Proposal

Adaptation to Water-related Disasters Induced by Global Environmental Change

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Committee on Planet Earth Science and Committee on Civil Engineering and Architecture

Subcommittee on Land, Society and Natural Disasters

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Summary

1. Background

The Committee on Disaster Mitigation under Global Changes of Natural and Social Environments, Science Council of Japan (SCJ), issued on May 30, 2007 a report, “Policies for Creation of a Safe and Secure Society against Increasing Natural Disasters around the World.” The report, which includes an outline of Japan’s past responses to natural disasters of a global scale, provides a comprehensive discussion of a desirable direction for the development of infrastructure and social systems to meet the forthcoming changes in nature and society. Based on the report, the committee reported to the Minister of Land, Infrastructure and Transport, in response to the minister’s former inquiry. The Science Council of Asia (SCA) meeting in Okinawa held in the same year had a session on disasters, and several presentations have been made on the subjects.

This proposal is on countermeasures by adaptation to water related disasters, following the former report and the result of discussions made in the subcommittee.

2. Current status and problems

In Japan, over the past 30 years, the number of days of heavy rain with a daily rainfall of 200 mm or more have increased to about 1.5 times that of the first 30 years of the 20th century. It has been pointed out that this is likely to have been caused by global warming. The Fourth report of the IPCC indicates that even low-end predictions implies an unavoidable temperature rise of about 2°C, and, even if the concentration of greenhouse gases is stabilized, the ongoing warming and sea level rise will continue for several centuries.

In terms of social systems, population and assets are increasingly concentrated in metropolitan areas. At the same time, economic recession and aging of the population are accelerating especially in rural areas. The central parts of small- and medium-size cities have lost vitality, and so-called marginal settlements are increasing in farming, forestry and fishing villages. These factors make it difficult and complicated to maintain social functions to fight against natural disasters.

Under these circumstances, it is quite important in our country to take an action for adaptation to climate changes, where land is vulnerable to water and sediment disasters. The need for adaptation has widely been recognized in Europe, and various reports have been issued there. In Japan, initiatives to reduce greenhouse gases emission are being actively discussed, but both the central government and the people hardly recognize the importance of adaptation to water-related disasters. We cannot help but say that they do not seem to be greatly interested in the risk of increasing water and sediment disasters. The people has not long been experienced disasters, and they lack knowledge or awareness of disasters. They are also generally unprepared for them.

Elsewhere, increases in extreme weather and climate events have caused flood disasters, such as those that have been occurring with larger frequency in the downstream deltas of Asian rivers. The latter type of disaster is exemplified by the unprecedented huge flood disaster that occurred in Myanmar in May this year. Japan, which is in the Asian Monsoon Region, has a natural and social geography similar to these countries. Japan should implement strong assistance programs based on accumulated knowledge and advanced technologies developed.

3. Recommendations

(1) Promoting adaptation

The Government of Japan, which has been promoting a policy to reduce greenhouse-effect gas emission to mitigate global warming, also should recognize the importance of adaptation to mitigate impacts from water-related disasters arising from climate change due to global warming.

(2) Commitment to the international society

The Government of Japan should contribute to the international society by making the following commitments at important international meetings and conferences.

(i) Preventing water-related disasters is a core adaptation activity. The Government should make every effort to contribute to the solution of water hazard issues all over the world. Saving lives is the priority, so the Government should cooperate in observation/monitoring, forecasting and warning activities and in preparation of hazard maps. Also, the Government should provide assistance in policy and technology development for management of river basins to support the welfare of river-basin coexistence communities and sustainable development in the Asian Monsoon Regions. The capacity-building program related to these issues is also a key to reduce the disaster.

(ii) Recognizing that disaster prevention must be a component of development programs, the Government should take Disaster Risk Impact Assessments mandatory in all development assistance plans.

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1. Introduction

Extreme rainfall events are increasing in many parts of the world. In Japan, the number of days of heavy rain, (daily precipitation of 200 mm or more) in the past 30 years has been approximately 1.5 times as many as that in the first 30 years of the 20th century. Analysis of long-term daily precipitation trends shows a decreasing trend in light rainfall and an increasing trend in heavy rainfall. Monthly precipitation patterns show months of abnormal drought. It has been pointed out that these phenomena are possibly the effects of global warming. The Fourth Assessment Report of the IPCC[1)] (AR4) warns that global warming will progress further if current levels of greenhouse gas emissions continue or increase and that this will result in greater changes in the climate system in the 21st century than those in the 20th century. Further, according to a scenario of stabilization, a low-end prediction based on remarkable reductions of greenhouse gas emissions indicates that about 2°C rise in the global mean surface temperature cannot be avoided. Even if greenhouse gas concentrations are stabilized, anthropogenic warming and sea level rise will continue for several centuries. Such global environmental change will significantly affect the scale and frequency of water disasters such as floods and storm surges.

