addition, because many cities are based in the plains lower than the water level of a river, they are exposed to the risks of extensive damages once to the river floods.



Further, about 51% of the national land is a heavy snowfall area, which is inhabited by about 15% of the nation's total population (Figure 1-2-18). Sustaining the lives and economic activities of the people living there requires keeping them protected from avalanches and snowstorms and taking measures, such as clearing and melting the snow. In February 2014, heavy snowfalls hit Japan centering in Kanto and in Yamanashi and Nagano prefectures, dumping the deepest snowfalls in 100 years. Those heavy snowfalls caused huge damages paralyzing public traffic services and isolating many villages in the City of Kofu and elsewhere.

Japan is located in a quake-prone zone at the boundaries of four tectonic plates, where about 20% of the world's earthquakes having a magnitude of 6 or higher occur. In addition, Japan is prone to suffer from major damages from tsunami as the nation is surrounded by seas on its four sides, with the long and complex contours of its coastlines. A stage for recurring occurrences of widespread damages in history, the Nankai Trough, in particular, has hosted subduction-zone earthquakes measuring on the 8-magnitude order, each 150 years apart, since about 100 years ago. An increasingly impending risk of the occurrence of earthquakes in this region has been suggested in consideration of the frequencies with which quakes have occurred there in the past (Figure 1-2-19). Subduction-zone earthquakes measuring on the 8-magnitude order, equivalent to the Great Kanto Earthquake that occurred in 1923, are thought to hit the Tokyo metropolitan area every 200 to 400 years apart. Though the next occurrence is forecast to come 100 to 300 years ahead, it is forecast to be preceded with several occurrences of epicentral earthquakes on the 7-magnitude order occurring underneath the Tokyo metropolitan area (Figure 1-2-20).

Figure 1-2-18

Heavy Snowfall Region Specification Map, and Populations and Areas

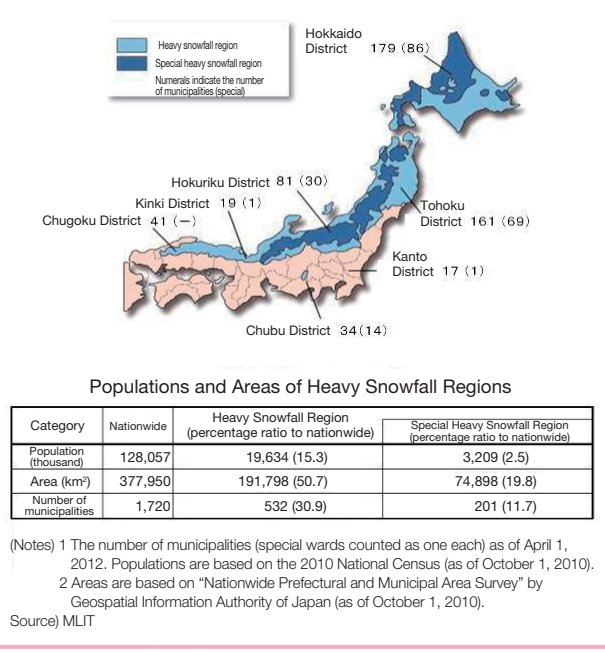
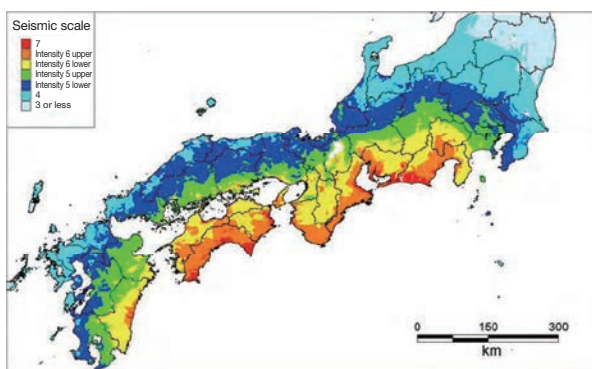


Figure 1-2-19

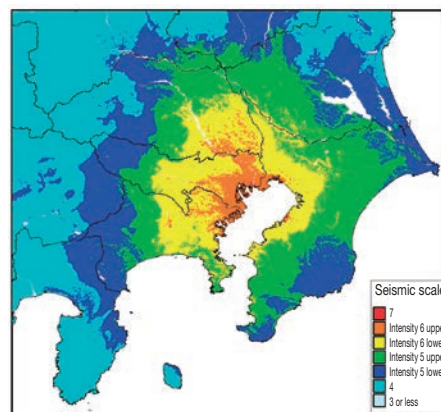
Distributions of Largest Seismic Intensities Assumed from a Nankai Trough Huge Earthquake



Source) Report by the Nankai Trough Megaquake Preparedness Review Working Group, Disaster Preparedness Measures Promotion Review Meeting, Central Disaster Management Council, Cabinet Office.

Figure 1-2-20

Distributions of Seismic Intensity Assumed from an Epicentral Earthquake Occurring underneath the Tokyo Metropolitan Area (downtown south)

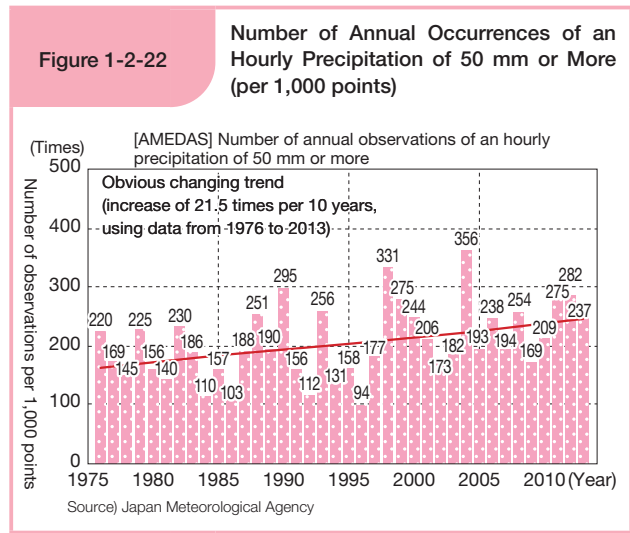
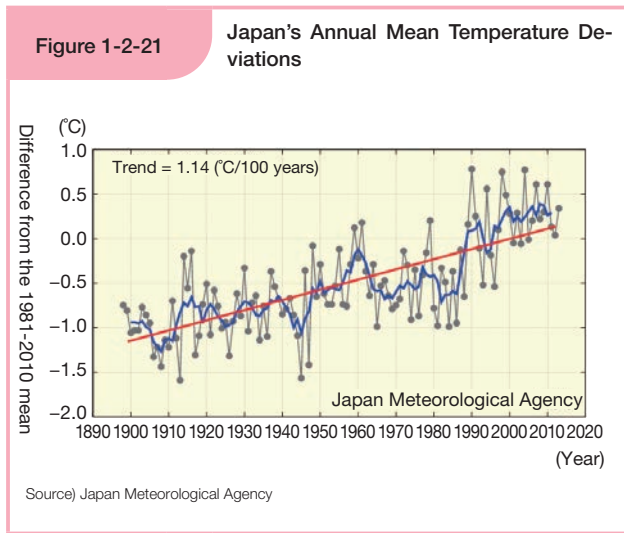


Source) Report by the Tokyo Metropolitan Area Epicentral Earthquake Preparedness Review Working Group, Central Disaster Management Council, Cabinet Office.

(2) Vulnerabilities brought by climate changes and urban modernization

The Working Group I Report (Physical Science Basis) of the United Nations Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report released in September 2013 says, "Warming of the climate system is unequivocal," and proceeds to predict, "Extreme precipitation events over most of the mid-latitude land masses and over wet tropical

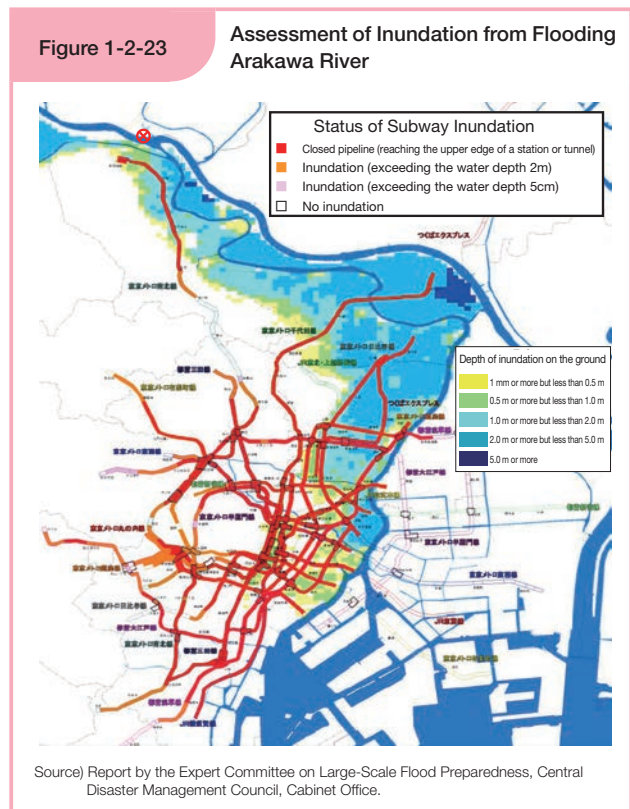
regions will very likely become more intense and more frequent by the end of this century, as global mean surface temperature increases.” The annual mean temperature has been rising in Japan as well. Though the statistical period is too short to draw any clear conclusion on the relationship between the rising annual mean temperature and global warming, the number of occurrences of an hourly precipitation of 50 mm or more as observed by AMEDAS (Automated Meteorological Data Acquisition System) is on the rise. This occurrence count is predicted to rise further towards the end of the 21st century in line with the progress of global warming (“Global Warming Prediction Information Volume 8” by the Japan Meteorological Agency), with the risks of occurrence of flood damages and landslide disasters mounting (Figure 1-2-21, Figure 1-2-22).



Amid growing concerns over imminent megaquakes and increases in the frequency with which torrential rainfalls occur, urban areas have been made increasingly vulnerable to the effects of natural disasters, such as exposure to urban-specific damages or escalating damages, as more populations, assets, traffic and so on continue to pour into them. It has been pointed out that big cities rely on electricity, public transport services and more to such extent that they could give rise to a huge number of commuters unable to find ways back home once these facilities are disrupted in times of quakes, throwing the cities into turmoil because of their crowding. Further, the continuing proliferation of high-rise condominiums in the urban areas threatens major oscillations during long-period seismic motion, which could shut down elevators on upper floors to hamper evacuation or the convenience of daily living up until the elevators are restored to normal.

Usage of underground spaces, as for shopping malls and subways, has been more developed in the nation's major cities than other nations, leaving them exposed to the risks of flood damages during heavy rainfalls. Large-scale floods hitting the Tokyo metropolitan area could give extensive damages to such underground spaces; e.g., ripping banks of Arakawa River are forecast to dip 17 subway routes and 97 stations, with a total extension of about 147 km (Figure 1-2-23).

With such characteristics of its land and harsh natural conditions, Japan is sought to build a high level of disaster preparedness facilities, such as advanced quake resistance and soft-ground improvement, into the social infrastructures



it develops. In addition, bridges, tunnels and other structures command a greater proportion of the nation's networks of roads, railways and so on to address its steep topographical features than other nations. These social infrastructures are considered to cost more to maintain, manage and upgrade (Figure 1-2-24, Figure 1-2-25).

