SI-CAT

FY2016

Report on Local Climate Change Adaptation in Japan

Toward Mainstreaming (English Edition)

Center for Regional Research, Hosei University

This English edition was prepared with cooperation from e's Inc.

Preface: Publication of the FY2016 Report on Local Climate Adaptation in Japan

This publication follows the FY2015 Japanese edition of the Report on Local Climate Adaptation in Japan. I would like to offer a few opening comments as Program Director of the Social Implementation Program on Climate Change Adaptation Technology (SI-CAT).

Society in general is well aware of the need for adaptation to climate change. This awareness is on the rise not only among local governments, but also in the business world and among actors in many sectors, including agriculture, forestry and fisheries. Costs and other challenges present obstacles for timely efforts to make society more resilient through far-reaching efforts for adaptation to climate change. Meanwhile, the need for mitigation of climate change is broadly known and understood, and this awareness on the frontlines of education and other areas is leading to practical actions by individuals. When individuals are conscious of the greenhouse gas (GHG) emissions resulting from their day-to-day activities, they are more likely to contribute to mitigation efforts.

In industry as well, steady progress is being made in GHG emission reduction efforts, including the actions of individual companies. Nevertheless, a broad reduction in GHG emissions is not a simple task for people of the world. Thus, to respond to the climate change we are facing, it is crucial to promote both mitigation and adaptation.

However, with the exception of certain sectors, there is lack of progress in preparing concrete actions and plans for climate adaptation initiatives by local governments and companies. Environmental personnel of local governments sometimes tell me that with proper explanations they can get local residents to understand the need for climate mitigation. But when it comes to adaptation, it can be a daunting task to get not only the residents but even local government colleagues to correctly understand the situation.

In response to this situation, SI-CAT was launched in December 2015. Its aims are to expand and promote scientific knowledge as well as research and development for detailed and precise climate change projections, and also, from the perspective of significantly advancing climate adaptation, to promote the mainstreaming of climate change projection technologies in our society, particularly at the regional and local government level. Key concepts here are the development of policies and measures involving a variety of stakeholders, including government, business, and citizens.

With the second year of this program ending and the third approaching, this Report on Local Climate Adaptation in Japan was prepared to be widely used by local government staff and residents as well as businesses. It gives a current overview of the state of implementation of climate adaptation initiatives in Japan and presents new regional policy issues and important adaptation initiatives with the aim of identifying challenges and directions to be tackled going forward. I hope that it will be a useful reference for regional policy makers, for the academics and experts who support them, and for local communities.

Fujio Kimura, Program Director,
Social Implementation Program on Climate Change Adaptation Technology (SI-CAT)

The Paris Agreement, adopted at the 21st Session of the Conference of the Parties (COP 21) to the UN Framework Convention on Climate Change in December 2015, has a shared international long term goal of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels" and sets the direction toward net zero anthropogenic GHG emissions in the second half of the twenty-first century. Regarding "adaptation," the Agreement also calls for "enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change" and calls for Parties to "engage in the process to formulate and implement national adaptation plans."

The Social Implementation Program on Climate Change Adaptation Technology (SI-CAT) under Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) was launched in December 2015 and is entering its third year. Compared to conventional research projects, this Program promotes technology development for more precise and near-future climate change projections, and prioritizes the spread and expansion of concrete adaptation measures for "society adapting to climate change." As global warming continues, the ways in which climate change is manifested will differ significantly depending on the region. Even with the same degree of climate change, there will be regional differences in the actual impacts, due to different local circumstances and site conditions. In other words, at the regional and local government level, it will be important to make appropriate climate change projections and impact assessments looking at individual sites and regional characteristics, and to develop adaptation strategies that are regionally appropriate based on scientific data.

This Program aims to promote technology development for climate change projections that respond to local characteristics and local needs, and to promote the mainstreaming of adaptation measures. A key concept we use here is "social implementation" (in Japanese, shakai jisso, which could also be translated as "mainstreaming") of climate projections and other adaptation technologies. Based on

that concept, the Program identifies important themes for strategy development and popularization at the regional and local government levels.

