

# National Plan for Adaptation to the Impacts of Climate Change

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Contents

- Introduction ..... 1
- Part 1. Basic Concepts of the Plan ..... 3
  - Chapter 1. Context and Issues.....3
    - Section 1. International Trends in Climate Change and Adaptation .....3
    - Section 2. Adaptation Efforts in Japan .....4
  - Chapter 2. Basic Principles .....9
    - Section 1. Vision for Society.....9
    - Section 2. Target Period for the Adaptation Plan.....10
    - Section 3. Basic Strategies .....10
      - (1) Mainstreaming Adaptation into Government Policy ..... 10
      - (2) Enhancement of Scientific Findings..... 14
      - (3) Promotion of Understanding and Cooperation of Each Actor through Efforts such as Organizing and Sharing Climate Risk Information and Other Information ..... 15
      - (4) Promotion of Adaptation in Region ..... 17
      - (5) Promotion of International Cooperation and Contribution ..... 18
  - Chapter 3. Basic Approaches.....19
    - (1) Observation and Monitoring of Climate Change and Its Impacts .....19
    - (2) Projection and Assessment of Climate Change and Its Impacts .....19
    - (3) Consideration of Adaptation Measures and Systematic Implementation based on Results of Climate Change and its Impacts ..... 19
    - (4) Managing Progress and Revising the Adaptation Plan .....20
- Part 2. Basic Directions for Measures in Each Sector ..... 21
  - Chapter 1. Agriculture, Forest/Forestry, Fisheries.....21
    - Section 1. Basic Adaptation Measures for Agriculture.....22
    - Section 2. Basic Adaptation Measures for Forest/Forestry .....35
    - Section 3. Basic Adaptation Measures for Fisheries .....39
    - Section 4. Basic Adaptation Measures for Other Issues related to Agriculture, Forest/Forestry, and Fisheries..... 46
  - Chapter 2. Water Environment, Water Resources .....49
    - Section 1. Basic Adaptation Measures for Water Environment .....49
    - Section 2. Basic Adaptation Measures for Water Resources .....52
  - Chapter 3. Natural Ecosystems .....55
    - Section 1. Basic Adaptation Measures for Terrestrial Ecosystems .....56
    - Section 2. Basic Adaptation Measures for Freshwater Ecosystems .....58
    - Section 3. Basic Adaptation Measures for Coastal Ecosystems .....60
    - Section 4. Basic Adaptation Measures for Marine Ecosystems .....61
    - Section 5. Basic Adaptation Measures for Phenology .....61
    - Section 6. Basic Adaptation Measures for Shifts in Distribution and Populations .....62
  - Chapter 4. Natural Disasters, Coastal Areas ..... 63
    - Section 1. Basic Adaptation Measures for Water Disasters .....63
    - Section 2. Basic Adaptation Measures for Storm Surges and High Waves .....71
    - Section 3. Basic Adaptation Measures for Sediment-related Disasters.....75
    - Section 4. Basic Adaptation Measures for Other Impacts (e.g., Strong Winds) .....77

Chapter 5. Human Health .....	78
Section 1. Basic Adaptation Measures for Heat Stress .....	78
Section 2. Basic Adaptation Measures for Infection .....	79
Section 3. Basic Adaptation Measures for Other Human Health Impacts.....	80
Chapter 6. Industrial and Economic Activity .....	81
Section 1. Basic Adaptation Measures for Industrial and Economic Activity .....	81
Section 2. Basic Adaptation Measures for Finance and Insurance.....	82
Section 3. Basic Adaptation Measures for Tourism .....	83
Section 4. Basic Adaptation Measures for Other Impacts (e.g., Overseas Impact) .....	84
Chapter 7. Life of Citizenry, Urban Life .....	85
Section 1. Basic Adaptation Measures for Urban Infrastructure, Critical Services .....	85
Section 2. Basic Adaptation Measures for Life with Sense of Culture and History .....	87
Section 3. Basic Adaptation Measures for Others (Impact on Life due to Heat Stress).....	88
Part 3. Basic and International Measures .....	91
Chapter 1. Basic Measures regarding Observation, Monitoring, Studies and Research.....	91
Chapter 2. Basic Measures for Sharing and Providing Information related to Climate Risk .....	92
Chapter 3. Basic Measures for Promoting Adaptation in the Region.....	93
Chapter 4. International Measures .....	95
Appendix. Approach for Assessment of Climate Change Impacts (Approach used in the Climate Change Impact Assessment Report) .....	97
<Approach for Assessment of Significance> .....	99
<Approach for Assessment of Urgency> .....	101
<Approach for Assessment of Confidence>.....	101

## **Introduction**

In recent years, extreme weather events have been observed around the world. Disasters have occurred due to strong typhoons and hurricanes, intense heavy rainfall, drought, heat waves, and other extreme weather events, and there are reports every year about the enormous amount of damage that results.

The summer of 2013 brought record-breaking temperature to Japan, with a record daytime high of 41.0°C, an all-time maximum temperature record for this country. Hiroshima City suffered extensive damage in August 2014, with 75 people killed due to sediment-related disasters, when a maximum hourly rainfall of 101 mm was recorded, an all-time record since observations began. In addition, the enormous damage that occurred due to inundation damage in a wide area from a heavy rainfall disaster in the Kanto and Tohoku regions in September 2015 is still a fresh memory in Japan.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) points out that throughout history, people and societies have adjusted to and coped with climate, climate variability, and extreme events, with varying degrees of success. In addition, the report points out that since the 1950s, many of the observed changes are unprecedented over decades to millennia, and climate change is already having impacts on nature and human society, and an increase in magnitudes of warming increases the likelihood of severe, pervasive, and irreversible impacts. Moreover, the report shows that to limit climate change, substantial and sustained reductions in greenhouse gas emissions will be required; it also projects that global mean temperature will increase whatever future scenario greenhouse gas emissions follow, and that the risk of impacts of climate change will increase toward the end of the 21st century.

Thus, in order to address the impacts of climate change, it is important to not only promote “mitigation” to limit emissions of greenhouse gases, but also “adaptation” to impacts that are already evident, as well as impacts that cannot be avoided in the medium- and long-term.

Like other countries, Japan has already been promoting observation and monitoring relating to climate change and its impacts, as well projections and assessments, studies and research. Making use of scientific findings thereby obtained for the formulation of an adaptation plan for the Government, the Central Environment Council (an advisory body of the Japanese Cabinet) has assessed the impacts of climate change, with the participation of experts from a broad range of disciplines. The resulting “Report on Assessment of Impacts of Climate Change in Japan and Future Challenges” was submitted to the Minister of the Environment as a Comment Submission in March 2015.

It showed that the impacts of climate change are appearing in Japan, including an increase in temperature and frequency of heavy rainfall, a decrease in number of days with precipitation, and an increase in sea surface temperature, and that due to high temperature, impacts can already be seen, including a decline in quality of agricultural crops, and shifts in the distribution of flora and fauna. The submission also revealed that in the future, there may be further increases in temperature and the frequency of heavy rainfall events, decreases in the number of days with precipitation, and increases in sea surface temperature, as well as increases in the amount of precipitation falling in heavy rainfall events, increases in the maximum intensity of typhoons, and sea-level rise. The report reveals that a variety of impacts may occur in various sectors, including agriculture, forestry, fisheries, the water environment,

water resources, natural ecosystems, natural disasters, and human health.

In order to promote systematic and integrated efforts that are coordinated to address these impacts of climate change, the Government has formulated its first Adaptation Plan, which establishes the basic principles, such as a vision for society, as well as basic approaches, the basic direction for measures in each sector, basic measures, and international measures.

The aim of this Adaptation Plan is to minimize or avoid damage from the impacts of climate change, and create a secure, safe, and sustainable society that can quickly recover from those impacts. To avoid rework and to promote timely and appropriate adaptation, the Government will continue to observe and monitor climate change and its impacts, ascertain the latest scientific findings, implement regular assessments of climate change and its impacts, consider and implement adaptation measures in each sector based on the results of the impact assessments, assess progress, and revise the plans as required. By repeatedly following this cycle, the Government will work in a unified way to systematically promote adaptation to the impacts of climate change.

# **Part 1. Basic Concepts of the Plan**

## **Chapter 1. Context and Issues**

### **Section 1. International Trends in Climate Change and Adaptation**

Since it was first established in 1988, the Intergovernmental Panel on Climate Change (IPCC) has conducted assessments and formulated reports of the latest scientific findings about climate change. The IPCC's Fifth Assessment Report was approved and published between September 2013 and November 2014. It states that warming of the climate system is unequivocal; that it is extremely likely that human influence has been the dominant cause of the observed warming in recent decades; that changes in climate have caused impacts on natural and human systems on all continents and across the oceans; and that continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.

As for mitigation of climate change (interventions such as efforts to reduce the emission of greenhouse gases), at the 18th Conference of the Parties (COP 18) to the United Nations Framework Convention on Climate Change (UNFCCC, or the Convention) in November and December 2012, it was agreed to take urgent actions deemed necessary to significantly reduce greenhouse gas emissions in order to limit the increase in global mean temperature to less than 2°C above pre-industrial levels. However, according to the IPCC's Fifth Assessment Report, the global mean temperature will increase whatever scenario is followed for future greenhouse gas emissions, and the projected risks of impacts of climate change increase by the end of the 21st century.

Thus, in order to address the impacts of climate change, it is important to not only promote "mitigation" to limit emissions of greenhouse gases, but also "adaptation" to impacts that are already evident, as well as impacts that cannot be avoided in the medium- and long-term.<sup>1</sup>

As for adaptation, in the Cancun Agreements adopted at the 16th Conference of the Parties to the Convention (COP 16) in December 2010, in order for all Parties to strengthen actions for adaptation, it was agreed to launch a planning process for medium- and long-term adaptation in least developed countries (LDCs), and also to establish the Cancun Adaptation Framework, including an Adaptation Committee. Also, with the Lima Call for Climate Action adopted at the 20th Conference of the Parties (COP 20) in December 2014, it was agreed that the international climate change framework for 2020 and beyond, expected to be adopted at the 21st Conference of the Parties (COP 21) to be held in November and December 2015, would include the strengthening of adaptation actions.

As for Europe and North America, the Netherlands published "The effects of climate change in the Netherlands" in 2005 and the "National Programme on Climate Adaptation and Spatial Planning" in 2007, and issued a revised "The effects of climate change in the Netherlands" in 2013. The United Kingdom published the "UK Climate Change Risk Assessment" in 2012 and "National Adaptation Programme" in

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<sup>1</sup> In the IPCC Fifth Assessment Report, Working Group II Report, Box SPM.2, adaptation is defined as "The process of adjustment to actual or expected climate and its effects."

2013. The United States published “Global Climate Change Impact in the United States” in 2009, had Executive Order 13653 issued in 2013 indicating the direction of future adaptation efforts, and published a revision of “Global Climate Change Impact in the United States” in 2014. As for Asia, in 2010, Korea published both the Korean Climate Change Assessment Report 2010 and the National Climate Change Adaptation Master Plan 2011–2015. These are some examples of countries that are already engaged in efforts to assess the impacts of climate change and to formulate adaptation plans.

Meanwhile, as developing countries may lack the adaptive capacity to address the impacts of climate change, a variety of adaptation-related support is being provided through the related institutions inside and outside the UNFCCC so that developing countries will be able to adapt appropriately. For example, the LDCs Expert Group under the UNFCCC provides technical support for short- and long-term adaptation planning processes in LDCs, as well as the sharing of experience and findings among countries.

## **Section 2. Adaptation Efforts in Japan**

Japan has also been engaged in consideration of adaptation to the impacts of climate change based on the IPCC’s latest scientific findings and international trends, as described above. Japan’s Third Basic Environment Plan (decided by Cabinet in April 2006) specified actions such as promoting consideration of and technical research relating to appropriate adaptation measures, and implementation of the necessary adaptation measures in Japan making use of the research results.

From FY 2007 to 2011, the Ministry of Education, Culture, Sports, Science and Technology conducted the “Innovative Program of Climate Change Projection for the 21st Century” (KAKUSHIN Program), including activities such as enhancing climate models and projecting future climate change, and assessing the impacts of climate change on natural disasters. It also implemented the “Research Program on Climate Change Adaptation (RECCA)” from FY 2010 to FY 2014, which involved research and development necessary to provide scientific findings for development of climate change adaptation measures on a regional scale. Since FY 2012 the Ministry has been implementing the “Program for Risk Information on Climate Change (SOUSEI),” with the aim of further improving climate change projections and generating the information required as a basis for managing various risks arising from climate change. From FY 2015, it has been promoting activities such as the development of basic common national applications as well as social implementation, under the “Social Implementation Program on Climate Change Adaptation Technology (SI-CAT).”

The Japan Meteorological Agency—for consideration of climate change impact assessments and measures in Japan, awareness raising about adaptation research, and scientific understanding of climate change—has been publishing “Global Warming Projection” reports based on the results of numerical model simulations, with Volume 7 published in March 2008, and based on projection results from higher resolution numerical models, Volume 8 in March 2013. The Japan Meteorological Agency has also published the “Report on Extreme Weather Events” eight times since 1974, covering extreme weather events in Japan and the world, plus the current status and projections of climate change including global warming as well as other global environmental changes; the latest findings were formulated and



published in March 2015 as the “Report on Extreme Weather Events 2014.” Since 1996, the Japan Meteorological Agency has also been formulating and annually publishing the results of observation and monitoring of the marine and atmospheric environments in the “Climate Change Monitoring Report.”

The Ministry of the Environment implemented the “Comprehensive Assessment of Climate Change Impacts to Determine the Dangerous Level of Global Warming and Appropriate Stabilization Target of Atmospheric GHG Concentration,” from FY 2005 to FY 2009 as S-4 Strategic R&D Area Project funded by the Global Environment Research Fund, and conducted integrated assessments of the impacts of climate change in major categories. In addition, the “Comprehensive Study on Impact Assessment and Adaptation for Climate Change (S-8)” was implemented from FY 2010 to 2014, conducting research on topics such as region-by-region impact projections, and approaches to promote adaptation in Japan. In the water environment category, the Ministry of the Environment conducted work from FY 2009 to FY 2012 to ascertain the impacts of climate change on issues such as water quality of public waters, and to project impacts of future climate change on water quality. The findings were formulated in the “Report on the Impacts of Climate Change on Water Quality.”

The Ministry of Education, Culture, Sports, Science and Technology, the Japan Meteorological Agency, and the Ministry of the Environment formulated “Climate Change and Its Impacts in Japan” in FY 2012 to provide the latest findings about climate change and its impacts, mainly in Japan.

Based on this progress in studies and research on climate change impacts, adaptation, and international trends, Japan’s Fourth Environment Basic Plan (decided by Cabinet in April 2012) prescribes various actions, including the following: ascertain impacts, and collect and share scientific findings of the impacts; promote adaptation to prevent and mitigate the most immediate short-term impacts; and promote consideration of ways to enhance the capacity to adapt, in order to contribute to the prevention and mitigation of impacts that may occur in the medium- and long-term. Furthermore, moving toward the formulation of an adaptation plan for the Government, the “Annual Report on the Environment, the Sound Material-Cycle Society and the Biodiversity in Japan 2013” (decided by Cabinet in June 2013) calls for the implementation of projections and assessments of climate change impacts in order to ascertain the nature of those impacts in Japan, and based on the results, the formulation of an adaptation plan as comprehensive and systematic efforts of the Government.

Based on this governmental orientation, to move toward the formulation of an adaptation plan for the Government, the Expert Committee on Climate Change Impact Assessment was formed in July 2013 under the Global Environment Committee of the Central Environment Council, in order to summarize information such as climate change projections and impact assessments from existing research, and to engage in comprehensive deliberations regarding climate change impacts and risk assessments for Japan. Then, to accelerate discussions of the Expert Committee, sectoral working groups considering climate change impacts (WG) were formed to address the impacts of climate change on different sectors; with the Expert Committee and additional members, a total of 57 persons discussed assessments of the impacts of climate change on Japan, in five WGs: Agriculture, Forest / Forestry and Fisheries WG; Water Environment / Water Resources and Natural Disasters / Coastal Areas WG; Natural Ecosystems WG;

Human Health WG; and Industrial / Economic Activities / Life of Citizenry and Urban Life WG.

For formulation of the National Adaptation Plan, to be able to identify the sectors and categories where impacts could be expected to occur as well as the necessary measures, impacts were summarized in seven sectors, with 30 categories and 56 sub-categories; over 500 documents regarding the impacts of climate change were reviewed, including literature and projections of climate change and its impacts; and assessments were conducted from the perspective of significance (what kind of impacts could be occurring due to climate change in Japan, as well as factors such as the extent and probability of impacts), urgency (timing of occurrence of impacts, timing required to initiate adaptation measures and critical decision-making), and the confidence (certainty of information).

Taking into consideration public comments received in January and February 2015, the results were formulated as the “Report on Assessment of Impacts of Climate Change in Japan and Future Challenges” (hereinafter “Climate Change Impact Assessment Report”)<sup>2</sup> and submitted in the form of a comment submission from the Central Environment Council to the Minister of the Environment.

As for the current status of climate change in Japan, the Climate Change Impact Assessment Report indicates that it is virtually certain that annual mean temperature has increased from 1898 to 2013 at a rate of 1.14°C per 100 years, and the number of days with maximum temperatures of 35°C or higher is extremely likely to have increased from 1931 to 2013. As for annual precipitation, the report indicates that no long-term trend is evident, but annual figures have become more variable since the 1970s. Also, it is extremely likely that the annual number of days with precipitation of  $\geq 100$  mm and 200 mm has increased from 1901 to 2013, while the annual number of days with precipitation of  $\geq 1.0$  mm has decreased. The rate of increase of sea surface temperature (annual mean) around Japan over the last 100 years up to 2013 was +1.08°C/100 years, and the accumulated sea ice extent<sup>3</sup> and maximum sea ice extent<sup>4</sup> in the Sea of Okhotsk showed a long-term decrease during the period 1971 to 2013.

As for future projections, the higher the greenhouse gas emissions, the more the global mean temperature is expected to increase; by the end of the 21st century the annual mean temperature in Japan is projected to increase by 1.1°C (confidence interval 0.5–1.7°C)<sup>5</sup> relative to the end of the 20th century, even if the necessary global warming measures are taken to limit the extent of warming to a relatively low level, and by 4.4°C (confidence interval 3.4°C to 5.4°C) if greenhouse gas emissions are at a very high level. As for precipitation, the amount of annual precipitation is characterized by a large range of inter-annual variability, and both increases and decreases are projected, but projections are for an increase in the frequency of heavy rainfall and short-term intense rainfall, an increase in the amount of precipitation

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<sup>2</sup> URL <http://www.env.go.jp/press/upload/upfile/100480/27461.pdf>

<sup>3</sup> Accumulated sea ice extent: The sum of sea ice extent every five days from December 5 of the previous year to May 31.

<sup>4</sup> Maximum sea ice extent: The extent of sea ice for the five-day period when the sea ice extent was at its maximum for the year.

<sup>5</sup> Confidence interval 90%: The product of standard deviation calculated as a combination of uncertainties multiplied by a constant in the standard distribution table (approx. 1.64), based on the results of multiple projection calculations conducted using modified criteria.

from heavy rainfall (amount of precipitation in one day from the top 5% of precipitation events), and an increase in the number of dry days (daily precipitation of less than 1.0 mm). In addition, projections indicate further increases in sea surface temperature, decreases in sea ice extent, decreases in snow cover and snowfall, and rising sea levels; they also indicate increases in indicators such as the formation of strong typhoons, the maximum intensity of typhoons, and precipitation intensity at the time of maximum intensity.<sup>6</sup>

As for the impacts of climate change, associated with impacts such as an increase in temperature and water temperature and a decrease in the number of days with precipitation, it has been shown that impacts already evident include changes in crop yields and declines in crop quality, changes in fish catches, shifts in the distribution of flora and fauna, coral bleaching, and earlier flowering of cherry blossoms. For the future, projections indicate the threat of impacts such as significant reductions in crop quality, severe drought, extinction of many species, increases in heavy rainfall events causing flood damage and slope failure disasters, increases in storm surge and high wave risk, and increases in the frequency of summer heat waves.

Based on the current status and future projections of climate change impacts described above, when assessing seven sectors, these broad sectors included sub-categories where impacts were assessed as being particularly high in magnitude and also high in urgency: Agriculture, Forest / Forestry, Fisheries; Water Environment, Water Resources; Natural Disasters, Coastal Zones; Natural Ecosystems; Human Health; and Life of Citizenry, Urban Life. Furthermore, nine sub-categories were assessed as also having a high level of confidence: paddy field rice; fruit trees; plant pest and weeds (placed in the Agriculture, Forest / Forestry, Fisheries sector); shifts in distribution and populations (placed in the Natural Ecosystems sector); floods; storm surges and high waves (placed in the Natural Disasters, Coastal Areas sector); risk of mortality, heat illness (placed in the Human Health sector); and impacts on life due to heat stress (placed in the Life of Citizenry, Urban Life sector).

The relevant government ministries and agencies held discussions about adaptation based on the results of studies and research to date relating to climate change, and then, in order to reflect the findings of the Climate Change Impact Assessment Report in the Government's adaptation plan they formulated approaches to deal with adaptation in major sectors where the impacts of climate change are occurring or may occur.

The Ministry of Agriculture, Forestry and Fisheries established the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan Promotion Headquarters in April 2014, chaired by one of the Ministry's Parliamentary Vice-Ministers, and began discussions about a Climate Change Adaptation

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<sup>6</sup> In the IPCC Fifth Assessment Report, Working Group I Report, Table SPM.1, regarding increases in intense tropical cyclone activity in the late 21st century, the likelihood is assessed as "more likely than not" (50-100% probability) in the Western North Pacific and North Atlantic. Also, in WGI AR5, Figure TS.26, the expected percent change in the average over the period 2081–2100 relative to 2000–2019 under A1B-like scenarios indicates that, in the Western North Pacific, the total annual frequency of tropical storms classified as category 4 and 5, the mean Lifetime Maximum Intensity (LMI; the maximum intensity achieved during a storm's lifetime), and the precipitation rate within 200 km of storm center at the time of LMI, are projected to increase.

Plan of Ministry of Agriculture, Forestry and Fisheries. The state of discussions with the Promotion Headquarters were reported, as appropriate, to joint meetings of the Global Environment Sub-Committee of the Planning Committee of the Council of Food, Agriculture and Rural Area Policies; the Global Environment Sub-Committee of the Policy Committee of the Forestry Policy Council; and the Global Environment Sub-Committee of the Planning Committee of the Fisheries Policy Council. Based on discussions, including results of reports to the joint meetings, the Climate Change Adaptation Plan of Ministry of Agriculture, Forestry and Fisheries was formulated in August 2015.

At the Ministry of Land, Infrastructure, Transport and Tourism, the Minister sent a formal inquiry in December 2013 to the Chair of the Council for Social Infrastructure advice regarding “Issues for climate change adaptation relating to water disasters,” whereupon deliberations were held by the Sub-Committee on Flood Control Measures for Adaptation to Climate Change, under the River Committee of the Council for Social Infrastructure; in August 2015, the formal response was formulated entitled “Issues for Climate Change Adaptation relating to Water Disasters: Shares Disaster Risk Information and Crisis Perception, toward a Disaster Mitigation Society.” In addition, the Environmental Policy Promotion Headquarters of the Ministry of Land, Infrastructure, Transport and Tourism promoted discussions about adaptation in several sectors (water disaster, coastal areas, water resources, industry and life of citizenry), and formulated the Ministry of Land, Infrastructure, Transport and Tourism Climate Change Adaptation Plan together with National Plan for Adaptation to the Impacts of Climate Change.

At the Ministry of the Environment, the Study Group on Approaches to Climate Change Adaptation held sessions in FY 2013 and FY 2014 with the aim of contributing to discussions about the governmental adaptation plan; it discussed basic concepts about the formulation of adaptation plans, and formulated the outcomes as a report entitled “Approaches to Climate Change Adaptation (Report).” Discussions about the water environment sector were held by the Study Group on Climate Change Impact Assessments and Adaptation for Lakes and Marshes, starting in FY 2013; it discussed projected impacts on water quality and ecosystems of lakes in particular, as well as the necessary adaptation measures, and the results of discussions were formulated in July 2015 in a report on climate change impacts on water quality and ecosystems in lakes and marshes, and adaptation. Also, a study group was launched in January 2015 to discuss climate change adaptation in the area of biodiversity, consider important perspectives as well as concepts about adaptation and ways to proceed, and in July 2015 formulated the discussions as “Basic Concepts relating to Climate Change Adaptation in the Area of Biodiversity” and “Immediate Concrete Actions.”

Meanwhile, regarding Japan’s international cooperation in the area of adaptation, the Prime Minister of Japan announced the Adaptation Initiative at the September 2014 UN Climate Summit, committing to provide comprehensive support to developing countries, from the development to implementation of adaptation policies.

In September 2015, the Inter-Ministry Meeting for Climate Change Adaptation was established in order to comprehensively and systematically promote the necessary measures for adaptation to the impacts of climate change through close collaboration among the relevant government ministries and agencies. This

Inter-Ministry Meeting was the body that formulated this Adaptation Plan.

Because the impacts of climate change are diverse and far-reaching, in order to promote coordinated efforts, it is important to formulate a national adaptation plan that presents unified concepts and approaches. Thus, based on the results of discussions among the relevant government ministries and agencies, in order for the Government as a whole to promote systematic and comprehensive climate change adaptation measures that are interdisciplinary and coordinated, the Inter-Ministry Meeting formulated the first National Plan for Adaptation to the Impacts of Climate Change, which specifies basic principles such as a vision for society, as well as basic approaches, basic directions for measures in each sector, basic measures, and international measures.

The contents of this Adaptation Plan, such as basic concepts and basic adaptation measures in each sector, reflect the basic concepts and basic adaptation measures formulated in the above-mentioned adaptation plans in sectors such as the agriculture, forest / forestry and fisheries sector, the land, infrastructure and transport sector, the water environment sector, and the biodiversity sector. Also, the actors that formulated content such as the adaptation plans in each sector are expected to promote the concrete efforts relating to adaptation, based on the plans.

## **Chapter 2. Basic Principles**

### **Section 1. Vision for Society**

#### **(Adaptation: A challenge that requires immediate and long-term action)**

According to the IPCC's Fifth Assessment Report, the warming of the climate system is unequivocal, many of the observed changes since the 1950s are unprecedented over decades to millennia, impacts have already been observed across all continents and oceans, and they are affecting people and ecosystems. The report also indicates that surface temperature is projected to increase over the 21st century under all assessed emission scenarios, and in many regions, that it is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions.

In Japan as well, extreme weather events have been observed, and water disasters and sediment-related disasters have been occurring around the country almost every year, causing significant damage. The Climate Change Impact Assessment Report has clarified that impacts are already evident, such as changes in yields of crops and declines in quality of crops, changes in fish catches, shifts in the distribution of flora and fauna, coral bleaching, and earlier flowering of cherry blossoms; the report also indicates projections of possible future impacts in a variety of areas, with a variety of changes in the climate such as an increase in temperature and changes in precipitation, as well as sea-level rise and ocean acidification; other projected impacts include an increase in disaster risks such as severe drought, water disasters and sediment-related disasters, storm surges and high waves, deterioration of water quality, and changes in people's sense of the seasons, such as the timing of flowering of cherry blossoms.

The Fourth Assessment Report also calls for efforts to improve the capacity to adapt to the impacts that may occur in the medium- and long-term, as well as efforts to adapt to short-term impacts. Based on the

above points, it is necessary to take action as soon as possible for adaptation to the impacts that are already evident, and to strengthen both mitigation and adaptation, taking the perspective of long-term risk management relating to climate change.

### **(Vision for Society)**

Based on the above-mentioned topics, this Adaptation Plan aims to create a secure, safe, and sustainable society that, whatever impacts arise from climate change, is able to minimize or avoid any damage—such as loss of life of citizens, and damage to property, livelihoods, the economy, and the natural environment—and is able to recover quickly. This is to be achieved through facilitating adjustment of social systems and natural systems<sup>7</sup> by promoting measures to adapt to the impacts of climate change.

## **Section 2. Target Period for the Adaptation Plan**

While having a long-term perspective to the end of the 21st century, this Adaptation Plan provides the basic strategies of the Government for adaptation to the impacts of climate change, and the basic directions of measures for the Government to implement in each sector during approximately the next ten years.

## **Section 3. Basic Strategies**

In this section, in promoting adaptation systematically and comprehensively by the Government, the following basic strategies are established in order to minimize or avoid damage from the impacts of climate change, and create a secure, safe, and sustainable society that can recover quickly even in the worst-case scenario<sup>8</sup> of the impacts of climate change based on the perspective of sound risk management. Toward the realization of these basic strategies, the relevant government ministries and agencies are expected to work collaboratively to effectively promote the sectoral measures as indicated in **Part 2**, and the basic measures and international measures indicated in **Part 3**.

