Civil Engineers Confront Global Warming

Mitigation and Adaptation Plans in Japan to Decrease the Risks of Global Warming

May 2009

Japan Society of Civil Engineers

President's Message

In addition to helping to combat global warming by building the infrastructure for energy sources such as hydroelectric power and nuclear power, developing alternative energies, optimizing the transportation system, optimizing the planning and design of facilities, and extending the lifespan of structures, it is also necessary for the civil engineers to contribute to the realization of a disaster-resistant society that is prepared to deal with rising sea levels and increasingly severe weather patterns as a result of global warming. "JSCE Agenda 21" was adopted by JSCE in 1994, two years after the Earth Summit (United Nations Conference on Environment and Development) was held in Rio de Janeiro. This document includes the following statement regarding the principles of action to be followed by civil engineers with regard to issues of the global environment, including global warming.

JSCE Agenda 21

1. Recognition of Global Environmental Issues and Self-Development

First of all, we will respect interdependence and diversity in the earth's ecosystems, as a foundation for human life. In order to ensure the right of future generations and to share the earth's environment, we have to undertake development in keeping with the concept of sustainability. This means that we must switch from development based solely on short-term objectives, and must stop wasting resources and energy. It is also important to search for a new and more appropriate sense of value and lifestyle by understanding the need to change them.

Civil engineering projects can contribute greatly to the welfare of human beings and the global environment over generations. If the direction is inappropriate, however, they will result in destructive effects to the environment. Therefore, we have to recognize that civil engineers bear a great responsibility to contribute to global environmental issues. For large-scale civil engineering projects, in particular, it is necessary to understand that projects often have complex environmental and social consequences, and that, if short-term economic merits are pursued by ignoring the degradation of environmental quality, it will result in severe economic losses in the longer term.

With such understanding in mind, we have to pay attention to global environmental issues, collect the required data, support environmental education at various levels and promote our own enlightenment. In addition, we must understand that global environmental issues have complex relationships with a variety of fields. This should lead us to exchange options and collaborate with people from other fields and disciplines in order to achieve sustainable development.

The members of JSCE are expected to follow the principles shown below in undertaking civil engineering works:

We have to make efforts to minimize the consumption of non-renewable energy, and, at the same time, to recycle and reuse renewable resources such as wood. Furthermore, it is desirable to assess the environmental effects throughout all the stages of a project, from planning to maintenance, and to use the results as a basis to judge for the appropriateness of the project.

We should incorporate into the economic evaluation of projects, both losses due to the deterioration of the environment and the benefits produced by environmental improvements. Further, we should evaluate both sides of the effects of construction works on our society and historical heritage, and, if adverse effects are predicted, we will try to implement mitigative measures.

We will be honest in recognizing the environmental problems caused by construction works, and be serious in taking the relevant measures to prevent them. In addition to providing related information to the public, we will try to enhance the understanding, participation, and support of citizens with regard to civil engineering projects.

(Quoted from JSCE Agenda 21. The entire text may be viewed at http://www.jsce-int.org/.)

This is the final report of the Special Committee for Action Plans Against Global Warming, which was established by JSCE for the time period of FY 2007-2008. In accordance with the principles of action described above, the purpose of this report is to present an overview of the latest knowledge, especially in relation to civil engineering, concerning the predicted effects of climate change, rising sea levels, and so on, adaptation measures to reduce damage from those effects on aspects such as shore erosion and flooding, and steps to reduce greenhouse gas emissions as measures expected of civil engineers to mitigate global warming; and to delineate the future course of action to be taken by civil engineers with regard to global warming. It is my hope that not only JSCE members but everyone connected to civil engineering will recognize the important responsibility of the civil engineers to combat global warming, and that they will develop a keen interest and become actively involved in this endeavor.

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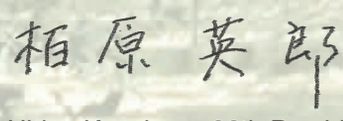

Hideo Kayahara, 96th President of JSCE

Message from the Chairman of the Special Committee for Action Plans Against Global Warming

The Japan Society of Civil Engineers (JSCE) has resolved to endeavor as a whole to combat global warming. In 2007, the president of JSCE established the Special Committee for Action Plans Against Global Warming. As shown in the diagram, the organization of this Special Committee involves JSCE's existing research committees in 28 fields of civil engineering. Three subcommittees have been established under the special committee:

- Subcommittee for Impact Estimation (compilation of basic data for the study of countermeasures regarding future changes in climate, sea levels, etc.)
- Subcommittee for Mitigation Measures (study of technologies to control greenhouse gas emissions and technologies for better ways to supply energy)
- Subcommittee for Adaptation Measures (study of countermeasure technologies for rising sea levels, weather anomalies, etc.)

The special committee obtains advice regarding its operations from an Advisory Board, which consists of JSCE researchers and experts who are working on issues of the global environment.

Its activities have included gathering and compiling the latest information regarding global warming countermeasures in the field of civil engineering; communicating this information to JSCE members in Japan, the general public, and policymakers by means of symposia, pamphlets, and reports; serving as JSCE's liaison office for international activities. In addition, the committee has specified the final structural and non-structural proposals which are intended to provide action guidelines for civil engineers, issuing this final report in 2008.

It is my hope that this report will help more people to understand the stance of civil engineers as they confront global warming, which is the greatest issue facing mankind in the twenty-first century, and that it will be of use to civil engineers as they develop their own action guidelines.