Japan had prepared flood control plans by introducing the concept of probability based on long-term meteorological observation data for the past 100 years or more. However, with patterns of weather phenomena in a stage of irregularity as compared to the more regular probability patterns that had been observed up until recently, the risk of 200-year probable rainfall along the country's large rivers has risen. The 200-year probable rainfall (rainfall with a probability of occurring once in 200 years) has been the level of rainfall used as the basic design rainfall probability standard for large and important rivers in Japan. This level of rainfall can now occur more frequently due to climate change. Occurrence of hourly rainfall of 50 mm have steadily increased. Their annual observation was 209 times between 1976 and 1985, 234 times between 1986 and 1995, and 288 times between 1996 and 2005.

In the Kanto alluvial plain, the land lies mostly below river flood levels, and more than one-fourth of the population of Japan lives in this area. Part of Tokyo situated in river mouth delta where population and assets are concentrated below sea level. Therefore, the area is more highly vulnerable to flooding and storm surges than comparable large cities in other advanced countries. An OECD report issued in December 2007[2)] listed Tokyo, Osaka and Nagoya as cities in Japan facing such risks, .

With the country's population and assets concentrated in metropolitan areas, Japan's rural areas are characterized by decline of economic growth and increase of aged population. City centers in small- and medium-size cities are on the decline, and so-called marginal villages are increasing mainly in farming and forestry villages in mountainous areas. This has made it increasingly difficult to maintain resistance and preparedness to natural disasters in such areas.

Since Japanese lands are vulnerable to water and sediment hazards, it is crucial that Japan embarks efforts to adapt to climate change, in addition to those to mitigate (reduce)

greenhouse gas emissions. The need for adaptation is widely recognized elsewhere, particularly in Europe. The European Commission (EC) issued a report entitled *Adapting to Climate Change in Europe – Options for EU Action*, in June 2007.[3)] The need to reduce greenhouse gas emission has been widely discussed in Japan, but both the political and private sectors have not yet sufficiently recognized the importance of adaptation, and insufficient interest has been paid for the increasing risk of water and sediment disasters. Japan, which is highly vulnerable to such disasters due to prevailing natural and social conditions, needs to take effort for adaptation that matches or surpasses the efforts performed in Europe and North America.

Elsewhere, increases in extreme weather and climate events have caused flood disasters, such as those that have been occurring with larger frequency in the downstream deltas of Asian rivers. The latter type of disaster is exemplified by the unprecedented huge flood disaster that occurred in Myanmar in May this year. Japan, which is in the Asian Monsoon Region, has a natural and social geography similar to these countries. Japan should implement strong assistance programs based on accumulated knowledge and advanced technologies developed.

Based on the background mentioned above, this report proposes following initiatives that must be taken from a new viewpoint, especially regarding water hazards and adaptation measures. Water hazards can come from both an excess of water in the case of flood and a deficit of water at drought. This proposal deals with water hazards brought by excess of water.

(i) Preventing water disasters is a core adaptation activity. The Government should make every effort to contribute to the solution of water hazard issues all over the world. Saving lives is the priority, so the Government should cooperate in observation/monitoring, forecasting and warning activities and in preparation of hazard maps. Also, the Government should provide assistance in policy and technology development for management of river basins to support the welfare of river-basin coexistence communities and sustainable development in the Asian Monsoon Regions. The capacity-building program related to these issues is also a key to reduce the disaster.

(ii) Recognizing that disaster prevention must be a component of development programs, the Government should take Disaster Risk Impact Assessments mandatory in all development assistance plans.

2. Why is adaptation necessary?

(1) Concept of adaptation

Adapting to water hazards means striving to create a disaster-resilient society with high adaptive capacity. Water-disaster resilience is composed of the four elements outlined below.

(i) Risk Awareness/Risk Assessment

Risk Awareness and Risk Assessment refer to an understanding of global warming and its various effects, spontaneous selection of adaptive actions, and support within the society taking such actions. In other words, awareness is a major element in decisions made on the direction of adaptation. It is at the core of a Disaster Awareness Society.

(ii) Physical and Social Infrastructure

Infrastructure is an outcome of investments made by society to guarantee and maintain the continuity of social activities. It constitutes an important part of adaptation. The term infrastructure should include not only disaster-prevention facilities, supply and treatment lifelines, roads, transportation, and telecommunications, but also core social services such as the provision of education and medical services. Such infrastructure should continuously function. This is defined as “public assistance” in a narrow sense. The infrastructure includes both physical facilities and social capital such as human resource development systems.