### **(1) Mainstreaming Adaptation into Government Policy**

**Basic Strategy 1: Mainstream adaptation into the relevant policies and measures of the Government, by building resilience, considering uncertainty, creating synergies (co-benefits), and developing and diffusing technologies, and address the current and future impacts of climate change.**

### **(Approaches to Adaptation in Other Countries)**

According to a report by the Organisation for Economic Cooperation and Development (OECD), many

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<sup>7</sup> In IPCC Fifth Assessment Report, Working Group II Report, Box SPM.2, adaptation is defined as “The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.”

<sup>8</sup> For example, according to the IPCC’s Fifth Assessment Report, the carbon dioxide equivalent concentration corresponding to RCP 2.6 (low stabilization scenario) is 450 (430 to 480) ppm, with a 66% to 100% certainty of limiting warming to 2°C in the 21st century (relative to 1850–1900). Meanwhile, the carbon dioxide equivalent concentration corresponding to RCP8.5 (high reference scenario) exceeds 1,000 ppm, with a 50% certainty of limiting warming to 4°C in the 21st century (relative to 1850–1900).

national governments use the approach of incorporating adaptation into existing government efforts and regulatory frameworks (i.e., mainstreaming) as part of their national strategies to promote adaptation.<sup>9</sup> A United States government report, “Recommended Actions in Support of a National Climate Change Adaptation Strategy” (2010), lists “Encourage and mainstream adaptation planning across the federal government” as the first of five policy goals. The European Union is beginning to mainstream adaptation planning into sectoral policies, including agriculture and forestry, coastal areas, fisheries and the marine environment, infrastructure, finance, water management, biodiversity, disaster risk reduction, and health. The United Kingdom, through its National Adaptation Programme (2013), is encouraging organizations and individuals to address the risks they will face from climate change.<sup>9</sup>

### **(Mainstreaming Adaptation into Policies and Measures relating to Climate Risk)**

To create social systems and natural systems in Japan that can minimize damage from the impacts of climate change and quickly recover from those impacts, it will be important to keep the following perspectives in mind and systematically mainstream adaptation into governmental policies and measures related to climate change impacts implemented by the relevant government ministries and agencies under the Adaptation Plan, while considering the Climate Change Impact Assessment Report.

#### **(i) Improving Adaptive Capacity through Building Resilience**

Climate resilience is seen as the capacity of social, economic, and environmental systems to avoid serious losses, to minimize or avoid damage, and to recover quickly, due to their flexibility and strength when facing any threat. In a discussion about urban areas the IPCC Fifth Assessment Report says, “Steps that build resilience and enable sustainable development can accelerate successful climate-change adaptation globally,” indicating the importance attributed to building resilience when promoting adaptation. The Cancun Adaptation Framework adopted at COP 16 invites all Parties to strengthen actions relating to adaptation, by efforts such as building resilience of socio-economic and ecological systems, including efforts that involve economic diversification and the sustainable management of natural resources.

The impacts of climate change in Japan affect a broad range of sectors, but the actual damage that occurs is expected to differ significantly depending on the conditions of society. The IPCC Fifth Assessment Report states that the risks of climate change impacts arise from interactions between “climate-related hazards” (natural hazards, such as dangerous events and trends), socio-economic “vulnerability”<sup>10</sup> (lack of ability to respond) to the impacts of climate change, and “exposure”<sup>11</sup> (the presence of people and property at the affected location), and suggests that adaptation requires a reduction in this vulnerability and exposure. Even where climate change impacts have become evident, in order to

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<sup>9</sup> OECD (2013), National Adaptation Planning: Lessons from OECD Countries.

<sup>10</sup> In the IPCC Fifth Assessment Report, Working Group II Report, Box SPM. 2, vulnerability is defined as “the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.”

<sup>11</sup> In the IPCC Fifth Assessment Report, Working Group II Report, Box SPM. 2, exposure is defined as “the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.”

minimize or avoid the damage and recover quickly, it is necessary to secure the resilience of social systems and natural systems and improve adaptive capacity, by ascertaining the current status and future risks of climate change and its impacts, and taking the long-term perspective to reduce vulnerability and exposure to climate change impacts. In addition, when considering this kind of adaptation by reducing vulnerability and exposure, it is important to consider the protection, restoration and creation of the natural environment—taking care to ensure that the adaptation measures themselves do not burden the environment—and, depending on the objectives and regional characteristics, to make use of the diverse functions of the natural environment.

When it comes to concrete adaptation measures, the IPCC's Fifth Assessment Report raises a broad range and large number of both material (e.g., physical infrastructure) and non-material (e.g., institutional, organizational) approaches, including early warning information systems, hazard mapping, diversification of water resources, rainwater and wastewater management such as by sewer systems, disaster risk management by improving road infrastructure, maintenance of wetlands and urban green space, ecosystem management such as by reducing the fragmentation of habitat, land-use planning such as by managing development in flood prone regions and other high-risk areas, breakwaters and levees, construction of storage facilities, new crops, water conservation, nature restoration, ecological corridors, soil conservation, structural and physical approaches such as afforestation, and institutional approaches such as insurance and building standards.

To accomplish this, when discussing the specifics of adaptation approaches, it is important to have the perspective of promoting adaptation in a comprehensive way that ensures the resilience of social and natural systems; for this, it is important to have the proper combinations of engineering and ecological, land use, social and institutional approaches, and to base measures on such factors as the socio-economic situation in Japan, regional and sectoral characteristics, and the extent of climate change impacts.

## **(ii) Responding to Climate Risk Involving Uncertainty**

The IPCC Fifth Assessment Report states that “Responding to climate-related risks involves decision making in a changing world, with continuing uncertainty about the severity and timing of climate-change impacts and with limits to the effectiveness of adaptation,” indicating that iterative risk management is a useful framework for adaptation.

In Japan as well, it is important to promote adaptation in flexible ways and with adaptive approaches (in which responses change in accordance with changes in the environment); this involves striving to gather the latest scientific findings that can be obtained through efforts such as ongoing monitoring, observation and projections of climate change and its impacts; implementing regular assessments of climate change and its impacts, while also considering changes in the social environment such as population decline and aging of society. Based on the results of those impact assessments, it is important to consider and implement adaptation measures in each sector, in ways that avoid rework; to monitor progress; and to revise plans as necessary.

When considering adaptation measures, for efficient promotion of adaptation it is useful to consider which measures should be prioritized based on factors such as urgency. According to the Climate Change



Impact Assessment Report, it is important to begin now to consider adaptation measures by considering both the “timing of occurrence of impacts” and “timing required to initiate adaptation measures and critical decision-making,” then by selecting the impacts that are most urgent, to assess the urgency and consider adaptation measures in sectors assessed to have a “high urgency” level, while also being conscious of uncertainty.

To conduct decision-making in the context of a certain degree of uncertainty with regard to climate change impacts, it is necessary to promote an accurate understanding of climate change among the stakeholders and the public.

### **(iii) Promoting Measures that Have Synergies (Co-benefits) with Adaptation**

The IPCC Fifth Assessment Report points out that adaptation strategies include actions with co-benefits for other objectives, and available strategies and actions can increase resilience across a range of possible future climates while helping to improve human health, livelihoods, social and economic well-being, and environmental quality.

In Japan as well, when the uncertainty of climate risk is considered, it is important to promote measures that have synergies (co-benefits) with adaptation, and have multiple policy objectives, including adaptation. For example, adaptation measures that make use of ecosystems—for example, reduction of damage from typhoons and storm surges by protecting coral reefs and planting seaside protection forests, and promoting transpiration and sun shading by planting trees—can create a variety of reciprocal social, economic and cultural benefits for local communities, contribute to the protection and sustainable use of biodiversity, promote carbon sequestration, and reduce greenhouse gas emissions. In addition, in the agricultural sector, actions such as the development of crop varieties that are resistant to high temperature can also contribute to a stable supply of food. In the water resource sector, for example, the development and diffusion of water conservation and efficiency technologies and efforts to raise awareness about water conservation can also have benefits such as reducing greenhouse gas emissions by reducing the amount of energy required for supply water and wastewater treatment. In the disaster risk reduction sector, for example, measures against tsunamis can also contribute to reduce damage from storm surges and high waves.

### **(iv) Research, Development, and Diffusion of Adaptation Technologies**

To promote adaptation measures, it is important to keep in mind a vision for society, to have the perspective of seeking ways to actually apply research results in society, and for the public and private sectors to cooperate to promote research, development and the dissemination of technologies that will contribute to adaptation.

Examples of useful actions relating to cross-sectoral supporting technologies include developing effective and efficient monitoring technologies; reducing uncertainty in predictions and impact assessments, as well as increasing their level of resolution; building and operating centralized databases; improving the information infrastructure to enable the sharing of a variety of data; and developing information platforms for easy-to-use data analysis, data processing, and data provision for local governments and other users. In particular, global environmental information is being seen as “big data,”

and its utilization is attracting attention as a way to solve a variety of environmental problems through international collaboration. In this regard, to promote adaptation, it is necessary to improve projection technologies that model and simulate climate behavior using atmospheric, marine, and terrestrial observation data, and to build platforms that integrate that information.

The IPCC Fifth Assessment Report provides a variety of examples of technologies in specific sectors, such as early warning systems, hazard mapping, diversification of water sources, improvement of drainage facilities, coastal afforestation, breakwaters and coastal protection structures, levees, water storage, new crop and animal varieties, efficient irrigation, water saving, desalination, food storage and preservation facilities, building insulation, green infrastructure, and ecological corridors. It is important to promote research and development into adaptation technologies in a wide range of sectors.

To promote private-public sector collaboration, it is also important to encourage public and private sector investment by providing information appropriately about technologies that can contribute to climate risk information and adaptation.

## **(2) Enhancement of Scientific Findings**

### **Basic Strategy 2: Continuously enhance scientific findings, through ongoing implementation of observation and monitoring, projection and assessment, and promotion of studies and research.**

To respond appropriately to the impacts of climate change under uncertainty, it is important to enhance scientific findings and constantly use the latest findings. For that, it is necessary for the relevant government ministries and agencies to accurately observe and monitor the state of climate change and its impacts, and to assess projections and impacts of future climate change on an ongoing basis.

#### **(Ongoing Implementation of Observation and Monitoring)**

Observation and monitoring are foundations for understanding climate change and its impacts, and for promoting proper adaptation. Also, observation and monitoring data play a major role in improving the accuracy of projections. To date, under the Earth Observation Promotion Strategy (decided by Council for Science and Technology Policy in 2004), priority has been assigned to elucidation of phenomena related to global warming, projections of its impacts, and the mitigation of and adaptation to global warming. Through collaboration among the relevant government ministries and agencies, as in the example of the Japanese Alliance for Climate Change Observation, observation is being implemented in various ways, including terrestrial fixed-point observation; ecosystem observation, from alpine to coastal areas; ocean and polar region observation such as by ship and Argo float; observation by aircraft; and satellite observation by remote sensing.

In the future, keeping in mind the applications of the data, including for making projections, it will be necessary to continue observation and monitoring by maintaining existing equipment and enhancing efficient observation frameworks, including a strengthening of the Japanese Alliance for Climate Change Observation.

#### **(Ongoing Implementation of Projection and Assessment)**

In terms of projection and assessment, under the auspices of various ministries—including the Ministry

of Education, Culture, Sports, Science and Technology, the Ministry of Land, Infrastructure, Transport and Tourism, the Japan Meteorological Agency, and the Ministry of the Environment—studies and research are being implemented relating to topics such as future climate projections using numerical models, and climate change impact projections using impact models in a variety of fields, including agriculture, forestry and fisheries, water resources, ecosystems, floods, and human health.

In the future, it will be necessary to make efforts to share information and to conduct ongoing projections and assessments of climate change and its impacts, based on the latest findings available from studies and research.

#### **(Promoting Studies and Research)**

It is necessary to promote studies and research in sectors and categories where the Climate Change Impact Assessment Report indicates that information is lacking.

Because there is uncertainty in projections and assessments of future climate change and its impacts, it is important to develop and improve projection and assessment methodologies and boost their accuracy, with the aim of enhancing scientifically-correct understanding of climate change. Efforts are also needed to enhance scientific findings by promoting studies and research relating to the impacts of climate change, the costs of adaptation and its impacts on the environment and society, quantitative assessments of impacts, indications of likelihood of occurrence, and technologies relating to adaptation.

It is important to monitor progress of the Adaptation Plan, and to reflect findings in the actual implementation of measures. There are challenges in doing this, however. For example, it is difficult to make a comparison of a situation with and without adaptation measures to gauge the degree of effectiveness, and it is difficult to determine progress if climate change and other factors cannot be separated. Other countries have been considering what indicators can be used to monitor progress while implementing their adaptation plans, once they have been formulated. In Japan as well, it is necessary to improve findings relating to approaches to ascertain the state of progress with the Adaptation Plan.

### **(3) Promotion of Understanding and Cooperation of Each Actor through Efforts such as Organizing and Sharing Climate Risk Information and Other Information**

**Basic Strategy 3: Promote understanding and cooperation through sharing and provision of information about climate-related risks.**

#### **(Organizing Climate Risk and Other Information)**

Information such as observation and monitoring of climate change and its impacts, as well as climate risk information, including projection and assessment data and information, is the foundation for actors' adaptation efforts; therefore, it is very important to facilitate each actor's access to climate risk and other information easily and get accurate and comprehensible information relating to climate risk and other information.

The IPCC Fifth Assessment Report states that "Adaptation planning and implementation can be

enhanced through complementary actions across levels, from individuals to governments.”<sup>12</sup> Thus, governments play an important role in promoting adaptation efforts by individual actors when they raise awareness, disseminate comprehensible knowledge, and provide information to many actors, including local governments, businesses, and citizens, about such things as risks, measures, and technologies relating to climate change.

Meanwhile, in addition to climate change-related data such as temperature and precipitation data, climate risk information covers a wide range of information relating to the impacts of climate change, including rice yields, water quality of lakes and marshes, distribution of plant and animal species, likelihood of flooding of river basins, and risk of heat illness.

In addition, the spatial dimension can range from the global level of the entire world to the national, prefectural, or municipal level, so various scales can be considered depending on the impacts and specifics of adaptation. For example, when a local government considers adaptation measures, it requires high-resolution climate projection data produced by downscaling, and impact assessment information based on that.

Furthermore, various time scales are being used, from the past to the end of the 21st century, and confidence ranges from high to low, based on the perspective of evidence (type, quantity, quality, and consistency) and agreement of opinion.

As these factors pose challenges for actors trying to use climate risk and other information, it is necessary for the relevant government ministries and agencies to work effectively and collaboratively to systematically organize climate risk and other information, in order to enable actors engaged in adaptation to easily utilize the information they require.

#### **(Sharing Climate Risk and Other Information)**

Regarding observation data that has been organized systematically and data and information relating to climate projections and impact assessments, it is necessary that the relevant government ministries and agencies collaborate to prepare information platforms and provide the information broadly to the actors.

If citizens, NPOs, businesses, and other local actors have gained local information such as the condition of the natural environment through the experience of living locally, or through social contributions and other activities over the years, it is beneficial to obtain that information through cooperation with the actors who possess it, and to share it extensively. Information sharing among actors is also important in terms of promoting the adaptation activities of each actor.

Furthermore, it is important to share climate risk information, with the participation of the actors, and to conduct decision making, under uncertainty, on adaptation to climate change impacts, while obtaining local ideas and other input from actors.

#### **(Building Bridging Functions with Policy Making)**

Because climate risk information is diverse and specialized, in order to implement adaptation

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<sup>12</sup> IPCC Fifth Assessment Report, Working Group II Report, Summary for Policymakers, C-1. Principles for Effective Adaptation.

effectively, it is necessary to make arrangements so that actors can mutually cooperate and easily share and utilize information. In particular, the IPCC Fifth Assessment Report points out that organizations bridging science and decision making play an important role in the communication, transfer and development of climate-related knowledge; when it comes to the utilization of data and information, it is important to provide support responding to the needs of users and to build the bridging function between scientific findings and policy making, so that actors can connect the information to effective adaptation activities.

#### **(Promoting Awareness, Enhancing Human Resources)**

For actors such as local governments, businesses, and citizens, it is important to have an accurate understanding of climate change and its impacts in order to promote adaptation effectively. Based on this, it is important to promote understanding of climate change and its impacts, through activities such as awareness raising and communications. In addition, as an understanding of adaptation has not necessarily permeated society sufficiently, it is necessary to foster human resources that can clearly communicate to a broad range of actors about the significance of adaptation and about specific actions that should be taken.

#### **(4) Promotion of Adaptation in Region**

**Basic Strategy 4: Promote regional adaptation efforts, through actions such as cooperation with local governments for climate change impact assessments, formulation of adaptation plans, and awareness-raising.**

#### **(Cooperating with Local Government)**

The content and scale of climate change impacts as well as vulnerability to the impacts will vary significantly depending on local characteristics, such as the climate conditions, geographical conditions, and socioeconomic conditions where the impacts are manifested. It is also important to see adaptation as an opportunity to create a new society by making use of the respective characteristics of each region. Thus, it is important that the adaptation measures devised for those impacts be based on local characteristics, and that the measures be locally considered and acted upon.

Because local governments implement a variety of measures that have a close connection with the lives of residents, it is important to conduct observation and monitoring of climate change and its impacts at the regional level, as well as assessments of climate change impacts, and based on the results, it is important that local governments establish organizational structures that work through collaboration among the relevant departments and divisions, incorporate adaptation into their own measures, and advance efforts in a comprehensive and systematic way. Meanwhile, climate change impacts are already appearing and many local governments are aware of the need for adaptation, but have not yet started impact assessments or the formulation of adaptation plans.

Thus, it is necessary to promote the implementation of impact assessments and formulation and implementation of adaptation plans by local governments.

## **(5) Promotion of International Cooperation and Contribution**

**Basic Strategy 5: Strongly promote international cooperation and contributions in the area of adaptation, through support for the formulation of adaptation plans and implementation of measures, and disaster risk reduction, as well as human resource development and the utilization of Japanese science and technology, to developing countries.**

### **(Cooperating with Developing Countries)**

Many developing countries lack the capacity to address the impacts of climate change. Least developed countries and small island developing states in particular are highly vulnerable to current and future climate change and the impacts of climate change may be more severe for them, as many of these countries have economic structures that depend on agricultural, forestry and fisheries industries, which are easily affected by climate change; also, their poor populations in particular have low adaptive capacity.

The IPCC Fifth Assessment Report points out impacts: in Asia, for example, increases in flooding along rivers, in coastal areas and urban areas, as well as increases in mortality risk associated with heat illness, and increases in water and food shortages due to drought; in small island developing states, sea-level rise is pointed out.

In the future, if impacts of climate change such as floods and extreme weather events become significant in developing countries, there will also be concerns in Japan about impacts such as food shortages, changes in import prices of agricultural and fishery products, and direct and physical impacts on the production facilities of overseas corporations.

In order to limit these kinds of impacts, it is important to cooperate with adaptation in developing countries. In this context, the Prime Minister of Japan announced the Adaptation Initiative at the September 2014 UN Climate Summit, committing to strengthen comprehensive assistance to developing countries from the development to implementation of adaptation policies. Also, at the Third UN World Conference on Disaster Risk Reduction, in March 2015, he announced the Sendai Cooperation Initiative for Disaster Risk Reduction, an initiative to contribute to adaptation to the impacts of climate change, committing Japan to tackle disaster risk reduction as a priority category for support.

Based on the above points, in order to promote adaptation in developing countries, it is important that Japan strengthen international cooperation, by providing support for the formulation of adaptation plans (including the area of disaster risk reduction) and implementation of implementation measures, while making use of its technologies, as well as capacity building in the area of adaptation.

### **(International Contributions through Science and Technology)**

There are concerns that the impacts of climate change will become more significant on a global scale in the future.

In order to effectively promote adaptation in the whole world, it is important that Japan actively engage in international contributions through activities such as participation in international frameworks such as the IPCC, making use of the scientific findings and technologies it has cultivated.

### **Chapter 3. Basic Approaches**

In the context of uncertainty about factors such as the significance and urgency of climate change impacts, responses to climate-related risks involve decision making in the midst of a social environment that is experiencing changes such as a declining population and aging society. To avoid rework, and to promote timely and appropriate adaptation, iterative risk management will be conducted for the Adaptation Plan. Specifically, adaptation will be promoted by using an adaptive approach that involves a repeated cycle of conducting ongoing observation, monitoring, and projection of climate change and its impacts; based on their results and on literature review and other actions, ascertaining the latest scientific findings; implementing regular assessments of climate change and its impacts; and based on the results of those impact assessments, considering and implementing adaptation measures in each sector, monitoring the state of progress, and making revisions as required.

#### **(1) Observation and Monitoring of Climate Change and Its Impacts**

In order to promote adaptation measures, and also based on Japan's Earth Observation Promotion Strategy, it is essential to observe and monitor data relating to climate change impacts (including temperature, precipitation, and other data relating to climate change), as well as data such as agricultural crop yields, water resources, ecosystems, and the occurrence of flood and inland water, and to make that information widely available. Thus, the Government will implement this observation and monitoring, with cooperation from actors including local governments and the private sector.

#### **(2) Projection and Assessment of Climate Change and Its Impacts**

The projection and assessment of climate change and its impacts on Japan are to be conducted on an ongoing basis, by conducting reviews of literature such as the observational and monitoring results of (1) above, IPCC Assessment Reports, the latest research reports in Japan and overseas, and reports published by governments; and by implementing projection calculations using the latest climate models and impact models on a global and a regional scale. These projection and assessment results are to be published, and disseminated nationwide. Also, along with information relating to observation, monitoring, projection, and impact assessments, and information relating to uncertainty, an effort is to be made to organize the information centrally, and make it available in form that is convenient for users.

#### **(3) Consideration of Adaptation Measures and Systematic Implementation based on Results of Climate Change and its Impacts**

Basic measures relating to adaptation in each sector are to be established as indicated in **Part 2**, based on such input as the Climate Change Impact Assessment Report and the status of measures that have a connection with climate change. In addition, the relevant government ministries and agencies are to systematically implement concrete measures based on the basic adaptation measures in each sector.

#### **(4) Managing Progress and Revising the Adaptation Plan**

##### **(Managing Progress of the Adaptation Plan)**

To respond appropriately under uncertainty to the long-term issue of climate change impacts, it is necessary to have ongoing monitoring of the state of progress of this Adaptation Plan and the latest scientific findings, and to manage progress of the Adaptation Plan. However, in other countries that have already formulated an adaptation plan, many issues have been raised with regard to development of approaches to manage progress with their plans; Japan also lacks adequate findings and experience on these matters. Thus, after formulating this Adaptation Plan, with a time frame of approximately one year, studies will be conducted to examine the approaches being used in other countries to manage progress, and based on the findings, there will be a systematic consideration of approaches to ascertain the state of progress of the Adaptation Plan.

Based on consideration of trial approaches to monitor the state of progress mentioned above, and based on international trends, an effort will be made to develop approaches for progress management of the Adaptation Plan as a whole. The state of progress of this Adaptation Plan will be included in the National Communication that each party submits under the Convention, while also considering future international trends and the state of discussions about progress management.

##### **(Revising the Adaptation Plan)**

As for revisions of this Plan, an assessment of climate change impacts is to be implemented and formulated approximately every five years, while taking future international trends into account, and based on the results of the said impact assessment, the status of each measure and other factors, the Plan is to be revised as required. However, if new issues emerge at any time relating to the Adaptation Plan as a whole, or if new findings are obtained that could have an impact on the basic adaptation measures relating to individual sectors, a revision of this Adaptation Plan is to be considered at that time, as required.











## Part 2. Basic Directions for Measures in Each Sector

Part 2 presents summaries of the findings of Japan’s climate change impact assessments as well as basic adaptation measures for each of the seven sectors indicated in the Climate Change Impact Assessment Report (agriculture, forest / forestry and fisheries; water environment / water resources; natural ecosystems; natural disasters / coastal areas; human health; industrial and economic activities; and life of citizenry / urban life).

For the impact assessments, expert judgment based on scientific findings was used to rate the three parameters of “significance,” “urgency,” and “confidence” from the following perspectives: (For a more detailed explanation, please refer to “Appendix: Approach for Assessment of Climate Change Impacts.”)

- Significance—Assess in terms of three criteria: social, economic, and environmental.
- Urgency—Assess in terms of two criteria: Timing of occurrence of impacts, and timing required to initiate adaptation measures and critical decision-making.
- Confidence—Assess in terms of two criteria (applying to some extent the approaches to confidence used in the IPCC Fifth Assessment Report): Type of research/report (e.g., quantitative projection based on model simulation; projection using an index such as degree of increase in temperature; qualitative analysis or estimates); and degree of agreement. Where the amount of research or reporting is rather limited (for example, when there are only one or two cases), judgment is used to determine whether the contents are reasonable.

The impact assessment results are expressed using the following legend.

Legend:				
【Significance】		Very High		Not “Very High” —N/A (currently cannot be assessed)
				Criteria: Soc (Social), Ec (Economic), Env (Environmental)
【Urgency】		High		Medium
				Low —N/A (currently cannot be assessed)
【Confidence】		High		Medium
				Low —N/A (currently cannot be assessed)

### Chapter 1. Agriculture, Forest/Forestry, Fisheries

Recently, the production and foundation of the livelihood of the agriculture, forestry, and fisheries, including mountain and fishing villages in Japan, have been put at risk by hindered growth and declining quality of agricultural and fishery products due to high temperature, as well as large-scale disasters caused by record high temperature, torrential rainfall and heavy snow. In addition, as the IPCC AR5 report indicates, climate change without adaptation is projected to negatively impact production of the major crops, and the agriculture, forestry and fisheries industries are most likely to be impacted by climate change.

Unless measures for reducing and preventing negative impacts of climate change are appropriately implemented at the sites where agriculture, forestry and fisheries are operated, such negative impacts will pose a threat to securing a stable food supply, the demonstration of multiple functions such as conservation of the national land, the development of agriculture, forestry and fisheries, and the

promotion of farming, mountain, and fishing villages. Thus, it is extremely important to utilize the efforts for climate change adaptation in agriculture, forestry and fisheries.

## **Section 1. Basic Adaptation Measures for Agriculture**

### **Overview of Agricultural Production**

#### **【Impacts】**

In general, agricultural production is sensitive to climate change. A decrease in growth and a decline in quality, likely to be driven by climate change, have been observed.

Although projection of impacts has been conducted with a focus on major crops, it is necessary to conduct further research on projected impacts.

#### **【Basic Measures】**

Efforts have been taken in overall agricultural production as follows: dissemination of adaptation measures and instructions at production sites, such as technologies for avoiding and mitigating impacts such as those of high temperature, as well as introduction of high-temperature-resistant varieties and the demonstration of new adaptation technologies.

Furthermore, in cooperation with local governments (or related institutions), impacts of global warming are monitored and information related to adaptation measures are offered in the “Global Warming Impact Investigation Report” and on the website of the Ministry of Agriculture, Forestry and Fisheries.

Make special efforts for paddy field rice and fruit trees, and plant pests and weeds whose significance is especially high and whose urgency and confidence are found high in the Climate Change Impact Assessment Report.

Regarding other items, in addition to continuing to promote measures taken so far, based on future projection of impacts, develop new adaptive varieties and cultivation management technologies or conduct basic research.

Moreover, in continued cooperation with local governments (or related institutions), monitor global warming impacts, and offer information related to adaptation measures in the “Global Warming Impact Investigation Report” and on the website of the Ministry of Agriculture, Forestry and Fisheries.

**【Relevant Ministries<sup>13</sup>】 Ministry of Agriculture, Forestry and Fisheries**

### **Paddy Field Rice**

#### **【Impacts】**

Regarding the current status, as for paddy field rice, impacts such as declines in quality due to high temperature (including white immature grain<sup>14</sup>, cracked grain<sup>15</sup>, and decreases in the ratio of first-class

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<sup>13</sup> Relevant ministries here refer to the relevant government ministries and agencies.

<sup>14</sup> Rice grain that looks clouded due to insufficient accumulation of starch.

<sup>15</sup> Rice grain whose endosperm is cracked.

rice) have been already observed nationwide. In some regions and in extremely high temperature years, decreases in yields have also been observed.

Regarding the projected impacts, paddy field rice yields are projected to decrease under high temperature exceeding the current temperature by 3°C except for in northern Japan.

It is projected that if a shift to high-temperature-resistant varieties<sup>16</sup> does not proceed, the ratio of first-class rice will decrease nationwide, due to high temperature during the grain-filling period.

There is a report that if a shift to high-temperature-resistant varieties does not proceed, the ratio of first-class rice, particularly in the Kyushu region, will decrease by nearly 30 percent by the middle of 21st century, and by approximately 40 percent by the end of 21st century.

Regarding pests, it is projected in paddy fields that the species composition of parasitic natural enemies, some parasitoids, and pest insects will change by increases in the number of annual generations. Moreover, regarding crop damage due to disease, there is a case where the outbreak of diseases such as rice sheath blight disease and rice blast is projected to increase under the condition of elevated CO<sub>2</sub> concentration (an increase by 200 ppm from the ambient air) artificially created in an outdoor paddy field.