This FY2016 edition of the Report on Local Climate Adaptation in Japan was compiled for use by stakeholders at local governments as well as residents and businesses, and it summarizes the current climate change projection technologies in this Program, as well as the state of implementation of adaptation measures especially at the regional level. We will continue to promote the development of technologies that can be used in local communities, and work to enhance knowledge and data relating to adaptation measures. We welcome your support and cooperation in this Program, and invite you to contact us with any comments or suggestions you may have.

I heartily hope that many people will obtain this report and use it extensively when developing local climate adaptation measures.

Mitsuru Tanaka (Hosei University),
Chair of SI-CAT Implementation Team

Index

Chapter 1
Trends in Promoting the Mainstreaming of Climate Adaptation Measures

1-1. Science and Technology: Crucial Role in Climate Adaptation

Impacts that could be attributed to climate change, which arises from global warming, are becoming increasingly prevalent. The international community has recognized projections that climate change will intensify over the course of this century. We must be ready to prepare to respond to that change. However, the question is "How?" To answer this question, science and technology have at the very least a crucial role to play in explaining and offering climate change projections and impact assessments in ways that people can understand. The reason for this is that when it comes to addressing the challenges, more than other disciplines, the fields of science and technology need to be able to show that they are "in society" and "for society," or said differently, "together with society," because climate change itself is a global-scale challenge. Also, since climate change projections and impact assessments come with uncertainty due to the very nature of projections, their explanations must come with some consideration based on how they will be accepted in or by society.

For researchers in this area, it is obviously impossible for one single field of discipline to respond alone. A transdisciplinary approach is therefore needed due to the broad scope of stakeholders involved. Researchers must rise above their individual fields of discipline to collaborate with people in many other disciplines, including the humanities and social sciences. To develop further the mainstreaming of research findings, they must expand their scope to transdisciplinary research in collaboration with people involved, beyond science and technology.

In response to such needs, the Social Implementation Program on Climate Change Adaptation Technology (SI-CAT) was created with the aim of presenting concrete approaches to address challenges, and then links to local government and other bodies as part of mainstreaming. It could be described as an unprecedented, challenging and ambitious project, as it starts with climate research, continues with impact assessment research, and then makes the connection to local government and other bodies that are a part of mainstreaming. Even so, under the current situation there is insufficient public demand as the driving force for adaptation, so research and development could end up being isolated in individual disciplines, and there is the potential that cross-disciplinary cooperation and transdisciplinary research may not occur. However, even in that case, the research findings until then would not necessarily be wasted. The impacts of climate change are already present and adaptation is necessary not only now but also in the future. SI-CAT endeavors to create results that will serve as a foundation to that end, and will strive to present as many examples of actual cases of mainstreaming as possible.

1-2. Policy Trends of Climate Adaptation Measures in Japan

In November 2015 Japan's first National Plan for Adaptation to the Impacts of Climate Change was adopted by Cabinet Decision, clarifying in detail the country's basic approaches to climate change adaptation and measures in each sector and the implementation of the related measures started. Naturally, prior to that National Plan, measures were being taken in individual areas such as agriculture and water-related disasters, but this National Plan is based on input such as future climate projections and impact assessment results, and serves as a crucial starting point for initiatives to promote systematic adaptation measures for society as a whole.

This National Plan covers five basic strategies: (1) mainstreaming adaptation into a broad range of government policies and measures; (2) enhancing scientific knowledge through proper observation, monitoring, and research; (3) promoting public understanding and awareness by sharing and providing information about climate risks based on scientific knowledge; (4) promoting a variety of concrete adaptation measures by local governments and other actors; and (5) promoting international cooperation and contributions where adaptation needs are high, particularly in developing countries.

To promote sector-by-sector adaptation measures this way, the government is using the reiterative plan-do-check-act (PDCA) quality control cycle and revising plans as necessary, through ongoing observation and monitoring as well as projections of climate change. To do this it is working to keep abreast of scientific knowledge, conducting periodic climate change impact assessments, and ascertaining the state of progress with measures. The government has a framework to implement a climate change impact assessment and revise the National Plan approximately every five years.

