Chapter 5

Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

This chapter is a summary of the present knowledge and understanding regarding the projected impacts of climate change in Japan. Specifically, this chapter reviews the results of research being conducted on climate change in Japan and presents an organized analysis in order to clarify the impacts on the country.

Research to date indicates that climate change could significantly impact natural disasters, the water resources, food supplies, natural ecosystems, public health, and urban life, as well as various other sectors in Japan. Wise Adaption to Climate Change, a report by the Committee on Climate Change Impacts and Adaptation Research of the Ministry of Environment, for instance, points out that the impact of climate change is already appearing in Japan, and has rapidly emerged since the beginning of the 21st century. It is projected that climate change will significantly further impact the public's lives in a broad range of areas. Some examples of this are: increased frequency of heavy rain, intensified typhoons, increased water-related damage from rising ocean levels, disasters resulting from storm surges, increased number of sediment disasters, more frequent and intense droughts resulting from extremely low rainfall and significant decreases in snow, an increased risk of heat stroke, hyperthermic stress, infectious diseases, and air pollution, elevated household expenditures caused heightened agricultural crop prices and cooling and heating costs in addition to increased discomfort and stress caused by extremely hot days and tropical nights, the loss of natural scenery, recreational spaces, and a decrease in seasonal change..

When coupling the inherent vulnerability of both Japan's nature and society with these impacts mentioned above, the results show that the safety and stability of Japanese society could be severely impacted. Effective and efficient adaptation measures in response to the negative impact of climate change are thus deemed necessary. At the same time, there needs to be future research and consideration paid to regional-level climate change projections and impact evaluations, which are necessary for considering adaptation measures on a more intimate level.

Among the vast and diverse impacts of global warming, this chapter only addresses a very small number of items for which concrete research results have already been obtained. The results concentrate on the points of the aforementioned report. In addition, it should be noted that among the "impacts observed to date," there are items for which it cannot be definitively discerned at

present whether said items are the result of climate change. Accordingly, in using this report for evaluating performance under Article 4.1 (b) and (e) of the Framework Convention on Climate Change, sufficient consideration should be paid to the points above.

5.1 Impacts on Japan's Climate

5.1.1 Impacts on Temperature

The potential impacts of global warming on Japan's climate are evaluated based on two projections. One was the High-Resolution Coupled Ocean Atmosphere Climate Model (K-1 model) implemented by a joint research team comprised of the Center for Climate Research Studies (CCSR) of University of Tokyo, the National Institute for Environmental Studies (NIES), and the Frontier Research Center for Global Change (FRCGC) using the Earth Simulator. Another projections were made from the High-Resolution MRI Regional Climate Model 20 (MRI-RCM20 model) implemented by the Japan Meteorological Agency and the Meteorological Research Institute.

In the projections based on the K-1 model, two of the SRES scenarios introduced in the IPCC Fourth Assessment Report were used for its calculation: (1) Scenario A1B where internationalization of the world will advance with more importance attached to the economy, and (2) Scenario B1 where internationalization will advance with more importance attached to the environment. Comparing to the average daytime summer temperature in Japan (June, July and August) between the years of 1971 and 2000 and between the years of 2071 and 2100, the results on average were 3.0°C higher for Scenario B1 and 4.2°C for Scenario A1B. Likewise, the maximum daytime summer temperature in Japan for Scenario B1 is higher by 3.1°C and for Scenario A1B, 4.4°C. Furthermore, the results stated that precipitation during the summer in Japan would increase on average due to global warming. When comparing the average between the years of 2071 to 2100 to that between 1971 and 2000, there was a 17 percent increase for Scenario B1 and a 19 percent increase for Scenario A1B.

Also, when considering the projections based on the MRI-RCM20 model, calculation was made while employing Scenario A2 from the SRES scenarios, which presume that the future world will attach more importance to the economy and regional-oriented tendencies will intensify. The results were that, the average annual temperature will rise across Japan, and that the temperature is expected to rise by approximately 2°C to 3°C in about a century from now.