Figure 1-2-24

Comparisons of Bridge Beams in Japan and France



Source) MLIT

Figure 1-2-25

Comparisons of the Proportion of Structures by Country

Comparisons of the Proportions of Structures by Country		
Japan	24.6%	National expressway mean (2005)
U.S.	7.0%	Interstate highway mean (2003)
U.K.	4.4%	Superhighway and general highway mean (2001, England)
France	2.6%	Directly managed expressway and highway mean (2005)
Germany	10.1%	Federal Autobahn mean (2005)

(Note) Proportion of structures = (Bridge beam length + Tunnel length)/Total length
Source) Infrastructure Development Institute

In the present context of an increasingly harsh climate surrounding social infrastructures, including dwindling populations and tight financial constraints, how to respond to the vulnerabilities of the national land summarized so far should be integral part of our process of formulating evolving concepts of maintenance, management and upgrade of social infrastructures.

Column

Hurricane Sandy vs. U.S. Disaster Preparedness

On October 29, 2012, Hurricane Sandy landed on the East Coast of the U.S., dealing major storm-surge damages to New York for the first time in 74 years since 1938. The first massive disaster ever to deliver destructive damages to a major city in an industrialized nation packed with an advanced integration of urban facilities, the storm-surge damages claimed a total of 8,000 billion yen in the States of New York and New Jersey – the second-largest economic loss incurred in the U.S. history of natural disasters.

Hurricane Sandy landed on the U.S. as a huge storm speeding at an average wind velocity of about 36 m/s, equivalent to a Category 1 hurricane, with its sphere of influence covering about 1400 km. Since its landing concurred with a period of high tide, it brought about serious flood damages associated with storm surges in urban areas in the City of New York, including Manhattan, and the State of New Jersey. Floods caused by storm surges infiltrated subway, road and railway tunnels and substations, closing public transport services.

A substation located on East 13th street of Manhattan exploded as it was inundated by storm surges, blacking out the southern part of Manhattan. In addition, the New York Stock Exchange closed for two days to cancel transactions, adversely affecting the core of the nation's socioeconomic activities, including banking.

Figure 1-2-26 86th Street Station Flooded



Source) Metropolitan Transport Authority (MTA).

By comparison, Hurricane Sandy is said to have brought 2.7 times more blackout damages and 14 times more business impact to the key urban City of New York than Hurricane Katrina attacking on the rural City of New Orleans in the State of Louisiana in

2005. Big cities integrated with diverse social infrastructures are thus found more vulnerable to the magnified effects of natural disasters than smaller cities.

While Hurricane Sandy has brought devastating damages, responses taken by a U.S. hurricane preparedness program are said to have been greatly instrumental in mitigating its effects. U.S. disaster preparedness plans call upon the organizations concerned with disaster preparedness to act in a preprogrammed time-series sequence of events, called “timeline,” to respond to natural disasters when they occur, within their respective preassigned shares of responsibility. Disaster preparedness coordinators and firefighters are also supposed to have taken shelter safely by the time of disaster occurrence (“zero hour”).

Pursuant to this timeline, New York City Subway gave a prior notification to passengers one day before the scheduled date of landing of Hurricane Sandy and managed to resume train services in certain sections in two days at the shortest, despite some damages from flooding. In the State of New Jersey, the Governor called upon the residents to take shelter 36 hours before the landing of the

hurricane.

Such “anticipatory responses” may well have helped mitigate the impact of the hurricane as there was a time lag between its landing and the ensuing development of its damages.

Japan’s metropolitan regions have not experienced storm-surge damages for nearly 60 years since the Ise Bay Typhoon in 1959. Because Japan’s three major metropolitan areas are populated by a huge number of residents each, with the so-called “zero-meter regions” below seal level and huge subterranean spaces underneath, once a massive natural disaster of similar dimensions hits them, it could claim numerous human lives, threatening a tremendous impact on the nation’s economic activities as a whole. Lessons learned from this disaster should be factored into the future formulation of our approaches to disaster preparedness and actions.

(Reference)

Joint Investigation Team (2013) formed by the MLIT and academic associations relating to disaster preparedness “Field Report on a Survey of Hurricane Sandy in the U.S.”

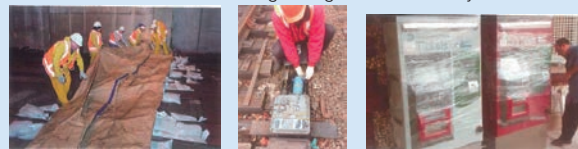
Figure 1-2-27 Timeline (State of New Jersey)

Decision	Time
Level 2 state, and prepare for Levels 3 and 4	120
Plan and prepare for evacuation centers	96
Plan and prepare for evacuation	96
Declare a state of emergency	72
Level 3 state	72
Local governments and state prepare emergency centers	48
Plan and prepare traffic regulations	48
Order evacuation	36
Open evacuation centers	36
Begin traffic regulations	36
Public transport services shut down	12
Level 4 state	24
Order on-the-spot evacuation	12
End traffic regulations	3
Supporters take shelter	0

*The zero hour is the time at which strong winds arrive as a result of a hurricane landing on the State of New Jersey.
 *Each time indicated is a time tracing back from the 0 hour.

(Reference) Joint Investigation Team (2013) formed by the MLIT and academic associations relating to disaster preparedness “Field Report on a Survey of Hurricane Sandy in the U.S.”

Figure 1-2-28 Measures Taken by the Railway Operator to Prevent Flooding during Hurricane Sandy



(Note) Left: sandbags used to cut off water; middle: motor removed at a point; right: ticket-vending machines guarded to cut off water

(Reference) Joint Investigation Team (2013) formed by the MLIT and academic associations relating to disaster preparedness “Field Report on a Survey of Hurricane Sandy in the U.S.”

Section 3 Status of Maintenance and Management of Social Infrastructures

As the climate of the economic society surrounding social infrastructures varies, how to maintain and manage the social infrastructures that have been developed to date should be a task of key importance in plotting the futures of our nation. This section sheds light on the status of aging social infrastructures and their maintenance and management to help develop a preliminary understanding of the evolving tasks of their maintenance and management.

1 Aging Social Infrastructures

In Japan, the infrastructures that have been developed since its period of rapid economic growth, including Metropolitan Expressway Route 1 built around the 1964 Tokyo Olympic Games, have been aging rapidly, suggesting an accelerating proportion of those facilities that have been aged for 50 years or older since initial construction for the 20 years to come (Figure 1-3-1).

Figure 1-3-1 Percentage Ratios of Social Infrastructures over 50 Years Old

	March 2013	March 2023	March 2033
Highway bridges [approx. 400 thousand bridges ⁽¹⁾ (of the about 700 thousand bridges at least 2 m long)]	Approx. 18%	Approx. 43%	Approx. 67%
Tunnels [approx. 10 thousand tunnels ⁽²⁾]	Approx.20%	Approx. 34%	Approx.50%
River management facilities (such as sluices) [approx. 10 thousand facilities ⁽³⁾]	Approx. 25%	Approx. 43%	Approx. 64%
Sewerage pipes [total length: approx. 450 thousand km ⁽⁴⁾]	Approx. 2%	Approx. 9%	Approx. 24%
Harbor quays [approx. 5 thousand facilities ⁽⁵⁾ (at least 4.5 m in water depth)]	Approx. 8%	Approx. 32%	Approx. 58%

(Notes) 1 About 300 thousand bridges whose year of construction is unknown have been excluded from the ratio calculations.
2 About 250 tunnels whose year of construction is unknown have been excluded from the ratio calculations.
3 Government-managed facilities only, including about 1,000 facilities whose year of construction is unknown. (Since the facilities developed within the last 30 years generally have a documented history, the facilities whose year of construction is unknown have been sorted as being 50 years old or older.)
4 Including sewerage pipes about 15,000 km long whose year of construction is unknown. (Since the pipes developed within the last 50 years generally have a documented history, the pipes whose year of construction is unknown have been sorted as being 30 years old or older and the lengths of the developed extensions of these unknown facilities have been prorated on the basis of the ratio of the developed lengths of the facilities having a documented history by the number of years elapsed.)
5 About 100 pier facilities whose year of construction is unknown have been excluded from ratio calculations.

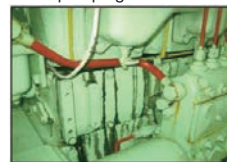
Source) MLIT

Figure 1-3-2 Aging of Various Infrastructures

[Examples of River Structures]
Aging Sluiceways



Wear, corrosion, etc. of
pumping facilities



Oil leakage from pump motors



Status of pump impeller rusting

Source) MLIT

[Examples of Bridges]
Rupture of a diagonal bracing



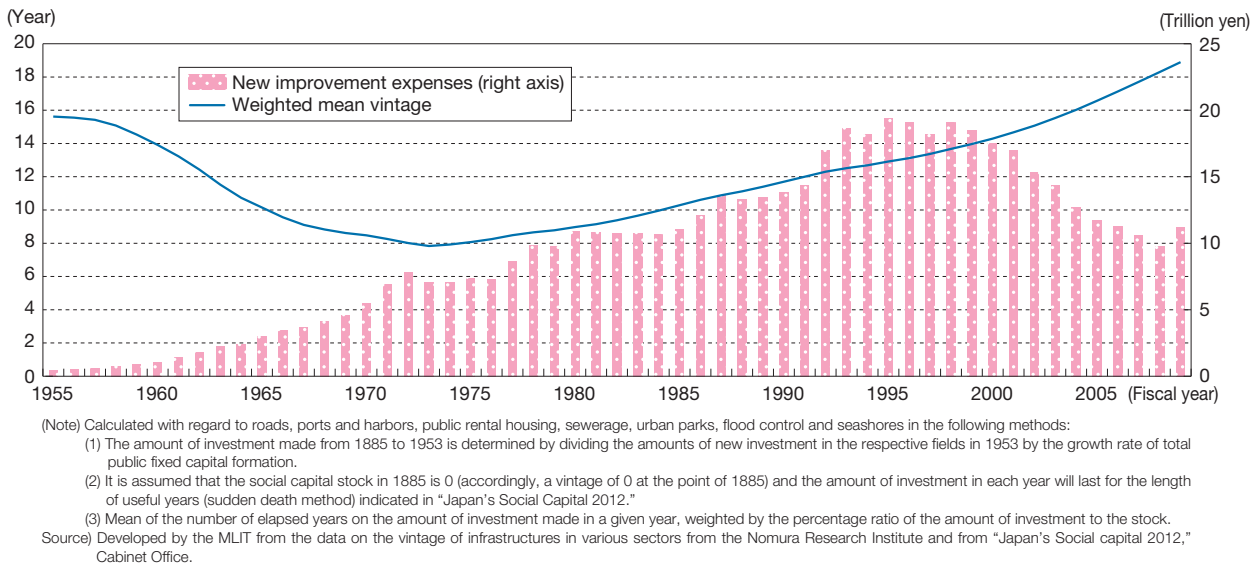
Scour and settling of bridge piers



To what extent aging of the nation's infrastructures has progressed as a whole will be examined using a concept called "vintage"^{Note 13}. Figure 1-3-3 presents preliminary calculations of the changes in the vintage of the infrastructures in eight sectors of national land and transportation based on data, such as that found in the Cabinet Office's "Japan's Social capital 2012." In the early postwar period, when Japan had a limited accumulation of infrastructures, their vintage would decline (the average number of years that have elapsed on the infrastructures decreased) in line with the progress of new investment. When infrastructures were accumulated to some extent as Japan emerged from the period of rapid economic growth, their vintage turned to rise. Continuing cuts in public investment since the onset of the 2000s have resulted in a proportionate reduction in the percentage ratio of new social capital, with the result of growing vintage.