Having this National Plan and the general flow of adaptation measures in place, in March 2017 the government issued a document entitled "Guidelines for Initiatives on Scientific Knowledge and Climate Risk Information to Promote Climate Change Adaptation Measures (Interim Report)." This report assessed and analyzed national government initiatives to date as well as local government trends based on the National Plan, and then while referring to input from experts, industry and others, it outlined the current status and challenges. Based on the direction of initiatives covered in the report, it is now necessary to get more specific about effective adaptation measures built upon collaboration with the relevant government ministries and agencies, and to encourage steady progress that reflects actual conditions in society.

Meanwhile, many fundamental social changes are occurring at the regional and local levels that affect local society and communities, including population decline, low birth rates and the aging of society, migration to bigger cities, changes in industrial structure, and geographical vulnerabilities. In response to regional differences such as these, the impacts of climate change will also vary greatly, and this will also affect the orientation of adaptation measures needed. In particular, to encourage initiatives such as self-directed efforts for climate adaptation plus policy formulation by citizens, businesses, local governments and other local stakeholders, tools are being developed such as the "Climate Change Adaptation Information Platform" for providing climate risk information and

the "Regional Adaptation Consortium Project" which supports the provision of scientific knowledge and tools relating to regional climate change projections and impact assessments through the collaboration of related parties. Going forward, we hope to see active progress toward an "adaptive society" and further utilization of these policy tools, plus the mainstreaming of the projection and impact assessment technologies that SI-CAT aims for.

Chapter 2
Status of Technological Development for Examining Adaptation Measures

2-1. Ensemble Climate Change Projection Database

Today, more than ever, there are significant questions in key areas relating to climate adaptation measures, including disaster prevention, agriculture, and health. For example, how concerned should we be about extreme events (heavy rainfall, droughts, extreme heat, etc.) compared to what we have experienced in the past, and what is their likelihood of occurring? To make projections of future variations in extreme events that occur infrequently but with some confidence once every several decades or more, it is useful to compare statistical values from sufficiently large samples. For this, we can conduct large-scale ensemble simulations* using supercomputers to model the past and future climates and use the latest climate models (similar to the models used for weather forecasts). In that context, SI-CAT has worked with the Program for Risk Information on Climate Change (SOUSEI) under Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) to create an ensemble climate change projection database known as the "database for Policy Decision making for Future climate change" (d4PDF), and both are engaged in technological development for local governments and other bodies to be able to effectively use the probabilistic information from the database to consider adaptation measures.