5.1.2 Impacts on Meteorological Characteristics of Japan

Changes as listed below are expected from the latest projections based on the K-1 and MRI-RCM20 models, etc.

- Reduction in the number of days with minimum temperature less than 0°C across Japan.
- Increase in the number of nights with minimum temperature of 25°C or higher across Japan.
- Increase in the number of days of heavy rainfall with daily precipitation of 100mm or more across Japan.
- Drastic decrease in the amount of snowfall from Hokkaido to the Sanin region mainly on the Japan Sea side.
- Considerable fluctuation in the amount of precipitation with an increase in the amount of annual rainfall. Also, an increase in the number of days with no precipitation.

The above-mentioned projections do not contradict the scientific findings shared in the IPCC Fourth Assessment Report.

5.2 Impacts on Natural Disasters

5.2.1 Impacts Observed to Date

The impacts on water-related disasters can be broadly separated into 1) flooding, landslides, etc. in river areas, and 2) disasters such as those resulting from storm surges in coastal areas. The number of times that daily rainfall amounts of 100 mm to 200 mm has influenced flooding, landslides, and other water-related disasters has increased significantly over the past 100 years. In recent years, there have been frequent occurrences of major rains totaling over 1,000 mm as well as localized major rains exceeding 100 mm in rainfall per hour. These have led to large-scale flooding and landslides in various areas throughout Japan on a yearly basis. In addition, as a phenomenon related to the rise of sea levels, which impacts disasters spawned from storm surges and such, the number of times that the corridor of Itsukushima Shinto Shrine, a World Heritage Site, has submerged underwater has significantly increased in the past few decades.

For this report, information on droughts is included in the Impacts on the Water Environment and Water Resources section.

- Occurrences of flood damage resulting from major rains totaling 1,000 mm or over.
- Flooding and submersion damage resulting from localized major rains exceeding 100 mm per hour.
- Increase in frequency of short-term strong rains exceeding 50 mm per hour.
- Occurrence of underground flood damage in urban areas.
- Increase in the number of times Itsukushima Shinto Shrine's corridor was submerged[1].
- Damage relating to storm surges resulting from typhoon no. 23 on the Nabae Coast of Kochi Prefecture.

[1] This is according to visually taken records in the shrine's Shrine Office Journal. It should be noted that these numbers vary by the year.

- Damage resulting from tidal waves on the Shimoniikawa Coast due to low-pressure systems in 2008.

5.2.2 Projected Impacts

It is projected at a high possibility for precipitation in high-latitude regions to increase, extremely heavy rains to occur more frequently, and there is a stronger potential for tropical cyclones to become more intense.

An estimate conducted to compare the highest annual daily precipitation in Japan today to that of 100 years from now has revealed that the rate of change from GCM20 predictions (A1B Scenario) was generally between 1.1 and 1.2 fold, and increased to nearly 1.5 at maximum.

If precipitation levels rise in the future, it is projected that the flood safety control level, which indicates the degree of safety of rivers in flood-control plans, will notably decrease, while the danger of flooding and overspilling in watershed areas will increase. For instance, it is predicted that the frequency of the flood safety control level targeted in current plans for rivers will drop from once from every 100 years to once every 30 years, thereby nearly tripling the frequency of flooding. It is also projected that increases in the amount of both short-term rainfall and total rainfall will lead to more frequent sediment disasters, including mudslides and landslides, changes in the period of occurrence for these disasters, and an increase in the intensity of such disasters.

Heat will cause sea levels to continue to rise for a few centuries, as it takes time for heat to disperse to deeper layers. Sea levels will actually increase even if the concentration of greenhouse gasses stabilizes. In addition, the intensification of typhoons will also cause sea levels to rise due to decreases in pressures while wind will cause larger drifts and waves. Therefore, the danger of storm surges is projected to increase due to both the rise in sea levels and the intensity and change in paths of typhoons. Meanwhile, coastal landscapes, which are formed by counterbalancing shifts in sediment towards and away from the coast, will recede beyond the increased water level due to changes in this counterbalance spawned by rising seas levels. Projections also indicate that shore erosion will advance further due to the increased number of high waves that accompany intensified typhoons.