- **Paddy field rice** [Significance : ● (Soc/Ec), Urgency : ● , Confidence : ●]

### 【Basic Measures】

Make active efforts to establish basic technologies of soil and water management for adaptation to high temperature, and to disseminate high-temperature-resistant varieties. Although the area in which high-temperature-resistant varieties are planted has increased gradually, such varieties have not fully prevalent since they do not meet actual consumers' needs (according to the Global Warming Impact Investigation Report 2014, the planted area of high-temperature resistant varieties was 77,500 ha).

Moreover, for pest control, promote pest control along with adjusting the timing, utilizing forecasting information.

In addition to the above efforts, the following measures will be taken hereafter:

Develop varieties based on varieties with high-temperature resistance, which are less likely to be damaged by high temperature.

A decrease in yield has been already evident in extremely high temperature years. Since much higher temperature is expected in the future, commencing from 2015 onward, develop breeding materials capable of maintaining fertility under high-temperature sterility<sup>17</sup> to prevent a decrease in yield.

Efforts are to continue to establish basic technologies of soil and water management. From 2016, support is to be provided to efforts to spread high-temperature-resistant varieties, such as selection and demonstration of high-temperature-resistant varieties and sampling promotion, with all the stakeholders such as producers, rice wholesalers, and actual consumers working together.

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<sup>16</sup> Varieties whose brown rice and yields are unlikely to decline in high temperature.

<sup>17</sup> Due to high temperature during the flowering period, insemination is hindered and starch does not accumulate in the grain.

Continuously promote adjusted pest control utilizing forecasting information. And by around 2019, develop and disseminate damage mitigation technologies against pests including rice sheath blight disease and rice streak, which are expected to increase due to global warming.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Fruit Trees**

### **【Impacts】**

In general, fruit trees and perennial crops, are less adaptive to climate change compared to annual crops. Thus, fruit trees are considered vulnerable to climate change, which tends to result in declining fruit quality, increased biennial fruiting,<sup>18</sup> and acceleration of physiological fruit drop.<sup>19</sup>

To be specific, the following phenomena are reported: poor coloring and delayed coloring of apples and grapes at the time of ripening, peel puffing<sup>20</sup> of satsuma mandarin oranges due to high temperature and heavy rainfall on thickening growth stage of fruit, sunburn of fruit due to high temperature and strong solar radiation, poor sprout emergence of Japanese pears due to high temperature from fall to the beginning of winter, and water core of Japanese pears due to high temperature and dryness before the harvesting period.

Regarding the projected impacts, the zone with favorable temperature for the production of satsuma mandarin oranges and apples is projected to move northward year by year due to climate change. Based on this projection, the existing major production sites may possibly become unsuitable for cultivation. Consequently, there is concern that stable production of such fruits will become difficult, and the supply-and-demand balance will be unbalanced, thereby leading to a considerable increase in prices and inability to secure a stable supply to consumers at an appropriate price.

Furthermore, apples account for 70 percent of the export value of fresh fruit, and are positioned as a major agricultural item in Japan for export. Therefore, there is a concern that it may pose a problem to implementation of export strategies if apple production becomes unstable due to climate change.

It is expected that not only the existing major production sites of grapes, peaches, cherries will possibly become unsuitable for production, but also that decreases in growth thereof will occur due to high temperature.

- **Fruit Trees** [Significance :  (Soc/Ec), Urgency : , Confidence : 

### **【Basic Measures】**

In order to mitigate the occurrence of sunburned fruit of satsuma mandarin oranges due to high temperature and strong solar radiation, thinning out of the upper part of the fruit tree crown exposed to

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<sup>18</sup> A phenomenon where crop yields of fruit trees increase or decrease year by year.

<sup>19</sup> A phenomenon where fruits naturally drop due to such causes as insufficient sunlight, dryness and high temperature.

<sup>20</sup> A phenomenon where the peel separates from flesh, resulting in a decline in quality.

direct sunlight has been promoted. For the purpose of mitigating the occurrence of peel puffing of fruit, the application of plant growth regulators such as calcium compounds has been promoted. Moreover, as also a measure against poor coloring, spraying of Figaron (ethychlozate),<sup>21</sup> which is used for the purpose of fruit thinning, has been promoted.

Replanting has been also promoted in order to switch from satsuma mandarin oranges to medium late ripening citrus fruits (such as *Citrus reticulata Shiranui* and blood orange) that prefer warm climate.

Regarding apples, in addition to introducing superior colored varieties including “Akibae” and yellow-colored varieties as measures against poor coloring, introduction of sprinkling water and reflective sheets have been promoted as measures against sunburned fruit and poor coloring.

As common measures against drought for fruits including peaches and cherries, the following measures have been promoted: utilization of water evaporation control with multilayered sheets, deep plowing and feeding organic substrates at the dormant stage in order to maintain soil moisture, and adjusting controls at the proper time for spider mites and other pests that are likely to occur at the time of drought. Also, as a measure against frost damage due to late frost during the flowering period, establishment of a frost damage alert system has been promoted.

As a common measure against poor coloring of fruit due to climate change, support for establishing a production and distribution system for fruits for processing use has been promoted in order to proactively utilize such fruits as raw ingredients for fruit juice.

In addition to the above efforts, the following measures will be taken hereafter:

Regarding satsuma mandarin oranges, accelerate dissemination of cultivation management technologies from 2015 as follows: spraying of gibberellin<sup>22</sup> combined with prohydrojasmon<sup>23</sup> that mitigate the occurrence of peel puffing, and active utilization of light-shielding materials that prevent sunburn of fruit. For the purpose of stabilizing the flower setting, commence development of production stabilizing technologies by improving fertilizer application and water management.

Regarding apples, commence development of cultivation management technologies from 2015, for the purpose of reducing the occurrence of poor coloring and sunburn fruits in high temperature.

In view of projection of the shift of suitable area for production, and in order to establish new orchards utilizing high-elevation zones, from 2016, provide support for cultivation demonstration toward such efforts and replanting for switching varieties, while promoting orchard infrastructure development at high-elevation zones.

In the case of grapes, the following measures will be taken: as measures against poor coloring, continuously promote introducing superior-colored varieties such as “Queen Nina” and yellow-green-

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<sup>21</sup> Plant growth regulator used for the purpose of accelerating the ripening period, fruit thinning and mitigating peel puffing of citrus fruits.

<sup>22</sup> Plant growth regulator used for the purposes including accelerating the growth of fruit trees, accelerating flowering and fruit enlargement.

<sup>23</sup> Plant growth regulator used for the purposes including accelerating coloring of fruit and mitigating peel puffing of satsuma mandarin oranges.

colored varieties such as “Shine Muscat.” At the same time, in order to mitigate the coloring trouble due to high temperature at the ripening stage, accelerate dissemination of production stabilizing technologies such as girdling<sup>24</sup> from 2015.

In the case of Japanese pears, the following measures will be taken for the purpose of mitigating damage caused by poor sprout emergence: utilization of a sprout promoter, further introduction and dissemination of technical measures such as changing the application timing of fertilizers, as well as the commencement of developing production stabilizing technologies in warm regions through measures including soil improvement.

On the other hand, in terms of breeding of satsuma mandarin oranges, apples and Japanese pears, develop breeding materials adaptive to high temperature conditions by or around 2019. Thereafter, the said developing new varieties will be cultivated. From 2027, actually introduce such varieties to the place of production for demonstration.

In addition to the above, in the case of the advancement of global warming due to climate change, it is projected that the area where subtropical and tropical fruits can be cultivated in facilities will expand. Thus, from 2016, introduce highly-valuable subtropical and tropical fruits (such as atemoyas, avocados, mangoes and lychees) for demonstration, and promote shifts from the existing fruits in line with local producers’ selection.

If the temperature zone favorable to the cultivation of apples moves northward due to the advancement of global warming, it is considered possible to form the production area in a new region. When forming such a new production site, promote establishment of low-cost and labor-saving orchards.

Considering that being perennial crops, fruit trees require a certain period of time to bear fruits, and that the prices of fruits tend to fluctuate due to supply-and-demand imbalances, it is necessary to implement measures from the long-term viewpoint more so than for other crops. Therefore, it is necessary to establish a network among major production regions and prefectures, in order to share precise information such as global warming impacts and adaptive measures and examine action plans at the sites of production.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Land-Extensive Crops**

### **【Impacts】**

Regarding the current status, the following damage is observed in the case of wheat and barley: internode elongation<sup>25</sup> due to a warm winter, early ear emergence and frost damage due to low temperature and late frost in the early spring thereafter, and moisture damage due to heavy rainfall during the overall growing period.

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<sup>24</sup> A technique leading to improvement of coloring as follows: peeling off the outer skin of a trunk, and sending nutrients made in leaves to a fruit cluster, without sending them to parts lower than the peeled part.

<sup>25</sup> A phenomenon where a stem starts growing and leaves crawling near the ground start standing upright.

The following damage is observed among soybeans: flower shedding and pod shedding, as well as green stem syndrome<sup>26</sup> due to moisture damage caused by heavy rainfall during the early growing period and due to high temperature and drought after the flowering period.

In Hokkaido, red beans have become smaller due to high temperature at the time of ripening.




The following damage is observed among tea plants: growth inhibition of sprouts of second or later-picked tea leaves due to high temperature and drought during the growing period, early sprouting due to warm winters, and frost damage due to late frost in early spring.

As for sugar beet, damage caused by disease is found to frequently occur due to high temperature and heavy rainfall from summer to fall.

Regarding the projected impacts, decreases in yields and declines in quality of wheat are projected due to the following reasons: standing stems due to a warm winter, early ear emergence and an increase in frost damage risk due to low temperature and late frost in early spring, and a shortened ripening period due to high temperature.

As for soybeans, it is projected that if the temperature exceeds the range of the most suitable temperature, a reduction in dry matter weight,<sup>27</sup> seed weight and harvest index<sup>28</sup> will occur.

In Hokkaido, although there is a possibility of increases in yields of sugar beets, soybeans, and red beans in the 2030s, there is a concern for pests as well as a decline in quality. A decrease in yield and a decline in quality of wheat are projected.

• **Barley/Wheat, Soybean, Feed crops, and Other Crops** [Significance :  (Soc/Ec), Urgency : , Confidence : ]

### **【Basic Measures】**

As for wheat and barley, the following measures have been taken against heavy rainfall and moisture damage: while completing basic techniques such as drainage measures, measures including preventing fusarium head blight at an appropriate time and harvesting at an appropriate time, a shift to resistant varieties against diseases including fusarium head blight and against pre-harvest sprouting<sup>29</sup> have been promoted. As a result, certain effects have been observed. Moreover, as measures against frost damage, efforts have been taken to develop and disseminate varieties and breeding materials adaptive to climate change, as well as production stabilizing technologies.

The following measures against heavy rainfall, high temperature and drought have been taken for soybeans: completing drainage measures and promoting the dissemination of a ground-water-level control system. As a result, certain effects have been observed. In addition, as pest control, efforts have

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<sup>26</sup> A phenomenon where pods are poorly grown and stems and leaves do not die, even during the harvest season.

<sup>27</sup> A weight obtained after being dried and having water content reduced, that is, the weight of a substance that a plant actually produced and accumulated.

<sup>28</sup> A ratio of the dry matter weight of harvested parts against the total dry matter weight.

<sup>29</sup> A phenomenon where a sprout comes out of a seed that grew on an ear due to events including rainfall before harvesting.

been taken to develop and disseminate varieties and breeding materials resistant to pests as well as weed control techniques. Further work has been done on developing a cultivating system less likely to be impacted by climate change, such as the application of organic manure and crop rotation, which mitigates pest and disease occurrence risks.

In the case of red beans, the dissemination of a high-temperature-resistant variety, “Kitaasuka,” has been promoted in Hokkaido (central Hokkaido and southern Hokkaido).

Regarding tea plants, a measure against frost damage has been promoted by implementing a frost protection technique with an energy-saving frost-protective fan system. As a result, certain effects have been observed. Moreover, the following drought measures have been implemented: soil moisture evaporation control by grass mulch and sprinkling water. As for pest control, forecasting technology has been introduced, and replanting of varieties resistant to white peach scale<sup>30</sup> has been promoted.

Regarding sugar beet, pests and diseases control has been taken to develop and disseminate species resistant to diseases, which are frequently caused by high temperature. As a result, certain effects have been observed. Measures for high temperature also have been periodically taken to monitor and investigate the production status at the production site and to accumulate findings for the purpose of selecting the most suitable species. Moreover, drainage measures against heavy rain have been taken.

Measures taken so far will be continuously promoted hereafter.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Horticultural Crops**

### **[Impacts]**

Regarding the current status, the following trends among open-field vegetables have been observed: harvesting seasons are becoming earlier among leafy vegetables such as cabbage, root vegetables such as daikon radish and fruit vegetables such as watermelons, and the frequency of decreasing growth thereof is increasing.

As for vegetables grown in greenhouses, the following phenomena have been observed: poor fruit bearing, fruit cracking, poor coloring of tomatoes due to high temperature in the summer, and a delay in flower bud differentiation of strawberries due to high temperature during the growing period. Moreover, the following impacts have been observed: a decline in photosynthesis caused by shading to avoid high temperature, a decline in pollination activities of bumblebees due to high temperature and collapsing greenhouses due to heavy snow.



A decrease in growth is observed among ornamental plants: the advancement or delay of the flowering season due to high temperature in the summer and fall, malformed flowers, short-stemmed flowers, and weakened stems.

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<sup>30</sup> A major pest insect for tea, which is a parasite living in the branches and trunk of a tea plant. It causes damages including dieback, due to decaying tree vigor. In recent years, its outbreak has been frequent nationwide, but there is no clear cause-and-effect relationship between climate change and the trend.



Regarding projected impacts, it is unlikely that the cultivation of vegetables will become totally impossible as long as the cultivation period is adjusted and appropriate varieties are selected. However, further climate change will possibly make it difficult to deliver vegetables in a planned manner.

- **Vegetables** [Significance: — , Urgency: , Confidence: 

### **【Basic Measures】**

Regarding vegetables, while promoting the development of breeding materials adaptive to warmer conditions and the dissemination of such varieties as measures against higher temperature, efforts have been made toward the stable supply of open-field vegetables by selecting adequate varieties, adjusting the cultivation periods, and pest control at appropriate times. The following drought measures have been promoted: establishing irrigation facilities, soil moisture evaporation control with multilayered sheets, and an appropriately timed extermination of spider mites and other pests that are likely to occur at the time of drought.

As for measures against high temperature concerning vegetables grown in greenhouses, efforts have been made to implement low-cost nighttime air-conditioning technologies by utilizing soil temperature-controlling multilayered sheets, light-shielding materials, fog cooling machines, pads and fans,<sup>31</sup> circulating fans, and heat pumps<sup>32</sup> mainly at relatively large facilities. The following measures against typhoons and heavy snow have been promoted: implementation of a low-cost weather-resistant greenhouse, reinforcement of a pipe-framed greenhouse, installation of a backup power source. As a result, certain effects have been observed.

As for measures against high temperature concerning ornamental plants, adequate use of sprinkling water has been promoted. In addition, work has been done on disseminating varieties adaptive to hot conditions.

As for measures against high temperature concerning ornamental plants grown in greenhouses, efforts have been made to implement low-cost nighttime air-conditioning technologies by utilizing soil temperature-controlling multilayered sheets, light-shielding materials, fog cooling machines, pads and fans, circulating fans, and heat pumps. In addition, the following measures against typhoons and heavy snow have been promoted: implementation of a low-cost disaster-resistant greenhouse, reinforcement of a pipe house, installation of a backup power source. As a result, certain effects have been observed.

Measures taken so far will be continuously promoted hereafter.

**【Relevant Ministries】 Ministry of Agriculture, Forestry and Fisheries**

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<sup>31</sup> A device made by combining a water-dampened cooling pad and a cooling fan, which obtains cooling effects by evaporatively cooling a greenhouse for agriculture.

<sup>32</sup> A technology that collects heat in the air by a small amount of input energy, in order to use it as a large amount of thermal energy.

## Livestock Farming

### 【Impacts】

As for the current status, regarding livestock, impacts of high temperature exceeding that of the summertime in an ordinary year are reported as follows: a decrease in milk yields, milk constituent and reproductive performance of dairy cows, and a decrease in the rate of gain of beef cattle, pigs, and meat-type chickens.

Regarding forage crops, the following impacts have been reported: a shift of locations suitable for cultivation, summer growth depression due to high temperature and light rainfall, in the summertime, and insect damage.

Regarding projected impacts, though differences may be seen depending on the species of livestock and breeding form, the following projections are reported: a decrease in feedstuff intake caused by an increase in temperature in the summertime will bring more impact on the growth of fat hogs and meat-type chickens, accompanied by the advancement of global warming: also, regions where the rate of gain decrease will extend, and the extent of such decrease will grow.

Regarding forage crops, although a study projects the amount of production of meadows by region, no projection has been made for a nationwide trend on yield increases and decreases.

- **Livestock Farming** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

### 【Basic Measures】

As for livestock, while securing an adequate livestock barn environment by disseminating summer heat measures, such as water sprinkling and misting in a livestock barn and application of lime and water sprinkling to the roof, the following efforts have been made: avoidance of close rearing and strict enforcement of clipping, and instruction and completion of adequate feeding management techniques, such as supplying cold water and feedstuff of good quality. Moreover, efforts have been taken to develop and disseminate productivity improvement techniques to prevent a decline in the rate of gain and fertility in the summertime through adequate nutrition management.

Regarding forage crops, establishment of a cultivating system adaptive to climate change, development and dissemination of summer heat measures including manuring management techniques, as well as varieties and breeding materials resistant to heat have been promoted. Also, disease and pest measures have been taken, such as development and dissemination of resistant varieties and breeding materials.

Measures taken so far will be continuously promoted hereafter.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## Plant Pests, Weeds, and Animal Infectious Diseases

### 【Impacts】

Regarding pests, although *Nezara viridula*, which causes serious damage to various crops such as paddy field rice, soybeans and fruits, used to be distributed in southwestern parts of Japan, (i.e., relatively

warm areas such as southern Kyushu), it has been expanding its range northward to part of the Kanto region in recent years. It has been pointed out that such changes have occurred due to an increase in temperature.

Regarding paddy fields, the species composition of parasitic natural enemies, some parasitoids, and pests is projected to change by an increase in the number of annual generations. As for vegetables, fruit trees, and tea plants, some point out that damage will possibly increase due to the following trends of pests such as *Lepidoptera* and *Hemiptera*: the overwintering area of such pests will expand northward, and the number of annual generations of such pests will increase. It is also pointed out that the period of migration and migrated populations of plant hoppers from overseas will possibly change.

Regarding crop damage due to disease, there is a case where the outbreak of diseases such as rice sheath blight disease and rice blast was projected to increase under the condition of elevated CO<sub>2</sub> concentration (an increase by 200 ppm from the ambient air) artificially created in an outdoor paddy field. Thus, there is a concern for increases in crop damage by other diseases due to climate change.

It has been pointed out that damage to agricultural crops will possibly increase due to increases in occurrence of pests and diseases, and the expansion of their distribution areas. Moreover, some are concerned about serious damage resulting from the introduction of pests and diseases that have never been present in Japan, triggered by climate change.

In the case of weeds, it has been pointed out that the area where certain types of weeds can take root will possibly expand or move toward the north due to an increase in temperature. Some are concerned that the growth of agricultural products will be hindered and that agricultural products will become the host of diseases and pests.

As for animal infectious diseases, there are growing concerns about the following: the expansion of an epidemic area and change of the epidemic period due to changes in the habitat and habitation period of vectors, which carry pathogens of domestic animal infectious diseases; and invasion by new diseases from overseas. For example, arbovirus infections (virus infection by bloodsucking vectors), which is carried by vectors such as mosquitos and biting midges, have spread mainly in western Japan. It is implied that climate changes affect the distribution of vectors; the habitat has moved toward the north. As a consequence, signs of a change have been seen in the trend of the outbreak of domestic animal infectious diseases such as the expansion of an epidemic area and epidemic period.

Moreover, in the future, if impacts are brought on a flying pathway and in the flying period of migratory birds, which are considered as a major factor for avian influenza outbreak in Japan, there is a possibility of seriously affecting the invasion risk of avian influenza in Japan.

- **Plant pests and weeds** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

### **【Basic Measures】**

It is important to understand appropriately the situations of the occurrence and damage of pests

presented in Japan. For this reason, a pest forecasting program applicable to the specified pests<sup>33</sup> will be continuously implemented, and while investigating changes of the status of the occurrence and damage, such information will be transmitted for the purpose of timely and proper pest control. Moreover, in response to climate change, commence reviewing the specified pests for the pest forecasting program and the pest control system in order to adapt to climate change.

As for serious pests<sup>34</sup> that are absent, or present but not widely distributed in Japan, while continuously taking phytosanitary measures in order to prevent the introduction of pests from overseas, domestic quarantines for preventing such pests from spreading in Japan, and surveillance as well as control of the pests, implement further risk assessment of pests based on information in the world, and work on reviewing phytosanitary measures based on the results of risk assessment of pests.

Regarding serious pests that are already present in a part of Japan, efforts will be gradually taken for technical development toward the improvement of accuracy of monitoring survey for newly invading pests, and the advancement of control techniques.

As for long-range migratory pest insects,<sup>35</sup> commence development of technology for clearing the change of the situations of migration from overseas, (i.e., the period of migration and the number of migrated insects), and technology for projecting the change of distribution area in Japan, (i.e., northward expansion of the overwintering area and the acceleration of occurring and migration).

Regarding diseases such as rice sheath blight and rice stripe, which is expected to occur increasingly in paddy fields, clarify the impacts on paddy rice yields, and develop technologies against such impacts.

Regarding weeds, while assessing the risk of occurrence of spoiled grains of soybeans due to increases in the amount of weeds remaining until the harvesting season, commence work on developing a technology mitigating damage on soybeans.

As for animal infectious diseases, the following efforts will be taken: selection of a vaccine candidate strain against livestock infectious diseases carried by vectors (virus for manufacturing vaccine suitable for epidemic infectious diseases), examination of risk management including effective preventive measures, and investigation on risks of migratory birds, which are considered a major factor for avian influenza invasion of Japan.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

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<sup>33</sup> As specified by the Minister of Agriculture, Forestry and Fisheries in Article 22 of the Plant Protection Act (Act No. 151 of 1950), pests and diseases of which distribution in Japan is not localized, and they spread quickly and tend to do material harm to crops.

<sup>34</sup> Pests and diseases that possibly do material harm to useful plants if they spread within the country.

<sup>35</sup> Insect pests that travel from several hundred kilometers to several thousand kilometers using not only their own flying capability, but also a large-scale weather phenomenon, including many serious-insect pests in agriculture such as plant hoppers, aphids, and Noctuidae. Insect pests such as rice brown plant hopper (*Nilaparvata lugens*) and the white backed plant hopper (*Sogatella furcifera*) are known to migrate mainly to western Japan across from mainland China by a low-level jet stream that develops during the rainy season in Japan.

## Water, Land and Agricultural Infrastructure

### 【Impacts】

As for the current status, regarding precipitation affecting water, land and agricultural infrastructure, the following tendencies are found: the range of fluctuation is becoming larger for both pluvial and dry years; and the frequency of heavy rainfall with a short duration of time is increasing. In response to a decline in quality of paddy field rice due to high temperature, influences on the utilization of water resources, such as changes in rice cropping season and water management, are observed.

Regarding the projected impacts, it is projected that water, land and agricultural infrastructure nationwide will be affected by an increase in occurrence of extreme events (heavy rainfall and drought) and an increase in temperature. In regions where snowmelt is used as a water resource in particular, water intake is projected to be largely affected in April and May, when agricultural water use is in high demand, due to early snowmelts and a decline in snowmelt runoff volume. Moreover, risk of farmland flooding is projected to increase due to an increase in the frequency and intensity of torrential rainfall.

- **Water, Land and Agricultural Infrastructure** [Significance:  (Soc/Ec), Urgency: , Confidence:  ]

### 【Basic Measures】

While formulating the “Global Warming Measures in Agricultural and Rural Development” and conducting examinations and investigations of measures concerning water, land and agricultural infrastructure, promote the development of technologies that contribute to the projected impacts of global warming and measures based on the technical development plan concerning agricultural and rural development.

In light of impacts such as an increase in temperature expected to occur in the future and a decline in snowmelt runoff volume, agricultural water will be effectively secured and utilized by appropriately combining measures in hard(structural) and soft(non-structural) aspects as follows: reducing the amount of irrigation water by automated water management and pipelining waterways and effective utilization of existing water resources by changing the operation of reservoirs and agricultural dams.

In order to respond to increasing torrential rainfall, efforts will be taken for disaster prevention in rural areas, as well as the maintenance and improvement of disaster reduction functions, by appropriately combining measures in hard(structural) and soft(non-structural) aspects as follows: promoting prevention of farmland flooding, by developing drainage pumping stations and drainage canals, grasping facilities and regions highly vulnerable to inundation, conducting risk assessment such as formulating hazard maps, and promoting the development of a business continuity plan by facility managers. In doing so, measures will be effectively taken by utilizing the existing facilities and by demonstrating local communities’ functions.

Under present circumstances, climate change projections are highly uncertain, and there are no sufficient grounds for conducting specific examinations based on projected impacts. Thus, in light of new scientific findings, accompanied by the advancement of climate change research, medium- to long-term impacts will be projected and assessed.

If the grounds for improving facilities based on projected impacts become definite in the future, due to new scientific findings and climate models as well as improved accuracy of the assessment methods of impacts on water, land and agricultural infrastructure, conduct examinations on desirable infrastructure improvement.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Securing Food and Feed Safety (Agricultural Products Including Cereal Grain and Cereal Products, and Feeds)**

### **【Impacts】**

Many kinds of fungi are present in soil. Some fungi-infected agricultural products trigger plant diseases that result in a decline in quality and yield, and mycotoxin<sup>36</sup> contamination which poses problems to food and feed safety. Among mycotoxins, aflatoxins are known to be extremely toxic. Maximum levels of aflatoxins in food and feed have been established in Japan as elsewhere. To date, reports of serious cases of aflatoxin contamination exceeding standards for agricultural products and feeds in Japan have been rare.

However, in a study of distribution of aflatoxin-producing fungi in domestic soil, it was reported that there was a high correlation between the limit of its distribution and the annual mean temperature, and that its distributional area possibly expanded compared to that of the 1970s. Regarding other mycotoxins' contamination, under present circumstances, such contamination has been confirmed to remain at a low level deemed unlikely to pose health problems for humans and livestock.

Due to an increase in annual mean temperature and an increase in occurrence of heavy rainfall and drought, during the growing period of agricultural products and feed crops, there is a possibility that the distribution and density of mycotoxin-producing fungi (in particular, aflatoxin-producing fungi) in field soil, will change, thereby changing the conditions of mycotoxin contamination within domestic agricultural products and feeds.

### **【Basic Measures】**

Through continuous surveillance of the distribution of mycotoxin-producing fungi in domestic field soil, and mycotoxin contamination of domestic agricultural products and feeds, endeavor to ascertain the impacts of climate change. If there is a possibility that increases in mycotoxin contamination of agricultural products and feeds will pose a health problem for humans and livestock, develop technologies to reduce contamination and extend such measures to producers of agricultural products and feeds. Mycotoxin contamination reduction measures will be regularly verified and reviewed in consideration of new findings.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

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<sup>36</sup> Natural chemical substances made by mold, which bring harmful effects on humans and livestock.

## Section 2. Basic Adaptation Measures for Forest/Forestry

### Mountainous Disaster and Forest Conservation Works and Forest Road Facilities













#### 【Impacts】

It is reported that the frequency of occurrence of short-term intense rainfall exceeding 50 mm or more of rain per hour has increased over the past 30 years, thereby resulting in an increase in the annual number of occurrences of sediment-related disasters damaging human habitations and villages. Moreover, it has been pointed out that the occurrences of excessive high tides have been possibly increasing worldwide since 1970.<sup>37</sup>

Regarding the projected impacts, one projection says that the annual maximum daily rainfall and the annual maximum hourly rainfall will increase by several dozens of percent compared to today. Under the premise that the rainfall conditions will become as harsh as projected, intensive landslides and debris flows will frequently occur, and impacts on the social life of hilly and mountainous areas will increase.

Drought is estimated to increase by increases in the number of rainless days and decreases in snowfall. Moreover, mismatch between water supply and demand is also projected because an earlier snowmelt period leads to decrease in river flow.

Some point out that the risk of high tides and coastal erosion will increase due to rising sea levels and increases in intensity of typhoons caused by climate change.