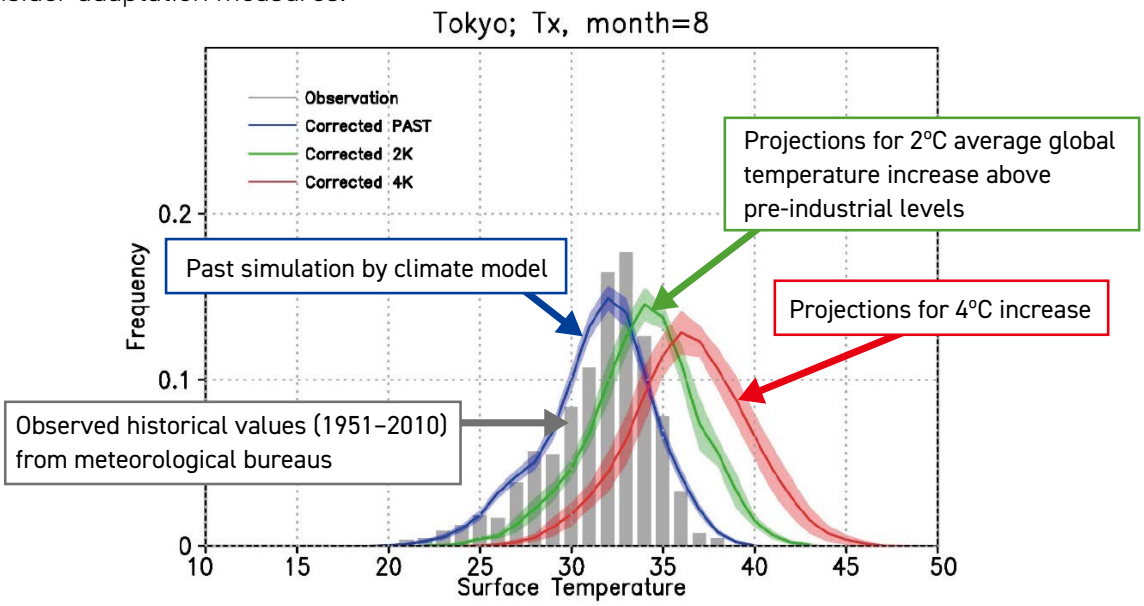


Figure 2-1: Frequency distribution of August maximum daily temperatures in Tokyo

The resulting quantitative projection information shows increased frequency of extremely hot days (35°C or higher) due to a warming climate.

All model values were corrected using methodology from Piani et al. (2010). Shadow bands show the standard deviation of the ensemble members. The graph was prepared using data from 48 members each (x 60 years) for the past for 4°C temperature increase simulations, and six members (x 10 years) for the 2°C temperature increase simulations.

* Ensemble simulations: These are iterative weather simulations for a specified time period conducted with small variations in the calculation parameters. For example for the 60-year period from 1951 to 2010, the data obtained from simulation for one case (counted as one "member") covers 60 years, but if this is increased to 100 members, data for 6,000 years can be obtained. This significantly increases the confidence level when assessing the statistical probability of a heavy rainfall that occurs once in 30 years.

Reference:

d4PDF website (http://www.miroc-gcm.jp/~pub/d4PDF/index_en.html)

2-2. Downscaling

The resolution of numerical models is an important factor when reproducing various climate and weather phenomena. The spatial resolution of the climate models for the Coupled Model Intercomparison Project (CMIP) of the World Climate Research Programme (WCRP) and other climate models being utilized for warming projections is on the scale of about 100 km. This is not always a sufficient level of resolution to provide detailed information directly for local governments and other bodies to evaluate climate change impacts and consider adaptation measures. Thus, for the mainstreaming of climate adaptation measures it is important to prepare detailed future climate information at the regional scale by developing information that boosts the resolution using methods known as downscaling. Two downscaling methods are widely used, statistical and dynamical, each with its own strengths and weaknesses.

Statistical downscaling combines statistical spatial interpolation and corrections of the model biases based on historical observation. It has the benefit of being able to handle a large number of scenarios since the demand on computing power is relatively small, but this technique also has some difficulties depicting features on small spatio-temporal scales if the resolution of the original datasets is coarse. On the other hand, dynamical downscaling can represent results in a physically-consistent form even for small-scale phenomena that are not reproduced in the original dataset, because a detailed spatio-temporal dataset is created using a regional climate model based on laws of physics, but datasets can only be created for a limited number of cases due to constraints in computational resources.

Combining these methodologies to match the purpose, the SI-CAT program prepares datasets with the detailed spatio-temporal scales that enable local governments and other bodies to utilize the warming projections. In terms of standard datasets for all of Japan, we prepare mesh level 3 data (1 km resolution) using statistical downscaling. To exploit the advantage that statistical downscaling can handle a large number of cases, these datasets are aimed at preparing climate scenarios that can

represent a spread of climate change projections. The spread is based on three factors: (1) differences in GHG emission scenarios, (2) uncertainty of climate models, and (3) natural variation. The spread for these first and second factors can also be assessed on a more regional scale by downscaling the results of many climate models, so we plan to work with warming projections calculated by several emission scenarios and as many climate models as possible. **Figure 2-2** is an example of calculation by statistical downscaling, showing the 1-km mesh annual average surface temperature distribution in February for the years 1990–2000 and 2040–2050.

At the same time, this program is also developing technology for dynamical downscaling that model local governments can use to develop and consider more specific adaptation measures. For example, because factors like localized rainfall, such as rainfall and snowfall associated with mountainous areas, cannot be represented well by statistical downscaling, we plan to prepare detailed datasets using dynamical downscaling and use them for river and coastal disaster prevention and mountainous area ecosystem assessments. However, because dynamical downscaling does not enable targeting of as many cases as statistical downscaling, we are conducting research and development of new methodologies that combine analytical and statistical methods to identify the cases required for development and consideration of adaptation measures.