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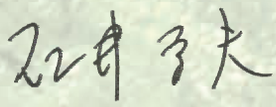
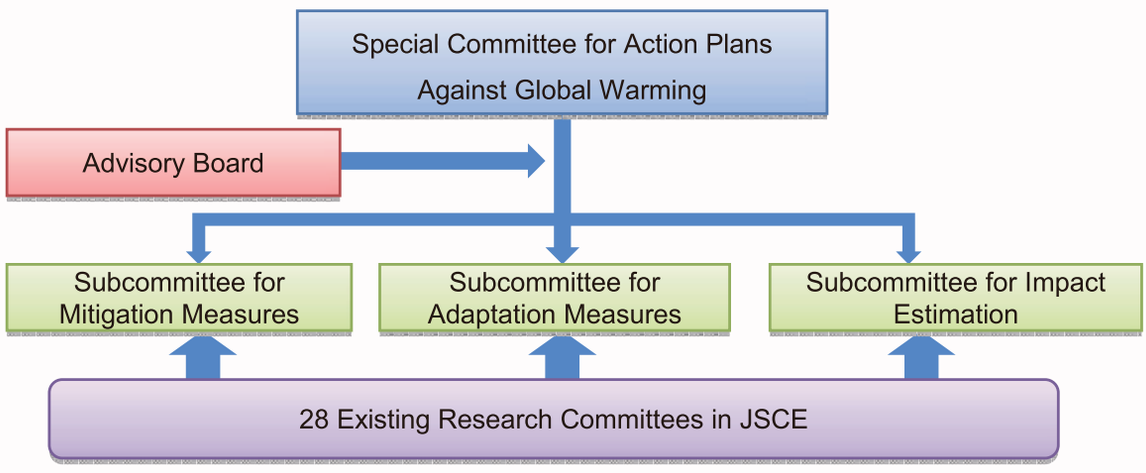


Yumio Ishii, Chairman of the Special Committee for Action Plans Against Global Warming (95th former president of JSCE)

Structure of JSCE's Special Committee for Action Plans against the Global Warming



Proposal by the Special Committee for Action Plans Against Global Warming, Japan Society of Civil Engineers:

Summary for policymakers

How should civil engineers confront global warming?

A. Climate change will lead to infrastructure crises

The effects of global warming are already broad and extensive, and if current trends continue, global warming is likely to pose a serious threat to society. The following statements can be made concerning the future impacts of climate change.

1. Even a small amount of warming, increasing ocean temperatures by 1°C, would have a significant effect on the terrestrial and marine ecosystems that support human society. In addition, a change of 1.5 to 2.5°C would have a significant effect in many areas, including Japan's water resources, disaster prevention, agriculture, public health, and tourism.

2. In places such as cities with well-developed infrastructure, economic activities and other factors are also causing significant environmental changes; therefore, it is difficult to isolate the effects of climate change. However, if meteorological aberrations escalate beyond the urban capacity for disaster prevention, the resulting damage will be severe.

3. From the standpoint of civil engineering, the effect of climate change is the following four aspects: the safety and performance of civil engineering structures and systems; the execution and efficiency of civil engineering projects; the functioning of civil engineering structures as infrastructure; and effects on the national environment and people's lives in terms of safety, security, and environmental conservation, both regionally and nationally.

4. There are two types of changes in global warming and climate change. First, there are changes in average values such as air temperature and sea level; and second, there are changes in extreme phenomena such as meteorological aberrations and typhoons. Changes of magnitude and frequency in extreme phenomena can directly affect the design standards for facilities, including anticipated external forces. However, many uncertainties still remain on this matter.

5. Effects of climate change are wide-ranging, complex and involving interactions among multiple effects. In addition, they appear in combination with other problems facing today's society such as earthquakes and other natural disasters, the aging population and declining birth rate, problems of resources and energy, and problems of food and water.

6. In developing countries, the infrastructure is less well developed, making these countries more vulnerable to climate change.

B. What should civil engineers do?

Because a wide range of mitigative and adaptive measures against climate change exists in the field of civil engineering, the problems of climate change induce new issues and missions for civil engineers. The following are the summary of what we should do.

1. Dual strategies:

The purpose of global warming countermeasures is to keep the human society and natural environment away from dangers caused by climate change. Therefore, it is necessary to appropriately combine the two pillars of mitigative and adaptive measures.

2. Mainstreaming countermeasures within social and economic policies:

Global warming countermeasures should be incorporated as a major policy area in social and economic policy.

3. **Considering special characteristics of civil engineering structures:**

Once a civil engineering structure is built, it lasts a long time. Since these structures are so long-lived, the area of civil engineering should contribute both to the creation of a low-carbon society and low-carbon land formation, which is the goal of mitigative measures, and to making the national environment safe and secure on the long term, which is the goal of adaptive measures.

4. **Realization of maximum co-benefits by policy integration:**

It is important to devise effective steps that can "kill two birds with one stone" for both mitigative and adaptive measures. Individual measures should also have subsidiary effects and compound effects.

5. **Establishment of strong national leadership and specialized departments for climate change in public and private sectors:**

It is necessary to implement global warming countermeasures as a national project, and to indicate guidelines for the future of Japan as a low-carbon society with a safe and secure national environment, as soon as possible. Smart policies must be devised, including the establishment of legal, economical, and technological mechanisms that are needed for this purpose, as well as finances, organizations, and human resources. Civil engineers should strongly initiate and support citizens and policy makers into this movement. It is also necessary to build a strong framework for implementation, including the establishment of specialized public and private organizations to handle these issues.

6. **Establishing an eminent persons council on global warming:**

Policies must be studied from a preventive standpoint in order to avoid devastating future risks amid the uncertainties of prediction. Therefore, a council consisting of high-ranked eminent persons on global warming should be established as an organization in which various experts will cooperatively study ways to deal with global warming, providing political and administrative leaders with various types of information and proposals to support effective decisions.