(iii) Resistance

Resistance refers to the ability of facilities and society to act against external forces that can cause disasters. This has been conventionally defined as mitigation in the disaster-prevention field. The United Nations has recently begun to use the concept of prevention. Japan’s mitigation plans has long been focusing on constructing facilities and structures. Control of land use is another important method. Regulating land use to cope with global warming and such as long-term sea level rise will become important in the future.

Maintaining resistance is as important as maintaining infrastructure, but the former includes maintaining private facilities and activities, and therefore its scope is far more wider.

(iv) Preparedness

Preparedness refers to society’s preparation for assumed hazards that cannot be deterred. In many developing countries, this is limited to preparing for emergent responses immediately after disaster strikes. It is, however, necessary to adopt a viewpoint of rehabilitation of society as a whole. This is resilience narrowly defined. Along with recovery, it is particularly important to deal with long-term restoration and economic activities and the psychological stress suffered by victims. Preparedness includes anti-disaster immunity, which will be discussed later.

Figure 1 shows the interrelationships among above mentioned adaptations.

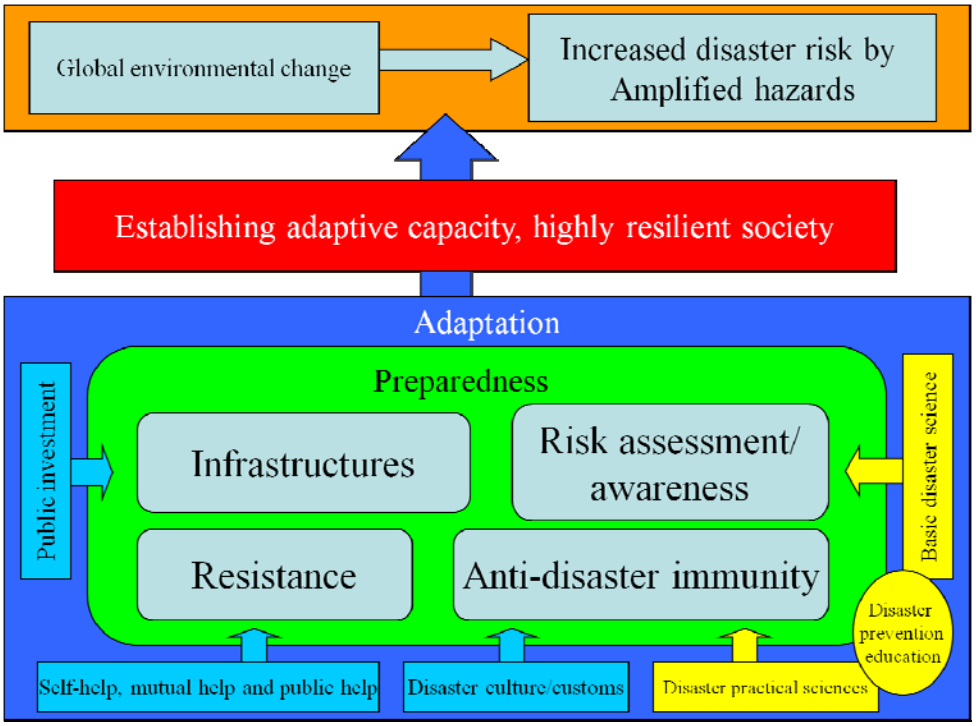

Figure 1. Adaptation to water-related disasters arising from global environmental change

Development of these elements will enhance society's capacity to adapt to water hazards brought about by global climate change. Described below is the increase in external disaster forces due to global climate change, increased imbalances between the damage-prevention capacity of nature and the society, and the necessity of adaptation to water hazards to cope with such forces.

(2) Concept of anti-disaster immunity

Land formation that has occurred over the ages has always been influenced by climate change. Civilizations have adapted to the natural disasters they experienced and people's daily lives have changed in response to the experience of victimization. This has led to the cultivation of what can be thought of as "anti-disaster immunity," a characteristic that is in addition to resistance achieved by building disaster-prevention facilities. It parallels to the immunity seen in nature. By adapting to natural hazards and constructing disaster-prevention facilities, communities have been able to deter damage to a certain extent from small- and medium-scale disasters that occur often. Periods during which huge disasters rarely strike can be regarded as periods in which the natural world and human society have adapted and acquired immunity against small- and medium-scale disasters. In such cases, a balance has been reached, more or less, between societies and external disaster forces. On the other hand, there is no immunity against disasters of a type beyond those that are often experienced — disasters that exceed people's awareness.

However, a steady increase in external forces induced by the recent global environmental change will increase the frequency of large-scale water-related disasters. The balance between the society and such external forces may be extensively disrupted.

Recently, the anticipation has appeared that a new imbalance may be generated in the near future (Figure 2). This is the reason why adaptation is necessary against water related disasters.