The development of methodologies for downscaling techniques described above is not just for the sake of preparing datasets; the knowledge of how to use that data can also lead to mainstreaming of adaptation measures by local governments. Thus, to expand efforts to formulate climate change adaptation measures, it is important to build up knowledge and experience that combines both the development and utilization of datasets.

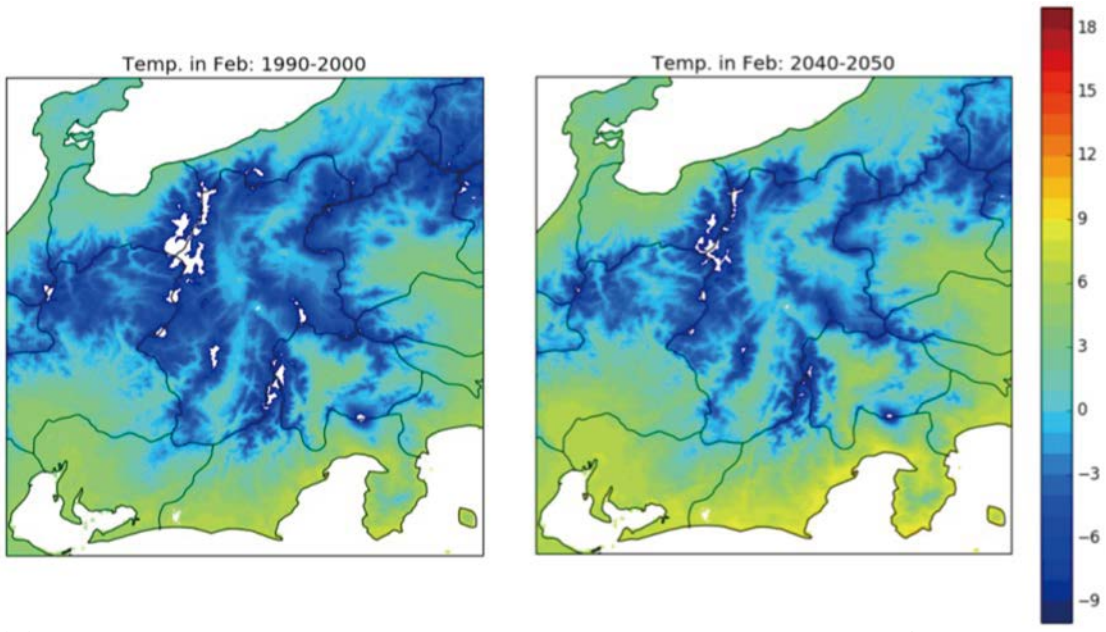


Figure 2-2: Distribution chart for 1-km mesh surface temperatures in February in the Chubu Region, prepared using statistical downscaling

Annual average for 1990–2000 (left) and 2040–2050 (right)

2-3. Climate Change Impact Assessments

In the project "Development of climate change impact assessment" in SI-CAT, we are developing integrated methodologies to create climate change impact assessment information with a resolution of about 1 km for several years to upwards of ten years (assumed around 2030), which can consider the effects of adaptation measures. We use reliable near-term projections and super-high-resolution downscaling projection results as climate scenarios, considering socio-economic scenarios as required.

National Level

· Water-related disasters (Tohoku University): Flood inundation, storm surge, soil and sand erosion, dam reservoir and lake water quality deterioration
· Sediment-related disasters (Fukushima University): Sediment-related disaster risk (including forest fires, wood debris, etc.)
· Forest ecosystems (Forestry and Forest Products Research Institute): Suitable area for forest ecosystem dominant species, the impact of forest change on water resources and sediment-related disasters
· Agriculture (Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization): Yield of major Japanese crops (mainly rice)
· Fruit trees (Institute of Fruit Tree and Tea Science, National Agriculture and Food Research Organization): Apples, mandarin oranges, and other major fruit trees, plus sub-tropical fruit trees expected to see increased production in the future
· Fisheries (Japan Fisheries Research and Education Agency): Variations in coastal environments that are rapidly changing with climate change, and their impacts
· Water resources (Kyoto University): River flow conditions and water resources associated with climate change
· Health (University of Tsukuba): Thermal environment, health impacts