7. **Integrating civil engineering technologies and contributing to the community:**

It is necessary to integrate nationwide civil engineering technologies towards climate change mitigation and adaptation. An active participation to regionally specified studies and implementation of global warming countermeasures is also needed by all civil engineers.

8. **Collaboration with citizens:**

Collaboration with local residents, NGOs, and related communities is important. Therefore, it is necessary to build proper framework, institutions, and instruments for collaboration, such as creating databanks and information and facilitation centers that anyone can freely approach to obtain relevant information on global warming, and to discuss on promoting countermeasures.

9. **International contributions:**

Measures to reduce carbon dioxide emissions in developing countries are extremely important, because emissions from developing countries are expected to increase significantly in the future. The participation of developing countries will be indispensable in the international framework of the post-Kyoto accord. Meanwhile, since major disasters, food crises, and the emergence of environmental refugees can lead to international instability, it is necessary for developing countries to incorporate adaptive measures for climate change in their economic development policies, and to make adaptive measures into mainstream policies. Civil engineers should act strongly towards such movement.

10. **More intensive and concrete implemention of JSCE action plans:**

It is necessary to adopt an effective and concrete action roadmap in accordance with "JSCE Action Plans Against Global Warming: JSCE Agenda 21."

11. **Building a strong framework for implementation:**

The Japan Society of Civil Engineers should organize a task force to handle strategies on global warming throughout all activities of JSCE. This would not be a research and survey committee. Rather, it is

necessary to arrange one of the directors to be in charge of strategies against global warming, convenes the task force, and answers directly to the Board of Directors, JSCE.

C. Mitigation of climate change

The most important mitigative measures for climate change is to reduce greenhouse gas emissions caused by energy consumption. The basic strategy for this purpose is twofold: reducing energy consumption, and developing and using low-carbon renewable energy sources as far as possible in the supply of energy. Because carbon dioxide is emitted in civil engineering projects, and because civil engineering is closely related to carbon dioxide emissions on the medium and long term due to the use of civil engineering structures as infrastructure, civil engineers should contribute to the reduction of greenhouse gas emissions as one of his basic strategies.

In research and development as well, civil engineering is related practically to all areas of climate change problems. In relation to mitigative measures, it is necessary to engage in research and development that makes use of the breadth of the field of civil engineering with regard to the linkage of various measures, scenario research, and issues of policy, industrial structure changes, social factors, and economic aspects.

Considering these characteristics, it is both effective and necessary for the field of civil engineering to develop and implement strategies toward the formation of a low-carbon society and lifestyle. These strategies can be roughly classified into the following eight categories.

1. **Reducing GHG emissions in civil engineering projects:**

   Reducing greenhouse gas emissions through energy conservation in civil engineering projects, including the use of higher-efficiency construction machinery and the development of energy-saving construction technologies.

2. **Reducing GHG emissions from the life cycle of civil engineering materials:**

   Identifying and reducing greenhouse gas emissions throughout the life cycle of civil engineering materials, for example, by using recycled cement and steel and other recycled materials, conversion to lumber and other low-carbon materials.

3. **Reducing GHG emissions through the entire lifetime of civil engineering facilities:**

   Constructing longer-lived civil engineering facilities, developing and widespread adoption of energy-recovery technologies, and energy-saving technologies for the operation of water supply and sewage facilities, etc.

4. **Implementation of lowering mechanisms of environmental burden from government procurement:**

   Public procurement by the government should be based on a system that evaluates not only the cost, but also the life-cycle environmental burden, including greenhouse gas emissions and the use of recycled materials.

5. **Promotion of more efficient energy saving civil engineering structures:**

   Developing and promoting the widespread adoption of technologies that contribute to energy conservation in the use of transportation facilities, including measures to reduce traffic bottlenecks at railroad and street crossings, and measures using ITS to facilitate the flow of road traffic.

6. **Development and promotion of innovative low-carbon energy technologies:**

   Supporting the development and widespread adoption of innovative and lower environmental load technologies. Candidates are, for example, water power and wind power, steady promotion of nuclear power. Promoting technological development for high-efficiency thermal power plants and carbon capture and storage are the others.

7. Developing low-carbon urban systems through city planning and transportation planning:

Forming low-carbon urban infrastructures and urban structures, shifting transport mode to lower CO_2 emission through city planning and transportation planning.

8. Support for developing countries:

Contributing to the reduction of greenhouse gas emissions in developing countries through support with regard to technologies and planning, supported by related institutional, political, economical mechanisms and so on, such as clean development mechanisms.

D. Adaptation to climate change

Sustainable societies can be achieved by ensuring security in the following three areas: water, food, and energy. It is necessary to adopt wise political and technological countermeasures in the uncertainties with regard to global warming, climate change, and social change. Adaptive measures will play an extremely important role in ensuring water security. Because civil engineering technologies have an extensive historical track record in relation to problems of water and flooding, civil engineers can offer many options in accordance with social changes and the advance of global warming, and are developing various methods for analysis and evaluation to enable wise choices in goal-oriented policies and technologies.

The options that should be selected need to have strong functionality so that they are resistant to damage and can be rapidly restored if damaged. Civil engineers have developed a great deal of technological expertise in this regard. In addition to the general aims described in part B, the following points are also important.

1. Mainstreaming and highlighting adaptive measures within social policies:

There are two aspects of adaptive measures. They are 1) physical facility developments/improvement, 2) managing/operating the facilities and institutions towards climate change adaptation. Both aspects are indispensable, and it is important for both to be performed smoothly, effectively, and efficiently to avoid confusion or misunderstandings among the general public. Therefore, it is necessary to mainstream the adaptation measures within many other social, economic, and national security measures. Also it is necessary to account clearly the costs of adaptive measures, and to highlight these measures in order not to be buried within business as usual public administration.