- **Debris flows, Landslide, and other disasters** [Significance:  (Soc/Ec) , Urgency:  , Confidence: 
- **Storm surges and high waves** [Significance:  (Soc/Ec) , Urgency:  , Confidence: 
- **Coastal Erosion** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence: 
- **Water supply (Surface water)** [Significance:  (Soc/Ec) , Urgency:  , Confidence: 

#### 【Basic Measures】

In order to fully realize the public functions of forests, such as headwater resource conservation and disaster prevention, while promoting designation of protection forests in a planned manner, the following measures have been taken for protection forests:

By means of promoting implementation of forest conservation facilities and forest management works, prevent mountainous disasters or minimize the damages from those disasters and improve the safety of hilly and mountainous areas. Establish the Forestry Agency Plan for Extending Service Life of Infrastructure (action plan), and appropriately maintain and update forest conservation and forest road

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<sup>37</sup> IPCC Fifth Assessment Report, Working Group I Report, Technical Summary, indicates that “ it is likely that the magnitude of extreme high sea level events has increased since 1979. Most of the increase in extreme sea level can be explained by the mean sea level rise.”

facilities. Cooperate with regional evacuation arrangements by offering information about high-risk areas, designated as Mountain Disaster Danger Zones (MDDZ), and implement effective projects toward disaster risk reduction. When implementing such projects, take local conditions into consideration and manage to conserve biodiversity, such as by installing fish ways at forest conservation facilities.

For the purpose of contributing to stable supply of good quality water through maintaining and enhancing of headwater resource conservation functions of forests, maintain and develop protection forests that contain rich forest soil having high infiltration and water-holding capacity, located in important headwaters for the upstream toe of a dam, or headwater conservation for a village.

By promoting coastal disaster prevention forests, enhance disaster prevention functions of forests such as preventing salt damage.

In addition to the above efforts, the following measures will be taken hereafter:

In order to respond to occurrences of mountainous disasters due to recent torrential rainfall, review the criteria investigation standards of MDDZ and figure out more precisely the zones with higher disaster risk. Promote measures including designating forests located in the MDDZ as protection forests for sediment runoff prevention, in order to improve functions for landslide prevention and sediment runoff prevention. On the protection forests, impose controls on harvesting and converting into other land use, provide forest conservation facilities and forest management activities, and develop forest roads.

In consideration of an increase in the frequency of occurrence of torrential rainfall in recent years, the improvement of forest road facilities will be promoted, aiming at improving disaster prevention functions of the facilities.

On the other hand, the risk of drought is concerning because of projections such as increases in the number of rainless days, decreases in snowfall, and early snow; therefore, promote forest management activities and forest conservation facilities and develop necessary forest roads in order to appropriately demonstrate water resource conservation functions, taking watershed characteristics into consideration.

In terms of coastal disaster-prevention forests, develop the growth base, which takes into account preventative function against storm surges and coastal erosion and enhance functions of tide embankments in light of local conditions.

Based on new scientific findings and the improved accuracy of climate models, consider improvement of the accuracy in ascertaining the MDDZ, improvement of facilities in response to disaster risks, and forest management that utilizes disaster risk reduction functions of forests.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**







## **Planted Forests**

### **【Impacts】**

Regarding the current status, it is reported that cedar tree forests have been declining in some regions, due to an increase in water stress caused by dry air resulting from an increase in temperature and changes in precipitation patterns.



Regarding the projected impacts, some report that areas unsuitable for growing planted cedar forests will possibly increase in regions with low rainfall. However, it is indicated that further research will be necessary for accurate projections.

- **Timber production (e.g., Plantations)** [Significance:  (Soc/Ec/Env), Urgency: , Confidence: ]
- **Planted forests** [Impacts on ecosystems. Significance:  (Env), Urgency: , Confidence: ]

### **【Basic Measures】**

Collect information related to climate change impacts through research and studies on climate change impacts on forests and the forestry industry.

In order to conduct the adaptability assessment of plantation wood against changes in the growth environment such as an increase in temperature and dryness, promote experimental planting of seeds and plants from different places of production widely for main plantation tree species such as cedar and cypress. Furthermore, as for climate change impacts on the growth of such plantation tree species and the surrounding environment of trees such as lower-layer vegetation, commence continuous monitoring of environmental impacts, assessment of risks on long-rotation forests, and development of varieties adaptive to climate change, such as high temperature and dryness stress.




**【Relevant Ministries】 Ministry of Agriculture, Forestry and Fisheries**

## **Natural Forests**

### **【Impacts】**

Regarding the current status, it has been reported that forests in alpine and subalpine zones have declined due to an increase in temperature and the earliness of snowmelt season. In some areas, it is highly likely that deciduous broad-leaved forests have been replaced by evergreen broad-leaved forests due to an increase in temperature.

Regarding the projected impacts, it has been reported that the distribution area of cool temperature tree species will shrink, while that of warm-temperature tree species will expand. However, uncertainties still remain that physiographic factors and anthropogenic impacts such as land use change should affect the actual forest distributions.

- **Natural forests/ Secondary forests** [Impacts on ecosystems. Significance:  (Env), Urgency: , Confidence: ]

### **【Basic Measures】**

In order to conduct impact assessments, endeavor to collect information concerning climate change impacts, including shifts in the distribution area.

Moreover, promote appropriate conservation and management of national forests, and establish areas including “Protected Forests,” which protect primary forest ecosystems and the growth and habitat of rare

wildlife species, as well as “Green Corridors,” which serve as migratory pathways for wildlife; precisely ascertain the situation through continuous monitoring surveys; and endeavor to form the forest ecosystem network together with mountain streams.

Data collection, future projections and vulnerability assessments will be conducted on the climate change impacts on the forest ecosystems of each World Natural Heritage Site, in order to examine measures. Furthermore, efforts will be taken to build a system for the purpose of conducting long-term monitoring of the climate change impacts on the surrounding environment including trees and lower-layer vegetation.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Pests**

### **【Impacts】**

Regarding the current status, it has been reported that areas damaged by pests have possibly been expanding due to an increase in temperature and a decrease in precipitation. However, considering that factors other than temperature contribute to such damage, it is necessary to carefully verify the current impact.

Regarding the projected impacts, some report that there is a concern about expanding damage due to an increase in risks of pests caused by an increase in temperature. It has been indicated that further research will be necessary in the future, in order to accurately project such damage.

### **【Basic Measures】**

In order to prevent the spread of forest pests, continuously conduct pest control in cooperation with prefectures, in accordance with the Forest Pest Control Act.

The distribution of pest-damaged area is deemed likely to expand due to intensified insect activities accompanied by an increase in temperature. While continuously promoting research on climate change impacts and damage control, continuously monitor forest damage.

Furthermore, for the purpose of mitigating forest pest damage, while developing varieties including those highly resistant to the pine wood nematode, promote development of an effective technique to judge the resistance of varieties.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Non-Wood Forest Products**

### **【Impacts】**

Regarding the current status, there is a report indicating the relationship between an increase in temperature in the summer, and the outbreak of disease-causing bacteria, as well as a decrease in the amount of shiitake (mushroom) fruit bodies generated. However, there are some opinions that due to insufficient data accumulated, further research will be necessary in the future.

Regarding the projected impacts, under the current circumstances of shiitake bed log cultivation, there

are no clear grounds for the relationship between an increase in temperature in the summer, and the outbreak of disease-causing bacteria, as well as a decrease in the amount of shiitake (mushroom) fruit bodies generated, and impacts on the shiitake bed log cultivation brought by higher temperature in the winter. Thus, there are some opinions that further research will be necessary in order to make accurate projections.

- **Non-wood forest products (e.g., Mushrooms)** [Significance:  (Soc/Ec/Env), Urgency: , Confidence: 

### **【Basic Measures】**

Take efforts such as ascertaining climate change impacts on shiitake bed log cultivation (the status of damage caused by disease-causing bacteria and the infection route; the status of occurrence of damage caused by fungus gnat pest insects; the influence on yields under high temperature conditions in the summer) and examine a cultivation method that controls an increase in temperature within a bed log laying yard by utilizing a lawn that blocks out sunlight.

Promote measures including data accumulation concerning outbreaks of disease-causing bacteria, influence on yields due to the advancement of climate change, development, verification and dissemination of shiitake cultivation techniques and breeds adaptive to global warming.

**【Relevant Ministries】 Ministry of Agriculture, Forestry and Fisheries**

## **Section 3. Basic Adaptation Measures for Fisheries**

### **Marine Fisheries**

#### **【Impacts】**

Regarding the current status, according to an analysis of climate change impacts on living aquatic resources through marine environmental research, shifts in the distribution area of marine organisms were observed worldwide accompanied by changes in seawater temperature. Changes in the fish catches triggered by such changes were also reported.

In the sea off Japan, an impact study was conducted on migratory fish and squid. The result reported shifts in the distribution and migration area among yellowtail, Japanese Spanish mackerel and Japanese common squid caused by high-water temperature centering in the Sea of Japan, thereby resulting in a decrease in the catch of such fish in some regions.

An increase in Southern Hemisphere fish species and a decrease in Northern Hemisphere fish species have been reported in coastal areas such as the Inland Sea of Seto, and the Wakasa Bay. Catches of spiny lobsters and abalone are reported to have decreased, accompanied by a decrease in seaweed beds due to damage caused by algae-eating organisms.

However, it cannot be ignored that the marine ecosystems are affected by not only continuous global warming impacts, but also global-scale climate change impacts on a cycle of ten to several decades. In waters surrounding Japan, changes in the marine ecosystems caused by ocean acidification are not specified at this point.

Regarding the projected impacts, for marine productivity, which largely affects the growth and survival










of fish and shellfish, it has been pointed out that there is a possibility of fluctuations in the biomass and primary productivity of phytoplankton accompanying climate change. Looking at such changes on a global scale, productivity is projected to decrease in tropical and subtropical waters, and increase in subarctic waters. While such a projection is considered moderately reliable, the credibility of the projection is not high in waters surrounding Japan located at the border of the subarctic zone and the subtropical zone.

As suggested in medium- to high-emission scenarios (RCP4.5, 6.0 and 8.5) in the IPCC Fifth Assessment Report, ocean acidification will pose a considerable risk to the marine ecosystems, particularly in polar regions and coral reefs.

The IPCC Fifth Assessment Report indicated shifts in the distribution of marine organism species on a global scale, and a decline in biodiversity in waters to be highly affected by climate change, which is projected to occur in the mid-21st century and thereafter.

In waters surrounding Japan, projections of impacts concerning a distributed migration range and changes in the size of salmon, yellowtail, Pacific saury, Japanese common squid, sardine, whose catches are large are reported. The distribution area is mostly projected to go north. The catch of some species is projected to decrease due to high water temperature in adjacent waters. In coastal areas, the catch of reef resources including abalone is projected to decrease due to changes in species composition and biomass of seaweed beds, caused by an increase in seawater temperature.

However, changes in catches and impacts on local industries are related to factors other than global warming. Thus, the accuracy of the projection is considered not high due to its high uncertainty.

- **Migratory fish stocks (Ecology of fishes)** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]
- **Marine ecosystems** [Significance:  (Soc/Env), Urgency:  , Confidence:  ]
- **Coastal ecosystems** [Significance:  (Env), Urgency:  , Confidence:  ]

### 【Basic Measures】

Endeavor to ascertain impacts such as impacts on living aquatic resources due to changes in marine environment by continuing marine environment studies at spawning areas and at the major fishing grounds of various living aquatic resources.

Moreover, improve the precision of an oceanic condition projection model in operation by upgrading the method including assimilation of various observational data obtained from research vessels and satellites. Based on such information, aiming at ascertaining and projecting the amount of resources under the changing environment, and improving the precision and efficiency of fishing ground projection, examine measures enabling adaptive fishery production activities in response to environmental changes.

Regarding highly migratory species, such as tuna and bonito, which require resource management by international efforts, for the purpose of estimating their carrying capacity, which is considered to fluctuate due to climate change impacts, aim hereafter to collect various data, such as resource information, genome information, and ocean information and develop a data integration and analysis system.

By specifying climate conditions and marine environment conditions that will become a factor for the outbreak of harmful plankton, and by utilizing satellite information and a variety of coastal observation information, develop a system to promptly provide information to the related institutions concerned with real-time monitoring.

Furthermore, as changes in the marine environment will possibly affect the survival of released juvenile salmon and other species, develop the releasing methods of juvenile salmon and other species in response to changes in the marine environment.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Marine Aquaculture**

### **【Impacts】**

Regarding the current status, the following phenomena, which are believed to be affected by an increase in seawater temperature, have been reported in many places: mass mortality of scallops and an increase in mortality rates of oysters, and changing in production volume. As for cultured laver, in some cases, annual crop yields have been decreasing in some regions due to a delay in seeding caused by high water temperature in the fall.







The following impacts through the changing in ecosystems have been reported: prolonged red tide, which affects pearl oysters; toxified shellfish by tropical toxic plankton; and feeding damage caused by short-neck clam proliferation accompanied by expanding distribution areas of Southern Hemisphere fish species including Longheaded eagle ray.

In waters surrounding Japan, impacts on marine aquaculture brought by ocean acidification are not reported at this point.

Regarding the projected impacts, in yellowtail aquaculture, while there is a concern about increases in mortality rate in the summer due to high water temperature, enhanced growth is projected in fall and winter. Some point out declining growth due to high water temperature and an increase in risks of developing infectious disease in red sea bream aquaculture. It is projected that locations suitable for farming yellowtail, tiger puffer fish, and flounder will move toward the north, thereby resulting in some waters becoming unsuitable for aquaculture.

In the case of a medium- to high-emission scenario (RCP4.5, 6.0 and 8.5), it has been pointed out that impacts on ocean organisms due to marine acidification will pose a considerable risk on vulnerable marine ecosystems, particularly coral reefs. Many kinds of mollusks possessing calcium carbonate frames and shells, as well as echinoderms, are likely to be affected by ocean acidification. As a result, some are concerned about impacts on shellfish aquaculture.

Others are concerned about increases in risks of mortality of bivalves as a result of increases in frequency of occurrence of red tides caused by high water temperature.

- **Propagation and Aquaculture** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]
- **Marine ecosystems** [Significance:  (Soc /Env), Urgency:  , Confidence:  ]

- **Coastal ecosystems** [Significance:  (Env), Urgency: , Confidence:  ]

### **【Basic Measures】**

Continue research and studies concerning the relationship between the occurrence of red tide plankton, which causes significant impacts on the aquaculture industry, and climate change.

Hereafter, while utilizing metagenome analysis technologies to develop methods that enable detecting with high sensitivity the emergence of tropical and subtropical red tide plankton, which is becoming a new threat, ascertain the physiology and biological characteristics of such plankton, and use such information for projections and development of preventive technologies and measures technologies.

Based on a concern for decreasing growth in the aquaculture areas, continuously work on developing breeds including high-water-temperature-tolerant culture breeds. As for seaweed in particular, further work will be done as follows: developing high-water-temperature-tolerant breeding materials by utilizing a new laver breeding technique based on already developed cytogamy techniques, and developing a breeding technique by separating a high-temperature-tolerant strain of large-sized algae such as wakame seaweed.

Hereafter, formulate measure guidelines for fish diseases that are expected to frequently occur at the time of high water temperature, as well as fish diseases that will possibly invade Japan from tropical and subtropical waters, accompanied by an increase in water temperature, and develop various measures technologies.

In consideration of the increasing possibility of occurrence of unknown fish diseases due to an increase in water temperature, aim to promptly respond to the occurrence of unknown fish diseases by systematizing and enhancing a series of technical developments including specifying pathogens, diagnosis, and measures regarding infectious diseases whose pathogens are unknown. Vaccinations for various fish diseases have already been developed. The efforts will be taken to further develop and disseminate vaccinations in response to various fish diseases.

Hereafter, in tandem with such measures for fish disease, by utilizing the latest breeding techniques, create strains that appear to be resistant to various fish diseases that are expected to break out accompanied by global warming, and aim to introduce such strains at the aquaculture sites.

In addition to the aforementioned technical developments, take efforts to identify the characteristics of pathogens, the working mechanisms of vaccinations, the molecular mechanism of disease tolerance and resistance and other.

While proceeding with monitoring and ecological surveys of breeds that appear as a result of an increase in water temperature such as Longheaded eagle ray, which eat bivalves including short-neck clams, and developing management technologies to prevent adverse impacts on ecosystems and aquaculture, proceed with developing efficient capturing methods, contributing to regional development, application technologies and high-value-added technologies.

Although the range of diurnal variability of partial pressure of carbon dioxide that affects the pH of seawater is known to be large in the coastal areas, it is unknown how this mechanism is affecting marine organisms. Thus, while solving such a mechanism and projecting acidification impacts on bivalve

aquaculture, develop measures technologies based on such projections.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Inland Water Fisheries and Aquaculture**

### **【Impacts】**







Regarding the current status, climate change impacts on inland water fisheries and aquaculture have not emerged yet. However, the following trend has been confirmed in some lakes and marshes: the circulation of lake water is weakened due to warm winters, causing a decline in dissolved oxygen at the bottom of lakes, thereby resulting in oxygen depression.

Regarding the ecosystems including resources applicable to fisheries in lakes and marshes, it cannot be ignored that some impacts are brought by eutrophication, not as a result of climate change.

Regarding the projected impacts, severe changes are projected to occur in lakes and marshes and reservoirs, compared with projected changes in rivers, such as advancement of oxygen depression due to enhanced stratification<sup>38</sup> within lakes and marshes and reservoirs caused by an increase in temperature and water temperature, and impacts on the species composition and the production of phytoplankton. In particular, there is a strong concern about impacts on deep lakes and marshes where eutrophication has progressed.

If the fluctuation range of precipitation increases, abnormal inundation and abnormal drought are projected to occur, thereby increasing the fluctuation range of river flow, and increases in the flow of earth and sand as well as substances, and affecting water quality and the environment of river beds. Moreover, the flowing pattern is projected to change due to changes in snowfall and snowmelt period.

The catch of pond smelt is projected to decrease due to high water temperature. If the highest water temperature rises by 3°C compared to today, the areas with rivers that cold-water fish can inhabit are distributed will decrease from 40 percent to approximately 20 percent of the whole land area. The habitat of such fish will be extremely limited on the mainland of Japan, in particular.

- **Propagation and Aquaculture** [Significance:  (Soc/Ec), Urgency: , Confidence:  ]
- **Freshwater ecosystems** [Significance:  (Env), Urgency: , Confidence:  ]

### **【Basic Measures】**

Assess impacts on the habitat and abundance of important resources in inland waters such as Salmonidae fish and Sweetfish that are brought by environmental change of rivers, as well as lakes and marshes, accompanied by climate change.

Based on a concern about decreasing growth in the inland water aquaculture areas, continuously work on developing breeds including high-water-temperature-tolerant culture breeds. Particularly, a seawater

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<sup>38</sup> A phenomenon where the density of an upper layer becomes smaller than that of a lower layer, thereby making it difficult for the upper layer and the lower layer to mix. In the ocean and lakes and marshes, water temperature and salt affect the density of water.

immersion treatment at the larval fish period is known to be effective in selecting individual landlocked salmon tolerant to high water temperature. Thus, a high-water-temperature-tolerant strain will be created by applying this technology to other Salmonidae fish.

In order to upgrade feeding and releasing technologies for pond smelt, whose catch is projected to decrease due to high water temperature, while aiming at stabilization, mass-production, and simplification of seedling production, hereafter efforts will be taken in the following areas: developing an efficient production technique of plankton bait, discovering the most suitable rearing density and bait density at the time of seedling production, and developing extensive and mass-productive seedling production techniques.

Collect Information concerning the outbreak of diseases caused by high water temperature. As for diseases of inland water fish, whose damage is expected to increase due to an increase in water temperature, conduct research on the characteristics and onset factors of pathogens, and develop measure technologies based on such research.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Improvement and Development of Fishing Grounds**




### **【Impacts】**

As for the current status, regarding seaweed beds off the coast of Japan, the following phenomena have been confirmed: the southern distribution limit of algae belonging to the Kajime (*Ecklonia cava*) family has moved toward the north, and varieties of warm sea algae have increased. In addition, some report intensified feeding behavior of phytophagous fish such as rabbitfish, and the expansion of the distribution. It has also been reported that such phenomena have caused a decrease in seaweed beds, thereby resulting in a fall in the catch of spiny lobster and abalone, which inhabit seaweed beds.

Moreover, changes are observed worldwide in the distribution areas of marine organisms accompanied by changing in seawater temperature. The following changes among migratory fish in waters surrounding Japan have been reported: changes in the distribution and migration areas due to high water temperature among yellowtail mainly in the Sea of Japan, and changes in the catch accompanied by such changes.

Regarding the projected impacts, reef resources including abalone are projected to be affected by changes in species comprising seaweed beds and the standing crop due to an increase in water temperature.

The distribution areas of many fishery target species are projected to move toward the north.

• **Propagation and Aquaculture** [Significance:  (Soc/Ec), Urgency: , Confidence: 

### **【Basic Measures】**

While precisely ascertaining changes in the distribution areas and the habitats of marine organisms due to an increase in seawater temperature, work on improving fishing grounds, which will become spawning and nursery grounds of marine creatures, in response to such changes. When improving and developing seaweed beds, in addition to seeding and transplanting high-water-temperature-tolerant species according



to the situation of the site, after making improvements, promote more effective measures by adopting an adaptive management method as follows: monitoring the condition of thickly growing algae and the movement of phytophagous animals, and implementing the measures for organisms causing feeding damage, such as removing phytophagous fish, according to the situation.

As the foundation for improving and developing fishing grounds adaptive to climate change, analyze accumulated observational data and fish catch data in order to work on technical development concerning the method assessing climate change impacts on coastal resources in each region.

By ascertaining the distributive characteristics, feeding habits, seasonal changes of organisms causing rocky-shore denudation and by utilizing the global warming projection model, project changes in the distribution areas and impacts. By selecting seaweed relatively resistant to such feeding damage, develop a reproduction technique. Moreover, develop a method for improving and developing combined seaweed beds for the purpose of regrowing seaweed beds in empty spaces within seaweed beds arising from feeding damage in a short period of time.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Fishing Ports and Villages**

### **【Impacts】**







Regarding the current status, it has been pointed out that the risk of damage from high waves and coastal erosion will possibly increase as a result of increases in storm surge deviation and ocean waves caused by mid- and long-term sea-level rise, and an increase in strong typhoons due to climate change. In the case of high waves, an increase in wave height has been confirmed off the Pacific coast from the fall to the winter, while an increase in the wave heights and the period of high waves has been confirmed off the coast of the Sea of Japan, due to changes in the pressure pattern in the winter.

Regarding the projected impacts, even in the case of controlling greenhouse gas emissions, a sea level rise to a certain extent cannot be avoided. Thus, fishing port functions may be affected due to inundation of the following facilities: berthing facilities, such as shallow draft wharves, whose crown height (height of the upper end of a structure) is low, and the difference in sea level is small between the facility and the surface of the sea; and freight handling areas.

Regarding high waves, there is a possibility of increases in risk of high waves in regions off the Pacific coast due to an increase in strong typhoons. Also, fishing port facilities are projected to be damaged by increases in wave heights and storm surge deviations. Furthermore, changes in wave height, wave direction, and period will possibly affect the state of calm (the state where wave height is small) within a port.

Some project that coastal erosion will take place due to sea-level rise and an increase in intensity of typhoons. To be specific, if a sea level rises by 30 cm or 60 cm, approximately 50 percent or 80 percent of beaches in Japan, respectively, are projected to disappear.

- **Sea-level rise** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

- **Storm surges and high waves** [Significance:  (Soc/Ec), Urgency: , Confidence:  ]
- **Coastal Erosion** [Significance:  (Soc/Ec/Env), Urgency: , Confidence:  ]

### **【Basic Measures】**

In order to respond to increases in high waves due to extreme weather events, while monitoring tide levels and waves for the purpose of precisely ascertaining signs of climate change impacts, promote the following measures in a continuous and planned manner: raising the levees of fishing port facilities such as breakwaters and shallow draft quay, and developing tenaciously structured shore protection facilities.

In consideration of socio-economic activities of the hinterlands and the mid- and long-term movement in land use, strategically and adaptively take measures in material and non-material aspects, which are combined in the most suitable manner (best mixed) going forward.

Moreover, develop design conditions for infrastructure facilities in response to rising water levels and increases in high waves, and a low-cost technique for improving the existing facilities.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Section 4. Basic Adaptation Measures for Other Issues related to Agriculture, Forest/Forestry, and Fisheries**

### **Global Warming Projection Studies and Technical Development**

#### **【Basic Measures】**

In terms of a global warming projection study, impact assessment of the agriculture, forestry and fisheries industries has been conducted and, by presenting future impact assessments, contributed to the preparation of the IPCC and various other reports. In terms of technical development, techniques for adaptation to issues that are currently occurring due to impacts such as declining quality of paddy field rice and fruit trees has mainly been developed.

While enhancing efforts on items requiring highly accurate projection studies on climate change impacts on the agriculture, forestry and fisheries industries, aim hereafter to provide substantial information concerning such items, in order to provide communities with an opportunity to tackle climate change.

As for technical developments, develop varieties and breeding materials in light of the mid- and long-term viewpoints based on forecast studies as well as production stabilizing technologies, and develop techniques in order to utilize opportunities brought about by climate change.

Continue to develop cultivation techniques adaptive to climate change and crops resistant to drought, develop techniques contributing to international contributions, and provide assistance for such technical developments.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

### **Expanding Measures to Regions Based on Projected Impacts**

### **【Basic Measures】**

By providing information concerning various adaptation measures indicated in a more detailed impact assessment and this Adaptation Plan, which is analyzed and organized in an easy-to-understand manner for each of the regions that are similar in terms of climate conditions, production items and other, assist the place of production to practice and promote the measures at its own discretion and prepare for future impacts.

Climate change affects not only the supply of the products, but also the surrounding environment such as farmland, forests, and related facilities as the infrastructure in the agriculture, forestry, and fisheries industries. Thus, promote dissemination and enlightenment activities concerning the necessity of the adaptation measures among all levels of citizens, including users of agricultural, forestry, and fishery products, as well as consumers.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

### **Heat Illness among Farmers, Forestry Workers and Fishermen**

#### **【Impacts】**

Regarding the current status, in recent years, there has been an upward trend in the number of deaths due to heat illness during operation in the agriculture, forestry and fisheries industries, including working in greenhouses, undergrowth mowing operations and field work in the summer.

Regarding the projected impacts, the rate of incidence of heat illness is expected to increase throughout the country in the future. According to age brackets, the rate of increase is projected to be the highest among elderly people aged 65 or over. Thus, it seems that impacts of heat illness will become more serious in the agriculture, forestry, and fisheries industries where the ratio of senior citizens is high.

- **Risk of Mortality** [Significance: ● (Soc), Urgency: ●, Confidence: ● ]
- **Heat Illness** [Significance: ● (Soc), Urgency: ●, Confidence: ● ]

#### **【Basic Measures】**

As the effort of the government for heat illness, the government designated July as a “Heat Illness Prevention Awareness Month” and set up the Inter-Minister Meeting for Heat Illness comprised of the relevant government ministries and agencies for the purpose of examining and exchanging information on efficient and effective methods for ensuring that heat illness preventative measures are intensively implemented especially during the prevention month.

Prior to the prevention month, while requesting prefectures and the related organizations to notify farmers, forestry workers and fishermen of precautions, such as frequent water intake, and wearing clothing made of perspiration-absorbing and quick-drying materials, prepare posters and flyers to raise awareness through the “Heat Illness Prevention Project,” a private-public initiative

In coordination with the relevant government ministries and agencies, and in cooperation with prefectures and the related organizations, hereafter promote the dissemination and guidance concerning

heat illness prevention measures for farmers, forestry workers and fishermen including use of new technologies and instruments, such as highly breathable work clothes and a heat illness meter, which notifies the wearer when the risk of heat illness is high.

In some cases, workers engaged in the agriculture, forestry and fisheries industries work under harsh working conditions, such as under a scorching sun and on steep slopes. Thus, by proactively introducing robot technology and the ICT, as well as high-performance machinery, aim to reduce the workload on such workers.

## **[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

### **Wildlife Damage**

#### **【Impacts】**

Regarding the current status, although a direct cause-effect relationship between wildlife damage and climate change is not clear, it is reported that expansion of distribution of wildlife has caused damages including damage to agricultural crops, forest trees, and living aquatic resources and has caused soil runoff.

Regarding the projected impacts, although a direct cause-effect relationship between wildlife damage and climate change is not clear, it is reported that expansion of distribution of wildlife has caused damages including damage to agricultural crops, forest trees, and living aquatic resources and has caused soil runoff.

- **Damage from Wildlife** [Impacts on ecosystems. Significance: ● (Env), Urgency: ●, Confidence: — ]
- **Shifts in Distribution and Populations** [Significance: ● (Env), Urgency: ●, Confidence: ● ]

#### **【Basic Measures】**

Until now, the following measures in each area have been taken:

In the case of field crops, take efforts and provide support to activities including installing intrusion-preventive fences to prevent damage by wildlife, and trapping. In the case of forests and forestry, take efforts to install guard fences to protect plantation wood and vegetation, and develop and demonstrate efficient control techniques. In the case of fisheries, implement the following various measures: removing great cormorants, shooting northern sea lions with rifles for preventing and mitigating damage on fisheries, and promoting the introduction of improved fishing gears, employing enhanced protective nets made of a new material.

While continuously working on installing intrusion-preventive fences, promoting population control, and improving techniques for controlling population and damage, hereafter continue to ascertain information on the condition of the habitats of wildlife and monitor damage on the agriculture, forestry and fisheries industries.