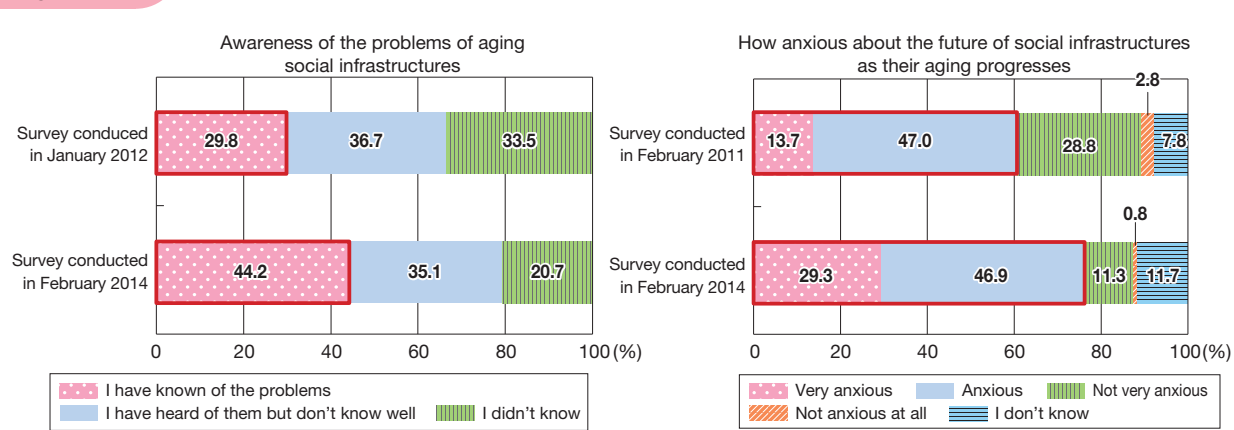
Note 13 "Vintage" refers to how old a facility and, in this context, means the average number of years that have elapsed on social infrastructures at a given point of time.

Figure 1-3-3 Vintage of Infrastructures in Eight Sectors of National Land and Transportation Relevant to the MLIT



Under the circumstances, public concerns over the aging social infrastructures continue to mount. On December 2, 2012, ceiling boards fell down in the Sasago Tunnel on Chuo Expressway, with road structures falling under the normal conditions of usage, incurring human deaths and injuries in an unprecedented serious accident in Japan. A questionnaire survey conducted by the MLIT (hereinafter "Public Awareness Survey")^{Note 14} indicates that a growing population of people are aware of the problems of aging social infrastructures and are also anxious about the futures of such social infrastructures in the wake of this accident, attesting to the growing public interest in the aging of social infrastructures (Figure 1-3-4).

Figure 1-3-4 Consciousness of Aging Social Infrastructures

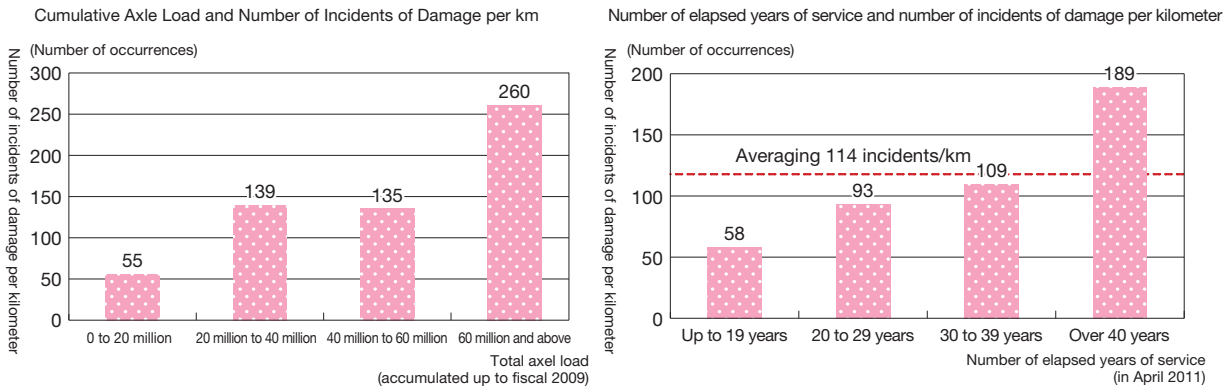


Source) "Public Awareness Survey", MLIT

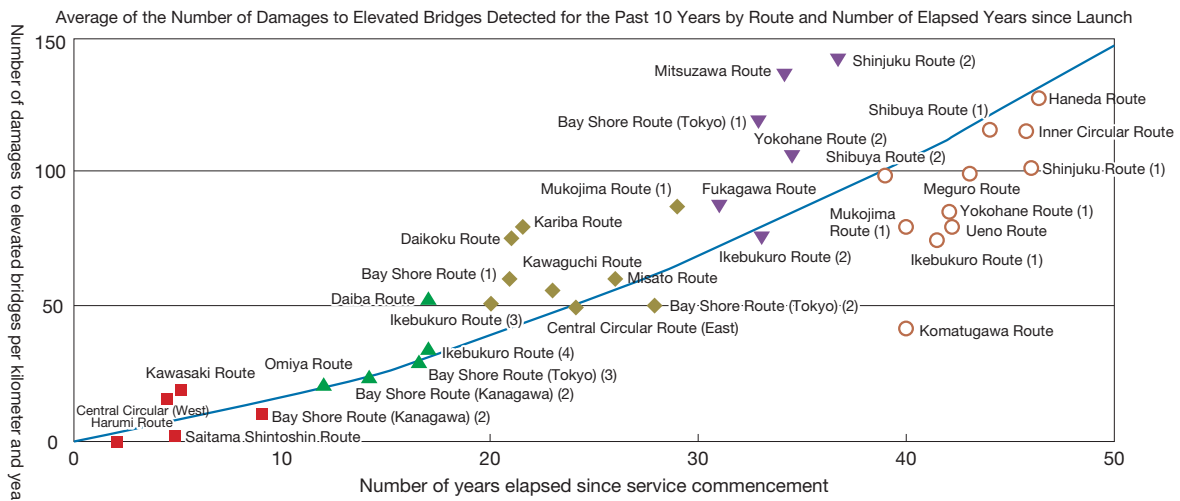
To what extent individual social infrastructures will age varies depending on where they are located, under what conditions they have been used and so on, they should generally get damaged progressively in pace with their length of service and repeated exposures to tough usage conditions, unless they are treated by major renovations and upgrades after their services commenced. A survey conducted by Metropolitan Expressway Co., Ltd., for example, confirms that the number of incidents of damages its facilities per kilometer grows in proportion with the length of service and cumulative traffic volumes (Figure 1-3-5).

Note 14 Conducted through the Internet from individuals nationwide in February 2014 (3,002 responses available). Survey findings used for comparison purposes are those of the surveys conducted on individuals nationwide through the Internet at the respective points of time.

Figure 1-3-5 Metropolitan Expressways Aging Status



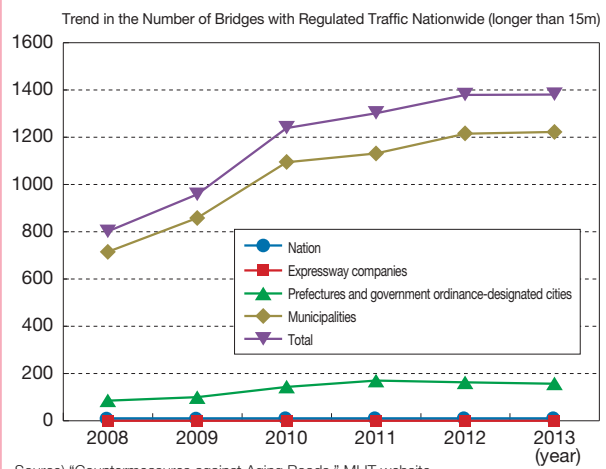
(Note) Cumulative axle load: A 10-ton equivalent of the cumulative volume of traffic since launch.
 (Source) Experts Panel on Revitalization of Metropolitan Expressways, MLIT



(Note) A summarized compilation of the number of damages to elevated bridges detected from 2001 to 2013.
 (Source) "Report by the Research Committee on the Direction for Major Upgrading of Metropolitan Expressway Structures" by Metropolitan Expressway Co., Ltd.

Desirably, aging infrastructures should be properly renovated and repaired to maintain their functionalities. Some, however, have been damaged to threaten safety to such extent, without appropriate renovations and repairs, that they can no longer be kept in service. These circumstances are considered more serious in municipalities. The number of bridges blocked and those with regulated traffic has increased in municipalities having more bridges to manage than the nation or other entities (Figure 1-3-6).

Figure 1-3-6 Number of Bridges Blocked and Bridges with Regulated Traffic Nationwide



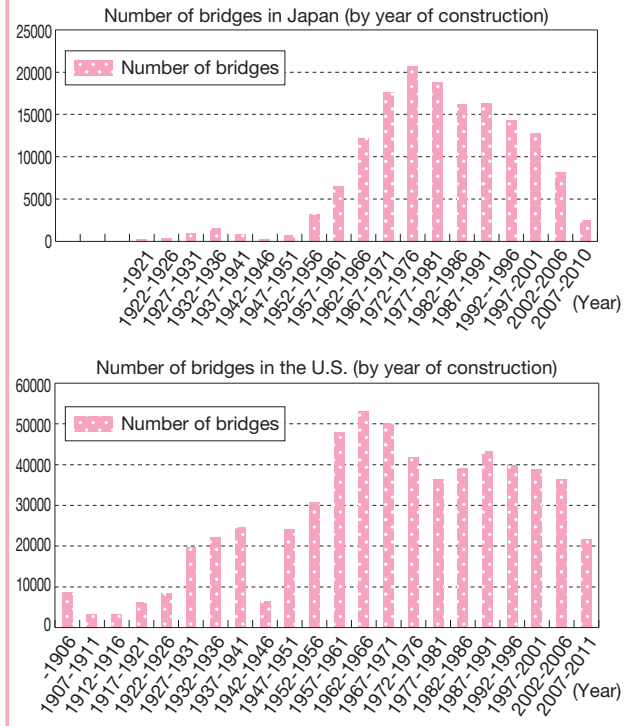
(Source) "Countermeasures against Aging Roads," MLIT website

2 “America in Ruins” and Subsequent Approaches

Figure 1-3-7 compares Japan and the U.S. in terms of the number of bridges by the year of construction. The number of bridges built is found to soar in Japan after the period of rapid economic growth, whereas the development of infrastructures has been driven on an extensive scale in the U.S. since the New Deal policy enforced in the 1920s. Thus, the U.S., which embarked on the development of infrastructures ahead of Japan, had the problems of aging infrastructures manifest earlier than in Japan.

In the U.S. in the 1980s, the worsening issues of aging infrastructures had impacted various aspects of the national economy and living. According to records dating back to those days, kids commuting to school on a school bus were forced to take a detour because of weight limitations on the bridges the bus passed or get off before the bridges and walk by^{Note 15}. As shown in Figure 1-3-9, while Manhattan Island is connected to surrounding areas by bridges, damage accidents had occurred on multiple bridges in the 1980s, sparking the execution of major renovations everywhere in the island. Under the circumstances, a book authored by Pat Choate and Susan Walter was published in 1981 as “America in Ruins” to warn of the status of decaying infrastructures. This book was translated into Japanese as well. The term “America in Ruins” has become a term

Figure 1-3-7 Number of Bridges in Japan and the U.S. (by year of construction)



Sources) National Institute for Land and Infrastructure Management Document No. 645
 *Collection of Basic Data on Road Structures in Fiscal 2009 and Fiscal 2010.
 Federal Highway Administration, U.S. Department of Transportation.