2. Innovations and their promotion of related technologies:

It is realistic to incorporate adaptive measures when renovating a structure or during disaster recovery. Therefore, it is necessary to improve the accuracy of prediction of external forces and evaluation of their impact; to reflect these improvements in design standards and achieve other related technological advances; to establish programs to cover the costs; and to develop systems such as databases regarding impacts and the handling of adaptive measures.

3. Implementation of well delivered, sustainable, and robust measures for adaptation:

To achieve wise choices and adaptive measures that will endure, it is necessary to integrate civil engineering technologies which is strongly supported by a council consisting of well-organized higher-classed and eminent persons on global warming.

4. Adaptive measures in hydraulic engineering, coastal engineering, and environmental engineering:

In hydraulic engineering, it is necessary to utilize the existing stock, develop and publish innovative methods to evaluate flood risk, transform water resource policies, provide support for adaptive measures in foreign countries, and reform education regarding water issues. In coastal engineering, it is necessary to minimize damage and achieve multiple effects through protection, acclimatization, withdrawal, and combinations of those types of measures, and to implement the measures with consideration for the anticipated timeline of the effects of climate change. In environmental engineering, it is necessary to improve the water metabolism system, to improve evaporative functions in cities, to contribute to food production by improving the nutrient cycle, and to promote countermeasures against pathogens and tropical diseases.

Impacts of Global Warming and Adaptation Strategies in Japan - Civil Engineers Perspective

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which was issued in 2007, global warming and the associated changes in climate are the result of past human activities. The adverse impacts are of such importance that it is necessary to implement both mitigation measures to halt or slow the progression of global warming as well as adaptation measures to reduce the negative effects and exploit the relatively few benefits of climate change. Adaptation is required in locations and sectors where impacts are already occurring or are anticipated to emerge in the future.

Climate change affects water resources such as surface and groundwater, coastal zones, and disasters such as flooding and inundation during high tides. Its impacts also extend to various other areas, including natural ecosystems, food production, human health and lifestyles, energy supplies, and industry.

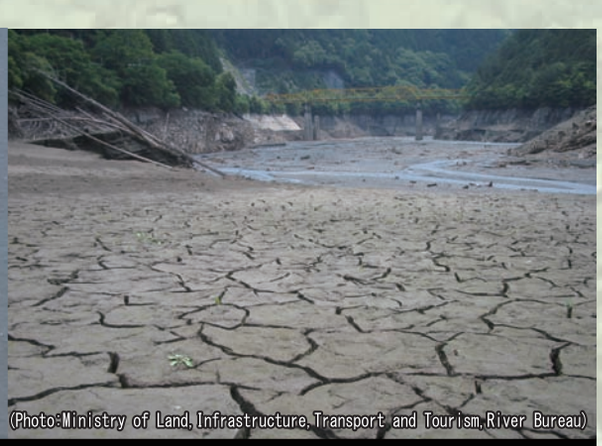
The effects of climate change are worldwide and cannot be avoided, even by Japan and other developed nations. In many developing countries in Asia, the Pacific, Africa and other regions, the effects of climate change are high.

From the standpoint of civil engineering, the effects of climate change include the following: (1) reductions in the safety and performance of civil engineering structures, (2) effects on the implementation of civil engineering projects, including planning, design, procurement, construction, maintenance and management, (3) decreased functionality of infrastructure facilities, and (4) adverse effects on safety and security, convenience, and environmental protection in the national and community levels. In addition to being strongly influenced by climate change, civil engineering can also play a major role in countermeasures to combat the adverse effects of climate change.

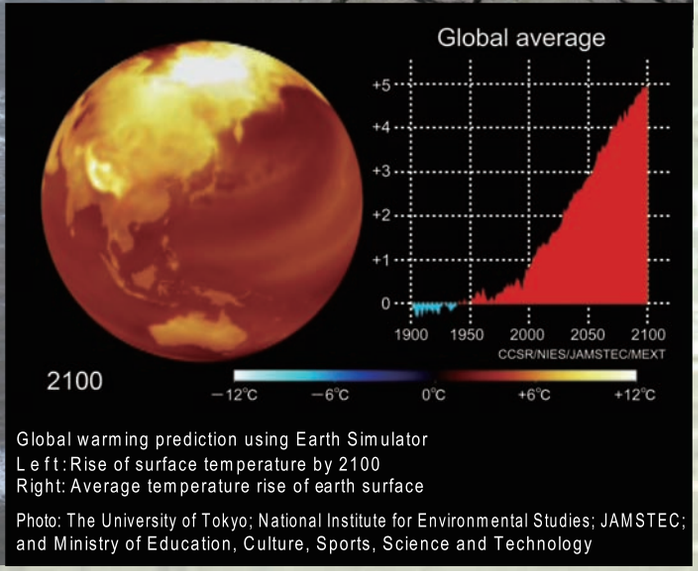
The effects of climate change, as well as the countermeasures, are characterized by complex interactions. For example, changes in the frequency of river flooding due to rising sea levels and changes in earthquake-related ground liquefaction risks due to higher groundwater levels are cases in which the level of damage from natural disasters could be increased as a result of climate change. In addition, the need to conserve water resources and aquatic ecosystems is closely interrelated not only with climate change itself, but also with changes in population and land use.

Because of the complexity of these effects, the countermeasures also need to be multipurpose in nature. Some countermeasures will likely have co-benefits as well as multi-layered effects, while those designed to address individual effects of climate change may involve tradeoffs. The most desirable countermeasures will produce diverse and comprehensive benefits by addressing multiple consequences of climate change, and thereby serve a dual purpose.