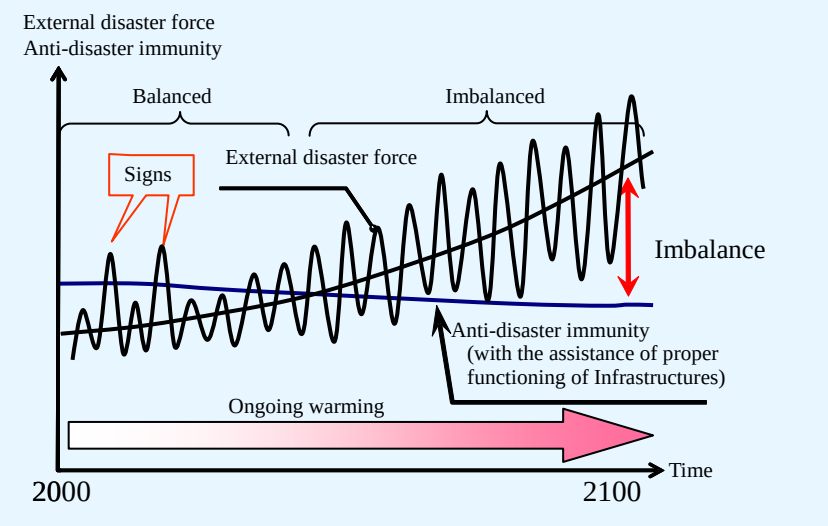

Figure 2. Relative declining in anti-disaster immunity

Anti-disaster immunity is composed of the three factors described below.

(i) Disaster resistance in nature (natural immunity)

Like living things, the nature acquires immunity, when it has long been encountered severe wind and rain. In the case of sediment disaster, areas likely to erode have already done so, and areas not likely to erode remain with increased resistance against wind and rain. In Japan, when Typhoon No. 10 in 2003 hit the Saru River and Atsubetsu River basins, Hokkaido, rainfall of about 300 mm in 24 hours was observed, a level far beyond that of past data in this area. The many slope failures that occurred and the large volume of drift wood generated caused bridges to wash away and other severe damages. However, no such damage by rainfall of 300 mm in 24 hours may occur in Kyushu, where heavy rain often occurs. A maximum instantaneous wind speed of 50 m/s was recorded in Sapporo on the occasion of Typhoon No. 18 in 2004, and roadside trees in Sapporo and rows of poplars at Hokkaido University tumbled down. No such falls of trees may occur in Okinawa where Typhoons frequently hit. A rapid increase in external forces produces a new situation without immunity for disasters, an extremely hazardous situation for which no one can predict where damage will occur.

(ii) Residents' disaster awareness and community resilience

A rise in external disaster forces in a given area will lead to severe damage, and residents' disaster awareness will be enhanced. If, however, they face disasters of a scale that they have not experienced, people and assets will be greatly damaged due to the lack of judgment ability and the panic. Community resilience and strong local

construction firms are required for swift recovery from disasters .

(iii) Social infrastructure and preparedness

Anti-disaster immunity depends also on the quality of the social infrastructure for daily life.

Europe was hit by heat waves in August 2003. In Paris, temperatures rose to 38°C or more for 10 days. About 15,000 people in France and 30,000 people across Europe died due to heat-related illness. Houses in France do not have air-conditioners, because summers are normally cool there. The society therefore failed to respond to the heat wave. Cities where summers are hot and air-conditioners are commonly used might respond to that kind of heat waves. In Okinawa, 90% of the buildings are made of reinforced concrete. They are built to prepare typhoons, but this is not the case in other areas of Japan. Infrastructure for living has been developed by the past experience responding to such forces.

It will require long time, large cost and experience to improve the three elements described above that would constitute anti-disaster immunity in response to the rapid growth of external disaster forces. Slow improvement of anti-disaster immunity may not catch up with the rapidly increasing external disaster forces as seen in Figure 2, and the imbalance between the immunity and disaster forces can be generated. Such imbalance which can appear within a few decades or a century will lead to an undefended situation in which communities will lack immunity for disasters. The society will be exposed to the damage of unforeseen dangers. Today, there is lack of awareness for the situation caused by the imbalance. The conventional measures are insufficient for adapting to the rapidly increasing external forces. For adaptation to avoid extensive damage, it is vital to extract and quantitatively evaluate components of anti-disaster immunity as soon as possible. It is necessary to identify signs of disaster and environmental change, by small changes induced by global warming in nature and society, and to build up new disciplines and technology for prediction and prevention.