Regional Level

· Storm surge, water- and sediment-related disasters (Kyushu University): River catchment inundation, storm surge inundation, sediment-related disasters, integrated assessment systems
· Agriculture (Ibaraki University): Yields of multiple crops (impacts on vegetable shipments, occurrence of chalky rice grains (CRGs) due to insufficient accumulation of starch, etc.)
· Fruit trees (NEC Solution Innovators, Ltd.): Recording and accumulating implementation experiences of climate change adaptation measures in production areas in detail, extracting effectiveness of adaptation measures and know-how on implementation

As outlined above, SI-CAT is engaged in impact assessments in many areas and working to develop models to quantitatively assess the effectiveness of various adaptation measures. In addition, we are developing applications tools (SI-CAT app) that can package data (technologies and products developed by SI-CAT) to be conveniently used by local government staffs responsible for considering adaptation measures, companies, and other bodies, with the outcomes of other technology development organizations.

Chapter 3
Topics for Local Governments Mainstreaming of Climate Adaptation

3-1. Climate Change Risk Assessments by Local Governments

To collect information on local governments' efforts to develop climate change adaptation strategies and measures, in fiscal 2015 and 2016 we implemented a survey in questionnaire format. The purpose was to clarify how SI-CAT model prefectures and other local governments in Japan perceived climate change risks as a whole, which consists of hazards, vulnerability, and adaptive capacity; the state of evidence of climate change impacts, as well as their magnitude and urgency; and the state of adaptation measures. In addition to these, we explored their needs for climate change projections and impact assessments, which we describe in the next section. Here we present the findings based on responses from 95 departments in 15 local governments (specifically, the environmental, agricultural policy, disaster prevention, health, and industry and tourism departments). We have aggregated the data on their perceptions about climate change risk, vulnerability and adaptive capacity into four topics, listed as (1) to (4) below. It is important to note that the number of responses varied by local government and the topics, and responses were based on the perceptions of the respondents in the course of executing their day-to-day duties so these are not the official responses of the departments. Also, we defined the term "risk assessment" as an overarching concept that covers a variety of factors necessary for adaptation strategies such as (1) to (4).

(1) Perceived risk of each event: **Figure 3-1-1**

(2) Critical hazards from climate change and sectors affected: **Figure 3-1-2**

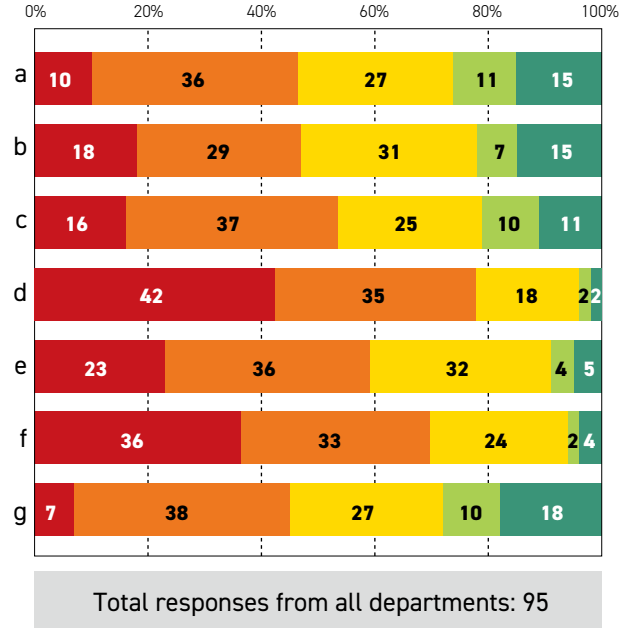
(3) Vulnerability to climate change, and challenges for adaptive capacity: **Figure 3-1-3**

(4) Climate change impact outcomes that should be avoided (worst-case outcomes): **Figure 3-1-3**