(Photo:Ministry of Land, Infrastructure, Transport and Tourism, Yokohama National Road Office Home Page)



(Photo:Ministry of Land, Infrastructure, Transport and Tourism, River Bureau)



Global warming prediction using Earth Simulator
Left: Rise of surface temperature by 2100
Right: Average temperature rise of earth surface

Photo: The University of Tokyo; National Institute for Environmental Studies; JAMSTEC; and Ministry of Education, Culture, Sports, Science and Technology

Impacts of global warming and the adaptation countermeasures related to civil engineering.

○Building a sustainable society based on wise choices and persistent adaptation

Greatly reducing risk through mitigative and adaptation measures

(1) Water security
(2) Food security
(3) Energy security
] Three kinds of security ⇨ Building a sustainable society with peace and vitality

Dealing with uncertainty
- Effects of global warming
- Future social changes

⇨ **Wise choices**
- Multiple options
- Appropriate choices and combinations
- Adaptation responses
- Mainstreaming of adaptation

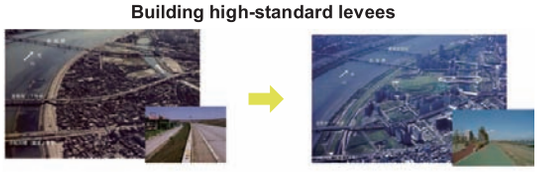
External forces that are greater than anticipated ⇨ **Persistent adaptation**
- Avoiding catastrophic damage
- Rapid recovery

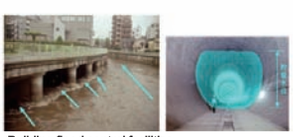
○Proposal of adaptation measures in water security

Adaptation measures for flood control (hydraulic engineering)

- Integrated flood control scheme by facilities and safety planning.
- Construction and overhaul of dikes, flood control basin, dams, etc.
- Using the existing stock in a way that is not limited by existing frameworks
- Developing and publishing methods for the evaluation of flood risk
- Supporting adaptation measures by developing countries
- Promoting innovative education regarding water issues
- Building frameworks related to legal, economic, and social structures and social systems
- Developing new lifestyles and institutions toward the realization of an sustainable society

Building high-standard levees





Building flood control facilities
(underground catchments)

(Photo: Ministry of Land, Infrastructure, Transport and Tourism)

Adaptation measures for coastal area (coastal engineering)

- Protect
- Accommodate
- Retreat

] Use of individual adaptation measures
Developing multi-purpose systems for disaster prevention and mitigation based on combinations of measures

- Planning and implementation of adaptation measures in view of anticipated timelines of the effects of global warming

Maintaining and improving the safety of existing facilities (example:coastal facilities)

Prior to corrective measures,these revetments were in a dilapidated state with deteriorating concrete.

(Photo: Ministry of Land, Infrastructure, Transport and Tourism)

The revetments after corrective measures,with anterior embankment widening.

Adaptation measures for water resources and environmental hygiene (environmental engineering)

- Promoting the reuse of water resources
- Mitigation of heat island phenomena
- Groundwater replenishment and utilization
- Restructuring water use systems within watersheds (agricultural, industrial, and city water use)
- Building water use systems for mutual accommodation within watersheds
- Establishment of sound nutrient salt cycles
- Countermeasures for pathogenic microorganisms and tropical diseases
- Adopting energy saving technologies

Before

After

Re-use of rebuilt discarded hydraulic power plant
(Photo: Tokyo Electric Generation Co., Ltd.)

Problems of global warming and climate change are closely related to social infrastructure construction.
→ It is essential to use civil engineering technologies effectively.
→ With knowledge and experience in a wide range of areas, JSCE has an important role to play.

Charting the effects of global warming and adaptive measures

Compiling and enhancing charts of the effects of global warming and adaptive measures
Based on a participatory model by JSCE as a whole, using the Internet, etc.

- ○ Collect the knowledge and experience of persons involved in a wide range of areas
- ○ Raise awareness of the effects of global warming and adaptive measures through the participation of many persons
- ○ Develop new adaptive measures by compiling and enhancing charts
- ○ Develop tools that can be used in various settings including practical operations, education, and research

Chart of effects and adaptive measures (example)

Phenomena caused by global warming	Phenomena	Effects	Adaptive measures
Rising air and water temperatures	Waste-related	Massive amounts of carbon dioxide emitted in recycling PET bottles	Discontinue recycling PET bottles
	Urban life	Increasing use of cooling equipment and decreasing use of heating equipment	Dissipate heat by sprinkling treated wastewater and groundwater
			Dissipate heat by planting trees
			Vitalize waterfront tourism industry
	Rural life	Land suitable for production is changing	Change farmland utilization
			Breed new varieties of crop seeds
		Accelerated timing of cultivation	A decision support system for agricultural crops that are suitable to the climate conditions
		Increasingly harsh agricultural work during the daytime	Plant trees as windbreaks and shades
Decreasing snowfall and snow accumulation	Water supply	Accelerated timing of snow melting	A device to operate dam reservoirs
			Review water rights
			Adjust agricultural work according to the seasons
	Urban life	Decrease in albedo (ratio of reflected to incident light)	Control snow removal
		Decline in the tourism and amusement industries that use snow, such as ski resorts	For the tourism industry, actively use artificial snow
Changing rainfall patterns 1 (measures for droughts)	Water supply	Increasing draught risk	Use recycled water in homes and buildings
			Use recycled wastewater
			Dam operation using high technology
	Wastewater processing	Increasing demand for recycled wastewater	Develop and apply advanced wastewater processing technology
			Develop systems and standards to promote the use of treated rainwater
Changing rainfall patterns 2 (measures for flooding due to torrential rains)	Water-related disasters (drainage basins, rivers)	Increasing flooding	Make efforts to increase the capacity of facilities, including levees and dams
		Increasing flooding risk	Concentrated measures for core function areas
			Divide flood hazard areas into blocks to prevent flood water from spreading
			Improve the disaster management support system and construct a disaster management network to provide against flood damage
			Improve the accuracy of rainfall forecast
Rising sea levels	Urban life	Increasing zero-meter zones, and decline in land prices	Increase the height of buildings
			Construct high-specification levees
			Increase the height of riverbanks
			Construct elevated land
			Increase the capacity of draining water in the areas protected by levees
Northward expansion of public health inspect pests	Rural life	Dengue fever, malaria, and others	Eliminate pools of water without fish
			Avoid damage to agricultural crops
Issues deriving from the relationship to mitigative measures (especially energy saving measures)	Water-related disasters (drainage basins, rivers)	Urban development of low-carbon and flood damage-adaptive type (such as "Lake Town" and intensive type urban development)	
	Water supply	Upstream water intake and water supply by gravity	
		Micro hydropower generation	
	Waste-related	Use of biogases	
		Convert waste into solid fuel	
		Convert waste into bioethanol	
	Urban life	Use groundwater and treated wastewater to sprinkle on the buildings to cool them	
		Plant trees along urban rivers and construct parks and greenways to form greenery networks for wind to pass through	