[Examples of main projected impacts]

- Enhanced intensity of typhoons.
- Increased danger of flooding and overspilling in watershed areas.
- More frequent sediment disasters, in addition to changes in the time and scale of their occurrence.
- Changes in the areas where damage related to storm surges occurs due to change in paths of typhoons.

- Increased number of high waves due to intensified typhoons.
- Increased danger of storm surges due to rising sea levels and intensified typhoons.
- The advancement of shore erosion spawning from increases in high waves accompanying rising sea levels and intensified typhoons (a one-meter increase in sea levels will cause 90% of sandy beaches to disappear).

5.3 Impacts on the Water Environment and Water Resources

5.3.1 Impacts Observed to Date

The direct impacts on the water environment and water resources appear as changes in water amounts, temperature, and quality for each type of water resource—i.e., rivers, lakes, dammed lakes, groundwater, etc. These changes affect the natural ecosystem, society's aquatic system, and the water demand structure. It is difficult to clearly discern at present whether these phenomena are the result of climate change. However, changes in the frequency of abnormal weather and fluctuations in rainfall and snowfall have been recorded and reported, and these changes may further amplify if climate change continues. Furthermore, a characteristic of the water environment and water resources sector is the impact that changes in water amounts and quality have on a vast spectrum of other sectors, including agricultural production, natural ecosystems, disaster prevention, and health.

- Restrictions on water intake and supply due to record-setting low rainfall, as well as stoppages on tap water supply.
- Abnormal occurrence of blue-green algae in lakes (impacts water usage and the ecosystems of water areas).
- Increased use of groundwater accompanying drought, also leading to the occurrence of ground sinking.
- Reduction in the possible amount of water that can be stably supplied from dams.

5.3.2 Projected Impacts

Projected impacts included those resulting from changes in normal weather events as well as fluctuations in the frequency and intensity of extreme weather events. There is also the potential that the changes in average water temperature and precipitation amounts will lead to such phenomena as changes in stream flow, reductions in snowfall, changes in snow melting times, altered lake water levels, and changes in water quality. These phenomena could impact water supply and the natural ecosystem. Moreover, increased frequency and intensity of extreme weather events—such as significantly low rainfall—may cause heightened risk for drought.

In the event that a rise in seas levels is assumed, groundwater salination in coastal areas is also projected as an impact.

[Examples of main projected impacts]

- Increased risk for drought.
- Increased water temperature of rivers, lakes, dammed lakes, and groundwater. Higher probability of blue-green algae appearing.
- Groundwater salination owing to rising sea levels, etc.

5.4 Impacts on Food

5.4.1 Impacts Observed to Date

Impacts on food occur as a result of impacts on the agricultural, livestock, and fishing industries. Until the present these impacts have included 1) high temperatures causing immature and cracked rice grains as well as drops in quality and taste, 2) increased freezing and frost damage to barley caused by early flower budding and reduced revenues owing to shorter grain filling periods, and 3) increased pest damage to soybeans and damage incurred by hot and arid climates. With regards to fruit trees, a decrease in quality and preservation ability has been recognized along with increases in damage to tea from freezing and frost as well as larger numbers of pests. In the livestock industry, a decline in conception rate, milk production, and development has been seen. Impacts to the fishing industry include an increase in fish varieties coming from the south, changes in harvest season, and sluggish aquafarming.