Figure 1-3-8

Kids Crossing a Bridge after Getting off a School Bus (State of Pennsylvania)



(April 27, 1981 issue, TIME)

Source) “Japan in Ruins, and Managing Roads to Save Japan from Ruins” - Taking Lessons from America in Ruins - Vol. 3, Road Bureau, MLIT

Figure 1-3-9

Bridge Damage Accidents in Manhattan Island in the 1980s and Major



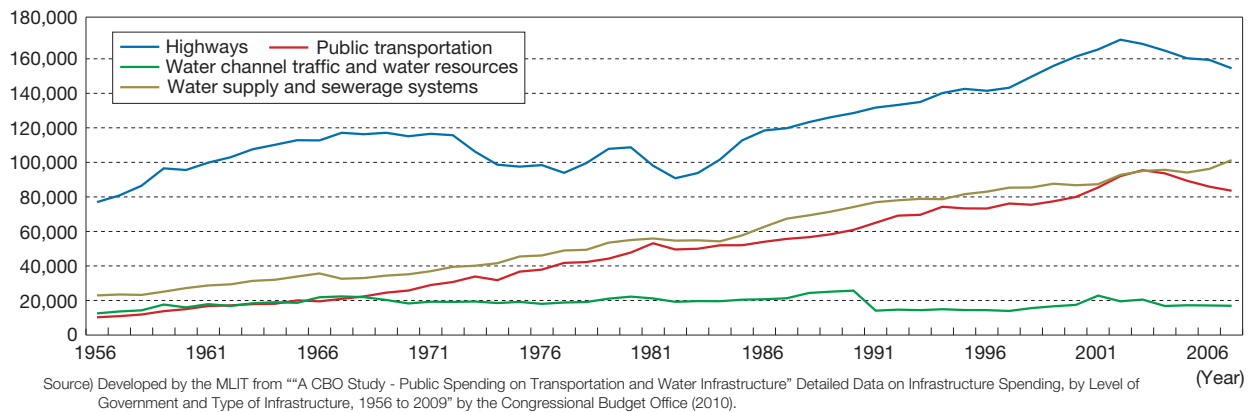
Source) “Japan in Ruins, and Managing Roads to Save Japan from Ruins” - Taking Lessons from America in Ruins - Vol. 3, Road Bureau, MLIT

Note 15 “Japan in Ruins, and Managing Roads to Save Japan from Ruins” - Taking Lessons from America in Ruins - Vol. 3, Road Bureau, MLIT

symbolic of the U.S. in the 1980s as it was confronted with the challenges of aging infrastructures.

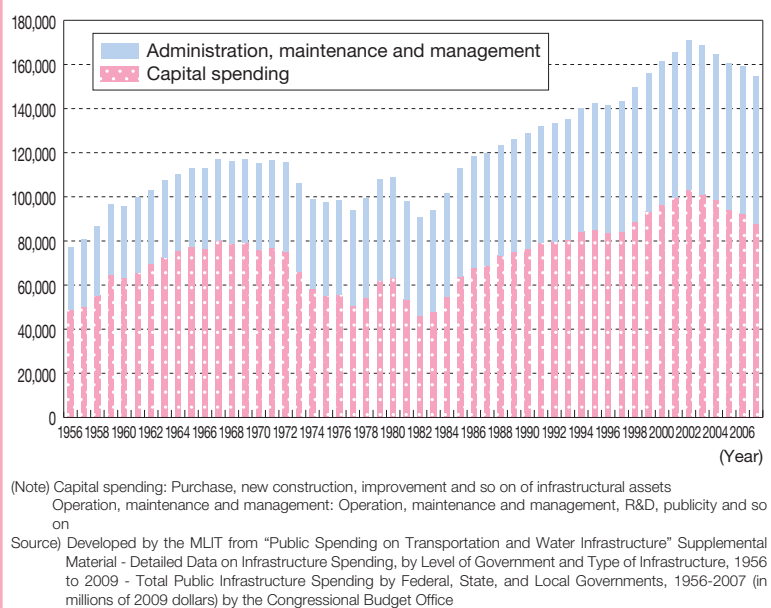
This situation incurred in the U.S. might be attributable in part to continuing highway budget cuts from the late 1960s to the 1970s to inhibit sufficient maintenance, management and upgrade (Figure 1-3-10).

Figure 1-3-10 Amounts of Investment in Infrastructures by the Federal, State and Local Governments (10 million dollars, real (2009 base))



As decaying infrastructures loomed into an issue of broad public concern, the U.S. raised the gas tax by 5 cent in 1983 to nearly double from its 1959 level, at which it had been kept in defiance of lingering inflation, in its effort to replenish its financial resources^{Note 16}. Figure 1-3-11 shows changes in the federal spending of highway expenditures broken down into capital spending and operation, maintenance and management. The chart suggests that the maintenance and management expenditures have been funded by not simply cutting new investment but by maintaining directing investment into the infrastructures as a whole to combine the proper maintenance of legacy infrastructures with the development of strategic infrastructures. The number of defective bridges in the U.S. has been consistently declining through the implementation of continuing efforts to maintain, manage and upgrade them (Figure 1-3-12).

Figure 1-3-11 Changes in Highway Spending by the Federal, State and Local Governments (million dollars, real (2009 base))



It should also be noted that such series of political responses to combat decaying infrastructures has been driven by formulating long-term, strategic schemes to define the nation’s traffic policy. While President Reagan advocated the “New Federalism” initiative in his pursuit of the formation of a “small government” by delegating federal authorities to state government and cutting federal spending, the Surface Transportation Assistance Act (STAA) enforced in 1983 amid the realities of “America in Ruins” to retain a greater proportion of federal government and secure revenues^{Note 17}.

The Obama Administration currently in office has also expressed its keen consciousness of the need to maintain high-

Note 16 The gasoline tax had been pegged at 4 cent per gallon since the 1960s but was raised up to 9 cent in 1983. Subsequently, it was raised each time a new program was formulated, reaching 14.1 cent in 1990 and 18.4 cent in 1994.

Note 17 Richard Weingroff, “Highway History – In Memory of Ronald Reagan,” Federal Highway Administration website <http://www.fhwa.dot.gov/infrastructure/reagan.cfm>

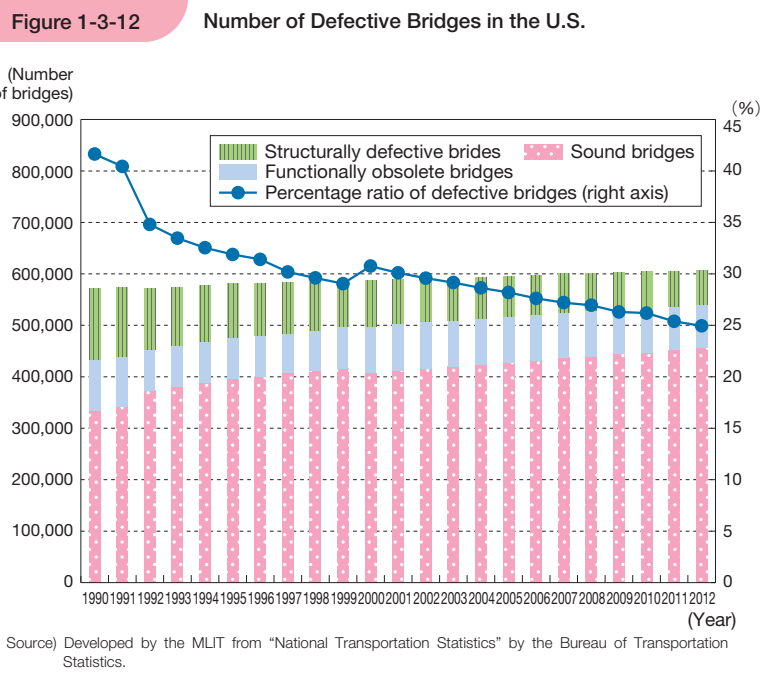
quality infrastructures to spur the accumulation of businesses and the creation of employment in a global economic climate. In his 2013 State of the Union Address, President Obama proposed, among else, the appropriation of 50 billion dollars to investment in the development of infrastructures, including a spending 40 billion dollars by the “Fix-It-First” program to maintain infrastructures needing urgent innovations and fixed, the inauguration of an “Infrastructure Bank” and the like to extend loans and provide debt guarantees to the infrastructural projects pursued on a public-private collaboration basis and the simplification of paperwork procedures relevant to the authorization of infrastructural projects. As a result of confusions, such as government closures, arising from twists between the Upper and

Lower Houses and conflicts over the nation’s financial policy between the Republican and Democratic Parties, many of the political programs, including Fix-It-First, were not put into action, but the betterment of the quality of infrastructures has remained a key political challenge for the Obama Administration as President Obama called upon Congress in his 2014 State of the Union Address to pass traffic bills to reinforce the facilities of the infrastructures^{Note 18}.

As Japan is also about to enter a sheer period of aging infrastructures, it should take lessons from the experience of the U.S. that endeavored to combat its seriously ailing infrastructures dubbed as “America in Ruins” in the 1980 and put forth long-term, strategic approaches to keep up the facilities of the infrastructures to avert “Japan in Ruins.”

3 Trends in the Maintenance and Management of Social Infrastructures

A summary insight into the status of social infrastructure maintenance and management works is given below, along with discussions of their characteristics and challenges from standpoints of local governments and builder.



Note 18 The White House “Fact Sheet: The President’s Plan to Make America a Magnet for Jobs by Investing in Manufacturing” 2013.2.20 <http://www.whitehouse.gov/the-press-office/2013/02/13/fact-sheet-president-s-plan-make-america-magnet-jobs-investing-manufacture>

The White House “President Barack Obama’s State of the Union Address” 2014.1.28

<http://www.whitehouse.gov/the-press-office/2014/01/28/president-barack-obamas-state-union-address>

Washington Post website “Obama’s 2013 State of the Union proposals: What flopped and what succeeded”

<http://www.washingtonpost.com/blogs/fact-checker/wp/2014/01/28/obamas-2013-state-of-the-union-proposals-what-flopped-and-what-succeeded/>

(1) Diversity and characteristics of maintenance and management services

The term “maintenance and management” may sound simple but the actual work involved varies greatly its embodiment depending on the kind of infrastructure involved, the kind of know-how required and how often and to what extent and with what emphasis it is carried out.

Figure 1-3-13 gives a summarized description of the services relevant to the maintenance and management of roads outsourced in a certain city during fiscal 2013, to help develop a general understanding of what services are required to maintain and manage familiar social infrastructures. Obviously, road maintenance and management services are numerous and diverse, ranging from

checking up, fixing and repairing pavements and roadside facilities, such as street lights and curb mirrors, through weeding, disinfecting and trimming plantations, cleaning public toilets, to managing elevators if installed in pedestrian bridges. In addition to routine maintenance and management activities, such as patrolling and cleanups, certain tasks occur periodically, if not frequently, including focused inspections and diagnostics on structural strengths and quake resistance, and major renovations, such as antiseismic reinforcements.

Further, services relevant to maintenance and management activities are often implemented on the infrastructures that are in service. Services for roads carrying heavy traffic, for example, need to be carried out during hours in which traffic is low, such as in the night, to minimize user inconveniences. In addition, infrastructures are sometimes surrounded by a complexity of other structures, such as railways and elevated bridges, which could restrict the work hours and environment. Some infrastructures, such as dams and harbor facilities, have a greater proportion of their geometries submerged in water. Some, such as large bridges, have their maintenance and management points located at higher elevations. Maintenance and management services for these infrastructures are bound to take place in a harsh work environment.

(2) Trends in maintenance and management spending

It is considered that maintenance and management spending is affected by the degree of accumulation of social infrastructures (Figure 1-3-15).