3. Approaches to adaptation

(1) Building community-based disaster awareness

The idea that “everyone should protect their own lives by themselves,” is fundamental of disaster prevention. There is a Japanese saying that “disaster will come when you have forgotten (in other words, disaster awareness will fade away with time).” Some people may have forgotten, but some even may have not experienced (or not had an opportunity to build the awareness) yet. In the midst of global environmental changes, both the magnitude and the aspect of disaster are changing. Can you protect your own life without an understanding of the disaster? From this viewpoint, emphasis should be laid on the necessity of building community-based disaster awareness. The basic requirements for the community being safe and secure against disaster are ‘Awareness’ and ‘Preparedness’.

‘Awareness’ means correct understanding and being always aware of natural disasters. ‘Preparedness’ means preventing and being able to appropriately cope with natural disasters.

Individuals should have the understanding and wisdom to cope with natural disasters, also should prepare against disasters at all time. However, modern communities are in a precarious situation. The reasons for this in regard to water disasters are described below.

The memories of severe water disasters in Japan between 1940s and 1960s have already faded away. At the present time, since river improvement, forest conservation and sabo works have been accomplished to certain extent, few people experienced disasters such as flood. It is therefore difficult for communities to pass on experience and wisdom to the next generation. Other problems are shortage of well-trained government personnel who can respond to disasters, increasing nuclear families, and increase of new residents in water hazardous areas. Factors such as the increase of aged people, decreasing the numbers of children, depopulation in rural areas and overcrowding in large cities, and changes in the industrial structure have led to increased vulnerability to disasters both in large cities and farming and forestry villages. Past experience is no longer a sufficient guide due to the changes in river basins caused by land development. In such circumstances, global environmental changes may induce unprecedented phenomena in the society.

Education is important in building community-based disaster awareness. Education on the area’s possible disasters should be conducted in elementary and junior high schools. Scientific education and practical training on global environmental changes (effects from global warming, population movements, and socioeconomic changes) are needed in high schools. Teachers must be trained for these purposes, and educational materials must be developed. Education and training programs supported by the government, the academic sector, and industry are needed to develop community leaders in disaster-prevention.

Furthermore, it is necessary to raise disaster awareness among the people by evaluating and communicating the vulnerability of society as a whole to natural disasters. For that purpose, preparation and effective promotion and utilization of hazard maps and other tools explaining the phenomena (what can happen) and countermeasures (what to do) are required.

(2) Developing physical and social infrastructures

Measures for adaptation include not only physical infrastructure (ex. flood control facilities), but also social infrastructure. Local communities have been weakened in Japan. It is necessary to reconstruct mutual aid system (social capital) for the occasion of disaster, which had been held by the Japanese communities in the past. This can be thought of as social technology against disasters. NPOs which can involve in such activities should be fostered.

Development of information systems is needed to overcome vulnerability to disaster. The precise and appropriate information, including forecast/prediction and

recovery/restoration information, can remarkably reduce damages from disasters. It is also important to develop and maintain lifelines such as medical services and water and energy supplies.

Reinforcing resistance capabilities of constructions for prevention against disasters is becoming increasingly important. With a sense of urgency, analysis of increasing trend of rainfall intensity must be reflected in planning and designing of new disaster-prevention facilities. Like the Netherlands, the United States has built levees designed to prevent overtopping from a 500-year flood in recent years.[4] Levees must be continuously inspected and maintained to ensure the security of specified functions in the event of a severe flood, and dams must be properly controlled for flexible operation of water-use and flood-control. Conventional construction technology is not enough. Formulating a framework for the establishment of a new technical system for adaptive management is an urgent task. Future goals should include single-purpose flood control dam, i.e. dry dam that stores water only during floods. Here, detailed and precise predictions for climate change conducted by utilizing the Earth Simulator is indispensable.

In addition to prevention achieved by using such flood-control facilities, structures of cities and other areas must be changed into flood-proof type. It will be difficult to adequately respond to unprecedented and devastating floods triggered by global climate change by only using flood control facilities. Cities should have water-resistant or flood-proof structures. This includes houses with strong resistance to flood damage and countermeasures against underground flooding in metropolises. Ideal land use is another agenda item for the future.

(3) Planning for recovery and restoration

With the progress of global warming, it is becoming more important to assess damage from floods and storm surges, and to prepare recovery/restoration measures in advance. Improper implementation of recovery/restoration measures after a large-scale flood will endanger the sustainability of affected communities and have an extensive impact on post-disaster economic activities. Japan’s security and the world economy will be adversely affected if devastating flood disaster occurs in a central city in Japan.

In the past, developed countries have taken many initiatives to mitigate direct damage. However, only a few of them have focused on post-disaster recovery and restoration. In addition to the progress of global warming, the example of Hurricane Katrina and other major disasters have prompted many countries to launch studies and initiatives. In the United States, some reports have been issued recently on adaptation for the transportation network,[5,6] but recovery and restoration are not covered. As a part of the impact assessment of post-disaster local economy in order to plan desirable recovery and restoration, Input-Output Analysis has been conventionally conducted.[7,8] Applicability of the conventional method to devastating disasters such as Hurricane Katrina is still in the research stage, because detailed analysis of the phenomena has not yet been completed.