Describing the effects and adaptive measures regarding each of the phenomena caused by global warming

Phenomena caused by global warming

- ● Rising air and water temperatures
- ● Decreasing snowfall and snow accumulation
- ● Changing rainfall patterns (measures for droughts)
- ● Changing rainfall patterns (measures for flooding due to torrential rains)
- ● Changes in typhoons and high tides
- ● Compound disasters
- ● Rising sea levels
- ● Northward expansion of public health inspect pests
- ● Issues deriving from the relationship to mitigative measures (especially energy saving measures)

Subject areas

- ● Water-related disasters
  - • Drainage basins (rivers)
  - • Coastal areas
- ● Water supply
- ● Wastewater processing
- ● Waste-related
- ● Water environment
- ● Urban life
- ● Rural life
- ● Small island states
- ● Others

Comments were given on 300 types of adaptive measures to mitigate 150 types of effects caused by global warming.

We continue to seek comments to further develop the options of ensuring the creation of sustainable society based on smart choice and persistent adaptation.

Adaptive measures in flood control

Shiro FUJITA, Deputy Manager, River Planning Coordination Office, River Planning Division, River Bureau, Ministry of Land, Infrastructure, Transport and Tourism

Considering future precipitation increase, design flood peak discharges need to be further raised if present flood safety levels are to be maintained. However, it is sometimes extremely difficult to construct structures, including river-improvement and flood-control structures, which can accommodate such increased discharges, because of social and other constraints. However, keeping present design discharges would result in severe drops in flood safety level in the future, and the risks of floodings and inundations may increase.

To solve these issues, the increment in external forces caused by climate change should be included and coped with in flood control policies

Specifically, future flood control policies should be multilayered. In addition to traditional “flood control policies to secure safety at the river level” through river improvement and the construction of flood control structures to meet target discharge levels for past and current river projects, “flood control policies to secure safety at the basin level” through preparation for possible increase in excess floods should also be implemented.

We will implement flood control policies in river basins in ways that are suitable in light of the regional situation of land use, including flood control structures such as retarding ponds, runoff control measures such as rainfall detention /infiltration facilities, and measures using secondary levees, ring levees, and earth fills from road and railroad construction to prevent flooding from spreading.

To cope with sea level rise and intensified typhoons, storm surge barriers should be implemented in an appropriate way. Concrete barriers should be rebuilt higher to enhance their protection capacities against intensified external forces, especially at a time of renewal so that the frequency of inundation can be reduced.

Photograph 1. An example of retarding ponds (Multipurpose retarding pond of Tsurumi River, Kanagawa Prefecture)

Transportation planning in Arakawa Ward

Yasunori MUROMACHI, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology

The transportation sector produces about 20% of Japan's carbon dioxide emissions, and most of this is due to the use of automobiles. Japan's excessive reliance on automobiles causes environmental problems including noise, as well as other problems for society such as traffic accidents. From the standpoint of sustainable development, this situation needs to be corrected. Many local governments are now developing and implementing plans to decrease reliance on automobiles and reduce carbon dioxide emissions from the transportation sector. The national government is also supporting endeavors such as environmental model cities and Environmentally Sustainable Transport (EST). For example, in Tokyo, Arakawa Ward has established an EST goal of reducing carbon dioxide emissions from the transport sector by 3,548 tons (1% lower than the previous year) from 2008 to 2009. To achieve this target, the ward has decided on car sharing, eco-driving, and mobility management as the primary strategies, based on cost-effectiveness analysis with the participation and collaboration of ward residents, businesses, government agencies, consultants, and scholars, and is in the process of implementing these measures. The ward is also distributing the "Arakawa Transportation Eco-Life Handbook" and encouraging all ward residents to participate and cooperate in this effort.