Estimates of the sum total of the expenditures needed to keep existing social infrastructures maintained, managed and upgraded were worked out in December 2013 by the Infrastructure Development Council and the Transport Policy Council, MLIT on the basis of their maintenance, management and upgrade results collected by probing into the number of facilities in 10 sectors of social capital (roads, flood control, sewage systems, ports and harbors, public rental housing,

Figure 1-3-13 Diverse Maintenance and Management Services

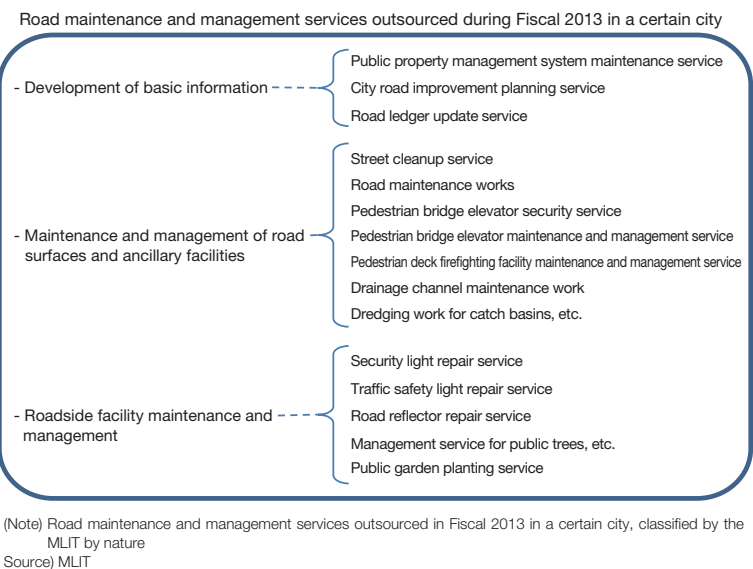
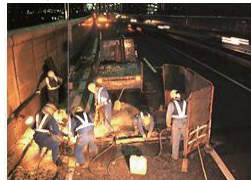


Figure 1-3-14 Embodiments of Maintenance and Management Services

Replacement repairs conducted in the nighttime



Underwater electrolytic protection work in harbor facilities**



Closeness to surrounding structures**



Bridge inspection work at an elevated location**



Source) * Metropolitan Expressway Co., Ltd. ** MLIT

parks, seacoasts, airports, navigation aids, governmental facilities) falling under jurisdiction of the MLIT, local governments, Local Road Public Corporations and the Japan Water Agency, an incorporated administrative agency. On the assumption of the current state of technology and framework, the maintenance and management spending is estimated to rise from 3.6 trillion yen in fiscal 2013 to reach approximately 4.3 to 5.1 trillion yen 10 years later and approximately 4.6 to 5.5 trillion yen 20 years later^{Note 19}. Uncertainties prevail over the perspectives of land usage, structural changes in urban and rural areas, possible cuts in the maintenance, management and upgrade spending resulting from technical developments, benefits of infrastructures and so on, but what is important is to get prepared for taking not an insignificant burden of the maintenance, management and upgrade spending and for putting relevant measures into action to keep economic competitiveness from being degraded and safety and security from being threatened by ailing infrastructures over a long period of time to come.

(3) Maintenance and management from a local government's perspectives

Local governments play a major role in developing appropriate responses to the challenges of social infrastructures maintenance and management.

If the social infrastructures managed by the central and local governments are broken down by facility, 90% or more of bridges 2 m long or more and 65% of the river management facilities are administered by prefectures, government ordinance-designated cities and municipalities. Generally, local governments take the responsibility for maintaining, managing and upgrading social infrastructures, though to a varying extent depending on the kind of infrastructure involved, highlighting the need for the local governments to reinforce their framework and to develop and maintain technicians (Figure 1-3-16).

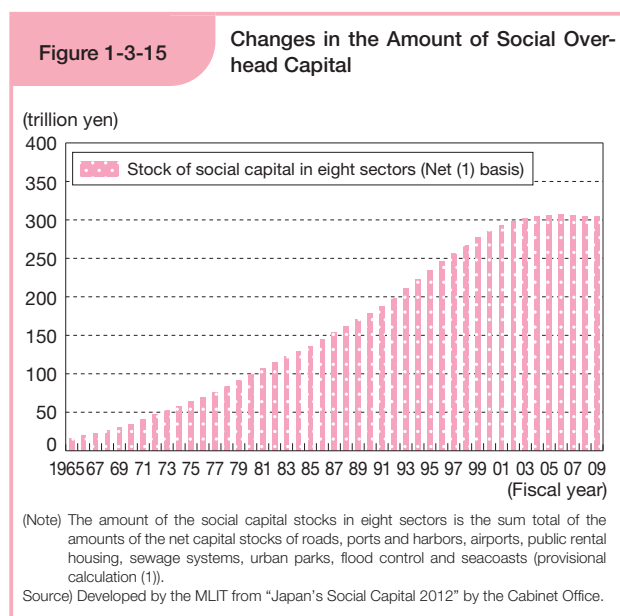


Figure 1-3-16 Percentage Ratios of Facilities by Management Body

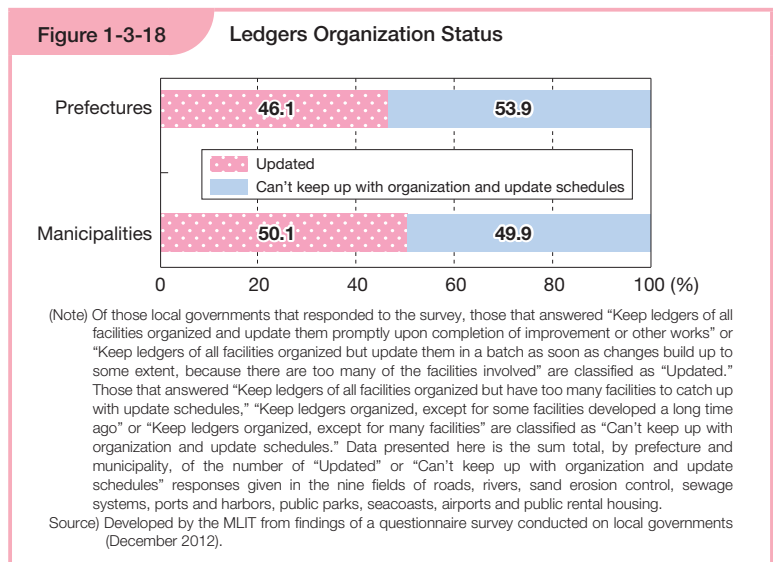
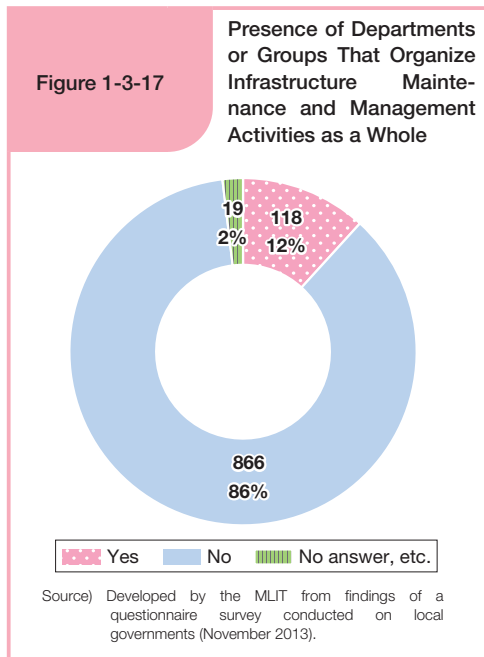
	Expressway company	Airport company	Nation	Prefecture	Municipalities (including government ordinance-designated cities)	Port management body
Roads (bridges at least 2 m long)	2%	-	4%	19%	75%	-
Roads (tunnels)	15%	-	13%	46%	26%	-
Roads (pavements)	3%	-	7%	21%	69%	-
Rivers	-	-	35%	65%		-
Sand erosion control (sand-control dams, floor fixing)	-	-	-	100%	-	-
Sewage systems (pipes and conduits)	-	-	-	2%	98%	-
Sewage systems (treatment plants)	-	-	-	9%	91%	-
Ports and harbors	-	-	9%	-	-	91%
Public rental housing	-	-	-	43%	57%	-
Parks	-	-	0.02%	1%	99%	-
Seacoasts	-	-	-	100%		-
Airports	-	3%	29%	68%		-
Navigation aids	-	-	100%	-	-	-
Governmental facilities	-	-	100%	-	-	-

(Note) Ratio of the number of facilities by owner for ports only

Source) Developed by the MLIT from "Recommendations on the Future Concepts of Social Infrastructures Maintenance, Management and Upgrade (December 2013)" by the Infrastructure Development Council and the Transport Policy Council, MLIT.

Note 19 Refer to "Recommendations on the Future Concepts of Social Infrastructures Maintenance, Management and Upgrade, Chapter 1 (December 2013)" by the Infrastructure Development Council and the Transport Policy Council, MLIT and Annex "Estimating the Amount of Future Maintenance, Management and Upgrade Spending."

However, local governments do not necessarily have an adequate framework or staff of technicians or the like ready to maintain, manage and upgrade their infrastructures. According to a survey conducted on local governments by the MLIT, only a little more than 10% of the local governments maintain a department or group to organize infrastructure maintenance and management activities. Moreover, only about half of the total number of prefectures and that of municipalities surveyed keep ledgers updated to summarize the status of infrastructures under their management. Local governments are thus found late to organize and update information about their infrastructures (Figure 1-3-17, Figure 1-3-18).



Seriousness of such status is particularly pronounced in small-size local governments. By size of population, the smaller a local government is, the less it has an understanding of the status of aging infrastructures or the more it uses a simple method of understanding it (Figure 1-3-19).

The reason why local governments have not necessarily taken adequate approaches to maintain and manage their infrastructures is that they have a limited staff of technically versed experts. According to Figure 1-3-20, most local governments cite shorts on budgets and manpower as concerns over aging infrastructures. In addition, about 40% of them mention a lack of technical capabilities as such. These constraints account in part for the inability of the local governments to take smooth responses to aging social infrastructures. Local governments that do not maintain a technical staff tend to resort to simpler methods to understand the aging status or to lack their understanding of the aging status when compared with those that maintain a technical staff. About 40% of the local governments wanting in their understanding of the mid- and long-term costs of infrastructure maintenance, management and upgrade blame it on a shortage of their technical knowledge (Figure 1-3-20 to Figure 1-3-22).

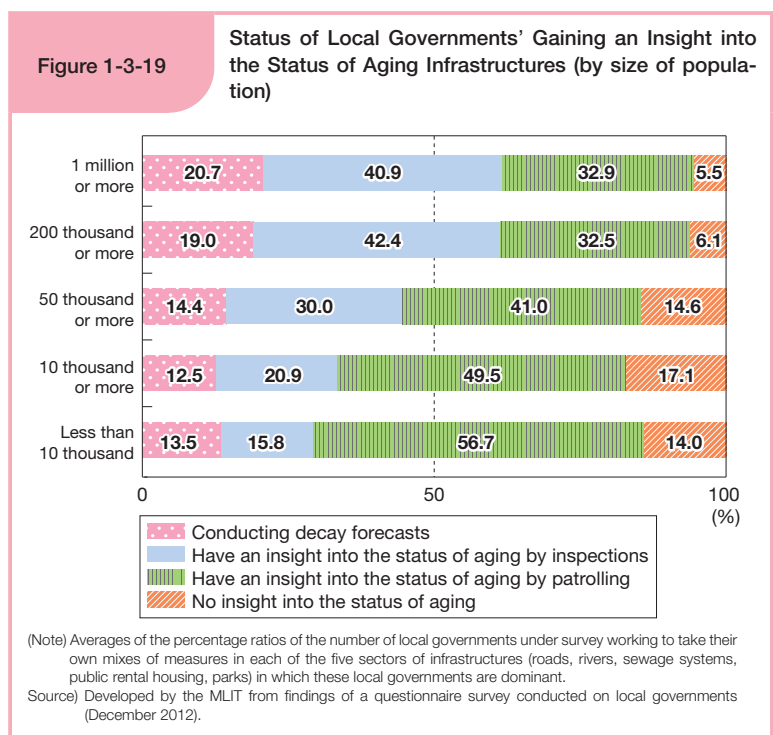
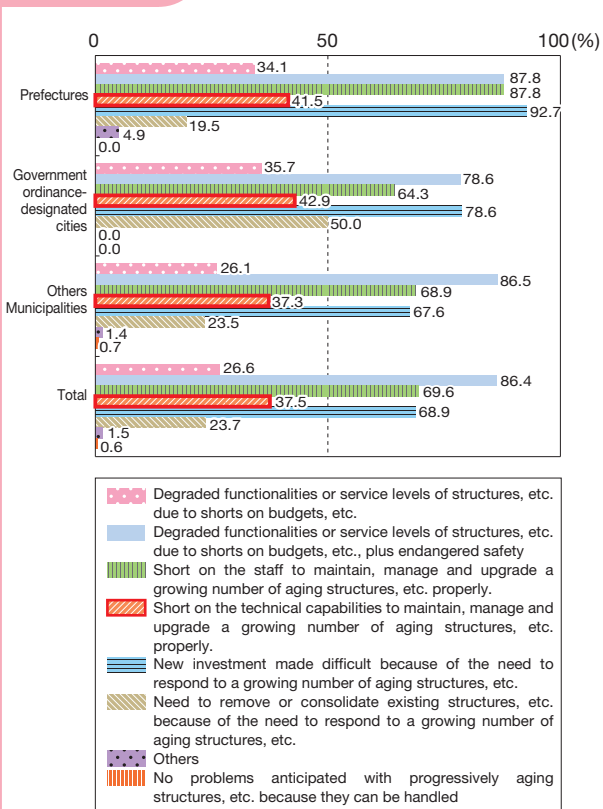
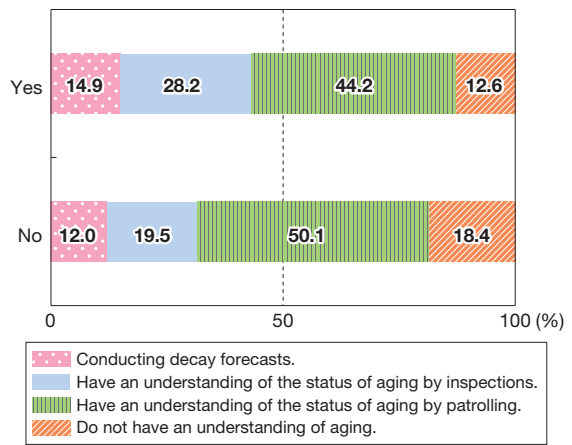