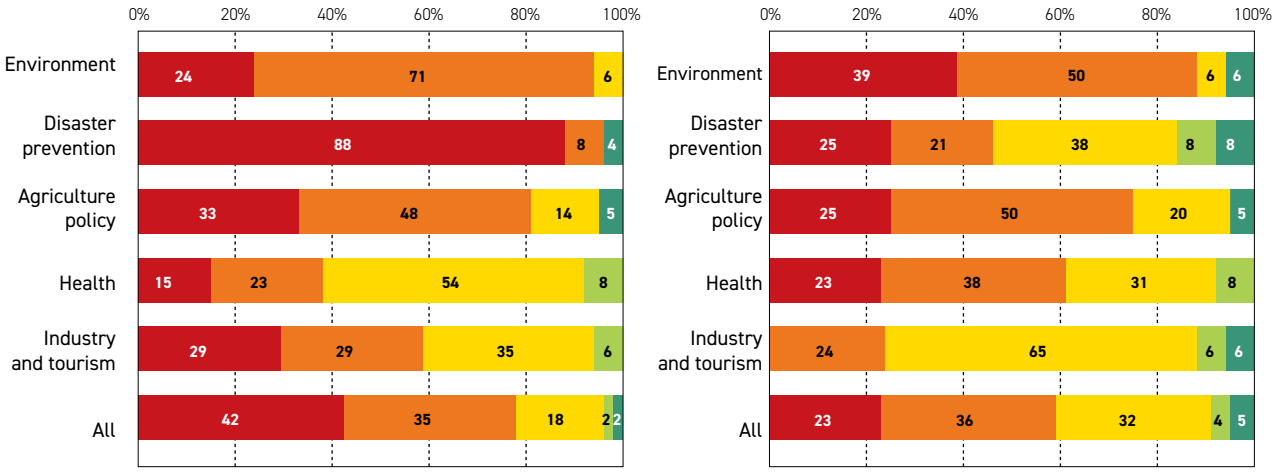
(1) Perceived Risk of Each Event in Terms of Preparing Policies and Measures

Figure 3-1-1 shows the aggregated results of perceived risk for each set of events from "a" to "g," which are potential hazards in preparing policies and measures. The figure denoted (a) shows the totals for responses from all 95 departments, while (b) shows the totals for each of the five categories of departments, for two sets of events associated with climate change impacts: "d" (weather-related disasters) and "e" (changes caused by global warming). The events for which most local officials responded "quite dangerous" or "somewhat dangerous" were "d" (weather-related disasters) and "f" (other natural disasters: earthquake, tsunami, volcanic eruption). Regarding "e" (changes caused by global warming), the most common response was "no particular perception," and the perception of

risk tended to be slightly weaker compared to "d" and "f." As for "d," 80% of environmental, disaster prevention, and agricultural policy officials responded "quite/somewhat dangerous," and in particular, disaster prevention departments have an extremely strong perception of risk. As for "e," approximately 90% of environmental departments responded "quite/somewhat dangerous," compared to only about 20% for industry and tourism departments, though the difference among departments was not statistically significant.



(a) Perceived risk of each event by all departments



P=0.000008

d. Climate-related disasters (flooding, landslide disasters, extreme heat, little rain, storm surges/high waves, tornadoes, heavy snowfall, etc.)

P=0.064165

e. Changes caused by global warming (increasing temperatures, rising sea levels, beach loss, inadequate snowfall, etc.)

(b) Perceived risk of each event by each department especially for d. Weather-related disasters and e. Changes caused by global warming

Numbers at bottom left are *p* values from $\chi 2$ tests. For (d) (weather-related disasters)," the differences among departments are significant at 1%, but for (e) (changes caused by global warming) they are not significant at 5%.

Figure 3-1-1: Perceived risk of each event in terms of preparing policies and measures

(2) Critical Hazards from Climate Change and Sectors Affected

Figure 3-1-2 provides an overview of the critical hazards from climate change and sectors affected, where local officials perceive the "impact is significant." It depicts what hazards (vertical axis) are perceived to affect what sectors (horizontal axis) by summarizing the results in matrix form. These are divided into long-term gradually-changing events ("e": changes caused by global warming, on left), and short-term extreme events ("d": weather-related disasters, on right). The figures in the matrix represent the number of respondents indicating that the respective hazard has an impact; the higher the number, the darker the color.

