CLIMATE CHANGE ADAPTATION PLAN OF THE MINISTRY OF AGRICULTURE, FORESTRY AND FISHERIES (OUTLINE)

October 2021

Ministry of Agriculture, Forestry and Fisheries

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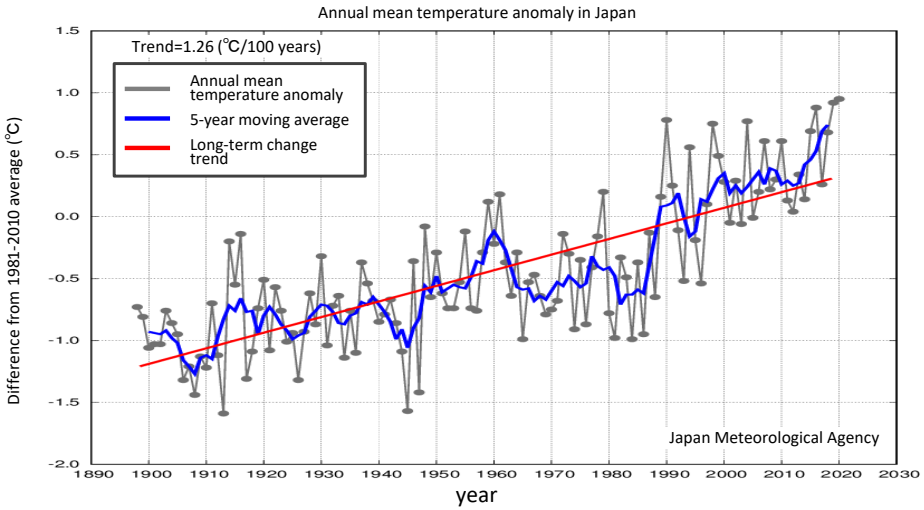
Climate Change and Increase in large-Scale Natural Disasters due to Global Warming

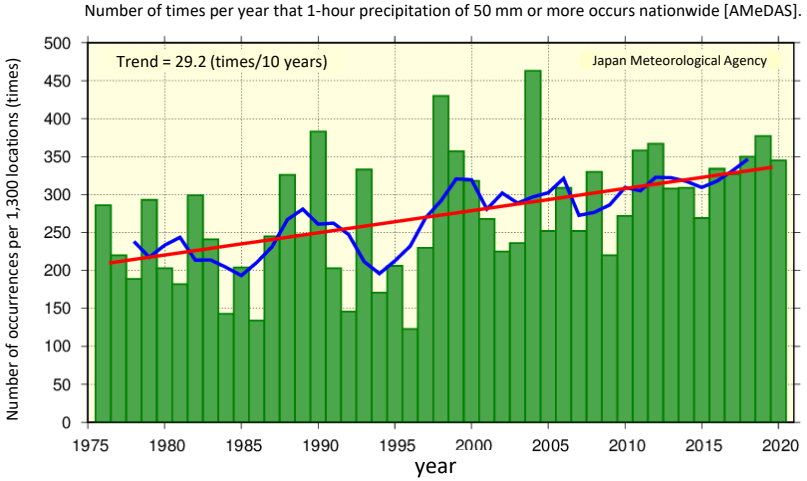
○The annual average temperature in Japan increases at a rate of 1.26°C per 100 years.
The annual average temperature in Japan in 2020 is the highest since statistics began being recorded in 1898.
○The agriculture, forestry and fisheries industries are susceptible to climate change and have already experienced quality deterioration due to high temperatures.
○Due to the increase in rainfall and other factors, disasters tended to be more severe. Damage also occurred in the agriculture, forestry and fisheries sectors.

■ Secular change in annual mean temperature anomaly in Japan



Annual average temperature has been increasing for a long period of time, and especially since 1990, there have been frequent high temperature years.

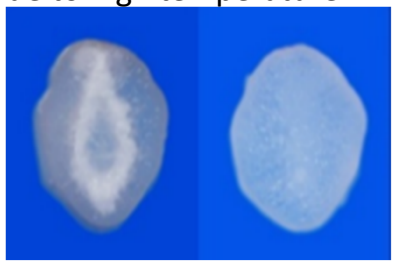
■ Number of times there was an hourly precipitation of 50 mm or more per year



The average number of occurrences over the 10-year period 2011-2020 is 334
Increased by 1.5 times compared to 1976-1985

■ Impacts of climate change on the agricultural sector

Rice: deterioration in quality due to high temperature



Cross section of white immature grain grain with white portion (left) and normal grain (right)

Apples: poor coloration and delayed coloration at maturity

■ Damage to the agricultural sector

Soaked cucumber
(Heavy rain caused by a front in August 2019)

A damaged glass house
(Typhoon on the Boso Peninsula in 2019)

Development and Promotion of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

Government-wide movement on climate change adaptation measures

(Impact Assessment)
March 2015 "First Climate Change Impact Assessment" was released (Ministry of the Environment)
(Planning)
November 2015 Cabinet approved the "Climate Change Adaptation Plan" (administrative plan)

(Legislation)
June 2018 Climate Change Adaptation Act promulgated.
(Planning)
November 2018 Cabinet approved the Climate Change Adaptation Plan based on the Act.

(Impact Assessment)
December 2020 the "Second Climate Change Impact Assessment" was released (Ministry of the Environment)
(Plan revision)
October 2021 Cabinet approved the revised "Climate Change Adaptation Plan"

History of the formulation and revision of the MAFF Climate Change Adaptation Plan

(Planning)
August 2015: Ministry of Agriculture, Forestry and Fisheries formulates climate change adaptation plan

(Plan revision)
November 2018: Revised Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

(Plan revision)
October 2021: Revised Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan

Key points of the second round of climate change impact assessment

○Enhancement of scientific knowledge on the impacts of climate change
In the field of agriculture, forestry and fisheries, 339 references were cited**, about 3.5 times** as many as in the previous survey (96 references in the previous survey).
(new predictions)

- Poor coloring of grapes
- Decreased production capacity and reproductive function of livestock
- Increased flood damage in low elevation paddy fields
- Simultaneous collapse of hillside slopes and increase in mudslides
- Decline in algae and shellfish aquaculture production due to changes in the distribution areas of migratory fish and increases in water temperature
- Many studies see global rice, wheat, soybean, and corn yields declining, but impacts vary by region, CO2 concentration, and adaptation measures

Key points of the revised MAFF climate change adaptation plan

○ Promote the development and dissemination of stable production technologies and varieties that adapt to climate change based on Strategy for Sustainable Food Systems.
・In apples and grapes, the introduction of excellent coloring varieties, etc.
・Promotion of measures against heat, such as watering and ventilation in barns
○ Maintaining and improving of disaster prevention and mitigation functions in rural areas
○ Prevention of mountain disasters through the deployment of erosion control facilities and forest maintenance, etc.
○ Improvement of the precision of stock assessment and development of algae tolerant to high water temperatures, etc.
○ Establishing comprehensive food security by conducting research and analysis of food supply and demand, etc.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Basic Concept]

Plan development based on current and future impact assessment	○ Develop plans to respond accurately and effectively to the impacts of climate change, consistent with government-wide impact assessments ○ Organize and promote plans for each field and item, focusing on initiatives necessary for the next 10 years.
Countermeasures to the impact of global warming	○ Research and development of adaptive technologies and varieties that reduce the decline in production quantity and quality of crops, etc. ○ Conversion to adaptable varieties and crops, and dissemination of adaptation technologies
Disaster prevention and response to disasters caused by extreme weather events	○ Severe flooding damage to agricultural land and mountain disasters caused by torrential rains, etc. ○ Increased risk of storm surge due to rising sea levels, etc. } In preparation for this, it will systematically promote the development of facilities that contribute to disaster prevention.
Utilization of climate change	○ Expansion of production area due to reduction of low temperature damage ○ Introduction and conversion of subtropical/tropical crops and creation of producing areas ○ Increase in yield due to expansion of growing period and cultivation area by shortening snow cover period
Collaboration among stakeholders and role sharing, information sharing	○ National government: Scientific assessment of current and future impacts of climate change, basic research and development of adaptation technologies, presentation of supportive measures for local initiatives in terms of both software and hardware, and collection and dissemination of domestic and international information. ○ Regions: Independent selection and promotion of adaptation measures by regional entities, etc. ○ Effective implementation of adaptation plans through cooperation between national and local governments
Promote initiatives by continuously reviewing and optimizing the plan	○ Review of the current status and future impacts assessment based on the latest scientific findings in the wake of new reports by the IPCC and other organizations. ○ Confirmation of the progress of adaptation measures and reflection of the latest research results, etc. } Ongoing review of the adaptation plan based on the results of these latest assessments, etc.

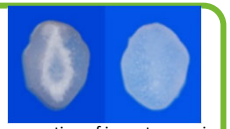
Major Adaptation Measures in the Agriculture, Forestry and Fisheries Sectors

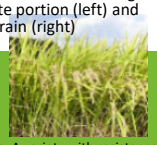
- **The agriculture, forestry and fisheries industries are susceptible to climate change, and have already been facing growth problems and quality deterioration due to high temperatures.**
- **Climate change may concurrently present some positive effects on these sectors, such as the expansion of cultivation areas for some crops due to rising temperatures.**

Photo source: MAFF, etc.

Paddy rice

・Deterioration in quality due to high temperatures.
・If the conversion to high temperature resistant varieties does not proceed, the percentage of the first-class rice may decrease nationwide.


Cross section of immature grain with white portion (left) and normal grain (right)


Hiroshima Prefecture: A variety with resistance to high-temperature "Koi-no-yokan"

・Development and dissemination of high temperature resistant varieties.
・Thoroughly implement basic techniques such as fertilizer and water management.

Livestock and forage crops

・During the summer, milk production, milk composition, and reproductive performance of dairy cattle decline, and the body mass index of beef cattle, pigs, and poultry deteriorates.
・Dry matter yields of forage crops are increasing year by year in some areas.


Kyoto Prefecture: Development of clothing for livestock using cool touch materials for humans

・Promotion of measures against heat, such as watering and ventilation in barns
・Development of productivity-enhancing technologies such as appropriate nutritional management
・Construction of cultivation system for forage crops, development and dissemination of cultivation management technology

Forestry

・Occurrence of woody debris flow accompanying hillside collapses triggered by external forces that exceed forests' ability to stabilize slopes.
・Possible increased risks of mountain disasters such as hillside collapses and debris flow due to more frequent heavy rainfall.
・Possible increase in growth problems of Japanese cedar planted forests in areas with already lower precipitation.


Large-scale mountain disaster caused by heavy rain


Withering cedar trees due to drought

・Prevention of mountain disasters including through erosion control facility deployment and forest management.
・Research and study on climate change impacts on forests and forestry

Fruit tree

・Poor skin color of apple and grape, peel puffing and sunburn of satsuma mandarin, and flowering disorder of Japanese pear.
・There is a possibility that the suitable areas for apple and satsuma mandarin cultivation will shift year by year.

Poor skin color of apple


Peel puffing of satsuma mandarin

・Introduction of superior-colored cultivars or yellow-green cultivars for apple and grape.
・convert to medium-late maturing citrus ('Shiranuhi', etc.), which prefer warmer climates to satsuma mandarin.


'Shiranuhi' have been developed by National Agriculture and Food Research Organization (NARO)

Agricultural production base

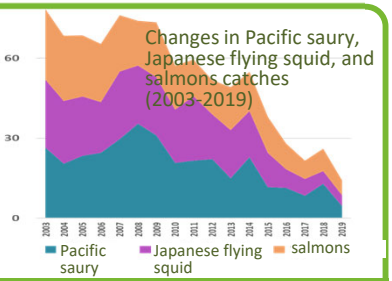
・In addition to the frequent occurrence of short duration heavy rainfall, drought due to low rainfall also occurred.
・A change in the timing of rice planting and an increase in water management labor.
・The risk of waterlogging damage to farmland may increase.


waterlogging damage to farmland caused by torrential rain

・Efficient use of agricultural water and maintaining and improving of disaster prevention and mitigation functions in rural areas through appropriate combination of hard and soft measures.

Fisheries

・Decline in catches of Pacific saury, Japanese flying squid and salmons.
・Mass death of scallop and oyster
・Decreased harvest of cultured laver due to shorter cultivation period.
・Changes in the distribution area and body size of migratory fish stocks, and possible impact on fish farming areas due to the rising water temperatures in summer.