- Immature rice grains (brown rice turning white), etc. occurring from the Tohoku region southward.
- Cracked rice grains (brown rice that has cracked) occurring at high frequency in the Tohoku and Hokuriku regions
- Higher temperatures in the winter season causing barley flowers and stems to sprout earlier than normal, as well as an increase in freezing and frost damage due to this.
- Separation between the skin and fruit portions of tangerines caused by high temperatures and low rainfall. Discoloration of grapes due to high temperatures.
- Answers to a survey regarding the current situation of agricultural impacts from global warming conducted on National Agriculture and Food Research Organizations in all of Japan’s 47 prefectures indicated that impacts thought to stem from global warming are in some form apparent in fruit trees (all prefectures), vegetables and flowers (90 percent of prefectures), and livestock (about 40 percent of prefectures).
- Belated seaweed harvesting season owing to lower water temperatures in autumn, etc.

5.4.2 Projected Impacts

In agriculture, predictions show that the decline in rice quality will become more serious, the proper time for wet-rice cultivation could become staggered (making cultivation occur later in warm southwest regions to the west of the Kanto region and earlier in all other regions), and that the staggered cultivation of wet-rice will lead to reductions in the average national harvest amounts. Projections also indicate that high temperatures will cause such impacts as reductions in barley and soybean harvests as well as movement in the areas where fruit trees can be suitably harvested. Increased agricultural labor may also become necessary to prevent pests and weeds as they become higher in number. Moreover, there is concern that drops in snowfall and earlier snowmelts will significantly impact water use from early spring forward in agricultural regions that rely on melting snow as a water resource. Predictions also show an increase in damage from sea breezes accompanying typhoons. Projections in the fishing industry indicate the possibility for the habitats of northern fish varieties to move further northward, an expanding habitat for southern fish varieties, a shift in locations suited to aquafarming, and increases in infectious diseases among farmed fish.

[Examples of main projected impacts]

- More serious problems pertaining to rice grain-filling (reduction in quality and grain weight).
- Shift of regions suited for apple cultivation to the north (possibility that cultivation will no longer be viable in the central plains of the Tohoku region).
- Pests moving northward due to higher temperatures.
- Impact on the rice planting season owing to drops in snowfall and earlier snowmelts.
- Decreased habitat for salmon species and shift of herring habitat northward.
- Stunted growth of saury due to worsening feeding environment, accompanied by an increase in egg production as a result of a increase the feeding environment during the egg-laying season (on the Pacific Ocean side of Eastern Japan).
- Shift of regions suited for torafugu globefish cultivation to the north.

5.5 Impacts on the Natural Ecosystem

5.5.1 Impacts Observed to Date

Impacts on natural ecosystems can be broadly separated into impacts on the various sub-ecosystems, such as forests, alpine regions, fresh waters, oceans, coastal regions, and marshes, as well as the impact on biodiversity. Changes have been reported in the distribution of living organisms as well as the foundations of ecosystems, such as vegetation and water. In addition, natural ecosystems were tremendously impacted by human activities before being impacted by

climate change, and there is concern that climate change will inflict the final blow to areas where ecosystems have already been depleted from human activity.

- Decline of beech tree forests, decrease in beech tree reproduction, pine wilt disease in *satoyama* regions, decline of alpine region vegetation.
- Drying of high moors and decline in snowfield vegetation.
- Changes in ecosystems due to factors such as stagnating vertical circulation of lakes and drops in dissolved oxygen at lake bottoms.
- Shrinking distribution areas for cold-water fish in freshwater areas.
- Increase in southern fish species, decrease in northern fish species, and bleaching and extinction of coral in coastal areas.
- Impact on biological production from higher temperatures in the Okhotsk and other seas as well as drops in dissolved oxygen.
- Earlier blooming times for camellia, plum, dandelions, cherry blossoms, and similar flowers and later color changes for gingko and maple tree leaves, in addition to later defoliation.
- Belated blooming of flowers in Kyushu due to lack of cold-shock dormancy awakening.

5.5.2 Projected Impacts

Predictions show that the impacts observed until now in forest, alpine region, freshwater, ocean, coastal region, and marsh ecosystems will continue to advance in the future. The distribution of many organisms is expected to shift northward, however it is highly likely that this northward shift will be deterred by the fragmentation of habitats. There is also the possibility for irreversible impact depending on the degree of climate change, such as the extinction of species owing to their loss of refuge areas and environments. The stagnation of vertical circulation in lakes will spread, engendering multiple changes with the impact from water pollution and exotic species. Acidification will advance in oceans, impacting plankton and calcified organisms.