Moreover, based on Wildlife Protection and Management Act, promote scientific and planned protection and control of wildlife by enhancing population control of wildlife such as the sika deer by

prefectures and training persons implementing population control of wildlife.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**

## **World Food Supply and Demand Forecasts**

### **【Impacts】**

Due to damage caused by unfavorable climate such as frequently occurring drought and torrential rainfall, the situation of the world food supply often becomes confusion. Accompanied by damage caused by unfavorable climate such as drought in Australia from 2006 to 2007 and the subsequent export restriction, confusion such as food price hikes and riots over the food balance occurred. In 2012, the international crop prices such as corn recorded an all-time high due to high temperature and dry conditions in the U.S., and thereafter, the international price of major crops remained high. Thus, the supply and demand of major crops is expected to be tight in the mid- and long-term.

### **【Basic Measures】**

Under such conditions, in order to precisely respond to risks anticipating food supply and demand in Japan in the future, in consideration of the IPCC's latest assessment results anticipating the situation in 2100 concerning climate change impacts on the world food supply and demand, build a system forecasting world food supply and demand in the long term, which applies the most suitable forecast models, including economic growth and population increases.

For the purpose of developing strategies toward securing a stable food supply in the mid-term, in consideration of climate change impacts and in light of social/economic trends including economic growth and the trends of policies of each country, continuously conduct mid-term forecasts concerning world food supply and demand, in coordination with the Policy Research Institute, the Ministry of Agriculture, Forestry and Fisheries.

While collecting and analyzing in an integrated manner information concerning food supply and demand overseas and impacts on stable food supply in Japan regarding the trends of world food supply and demand, analyze the causes of impacts on stable food supply in Japan. Such information will be continuously and widely provided.

Furthermore, in order to supplement and enhance information concerning the trends of food supply overseas, aim to obtain and accumulate earth observation data (including image analysis) such as soil moisture via satellite in collaboration with the Japan Aerospace Exploration Agency, and examine whether it is appropriate to analyze and utilize such data.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries**

## **Chapter 2. Water Environment, Water Resources**

### **Section 1. Basic Adaptation Measures for Water Environment**

#### **【Impacts】**

Regarding the water environment, changes expected to arise due to climate change include changes in

water temperature, water quality, and characteristics of runoff (including nutrients from watersheds).










Studies of water temperature changes over approximately the past thirty years (1981–2007) at 4,477 monitoring stations in public waters (rivers, lakes and marshes, and seas) nationwide in Japan found an increasing trend at 72% of the stations in summer and 82% in winter. Changes in water quality due to an increase in water temperature have also been pointed out.

Regarding lakes, marshes and dam reservoirs, in projections using the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)), Lake Biwa is projected to see a decrease in dissolved oxygen (DO) and a deterioration of water quality in the 2030s due to an increase in water temperature. Studies using the same A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)), have confirmed projections of an increase to 21 of the 37 multi-purpose dam reservoirs in Japan being classified as eutrophic water bodies in 2080–2099, with the largest increase in number being in eastern Japan.

As for rivers, an increase in precipitation due to global warming can increase sediment runoff and lead to increased turbidity in river water. Projections for all of Japan include increases in suspended sediments, with the largest increases being in September due to an increase in extreme weather events such as typhoons, increases in river flow volumes and in sediment production if August precipitation increases. Other projections include lower levels of dissolved oxygen (DO) due to an increase in water temperature, organic matter decomposition and enhanced nitrification by microorganisms associated with dissolved oxygen consumption, and an increase in abnormal odors and taste due to an increase in algae.

Regarding coastal areas and closed sea areas, from analysis of sea surface temperature data (1970s–2010s), a significant increasing trend has been reported at 132 of 207 sites nationwide (ave. 0.039°C/year, min. 0.001°C/year, max. 0.104°C/year). It is important to note that there may be anthropogenic impacts at some of the measurement sites where this increasing trend was observed. Other research reports also state that no significant warming or cooling trend was observed in seawater temperature in coastal areas around the island of Okinawa.

Although examples making quantitative projections have not yet been confirmed at present, it is expected that there will be an increase in areas affected by salt water intrusion in coastal areas due to sea-level rise.

- **Lakes/marshes, dams (reservoirs)** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence:  ]
- **Rivers** [Significance:  , Urgency:  , Confidence:  ]
- **Coastal areas and closed sea areas** [Significance:  , Urgency:  , Confidence:  ]

## 【Basic Measures】

### (General efforts for the water environment)

Based on the fact that various climate change-induced changes are expected, including changes in water quality, continue promoting studies and research relating to water quality monitoring and

projections, and promote water quality conservation measures. Specifically, as general efforts for the water environment, promote studies relating not only to direct changes in water bodies associated with climate change such as an increase in water temperature, but also relating to characteristics of runoff (including nutrients from watersheds), and continue to promote water quality conservation measures such as the use of advanced wastewater treatment and improvements in combined sewer systems. In addition, conduct the following efforts.

**(Efforts for lakes/marshes, dams (reservoirs))**

In lakes and marshes expected to have changes in phytoplankton and worsening of water quality associated with an increase in water temperature and changes in rainfall, promote measures to reduce the inflow loads, including measures for wastewater from factories and business premises and measures for domestic wastewater, and strengthen monitoring systems to properly ascertain changes in phytoplankton.

Consider bottom-layer environmental changes associated with changes in water temperature in lakes and marshes, and conduct projections relating to the risk of occurrence of bottom-layer oxygen deficiency, as well as red tides and blue tides.

In deep water layers of stratified lakes and marshes, where incomplete circulation is projected to occur in winter due to changes in water temperature, consider appropriate measures to improve dissolved oxygen (DO) at bottom layers.

Based on prior analysis, consider appropriate adaptation measures for lakes and marshes nationwide, endeavor to obtain the latest scientific findings and improve the accuracy of projections, and based on the results, consider additional measures as required.

Regarding reservoirs (i.e., dam reservoirs), continue implementing water quality conservation measures including the use of selective water intake equipment and aeration-circulation equipment, and consider actions including the review of operational rules of water quality conservation equipment responding to climate change-induced changes in water quality.

**(Efforts for rivers)**

Regarding climate change-induced impacts on rivers and related environments, some research is under way to make projections of changes in the water quality and water temperatures of specific rivers, but at present the quantity of examples is not yet sufficient, and the certainty of predictions is assessed to be low. Therefore, it is currently difficult to ascertain and make projections of the changes occurring in river environments overall. Therefore, continue to conduct actions including monitoring of river quality, and endeavor to collect more scientific findings.

**(Efforts for coastal areas and enclosed sea areas)**

Promote studies and research relating to impacts of climate change including impacts on water quality and biodiversity, as well as adaptation measures, and endeavor to collect scientific findings.










Consider changes in bottom-layer environment associated with changes in water temperature in port areas and inner bay areas, and consider projections relating to the risk of occurrence of bottom-layer oxygen deficiency, as well as red tides and blue tides.

[Relevant Ministries] Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment

## Section 2. Basic Adaptation Measures for Water Resources

### 【Impacts】

Although heavy rainfall events are occurring, with short-term intense rainfall exceeding 50 mm of rain per hour and total rainfall of several hundred mm, there are also declining trends in the number of days with precipitation per year, and droughts are occurring that require water withdrawal restrictions every year. For the future, there are projections for an increase in the number of rainless days and a decrease in the total amount of snowfall, leading to concerns about droughts becoming more frequent, lasting longer, being more severe, and causing more drought damage, due to changes in climate as a result of global warming. In the agricultural sector, as measures to address deterioration of quality of paddy field rice due to an increase in temperature, impacts can be seen in the utilization of water resources, including changes in rice cropping season and water management. An increase in temperature is also expected to affect water demand for agricultural use.

- **Water supply (surface water)** [Significance:  (Soc/Ec), Urgency: , Confidence:  ]
- **Water supply (groundwater)** [Significance: , Urgency: , Confidence:  ]
- **Water demand** [Significance: , Urgency: , Confidence:  ]

### 【Basic Measures】

#### (Basic Approach to Adaptation Measures)

Conduct assessments of water supply safety levels and drought risks for existing facilities that are the basis of measures to prevent and mitigate damage from droughts; also, prepare for droughts through drought risk information sharing with collaboration among actors, including the national government, local governments, water users, companies, and residents.

In order to promote adaptation measures to deal with droughts, in collaboration with the stakeholders, develop scenarios of drought impacts and damage, and promote efforts to formulate drought response action plans that stipulate matters including measures to mitigate damage from droughts.

#### (Assessment of disaster risks)

In order for stakeholders including residents and companies to undertake preparations for droughts, assess the safety of water supplies of existing facilities, and also, assess the situation facing the stakeholders as a drought progresses from the initial stage to become increasingly severe, and based on that information, assess drought risks such as impacts and damage in areas including socioeconomic activities, social and medical services, public facilities and services, and individual livelihoods; present the findings in comprehensible ways, and share the information with stakeholders, including the national



government, local governments, users, companies, and residents.

## **1) Measures to prevent damage from droughts that occur relatively frequently**

### **(Optimal use of existing facilities)**

In areas where development of water resources infrastructure are needed, promote initiatives for water resource development continuously and also consider other potential options to increase the capacity of existing facilities, including heightening the elevation of tide embankments, and excavating reservoirs or dredging sediment buildup in reservoirs. Also, maintain the capacity of existing facilities by conducting systematic maintenance, management and upgrades, including the implementation of steady actions such as measures against aging facilities. In addition, while taking into account factors such as each dam's water reserves and precipitation conditions, consider the potential for efficient dam operations, including integrated use of multiple dams in the same river catchment area.

### **(Use of rainwater, reclaimed waste water)**

Promote the consideration of revisions to technical standards relating to plans and designs in order to encourage the installation of facilities to utilize rainwater, based on tools such as enforcement of legislation relating to the promotion of rainwater use. Also, responding to local needs and other factors, promote the installation of faucets at wastewater treatment plants, and encourage the use of treated wastewater for applications including road maintenance and tree watering, and even in times of emergency; also, promote the re-use of water by considering standardization, including international standardization of Japanese water reclamation technologies.

### **(Information provision, awareness raising)**

Promote information dissemination and appeals for water-saving efforts during normal times and also at an early stage when drought concerns arise, through collaboration with the related institutions and media organizations. In order to promote efficient water use, conduct educational and awareness raising activities to deepen interest and understanding of citizens about the importance of water.

## **2) Measures to mitigate damage from droughts that exceed the capacity of facilities**

### **(Organizational systems for drought management in collaboration with stakeholders)**

Prior to a drought, among the stakeholders, consider water sharing and special water delivery systems; also, promote formulation of drought response action plans by making of guidelines as a basis for making a timeline that stipulates matters including the steps to be taken, through collaboration among the stakeholders, in order to mitigate damage as a drought gradually increases in severity. Also, endeavor to improve drought prediction technologies, including the utilization of information on medium- and long-term precipitation prediction, and consider the potential for actions such as implementation ahead of schedules of water withdrawal restrictions, depending on the circumstances, and based on factors such as drought impact and damage scenarios as indicated in the above-mentioned timeline.

### **(Measures to minimize damage from crisis-level droughts)**

In order to prepare for a crisis-level drought, conduct assessments of drought risks and the safety levels of water supplies of existing facilities, and consider actions including unified responses by governments, drought responses by companies, and establishment of priority levels for water recipients, including those to receive special water deliveries based on the assumption of effects and damages to socio-economic activities, healthcare and welfare services, and life of the people.

**(Monitoring and information gathering relating to river environments during times of drought)**

Due to reductions in river flows during times of drought, as there are concerns about impacts on river environments—affecting water quality and ecosystems, including aquatic flora and fauna that inhabit and grow in rivers—implement monitoring of the river environment during the drought, and endeavor to gather findings about the situation.

**(Utilization of groundwater and assessing the situation during times of drought)**

Groundwater is not only used during regular times, but can also serve as an emergency alternative water source during droughts. However, excessive groundwater withdrawals can lead to problems such as ground subsidence and groundwater salinization, and generally these types of issues are highly localized in nature.

Therefore, local governments or other regional stakeholders need to take the lead in groundwater management, including consideration of rules for sustainable groundwater conservation and use, reflecting local conditions. In addition, the national government is to conduct technology development to help understand groundwater conditions in order to facilitate consideration of groundwater use as an emergency alternative water source; also, create an enabling environment such as through the formulation of common rules for shared use of a variety of data collected by entities including the national and local governments. In addition, using this data, the national government endeavors to understand the groundwater balance and behavior, and relationships between factors such as groundwater withdrawals, ground subsidence, and salinization.

**3) Measures in agriculture, forest and forestry sectors**

In the agricultural sector, agricultural water will be effectively secured and utilized by appropriately combining measures in material and non-material aspects as follows: reducing the amount of irrigation water by automated water management and pipelining waterways, etc., and effective utilization of existing water resources by changing the operation of reservoirs and agricultural dams.

In addition, efforts will be made to maintain and develop protection forests that contain rich forest soil having high infiltration and water-holding capacity, located in important headwaters for the upstream toe of a dam, or headwater conservation for a village; also, based on factors including the risk of occurrence of drought, promote forest management activities and forest conservation facilities suitable for the characteristics of each basin and develop necessary forest roads in order to appropriately demonstrate water resource conservation functions.

**4) Promoting studies and research**

Promote studies and research relating to drought risks, including climate change-induced impacts on water resources and on society.

Because sub-surface structures where groundwater is present are diverse and regionally unique, promote research regarding poorly understood aspects, including the condition of groundwater reserves, water balance and groundwater behavior, and the relationships between surface water and groundwater; and promote studies and research regarding the impacts of climate change on groundwater.

Study the current status of water bank systems and water pricing systems being used in overseas countries as emergency water saving strategies, and promote studies and research regarding their applicability.

**[Relevant Ministries] Ministry of Health, Labour and Welfare; Ministry of Agriculture, Forestry and Fisheries; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

### **Chapter 3. Natural Ecosystems**

Considering that land, freshwater, coastal, and marine ecosystems are closely interconnected, and that climate change-induced changes in ecosystems are caused on the whole, **Chapter 3 on Natural Ecosystems** sets out the following basic approach and common efforts.

#### **(Basic Approach)**

For natural ecosystems, individual efforts are to be implemented based on the following basic approach.

- Measures by humanity will not be able to broadly limit climate change-induced changes in ecosystems, as the changes in ecosystems are caused on the whole.
- The basic approach to adaptation measures in the area of natural ecosystems is to use monitoring to ascertain changes in ecosystems and species, to pay attention not only to stresses arising from climate change factors but also to factors other than climate change, and by reducing these stresses and creating networks of ecosystems, to endeavor to conserve and restore healthy ecosystems that have a high degree of adaptability to climate change.
- Within a limited scope, proactive intervention to maintain ecosystems, species and ecosystem services may be possible, but careful consideration is necessary regarding factors such as impacts on ecosystems and the burden of ecosystem management.

#### **(Common Efforts)**

Based on the basic approach, the following efforts are presented as “common efforts” as outlined in **Sections 1, 2, 3, 4, and 6 of Chapter 3 on Natural Ecosystems**, and are to be implemented.

- Strengthen and expand monitoring in order to more accurately ascertain climate change-induced changes such as changes in ecosystems and distributions of species.
- Promote studies and research, and secure and develop human resources, in order to ascertain the impacts of climate change on biodiversity and ecosystem services.
- Continue to undertake efforts to reduce stresses other than those from climate change (e.g.,

development, environmental pollution, overuse, invasion of alien species). Also, when implementing adaptation measures, endeavor to avoid and minimize the negative impacts on biodiversity.

- Not only secure routes for flora and fauna to migrate and spread, but also promote the creation of networks of ecosystems that can be expected to serve multiple functions. Also, promote the restoration of damaged ecosystems, as required.
- Regarding measures relating to ecosystem conservation, consider reviewing factors such as the objectives, targets, and methodologies of conservation, with consideration given to the impacts of climate change, and build systems for considering and implementing adaptive adaptation measures in accordance with the results of monitoring.
- Only in cases of significant negative impacts of a loss of biodiversity and decline in ecosystem services, within a limited scope, consider proactive intervention such as management to maintain existing ecosystems and species, ex-situ conservation, and management to promote adaptability to climate change. That consideration must give careful thought to impacts on ecosystems and the burden of management.
- Promote studies and research relating to specific policies, methodologies, and technologies relating to implementation of adaptation measures.
- Through studies and research, collect information such as findings, examples, and methodologies to assess functions relating to adaptation measures that utilize ecosystems.
- Implement information sharing and awareness-raising about the relationships between climate change, biological diversity, and ecosystem services, and secure and develop human resources.

## **Section 1. Basic Adaptation Measures for Terrestrial Ecosystems**

### **【Impacts】**

In terms of the current status in alpine and subalpine zones, there have been reports of degeneration and shifts in distribution of vegetation, due to factors such as an increase in temperature and earlier snowmelt. As for natural forests and secondary forests, regarding the current status of climate change-induced displacement and expansion of suitable habitat, it is considered to be likely that in some places, evergreen broad-leaved forest has replaced what was previously deciduous broad-leaved forest, due to an increase in temperature, although confirmed examples are limited at present. Regarding planted forests, there have been reports of degeneration of cryptomeria forests in some areas due to increases in water stress caused by an increase in temperature, as well as changes in the spatial and temporal distribution of precipitation. Regarding damage from wildlife, an expansion of the distribution of wildlife such as the sika deer (*Cervus nippon*) nationwide in Japan has been confirmed, with conjecture that climate change impacts may be involved, but it has been attributed to complex factors, including a reduction in pressure from hunting, changes in land use, and a reduction in snow depth .

Regarding projected impacts, suitable habitat for plant species in alpine and subalpine zones is projected to change or shrink. For example, in all of the RCP scenarios, a reduction in the area of suitable

habitat for the Japanese stone pine (*haimatsu* in Japanese) is projected by the end of the 21st century compared to the present. Also, in some regions, the disappearance of populations of alpine plants is projected to occur due to earlier snowmelt. Regarding natural forests and secondary forests, projections utilizing scenarios such as the A2 scenario (a long term change (2090–2099) of 2.0°C to 5.4°C relative to the average of the years 1980–1999 (best estimate 3.4°C)) project that the suitable habitat of many of the component species of cool temperate forests will shift to higher latitudes and higher altitudes, resulting in the reduction of suitable habitat, while the suitable habitat of many component species of warm temperate forests will shift to higher latitudes and higher altitudes, resulting in the expansion of suitable habitat. Regarding planted forests, it has been projected that if the temperature increases by 3°C above the current level, annual transpiration will increase, resulting in greater vulnerability of cryptomeria plantations, particularly in areas with low precipitation; however, to obtain accurate projections, it is necessary to promote further research. Regarding damage from wildlife, it has been projected that an increase in temperature and a shorter period of snow cover will expand the habitat of sika deer and other wildlife, but only a small number of examples has been confirmed. Future changes may occur in migratory routes and timing of arrival of migratory birds in Japan—a possible major factor in carrying the avian influenza—which may affect the risk of arrival of avian influenza in Japan. Regarding the state of climate change-induced impacts on countryside-landscapes (*satochi-satoyama*) and material balance, comprehensive examples are limited at present.

• **Alpine / Subalpine zone**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Natural forests / Secondary forests**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Countryside-landscape (*satochi-satoyama*)**

[Impacts on ecosystems. Significance  , Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Planted forests**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Damage from wildlife**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence — ]

[Impacts on ecosystem services. Significance — , Urgency — , Confidence — ]

• **Material balance**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance — , Urgency — , Confidence — ]

**【Basic Measures】**

Based on the basic approaches introduced at the beginning of this chapter, implement the common efforts, as well as the following individual efforts.

In particular, implement priority monitoring and conduct assessments in places such as alpine zones that have a high likelihood of impacts occurring, and in places such as World Natural Heritage Sites, national parks, and protected forests of national forests, also conduct ongoing monitoring of wild flora and fauna, and endeavor to ascertain the impacts of climate change. Also, in order to conserve and restore healthy ecosystems with high adaptability to climate change, endeavor to bolster measures to protect biodiversity that have been implemented to date, by considering the projected impacts of climate change; examples include reviewing and properly managing protected areas in places including national and quasi-national parks; managing wildlife populations such as the sika deer, which has a growing population and is having significant impacts on ecosystems; taking measures to prevent damage from wildlife; conducting control and entry prevention measures for alien species; and protecting and propagating rare species. In addition, endeavor to create networks of ecosystems connecting places such as national and quasi-national parks, nationally designated wildlife protection areas, and protected forests of national forests, and promote the creation of forest ecosystem networks integrated with mountain streams.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**

**Section 2. Basic Adaptation Measures for Freshwater Ecosystems**

**【Impacts】**

Regarding lakes and marshes, although no examples making quantitative projections of impacts in Japan have been confirmed at present, for deep lakes where eutrophication is occurring, there are concerns about interruption of vertical circulation in lakes and oxygen deficiency due to an increase in water temperature, as well as the resulting impacts on benthic organisms, including shellfish, and further eutrophication. Also, laboratory experiments have shown that an increase in lake water temperature and carbon dioxide concentrations reduce the growth of zooplankton.

Regarding rivers, because water intake and flow control is conducted on Japan's rivers, it is difficult to detect climate change-induced impacts on river ecosystems, and no research results on direct impacts of climate change have been confirmed at present. However, if the maximum water temperature increases

nationwide by 3°C above the current level, the land area with rivers that can support cold-water fish in Japan is projected to decrease compared to the present, especially on the island of Honshu.

Regarding marshlands, marshland ecosystems are strongly affected by anthropogenic impacts other than climate change, and no examples have directly addressed the impacts of climate change at present, but it has been pointed out that a drying-out of marshlands may have resulted from a reduction of rainfall, a decrease in humidity, and a reduction in snow depth due to climate change. Also, there have been projections of impacts of a reduction in precipitation and lower groundwater levels on plant communities (sphagnum) in high marshlands, and a transition from marshland herbaceous communities to woody plant communities in low marshlands due to watershed loads (sediments and nutrients) caused by climate change.

• **Lakes / marshes**

[Impacts on ecosystems. Significance  (Env), Urgency , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Rivers**

[Impacts on ecosystems. Significance  (Env), Urgency , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

• **Marshlands**

[Impacts on ecosystems. Significance  (Env), Urgency , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

**【Basic Measures】**

Based on the basic approaches introduced at the beginning of this chapter, implement the common efforts, as well as the following individual efforts.

In order to more accurately ascertain changes such as changes in ecosystems and shifts in species distribution, endeavor to ascertain the impacts of climate change, by enhancing monitoring and promoting studies and research, specifically for important inland water bodies, as required.

In order to conserve and restore healthy ecosystems with high adaptability to climate change, endeavor to bolster measures to protect biodiversity that have been implemented to date, by considering the projected impacts of climate change; examples include reviewing and properly managing protected areas in places including national and quasi-national parks; managing wildlife populations such as the sika deer, which has a growing population and is having significant impacts on ecosystems; conducting control and entry prevention measures for alien species; and protecting and propagating rare species. Also, restore marshlands and other ecosystems, as required. In addition, promote the creation of networks of ecosystems connected by water that ensure the connectedness of water bodies including rivers, lakes and

marshes, marshlands, springs, ponds, canals, and paddy fields, and enable flora and fauna to move between them.

Regarding diseases affecting fish in inland waters, which are expected to undergo greater damage from an increase in temperature due to climate change, research the characteristics of pathogens and causative factors, and develop preventative measures utilizing the findings.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

### Section 3. Basic Adaptation Measures for Coastal Ecosystems

#### 【Impacts】

In the subtropics, coral bleaching is already appearing due to causes including an increase in seawater temperature. The distribution of coral in the Pacific Ocean has been shifting northward in areas south of the Boso Peninsula and along the west and north coasts of Kyushu. In the temperate and subarctic zones, in various places along the coast of Japan, a transition has been confirmed to be underway from cool-temperature to warm-temperature species as seawater temperature increases.

In terms of projections of future impacts, for the subtropics, under the A2 scenario (a long term change (2090–2099) of 2.0°C to 5.4°C relative to the average of the years 1980–1999 (best estimate 3.4°C)) there are projections for a reduction to half of the current sea area suitable for the growth of reef-building coral by 2030, and disappearance by 2040, due to an increase in seawater temperature and ocean acidification. Regarding temperate and subarctic zones, with an increase in seawater temperature, it is expected that there will be a shift toward warm-water species, for example, in the case of sea urchins, from *Strongylocentrotus intermedius* (*ezobafununi* in Japanese) to *Strongylocentrotus nudus* (*kitamurasakiuni*), and that this may lead to impacts on entire ecosystems, but quantitative examples are limited.

#### • Subtropics

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

#### • Temperate / subarctic

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance —, Urgency —, Confidence — ]

#### 【Basic Measures】

Based on the basic approaches introduced at the beginning of this chapter, implement the common efforts, as well as the following individual efforts.

Implement priority monitoring and conduct assessments of climate change impacts in tidal flats, salt marshes, seagrass beds, and coral reefs, especially where there is a high likelihood of impacts occurring.



Also, in order to conserve and restore healthy ecosystems with high adaptability to climate change, endeavor to bolster measures to protect biological diversity that have been implemented to date, by considering the projected impacts of climate change; examples include reviewing and properly managing protected areas in places including national and quasi-national parks; conducting control and entry prevention measures for alien species; and protecting and propagating rare species. Also, restore ecosystems such as tidal flats, as required. In addition, promote the conservation and restoration of areas including coastlines, tidal flats, salt marshes, seagrass beds, and coral reefs, and promote the creation of networks of ecosystems.

Regarding the occurrence of red tide plankton, continue studies and research about the relationship with climate change.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**

#### **Section 4. Basic Adaptation Measures for Marine Ecosystems**

##### **【Impacts】**

In the sea around Japan, particularly in the Oyashio Region and mixed water region, phytoplankton biomass and primary productivity may have begun to decline. However, opinion has not converged on a unified view.

Along with climate change, changes may occur with phytoplankton biomass, but models for the sea around Japan have low reliability, making it difficult at present to make projections of future changes. Moreover, it is difficult at present to project the impacts of changes in each region, caused by the above changes.

##### **• Marine ecosystems**

[Impacts on ecosystems. Significance  (Env), Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance  (Soc), Urgency — , Confidence  ]

##### **【Basic Measures】**

Based on the basic approaches introduced at the beginning of this chapter, implement the common efforts, and continue to conduct priority monitoring specifically for important marine areas, as well as studies and research relating to the relationship between climate change and the occurrence of red tide plankton.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**

#### **Section 5. Basic Adaptation Measures for Phenology**

##### **【Impacts】**

Many reports have been confirmed regarding changes in the phenology of flora and fauna, such as earlier flowering of plants and earlier initiation of calling by animals.

According to flowering models based on the A2 scenario (a long term change (2090–2099) of 2.0°C to 5.4°C relative to the average of the years 1980–1999 (best estimate 3.4°C)), impacts for a variety of

species are projected as a result of changes in phenology, such as earlier flowering of the Yoshino cherry tree (*Prunus yedoensis*; *someyoshino* in Japanese). Also, the impacts are not limited to individual species, and various interactions between species are also expected.

• **Phenology**

[Impacts on ecosystems. Significance  , Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance — , Urgency — , Confidence — ]

**【Basic Measures】**

Based on the basic approaches introduced at the beginning of this chapter, continue to implement monitoring in order to ascertain changes in phenology, including flowering of plants. Also, promote participative monitoring with cooperation from others, including research institutes and NPOs, while also working toward finding and developing human resources.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**

**Section 6. Basic Adaptation Measures for Shifts in Distribution and Populations**

**【Impacts】**

In terms of the current status, there have been confirmed cases of changes in life cycles and shifts in distribution and their life cycles that could be explained as impacts of an increase in temperature due to climate change, including expansion of northern limits of distribution to higher latitudes. However, a variety of factors other than climate change could also be involved, so it is difficult to show to what extent the observed changes are a result of climate change.

In terms of the projected impacts, climate change could lead to the extinction of certain species by causing shifts in species distribution and changes in their life-cycles, by causing further adverse impacts from changes in inter-species interactions due to species migration or localized extinction, and by species being unable to shift to keep up with climate change due to fragmentation of habitat. Also, no examples relating to the invasion and settlement of alien species due to climate change have been confirmed at present, although changes in the rate of invasion and settlement of alien species are expected.

• **Shifts in distribution and populations**

◆ **Native species**

[Impacts on ecosystems. Significance  , Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance — , Urgency — , Confidence — ]

◆ **Alien species**

[Impacts on ecosystems. Significance  , Urgency  , Confidence  ]

[Impacts on ecosystem services. Significance — , Urgency — , Confidence — ]

### **【Basic Measures】**

Based on the basic approaches introduced at the beginning of this chapter, implement the common efforts, as well as the following individual efforts.

Enhance monitoring in order to accurately ascertain shifts in species distribution and populations. Implement priority monitoring and assessments on species living in alpine zones and coastal areas particularly where there is a high likelihood of impacts occurring, as well as wildlife such as the sika deer, which are having serious impacts on ecosystems due to increasing populations, and exotic species.