・Comprehend the impact of marine environmental changes on fishery resources and improve the precision of stock assessment
・Improvement of aquaculture breeds tolerant to higher water temperatures and technology for monitoring harmful algal blooms over wider areas

《Examples of KPIs》
【Agriculture (paddy rice)】Percentage of area planted with high temperature resistant varieties (staple food rice)
【Forestry (timber production (plantation forests, etc.))】Percentage of prefectures where the pine weevil damage rate in pine forests to be conserved is kept at "slight damage" of less than 1%.
【Fishery (Migratory fish stocks (Ecology of fish, etc.)】Number of fish species assessed based on MSY (Maximum Sustainable Yields)

Examples of Leveraging the Opportunities Presented by Climate Change

Blood orange (Ehime, Japan)

In the Nanyo region of Ehime Prefecture, efforts have been made since around 2003 to introduce and popularize blood orange ("Tarocco" and "Moro") in order to deal with the impact of global warming and citrus anniversary supply, and steady production has been promoted.
(Cultivation area (Ehime Prefecture): 2008: 13.5 ha → 2018: 27.3 ha)

Peach (Aomori Prefecture)

In the Central South Region, which accounts for 70% of the apple cultivation area in Aomori Prefecture, the production of peaches has been promoted in recent years, and efforts are being made to study promising varieties and improve cultivation techniques for high-quality production and branding.
(Cultivated area (Aomori Prefecture) 2007: 91.4 ha → 2018: 122.2 ha)

Avocado (Ehime, Japan)

The introduction and spread of avocados has been promoted in the island and coastal areas of Matsuyama City, Ehime Prefecture since around 2008.
(Cultivation area (Ehime Prefecture): 10.8 ha in 2018)
In the future, the goal is to establish cultivation techniques for stable production and to expand the cultivation area to 10 ha in 2025.

Japanese cypress (Yamagata Prefecture)

As part of the project to introduce warm-season crops, a field experiment is underway to test the tree mortality of Japanese cypress, a tree species hitherto considered unsuitable in Yamagata, monitor their growth and occurrence of damage caused by climatic conditions, insects and wildlife, and explore the possibility of its introduction at scale.

Atemoya (Mie Prefecture)

In order to develop a subtropical fruit tree specialty that takes advantage of the mild climate of Mie Prefecture, we have studied the adaptability of Atemoya to cultivation, selected an excellent variety, and established cultivation techniques for stable production.
Although facility cultivation is required, it can be cultivated in winter with enough heat to prevent freezing, and we are working on its production in the prefecture. (Cultivation area (Mie Prefecture): 12a in 2020)

Processed yellowtail products (Hokkaido)

Since 2011, the increase in yellowtail landings in Hokkaido (Hakodate Port, etc.) has been utilized to develop processed products.

(Landings of yellowtail [fresh and processed] in Hokkaido: 2,190 tons in 2010 → 10,817 tons in 2019)

Outline of the MAFF Climate Change Adaptation Plan [Examples of Climate Change Predictions in Japan]

Temperatures

○ Annual average temperatures at the end of the 21st century* will increase by an average of 1.4-4.5 ˚C nationwide compared to the end of the 20th century**, depending on the forecast scenario.

○ As temperatures rise, the annual number of extremely hot days increases in many areas of Japan

(* End of 21st century: average of 2076-2095
** End of 20th century: 1980-1999 average)

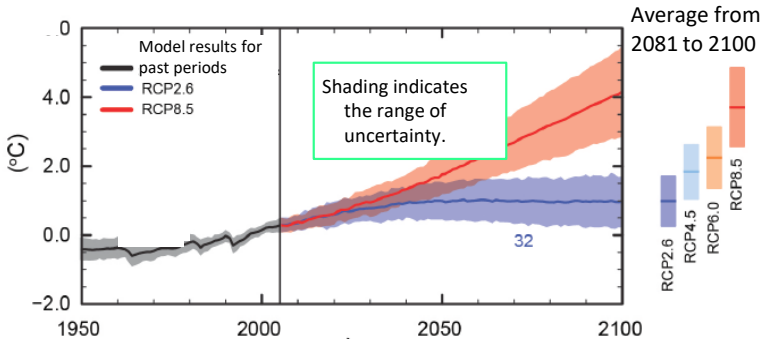


Figure: Image of average surface temperature change by prediction scenario (global average)

Source: IPCC Fifth Assessment Report Summary for Policy Makers

※RCP (Representative Concentration Pathway)
Scenarios that include time-series data on emissions and concentrations of greenhouse gases, etc.
- RCP2.6: Severe mitigation scenario (2 ˚C rise scenario)
- RPC4.5, RCP6.0: Intermediate scenario
- RCP8.5: Scenario with very high GHG emissions (4˚ C rise scenario)

Rainfall

○ The frequency of heavy and short duration rainfall will increase nationwide.
○ The rainy season precipitation zone in early summer (June) is expected to intensify and be located farther south than at present.

Tropical cyclone

○ Increase in the proportion of very intense tropical cyclones to all tropical cyclones worldwide
○ Typhoon strengthens near Japan
○ No change in the total annual amount of rainfall associated with typhoons near Japan, but an increase in the amount of precipitation from individual typhoons

Snowfall and snow accumulation

○ The amount of snowfall and the deepest snowfall of the year are decreasing.
○ In some areas, snowfall during severe winters increases as water vapor increases due to rising temperatures.

Seawater temperature

○ Annual average sea surface temperatures in the seas around Japan increased by 1.1 to 3.6 ˚C.

Sea level

○ Annual average sea level rise of 0.39 to 0.71 m along the Japanese coast

Outline of the Climate Change Adaptation Plan of the MAFF [Agricultural Production Review]

Impact

	seriousness	urgency	certainty	impact
Paddy rice	●	●	●	Cultivation and livestock farming are susceptible to climate change. Climate change can be the cause of growth disorders and quality deterioration in various crops and livestock.
Fruit tree	●	●	●	
Land use crops (wheat, soybeans, etc.)	●	▲	▲	
Horticultural crops (vegetables, flowering plants)	◆	●	▲	
Livestock farming	●	●	▲	
Pests, weeds, etc.	●	●	●	
Agricultural production infrastructure	●	●	●	

Legend:

[Seriousness]	●: Extremely serious impact is recognized.	◆: Impact is recognized		- : Cannot be assessed at present
[Urgency]	●: High	▲: Medium	■: Low	- : Cannot be assessed at present
[Certainty]	●: High	▲: Moderate	■: Low	- : Cannot evaluate at present

Note: Severity, urgency and certainty in the table above are excerpts from the "Climate Change Impact Assessment Report" (published by the Ministry of the Environment in December 2020).

Countermeasures

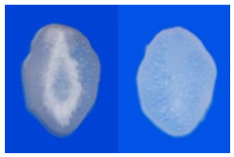
General agricultural production initiatives	Efforts by Item
○Development and dissemination of cultivation stabilization technologies and corresponding technologies, including the conversion of varieties and commodities, in order to avoid and mitigate damage caused by climate change. ○Farmers' own risk management for climate change and other efforts to reduce risks to agricultural production ○Demonstration of the introduction of new adaptive technologies ○Monitoring the impact of global warming in cooperation with local communities ○Dissemination of information through the Global Warming Impact Study Report, the Ministry of Agriculture, Forestry and Fisheries website, etc.	[Rice, fruit trees, pests, weeds, etc]. ○More focused efforts based on the fact that the climate change impact assessment report identified the significance as particularly large and the urgency and certainty as high (see table above). [Other crops] ○Continue to work on measures that have been taken in the past. ○Development of new adapted varieties and cultivation management techniques, or basic research for them, based on the forecast of future impacts.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Paddy Rice]

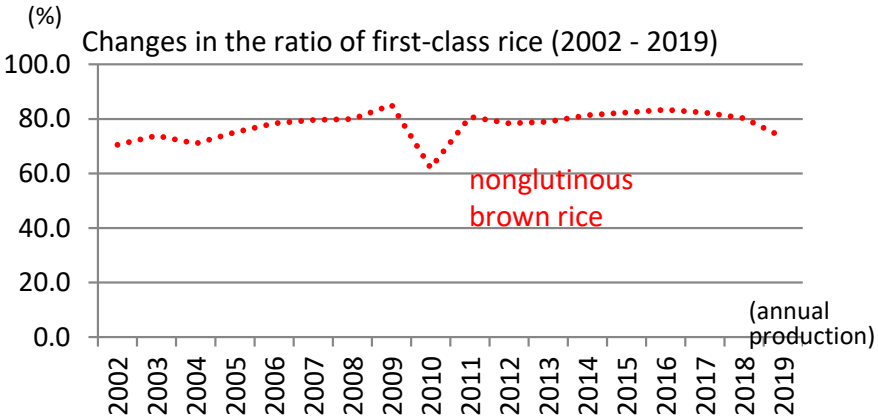
Impact

<Current status>

- ○ Deterioration in quality due to high temperature.
- ○ Yield reduction in some areas and in high temperature years.



Cross section of immature grain with white portion(left) and normal grain (right)



Note 1: Immature grains with white portion are grains that appear cloudy white due to insufficient starch accumulation. The occurrence increases when the average temperature for about 20 days after heading ~~ear~~ is 26 to 27° C or higher.

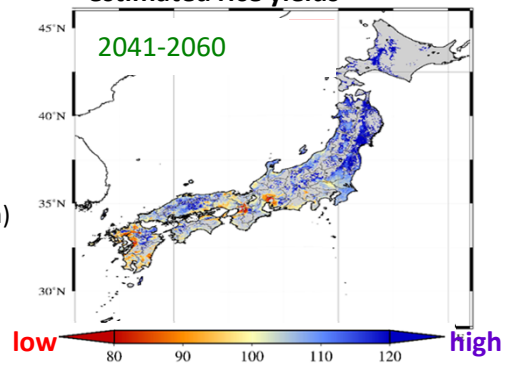
Note 2: In 2010, due to the record-breaking hot summer, immature grains with white portion occurred and the ratio of first-class rice decreased significantly.

<Future prediction>

- ○ Rice yields will increase nationally from 2061 to 2080, but will begin to decline by the end of the 21st century.
- ○ The percentage of generated milky white grain compared to the 2010s is projected to increase in the 2040s, resulting in a significant increase in economic losses due to a decrease in the area of first-class rice.

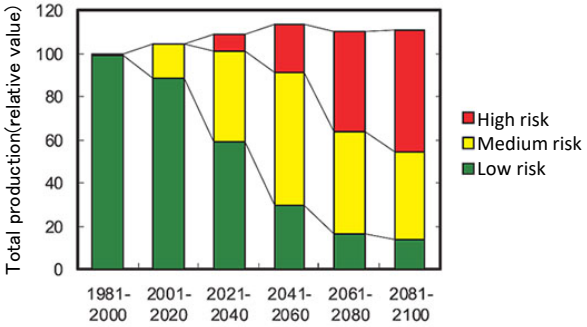
In the case of climate change scenario with large increase in temperature and CO2 concentration

1) Prediction of the distribution of estimated rice yields



(Average yield for each decade, with the average yield for 1981-2000 set at 100)

2) Prediction of national rice production and risk of quality decline



Production: Relative to the average yield of 1981-2000, which is 100.
Risk of deterioration in quality: Estimated based on the projected increase in average daily temperature after heading.

Figure: Prepared based on the "Results of Agricultural Products Inspection for Rice" by MAFF

Source: NARO

Countermeasures

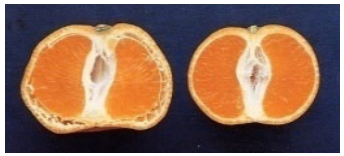
Development and dissemination of adaptation technologies	Development and disseminationof varieties
[Measures for high temperature] ○Thorough implementation of basic techniques such as manure management and water management [Pest Control] ○Thorough implementation of timely pest control, etc., using information on predicted outbreaks, etc.	[Measures for high temperature] ○Promotion of development and dissemination of high temperature resistant varieties ○Future variety development should be based on providing high temperature resistance ○Development of varieties and breeding materials with resistance to high temperature sterility

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Fruit Trees]

Impact

< Current status>

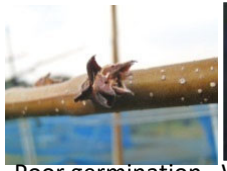
- ○Peel puffing and physiological fruit drop in citrus
- ○Poor coloring, sunburn, and fruit softening in apples
- ○Poor germination in Japanese pears, watercore in peaches, poor coloring in grapes, softening of persimmon fruit, etc.
- ○ In some areas, the suitable cultivation areas are expanding.