[Examples of main projected impacts]

- Decline in distribution suited to beech trees, as well as subalpine and subarctic conifer forests. Rapid decline in alpine vegetation.
- Expansion of bamboo groves as well as pine wilt disease in the Tohoku region.
- Increase in carbon dioxide emissions from forest soil in cold regions.
- Expansion of vertical circulation stagnation in lakes and oceans.
- Changes in species distribution and entry of new exotic species in freshwater areas.
- Competition and intercrossing between related species following the northward shift of southern species and subspecies.
- Reductions in sea ice in the Okhotsk Sea, leading to changes in the food chain and the migration route of migrating organisms.
- More significant impact on plankton and calcified organisms such as coral due to the

acidification of oceans.

- Increased bleaching of coral and decline in sandy beaches.

5.6 Impacts on Human Health

5.6.1 Impacts Observed to Date

The impacts on human health can be broadly separated into direct impacts resulting from heat and indirect impacts from phenomena including infectious diseases, air pollution, large-scale natural disasters and pests. Regarding the impacts from heat, reports have been made on increased mortality rates for patients with cardiovascular disease and respiratory disease, as well as a higher number of patients suffering from heat stroke. In regards to infectious diseases, reports have been made on the changes in the distribution of pathways for infectious diseases such as a northward shift in domestic distribution of tiger mosquitoes, which are carriers of dengue fever and other diseases, as well as the infiltration of sources from Southeast Asia carrying the new Japanese encephalitis. In addition, reports have been made that the seawater detection area for waterborne bacteria transmission is shifting northward as well.

- Increase in excess mortality caused by heat stress.
- In 2007, many cities recorded record-high numbers of heat stroke patients[2] (Over 5,000 patients in Tokyo and 17 other government-designated cities).
- Expanded distribution region for the tiger mosquito, which is a carrier of dengue fever and other diseases, and the infiltration of new Japanese encephalitis vectors from Southeast Asia.
- Northern shift of seawater detection area for the vibrio vulnificus bacteria.

5.6.2 Projected Impacts

Projections on the impacts of heat indicate an increased mortality risk from heat stress and particularly a rise in the number of cardiovascular disease patients. Projections also show an increase in the number of heat stroke patients, as well as such phenomena as the rise in nighttime sleep disorders owing to a larger number of tropical nights. These heat-spawned impacts are expected to be especially significant for elderly people. Projections on the impacts on infectious diseases include northern shifts in the distribution region for tiger mosquitoes in the Tohoku region and Hokkaido, as well as the spread of epidemic risks of dengue fever and Chikungunya fever throughout all of Japan due to the infiltration of dengue mosquitoes. Also, it is expected that the occurrence area of Japanese encephalitis would shift northward.

[2]The number of heat stroke patients here is the number of patients transported in ambulances under the jurisdiction of the Fire and Disaster Management Agency and the Fire Bureau. Patients that received treatment directly from medical institutions without using an ambulance and patients that did not receive treatment are not included in this number.

[Examples of main projected impacts]

- Increase in excess mortality caused by heat stress.
- Rise in the number of heat stroke patients (future prediction based on Tokyo).
- The possibility of expanded distribution regions for tiger and dengue mosquitoes, which are vectors of dengue fever, etc.

5.7 Impacts on Public and Urban Life

5.7.1 Impacts Observed to Date

The impacts of climate change on the lives of the public in general and on urban life in particular are closely related to each individual citizen and are present in their everyday lives. The question of how the impacts noted in sections 5.2 through 5.6 affect peoples lives can be organized into stage-based classifications of public life, particularly: safety, healthy, economically affluent, comfortable, and receptive to culture and history.