In the United Kingdom, various studies are in progress, learned from the two major floods in 2007. In this process, recovery and restoration have been recently added as study items.[9)]

Effective system of flood insurance that could play a vital role in recovery and restoration has been studied in some countries, including the United States, where insurance became a major issue in the aftermath of Hurricane Katrina.[10,11)] The amount of funds in the capital market generated by Cat bonds, a newly developed security, to assure the solvency of insurance, and reinsurance companies are rapidly increasing. But, it does not account for a large share of the insurance needed. There still remain many issues to be resolved, including the preference of insurance purchasers, nurturing self-help for damage mitigation, measures for the poor, and a degree of governmental involvement. Among others, a key issue to address is the ability to project the frequency and extent of damage that could be triggered by global environmental change in order to guarantee the normal functioning of the insurance system.

In Japan, the Cabinet Office's Expert Examination Committee on Large-Scale Flood Countermeasures [12)] has dealt with the issue on post-disaster countermeasures in the Tone and the Ara River systems. The study on detailed damage estimates is the first step, and the committee is expected to play an important role in planning the recovery and restoration measures, utilizing the results of the study. It is significant that the committee has been sharing information with lifeline administrators in the study. Not only the quick recovery of lifelines, the duration needed for drainage of the water flowing through levee breaches would also affect post-disaster recovery and restoration. Securing drainage pump function is a key for reducing this duration, as seen in the case of Hurricane Katrina recovery work. It is noteworthy that the effects of pre-disaster structural measures, such as waterproofing of drainage pumps and securing necessary heights for fuel-feeding system, were quantitatively identified on the basis of the time-span needed for drainage.

The Chubu Regional Bureau of the Ministry of Land, Infrastructure and Transport has organized the "Tokai Netherlands Regional Council against Storm Surge and Flood" in cooperation with many related organizations. The council has established a "Crisis Management Action Plan (1st Edition)" [13)] based on the specific damage estimates. This is a valuable attempt to build awareness among the related organizations by calling for the preparation of a wider-area evacuation plan. Hopefully, another revised plan will be made more specifically, focusing not only on emergency measures, but also on recovery and restoration measures.

Based on the current initiatives, the measures described below should be implemented for recovery and restoration.

(i) Nationwide studies of post-disaster recovery/restoration measures based on detailed disaster estimates and promotion of pre-disaster measures

It is said that nothing is better than pre-disaster measures in recovery and restoration. The such detailed disaster estimates as those conducted by the Cabinet Office and the

Chubu Regional Bureau of the Ministry of Land, Infrastructure and Transport will serve to prepare pre-disaster structural and non-structural measures and to recognize the importance of those measures nationwide. Therefore, such estimates should be promoted nationally, and post-disaster measures should be promoted in the future.

(ii) Studies on adverse effects related to time-length needed for post-disaster recovery

The longer the recovery period, the greater the adverse effects on the victims—on their local culture and on their psychological or mental state.[14)] It is very likely that the adverse effects on the economy will be rapidly amplified over time in case functions of metropolis are damaged.[15)] With this in mind, studies should be conducted on various effects depending on the time-length needed for post-disaster recovery of major lifelines leading to full restoration, and the results should be shared with residents and the industry and be reflected in pre-disaster strategies for recovery.

(iii) Improving disaster prevention measures in the period of restoration

In view of the progress of global warming, it is indispensable to incorporate measures to improve disaster prevention in restoration efforts. Nagoya City made construction of flood-proof structures obligatory during restoration against the Ise Bay Typhoon hit central Japan in 1959. With the exception of disaster hazard areas, however, these types of measures are not conducted in Japan afterwards. As time is limited after disaster, it is better to study improvement of disaster prevention incorporated in post-disaster restoration efforts in advance.

(iv) Study of flood insurance

Various studies have been conducted on desirable flood insurance. They must be pursued further in coordination with the other studies discussed above, based on the damage estimates of large-scale floods. It is crucial that such insurance system must be designed to contribute to disaster-reduction efforts made by individuals and businesses.

(v) Continuous monitoring of adaptive capacity

Continuous monitoring of adaptive capacity of each area along with the phases of implementation of new disaster-prevention measures and post-disaster recovery/restoration can serve as a basic adaptation measure to changing climate. This work will be of use in accelerated development of recovery and restoration measures.

(4) Research and development for adaptation

The effects of climate change due to global warming vary from area to area. Japan's territory stretches from north to south, from the subpolar zone to the subtropical zone. Changes in rainfall due to climate change should be studied in detail. Highly precise, detailed projections of changes in each area are needed, including work done with the Earth Simulator.