Figure 1-3-20 What Are Disquieting about Progressive Aging?



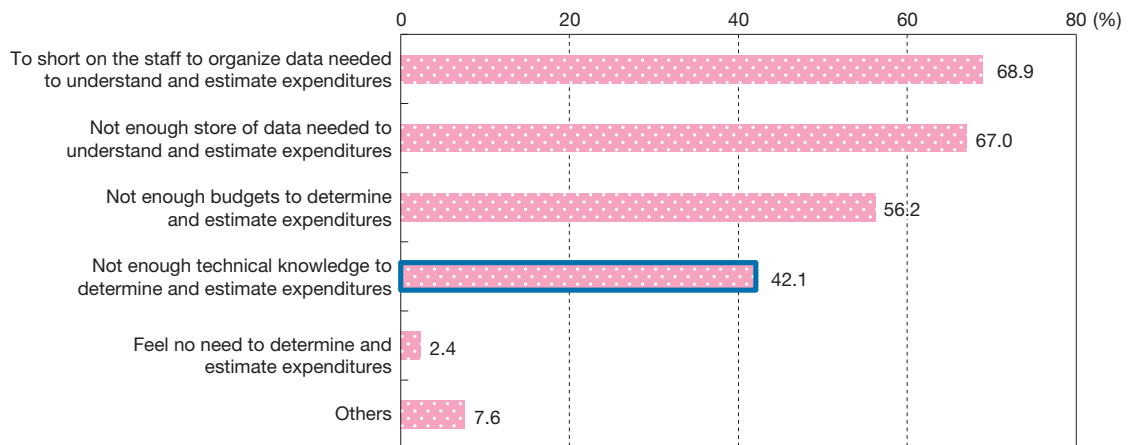
Source) Developed by the MLIT from "Recommendations on the Future Concepts of Social Infrastructures Maintenance, Management and Upgrade (December 2013)" by the Infrastructure Development Council and the Transport Policy Council, MLIT.

Figure 1-3-21 Status of Understanding of Aging by Local Governments (Have Technical Staff or Not)



(Note) Averages of the percentage ratios of the number of local governments under survey working to take their own mixes of measures in each of the five sectors of infrastructures (roads, rivers, sewage systems, public rental housing, parks) in which these local governments are dominant.
Source) Developed by the MLIT from findings of a questionnaire survey conducted on local governments (November 2013).

Figure 1-3-22 Reasons for Not Understanding the Costs of Maintenance, Management and Upgrade

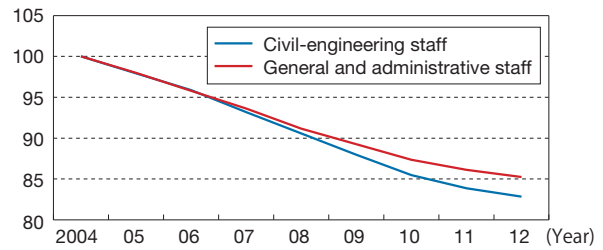


Source) Developed by the MLIT from "Recommendations on the Future Concepts of Social Infrastructures Maintenance, Management and Upgrade (December 2013)" by the Infrastructure Development Council and the Transport Policy Council, MLIT.

Civil engineering is sometimes called “experience engineering.” It means that technicians acquire practical experience in the field, which is passed on from generation to generation to build a store of technical know-how. Amid recent tight budgets and administrative reforms, local governments have a linearly shrinking civil-engineering staff (Figure 1-3-23). Concern grows in the circumstances as local governments find it increasingly more difficult than before to build a store of technical know-how relevant to infrastructure maintenance and management.

Figure 1-3-23

Changes in the Number of Local Government Employees



(Note) Indexed in relation to the number of employees in 2004 as 100. “General and administrative” means the total number of employees in the fields of the council, administrative and planning, tax, labor, agriculture, forestry and fisheries, commerce and civil engineering.
 (Source) Developed by the MLIT from the “Local Government Employee Count Management Survey”, MIC.

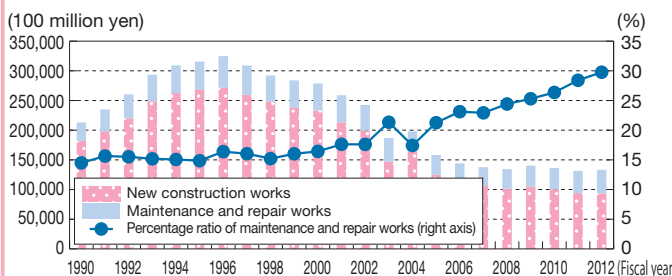
(4) Trends in the execution of infrastructure maintenance and management works

The percentage ratio of infrastructure maintenance and management works to public works ordered had moved at around 15% in the 1990s but tended to rise subsequently to account for nearly 30% in recent years (Figure 1-3-24).

In the meantime, a greater proportion of the orders for maintenance and management works awarded by public offices are smaller than the orders for new construction and other works in terms of the amount of contract per order. If the scale of construction works is compared by ordering office and by work category on the basis of the findings of “Construction Works Order Dynamic Statistical Survey” released by the MLIT, the maintenance and management works command about 40% of the new construction and other works for both the central and local governments (Figure 1-3-25).

Figure 1-3-24

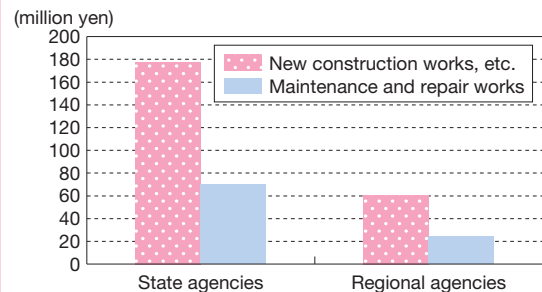
Changes in the Amount of Prime Contractors’ Construction Revenues in the Implementation of Public Works (New, and Maintenance and Repair Works) and Percentage Ratio of Maintenance and Repair Works



(Note) “Maintenance and repair works” in “Construction Works Execution Statistical Survey” means all kinds of works other than new construction and includes routine repairs conducted to preserve the original functionalities of existing structures and ancillary facilities, renovation, relocation, disaster recovery, partition marking and other works (operations).
 (Source) MLIT, “Statistics on Construction Undertaken”

Figure 1-3-25

Amounts of Contract per Order (New, and Maintenance and Repair)



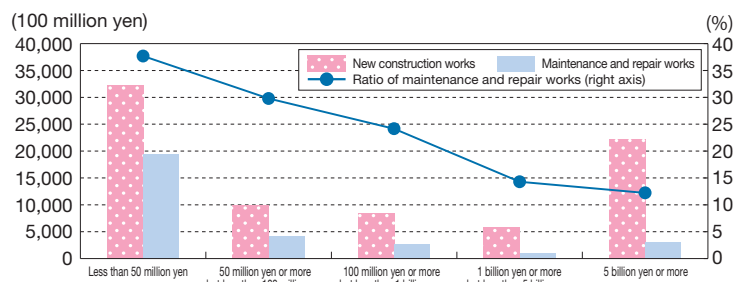
(Note) “Maintenance and repair works” in “Current Survey on Orders Received for Construction” means routine repairs conducted to preserve the original functionalities of existing architectural structures, etc., renovation and other kinds of works intended to restore them by fixing their breakages, tear and wear, failures and other conditions.
 (Source) MLIT, “Fiscal 2012 Current Survey on Orders Received for Construction”

A look at the amounts of new construction works and prime contractors’ amounts of maintenance and management works completed by contractor’s capital size suggests that the maintenance and management works account for a greater share of the prime contractors’ amounts of completed works (Figure 1-3-26).

Let us look at the findings of a questionnaire survey conducted on civil-engineering consultants (hereinafter called “Constructor Questionnaire on Maintenance, Management and Repair

Figure 1-3-26

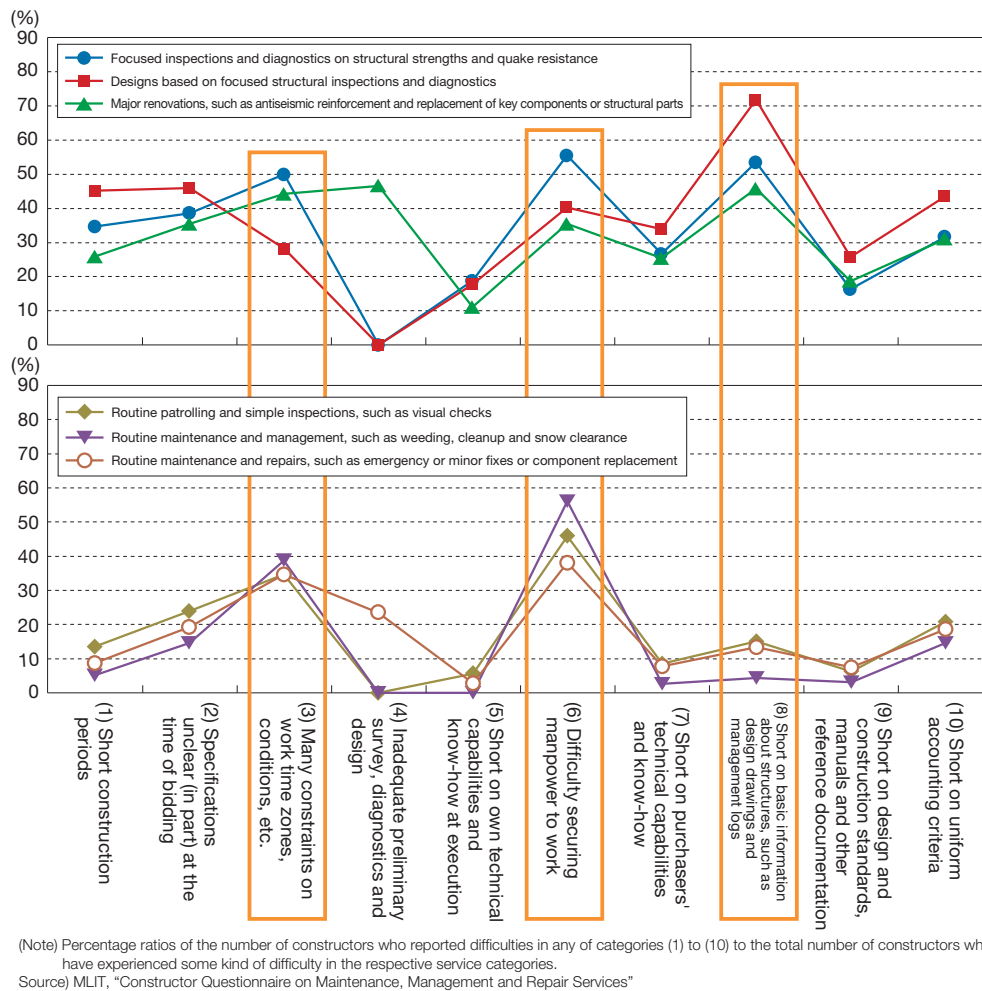
Changes in the Amount of Prime Contractors’ Construction Revenues by Capital Level (New, and Maintenance and Repair Works) and Percentage Ratio of Maintenance and Repair Works



(Note) Amount of construction revenues in the implementation of public works by full-time constructors, corporations and constructors authorized by the Minister and Prefectural Governors
 (Source) MLIT, “Statistics on Construction Undertaken (Fiscal 2012)”

Services”)^{Note 20}. Figure 1-3-27 summarizes the results of a hearing about what kind of difficulty respondents had experienced in executing maintenance and management services. According to these results, many had experienced difficulties securing manpower to carry out works centering on daily patrolling and minor repairs.