Peel puffing of Satsuma mandarin

Poor coloring in apples

Poor coloring in grapes



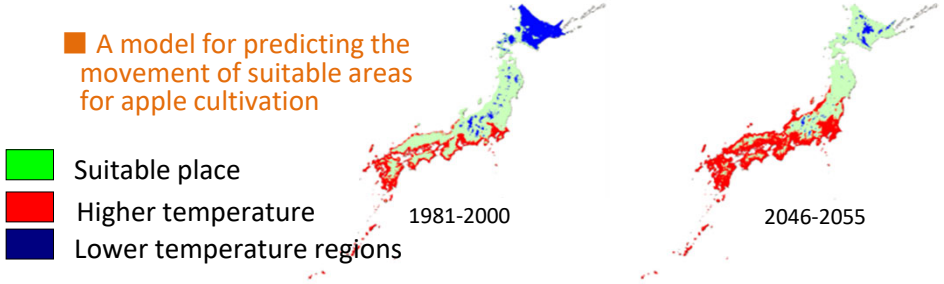
Poor germination of Japanese pear

Watercore in Japanese pear

<Future prediction>

- ○ The optimal cultivation areas for Satsuma mandarins and apples have shifted.
- ○ In grapes, peaches, sugar beets, etc., growth disorders caused by high temperature occur.
- ○ Regarding Japanese pears, there is a possibility that cultivation of varieties with high chilling requirements will become difficult in more areas.
- ○ In low temperature regions, where fruit trees have been difficult to grow, suitable areas for fruit tree cultivation have expanded.

■ A model for predicting the movement of suitable areas for apple cultivation



Source: MAFF, "Future Prospects for Adaptation to the Impacts of Climate Change" (2019).

Countermeasures

Development and disseminationof adaptation technologies

[High temperature measures}

(Mandarin Oranges)

- ○Promote the use of calcium agents, etc., to prevent Peel puffing
- ○Promoting the use of ethychlozate spraying to prevent poor coloration
- ○Promotion of cultivation management techniques such as spraying with a mixture of gibberellin and prohydrojasmon (to prevent Peel puffing) and active use of shading materials (to prevent sunburn)

(Apples)

- ○Promotion of watering and introduction of reflective sheets to prevent sunburn and poor coloration of fruits
- ○Promotion of cultivation management techniques to reduce the incidence of poor coloring and sunburn

(Grapes)

- ○Promotion of girdling, etc. as a measure against poor coloration

(Pear)

- ○Promote the introduction and dissemination of technical measures to reduce poor germination

Note: Figaron, gibberellin and prohydrojasmon are plant growth regulators.

Development and dissemination of varieties, conversion of products

[High temperature measures}

(Mandarin Oranges)

- ○Promote planting to convert to mid/late-season citrus

(Apples)

- ○Introduction of superior-colored varieties such as "Akibae"
- ○Support for cultivation demonstration utilizing elevation differences, planting for variety conversion, etc.

(Grapes)

- ○Promote the introduction of superior-colored varieties such as "Grose krone" and yellow-green varieties such as "Sunshine Muscat"

(Cross Item)

- ○Development of breeding materials adapted to high temperature conditions and breeding of the relevant varieties

[Taking advantage of opportunities}

(Subtropical and tropical fruit trees)

- ○Promote initiatives to demonstrate the introduction of atemoya, avocado, mango, lychee, etc.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Land Use Crops (Wheat, Soybeans, Tea, etc.)]

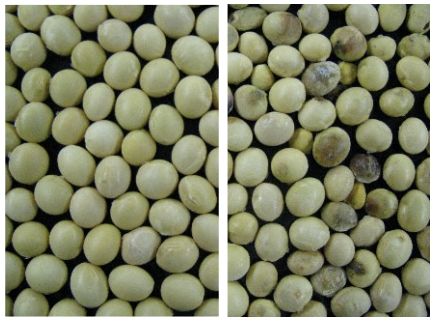
Impact

<Current status>

- ○ Delay in sowing time and advance in heading time (i.e. shortening of growing period) in wheat
- ○ Decrease in hundred grain weight, pod number, and deterioration of seed quality in soybean
- ○ Suppression of sprout growth in tea, frost damage
- ○ Increase of disease in sugar beet
- ○ Overwinter survival of unharvested potato tubers expected to volunteer potatoes

<Future-prediction>

- ○ Increase in risk of frost damage and decrease of protein content in grain in wheat
- ○ Lower yield and deterioration of grain quality in wheat (Hokkaido)
- ○ Increase of diseases and deterioration of quality in sugar beet, soybeans, red beans, and potatoes (Hokkaido)



Sucking damage to soybeans by stink bugs (The damaged soybeans are on the right.)

Deformity of tea shoots due to frost damage. (right end is normal)

Countermeasures

Development and dissemination of adaptation technologies

[Wheat and Barley]

- ○Implementation of basic technologies such as drainage and proper control of scab, etc.to reduce risks caused by high precipitation
- ○Development and dissemination of stable cultivation techniques to prevent frost damage

[Soybeans, red beans, etc.]

- ○Implementation of drainage and dissemination of Farm-oriented enhancement for aquatic system as countermeasures against high precipitation, high temperature and drought
- ○Development and dissemination of weed control technology, etc.

[Tea]

- ○Introduction of frost prevention technology using power-saving frost prevention fan systems, etc. as a measure against frost damage
- ○As drought countermeasures, control evaporation of soil water by bedding grass, etc. and implement irrigation.
- ○Demonstration and introduction of an integrated pest management system as a countermeasure against pests

[Sugar beet]

- ○Periodic monitoring of growth condition to take appropriate countermeasures against high temperature
- ○Drainage coping with high precipitation

[Potato]

- ○Prevention of overwintering of unharvested potatoes by snow plowing and snow compaction

Development and dissemination of varieties

[Wheat and Barley]

- ○Development and dissemination of varieties resistant to scab, pre-harvest sprouting, etc. as a countermeasure against high precipitation and moisture
- ○ Development and dissemination of varieties adapted to climate change to prevent frost damage

[Soybean]

- ○Development and dissemination of pest-resistant varieties

[Tea]

- ○Promote planting of varieties with resistance to pests

[Sugar beet]

- ○Dissemination of varieties with multiple disease resistance
- ○Acquirement of expertise for selecting the best variety

Pre-harvest sprouting in wheat

Damage caused by the mulberry white beetle in tea

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Horticultural Crops (Vegetables and Flowering Plants)]

Impact

< Current status>

[Open-air vegetables]

- ○ Harvest season tends to be earlier.
- ○ Increased frequency of growth disorders

[Flowering plants]

- ○ Advance or delay in flowering period, poor growth (deformed flowers, short-stemmed flowers, etc.)

[Facility vegetables and flowers]

- ○ Poor fruit set, poor growth (split fruit, poorly colored fruit, etc.) of tomatoes, etc.
- ○ Delayed flower bud differentiation in strawberry
- ○ Collapse of greenhouses due to natural disasters

<Future prediction>

[Vegetables]

- ○ In many cases, it is assumed that the cultivation of leafy and root vegetables can be continued by shifting the cultivation period.
- ○ In leafy greens such as cabbage and lettuce, early growth, the northward expansion of cultivation areas, and an increase in weight are expected.
- ○ There are concerns about the impact on fruit size and yield of fruit crops (tomatoes, bell peppers).


Fruit cracking


Poor coloring in tomatoes


Chrysanthemum normal flower


Chrysanthemum deformed flower

Countermeasures

Development and dissemination of adaptation technologies

[Open-air vegetables]

- ○ Promote adjustment of the cultivation period and timely pest control.
- ○ As a countermeasure against drought, deep tillage, application of organic matter, improvement of irrigation facilities, and use of mulch sheets to control soil moisture evaporation are promoted.
- ○ Appropriate control of spider mites, which tend to occur during droughts.

[Flowering plants]

- ○ Appropriate watering to prevent high temperature, etc.
- ○ Improvement of irrigation system, prevention of soil evaporation by mulching, etc., and timely control of pests that tend to occur during droughts.

[Facility vegetables and flowers]

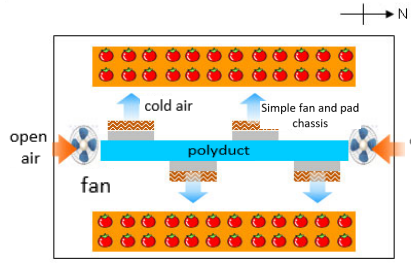
- ○ As a countermeasure against high temperature, appropriate ventilation and shading, mulching to control soil temperature, introduction of fogging system, fan and pad cooling, circulation fans, heat pump cooling, etc.
- ○ As countermeasures against natural disasters in general, introduction of disaster-resistant low-cost weatherproof greenhouses, reinforcement of pipe greenhouses, introduction of auxiliary power sources, preparing BCP, etc.


Ground temperature control mulch


Fine mist cooling


Heat pump

Simple installation of fan and pad



chassis layout

Equipment appearance and installation conditions

Development and dissemination of varieties

[Vegetables]

- ○ Development and dissemination of varieties adapted to high temperature conditions
- ○ Appropriate variety selection

[Flowering plants]

- ○ Selection of varieties adapted to high temperature conditions

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Livestock]

Impact

<Current status>

- During the summer season, the milk yield and composition of dairy cattle decline, the growth and meat quality of beef cattle, pigs and meat chickens decline, and the egg-laying rate and egg weight of egg-laying hens decline.
- Northward expansion of the habitat of arthropods such as mosquitoes and nucellus, biting midges, etc.
- In the case of forage crops, there are some reported cases of increasing annual dry matter yield in forage corn during the period 2001-2012 in parts of the Kanto region.

<Future prediction>

- Impacts on livestock growth are predicted as global warming progresses.
- In forage corn, the suitable area for double cropping is expected to expand in the 2080s.

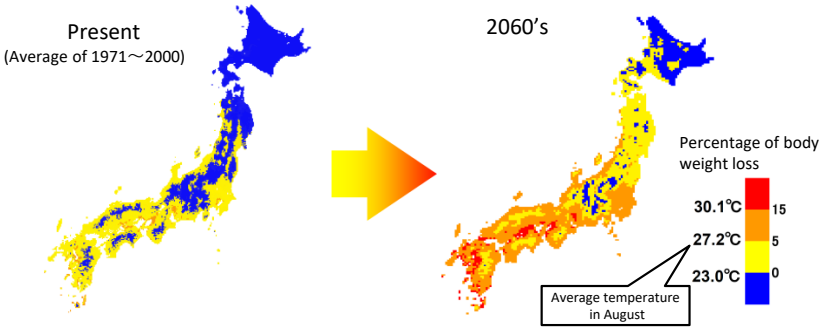
Occurrence of Global Warming Impacts in Dairy Cattle

Main phenomena	Number of reporting prefectures					Outbreak of Main cause	Main impact
	R2	R1	H30	H29	H28		
Decrease in milk yield and milk composition	17	14	14	16	15	High temperature	Decline in quality and production volume
Falling dead	12	15	17	15	14	High temperature	Decline in production
Decline in breeding performance	11	8	7	8	9	High temperature	Decline in production
Disease outbreaks	2	3	4	3	3	High temperature	Decline in quality and production volume

(Source: Crop Production Bureau, MAFF)

Forage corn

Impacts of Global Warming on Chicken Production



Source: NARO

Countermeasures

Development and dissemination of adaptation technologies

(Livestock)
[High temperature measures]

- Ensuring an appropriate livestock barn environment through the spread of heat-heat measures such as sprinkling and misting inside livestock barns, ventilation, and lime application and sprinkling of water on roofs
- Guidance and thorough implementation of appropriate feeding management techniques, such as feeding cold water and high-quality feed
- Development and dissemination of productivity-enhancing technologies, etc. to prevent the decline in body growth rate and fecundity in summer

Exhaust fan on barn wall

Lime application to barn roofs

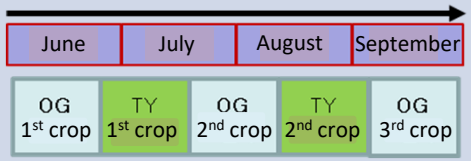
Sprinkler installation on barn roof

(Animal infectious disease)

- Review of risk management measures for arthropod-borne infectious

(Forage crops)
[Measures against high temperature and weather disasters] [Measures against pests and diseases]

- Establishment of cultivation system in response to climate change
- Development and dissemination of cultivation management technology



Examples of risk-distributed roughage production initiatives
By planting grasses with different optimal harvest times, yield reduction due to unseasonable weather is mitigated.
(OG: Orchard Grass, TY: Timothy)

Development and dissemination of varieties

(Forage crops)
[Measures against high temperature and weather disasters]

- Development and dissemination of varieties and breeding materials with heat resistance, wide ripening period, etc.