Research and development on flood control facilities should achieve anti-disaster immunity that goes beyond conventional concepts. To definitely prevent unexpected devastating disasters, it is vital to establish a new engineering field as soon as possible to prevent devastating disaster by developing techniques of parameterizing and quantitatively evaluating components of anti-disaster immunity, and identifying signs of disaster and environmental change from smaller changes occurring in the natural world and in communities because of global warming. The development of disaster-reduction technology from the new viewpoint is an urgent task. Examples include wide-range water depth monitoring system needed to help prevent the collapse of landslide dams, and dry dam as a sediment control measure against large-scale slope failures in upstream areas.

4. Reforming the national land structure

In addition to the specific challenges mentioned above, it is necessary to consider reformation of national land utilization as a medium and long-term paradigm shift to cope with changes caused by global warming.

In regard to the structure of national land utilization, if the current socioeconomic structure is to be sustained, the concepts and methods of adaptation to be applied can be different between large cities where population and assets are concentrated and rural areas characterized by depopulation.

Located in low-lying areas, Japan's large cities are especially vulnerable to water-related disasters, such as floods that are growing in scale and sea level rise caused by global warming. For example, dyke breakage during a flood can result in catastrophic damage in large cities. In this situation, the country may possibly face difficulties in view of political and economic security. Psychological damage to the people will also be severe. In such large cities, construction of disaster prevention facilities such as high-standard levees (super levees) should be implemented.

On the other hand, the rural population has been decreasing. The supply of low-cost energy that has supported and maintained societies with living spaces expanding into suburbs is becoming more uncertain. Under these circumstances, it is likely that sustaining societies inconsistent with efficient government services will become increasingly difficult. Therefore, investments to build compact cities and farming, forestry and fishing villages that are resilient against natural disasters will become important. In other words, it is time to consider opting for compact locations made suitable for living and economic activity. In this case, integration of roads and levees and flood countermeasures such as circle levees should be considered. The need for Japan to efficiently invest in this kind of adaptation becomes clearer by the aging and shrinking of population and by the possibility that the scale of economy may decline. Nationwide uniform investment is not necessary, and the investment should be made carefully and effectively, after fully identifying the properties and the vulnerability of individual river basins and communities.

In addition to socioeconomic effects, the global warming can yield psychological effects

on people and their sense of values. If it occurs, other scenarios should be employed. Japan's social and land-utilization systems are vulnerable for water-related disasters, because population and assets accumulated and concentrated in alluvial plains. Japanese food supply highly depends on other countries. Overall reform for land use must be discussed also from the viewpoints of disaster-risk diversification and sustainability. In other words, comprehensive studies should be promoted, incorporating the viewpoint of reforming the structure of land use. Analysis and consideration from medium- and long-term standpoints are needed to derive the direction to sustainable, safe and secure land utilization. Full consideration must be made in treating the subject, including social values and the selection of residential areas by people; the possibility of maintaining and developing the rural economy in an era of globalization; the pros and cons of decentralizing economic functions now concentrated in large cities; and the roles of the government, municipalities and the private sector.

5. International contributions to prevention of water hazards

COP13 (the 13th Conference of the Parties to the Framework Convention on Climate Change) recognized for the first time in its Bali Action Plan that adaptation as well as mitigation is important in the effort to counter the effects of global environmental changes. This recognition in the international society has great political meaning, and both developed and developing countries have begun to step up initiatives for adaptation to climate change.

Water hazard countermeasures are crucial for adaptation to climate change. In this area, expectations for Japan, a country that has achieved economic growth while living and struggling with water over a long period of time in the Asian Monsoon Region, are very high. The country's experience, technology and funds will be relied on.

International contributions win respect in the international community. This strengthens the Japanese national security and directly leads to greater economic strength based on its technology and experience. The same applies to European and North American countries. Diplomacy based on scientific and technological contributions became an intense international competition.

Under these circumstances, there has been an early recognition that disaster management should be placed at the center of Japan's scientific and technological diplomacy. Japan hosted the Hyogo Framework for Action Conferences and established ICHARM (International Center for Water Hazard and Risk Management supported by UNESCO), which are highly evaluated internationally. However, the government's system for promoting highly effective international contributions is not sufficient and is well behind those of Europe and America, particularly in strategic efforts. Japan's ODA budget has been rapidly decreased from its peak in 1997, and the country's international contribution system as a whole is being reviewed.

The major cause of natural disasters in developing countries are often poverty and governance issues, which sometimes transcend the lack of individual infrastructure in

reducing disasters. Development may often result in the destruction of traditional patterns of life in developing countries. International contributions to disaster prevention should take these issues into account.