Arakawa Transportation Eco-Life Handbook

Energy-derived carbon dioxide emissions: 1,203

Energy conversion sector 78.5

Using renewable energy

Promoting the use of hydro and wind power
Using cold thermal energy of snow and ice

Effective use of solid matter and waste heat

Effective use of heat from combustion
Biogas production
Using sewage heat for heating and cooling

Supporting the use of low-carbon energy technologies

Steady promotion of nuclear power
Development of high efficiency thermal power generation

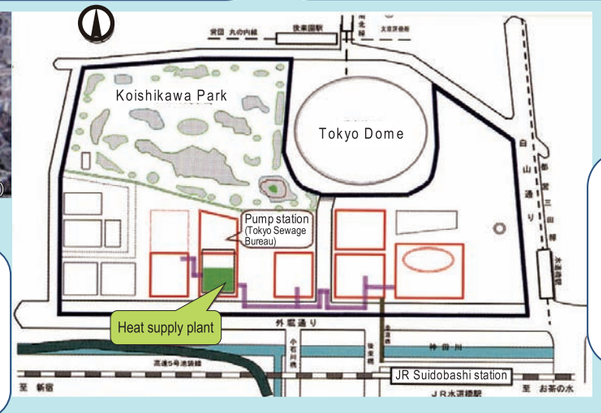
Development of carbon capture and storage (CCS) systems

Industrial sector 456

Including:
Steel industry: 182
Cement industry: 21.8
Construction industry: 5.2*


(Photo:Eurus Energy Holdings Corporation)


(Photo:Tokyo Sewage Energy Co., Ltd.)



Measures during construction work

Development and promotion of energy efficient construction technologies
Promoting the use of energy efficient construction machinery

Lower-carbon construction materials

Saving energy and improving efficiency during materials production
Using recycled materials
Switching to low-carbon materials including lumber

Transportation sector 257

"Hard" measures related to transportation

Improving public transportation systems
Improving road traffic flow
More efficient distribution (logistics)

"Soft" measures related to transportation

Traffic demand management (TDM)
Mobility management

Designing low-carbon transportation and distribution systems

Building low-carbon transportation systems
Establishing low-carbon distribution systems

Business sector 238

Including:
Water supply and waste businesses : 14.5

Saving energy in water supply and sewer facilities and waste disposal and processing

Low-carbon waste materials
3R activities


Plant for recovering waste for re-use

(Photo:JSCE Magazine Vol.89)

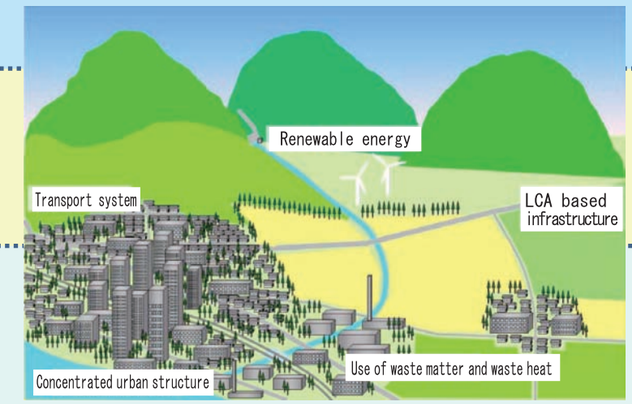
Saving energy in the operation of civil engineering structures and buildings

Residential sector 174

Appropriate and longer lifespans for civil engineering structures and buildings

Designing low-carbon cities and regions

Realizing compact, low-carbon urban structures
Mitigation measures at the block and district level
Improving the thermal environment through greenery and other heat island measures



Non-energy-derived carbon dioxide 90.6

Other greenhouse gases 66.4

Including:
Derived from waste materials and wastewater : 48.2

Reducing greenhouse gas emissions during the disposal process of solid waste and wastewater

Japan's greenhouse gas emissions (FY 2005,in millions of tons of CO2)

Based on *Japan's Greenhouse Gas Emissions,* Ministry of the Environment
Note: Figures for direct emissions by the construction industry are totals for member companies of three major construction industry organizations. (Source: Japan Civil Engineering Contractors' Association, Inc.)

Mitigation measures against global warming in Japan

Low-carbon society and civil engineering

The relationship of civil engineering projects to greenhouse gas emissions is complex. In addition to direct emissions from infrastructure engineering projects, there are emissions related to their operation and maintenance, emissions resulting from production of materials, and so on. Therefore, it is possible to reduce emissions through a variety of activities, which include the study of whether or not to build infrastructure structures, introduction of emissions to evaluation of procurement, as well as approaches to design, design standards, and technological development. These efforts are thought to have a great deal of potential.

Civil engineering strategies for a low-carbon society

Reducing emissions in infrastructure projects

The goal is to reduce greenhouse gas emissions by conserving energy in infrastructure projects, including the use of more efficient construction equipment and development of energy efficient construction technologies.

Reducing emissions resulting from civil engineering materials

The goal is to reduce greenhouse gas emissions throughout the lifespan of civil engineering materials by using recycled materials and switching to low-carbon materials including lumber.

Reducing greenhouse gas emissions during the operation of infrastructure facilities

The goal is to reduce greenhouse gas emissions by developing and promoting the use of energy saving technologies and energy recovery technologies during the operation of water supply and sewer facilities, etc.

Reducing greenhouse gas emissions accompanying the use of infrastructure structures

The goal is to reduce greenhouse gas emissions by developing and promoting the use of technologies that contribute to energy conservation during the use of transportation facilities including roads.

Supporting the development of low-carbon energy technologies

The goal is to reduce greenhouse gas emissions by developing renewable energy utilization such as wind and hydro power, and by supporting technological development for promotion of nuclear power, high-efficiency thermal power, carbon capture and storage, and so on.

Building low-carbon urban systems through city and transportation planning

The goal is to reduce greenhouse gas emissions through city and transportation planning for a low-carbon urban structure.