[Pest Control]

- Development and dissemination of resistant varieties and breeding materials

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Pests, Weeds, etc.]

Impact

<Current status>

[Pests and Diseases]

○ The distribution areas of the southern green stink bug and the golden apple snail have expanded from parts of the southwestern warm regions to parts of the Kanto region.

[Weeds]

○ Some weeds have expanded their distribution areas northwards because of successful overwintering.

○ Expansion of the distribution area of invasive weeds including invasive alien species

[Mycotoxins]

○ Temperature may influence the distribution of aflatoxin-producing fungi.

Golden apple snail

Photo: Mie Prefectural Agricultural Research Institute

Current distribution of the southern green stink bug

Source: MAFF and Pest forecasting information by each Prefecture (Oct. 2018)

<Future prediction>

[Pest]

○ Changes in the composition of pests and natural enemies in paddy fields, increase in damage due to an increase in the number of generations per year, and possibility of changes in the overseas situation of migratory pests

○ Possibility of increasing difficulty in pest control due to an increase in the amount of occurrence and changes in seasonal occurrence.

[Diseases]

○ Increase of rice sheath blight under high CO_2 conditions

[Weeds]

○ Possible expansion of established area and agricultural damage in some species

[Mycotoxin]

○ Concerns about increasing density of mycotoxin-producing fungi in the soil

healthy infected

rice sheath blight

Photo: Kyushu-Okinawa Agricultural Research Center, NARO

Source: Central Agricultural Research Center, NARO

Countermeasures

Implementation of countermeasures

[Pests and Diseases]

○Understand the situation of occurrence and damage of pests and review the plants and animals designated as harmful speciesthrough the pest forecasting service.

○Establishment of a pest control system that responds to climate change

○Review and revision of import quarantine, pest risk analysis (PRA), and measures based on the results of PRA to prevent introduction of pests and diseases from overseas

○Domestic quarantine, invasion alert survey and control of invasive pests

[Mycotoxin]

○Investigating occurrence data

○Formulate and disseminate safety improvement measures in cooperation with producers, and verify their effectiveness after a certain period of time.

Research and Development

[Pests and Diseases]

○Development of technology for monitoring changes in the dispersal of long-distance migratory insect pests from overseas and technology for predicting changes in their distribution areas in Japan.

○ Development of prediction techniques for the entry and occurrence of transboundary pests such as planthoppers and cutworms

○ Development of a support system for control of the golden apple snail

[Weeds]

○ Development of management techniques for invasive weeds that cause agricultural damage

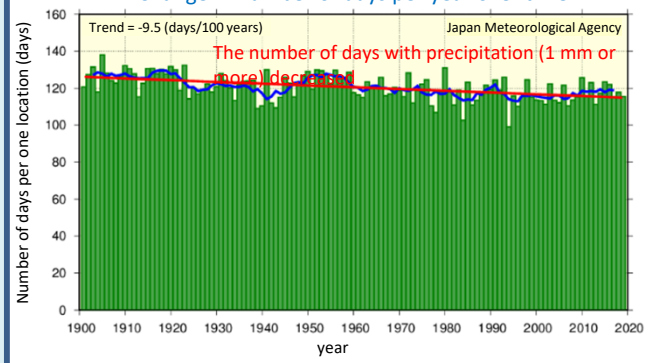
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Agricultural Production Infrastructure]

Impact

<Current status>

- ○ Short, heavy rains occur frequently, while droughts due to light rainfall also occur.
- ○ In response to high temperatures, changes in the timing of rice planting, changes in water management, etc., will affect water demand.

Daily precipitation of 1.0 mm or more
Change in number of days per year over time



Source: Japan Meteorological Agency

Coping with high temperatures and Impact on water demand (example)

○ Late planting of rice
Postponement of irrigation period
○ Daytime deep water and nighttime drop water management
→Increase in the amount of water used

Extension of waterlogging period
→Increase in the amount of water used

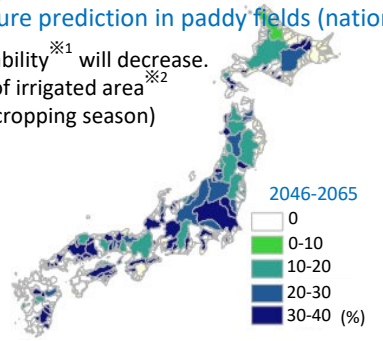
Source: Institute of Rural Engineering, NARO

<Future prediction>

- ○ Decrease in snowmelt runoff volume, affecting water intake at agricultural water utilization facilities
- ○ Increased risk of waterlogging damage to farmland due to increased rainfall intensity
- ○ The number of days without rainfall has increased, affecting the recovery of reservoir storage capacity.

Example of future prediction in paddy fields (nationwide)

Water availability※1 will decrease.
Proportion of irrigated area※2
(during the cropping season)



※1 Sufficiency ratio: Amount of water supplied / amount of water required
※ 2 Total irrigated land in the basin between 2046 and 2065
Percentage of districts with lower fill rates relative to the number of districts

Source: Rural Engineering Research Division, NARO

Waterlogging damage to farmland caused by torrential rain

Countermeasures

Drought prevention measures	Measures against waterlogging, etc.
○Efficient securing and utilization of agricultural water through an appropriate combination of hard and soft measures ・Reduction of water consumption through automation of water management and use of pipelines, etc. ・Effective use of existing water sources through changes in the operation of reservoirs and agricultural dams	○Maintaining and improving of disaster prevention and mitigation functions in rural areas through an appropriate combination of hard and soft measures. ・Promotion of the prevention of waterlogging damage to farmland by improving drainage pump stations and drainage channels. ・Grasp facilities and areas that are highly vulnerable to waterlogging, and conduct risk assessments such as developing hazard maps. ・Promotion of the formulation of business continuity plans by facility managers. ・Implementation of efficient countermeasures by effectively using existing facilities and utilizing the functions of local communities.

○Prediction and assessment of medium- to long-term impacts based on new scientific findings
○Establishing an impact assessment method and clarifying the rationale for developing facilities based on future prediction

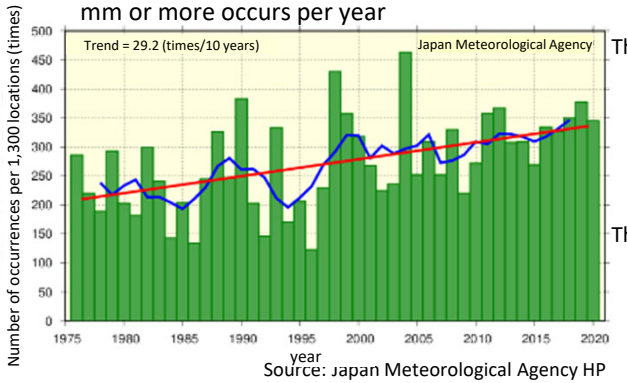
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Mountainous Disaster and Forest Conservation Works and Forest Road Facilities]

Impact

<Current status>

- ○ Concentrated torrential rainfall caused by the formation of linear precipitation zones triggers multiple surface collapses and mudslides.
- ○ Driftwood disasters occur frequently when collapsed sediment flows downstream, engulfing standing trees and sediment in the vicinity of the stream, causing a large amount of driftwood.

■ Number of times an hourly precipitation of 50 mm or more occurs per year



Source: Japan Meteorological Agency HP

■ Severe mountain disasters caused by torrential rains

The outbreak of simultaneous collapses

Heavy rainfall in July, 2018 (Hiroshima, Japan)

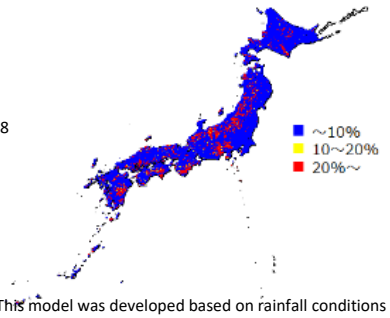
The occurrence of severe driftwood disasters

July, 2017 Devastated northern Kyushu (Fukuoka, Japan)

<Future prediction>

- ○ Increase in the frequency of heavy rainfall due to climate change, and increase in the number of simultaneous collapses of hillside slopes and mudslides due to increased localized heavy rainfall
- ○ Increased risk of damage from storm surges, tidal waves and tsunamis, and increased coastal erosion trends

■ Slope Failure Probability (2081-2100)



※This model was developed based on rainfall conditions and disaster records in one area. It is necessary to verify the rainfall conditions and disaster records for a wide area in the future.

Source: Integrated Report on Climate Change Observation, Prediction and Impact Assessment 2018

■ 1/25-year probability with uncertainty
Projected future changes in storm

※ Storm surge anomaly (rise and fall of sea level due to storm surge) with a probability of occurrence of 1/25 years (4% annually)

Source: Integrated Report on Climate Change Observation, Prediction and Impact Assessment 2018

Countermeasures

Implementation of countermeasures, research and development, etc.

[Increased risk of occurrence of mountain disasters]

- ○Promotion of mountain control measures and forest improvement based on the "Five-Year Acceleration Plan for Disaster Prevention, Disaster Mitigation, and Building National Resilience" and other measures
- ○Development of forest road facilities in consideration of the increased frequency of torrential rains.

(Response to changes in the form of disasters such as river flooding)

- ○Promote efforts to improve and conserve forests in the upper reaches of rivers, etc., in cooperation with efforts for watershed flood control.
- ○Reduce the risk of driftwood disasters by installing driftwood-catching dams, conducting forest maintenance such as thinning to promote the development of root systems, cutting down dangerous trees in mountain streams, and changing forest types with consideration for the stream ecosystem.
- ○Control of sediment runoff through the careful placement of erosion control dams.

[Increased risk from storm surges, tidal waves and tsunamis]

- ○Strengthen development of coastal disaster prevention forests to protect against tsunami and wind damage.

[Research and development, etc.]

- ○Study to improve the accuracy of identifying high-risk areas for mountain disasters by using laser surveying, etc.
- ○Study on the development of facilities to cope with disaster risks and forest management utilizing the disaster prevention and mitigation functions of forests.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Planted Forests]

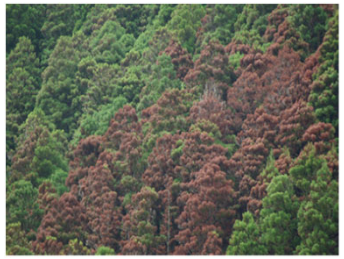
Impact

<Current status>

○ It has been reported that cedar forests are declining due to increased water stress caused by the drying of the atmosphere in some areas.

○ It has been reported that high temperatures increase the risk of forest pests and diseases.

※Since factors other than temperature can also affect damage, careful verification of the current impact is needed.



Withering cedar trees due to drought

Vectors of pine wilt disease (Bursaphelenchus xylophilus)

<Future prediction>

○Vulnerability of planted cedar forests may increase in areas with low rainfall

○There are examples of studies that predict an increase in the distribution of forest pests and diseases

Decreased growth and death of trees due to increased temperatures, dryness, and weather damage

Occurrence in areas where pine beetle damage has not been seen in the past, such as high latitudes and high elevations

Research and study on the impact of climate change on the forest and forestry sectors is needed.

Countermeasures

Research and Development

○Assessment of climate change impact prediction and adaptation measures for forestry

○Continue monitoring of forest damage

Long-term monitoring of plantation forest growth

Pine wood nematode disease monitoring study sites

Implementation of countermeasures

○Evaluate the adaptability of plantation trees by conducting wide-area planting tests of seeds and seedlings of major plantation tree species from different origins.

○Control of forest pests shall be continued in cooperation with prefectures, etc. based on the Law for the Control of Forest Pests in order to prevent the spread of forest pests

Responding to Climate Change. Promotion of variety development

Prevention of infection (chemical spraying)

Felling and extermination (fumigation treatment)

Measures against pine weevil damage

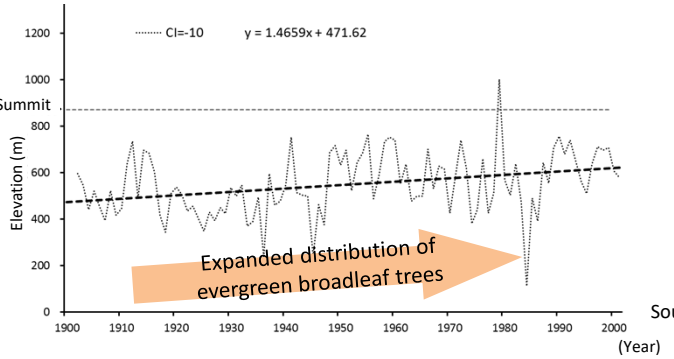
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Natural Forest]

Impact

<Current status>

○ There are areas where deciduous broadleaf trees are likely to have been replaced by evergreen broadleaf trees due to rising temperatures.