In view of the facts mentioned above, international contributions for disaster prevention should be implemented in ways outlined below.

(i) Integration of disaster prevention assistance and development assistance

Disaster prevention should not be limited to humanitarian assistance focusing on post-disaster rescue operations. It must be planned and implemented in connection with all development projects. It is necessary to review the standard adopted by the OECD's Development Assistance Committee (DAC) and obligate implementation of the Disaster Risk Impact Assessment (DRIA) for all ODA items.

(ii) Strengthening and mobilizing assistance capabilities in advanced technology and policy technology

Japan should intensively strengthen and mobilize its capabilities as indicated below. They are areas pertaining to disaster-prevention assistance for which Japan is internationally competitive, and other countries are expecting highly.

- Advanced technology for long-term projections of climate change, observation/monitoring, forecasting and warning, information transmission technology, and hazard mapping.
- Policy and technology to manage river basin coexistence communities; measures supporting the sustainability of the Asian Monsoon Region.

(iii) Assistance in capacity building

The aim in providing assistance to developing countries should be to contribute to their independent, sustainable development. Capacity building and educational assistance should be enriched for that purpose. They have high expectations for water hazard programs, which should be the pillar of adaptation assistance for climate change.

(iv) Foster the development of a group of international engineers

Japan lacks a system to derive full benefit of experience and information of the engineers involved in international contributions especially of the government officials experienced overseas. This deters the country's strategic international contributions. Creating an information hub and developing and maintaining groups of engineers with international experience are urgent task.

(v) System of strategic international contributions and scientific and technological diplomacy

Scientific and technological diplomacy based on international activity contributes to national security. It is necessary to build a system beyond sectionalism to implement diplomacy in an integrated and efficient manner under a state strategy.

(vi) At important conferences to be held in the future, Japan should commit to making international contributions in the following ways:

- Adaptation focusing on water hazards: Japan should contribute to this adaptation throughout the world.
- Protecting human life is the priority: Japan will cooperate in observations/monitoring, forecasting and warnings, and hazard mapping.
- Building river basin coexistence communities to support sustainable development in the Asian Monsoon Region and providing political and technological assistance for its management.
- Assistance capacity-building programs in related above items.
- Disaster prevention should be included in development plans. Disaster Risk Impact Assessments should be included in mandatory part of all of Japan’s development assistance plans.

<**Glossary**>

Marginal settlements (p. iii, p. 1)

These are settlements where the elderly account for the majority of the population and where maintaining community life is difficult, as reflected in few weddings, funerals, or coming-of-age ceremonies; where residents find it difficult to cooperate in management of farmland; and where it is difficult to maintain community roads. According to the Ministry of Land, Infrastructure and Transport, in 7,878 settlements out of 62,273 settlements surveyed, the elderly (age 65 or over) accounted for the majority of the population (as of April 2006).

River-basin coexistence management (p. iv, p. 2, 13)

Management of hydrological cycle systems for land and water to build human activities changing over time that remain in good balance with the natural environment (river-basin coexistence communities), and to realize sustainable life and production. Japan has been introducing this concept, as development of "River Basin Communities," since its 3rd Comprehensive National Development Plan.

Adaptive Capacity (p. 3, p. 10)

The ability to adapt is called adaptive capacity. It refers to the capacity to comprehensively adapt to changes by reducing damage resulting from climate change and extreme weather events and coping with the results and effects. As a broad concept, it includes construction of disaster prevention facilities, building disaster awareness of residents, and organizing residents' mutual-aid.

Resilience (p. 3)

The ability of a society to absorb effects of changes in the external environment and adapt to stresses and changes, while maintaining basic structures and functions. Important components include the ability to mount strong disaster-recovery efforts and competently handle restoration work.

Social Capital (p. 3, p. 7)

There are many definitions, but Putnam defines the term as "features of a social organization such as networks, norms, and social trust that facilitate coordination and cooperation for mutual benefit." Mutual-help in response to a disaster would fall under this definition.

Cat bond (Catastrophe Bonds) (p. 9)

Bonds used for conditions such as an earthquake or hurricane in which the probability is low, but if one occurred, it would cause very great damage. Through securitization, this type of bond is used to transfer the risk of such a disaster to capital markets. This is a measure, other than reinsurance, used to secure solvency for insurance companies.

High-standard levees (p. 11)

Under the River Law, high standard levees are defined as “levees having a standard structure designed to withstand floods in which the flow exceeds the design flood discharge, including cases in which the majority of land within the area of the levees is made available for normal use.” To avoid catastrophic damage involving dike breakage, construction is ongoing in five river systems in large cities, namely Tone, Ara, Tama, Yodo and Yamato. The city side of the embankment forms a vast gentle back slope that can be used for normal land use. Theses are also called “super levees.”

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