Figure 1-3-27 Difficulties Experienced by Constructors and the Like in Executing Maintenance and Management Services



Many respondents mention shorts on basic information, such as drawings and management logs, in their execution of those services that require a detailed knowledge of the conditions of the target structures, such as focused inspections and resultant designs and subsequent major renovations, suggesting that the development of an infrastructure information base is urged. A large share of respondents also pointed out problems in all categories of services mainly involving fieldwork, evidencing the difficulty of working on the infrastructures that are in service.

(5) Status of labor force in the construction industry

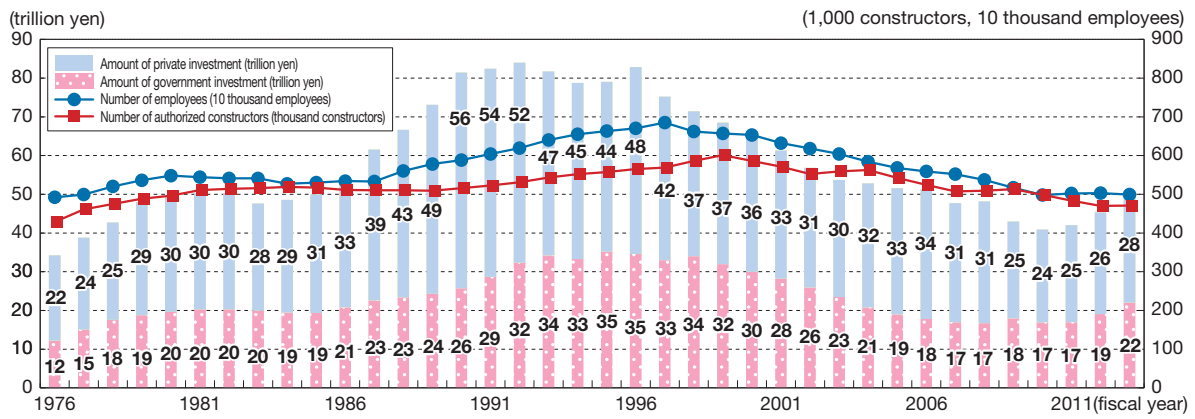
As many constructors talk of the difficulties gaining human resources, the availability of appropriate labor force to the construction industry should be of vital importance to provide a positive solution to the issues of infrastructure maintenance and management that are anticipated to set into full motion from now on. Obviously, from Figure 1-3-28, the number of authorized constructors and the number of employees in the construction industry have been declining rapidly since 1997 in pace with sagging construction investment, with greater decreases in the number of employees when compared with the rest of the industries (Figure 1-3-29).

As can be seen from changes in the number of employees in the construction industry by age group shown in Figure

Note 20 A survey was conducted by the MLIT in February, 2014 through The Associated General Constructors of Japan, Inc., All-Japan Smaller Construction Contractors Association and The Japan Civil Engineering Consultants Association, with responses collected from 521 constructors and 150 civil-engineering consultants.

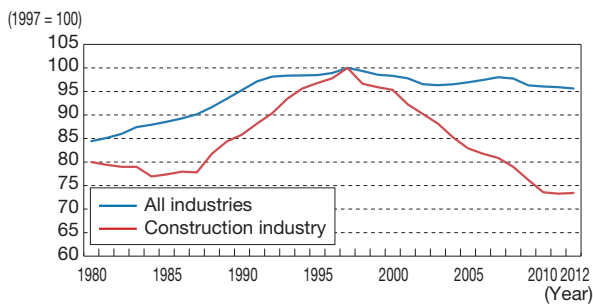
1-3-30, peaks in the number of employees in the construction industry are found in the age groups of the late 20s and the early 50s in 2000, and these peaks have since shifted to right as they got smaller. According to the chart, the number of employees in the construction industry is found to decline as aging workers retire, urging the construction industry to encourage retirees to get back to their previous jobs and secure a new population of younger workers.

Figure 1-3-28 Changes in Construction Investment, Number of Authorized Constructors and Number of Employees



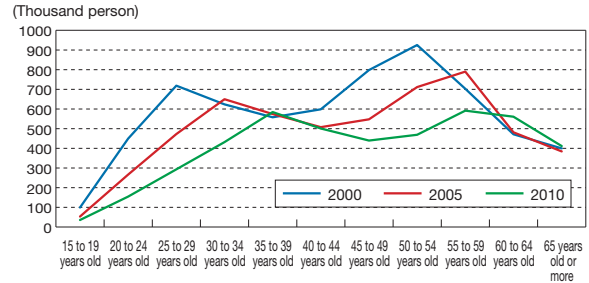
(Notes) 1 The amounts of investments are actual up to fiscal 2010, estimates for fiscal 2011 and 2013 and forecasts for fiscal 2013.
 2 The number of authorized constructors is the value effective at the end of each fiscal year (end of March of the following year)
 3 The number of employees is a yearly average. The 2011 value was estimated from a projected population based on the results of the 2010 National Census after a retrospective correction to allow for complementarily estimated values derived from the three quake-stricken prefectures of Iwate, Miyagi, Fukushima.
 Source) "Construction Investment Estimates" and "Licensed Contractor Count Survey" by the MLIT and "Labor Force Survey" by the MIC

Figure 1-3-29 Changes in the Number of Employees (in All Industries and the Construction Industry)



Source) Developed by the MLIT from a "Labor Force Survey", MIC.

Figure 1-3-30 Changes in the Age Composition of Employees in the Construction Industry



Source) Developed by the MLIT from a "National Census", MIC.

As the number of employees in the construction industry continues to fall in the future, degrading the added value (value of production) that can be created by the construction industry, the implementation of relevant anti-aging measures could be affected. To keep social infrastructures properly maintained, updated and upgraded for long, continuing efforts would be necessary to develop and maintain human resources on a planned basis to take these tasks and to boost labor productivity in the construction industry.

Column

Lives of Concrete

When you hear about the title “useful lives of concrete,” you might wonder if concrete has a life in the beginning. As we have seen in Figure 1-3-4, the public awareness of the problems of aging social infrastructures has been mounting since the Sasago Tunnel accident, but more than half of the respondents answered that they “did not know” or “have heard of but know little” about them.

This Column introduces to you, by way of an interview of Professor Toshiaki Mizobuchi, at the Faculty of Engineering and Design, Hosei University, the author of “How To Get Prepared Against Collapsing Concrete Crises,”* that even concrete, which appears robust, could have its life varied depending on its materials, the method of construction used, the environmental conditions in which it is constructed and so on.

(*Toshiaki Mizobuchi (2013); “How To Get Prepared Against Collapsing Concrete Crises,” PHP, Inc.)

○ You also touch upon the history of concrete in your book.

- The oldest cement material known to date dates back to the one excavated found at the ancient ruins of Iftah, Israel, though it does not have the same composition and process as concrete as we use it today. Concrete excavated from a floor of a large dwelling site has a compressive strength of 15 to 60 N / mm², which is equivalent to or better than the concrete used today. Since Iftah dates back to some 7000 years BC, this concrete can be said to have a life of 9,000 years at least.

○ I see concrete has such a long history. Does the fact that concrete is found in such ancient runs suggest that it is considerably long-lived?

- Characteristically, concrete is resistant to pushing forces but vulnerable to pulling forces. As a solution to these problems, iron-reinforced concrete, or concrete internally reinforced with iron bars, came to be developed with the coming of the 19th century. A gardener named “Joseph Monier” is recorded to have exhibited iron-reinforced flowerpots at the Paris Exposition of 1867. While the advent of iron-

reinforced concrete opened a way for building architectures of unprecedented shapes, it raised the problems of decaying internal iron bars in the meantime, which have trimmed the lives of concrete from several hundred years to several ten years.

The life of concrete is also a parameter of the method of construction used at a construction site. Prewar practice had been to carry hard concrete in a hand cart to construction sites, but in the ages of mass and quick construction following a period of rapid economic growth, the method of pumping concrete to a site needing it after it had been transported from a factory gained popularity. In order for concrete to be pumped under pressure, it must be mixed with lots of water to soften it.

Concrete thus constructed is said to be lived for one hundred years or so under relatively favorable conditions and for 50 years or so under harsher conditions, such as those encountered seaside.

○ Well, do you mean that the life of concrete is also varied by metrological conditions?

- Factors, such as materials, temperature and humidity, the moisture content and the amounts of chlorides and carbon dioxides present at the installation environment, can also affect the life of concrete. Decaying concrete goes through a number of diverse and complexes processes. As one example, concrete placed in the vicinity of a seaside or concrete kept in contact with a snow melting agent in the winter time could be internally permeated by salt to react with steel reinforcements to corrode them. As another, concrete made of materials, such as andesite, is known to develop alligator cracks as a result of a process called “alkali silica reaction.” This phenomenon made a topic as a “concrete crisis” in the 1980s.

Thus, seemingly everlasting concrete decays progressively inside over time for various reasons. Giving proper maintenance to concrete to sustain and care for the functionalities of the concrete structures is important.