Also, in order to conserve and restore healthy ecosystems, endeavor to bolster measures to protect biodiversity that have been implemented to date, by considering the projected impacts of climate change; examples include managing wildlife populations such as the sika deer; conducting control and entry prevention measures for alien species; and protecting and propagating rare species. In addition, promote the creation of networks of ecosystems to secure routes for flora and fauna to migrate and spread. When doing so, also consider concerns about leading to expansion of the range of alien species and sika deer, and the impacts on native species.

In addition, for national programs such as Programs for the Rehabilitation of Natural Habitats and Maintenance of Viable Populations for endangered species of wild fauna and flora in Japan, on the next reviews of these programs, consider the impacts of climate change, and confirm whether or not the existing objectives and measures are still appropriate.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of the Environment**







## **Chapter 4. Natural Disasters, Coastal Areas**

### **Section 1. Basic Adaptation Measures for Water Disasters**

#### **【Impacts】**

Heavy rainfall events are occurring, with short-term intense rainfall exceeding 50 mm or more per hour and total rainfall of several hundred to more than 1,000 mm, and significant water disasters (flood, inland water, storm surges) are occurring nationwide almost every year. Many published studies are consistent with the view that, according to future projections such as the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)), heavy rainfall events that can cause flood in major river basins in Japan will increase significantly by the end of this century compared to the present, and rainfall amounts of the same frequency will increase by an order of 10 to 30%. These impacts are expected to increase in the future due to climate change, and there are growing concerns about the frequent occurrence of water disasters due to natural hazards (such as torrential rainfall events causing disasters and natural phenomena including storm surges) that exceed the capacity of facilities, and about the occurrence of water disasters on an extremely large scale, caused by natural hazards that significantly exceed the capacity of facilities but are relatively rare.

- **Floods** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence:  ]

- **Inland waters** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence:  ]
- **Storm surges and high waves** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

## **【Basic Measures】**

### **(Basic Approach to Adaptation Measures)**

Regarding natural hazards that could occur relatively frequently, continue to steadily promote improvements that have been ongoing to date for construction of levees, flood control structures, and sewer systems, and conduct maintenance and upgrades as appropriate. The goal of these efforts is to prevent the occurrence of water disasters. When doing so, while referring also to measures of other countries and considering possible future climate-change-induced increases in natural hazards, promote efforts in an adaptive way, such as improvements and maintenance that can provide additional measures that—to the extent possible—avoid rework.

Regarding natural hazards that exceed the capacity of facilities, endeavor to reduce risk by making improvements in facilities' operations, design and implementation procedures; promote urban and local development in ways that consider disaster risk reduction; and endeavor to enhance preparedness for actions such as evacuations, emergency operations, and business continuity. Through these efforts, aim to reduce damages to human life, property, society, and the economy to the greatest extent possible. Also, regarding promotion of measures concerning aspects such as urban design and evacuations, based on inundation scenarios for various natural hazards, promote measures with stakeholders such as local governments, businesses, and residents having an awareness of what kinds of damage can occur.

In particular, for natural hazards that significantly exceed the capacity of facilities, aim for the protection of human life to the greatest extent possible and to avoid catastrophic damage to society and the economy, through voluntary collaboration among stakeholders, including the national government, local governments, public utilities, and businesses, considering worst-case scenarios, and by developing measures with an emphasis on non-structural measures.

### **(Assessment of Disaster Risks)**

It is important that the key actors in the implementation of measures, including local governments, businesses, and residents, promote measures with an awareness of what kind of damage may occur and with what frequency of occurrence; therefore, provide detailed disaster risk information that is comprehensible from the perspective of each actor. Additionally, prepare and provide inundation scenarios for not just one, but various magnitude of natural hazards, and present information about the frequency of occurrence of inundation above floor level and potential risks to human life, as well as information about such aspects as the capacity and state of preparedness of facilities. Also, make use of various fora in which each actor participate to share disaster risk information and to promote measures.

Regarding detailed damage scenarios needed for each actor to promote measures, consider local conditions, including the concentration of population and property in flood plains; the location of infrastructures, lifelines, hospitals, and welfare facilities; the structure and location of industries; and the

aging of the population.

In order to consider measures that include worst-case scenarios, target the largest magnitude natural hazards conceivable in the inundation risk zones, and target not only inundation from flood but also inland water and storm surges. When doing so, provide information not only on depth of inundation but also duration, as required, to enable local governments, businesses, governing bodies, and residents to consider evacuation and other actions.

### **1) Disaster prevention measures to address natural hazards that occur relatively frequently**

Regarding natural hazards that occur relatively frequently, steadily promote disaster prevention measures to prevent the occurrence of water disasters by continuing to steadily promote improvements that have been ongoing to date for facilities, and conduct maintenance and upgrades as appropriate.

#### **(Steady Improvements to Facilities)**

Continue to steadily implement improvements of facilities including levees, flood control structures, and sewer systems. When doing so, endeavor to promote improvements effectively and efficiently, based on disaster risk assessments. Also, review aspects such as the objectives and details of facilities plans, as required, with consideration of factors such as increases in the frequency of occurrence of heavy rainfalls in recent years.

#### **(Improvements in Capacity of Existing Facilities)**

Endeavor to significantly improve the capacity of existing stock, through actions such as refurbishing dams to strengthen their flood control capacity; strengthening, repairing, and maintaining existing sewer facilities; and improving water storage facilities.

#### **(Enhancement of Maintenance and Upgrades)**

Making use of information and communication technologies (ICT), ascertain in detail the condition of river, sewer system, and other facilities. Also, endeavor to make use of video monitoring (close-circuit television, or CCTV) and other technologies to obtain information about flood and inland water.

In order to maintain and secure the required water storage capacity, continue to promote measures to cope with sedimentation in dam reservoirs.

#### **(Installation of Remote Control for Facilities such as Water Gates)**

Promote the installation of features such as remote control and automation for operation of facilities such as water gates, in order to ensure their reliable operation and the safety of operators.

#### **(Comprehensive Sediment Control)**

Consider the objectives of sustainable sediment control in terms of the entire sediment transport system, and promote initiatives for comprehensive sediment control, including the use of sediment supplied from dam reservoirs and dredging sand as beach replenishment material, and the use of sand bypasses to ensure the continuity of longshore sediment transport.

#### **(Design of Facilities to Avoid Rework)**

Endeavor to design facilities to avoid, to the extent possible, rework and to be able to adaptively keep up with increases in natural hazards, such as through the selection of structural designs that can easily be modified, and reinforcement of foundations and other components before it becomes necessary. Do this in order to be able to easily respond even if natural hazards increase due to climate change and additional works, including replacement of facilities, become necessary in the future.

**(Improving Climate Change Projection Technologies for Facilities Plans and Designs)**

Undertake efforts such as improving climate change projection technologies, because it is necessary to have detailed scenarios for the impacts of climate change when designing facilities in ways that will avoid rework.

**(Considering the Impacts of Sea-Level Rise, as well as Sediment and Wood Debris Runoff)**

Clarify the increased risk of damage from storm surges and high waves accompanying climate-change-induced sea-level rise, as well as impacts from factors such as inundation accompanying constrained inland drainage conditions. Also, clarify climate-change-induced changes in sediment and wood debris runoff volumes, and the impacts on river channels, etc.

**(Integrating Control of River and Sewer System Facilities)**

In order to promote integrated control of river and sewer system facilities, promote improvements such as culverts to connect existing river and sewer facilities, and improvements in facilities such as joint-use (river/sewer) water storage facilities.

**2) Disaster-reduction Measures to Cope with Natural Hazards that Exceed the Capacity of Facilities**

Regarding natural hazards that exceed the capacity of facilities, endeavor to reduce risk by making improvements in facilities' operations, design and implementation procedures; promote urban and local development in ways that consider disaster risk reduction; and endeavor to enhance preparedness for actions such as appropriate evacuations, smooth emergency operations, and business continuity. Through this, mobilize the full line and capacity of measures, and undertake disaster reduction measures to reduce damage as much as possible.

**(i) Improving aspects such as facilities' operations, design, and maintenance/upkeep procedures.**

Regarding natural hazards that exceed the capacity of facilities, endeavor to reduce the effect of disasters by promoting conventional measures with additional consideration for risk of excessive flood, and make improvements in facilities' operations, design and implementation procedures.

**(Enhancing Observation and Other Functions)**

Endeavor to improve and deploy observation equipment in order to reliably observe hydrologic/hydraulic parameters such as water levels of rivers and sewer systems.

**(Enhancing and Strengthening Flood Defense Systems)**

During flood events, provide flood defense managers with detailed information about locations that are

critical for flood prevention and locations that are at risk. Also, provide notification about water levels of not only flood in rivers but also inland water and storm surges. In addition, improve facilities that serve as staging areas in response to flood and inland water, and stockpile flood defense supplies, equipment, and materials.

**(Securing Evacuation Sites that Make Use of River Management Facilities)**

In order to contribute to smooth and rapid evacuations, endeavor to identify and secure evacuation sites and routes, making use of facilities such as river management facilities, including levees and river disaster prevention stations.

**(Checking/Reviewing Plans including River Infrastructure Improvement Plans based on Disaster Risk Posed by Various Natural Hazards)**

For natural hazards of various levels up to the probable maximum magnitude, review river improvement plans as required so that they may provide details and procedures for optimal river improvements, considering from the perspective of disaster reduction, and also considering factors such as balances between upstream and downstream areas, as well as between main channels and tributaries. In addition, in order to respond to impacts such as increasingly intense and frequent localized torrential rainfall events, based on detailed disaster risk assessments from inundation simulations, etc., promote the formulation of measures to prevent inundation plans for sewer systems from both the structural and non-structural perspectives.

**(Designing Levees to Delay Collapse)**

Consider designs of levees that can delay collapse and ensure the greatest amount of time possible for evacuation and other actions, including the perspective of improving the reliability of levees that have already been constructed.

**(Making the Most Use of Existing Facilities)**

For existing dams, consider methods of operation to achieve the maximum performance from their flood control capabilities. Also, by improving the accuracy of forecasts of rainfall amounts in the upstream catchment area of dams and flow volumes into dam reservoirs, endeavor to further optimize dam operation.

Regarding measures for inland water, consider approaches for operation of sewer pipe networks and drainage pumps that make use of resources such as information on water levels.

**(Inspecting Large Structures)**

Regarding large structures such as dams and weirs, conduct inspection on any possible damages and/or their impacts on the structure, considering the possible occurrence of natural hazards exceeding the design capacity, such as the probable maximum flood, and implement measures as required.

**(ii) Integrating with Urban Development/Local Development**

In urban areas and mountain regions, endeavor to reduce the damages from disasters by promoting urban and local development that considers disaster risk, taking the opportunity of reconstructing towns

and regions as population declines.

**(Comprehensive Measures against Inundation)**

Promote comprehensive measures against inundation, such as securing the water storage and retention capacity of watersheds.

**(Water Induced Disaster Prevention Measures Considering Land Use Conditions)**

Promote water induced disaster reduction measures that consider land use conditions, while also considering local opinions; for example, a combination of structural improvements such as ring levees, and non-structural measures such as the regulation of land uses.

**(Measures against Inundation in Underground Spaces)**

Promote measures against inundation and secure evacuation of underground spaces, in order to prevent inundation of important underground facilities and secure time to evacuate from underground spaces, such as the installation of water stop boards by facilities managers and appropriate guidance for evacuation from underground facilities.

**(Providing/Sharing Detailed Disaster Risk Information)**

Provide disaster risk information in a form that is easy for recipients to understand, in order to contribute to urban and local development, private sector investment, and ingenuity of living, whilst promoting initiatives to provide information by making use of a variety of opportunities to do so, in cooperation with the related organizations.

**(Urban Development/Living based on Disaster Risk Information)**

When it comes to promoting compact urban development, encourage living and urban functions to be located in areas with low disaster risk, by indicating which areas have a high level of disaster risk.

**(Measures to Reduce Inundation in Cooperation with Urban Development/Local Development)**

In areas where urban functions and housing are already concentrated but with relatively high disaster risk, with the appropriate allocation of roles, promote river improvements to reduce disaster risk, and promote prioritized actions such as improvements in sewer systems, conducted efficiently in collaboration with multiple municipalities, as well as installation of water stop boards, rainwater storage, infiltration facilities, etc., by private sectors.

**(Restraining the Extent of Flooding in Cooperation with Urban Development/Local Development)**

Consider frameworks to restrain the extent of flooding, in cooperation with urban and local development, such as care/protection of secondary levees, natural levees, and continuous dikes, as well as the construction of secondary levees by municipalities and other bodies.

**(iii) Preparing for Evacuation, Emergency Operations, Business Continuity**

Regarding natural hazards that exceed the capacity of facilities, endeavor to enhance preparedness for actions such as appropriate evacuations, smooth emergency operations, and business continuity. In particular, for natural hazards that significantly exceed the capacity of facilities, considering worst-case



scenarios, develop measures with an emphasis on non-structural measures, through voluntary collaboration among stakeholders including the national government, local governments, public utilities, and businesses.

**(Supporting Municipal Leaders to Issue Evacuation Advisories Appropriately)**

Enhance structures and programs so that the national and prefectural governments could support municipal governments in times of emergency, and provide detailed information relating to disaster risk in dangerous locations even during non-emergency times.

**(Providing Easy-to-Understand Information to Facilitate Evacuation)**

To communicate clearly to residents about the degree of urgency of risks such as rising river water levels due to floods and an increase in rainfall amounts, or storm surges from typhoons and cyclones, endeavor to provide information so that recipients can easily understand; for example, by providing an organized relationship between disaster prevention information and the degree of urgency.

**(Enhancing Pre-disaster Initiatives to Promote Facilitation and Acceleration of Evacuation)**

Regarding hazard maps, endeavor to ensure the displayed information is easy for residents and others to understand, and in the streets, promote the installation of signs that indicate information such as the expected depth of inundation, the location's elevation, the direction of evacuation, and the name and distance to an evacuation area.

**(Enhancing Preparedness for Evacuation and Rescues)**

Formulate disaster prevention action plans to enable evacuations, rescue and emergency operations, and emergency transportation, in cooperation with relevant stakeholders such as national and local governments, and public utilities. These disaster prevention action plans should be based on damage assessment, such as the number of fatalities and possibility of persons being isolated during times of large-scale water disasters, etc.

**(Strengthening Support/Relief Systems for Municipalities during Times of Disaster)**

Strengthen support systems for municipalities implemented by the Technical Emergency Control Force (TEC-FORCE) and other entities.

**(Formulating Business Continuity and Related Plans by Organizations Involved in Disaster Prevention, Public Utilities, etc.)**

In order for the organizations to be able to continue activities such as emergency response, reconstruction and recovery, consider measures to promote the implementation of measures to prevent the inundation of important facilities (e.g., municipal offices and other government buildings, fire stations, police stations, and hospitals), the preparation of their backup functions, and the formulation of business continuity plans. Also, consider measures to promote the participation of public utilities in disaster prevention action plans in order to reduce the damage as much as possible, and to recover as quickly as possible.

**(Restraining the Extent of Flooding; Draining Floodwaters)**

In the event of a large-scale water disaster, to restrain the extent of flooding damage and for early reconstruction and recovery, it is very important to quickly drain the floodwaters away. Plan floodwater drainage in advance, and promote efforts to improve drainage gates for rapid drainage of floodwaters, to waterproof equipment including drainage pumping stations, to secure access routes for purposes such as fuel replenishment, and to secure auxiliary electrical power supplies and fuel stockpiles.

**(Improving Disaster Prevention Awareness among Businesses; Preparing BCPs for Flood Damage)**

In order to reduce damage to businesses and to quickly resume business operations after a flood event, consider the preparation of business continuity plans (BCPs) to cope with water disasters, and policies to promote the implementation of measures against inundation.

**(Improving Institutional Arrangements for Disaster Response through Collaboration among All Stakeholders)**

Develop unified disaster prevention action plans for the stakeholders, including national and local governments, and public utilities, for scenarios of events such as large-scale flooding due to natural hazards that significantly exceed the capacity of facilities.

**(Promoting Studies and Research)**

As natural hazards are expected to increase due to the impacts of climate change, promote research relating to topics including the following: quantitative assessments of the increasing natural hazards, and ways to deal with the magnitude of their probability of occurrence; improving the methods of determining the probable maximum magnitude of natural hazards; and new approaches to flood prevention and reduction plans. Also, as sediment runoff is expected to increase, promote research about impacts on river channels, etc.

Regarding increased risks of water disasters due to climate change, promote research relating to the potential for new adaptation measures not addressed by existing programs and methods, through efforts such as analysis of the state of use of flood insurance.

**3) Measures in the Agriculture Sector**

In the agriculture sector, to cope with increases of intense of torrential rainfall and other impacts, make efforts to maintain and improve disaster prevention and disaster risk reduction capabilities of agricultural areas, through appropriate combinations of material and non-material measures, including promoting the prevention of flood damage and other damage on agricultural land by improving facilities such as drainage pumping stations and drainage canals; ascertaining which facilities and regions are highly vulnerable to flooding; implementing risk assessments, including the development of hazard maps; and promoting the development of business continuity plans for facilities managers. In the process, conduct the measures efficiently through the effective use of existing facilities and activation of local community capabilities.

Since climate change projections have a high degree of uncertainty and the basis for concrete discussions based on future projections is limited, conduct projections and assessments of medium- and

long-term impacts based on new scientific findings, accompanying progress made in climate change research.

**[Relevant Ministries] Cabinet Office; National Police Agency; Ministry of Internal Affairs and Communications; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism**

## **Section 2. Basic Adaptation Measures for Storm Surges and High Waves**







### **【Impacts】**




Regarding sea-level rise, there is a high possibility that, compared to the average for the years 1986 to 2005, the increase in global mean sea level from 2081 to 2100 will be in the range of 0.26 to 0.55 m under the RCP2.6 scenario (a long term change (2081–2100) of 0.3°C to 1.7°C (average projection 1.0°C) relative to the average for the years 1986–2005), 0.32 to 0.63 m under the RCP4.5 scenario (a long term change (2081–2100) of 1.1°C to 2.6°C (average projection 1.8°C) relative to the average for the years 1986–2005), 0.33 to 0.63 m under the RCP6.0 scenario (a long term change (2081–2100) of 1.4°C to 3.1°C (average projection 2.2°C) relative to the average for the years 1986–2005), and 0.45 to 0.82 m under the RCP8.5 scenario (a long term change (2081–2100) of 2.6°C to 4.8°C (average projection 3.7°C) relative to the average for the years 1986–2005), and these increases are inevitable even if greenhouse gas emissions are suppressed.

Regarding storm surges, the possibility is extremely high that sea levels will rise due to climate change and the risk of storm surges will increase. Regarding high waves, under the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)), there are projections of the possibility of increase in risk of high waves in coastal areas of the Pacific Ocean due to increases in typhoon strength, and damage to breakwaters in harbors and fishing ports due to increase in wave height and storm surge anomalies.

In coastal areas (ports and harbors), there are concerns about greater inundation damage from storm surges and other events, and sea-level-rise-induced declines in port waterfront industries and logistics (including decreases in cargo handling efficiency), due to factors such as increases in storm surge anomalies and stronger waves as a result of climate change-induced increases in typhoon strength, as well as a medium- and long-term sea-level rise.

In coastal areas (coastlines), concerns already have arisen about an increase in coastal erosion and damage on the land-side of levees due to inundation from storm surges and other events, considering increases in typhoon activity already occurring, and there are concerns about more severe impacts due to factors such as increases in storm surge anomalies and stronger waves as a result of climate change-induced increases in typhoon strength, as well as a medium- and long-term sea-level rise

- **Sea-level rise** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]
- **Storm surges and high waves** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

- **Coastal erosion** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence:  ]

## **【Basic Measures】**

### **1) Harbors and Fishing Ports**

#### **(Basic Approach to Adaptation Measures)**

Based on a report entitled “Appropriate State of Port and Harbor Policies and Measures for Climate Change due to Global Warming” (Submission from the Transportation Policy Council, March 2009, in Japanese) and taking into account socioeconomic activities and land uses in areas on both water-side areas and the land side, endeavor to limit the extent of risks on water-side and land-side areas from storm surges and other events, and to maintain port and harbor activities, by strategically and adaptively promoting the optimal combinations of the following types of structural and non-structural measures. Also, incorporate climate change adaptation into various types of programs and plans, and promote the implementation of adaptation measures effectively, through coordination with a variety of other policies and efforts (mainstreaming of adaptation measures).

#### **(Common Items for Ports and Harbors: e.g., Monitoring, Impact Assessments, Information Provision)**

Implement weather and marine monitoring, regularly assess the impacts of climate change by conducting simulations of projections for inundation due to storm surges and high waves, and provide the information to the related institutions. Use hazard maps and other means to notify port and harbor users and other about increases in disaster risks due to increases in storm surge anomalies and stronger waves as a result of increases in typhoon strength, as well as sea-level rise; and assess the impacts of decreased cargo handling efficiency associated with sea-level rise. Formulate plans relating to evacuation for businesses and other entities on water-side areas and residents on the land side, and promote actions, including the implementation of trainings. In addition, on water-side areas, make an effort to coordinate evacuations and operational rules for land locks (formulated by coastal management authorities), to support smooth evacuation actions by users and other.

#### **(Adaptation Measures for Impacts on Outlying Facilities such as Breakwaters and Other Structures, and on Port and Harbor Functions)**

If reviews of natural hazards are required as a result of monitoring results and other information, by reviewing designs in response, maintain the important functions of facilities including moorings and breakwaters. Promote actions including improvements to make structures more robust, so that they can perform well for disaster reduction even in the event of natural hazards that exceed the scale of design parameters, in cases where there are concerns about significant impacts on human life, property, or socioeconomic activities resulting from damage to structures such as breakwaters and dikes. Where there are concerns about the possible infilling of navigation channels and anchorages due to the impacts of climate change, implement measures to prevent infilling, including the construction of groins. In collaboration with the stakeholders, formulate port and harbor business continuity plans (BCPs), in order

to maintain the important functions of ports and harbors even after the occurrence of a disaster, and aim to enhance the BCPs through reviews, as appropriate.

**(Adaptation Measures for Impacts on the Water-Side Areas: E.g., Wharfs, Cargo Handling Areas, Industrial Lands)**

Ascertain and assess the performance of coastal protection facilities and port and harbor facilities, and organize information so that it can contribute to actions that include consideration of high-risk locations. Consider optimal approaches to upgrades and other actions, so that adaptation can be conducted progressively, without requiring large additional costs in response to gradual increases in natural hazards as a result of climate change. Share information with related areas about observed tide levels and waves, to contribute to evacuation decisions. Consider providing detailed information relating to disaster risk, in order to encourage actions such as investments by businesses and other bodies for self-protection and disaster prevention. If land reclamation by landfill is being done where the future rise in sea levels is acknowledged to be significant, while considering the compatibility with factors such as the use of the water level of seawalls and the path of goods, endeavor to ensure that ground surface levels will be sufficient to minimize the risk of inundation, giving prior consideration to increases in storm surge anomalies and stronger waves as a result of increases in typhoon intensity. Promote efforts such as measures to prevent runaway cranes, in anticipation of changes in wind conditions due to climate change.

**(Adaptation Measures for Impacts on the Land Side (Land-side Areas))**

Ascertain and assess the performance of coastal protection facilities and port and harbor facilities, and organize information so that it can contribute to actions that include consideration of high-risk locations. Consider optimal approaches to upgrades and other actions, so that adaptation can be conducted progressively without requiring large additional costs in response to gradual increases in natural hazards as a result of climate change. Consider how to achieve the use of privately-owned facilities (e.g., parapet walls, sheds, warehouses, and green spaces) for evacuation and as facilities to prevent or reduce the incursion of seawater. In the medium- and long-term, reconstruct the protection lines in coastal areas by taking advantage of opportunities such as chances to reallocate land uses, and promote a shift toward land uses with lower disaster risk from storm surges and other events.

**(Adaptation Measures for Impacts on the Clearance Under Bridges)**

If the future rise in sea levels is acknowledged to be significant, properly ascertain the degree of sea-level rise, indicate traffic ban areas and times, endeavor to prevent vessels from colliding with structures including bridges and water gates, and endeavor to relocate port and harbor functions (for example, by placing mooring facilities on the seaward side of bridges where there are concerns about clearance).

**2) Coastlines**

**(Basic Approach to Adaptation Measures)**

Endeavor to limit any increases in disaster risk from storm surges and other events and conserve land along coastlines, by accurately identifying signs of impacts from climate change through marine

monitoring, considering the medium- and long-term trends in socioeconomic activities and land uses on the land side, and strategically and flexibly promoting the optimal combination of the following structural and non-structural measures.

**(Disaster Risk Assessments, and Measures in Response to Disaster Risks)**

In order to respond to increases in storm surge anomalies and stronger waves as a result of factors such as increases in the number of large typhoons believed to be partly induced by climate change, determine areas that have high disaster risk along a continuous bank protection line in consideration of the status of the land side uses and state of improvement of coastal protection facilities; clarify the disaster risks, and promote measures with the optimal combination of structural and non- structural measures in response to the disaster risks.

**(Responses to Natural Hazards that Exceed Levee Protection Standards)**

Promote research and studies relating to impacts on decreases in safety of coastal protection facilities if they are affected by excessive natural hazards from storm surges; promote improvements to make levees and other structures more robust, while considering factors such as the conditions in the land side; and also, develop non-material measures such as timely information transmission to support appropriate evacuation from storm surges and other events.

**(Strategic Development of Measures to Address Increasing Natural Hazards)**

If sea-level rise is acknowledged due to the impact of climate change, conduct measures in an adaptive way, including facilities improvements and upgrades, giving prior consideration to responses to future sea-level rise. Also, in response to gradual increases in natural hazards due to climate change, promote consideration of topics including technology development relating to adaptation, including having the adaptability to heighten levees by improving the foundations of structures, with prior consideration of future loads if the elevations of levees are raised.

**(Strengthening Responses to Advancing Coastal Erosion)**

Promote efforts including improvements in structures to facilitate proper sediment balance by longshore sediment transport, and as required, implement efforts addressing the transport of sediment away from shore, which could increase due to climate change. Also, promote wide-area and comprehensive measures through collaboration with the related institutions, including collaboration on integrated sediment control measures throughout the entire sediment transport system of rivers, from upstream down to the coast.

**(Coordination with Measures and Actors in Other Sectors)**

Incorporate climate change adaptation measures into various systems and plans, and promote the implementation of adaptation measures effectively through coordination with a variety of other policies and efforts (mainstreaming of adaptation measures). Specifically, endeavor to expand comprehensive, efficient, and effective measures that harmonize coastal protection from disasters, improvements and conservation of the coastal environment, and appropriate public use of coastlines, while also seeking

coordination with the relevant government sectors, private sector, and residents, who all bear responsibility for the land side along coastlines, including evacuation, land use plans, and other disaster prevention and disaster reduction measures. Also, endeavor to identify innovative examples of adaptation measures in other countries, and consider introducing the applicable measures in Japan.

### **3) Fishing Ports, Fishing Villages, Coastal Protection Forests**

Continue to systematically promote raising the elevation of fishing port facilities, including breakwaters and port handling facilities, and to improve coastal protection facilities by having more robust structures. Also, with regard to seaside protection forests, endeavor to improve the growing conditions for vegetation, taking account of disaster mitigation effects against storm surges and coastal erosion, and also to strengthen the performance of structures, including tide embankments.

### **4) Promoting Research and Technology Development**




Promote technology development on topics including levees, based on the impacts on facilities in the event of excessive natural hazards, and promote development of new technologies for measures against coastal erosion. Also, promote studies and research relating to adaptation in the coastal sector, including the development of quantitative methods to assess the disaster reduction functions of ecosystems in coastal areas.

**[Relevant Ministries] Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism**

## **Section 3. Basic Adaptation Measures for Sediment-related Disasters**

### **【Impacts】**

In recent years, sediment-related disasters have occurred frequently all over Japan, and have caused significant damage, including large-scale sediment-related disasters that occurred in Izu Oshima and Hiroshima City. There are concerns about more frequent sediment-related disasters associated with increases in the number of heavy rainfall events and their intensity in the short term; increases in sediment-related disasters involving short lead times and evacuation due to sudden and localized torrential rainfall events; and increases in deep-seated slope failure associated with record heavy rainfall from typhoons and other storms.

- **Debris flows, Landslide, and Other Disasters** [Significance:  (Soc/Ec), Urgency: , Confidence:  ]

### **【Basic Measures】**

#### **(Measures to Address Increased Frequency of Sediment-related Disasters)**

Considering the expectation that the frequency of occurrence of sediment-related disasters will increase in due to climate change, prioritize the promotion of improvements in facilities and equipment in locations that can be most effective in protecting human life, and implement improvements in evacuation sites and routes, public facilities, and facilities that protect socioeconomic activities. Also, utilize existing facilities effectively; for example, by removing debris as appropriate from sediment control dams.

Furthermore, consider the most practical plans and design methods for facilities, as well as materials used.

Also, sediment-related disasters are difficult to predict accurately, as there are complex triggers and factors associated with their occurrence, so it is important to promote both material and non-material measures in a unified way.