■ The upper limit of the potential vertical distribution of evergreen broadleaf forests



Source: FFPRI

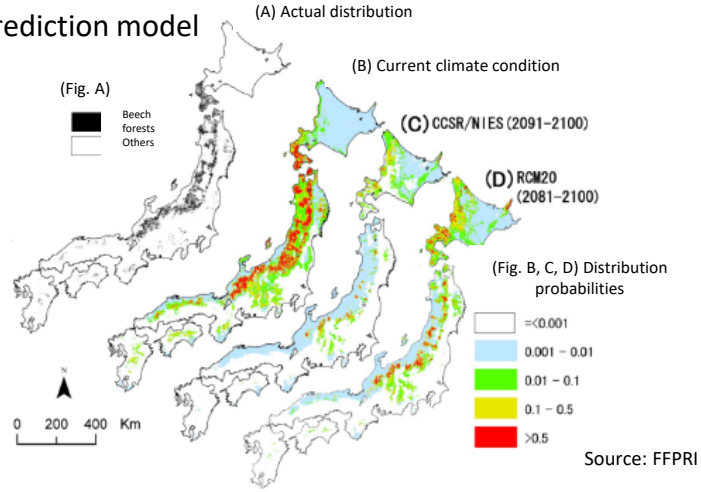
The upper elevation of the warm-temperate evergreen broad-leaved forest zone on Mt. Tsukuba has increased by 147 m over the past 100 years*.

※ Estimating the distribution limit elevation of evergreen broad-leaved trees using climate data for the past 100 years

<Future prediction>

○ It has been reported that the distribution area of some cool-temperate species decreases and that of some warm-temperate species increases.

■ Distribution prediction model for beech forests



Source: FFPRI

The probability of beech distribution in 2081-2100 decreases when the temperature rises 4.9° C above the present level (C) or 2.9° C above the present level (D).

Countermeasures

Implementation of countermeasures

○Promote appropriate conservation and management through ongoing monitoring surveys and other measures in "protected forests" and "green corridors" in state-owned forests.

A black bear in the Green Corridor

Protected forests that are properly protected and managed

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Non-Timber Forest Products (Mushrooms, etc.)]

Impact

<Current status>

○ Increase in temperature during the summer, resulting in the outbreak of pathogenic bacteria and a decrease in the amount of shiitake mushroom bodies (mushrooms) produced

Hedgerow infected with pathogen

■ **More reports of damage caused by Hypocreia spp. in Kyushu**

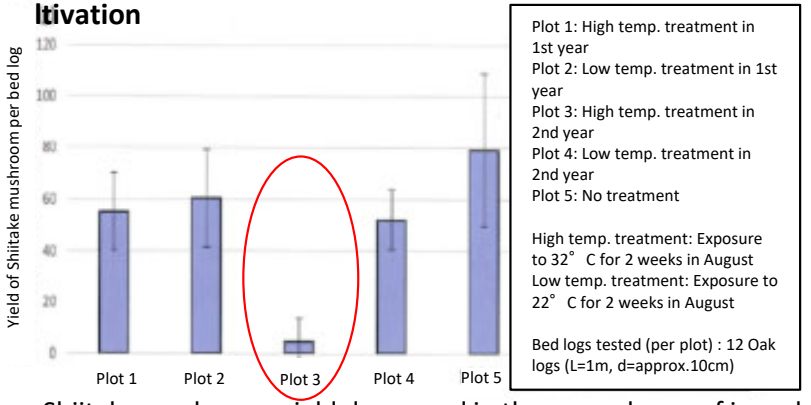
Source: Kyusyu Research Center, FFPRI

<Future prediction>

○ Decrease in outbreaks of pathogenic fungi and the amount of shiitake mushroom bodies (mushrooms) due to rising temperatures in the summer

○ Impact of rising temperatures in winter on log cultivation

■ **Impacts of temperature treatment in summer on shiitake ltivation**



Shiitake mushroom yield decreased in the second year of inoculation in the test area under high temperature

Vertical line: Standard deviation, * Yield: Dry weight (g) Source: Kyusyu Research Center, FFPRI

Countermeasures

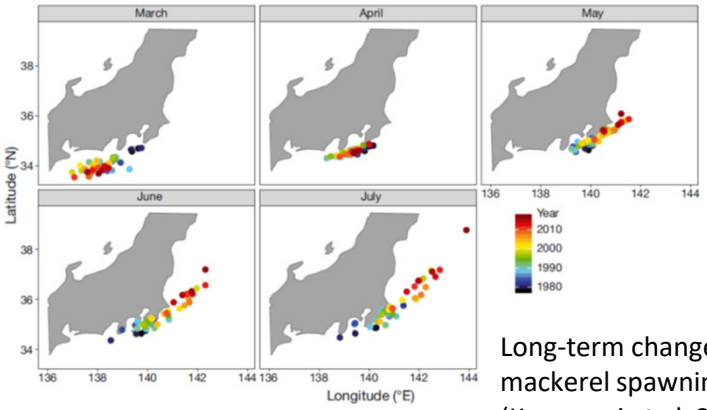
Understanding of the impact	Research and Development
○ Estimation of damage caused by pathogens and infection routes	○ Study of cultivation method to suppress temperature rise in the field
○ Occurrence of damage caused by the mushroom fly	○ Promote the development, demonstration, and dissemination of cultivation techniques and varieties of shiitake adapted to a warming climate.
○ Yield in high temperature environment in summer	
○ Promote accumulation of data on outbreaks of pathogens, yield, etc.	

Outline of the Climate Change Adaptation Plan of the Ministry of Agriculture, Forestry and Fisheries [Marine Fisheries]

Impact

<Current status>

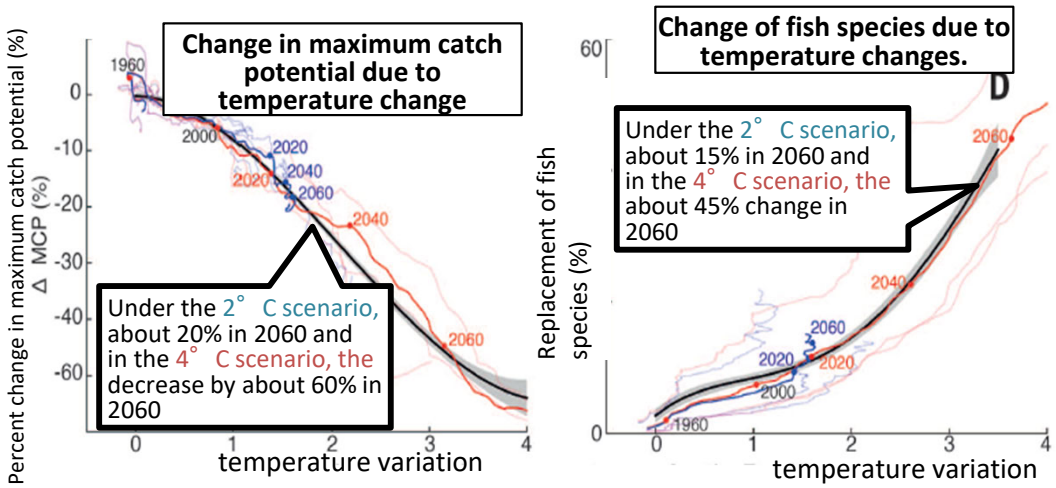
- ○Northward shift of mackerel spawning grounds and extension of spawning period
- ○Increase in catches of yellowtail and Spanish mackerel
- ○Decrease in return rates of chum salmon
- ○Decrease in recruitment and survival of Japanese flying squid
- ○Offshore shift of fishing grounds and spawning grounds for saury
- ○Decrease in pollock recruitment
- ○In some areas, the processing and distribution industries have been affected by the above changes.



Long-term changes in estimated mackerel spawning grounds (Kanamori et al. 2019)

<Future prediction>

- ○ Decrease in global potential maximum catch
- ○ The following forecasts have been reported for the waters around Japan
  - ・Decrease in the distribution area of salmon and trout
  - ・Offshore shift to high seas of Pacific saury fishing grounds
  - ・The sparse distribution is expanding and size of Japanese flying squid is decreasing in the Japan Sea.
  - ・ Northward shifts of adult Japanese anchovy distribution and high survival area of juvenile anchovy
  - ・ Northward shifts of yellowtail distribution and changes in their wintering area



*Prepared by Fisheries Agency from Cheung et al. (2016).

Countermeasures

adaptation plan

[Migratory fish]

○Necessity to properly assess the impact of environmental changes in promoting resource management based on scientific stock assessment

○For this purpose, marine environmental surveys will be utilized to improve the accuracy of predicting fishing grounds and stock assessment results, which will lead to promote measures for adaptive fisheries production in response to environmental changes.

[Target species for multiplication]

○Development of release methods for juvenile salmon and other fish in consideration of marine environmental changes.

[Fishing environment]

○Identification of factors affecting harmful algal blooms and countermeasures based on real-time information from various coastal observations

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Marine Aquaculture]

Impact

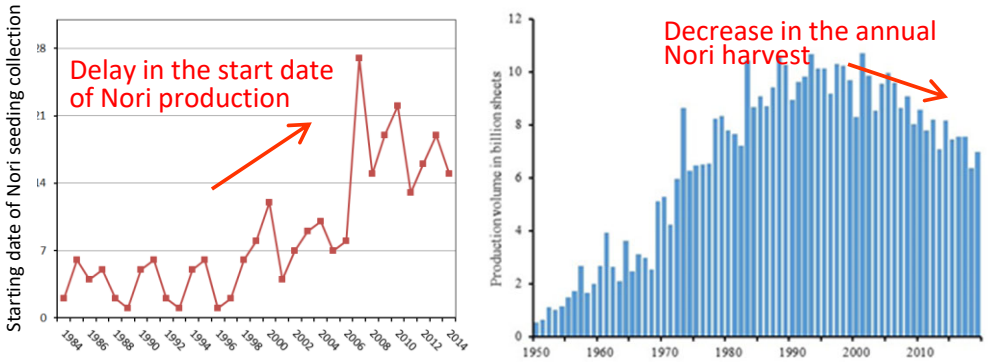
<Current status>

○Increase in mass death of scallop and oyster, and changes in their amount of production in various regions

○Decrease in annual harvest of cultivated laver due to delays of seeding periods

○Identification of northward shift of harmful algal bloom, and occurrence of warm-water species in cold regions and their acceleration

○Delay harvest timing of nori and their unstable amount of production due to high water temperature in autumn



Note: Factors other than global warming may have contributed to the delay in the start of production and the change in yield.

<Future prediction>

○ In yellowtail aquaculture, mortality will increase in summer and growth rates will increase in autumn and winter.

○ In red sea bream aquaculture, growth rate will decrease, and risk of infectious diseases will increase.

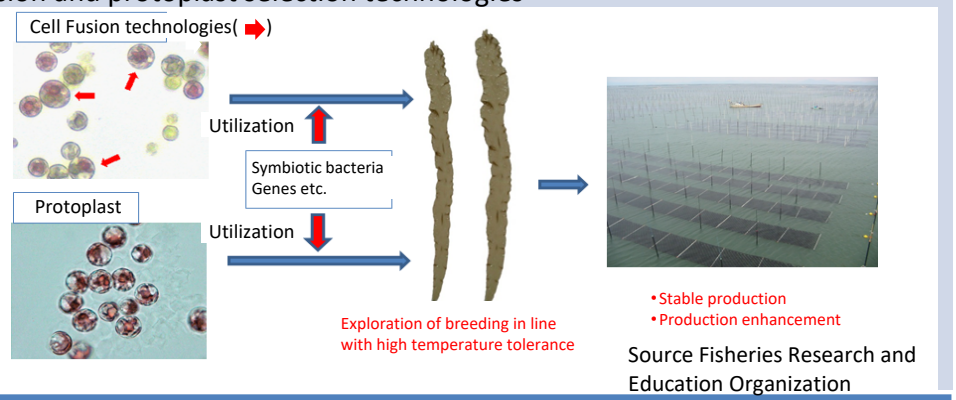
○ The suitable areas for yellowtail, tiger puffer, and flatfish cultivation will move northward, and some areas will become unsuitable for cultivation.