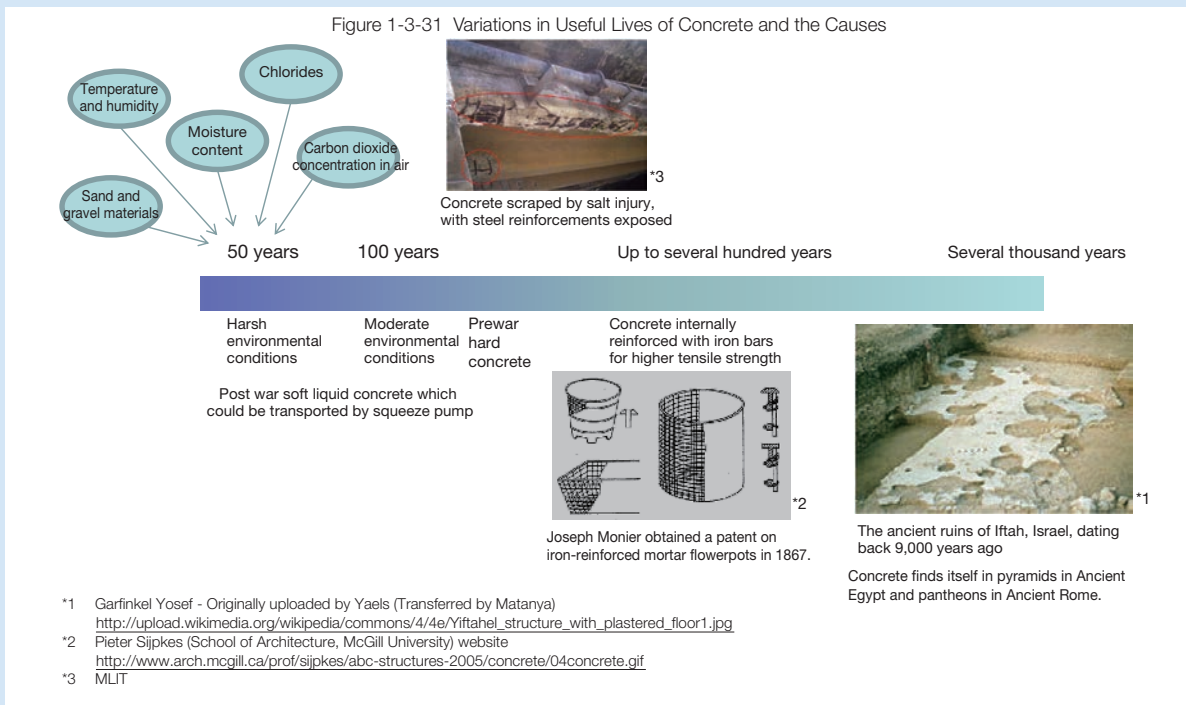
○ Now aging social infrastructures have been

looming into major concern, would you please tell us about the future approaches you feel particularly significant?

- That should be the development of human resources above anything. Civil engineering had been a very popular segment of industry in the postwar period, because it had a close bearing on the rehabilitation of the national land and on nation-building. But civil engineering is no longer as popular among students as it used to be. Further, modern students joining in civil-engineering faculties seem greatly interested in such issues as planning, community renovation and rehabilitation. As their

interest focuses on planning and community renovation, they appear to take less interest in the lectures on maintenance as I deliver them.

Utilizing a qualification system, for example, might be one way to motivate students to learn more about the concepts of maintenance and gain know-how about them. Since modern students are highly oriented towards career development, appealing the advantages of acquiring a socially accredited and esteemed qualification to them should naturally lead to the growth of young engineers.



Column

Aging Condominiums

Today, social infrastructures alone are not decaying at a serious tempo in Japan.

Postwar Japan has followed a continuing pace of urbanization, creating a large supply of condominiums to house the population flowing into urban areas since the onset of the 1970s. From now on, many of these condominiums are entering a period of major repairs and renovations as they have been in existence for long since their initial construction.

Condominiums that have aged without appropriate maintenance and management care could not only suffer losses of structural safety and worsening residential environments but might induce a host of problems, such as a worsening of the surrounding living environment or urban environment.

As distinct from office buildings or privately owned houses, which are commonly owned by single entities, condominiums are each inhabited by a population of owners varying in value and in economic status, each holding ownership of one or more apartments of the condominium. Because of this characteristic, owners of the apartments of a condominium sometimes find it difficult to form consensus on the implementation of major repairs or the like.

In addition, there are problems of shorts on human resources and money. As condominiums grow old, the residents get aged as well, so that an increasing number of management associations are short of volunteers to work as officials. According to a survey conducted by the MLIT, about one fourth of all the condominium management associations are anxious about possible shorts on their renovation reserve funds, while about 15% feel uneasy about condominium common service fees in arrears and the difficulty of running their management associations.

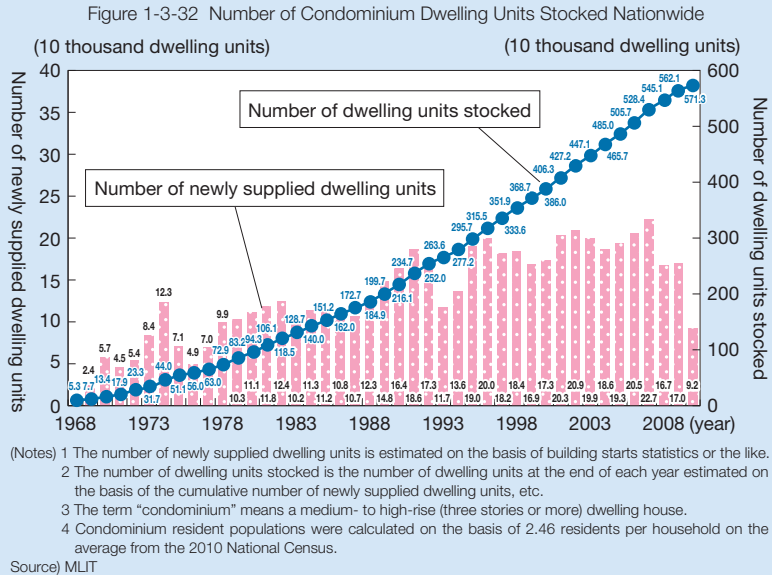


Figure 1-3-33 Number of Condominiums Over 30, 40 and 50 Years Old

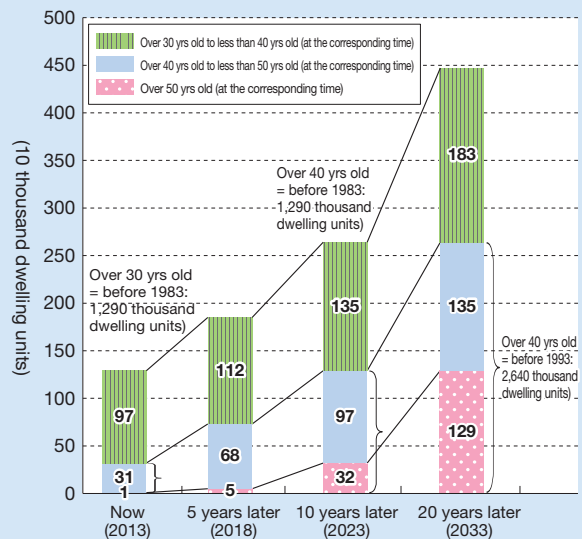
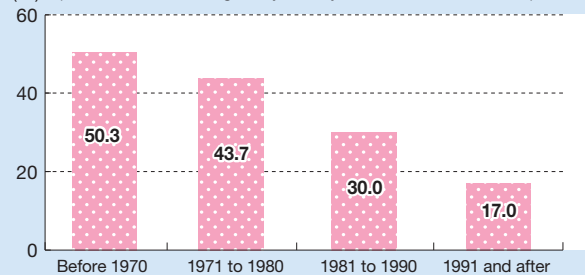


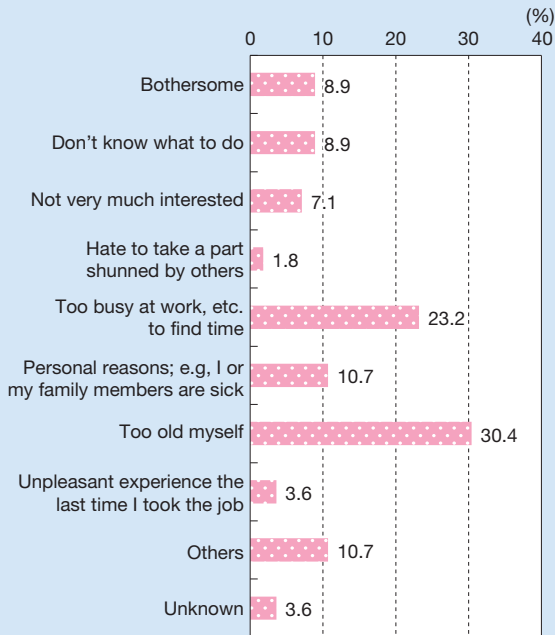
Figure 1-3-34 Aging Condominium Residents Status of Aging Residents of Condominiums by Year of Completion (%) (households consisting solely of 60-year-old or older residents)



The MLIT implements Projects Aimed at Normalizing the Management of Condominiums and Promoting Their Renovation to drive the maintenance and management and renovation of condominium stocks. In June 2014, the Law That Partially Amends the Law Concerning the

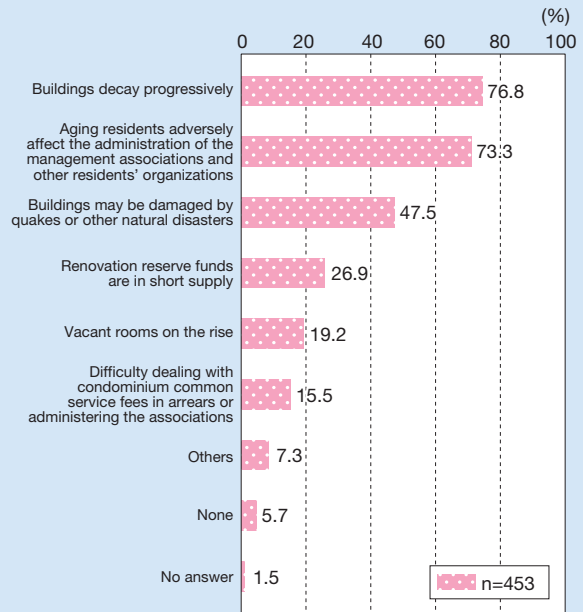
Facilitation, etc. of the Reconstruction of Condominiums came into effect, opening a way to sell the sites of aged condominiums to facilitate their renovation. (For detailed information about the approaches taken by the MLIT, see Section 1, Chapter 5, Part II.)

Figure 1-3-35 Reasons for Not Accepting Position As an Official at Your Management Association (multiple choices) (%)



Source) "Fiscal 2013 Condominium General Survey," MLIT.

Figure 1-3-36 Concerns over the Administration of Condominium Management Associations (%)



Source) "Questionnaire on the Status of Review of Plans to Reconstruct Condominiums, etc.," MLIT.

Conclusions

Thus discussed, Japan has long developed social infrastructures in history, with the resultant store of social infrastructures underlying various activities of our present-day economic society and our daily lives.

As Japan continues to slip into a society of dwindling population, it needs to keep up with consistent economic activities to achieve a certain rate of economic growth amid predictions of sharply falling population while tiding over the problems of tight financial conditions. Japan also needs to keep the nation assured of safety and security under the framework of the tough land conditions specific to the country. Just as concrete has a life, so does a developed infrastructure. The usefulness of an infrastructure won't last permanently. What is important is to keep the social infrastructures already developed so far under proper maintenance and care to allow them to demonstrate their utilities to a successful extent and also to develop vital social infrastructures at a higher level of refinement. A strategic scheme of keeping these initiatives in continuing progress would be necessary for the sake of our future generations.

To this end, "intelligence" is sought to make efficient and effective of the social infrastructures stored so far amid tight financial positions. Because social infrastructures have as their function to support economic activities, the relevant perfection of such function could support economic growth. Making more intelligent use of the existing social infrastructures should help augment our growth potentials.

Further, it is true that social infrastructures have been developed, maintained and managed in the initiative of public entities as the history tells us, though public entities have not done everything and various kinds of stakeholders have been at work according to urges of the times. Just as some bridges had been managed by local residents in the Edo Period, various kinds of stakeholders working in accord while leveraging their own wisdom in their properly defined shares of responsibility would be essential for the sake of "shared support" of essential social infrastructures.

Then, promoting future-oriented initiatives at all times while taking lessons from the history would be essential to sustained growth of our economic society. “America in Ruins” offers a significant lesson for us to learn in probing into the future scheme of maintenance and management of the nation’s social infrastructures. The cost of being overly concerned with immediate benefits and lacking in a long-term perspective would be passed on to our future generations. Future generations would be unable to reverse the decisions made by their predecessors. It would be necessary, therefore, to promote the implementation of “farsighted initiatives,” including drastic scrapping of social infrastructures no longer in effective use, with future risks, burdens and so on taken into consideration.

Chapter 2 introduces various initiatives now being pursued from the three standpoints of intelligent usage, shared support and farsightedness and proceeds discuss why these initiatives are sought.