Supporting developing countries

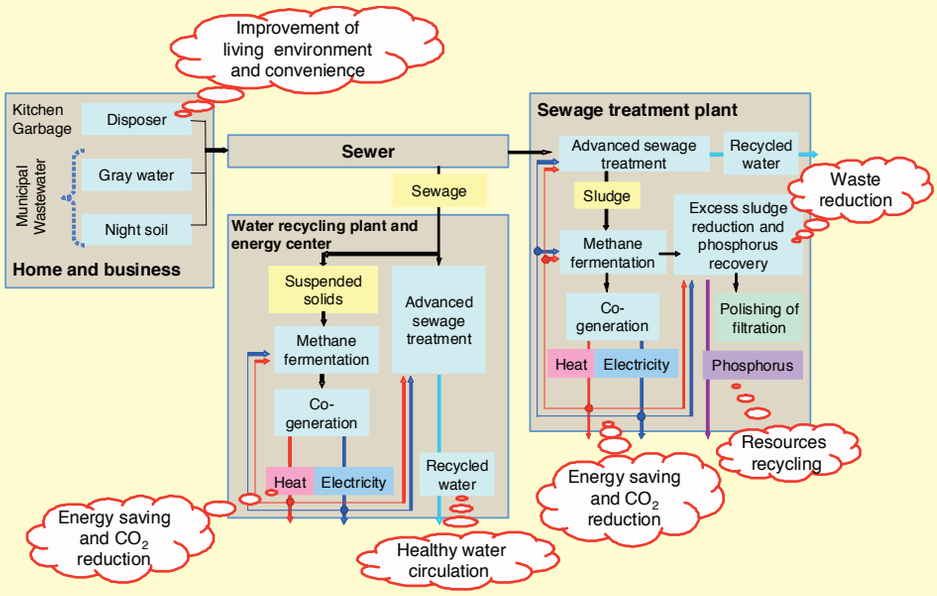
The goal is to reduce greenhouse gas emissions in developing countries by providing support on low-carbon technologies and planning methodologies.

The Nunobiki Plateau Wind Farm in Koriyama, Fukushima Prefecture produces enough electricity for about 35,000 households, resulting in an annual reduction of 53,000 tons of carbon dioxide per year.
(Photo: J-Power)

Technological development for resource recovery and recycling in urban wastewater and waste treatment systems

Hiroshi TSUNO, Professor, Graduate School of Engineering, Kyoto University

We are developing component technologies with the goal of establishing a unified treatment system for the resource and material resource recycling of wastewater and waste in urban areas. In the system we envision that kitchen garbage is passed through a garbage disposer and enters the sewer, and then the suspended solids will be collected and used to generate energy by methane fermentation. Meanwhile, usable water will be produced from sewage to support the regional water cycle. The system will create energy from primary sedimentation sludge at the sewage treatment plant, while reducing excess sludge and recovering phosphorus. This system is expected to reduce the amount of energy consumed in the transportation of wet waste; to provide an improved living environment and greater convenience by eliminating wet waste; to generate electricity, heat, and water resources; to recover phosphorus, which will become depleted in the future; to save energy and solve the problem of land for treatment plants by reducing the volume of sludge production; and to create new industries. In addition to reducing carbon dioxide emissions, it is expected to contribute greatly to sustainability and an improved regional environment.

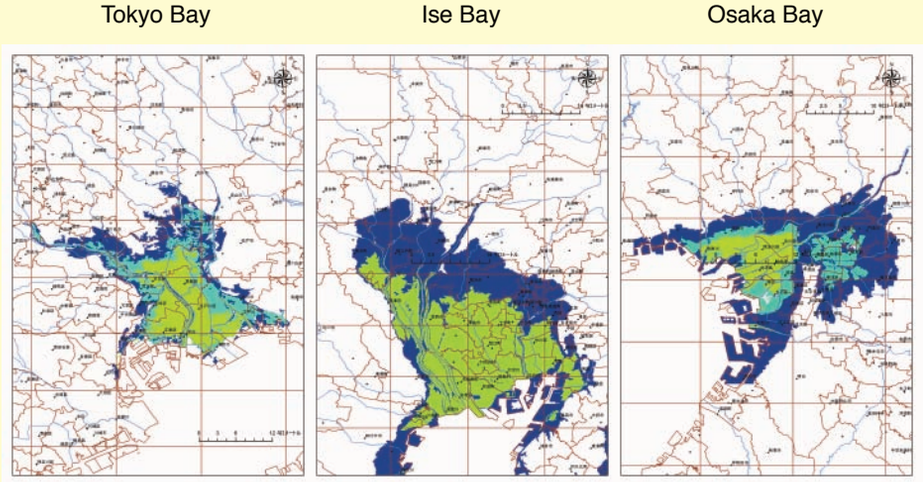


Proposal of a new municipal waste and wastewater management system for improvement of global and local environment
(Hiroshi TSUNO, Professor, Kyoto University)

Risk of inundation in Japan's coastal cities due to rising sea levels:

Predicted areas of flooding with higher sea levels at Tokyo Bay, Ise Bay, and Osaka Bay

The figure below shows the areas around Tokyo Bay, Ise Bay, and Osaka Bay which are expected to be flooded. These areas are shown in three colors, indicating the areas which experience flooding at the current sea level (yellow-green), areas which would be flooded with a 59-centimeter rise in sea level (light blue), and areas which would be flooded when taking historic record storm surges into consideration (dark blue). This is an indication of the potential for flooding without coastal and harbor structures such as revetments, because such structures are not taken into consideration in these predictions. For example, the coastal area around Tokyo Bay which lies below the current high-tide sea level is 117 square kilometers, but the potential area of flooding is 204 square kilometers at a higher sea level, or 322 square kilometers if historic record storm surges are taken into consideration. The population affected by flooding would increase from 2.32 million at present to 3.233 million or 4.156 million, respectively (2000 national census). In coastal areas that are being protected by structural means, including these three major bay coasts, the indicated areas of flooding are not so much a prediction of damage as an expression of the potential benefits of structural protection.



Maps by Yuji KUWAHARA, Department of Urban and Civil Engineering, Ibaraki University

With cooperation from Ibaraki University

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