○ Ocean acidification is expected to affect mollusks and echinoderms that have calcium carbonate skeletons and shells. Acidification of the oceans will affect mollusks and echinoderms with calcium carbonate skeletons and shells, and other sensitive aquaculture species.

○ Harmful algal blooms related to rising sea temperatures are expected to increase the risk of bivalve die-offs.

Examples of Initiatives

○ Development of breeding materials for Nori and other species with high water temperature tolerance using novel breeding technologies such as cell fusion and protoplast selection technologies



Source Fisheries Research and Education Organization

Countermeasures

adaptation plan

[Red Tide]

○Continuation of research on the relevance of climate change

○Understand the physiological and ecological characteristics of harmful algae, and develop prediction and prevent technologies for harmful algal blooms.

[Growth, Disease Control]

○Development aquaculture varieties with high water temperature tolerance, etc.

○Develop countermeasure technologies for fish and shellfish diseases that occur at high temperatures and create guidelines for countermeasures against diseases that are feared to invade Japan.

[Ocean Acidification]

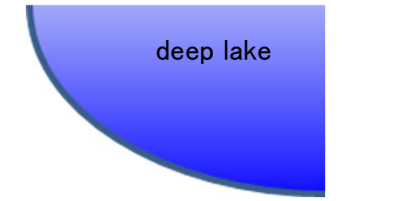
○Development countermeasure technologies based on predictions of the impact of acidification on bivalve aquaculture, etc.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Inland Fisheries and Aquaculture]

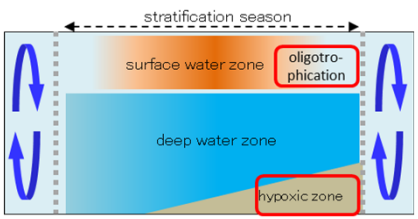
Impact

<Current status>

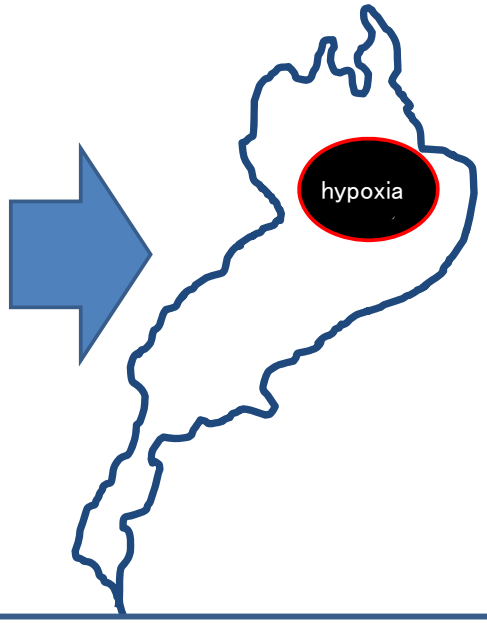
○ Impacts on inland fisheries and aquaculture are not yet apparent.
○ However, in some lakes and marshes, the warm winter has weakened the circulation of lake water, resulting in a decrease in dissolved oxygen at the bottom of the lake and a tendency toward anoxia.
○ High mortality of Japanese pond smelt due to high lake water temperature



hypoxia at the bottom of lake



Hypoxia causes die-offs of fish and decreases habitat area

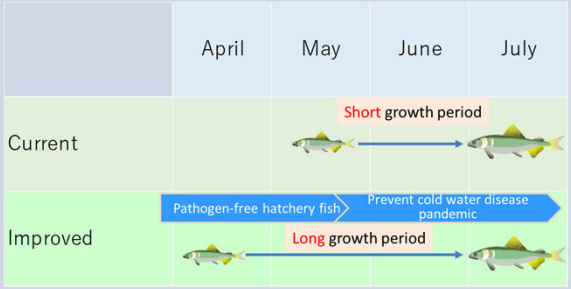


<Future prediction>

○ Habitat contraction of cold-water fish (larger contraction especially in rivers in Honshu)
○ Decrease in catches of Japanese pond smelt due to high water temperature in lakes
○ Earlier run-up of ayu (sweetfish) and reduction in the number of run-ups due to rising water temperatures in the ocean and rivers

Examples of Initiatives

○Study of release methods with changes in the run-up of ayu
○Maximize the effect of hatchery release for juvenile ayu of the appropriate growth stage and time.



Countermeasures

adaptation plan

[Understanding the impact]
○Assess environmental changes in rivers and lakes and their impact on habitats for important resources
○Collect information on disease caused by high water temperature
[Growth, Disease Control]
○Development of technologies for hatchery release and prey plankton production, etc., for the advancement of feeding and releasing techniques for Japanese pond smelt.
○Analyze the impact of rising water temperature on the run-up, run-down, and growth of ayu fish, and develop effective discharge methods.
○Research on the characteristics and pathogenic factors of pathogens originating from high water temperature, and development of technology for control measures

Outline of the Climate Change Adaptation Plan of the Ministry of Agriculture, Forestry and Fisheries (MAFF) [Constructed Fishing Grounds]

Impact

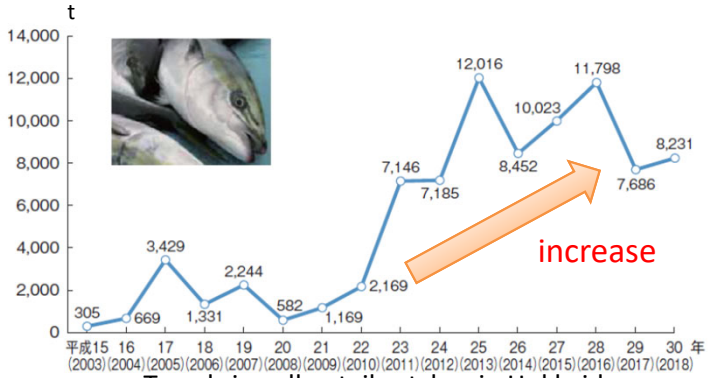
<Current status>

- ○Northward expansion of the southern limit of the distribution of algae in the family Sciaenidae
- ○Increase in feeding behavior and expansion of distribution of plant-eating fish such as lingcod
- ○Changes in the distribution of many marine organisms

A flock of Eigo and Notorious Sparrowhawk

<Future prediction>

- ○Changes in the species composition and existing amount of seaweed beds due to rising sea temperatures, and the impact on rocky root resources
- ○Northward shift of the distribution of many target species



Trends in yellowtail catches in Hokkaido

Countermeasures

adjustment measures

- ○Promotion of wide-area measures that integrate the understanding of the factors behind the decline of seaweed beds and tidal flats in each sea area, hard measures such as the creation of seaweed beds and tidal flats implemented by local governments, and soft measures such as conservation activities implemented by fishermen and local residents.
- ○Strengthen the monitoring system, develop infrastructure to cope with changes in the distribution of fish and seaweed, and promote the development of fishing grounds based on the life history of fishery organisms in cooperation with resource management efforts.

Implementation of fishing ground improvement in line with the arrival of warm-sea fish.

Arrival of yellowfin grouper

Installation of fish reefs to serve as habitats

Feeding damage caused by lice and other insects

Extermination of pests

Change of seagrass bed component species to southern seaweeds

Responding to changes in constituent species
Creation of seaweed beds

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Fishing Ports and Villages]

Impact

<Current status>

○Analysis of tide level observation records shows that the sea level is on the rise.

○Regarding storm surges, it has been pointed out that there is a high possibility that the occurrence of extreme high tide levels is increasing, and regarding storm waves, it has been confirmed that the maximum value of significant wave height is also on the increase.

Storm surge damage caused by low pressure

High waves over the breakwater

<Future prediction>

○If the sea level rises, the functions of coastal disaster prevention facilities, fishing port facilities, etc. may be degraded or damaged, and coastal areas may be submerged or flooded, and coastal erosion may be accelerated.

○There is a risk that storm surges and tidal waves may cause many coastal disaster prevention facilities and structures such as fishing port facilities to become unsafe.

Wave overtopping by high waves

Coasts that need to be protected against storm surge and tidal waves

Countermeasures

Basic Concept

○Fishing ports are located in coastal areas, and it is predicted that the safety and convenience of the facilities will be greatly affected by the rise in sea level, tidal deviation, and increase in wave height due to climate change, therefore strategic and adaptive adaptation measures will be taken.

○Promote disaster prevention and disaster mitigation measures against typhoons and cyclones, which are expected to become more severe in the future and create disaster-resistant fishing communities.

Basic Measures

○ Monitoring of tide levels and waves to accurately detect signs of climate change impacts in response to rising sea levels, tide level anomalies due to extreme weather events, and increased wave heights

○ Based on the results, systematically promote the development of fishing port facilities and coastal conservation facilities that take into account long-term changes in external forces due to the impact of climate change.

Raising of breakwaters

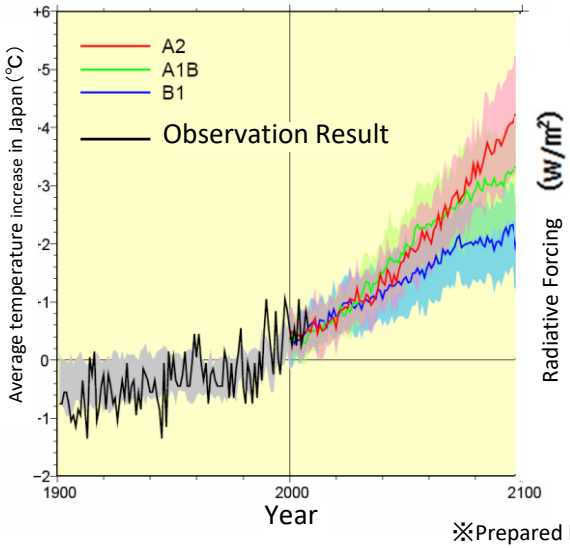
Raising the parapet

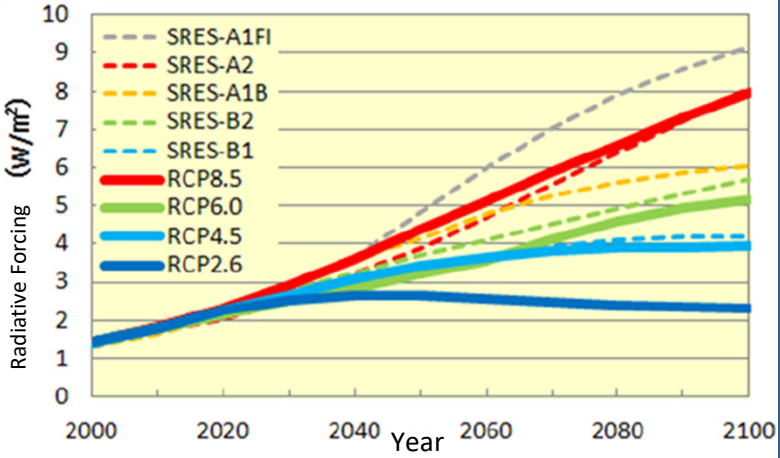
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Global Warming Prediction Research, Technology Development]

temperature increase forecast

Projected increase in average temperature in Japan

○The projected average temperatures in Japan under the A2 (emphasis on economic development and regionalism), A1B (emphasis on economic development, globalization, and energy balance), and B1 (emphasis on sustainable development and globalization) scenarios of the multiple climate prediction models used in the IPCC AR4 show that the average temperatures in Japan will increase by 4.0° C, 3.2° C, and 2.1° C, respectively, from the end of the 20th century (1980-1999) to the end of the 21st century (2090-2099). 4.0° C, 3.2° C, and 2.1° C, respectively, by the end of the 21st century (2090-2099), exceeding the global average (3.4° C, 2.8° C, and 1.8° C) in all scenarios.





※Prepared based on press releases by MEXT, METI, JMA and MOE, September 27, 2013.