- Increase in international prices for wheat, corn, soybeans, etc. [3]
- Early blooming of plum, cherry, and other blossoms and delaying of autumnal leaves and defoliating .
- Impact on sightseeing and sports industries (ski resorts, etc.) due to changes in the natural environment and weather conditions.
- Increased records of Suwa Lake not freezing over and no formation of “Omiwatari,” the band of raised ice across the lake caused by the explosion of expanded ice.
- More frequent underwater submersions of the corridor at Itsukushima Shrine.
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5.7.2 Projected Impacts

Public and urban life is predicted to be widely impacted by climate change, including impacts relating to the safety and wellbeing, impacts on economic lifestyles, and impacts on the higher emotional demands of the public. These impacts are believed to affect residential areas (city and agricultural areas) and their constituents (individual, household, elderly people, educational institutions, local governments, etc.) in different ways and to varying degrees.

[Examples of main projected impacts]

- Loss of life, assets (houses, etc.), and communities due to damage from abnormal weather.
- Impacts on regional transportation modes, communication facilities, etc. due to abnormal weather.

[3] In addition to the impact from climate change, the rise in international prices is also related to such factors as the increased food demand owing to the economic development of massively populated nations such as China and India, as well as a rise in global demand for cereal crops and the such as raw material for biofuel.

- Increase in mortality, heat stroke, and infectious diseases due to heat waves.
- Stronger burden on household expenditures due to heightening agricultural crop prices and longer usage times for air conditioning.
- Raised levels of stress and discomfort in everyday life owing to a larger number of extremely hot days and tropical nights.
- Impacts on the tourism industry and recreational opportunities spawning from changes in ecosystems, including less alpine vegetation, loss of sandy beaches, and the reduction of marshes.
- Impacts on the sports industry resulting from declining and later seasons for snowfall.
- Lack of snow, changes in the season that cherry blossoms bloom, etc. eliciting impacts on community culture and the loss of regard for the seasons.

5.8 Adaptation Measures

With regards to adaptation towards addressing climate change, a report by Working Group II within the Fourth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC) stated that, “Even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential, particularly in addressing near-term impacts.”[4]

In June 2008, the Committee on Climate Change Impacts and Adaptation Research of the Ministry of the Environment produced a report entitled Wise Adaption to Climate Change. This report indicated that in order to ensure an effective and efficient “wise adaption” to properly address the negative impacts of climate change, which tremendously affect the lives of all Japanese citizens, it is important to 1) utilize the latest results from regional vulnerability assessments, monitoring, etc., 2) consider and integrate various adaptation measure options, 3) Consider that temperature width and leeway are potentially addressable by adaptation measures with views on the short and long term, 4) properly incorporate adaptation measures into existing policies, if relevant, such as disaster prevention plans, and 5) to make natural and socioeconomic systems more flexible and responsive. In addition, the report noted the need to swiftly conduct these considerations from a preventative viewpoint.

[4]The United Nations Framework Convention on Climate Change establishes its ultimate objective as being the, “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system,” (Article 2). In aim to achieve this ultimate objective it is first important to allot the utmost efforts to appeasing climate change. Just as indicated in the Fourth Assessment Report by the IPCC, adaptive and appeasing efforts cannot avoid every impact of climate change if employed individually. However, utilizing both efforts in a mutually complementary manner will allow for significantly reducing the risk of climate change (Synthesis Report, Summary for Policymakers, pg.19).

Efforts were later made to conduct effective and efficient adaptation measures by partnering with administrative organizations, including the establishment of a liaison conference with relevant government ministries concerning adaptation. The Cabinet Office's Council for Science and Technology Policy established a task force in March 2009 to plan the direction of technological development aimed at realizing a society adaptive to climate change. This task force compiled a mid-term report in June 2009 and submitted it to the Council. The report established the following as issues that should be swiftly addressed in the future, along with technology aimed at addressing these issues: 1) strengthening infrastructure to realize a "green society" and expanding environmentally safe domestic demand, and 2) urban development for environmentally-advanced cities that are leaders in the international community, and creating a futuristic city that citizens will want to live in. The task force plans to conduct its final report in FY2009.