Based on an Amendment of the “Sediment Disasters Prevention Act,” promote the designation of sediment-related disaster hazard areas, announce the results of baseline surveys even at the stage prior to that designation, and inform residents at an early stage regarding sediment-related disaster dangers. In addition, endeavor to improve and strengthen warning and evacuation systems through actions such as the provision of support for the formulation of hazard maps and disasters prevention action plans, and promote the development of human resources that are knowledgeable about sediment-related disasters, through awareness-raising targeting audiences including residents and local government personnel.

**(Measures for Sediment-related Disasters with Short Warning/Evacuation Lead Times)**

Endeavor to disseminate accurate information about sediment-related disasters, through hands-on disaster prevention trainings and disaster prevention educations, in order to ensure adequate awareness about such matters as dangerous locations, refuge locations, and directions to move and to ensure that the residents can evacuate immediately. Also, consider matters such as improving Sediment Disaster Alert, and the utilization of various means of information collection and sharing, including social media.

**(Measures for Sediment Transport Events Exceeding Design Scale)**

Consider factors such as the location and design of sediment control dams and other structures so that their disaster reduction functions can be extended, even by a small amount of time. Also, through coordination of both structural and non-structural measures, consider factors such as ways more residents can be given more time for evacuation, and how evacuation sites and routes can be secured.

**(Measures for Deep-Seated Catastrophic Landslide and Other Events)**

Strengthen national land monitoring systems by the use of satellites and other equipment, and promote improvements in crisis management systems that can more quickly detect the occurrence of events such as deep-seated slope failures and natural damming of a river. Also, promote the use of new technologies, including the use of airborne electromagnetic surveys. In cases where there is concern about significant damage due to natural damming of a river and other events, endeavor to accelerate responses and improve the quality of response, through measures such as urgent surveys, and the provision of information about these results to municipalities based on their results; implementation of hands-on trainings in collaboration with the related institutions; and the use of unmanned aerial vehicles (UAV).

**(Measures for Sediment-related Disasters in Places that Do Not Clearly Exhibit Valley Topography)**

In order to identify locations that require priority measures, consider methods to assess risk levels, and consider the optimal designs of structures for those locations.

**(Debris Flows that Cross Watershed Boundaries)**

Properly estimate the volume and extent of debris flows that cross over watershed boundaries, and



consider the use of structural and non- structural measures as a result of the estimates.

#### **(Measures for Disasters from Woody Debris)**

Consider the use of slit dams with good log capture capabilities, the installation of log booms, and the upgrading of existing dams to slit dams if they currently do not have flow-through features.

#### **(Headwaters Management)**

Endeavor to strengthen national land monitoring systems by routinely accumulating detailed topographical and other data obtained through satellite and aerial laser surveys. In addition, from the perspective of national land management, promote rural erosion control projects and green belt projects on hillsides near urban areas in order to prevent land degradation in upstream areas.

#### **(Land Use and Housing with Consideration of Disaster Risk)**

Encourage safer land use by promoting the designation of sediment-related disaster hazard areas and publishing basic survey results. In particular, promote efforts to ensure the safety of facilities used by people who require special assistance, and disaster prevention centers.

Also, in areas with particularly high disaster risk, promote structural design standards based on designation of special sediment-related disaster hazard areas, make regulations to discourage activities such as housing development, and resettle housing from those areas to safe areas, through the use of programs to resettle at-risk housing away from areas adjacent to steep slopes.

#### **(Promote Studies and Research)**

Regarding sediment-related disasters, promote research relating to ways to notify the affected municipalities and residents more accurately about disaster prevention information, combined with information about the urgency of disaster risk, and information including the occurrence of disaster events, rainfall conditions, and sediment-related disaster hazard areas.

Regarding avalanche disasters, continue monitoring parameters such as snowfall and snow cover, because there have been cases of an extremely rapid increase in heavy snowfall in recent years in regions that usually do not have much snow, in addition to changes in both the amount and quality of snowfall, associated with climate change; also, promote more research relating to disaster-related impacts of heavy snowfall and avalanches.

#### **[Relevant Ministries] Ministry of Land, Infrastructure, Transport and Tourism**

### **Section 4. Basic Adaptation Measures for Other Impacts (e.g., Strong Winds)**

#### **【Impacts】**

Regarding increases in damage by increases of strong winds and strong typhoons accompanying climate change, at present, no concrete examples have been confirmed.

A study using the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)) projects increases in strong winds and strong typhoons due to climate change, starting in the near future (2015–2039). Projections for the end of the

21st century in Japan nationwide (2075–2099) using the same A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)) are for a higher frequency of occurrence of conditions for the occurrence of tornadoes mainly from March to May.

- **Strong winds and other** [Significance:  (Soc/Ec/Env), Urgency:  , Confidence:  ]

### **【Basic Measures】**

As indicated above, as increases are expected in strong winds and strong typhoons due to climate change, starting in the near future (2015–2039), in response to stronger typhoons associated with climate change, continue to promote the introduction of low-cost weather-resistant houses that are disaster resistant; and in response to tornadoes, promote the use of information to provide notification when weather conditions are prone to produce violent gusts and tornadoes, and promote actions to ensure personal safety in cases where signs of approaching cumulonimbus clouds have been observed. Also, promote studies and research relating to impacts of climate change including impacts on strong winds, as well as adaptation measures, and endeavor to collect scientific findings.

**[Relevant Ministries] Cabinet Office; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism, Ministry of the Environment**

## **Chapter 5. Human Health**

### **Section 1. Basic Adaptation Measures for Heat Stress**

#### **【Impacts】**

In terms of the current status, regarding mortality risk, it has been confirmed globally that excess mortality (an indicator showing the extent to which total mortality from a given illness has increased, whether directly or indirectly) is already occurring due to an increase in temperature. Regarding increases in heat illness, increases in the number of heat illness patients transported by ambulance have been reported nationwide, although it cannot be stated with certainty that all of the increases are an impact of climate change. Only a limited number of reports has been published in Japan relating to health impacts that do not lead to mortality or morbidity, such as impacts on labor efficiency.

In terms of the projected impacts, relating to mortality risk, the frequency of summer heat waves is projected to increase in Tokyo and several other Asian cities, and it is also projected that heat stress related to mortality and morbidity may also increase. The mortality risk from heat stress is projected to increase in Japan by the mid-21st century (2050s) to about 1.8–2.2 times the level in 1981 to 2000, and to about 2.1–3.7 times by the end of the century (2090s), respectively, under the 450s scenario and BaU scenario (with average temperature increases in 2100 relative to pre-industrial levels of about 3.8°C and about 2.1°C). Regarding heat illness, a projection using the RCP8.5 scenario (a long term change (2081–2100) of 2.6°C to 4.8°C (average projection 3.7°C) from the average for the years 1986 to 2005 ) projected more than a doubling of heat illness patients transported by ambulance in the majority of prefectures (with the exception of Shikoku) by the middle of the 21st century, and by the end of the 21st

century, with the exception of a projection using RCP2.6 scenario (a long term change (2081–2100) of 0.3°C to 1.7°C (average projection 1.0°C) from the average for the years 1986 to 2005), more than a doubling in almost all prefectures.

- **Risk of Mortality** [Significance: ● (Soc), Urgency: ● Confidence: ● ]
- **Heat Illness** [Significance: ● (Soc), Urgency: ● Confidence: ● ]

### **【Basic Measures】**

Regarding the correlation between climate change-induced temperature increases and mortality risk, continue efforts to collect scientific findings.

Based on climate change-induced impacts on heat illness, under the Inter-Minister Meeting for Heat Illness and through collaboration among the relevant government ministries and agencies, provide meteorological information, implement actions including appropriate information provision relating to topics such as cautionary alerts, awareness raising regarding prevention and treatment, and status of outbreaks of heat illness, in various situations including emergency response, education, health care, labor, agriculture, forestry and fisheries industries, and everyday life. More specifically, continue conducting studies and announcing the number of heat illness patients transported by ambulance, as well awareness raising for the purpose of prevention. As for measures against heat illness at schools, continue reaching out to bodies such as boards of education to bring attention to prevention of heat illness incidents. As for the work of the agriculture, forestry and fisheries industries, since labor is performed in some cases under severe working conditions including strong sunlight and steep slopes, make efforts to reduce the exertion level of the work, by upgrading equipment performance, and actively introducing robotic technologies and information and communication technologies (ICT). Continue promoting measures to address heat illness in the workplace, including the manufacturing and construction industries.

**[Relevant Ministries] Ministry of Internal Affairs and Communications; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Health, Labour and Welfare; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**





## **Section 2. Basic Adaptation Measures for Infection**

### **【Impacts】**

It has been confirmed that the habitat of mosquitoes (*Aedes (Stegomyia) albopictus*) that are vectors of infectious diseases such as dengue fever have expanded to rural northern parts of the Tohoku region. Climate change-induced increases in temperature and changes in the spatial and temporal distribution of precipitation may change the suitable habitat for arthropods that are vectors for infectious diseases, and increase the risk of vector-borne diseases; however, the expansion of possible distribution does not necessarily lead immediately to more occurrences of disease.

Regarding other diseases (including water- and food-borne diseases), the potential exists for changes in

risk of occurrence accompanying an increase in temperature, but examples are limited.

- **Vector-borne diseases** [Significance:  (Soc), Urgency:  Confidence:  ]
- **Water- and food-borne diseases** [Significance: — , Urgency: — Confidence:  ]
- **Other infectious diseases** [Significance: — , Urgency: — Confidence: — ]

### **【Basic Measures】**

Regarding the correlation between infectious diseases and climate change, because there are only a limited number of examples and many factors involve uncertainty, make an effort to collect scientific findings about aspects such as the correlation between an increase in temperature and changes in the risk of occurrence of infectious diseases.

Also, in order to continue preventing the occurrence and limiting the spread of mosquito-borne infectious diseases, based on the Special Guidance on Mosquito-borne Diseases (April 28, 2015), prefectural governments and other bodies are to strive to implement measures including ongoing fixed-point observation in areas where mosquito vectors of infectious diseases occur, measures targeting sources of larvae, extermination of adult insects, and calling attention to mosquito-prevention measures; also, they are to make efforts to understand trends in the occurrence of infectious diseases.

**[Relevant Ministries] Ministry of Health, Labour and Welfare; Ministry of the Environment**

## **Section 3. Basic Adaptation Measures for Other Human Health Impacts**

### **【Impacts】**

In terms of the current status, regarding the combined impacts of increases in temperature and air pollution, there have been reports of changes in the concentrations of various pollutants, including particulates, due to factors such as reactions leading to their formation being promoted by an increase in temperature. Regarding impacts on vulnerable populations, the elderly are frequently referred to as a population vulnerable to heat stress, and there have been reports in the United States about impacts on young children and fetuses (expectant mothers), but in Japan, information on these aspects is not available. There are only limited reports from Japan relating to health impacts without leading to clinical symptoms. Regarding diarrhea outbreaks that may occur if water becomes contaminated in closed water bodies and rivers downstream, in the event of overflow of combined sewer systems due to localized torrential rainfall, there have been reports from the United States, which has rainwater treatment approaches similar to those in Japan, but there is no specific report in Japan.

In terms of the projected impacts, regarding the combined impacts of an increase in temperature and air pollution, it is expected that damage to health will increase with higher oxidant concentrations due to an increase in temperature in urban areas, but these impacts are greatly affected by future air pollution levels, and it is not easy to make projections. Regarding diarrhea outbreaks that may occur if water becomes contaminated in closed water bodies and rivers downstream, in the event of overflow of combined sewer

systems due to localized torrential rainfall, the outbreaks are expected to be increase, but there is a lack of epidemiological data.

- **Others**

- ◆ **Combined impacts (warming and air pollution)** [Significance: —, Urgency:  Confidence: 

- ◆ **Impacts on vulnerable populations** [Significance: —, Urgency:  Confidence: 

- ◆ **Health impacts without leading to clinical symptom** [Significance: —, Urgency: , Confidence: 

### **【Basic Measures】**

Based on the above impact assessments, with regard to the risk that diarrhea outbreaks will occur if water becomes contaminated in closed water bodies and rivers downstream in the event of overflows of combined sewer systems due to the combined impacts of increases in temperature and air pollution as well as localized torrential rainfall, continue promoting water quality improvement measures such as air pollution prevention and measures to upgrade combined sewer systems, and make active efforts to collect scientific findings. Regarding impacts on vulnerable populations and health impacts without leading to clinical symptoms, make active efforts to collect scientific findings, as current findings are insufficient relating to the impacts of climate change.

**[Relevant Ministries] Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

## **Chapter 6. Industrial and Economic Activity**

### **Section 1. Basic Adaptation Measures for Industrial and Economic Activity**

#### **【Impacts】**








For the manufacturing sector, some examples suggest that an increase in mean temperature has impacts on production and sales processes of businesses and on-site selection for production facilities. Some examples also suggest that possible long-term sea-level rise and an increase in the frequency and intensity of extreme events could cause direct physical damage to production facilities. Meanwhile, some examples suggest that climate change could lead to the creation of new business opportunities.

Regarding energy demand and supply, due to the limited number of examples, it cannot be inferred that there is consensus regarding damage and impacts on the energy infrastructure due to an increase in the frequency and intensity of extreme events or long-term sea-level rise.

Regarding the commercial sector, very few examples evaluate future impacts of climate change on this sector, so impacts on this sector currently cannot be assessed.

The construction industry is also expected to be affected by factors such as damage to infrastructure due to climate change-induced impacts including an increase in the frequency and intensity of extreme weather events, an increase in temperature, flood and storm surge. Meanwhile, confirmed examples are limited regarding impacts on the construction industry, so impacts on this sector currently cannot be assessed.

As for the medical industry, impacts are expected from climate change-induced increases in temperature, increases in disaster risk, and increases in drought. Meanwhile, no concrete examples regarding impacts on the medical industry have been confirmed, so impacts on this sector currently cannot be assessed.

- **Manufacture** [Significance:  , Urgency:  , Confidence :  ]
- **Energy demand and supply** [Significance:  , Urgency:  , Confidence :  ]
- **Commerce** [Significance: — , Urgency: — , Confidence :  ]
- **Construction** [Significance: — , Urgency: — , Confidence : — ]
- **Medical** [Significance: — , Urgency: — , Confidence : — ]

### **【Basic Measures】**

As there are currently few examples regarding the impacts of climate change on industries such as manufacture, energy demand and supply, commerce, and medical, strive to collect scientific findings. Also, based on the findings obtained, through provision of information relating to climate change impacts, promote adaptation efforts by businesses between the public and private sectors, as well as the development of adaptation technologies.

### **(Adaptation Measures for Distribution)**

Raise awareness about Business Continuity Plan (BCP) Guidelines formulated in FY 2014 through collaboration between shippers and the distribution/logistics industries, in order to promote the development of BCPs. Also, in order to facilitate the storage of relief supplies during times of disaster, promote the conclusion of “Relief Supplies Storage Agreements” between the stakeholders including local governments and storage businesses, and expand and review lists of private sector distribution and logistics centers. In addition, from the perspective of promoting rail freight transport, develop measures in collaboration with the stakeholders to deal with the occurrence of damage to cargo transport as a result of disasters such as typhoons, avalanches, and sediment-related disasters.

**[Relevant Ministries] Ministry of Health, Labour and Welfare; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

## **Section 2. Basic Adaptation Measures for Finance and Insurance**

### **【Impacts】**

Based on trends in natural disasters and associated insured losses over approximately thirty years since 1980, insured losses have increased significantly and it has been confirmed that the likelihood that losses will regularly occur has been increasing. For insurance companies, there are reports that it has become difficult to project the future trends using traditional risk quantification methods alone, and that

development of new methods of risk hedging and diversification that consider the future impacts of climate change will be necessary.

Projections have indicated increases in insured losses associated with a growing number of natural disasters, increases in insurance payments and reinsurance premiums. However, at present, examples of research are limited in Japan.

- **Finance, insurance** [Significance:  (Ec), Urgency:  , Confidence :  ]

### **【Basic Measures】**

Regarding efforts to address natural disasters, the Seventh Mid-Term Business Plan (FY 2015–2017) of the General Insurance Association of Japan states “Promote efforts to maintain and improve the soundness of the insurance industry by upgrading risk management for natural disasters.” Continue to pay attention to initiatives to improve risk management among insurance companies, and efforts of the General Insurance Association of Japan.

Also, continue making efforts to collect scientific findings relating to the impacts of climate change.




**[Relevant Ministries] Financial Services Agency; Ministry of the Environment**

## **Section 3. Basic Adaptation Measures for Tourism**

### **【Impacts】**

The tourism industry could also be affected by climate changes impacts, including impacts on travelers due to wind and flood damage. In addition, leisure industries that utilize natural resources (e.g., forests, snowy mountains, sandy beaches, and tidal flats) may be subject to impacts from an increase in temperature, changes in the amount of rainfall and snowfall, changes in the spatial and temporal distribution of precipitation, and sea-level rise. However, at present, confirmed examples are limited. Reports have been confirmed about a reduction in snow depth at ski resorts due to an increase in temperature.

A study using the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)) projected that in about 2050, the tourism climate index will be reduced in summer due to an increase in temperature, and an increase in spring and autumn to winter. A study using the A2B scenario (a long term change (2090–2099) of 2.0°C to 5.4°C relative to the average of the years 1980–1999 (best estimate 3.4°C)) projected that snowfall and maximum snow depth in 2031 to 2050 will be reduced (with the exception of some areas inland in Hokkaido and Honshu), and that almost all ski resorts will see a reduction in snow depth. A loss of sandy beaches is expected to occur due to sea-level rise, with impacts on leisure industries in coastal areas.

- **Tourism** [Significance:  (Ec), Urgency:  , Confidence :  ]

### **【Basic Measures】**

Recognizing the above climate change impacts, in order to ensure the safety of travelers, including foreign nationals, promote the establishment of multilingual relief centers for times of disaster, in collaboration with stakeholders including regional tourism associations and international exchange organizations; promote the preparation of disaster evacuation support plans for tourism and accommodation facilities; and provide disaster information, alerts, damage information, evacuation approaches, and other information using tools such as mobile phone apps, and Internet portal sites. In addition, recognizing the need to promote the signing of agreements regarding the utilization of accommodation facilities as evacuation centers during times of disaster, reach out to disaster risk reduction departments of local governments, in cooperation with the relevant government ministries and agencies. In addition, in order to prevent damage to the brand or reputation of regions not directly affected by a disaster, seek to minimize the socioeconomic damage to regions near the disaster affected region by means such as the provision of accurate information on the disaster status, and transportation via channels such as websites, overseas travel fairs, and travel promotion assistance programs to attract incoming travelers.

For tourist industries such as skiing and coastal leisure industries, because of the importance of taking regional characteristics into account when considering adaptation measures, promote actions including the development of adaptation measures by local governments.

**[Relevant Ministries] Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

#### **Section 4. Basic Adaptation Measures for Other Impacts (e.g., Overseas Impact)**

##### **【Impacts】**

Based on examination cases conducted in the U.K., there are concerns in Japan as well about changes in import prices of energy; direct and physical impacts on manufacturing plants operating overseas; and impacts of the spread of infectious diseases via migrants and incoming travel, associated with an increase of disease carriers overseas.

The IPCC Fifth Assessment Report indicates that it is very likely that sea-ice area in the Arctic region will continue to shrink, and during the 21st century, the global mean temperature will continue to increase and sea ice will also continue to become thinner.

As for other impacts (including overseas impacts), regarding what impacts might be experienced within Japan due to impacts from overseas, these center on secondary impacts, would include social sciences, and involve complex factors; at present no concrete examples covering these topics have been confirmed.

- **Other Impacts (e.g., Overseas impact)** [Significance: — , Urgency: — , Confidence :  ]

##### **【Basic Measures】**

Regarding other impacts (including overseas impacts), as the degree of confidence about the impacts of climate change has been assessed as low, make an effort to collect scientific findings.



### **(Utilizing Arctic Sea Route)**

Due to the expected reduction of sea-ice area in the Arctic Ocean as a result of climate change, the potential to utilize Arctic Sea Route is attracting international attention. Therefore, promote environmental improvements toward utilization of the Arctic Sea Route by stakeholders including shipping companies, and based on the framework of the China-Japan-Korea Ministerial Conference on Transport and Logistics, strive for mutual cooperation through information exchange relating to Arctic Sea Route.

**[Relevant Ministries] Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

## **Chapter 7. Life of Citizenry, Urban Life**

### **Section 1. Basic Adaptation Measures for Urban Infrastructure, Critical Services**

#### **Water Supply, Transportation, and Other**

##### **【Impacts】**

Impacts have been confirmed in many places in recent years, including underground inundation, power outages and impacts on subway systems due to record torrential rainfall; impacts on water supply infrastructure due to drought, flood, and water quality deterioration; and impacts on cut slopes due to heavy rainfall and typhoons. However, it is difficult to clearly determine whether or not these incidents were impacts of climate change.

There are concerns about impacts on infrastructure and critical services if climate change results in events such as an increase in short-term intense rainfall events and droughts, and an increase in strong typhoons.

- **Water supply, transportation, and other** [Significance: ● (Soc/Ec), Urgency: ●, Confidence: □]

##### **【Basic Measures】**

#### **(Adaptation Measures for Distribution/Logistics)**

Raise awareness about Business Continuity Plan (BCP) Guidelines formulated in FY 2014, in order to promote the development of BCPs through collaboration between shippers and the distribution/logistics industries. Also, in order to facilitate the storage of relief supplies during times of disaster, promote the conclusion of “Relief Supplies Storage Agreements” between stakeholders including local governments and storage businesses, and expand and review lists of private sector distribution/logistics centers. In addition, to promote freight transport by rail, develop measures in collaboration with stakeholders to deal with incidents of damage to cargo transport from disasters such as typhoons, avalanches, and sediment-related disasters.

#### **(Adaptation Measures for Rail Transport)**

Based on information including hazard maps, in underground stations and other places where inundation damage can be anticipated, promote measures against inundation such as entrances, exits and

tunnels; in addition, promote measures against rock fall and avalanches, as well as conservation of coastlines and other areas, in order to prevent impacts such as coastal erosion due to increases in risks of storm surges and high waves, including sediment-related disasters due to more severe heavy rainfall disasters affecting rail facilities.

#### **(Adaptation Measures for Ports and Harbors)**

To ensure the functioning of marine transportation, which sustains Japan's economy and citizens' livelihoods, as measures against impacts such as inundation damage and reductions in cargo handling efficiency associated with sea-level rise, maintain essential functions such as mooring facilities, breakwaters, and tide embankments. In addition, promote efforts such as measures to prevent runaway cranes, in preparation for changes in wind conditions due to climate change. In order to maintain port cargo handling capacity in times of disaster and to minimize the impacts on the supporting industries, endeavor to maintain the essential functions of facilities, endeavor to provide risk information to businesses and other stakeholders, and work to formulate business continuity plans (BCPs) for ports and harbors.

#### **(Adaptation Measures for Airports)**

Regarding airports in coastal areas, from the perspective of protecting human life, prepare hazard maps based on inundation scenarios associated with events such as storm surges, consider systems to provide disaster risk information, and endeavor to make them fully known to airport users and other stakeholders. Also, consider and endeavor to reconfigure airport snow removal systems in consideration of factors such as changes in snow quality in recent decades.

#### **(Adaptation Measures for Roads)**

Develop safe and reliable road networks and remove utility poles along routes, so that the road networks can serve as emergency transportation routes for quick movement of police, fire and the Self Defense Forces. Improve disaster risk reduction capabilities of "Michi-no-Eki" resting areas.

In a time of disaster, quickly comprehend the situation of damage, reopen damaged roads and provide quick recovery treatment to support lifesaving activities and emergency transportation. Also, in the event of road restrictions or other controls, provide information in a timely way by using information and communication technologies (ICT).

#### **(Adaptation Measures for Water Supply Infrastructure)**

Considering concerns about climate change impacts on the water supply infrastructure, secure backup systems including water system interconnections; promote equipment and facilities upgrades to be resistant to natural disasters, including through upgrading of aging pipes with earthquake-resistant water pipes that are also able to withstand natural disasters such as water disasters; also, improve systems to be able to take timely and appropriate emergency response measures and conduct repairs in the event of a reduction or halt of water supplies due to reasons such as damage to facilities.

#### **(Adaptation Measures for Waste Disposal Facilities)**

Considering concerns that climate change may have impacts on waste disposal facilities, which are part of the social infrastructure, from the perspective of enhancing the resilience of regional waste treatment systems as the preparedness during peacetime, promote improvements by municipalities and other stakeholders to make waste disposal facilities more resistant to flood disasters and other natural disasters, and promote the development of coordination and support systems among the local governments and the related institutions.

#### **(Adaptation Measures for Traffic Safety Facilities)**

In order to secure safe and smooth traffic in times of disaster, promote improvements of traffic safety facilities including traffic control centers, traffic monitoring cameras, vehicle detectors and traffic information boards, and implement traffic controls including road closures quickly and effectively. Also, promote preparation of traffic lights with additional power supply devices which prevent outages of traffic lights due to a power failure when a disaster occurs.

#### **(Studies and Research)**

Regarding impacts of climate change on infrastructure and critical services, as there are few examples of specific assessments and the level of confidence is low, promote research and endeavor to collect scientific findings.

**[Relevant Ministries] National Police Agency; Ministry of Health, Labour and Welfare; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

## **Section 2. Basic Adaptation Measures for Life with Sense of Culture and History**



### **Phenology, Traditional Events / Local Industry**

#### **【Impacts】**

Reports have been confirmed regarding phenological changes for flora and fauna that people commonly experience, including cherry blossoms, the Japanese maple, and cicadas. However, regarding the impacts of these changes on citizens' sense of the seasons and on local traditional events and tourism, no concrete examples have been confirmed at present.

For flowering dates and the duration of full blooming of cherry blossoms, the A1B scenario (a long term change (2090–2099) of 1.7°C to 4.4°C relative to the average of the years 1980–1999 (best estimate 2.8°C)) and A2 scenario (a long term change (2090–2099) of 2.0°C to 5.4°C relative to the average of the years 1980–1999 (best estimate 3.4°C)) indicate a trend for earlier flowering dates in the future in northern Japan, but later dates in southwestern Japan. Also, by the middle and end of the 21st century, they indicate a shortening of the duration from flowering until full bloom, due to an increase in temperature. Associated with that, impacts are projected for a reduction in the number of days for flower blossom viewing, and then for regions that treat cherry blossoms as a touristic resource.

• **Phenology** [Significance:  , Urgency:  , Confidence:  ]

- **Traditional events, local industry** [Significance: — , Urgency:  , Confidence:  ]

### **【Basic Measures】**

As outlined above, some impacts of climate change may include impacts on phenology, traditional events, and local industries. To undertake regional adaptation, it is important to properly consider these issues. Promote the provision of related information to the regions, and the sharing of information among the stakeholders. In addition, implement phenological monitoring, including parameters such as plant flowering and autumn foliage.

Regarding impacts of climate change on traditional events and local industries, as there are few examples of specific assessments and the level of confidence has been assessed as low, promote research and endeavor to collect scientific findings.

**[Relevant Ministries] Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment**

## **Section 3. Basic Adaptation Measures for Others (Impact on Life due to Heat Stress)**

### **【Impacts】**

An increase in temperature is already noticeable in urban areas, and causing large impacts on urban living, including increases in heat illness risk and loss of comfort. There are concerns about an even greater range of an increase in temperature in urban areas in the future, due to the combination of the urban heat island effect and an increase in temperature from climate change.

Reports have been confirmed stating that the rate of temperature increase per 100 years in small and medium-sized cities was 1.4°C (for the statistical period 1931–2014), compared to 2.0°C to 3.2°C in major large cities, and that in large cities the effects of an increase in temperature due to climate change are combining with the heat island effect.

- **Impact on life due to heat stress** [Significance:  (Soc/Ec), Urgency:  , Confidence:  ]

### **【Basic Measures】**

#### **(Basic Approach to Adaptation Measures)**

In order to mitigate the heat island effect, promote continuation of feasible measures, and also implement measures that quickly produce results. In addition, recognizing that long term actions are needed to mitigate the heat island effect, monitor its actual conditions, and conduct technical studies and research for measures against the heat island effect.

#### **(Improving Ground Cover Using Vegetation and Water)**

Endeavor to improve ground cover, in order to avoid high temperature on the ground surface due to reductions in green space and water surfaces (which have an effect of suppressing an increase in temperature) and due to the ground surface being covered with structures and pavement.

Specifically, promote the use of tools such as green space policies that require greenery to cover at

least a certain ratio of total area in the case of new construction or expansion of buildings on large sites, and promote greening through subsidies and other programs relating to housing and building improvements; also, promote greening in places such as private lands, buildings and structures by using tools such as comprehensive building design systems that provide for increased floor-area ratio (or floor space ratio) for large buildings that have a certain ratio of open space. In addition, promote improvements of urban parks, and greening of public spaces such as roadways and wastewater treatment plants, as well as government building grounds, and promote greening on rooftops when rental housing operated by Urban Renaissance Agency is being rebuilt. In addition, urban farmland is an important component of green space in cities, and since it plays a role in land and environmental conservation, including its role in mitigating the heat island effect, promote the conservation of urban farmland in urban areas and surrounding regions.