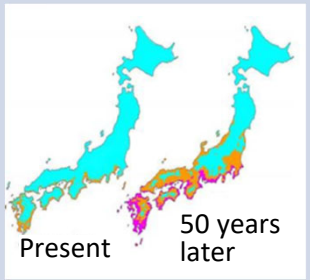
Countermeasures

predictive research

(Impact Assessment)

[Current Status]

○ Implementation of various impact assessments in the field of agriculture, forestry and fisheries



[Future vision (goal)]

○ More predictive research on needed items

○ Provide information that will serve as an opportunity for local communities to take actions on climate change

technological development

(Technology Development)

[Current Status]

○ Focusing on technological development to adapt to issues that are currently affecting rice and fruit trees, such as quality deterioration

[Future vision (goal)]

○ Development of varieties, breeding materials and stable production technologies based on medium- and long-term perspectives based on forecasting research, etc.

○ Develop technologies to take advantage of the opportunities presented by climate change

○ Development of technologies that contribute to international contributions to the Asian monsoon region, where climatic conditions and production structures are different from those in Europe and the United States, such as the technology development towards building a new food system with improved productivity, sustainability and resilience.

Regional Deployment of Adaptation Measures Based on Future Prediction

(Image of Cooperation, Division of Roles, and Information Sharing among related Parties)

National government (Ministry of Agriculture, Forestry and Fisheries)

- ○ Implementation of current and future impact assessment
- ○ Research and development of basic response technologies
- ○ Provide support measures to facilitate on-site efforts

  (Introduction of an early warning system
  Introduction of new varieties and demonstration of adaptation technology
  Introduction of weather-resistant greenhouses and adaptive materials)
- ○ Collection and dissemination of domestic and international information

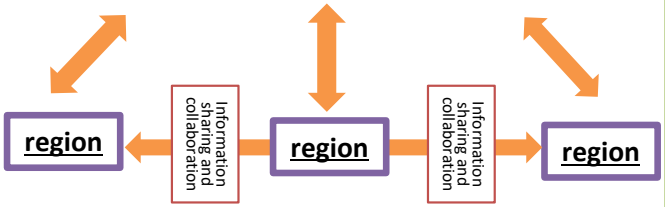
  (Provision of information through global warming impact study reports, etc.)

Regional deployment of adaptation measures based on future prediction

- ○ Provide more precise impact predictions and adaptation measures in this plan to regions with similar climatic conditions by analyzing and organizing them in an easy-to-understand manner.
- ○ Production areas in the region will implement and promote adaptation measures based on their own judgment and choice.

Region (local government, etc.)

- ○ **Independent selection of adaptation measures** offered as options
- ○ **Planning and promotion as a region**



- ○**Implementation of adaptation measures**

  e.g., introduction of new varieties, introduction of adaptive technology in cultivation management, etc.

Provide information, analysis and support to the community

Information sharing on the status of adaptation efforts in the region.

Dissemination and enlightenment to all segments of the public (users and consumers of agricultural, forestry and marine products, etc.)

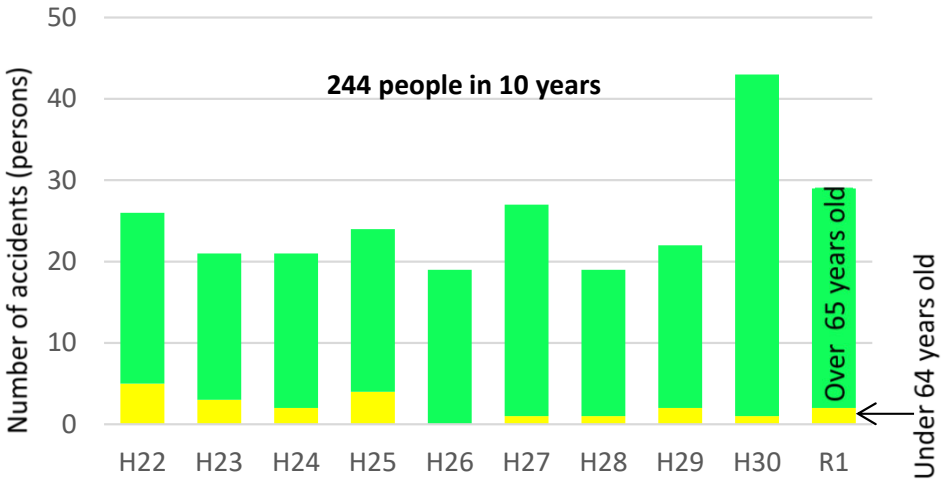
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Heat Stroke]

Impact

<Current status>

○The number of deaths due to heat stroke during work in the agriculture, forestry, and fisheries industries has been on the rise in recent years.

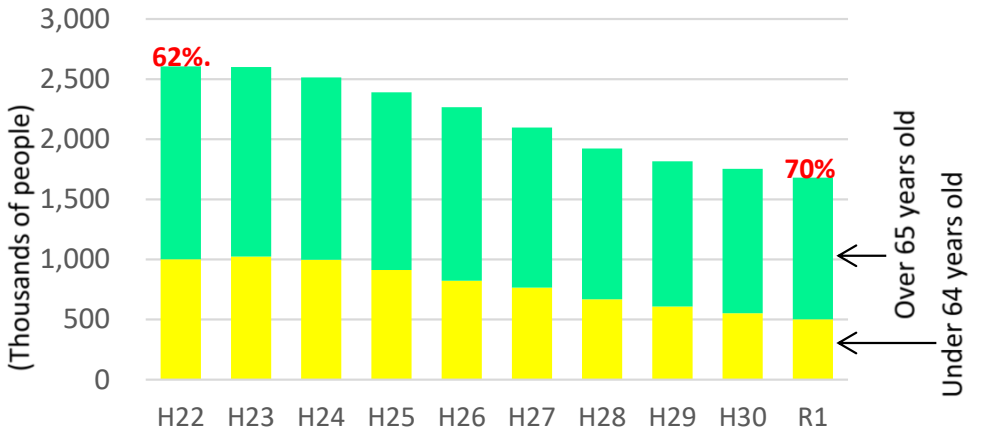
Number of fatalities due to heat stroke during agricultural work



<Future prediction>

○ The proportion of people aged 65 and over is increasing, and the incidence rate is also increasing

Changes in the agricultural workforce



(According to the MAFF)

Countermeasures

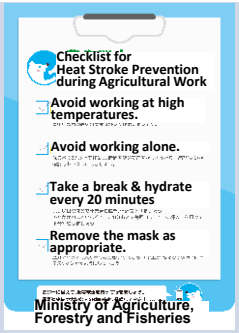
Basic measures

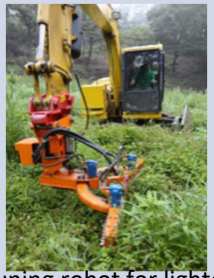
○In accordance with the Action Plan for Prevention of Heat Stroke, public information on heat stroke prevention will be disseminated by strengthening cooperation among relevant government ministries and agencies during the period of the "Campaign for Strengthening Prevention of Heat Stroke" from April to September every year.

○ Requesting prefectures and related organizations to inform workers in the agriculture, forestry, and fisheries industries about precautions such as frequent intake of water and salt, and use of sweat-absorbent and quick-drying clothing, as well as creating posters and flyers to raise awareness.

○ Promote awareness and guidance on heat stroke prevention measures for workers in the agriculture, forestry, and fisheries industries, including promotion of the use of the MAFF application, which has an additional function to notify workers of "heat stroke alert," in cooperation with relevant ministries and agencies, prefectures, and related organizations.

○ Promote the development of automated technologies for agricultural work conducted outdoors during the hot season, and actively introduce robotic technologies and ICT to lighten the workload.





A pruning robot for lightening the workload of pruning in forestry

Awareness-raising posters and flyers

Weeding Robot for Lightening the Workload of Weeding

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Bird and Animal Damage]

Impact

<Current status>

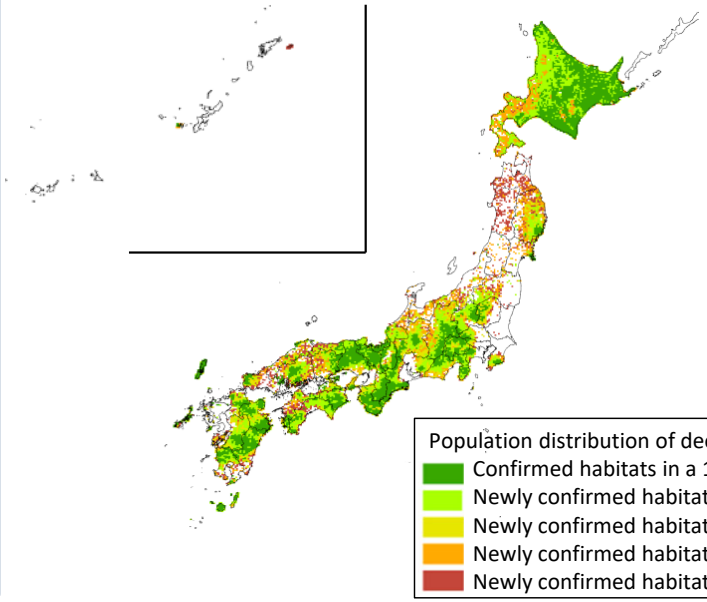
○Although the direct causal relationship with climate change is not clear, it has been reported that the expansion of the distribution of wild birds and animals has caused damage to agricultural crops, forestation trees, and fishery resources, as well as soil erosion.

<Future prediction>

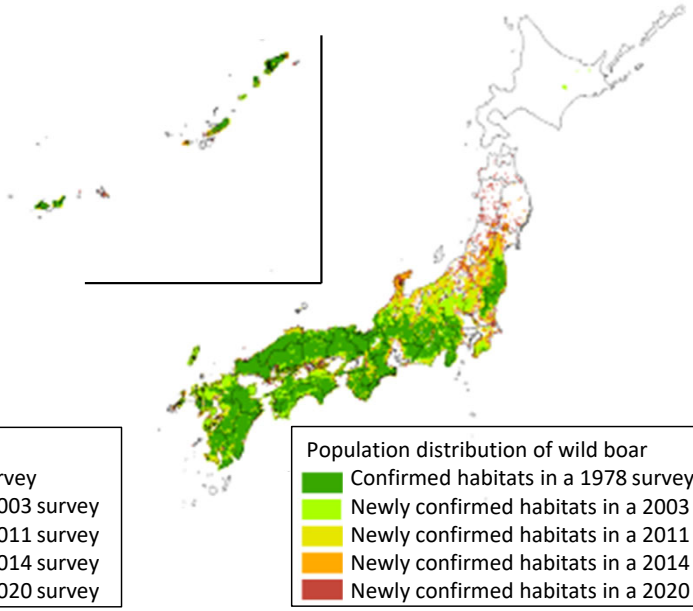
○ As for Japanese deer, it is predicted that the suitable habitat for Japanese deer in 2103 will increase to more than 90% of the national territory due to the decrease in snow cover caused by climate change. (Similar findings have not been confirmed for wild boar, etc.)

<A comparison of habitat distribution meshes across Japan (partially modified from data published by the Ministry of the Environment)>

deer (Cervus nippon)



wild boar



A radish field ravaged by wild boars

Standing trees damaged by deer stripping

Countermeasures

[Bird and animal damage prevention]

○ Since there are concerns about the expansion of the habitat area and the number of wild birds and animals, we will continue to promote the installation of intrusion prevention fences, the reinforcement of trapping activities including wide-area measures, the upgrading of techniques for trapping and damage control, and human resource development.

[Survey]

○ Grasping information on the habitat conditions of wild birds and animals

○ Continued monitoring of damage to agriculture, forestry and fisheries caused by wild birds and animals

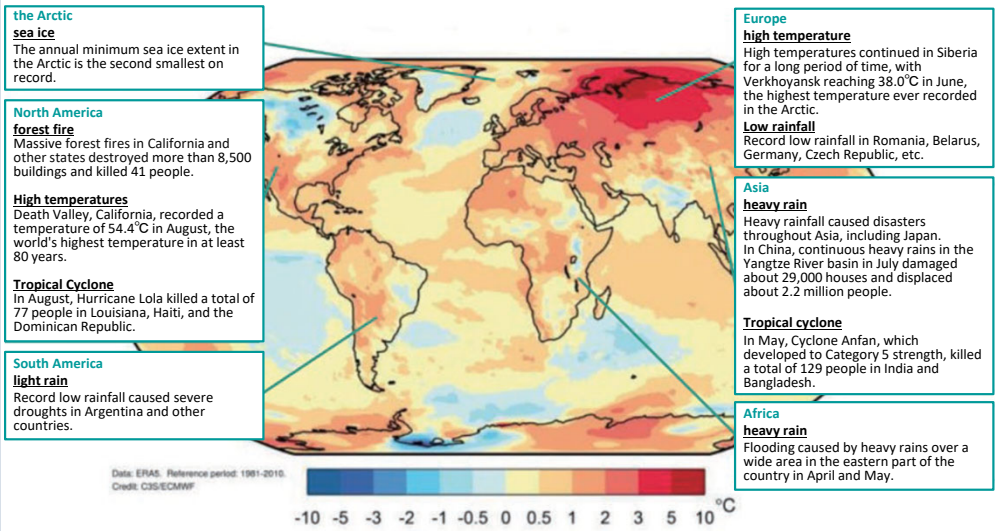
Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Food Supply and Demand]

Impact

<Current status>

○ The impacts of climate change on yields and other factors has been reported in many parts of the world, especially for major grains (wheat, soybeans, corn, and rice).