5.8.1 Adaptation Efforts for Natural Disasters

○ The role of adaptive measures in the water-related disaster sector for climate change accompanying global warming (Report)

In June 2008, the Council for Social Infrastructure of the Ministry of Land, Infrastructure, Transport and Tourism produced the report "The role of adaptive measures in the water-related disaster sector for climate change accompanying global warming" regarding the role of adaptation measures in the water-related disaster sector.

For adaptive measures to such disasters as floods, storm surges, and landslides, the report noted the adequate combination of 1) adaptive measures to facilities, 2) adaptive measures conducted in unison with community development, and 3) adaptive measures focused on handling crisis management. As large deviations in predictions exist against a backdrop of uncertainty about mitigation measure efforts and changes in social conditions, the report also suggested that monitoring be conducted with the purpose of assessing climate change.

Adaptive measures to facilities include: developing flood control facilities such as dams and flood spaces, revamping river channels by creating levees, thorough utilization of existing river management facilities, and establishing balancing reservoirs, rainwater storage facilities, and other facilities in water areas.

Adaptive measures conducted in unison with community development include: regulations and guidance on land use in disaster-prone areas as well as unified flood control measures, along with

an intensive urban development that allows for easily implementing said measures.

Finally, adaptive measures focused on handling crisis management include the formation of regional disaster-prevention networks, used for securing roads in times of disaster, provision of hazard maps, and enhancing river information provision for flood warnings.

In considering adaptive measures, proper combinations will be selected after evaluating the risk of water-related disasters that could occur from climate change, and these measures will be steadily implemented based on an implementation roadmap. In addition, an adaptive response system will be created by adequately monitoring fluctuations in precarious climate change phenomena, as well of social conditions. Revisions of the content and combinations of adaptive measures will be made accordingly when monitoring results and improvements in projection accuracy.

○ “The role of port policy in regards to climate change resulting from global warming” (March 25, 2009 Report)

This report organizes the basic understanding of changes in marine phenomenon and increases in disaster risk in coastal regions that accompany climate change and other factors resulting from global warming. The report also stipulates a basic direction and fundamental policies for ports in order to respond to these issues.

○ Large scale storm surge and flooding scenario in Tokyo Bay

A storm surge and flooding scenario was conducted in order to verify the present protective ability against such events and assess the risk of long-term climate change along the Tokyo Bay coastline, and the results have been publicly released. There are now plans to pull together counter policy measures for reducing the risk of disasters, such as damage to areas behind the bay incurred by storm surges, and for maintenance of port activities.

○ Reducing flood damage in cities

Efforts will be made to develop sewer systems and rainwater storage facilities to better respond to disasters resulting from heavy rain, which will intensify with climate change.

5.8.2 Adaptation Efforts in the Water Environment and Water Resources Sector

○ Promotion of rainwater and reclaimed water use

The use of rainwater and reclaimed water will be promoted in order to respond to the risk of drought, which will increase with climate change.

5.8.3 Adaptation Efforts in the Food Sector

○ Development of adaptive technologies in the agricultural, forest, and fishery sectors

It is important to prioritize the development of adaptive technologies to such phenomena as high temperature injury in consideration of the needs of production sites, as well as to conduct research in a planned manner that takes into account the projected impacts of global warming.

- Varieties that respond to high temperature injury, a problem that should be resolved in the short-term at production sites, are being cultivated and cultivation technologies are being improved in a planned manner.
- Varieties adjusted to the progression of future warming are being cultivated, cultivation as well as breeding and aquafarming technologies are being developed, and management methods for land improvement facilities that respond to changes in water demand that accompany a shift in cropping seasons are being established in a planned manner.
- It is planned that technologies responding to agricultural dangers (drought, flooding, etc.) as well as other disasters in agricultural lands, mountain areas, coastal areas, and fishing ports resulting from climate change will be developed in a planned manner.
- It is planned that technologies will be developed to predict the occurrence of and to handle new infectious diseases, pests, foreign fish species, and noxious organisms, which bear an increasing risk of impact on the agriculture, forest, and fishery industries due to the progression of global warming.
- It is necessary to continue scientific discussion on the limit (threshold) of warming impacts from a mid- to long-term perspective. Changes in production location and product serve as an index for making decisions, and these discussions should also include the viewpoint of agricultural, forest, and fishery ecosystems.