Endeavor to expand water surface area by supporting efforts such as efforts of local governments to expand the use of water from wastewater treatment such as for small streams and for maintaining river flows, as well as promoting the installation of rainwater storage and ground permeation facilities.

In addition, evaluate the effectiveness of road surfacing technologies that keep surface temperature from rising, and endeavor to further develop details of comprehensive packages of steps for preventing temperature rise on roads, including road greening, to provide a comfortable environment.

#### **(Reducing Artificial Exhaust Heat from Human Activities)**

Promote greater energy efficiency of housing and buildings, based on the Act on Improvement of Energy Consumption Performance of Buildings; promote the diffusion and greater use automobiles with superior environmental performance, to contribute to the reduction of waste heat from automobiles; promote the use of public transportation, including modes such as urban rail, urban monorail, new transportation systems, and trolleys; and work to improve the efficiency of energy-consuming equipment. Also, promote traffic flow measures that make smart use of road networks, in order to make roads more comfortable for driving, without road congestion. Promote a modal shift for cargo, from truck transport to rail and coastal shipping, and endeavor to boost the efficiency of truck transport through means such as consolidated collection and delivery. In addition, promote the effective use of heat from wastewater, by means such as providing support for project formulation for wastewater heat utilization, promoted under public-private liaison councils.

#### **(Improving Urban Design (Including Creation of Wind Paths from Green Spaces and Water Surfaces))**

By promoting use of the “Urban Design Guidelines to Mitigate the Heat Island Effect” (in Japanese), which indicate factors to consider in order to utilize wind paths flowing over urban areas, promote urban planning—adapted to the respective scale of region, city, district—that incorporates appropriate measures, including improvements of urban design and ground cover, and reductions in artificial waste heat.

Also, promote the creation of networks of water and green space in urban areas by promoting efforts based on the “Grand Design for Urban Environmental Infrastructure in the National Capital Region” and

“Grand Design for Urban Environmental Infrastructure in the Kinki Metropolitan Region” (both in Japanese), conserving green space through programs such as the “Special Green Space Conservation Zone Program,” improving green belts on urban slopes, and improving streams through the reuse of rainwater and treated wastewater.

**(Lifestyle Improvements)**

Regarding improvements in lifestyle, promote efforts geared toward improving lifestyles from the perspective of aiming to limit the generation of urban heat (for example, implementing citizen activities to spray water onto streets for the cooling effect; promoting the popularity of “green curtains” of living plants; promoting the installation of energy-efficient products; and promoting the practice of wearing lighter clothing in summer); and endeavor to make automobile use more efficient (through promotion of eco-drive).

**(Strengthening Observation/Monitoring Systems and Promoting Research)**

Conduct observation and monitoring of the heat island effect, analyze the driving factors, publish the findings through “Heat Island Monitoring Reports” and other channels, and endeavor to improve the information. Promote the development and diffusion of the Comprehensive Assessment System for Built Environment Efficiency (CASBEE), and conduct research and studies on technologies relating to urban planning, in order to effectively deal with the heat island effect. Also, because monitoring and changes over time of ground cover and the status of land use are important for assessing the spread of urbanization and to assess the heat island effect, detailed land cover maps are being produced and published with a spatial resolution of 30 m, using data from “Daichi” Earth observation satellites. In the future, promote further improvements in land cover classification maps through means such as upgrading the algorithms used.

**(Promoting Adaptation Measures to Mitigate the Impacts on Human Health)**

In order to help reduce heat stress by escaping from heat, calculate current and projected WBGT (Wet Bulb Globe Temperature) heat indexes nationwide, based on meteorological data, and publish the information on websites, with other heat illness prevention information.

**[Relevant Ministries] National Police Agency; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

## **Part 3. Basic and International Measures**

This part covers the measures that form the foundations of basic measures in each sector indicated in **Part 2**, as well as international measures based on basic strategies for **Part 1, Chapter2, Section3(5)** “Promotion of International Cooperation and Contribution.”

### **Chapter 1. Basic Measures regarding Observation, Monitoring, Studies and Research**

#### **(Observation and Monitoring)**

At the alliance for global warming sectors established based on the “Earth Observation Promotion Strategy” (Comment Submission, Council for Science and Technology, 2004), collaborate with the relevant government ministries and agencies to achieve objectives such as gathering comprehensive data, realizing long-term continuous observation, and improving data usability.

Ascertain the status of atmospheric and ocean environmental change by means including land-, ship-, aircraft-, and satellite-based observation; provide long-term observation information relating to climate change (including greenhouse gases); and provide detailed information relating to phenomena such as increases in frequency of heavy rainfall events and increases in ocean acidification. Also, continue observing tide levels using tide gauges nationwide, and publish literature from the Coastal Movements Data Center (CMDC) that can help research in Earth sciences, including changes in sea level.

GEONET (GNSS Earth Observation Network System), a nationwide GNSS (Global Navigation Satellite System) observation network, is utilized for crustal deformation and sea level change monitoring. In addition, the “Daichi-2” Earth observation satellite is used for ground surface deformation monitoring, which provides information to relevant organizations.

In order to enhance observation technologies, develop satellite-based sensors that measure the global distribution of greenhouse gases and atmospheric pollutants, and strengthen the observation of oceans and polar regions. Especially for the Arctic, based on Japan’s Arctic Policy (decided by the Headquarter of Ocean Policy, October 16, 2015), promote efforts including research and development relating to climate change in the Arctic. In addition, conduct high-precision measurements of parameters such as regional solar radiation, wind conditions, temperature, rainfall, and aerosols. Also, it is believed that an understanding of changes in ecosystems that are directly affected by the impacts of those parameters can play a fundamental role in the observation and monitoring of impacts of climate change on human livelihoods and various sectors that depend on ecosystems. For this reason, strengthen and expand the monitoring of parameters including climate change-induced changes in ecosystems.

#### **(Projection Technologies)**

Enhance modeling technology and simulation technology using supercomputers and other equipment, increase time-scale and spatial-scale resolution, and produce climate change projection information that includes the likelihood of occurrence. Also, consider increasing the resolution of climate predictions.

Strive to enhance climate projections by implementing projections of future climate change in Japan associated with the advance of global warming, by applying the latest numerical simulation technologies,

and provide detailed information using such means as publishing the “Global Warming Projection” including analysis of heavy rainfall and other extreme events.

Analyze future changes in natural hazards due to flood and storm surge by utilizing the latest climate change projection data and downscaling global climate models. Build high-precision storm surge and high wave models incorporating local-scale meteorological models for harbors.

### **(Studies and Research)**

In order to contribute to activities such as assessments of specific natural disaster risks at the local level based on the National Land Survey Act, steadily improve and make available the National Land Survey (Land Classification Basic Survey) which consolidates information such as the original land natural topography and geology, as well as information on past land use changes and disaster history; and the National Land Survey (Water Basic Survey), which consolidates basic information on surface water and groundwater.

Promote studies and research relating to policies/measures that have cobenefits with adaptation, and policies/measures having multiple policy objectives including adaptation; studies and research relating to climate change impacts, costs, and social vulnerability; studies and research relating to economic assessments of adaptation measures, and impacts on society and the environment; and the collection of findings relating to adaptation measures utilizing ecosystems.

Promote improvements of observation databases, as well as research and development relating to improvements of information platforms for enabling the shared use of a variety of data.

Promote studies and research relating to topics such as impact assessments and adaptation plans for climate change impacts overseas.

Regarding climate change impacts in snowy and cold regions, conduct studies relating to changing trends such as with snowstorms and poor visibility associated with rapidly forming low pressure systems; methodologies to ascertain the amount of snow cover and snowmelt in dam catchment areas; and topics such as impacts on river environments, water resources, and water utilization.

In snowy regions such as Hokkaido, because there are projections for frequent slope failures due to rapid snowmelt or rainfall caused by rapid temperature increases during the snowmelt period, consider methods to assess slope stability based on accurate projections of snowmelt amounts.

**[Relevant Ministries] Cabinet Office; Ministry of Internal Affairs and Communications; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

## **Chapter 2. Basic Measures for Sharing and Providing Information related to Climate Risk**

Given that information related to climate risk is the foundation for adaptation efforts of each actor, conduct discussions among the relevant ministries regarding platforms relating to climate change adaptation, in order to systematically collect and organize a variety of information related to climate risk. In the process, also consider utilizing the global environmental information platform which in the



Comprehensive Strategy on Science, Technology and Innovation 2015 (decided by Cabinet, June 19, 2015) was identified as an important effort toward resolution of socio-economic issues.

The relevant government ministries and agencies are to provide information related to climate risk in a form that is useful for actors, synergistically utilizing the information platforms of the databases and other resources of the ministries as well as experimental research institutes and other institutions; also, strive to develop and operate support tools to facilitate impact assessments and the development of adaptation measures in response to users' needs, and to collect, organize, and provide good practices. In addition, through these efforts, strive to build bridging functions between scientific findings and policy making.

Through mutual cooperation the relevant government ministries and agencies are to promote awareness-raising activities in form comprehensible for each segment of society, regarding information related to climate risk, through means such as symposiums, pamphlets and other publications, and the Internet.

Develop human and other resources that will be able to clearly communicate to a broad range of actors about the significance of adaptation and specific actions that should be taken.

In order to contribute to discussions about urban and local development and private sector investment, prepare inundation scenarios based on various magnitudes of natural hazards, and present disaster risk information in a comprehensible form to audiences such as local governments, businesses, and residents, including aspects such as the frequency of inundation above floor level and potential risks to human life, as well as specific disaster examples. Also, from an early stage as events progress, provide time-series information such as an increase in rainfall or rise in river levels, so that the degree of imminent danger can be communicated clearly to residents.

In order to contribute to smooth and proper implementation of disaster risk reduction measures such as preparation and emergency response for large-scale disasters, aerial photographs of damaged areas are taken immediately after a disaster occurs and provided to the related organs. National base maps such as the Digital Japan Basic Map and the National Land Numerical Information are also developed, updated and provided for disaster analysis.

**[Relevant Ministries] Cabinet Office; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

### **Chapter 3. Basic Measures for Promoting Adaptation in the Region**

To promote adaptation efforts by local governments, conduct model projects that support implementation of climate change impact assessments and the formulation of adaptation plans, for local governments that are implementing innovative adaptation efforts. In addition, summarize topics such as preparation procedures and issues for adaptation plans, based on findings obtained through the model projects, then formulate guidelines, and offer them to other local governments.

In cooperation with local governments, collect locally-specific information—such as impacts of climate change on local products—and using that information, promote studies and research relating to

local adaptation. Also, ascertain and share information that is possessed by citizens, NPOs, businesses, and other local actors (such as the condition of the local natural environment), working in cooperation with the actors that have the information.

With the platform and other items related to climate change information described in **Chapter 2**, enable access to various data and information needed at the regional level, such as high-resolution data obtained by downscaling, and provide information in a convenient form for utilization by local governments. Also, develop and operate support tools to facilitate impact assessments and the development of adaptation measures by local governments; and collect, organize, and provide good practices.

In cooperation with local governments and other bodies, through regional symposiums and publications and so on, promote awareness-raising activities that convey in comprehensible ways the scientific and expert findings relating to climate change impacts facing the regions, as well as adaptation efforts that individuals can put into practice. In addition, while promoting the incorporation of adaptation into various human resource development programs, promote the development, in local communities and elsewhere, of resources including human resources that are knowledgeable about climate change impacts and adaptation and are able to conduct activities such as awareness raising.

Periodically formulate the results of observations and projections of local changes in the climate, and disseminate the information.

In cooperation with actors including local governments, conduct monitoring that includes the impacts of warming, and summarize impacts that may be due to global warming (including high temperature damage at agricultural production sites) as well as adaptation measures, and disseminate the information by means including the “Global Warming Impact Investigation Report.”

For the awareness-raising of knowledge about climate change and weather-related disasters, lectures are to be held on topics including climate and prevention of weather-related disasters. Also, provide support for disaster risk reduction education efforts at schools to raise awareness about disaster prevention; implement awareness raising through channels such as information meetings and media organizations by making use of opportunities to publicize inundation scenarios and hazard maps; and provide support for river environment conservation and other activities by actors including organizations and residents that cooperate on river issues. To disseminate accurate knowledge about sediment-related disasters, promote activities such as hands-on disaster prevention trainings, disaster prevention education for children and students, lectures for residents, and trainings for audiences including local government personnel. In addition, in order to promote efficient water use, conduct educational and awareness-raising activities to deepen citizens’ interest and understanding about the importance of water. Also, share information and raise awareness about the relationships between climate change, biodiversity, and ecosystem services.

**[Relevant Ministries] Ministry of Internal Affairs and Communications; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Agriculture, Forestry and Fisheries; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

## Chapter 4. International Measures

### (Support for Developing Countries)

Regarding support for developing countries, including small island developing states that are vulnerable to climate change, provide cooperation for climate change impact assessments and the formulation of adaptation plans in developing countries, through actions such as creating collaborative frameworks with partner governments and the related institutions, based on Japan's experience with adaptation plan formulation. In these efforts, keep in mind each country's needs and policy priorities, and be mindful to follow guidelines and guidance relating to the formulation of national adaptation plans, based on decisions of the Framework Convention on Climate Change, including such matters as gender consideration and encouraging the participation of local residents. Establish sustainable industries and promote efforts that help maintain livelihoods while overcoming climate change vulnerability utilizing Japanese corporate technologies, including, for example, efforts to improve productivity through breeding of agricultural crops for salt-damaged farmland in Asian coastal areas.

Support the implementation of adaptation measures while utilizing Japan's technologies and experience in a variety of sectors, including water resources and disaster risk reduction, food and agriculture, the natural environment and ecosystems, which are projected to have an increase in risk due to climate change.

Particularly for small island developing states, implement comprehensive support by providing the necessary equipment and making use of Japan's experience and knowledge.

For reduction of risk from flood and other events for which risks are expected to increase due to the effects of climate change, provide support to speed reconstruction and strengthen disaster risk reduction capabilities from material and non-material perspectives, by means such as stand-by loans from the Government of Japan for disaster risk reduction and disaster reconstruction.<sup>39</sup> Targeting representative river basins in Asia where there are concerns about water disasters, conduct water disaster risk assessments that consider climate change, and provide the necessary information for developing adaptation plans.

Regarding droughts that are also natural disasters associated with climate change, provide support to enhance resilience with regard to droughts in arid and semi-arid area regions.

Regarding harbors and coastal areas, implement trainings for technical personnel in developing countries on climate change impacts and measures. Regarding coastal erosion due to climate change, make proposals and other actions for coastal conservation utilizing local ecosystems, including coral reefs and mangrove forests. Make use of Japan's technologies for international cooperation in the area of adaptation, through efforts such as promotion of disaster management collaboration dialogue, provision of global observation data and climate change projection data, and the provision of technologies and

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<sup>39</sup> A yen-denominated government loan with the ceiling agreed prior to occurrence of a disaster, set up in order to enable implementation of financing in a timely way upon request from a borrowing country when a disaster occurs; the aim is to provide rapid support in response to a developing country's need for funding at the reconstruction stage after a disaster.

knowhow by industry, government and academia working together.

Studies have been conducted regarding such topics as contributions through provision of Japan's technologies and products for adaptation actions of developing countries, including countries in Asia, Africa, and small island developing states, as well as feasibility of projects. Continue to implement studies about support for adaptation actions of developing countries, and feasibility of projects. Also, continue to disseminate the outcomes within Japan and to the rest of the world.

**[Relevant Ministries] Ministry of Foreign Affairs; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

### **(Support and International Contributions through International Frameworks)**

The Board of the Green Climate Fund (GCF), to which Japan has contributed 1.5 billion U.S. dollars, has decided on a 50:50 ratio of fund allocation on mitigation and adaptation for support to developing countries, and in the adaptation category, to allocate at least 50% of funds to adaptation in least developed countries (LDCs), island states, and Africa. Based on this, actively encourage fund distribution for adaptation projects in countries that are actually vulnerable to climate change.

Contribute to human resource development in the area of adaptation by broadly sharing Japan's experience and findings, through international networks such as the Asia Pacific Adaptation Network (APAN) and Global Adaptation Network (GAN). Also, strive to promote adaptation measures by improving the AMICAF framework (Assessments of Climate Change Impacts and Mapping of Vulnerability to Food Insecurity under Climate Change to Strengthen Household Food Security with Livelihoods' Adaptation Approaches), while also making use of South-South cooperative mechanisms.

Looking toward the preparation of the IPCC Sixth Assessment Report, contribute to IPCC activities and report writing, by providing findings through the dispatch of Japanese experts to IPCC Plenary Sessions and various other meetings, by providing report authors and promoting support for activities of authors, and by other efforts.

Regarding international standardization related to adaptation, under the International Organization for Standardization (ISO) and other bodies, contribute based on Japan's experience and technologies while following trends in the discussions.

In order to contribute to monitoring sea-level rise and other, Japan is involved in international observation by Very Long Baseline Interferometry (VLBI) and developing a new VLBI observing system for higher accuracy. Japan also develops and updates basic geospatial information (global maps) with global coverage, in collaboration with National Geospatial Information Authorities, for a better understanding of global environmental issues and formulating policy and measures to tackle them.

**[Relevant Ministries] Ministry of Foreign Affairs; Ministry of Finance; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Agriculture, Forestry and Fisheries; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure, Transport and Tourism; Ministry of the Environment, etc.**

## **Appendix. Approach for Assessment of Climate Change Impacts (Approach used in the Climate Change Impact Assessment Report)**

### **1. Basic Approach**

Assessments are done for the sub-categories indicated in Table 1, in terms of significance, urgency, and confidence. It is difficult to mechanically and quantitatively establish assessment criteria across the board due to the unique characteristics of each sector. As a result, it was decided to use expert judgment based on scientific findings in each Working Group, while using common metrics in each sector for “significance,” “urgency,” and “confidence.” In addition, the Expert Committee considered the results of the discussions in each sector.

### **2. Criteria for Assessment**

- Significance: Assess in terms of three criteria: social, economic, and environmental.
- Urgency: Assess in terms of two criteria: Timing of occurrence of impacts, and timing required to initiate adaptation measures and critical decision-making.
- Confidence: To some extent, applying to the approaches to confidence used in the IPCC Fifth Assessment Report, assess in terms of two criteria: Type of research/report (e.g., quantitative projection based on model simulation; projection using an index such as degree of an increase in temperature; qualitative analysis or estimates); and degree of agreement. Where the amount of research or reporting is rather limited (examples are only one or two cases), judgment is used to determine whether the contents are reasonable.

Table 1. Classification of Sectors and Categories

Sectors	Categories	Sub-categories
Agriculture, Forest/Forestry, Fisheries	Agriculture	Paddy field rice
		Vegetables
		Fruit trees
		Barley/Wheat, Soybean, Feed crops, and other crops
		Livestock Farming
		Plant pests and weeds
		Water, Land and Agricultural Infrastructure
	Forest/Forestry	Timber production (e.g., Plantations)
		Non-wood forest products (e.g., Mushrooms)
	Fisheries	Migratory fish stocks (Ecology of fishes)
Propagation and Aquaculture		
Water Environment, Water Resources	Water environment	Lakes/ Marshes, Dams (Reservoir)
		Rivers
		Coastal areas and Closed sea areas
	Water resources	Water supply (Surface water)

Sectors	Categories	Sub-categories
		Water supply (Groundwater)
		Water demand
Natural Ecosystems	Terrestrial ecosystems	Alpine/Subalpine zone
		Natural forests / Secondary forests
		Countryside-landscape (Satochi-Satoyama)
		Planted forests
		Damage from wildlife
		Material balance
	Freshwater ecosystems	Lakes / Marshes
		Rivers
		Marshlands
	Coastal ecosystems	Subtropics
		Temperate / Subarctic
	Marine ecosystems	
	Phenology	
Shifts in distribution and populations		
Natural disasters, Coastal areas	Rivers	Floods
		Inland waters
	Coastal areas	Sea-level rise
		Storm surges, High waves
		Coastal erosion
	Mountain areas	Debris flows, Landslide, and other disasters
Others	Strong winds and other	
Human Health	Winter warming	Mortality in winter season
	Heat stress	Risk of mortality
		Heat illness
	Infection	Water- and food-borne diseases
		Vector-borne diseases
		Other infectious diseases
Others		
Industrial / Economic activities	Manufacture	
	Energy	Energy demand and supply
	Commerce	
	Finance, Insurance	
	Tourism	Leisure
	Construction	
	Medical	
	Others	Other impacts (e.g., Overseas impact)
Life of Citizenry, Urban Life	Urban infrastructure, Critical services	Water supply, Transportation, and other
	Life with sense of culture and history	Phenology, Traditional events / local industry
	Others	Impacts on life due to heat stress

### <Approach for Assessment of Significance>

- The assessment of significance of impacts was done from three criteria: social, economic, and environmental. Reference was made to four elements listed in the IPCC Fifth Assessment Report as a basis to identify key risks (see below) as “Criteria used in the IPCC Fifth Assessment Report as a basis to identify key risks” (“timing of impacts” to assess urgency and “potential to reduce risks through adaptation or mitigation” were excluded), and also to the U.K. CCRA<sup>40</sup> approach.
- The assessments are conducted, in principle, based on science, including the contents of research papers and other materials. Also based on the assessment approach shown in Table 2, expert judgment is used to determine if an impact is “particularly high” or “not particularly high.”
- Also, the term “N/A (currently cannot be assessed)” is used to indicate cases where assessment is difficult to do under current conditions.
- As for “the potential to reduce risks through adaptation or mitigation,” the potential to reduce risk through *mitigation* is not considered because it is difficult to make an assessment for each impact compiled, but for the potential to reduce risk through *adaptation*, comments are provided as required, for reference.

### **Criteria used in the IPCC Fifth Assessment Report as a basis to identify key risks**

- Magnitude (of impacts)
- Probability
- Irreversibility
- Timing (of impacts)
- Persistent vulnerability or exposure contributing to risks
- Limited potential to reduce risks through adaptation or mitigation

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<sup>40</sup> U.K. CCRA: U.K. Climate Change Risk Assessment

Table 2. Approach for Assessment of Significance

Criteria for Assessment	Metrics for Assessment (Approach)		Means of Indicating Final Assessment
	Particularly High	Not Particularly High	
	<p>Assess significance in terms of social, economic, environmental impacts based on the following criteria:</p> <ul style="list-style-type: none"> <li>● Magnitude of impacts (area, duration)</li> <li>● Likelihood of occurrence of impacts</li> <li>● Irreversibility of impacts (difficulty of restoring original conditions)</li> <li>● Persistent vulnerability or exposure contributing to the impacts of concern</li> </ul>		<p>Indicate the degree of significance, and where it is particularly large, indicate the criteria.</p>
1. Social	<p>At least one of the following applies:</p> <ul style="list-style-type: none"> <li>● Involves the loss of human life, or on the health dimension, the extent of impacts and likelihood of occurrence are particularly high (abbreviated as “extent” below). e.g.: Hazards (disasters) could result in the loss of human life Health impacts for large numbers of people</li> <li>● Magnitude of impacts on local society and community is particularly high e.g.: Impacts are nationwide Impacts are not nationwide, but are serious locally</li> <li>● Magnitude of impacts on cultural assets and community services is particularly high e.g.: Irreversible impacts on cultural assets Serious impacts on life of citizenry</li> </ul>	<p>An assessment of “particularly high” does not apply.</p>	
2. Economic	<p>The following applies:</p> <ul style="list-style-type: none"> <li>● Magnitude of economic losses is particularly high e.g.: Large-scale losses occur to assets and infrastructure Loss of employment opportunities for a large number of citizens Large-scale disruptions of transportation networks over a large area</li> </ul>	<p>An assessment of “particularly high” does not apply.</p>	
3. Environment	<p>The following applies:</p> <ul style="list-style-type: none"> <li>● Magnitude of losses to environment and ecosystem functions is particularly high e.g.: Large-scale loss of important species, habitats, and landscapes For ecosystems, significant deterioration in quality of places that are important internationally and nationally Significant decline in land/water/atmospheric/ecological functions over a broad area</li> </ul>	<p>An assessment of “particularly high” does not apply.</p>	



### <Approach for Assessment of Urgency>

- For criteria corresponding to urgency, reference was given to the IPCC Fifth Assessment Report “timing of impacts” and U.K. CCRA<sup>41</sup> “timing of impacts” and “urgency with which adaptation decisions need to be taken.” These are different concepts, but here, it was decided to consider both approaches and adopt the one that has the highest urgency. It should be noted that because adaptation includes measures that need to be implemented in the long term and on an ongoing basis, for the “timing of impacts” and “urgency with which adaptation decisions need to be taken” it is necessary to consider the amount of time required to implement measures.
- Also, the term “N/A(currently cannot be assessed)” is used to indicate cases where assessment is difficult to do under current conditions

Table 3. Approach for Assessment of Urgency

Criteria for Assessment	Metrics for Assessment			Means of Indicating Final Assessment
	High Urgency	Medium Urgency	Low Urgency	
1. Timing of impacts	Impacts are already evident.	High likelihood that impacts will occur <i>by</i> about 2030.	High likelihood that impacts will occur <i>after</i> about 2030. Or level of uncertainty is extremely high.	The level of urgency is to be indicated for each sub-category as one of three levels, with criteria 1 and 2 both considered.
2. Timing needed to initiate adaptation measures and make critical decisions	Decisions need to be made as soon as possible.	Major decisions need to be made before about 2030.	There is not much need to make major decisions before about 2030.	

### <Approach for Assessment of Confidence>

- The assessment of confidence is conducted, in principle, based on the IPCC Fifth Assessment Report’s “type, amount, quality, and consistency of evidence,” and “degree of agreement,” and the assessment is expressed with five terms (very high, high, medium, low, and very low).

Types of evidence: Monitoring/observation to date, models, experiments, paleoclimatic analogues

<sup>41</sup> U.K. CCRA: U.K. Climate Change Risk Assessment

Quantity of evidence: Numbers of research and reports

Quality of evidence: Qualitative content of research and reports (e.g., ask whether assumptions are reasonable)

Consistency of evidence: Consistency of research and reports (e.g., consistency of scientific mechanisms)

Agreement of opinion: Agreement of opinion among research/reports

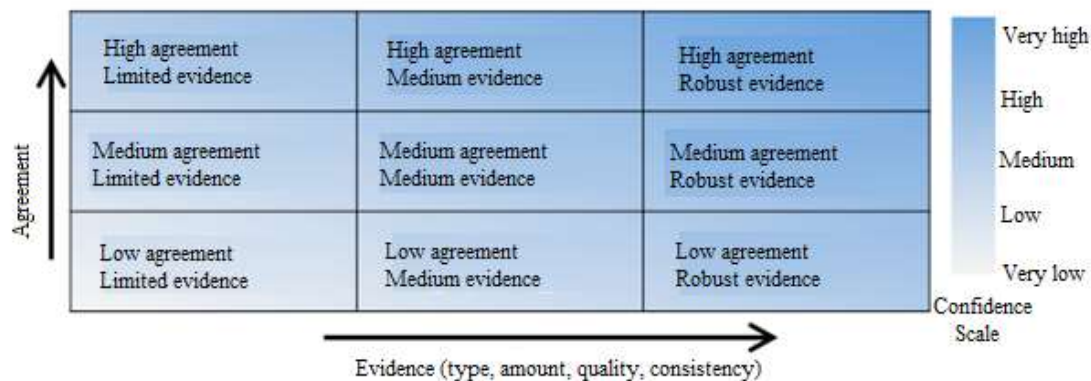


Figure 1. Evidence and agreement statements and their relationship to confidence

Confidence increases toward the top right corner. Generally, evidence is most robust when there are multiple, consistent, independent lines of high-quality evidence.

Source: Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties (IPCC 2010)

- Here, the same two metrics are utilized as in the IPCC Fifth Assessment Report (“type, amount, quality, and consistency of evidence” and “degree of agreement”). Regarding “type, amount, quality, and consistency of evidence,” integrated judgment is to be used, but the amount of research and reports with projections of future impacts in Japan is believed to be less available than in IPCC discussions. Thus, as an approach and metric for judgment, evaluators could consider whether or not research and reports with quantitative analysis are available.
- Regarding the assessment levels, it may not be possible to obtain a sufficient amount of literature, so only three options are used: high, medium, and low.
- When assessing confidence, the assessment shall also take into account the degree of certainty of projections (e.g., the amount of precipitation) from climate models on which projections are based.
- Also, the term “N/A (currently cannot be assessed)” is used to indicate cases where assessment is difficult to do under current conditions.

Table 4. Approach for Assessment of Confidence

<b>Considerations for Assessment</b>	<b>Levels of Assessment (Approach)</b>			<b>Means of Indicating Final Assessment</b>
	<b>High Confidence</b>	<b>Medium Confidence</b>	<b>Low Confidence</b>	
IPCC Assessment of Confidence • Type, amount, quality, and consistency of research/reports • Degree of agreement in research/reports	Corresponds to IPCC confidence rating of “high” and above	Corresponds to IPCC confidence rating of “medium”	Corresponds to IPCC confidence rating of “low” and below	Using the IPCC’s level of confidence, indicate the level of confidence for each sub-category using one of three levels.