Extreme weather around the world in 2020



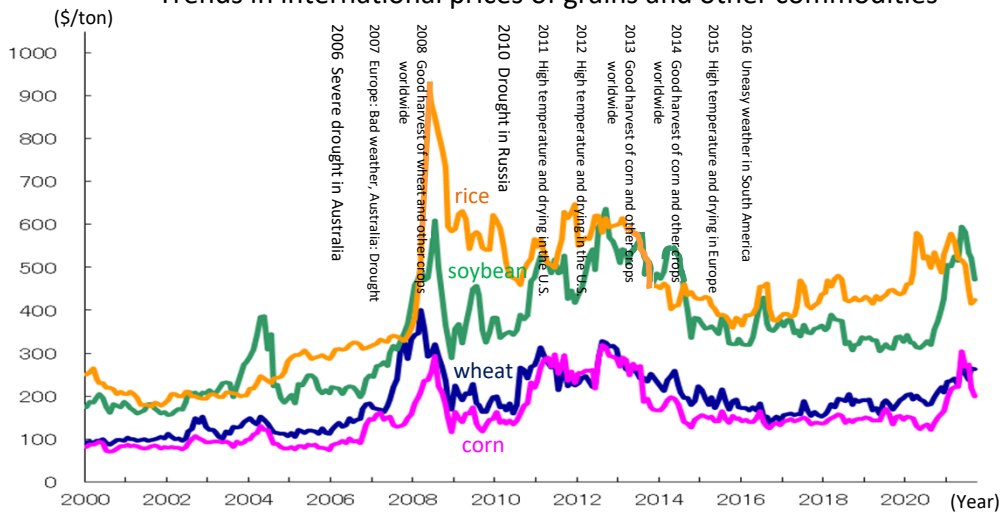
Temperature anomalies for January-October 2020 relative to 1981-2020 average

Source: 2021 White Paper on the Environment, Sound Material-Cycle Society and Biodiversity (MOE)

<Future prediction>

○ Globally, numerous literature review studies have confirmed that projected future temperature increases will reduce yields of rice, wheat, soybeans, and corn.

Trends in international prices of grains and other commodities



Note 1: For wheat, corn and soybeans, the settlement price is the closing price on the Chicago Board of Trade on the first Friday of each month. The price of rice is the FOB price of 100% Thai milled leach rice (2nd class) on the first Wednesday of each month as published by the National Board of Trade of Thailand.

Note 2: For the highest historical price, the highest price published by the National Board of Trade of Thailand for rice, and the highest closing price of the period for all trading days on the Chicago Board of Trade for all prices other than rice.

Countermeasures

In order to prepare for unforeseen circumstances, we will analyze and assess the impact of climate change, conduct research and analysis on Japan's future food supply and demand, and study and review countermeasures to establish comprehensive food security.

○Collection and analysis of information on domestic and international food supply and demand trends and analysis of their impact on the stable supply of food in Japan, and provision of a wide range of information

○The agro-meteorological information satellite monitoring system developed in cooperation with JAXA was opened to the public and utilized to monitor food supply trends overseas.

○Based on the results of the IPCC's climate change assessment and the world's ultra-long-term food supply and demand predictions based on economic growth predictions, etc., we will consider appropriate responses to risks with a view to future food supply and demand in Japan.

○Continuously conduct medium- to long-term forecasts of global food supply and demand based on trends in each country's economic growth and policies.

Outline of the Ministry of Agriculture, Forestry and Fisheries Climate Change Adaptation Plan [Food Manufacturing]

Impact

<Current status>

○ The food manufacturing industry is considered to be particularly vulnerable to the impacts of climate change on raw material procurement and quality, and there are reports of cases where these impacts have already begun to occur.

<Future prediction>

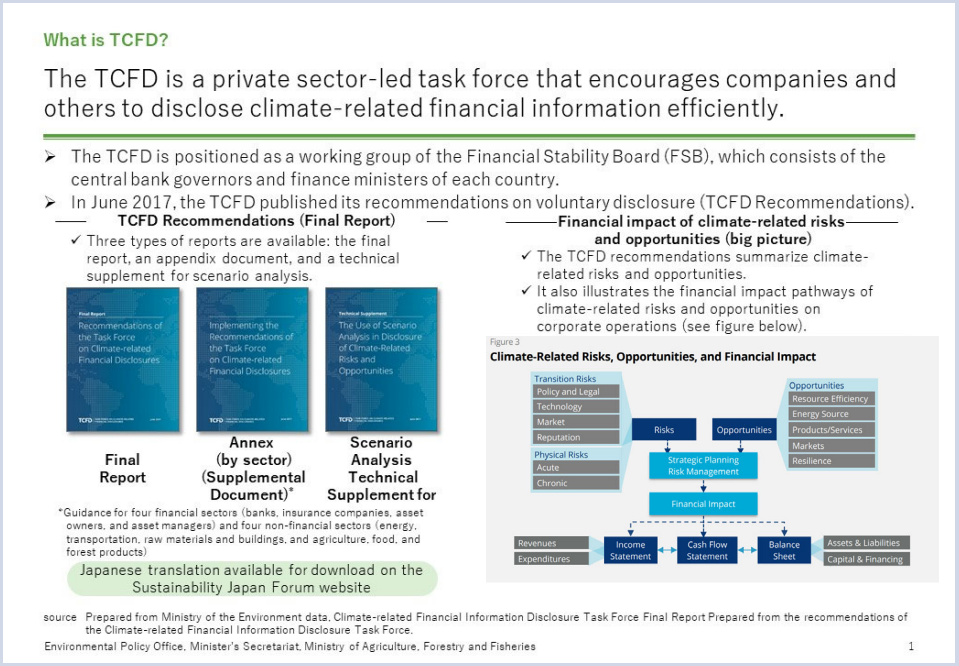
○ Historically, companies have perceived climate change as a risk and an opportunity.

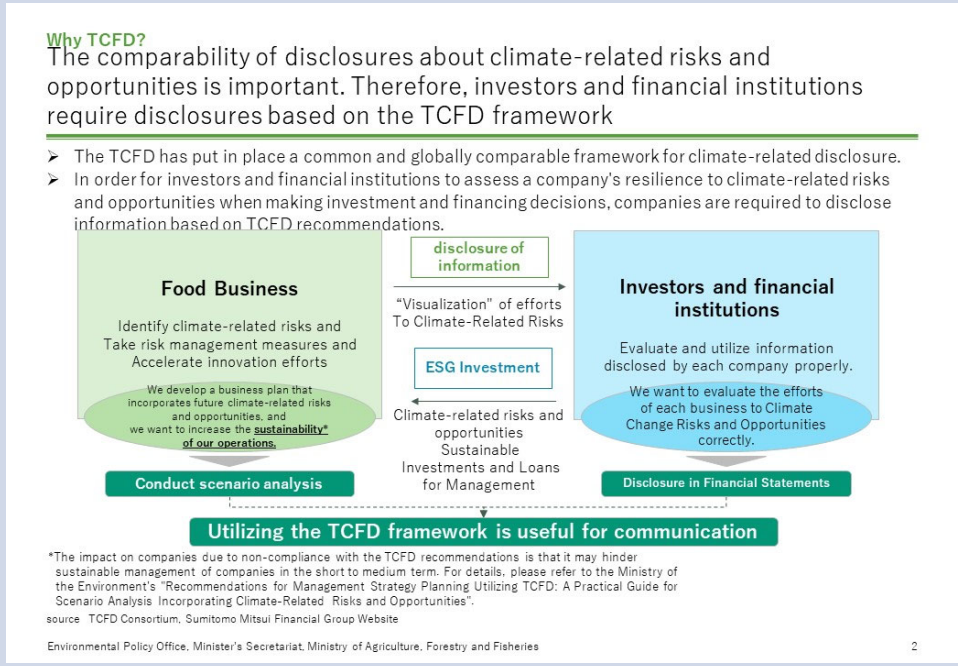
Countermeasures

○Promote efforts by food-related businesses to disclose climate-related information based on the guidance in the TCFD recommendations (the final report on a framework for disclosing information on climate change risks and opportunities) and examples of initiatives.

○The food manufacturing industry is considered to be particularly vulnerable to the impact of raw material procurement and quality through, for example, deterioration in the quality of agricultural crops, reduced yields, and the impact of disasters on the supply chain.

○In view of the expected tightening of imported raw materials due to climate change and increased global demand for raw materials, it is necessary to consider the reduction of losses in the supply chain and diversification and backup of suppliers for sustainable and stable procurement of raw materials.





Source: Introduction to the Disclosure of Information on Climate Change Risks and Opportunities in the Food, Agriculture, Forestry and Fisheries Industries (TCFD Guide), published by MAFF in June 2021)
http://www.maff.go.jp/j/kanbo/kankyo/seisaku/climate/attach/pdf/visual-60.pdf

International Cooperation on Adaptation

Back view

<Paris Agreement (Adaptation: Article 7)>

- ○ Recognizing the importance of support and international cooperation in adaptation efforts and the importance of taking into account the needs of developing countries and countries particularly vulnerable to the adverse impacts of climate change
- ○ Strengthen cooperation to enhance action on adaptation (e.g., information sharing, strengthening organizations, enhancing scientific knowledge)
- ○ Provide ongoing international support to developing countries for the implementation of this article.

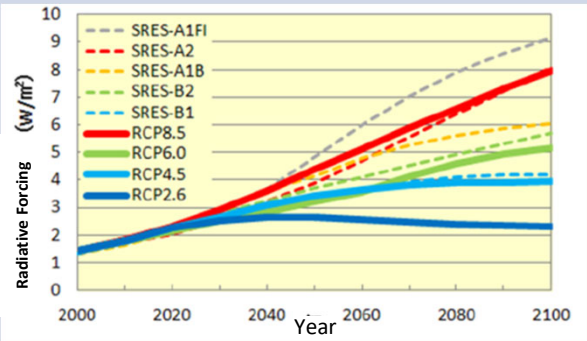
<International Agriculture, Forestry and Fisheries Research Strategy>

- ○ Promotion of technological development in developing regions
  To contribute to global efforts to ensure global food security and to solve various problems in emerging and developing countries by conducting joint research in developing regions, and to disseminate the results widely.
- ○ Promotion of international agriculture, forestry and fisheries research leading to increased international contributions on a global scale

As the chair of the Global Research Alliance (GRA) on Greenhouse Gases in Agriculture, we held a side event at COP23 to introduce the GRA's initiatives (November 2017).

Countermeasures

Cooperation through the provision of scientific knowledge, etc.	International cooperation through contributions to international organizations	Technical cooperation
○Provision of scientific findings to the IPCC Sixth Assessment Report, etc.	○Promote the technology development towards building a new food system with improved productivity, sustainability and resilience. ○Promote the spread of measures to strengthen community resilience in mountain watersheds by utilizing the disaster prevention and mitigation functions of forests.	○Support initiatives for sustainable forest management and forest conservation in developing countries, and promote the development of technologies that contribute to enhancing the forest functions of disaster prevention and mitigation.



Ongoing Review of the Adaptation Plan and Management of the Progress of Initiatives

Ministry of Agriculture, Forestry and Fisheries
Climate change adaptation plan

Adaptive response to long-term challenges with uncertainty

Review and inspection of adaptation plans

(i) Review of current and future impact assessments (government-wide)

○ When to conduct a review
- New impact assessment
- Publication of the latest scientific findings by the IPCC, etc.
- Emergence of new issues, etc.

(2) Inspection of the progress of initiatives (Ministry of Agriculture, Forestry and Fisheries)

○ Inspection from a professional perspective in the field of agriculture, forestry and fisheries
- Status of dissemination of adaptation measures
- Results and progress of research and development, etc.

Adaptation plans will be reviewed at the time of the review of current and future impact assessments.