○ Promotion of global warming adaptive measures in the agricultural sector

- In June 2007, the Report on Adaptive Measures to Global Warming by Item was created.

  (The report introduced adaptive measures from a technological perspective, covering currently used as well as newly developed technologies.)

- In September 2009, the 2008 Survey Report on the Impacts of Global Warming was created.

(This report is a survey of the impacts of and adaptive measures to global warming in fiscal 2008. The same report has been created every year since fiscal 2006.)

- From 2008 the verification and spread of stable agricultural production technologies adapted to global warming was launched as part of the Project for Comprehensive Countermeasures to Global Warming for Agricultural Production. This was an effort to promote the verification and spread of agricultural production technologies that avoid high temperature injuries as a result of the impact of global warming.

From 2009 the Project for Establishing a Strategic Response System for Global Warming was launched as part of the Project for Comprehensive Countermeasures to Global Warming for Agricultural Production. This was an effort to develop a promotional structure for global warming adaptive measures that would offer a strategic response, while also supporting the efforts of model production regions via area diagnosis and technical guidance.

○ Development and promotion of adaptive measures in the fishing sector

Adaptive measures to global warming will be promoted in the fishing sector by developing impact assessment methods via the coastal fishing environment. These will be monitored by automated observation buoys utilizing swift and simple methods. Molecular biology methods will be used to monitor toxic and harmful plankton. In addition, aquafarming fish types that are highly resistant to high water temperatures will be assessed and selected utilizing genomic information such as DNA markers.

5.8.4 Adaptation Efforts for Natural Ecosystems

- In order to assess the impacts on Japan's ecosystems from global warming, monitoring sites have been installed in nearly 1,000 locations throughout the country, including areas such as alpines regions, marshes, tidelands, and coral reefs, for which the impact of global warming is thought to be particularly prominent. These sites are used to promptly record such changes through the implementation of the Project to Promote Regional Monitoring of Important Ecosystems (Monitoring Site 1000). In addition, other projects such as for natural restoration are being implemented in river areas to preserve, restore, and create a favorable natural environment. Time-based monitoring is underway via the National Survey On Natural Environment In River And Watershore to assess the changes in river environments.
- The adaptation efforts of major players including the national government, local public authorities, researchers, and NPOs and NGOs will be promoted by disseminating basic information necessary for adapting to global warming.
- An investigative commission was held three times between January and March 2009 to discuss such issues as the role of an ecological network, which is believed to contribute to boosting the capacity for adapting to environmental changes such as climate change. During these sessions the commission deliberated on a nationwide framework for Eco Net.

5.8.5 Adaptation Efforts in the Health Sector

- In regards to heat stroke prevention, efforts are being made to create materials such as manuals and leaflets, distribute them to relevant organizations, and educating the public about heat stroke, as such measures have been deemed important. In addition, information is provided via flash bulletin on websites regarding projected and preliminary heat index figures

(WBGT) as well as details about the occurrence of heat stroke patients, which contribute to preventing heat stroke. The Ministry Liaison Conference on Heatstroke is also held between related ministry offices in order to deliberate on efficient and effective measures to counter heatstroke as well as to share information.

References

IPCC (2007): The Fourth Assessment Report

The Committee on Climate Change Impacts and Adaptation Research, Ministry of the Environment (2008): Wise Adaption to Climate Change

Council for Social Infrastructure, Ministry of Land, Infrastructure, Transport and Tourism (2008): The role of adaptive measures in the water-related disaster sector for climate change accompanying global warming (Report)