In the agricultural sector, with the exception of ocean-related hazards, nearly all hazards (particularly those related to temperature and precipitation) are perceived as important. It is also clear that with water- and sediment-related disasters, there are strong concerns about hazards from increases in precipitation associated with global warming, as well as torrential rains, heavy rainfall, and strong typhoons associated with weather-related disasters. It is also worth noting that almost all hazards are perceived as an impact on industry and economic activity as well as citizen livelihood and urban living sectors.

Total responses from all departments: 89

	Agriculture	Forestry	Fisheries	Water environment	Water resources	Natural ecosystem	Flood damage	Landslide disasters	Coasts	Summer heat	Infectious diseases	Industrial/economic activities	People's lives /Urban life
Average temperature increases	17	5	0	1	1	10	3	4	0	10	7	3	5
Highest temperature increases	14	3	0	1	1	5	3	3	0	14	3	3	4
Lowest temperature increases	9	4	0	1	1	5	2	2	0	4	3	2	4
Decreased rainfall	13	3	1	4	12	7	1	2	0	0	0	5	2
Increased rainfall	13	4	1	0	2	4	22	28	0	0	0	8	2
Decreased snowfall	6	2	0	3	4	4	0	0	0	0	0	2	2
Rise in sea levels	1	0	2	2	0	2	4	0	6	0	1	1	1
Rise in sea temperatures	0	0	4	2	0	2	1	1	0	0	0	2	1
Other	0	0	0	0	1	0	0	0	0	0	0	0	0

	Agriculture	Forestry	Fisheries	Water environment	Water resources	Natural ecosystem	Flood damage	Landslide disasters	Coasts	Summer heat	Infectious diseases	Industrial/economic activities	People's lives /Urban life
Extreme summer heat	18	2	0	0	1	3	0	0	0	18	3	6	4
Localized downpours of short duration	12	2	0	0	0	2	27	34	0	0	1	7	3
Heavy rains exceeding several hundred mm of rainfall	10	2	1	0	0	3	30	34	0	0	1	9	3
Intermittent spells of heavy rain	12	2	0	0	0	2	29	33	0	0	2	8	3
Extremely small amounts of rainfall	15	2	1	4	8	3	1	2	0	0	0	8	2
Storm surges/high waves	2	0	2	0	0	0	5	0	7	0	0	4	2
Strong typhoons	14	2	2	0	1	0	21	25	2	0	0	11	3
Heavy snowfall	7	2	0	0	0	1	4	7	0	0	0	10	3
Snowmelt flooding	2	1	0	1	0	0	9	7	0	0	1	4	1
Strong winds/tornados	10	2	2	0	0	0	3	5	0	0	0	10	5
Other	1	0	0	0	0	0	0	0	0	0	0	1	0

Figure 3-1-2: Critical hazards from climate change and sectors affected

Long-term gradual changes (above), Short-term extreme events (below)
Figures indicate the number of respondents indicating "Impact is significant."

(3) Vulnerability to Climate Change, and Challenges for Adaptive Capacity

The magnitude of impact from climate change is determined by the relationship between external forces of climate change (hazards) and resilience (vulnerability and adaptive capacity). In other words, where there is susceptibility (vulnerability) but inadequate preparation (adaptive capacity), the impact will be larger for any given climate hazard. **Figure 3-1-3** summarizes the sectors where local officials perceive there are challenges in terms of vulnerability and adaptive capacity, and the outcomes they think should be avoided. In each matrix, the higher the number, the stronger the color.

Overall, the disaster prevention departments tend to have the strongest perception that there are challenges with resilience to impacts, and strongest perception of risk in relation to outcomes that should be avoided. There are some differences by department, owing to differences in sectors for which they are responsible. Also, the figure shows that health departments tend to be more concerned about the number of physically vulnerable people as well as the impacts of extreme heat, and human casualties; agricultural policy departments tend to be more concerned about depopulation, problems with forest and rural land management, and difficulties in sustaining agriculture, as well as deterioration of the natural environment.

Risk sensitivity/adaptability	Environmental administration bureaus	Disaster prevention bureaus	Agriculture-related bureaus	Health services bureaus	Industry /Tourism bureaus	Total
N of responses	20	24	21	13	15	93
Sensitivity						
People and property are located in areas that are low-lying or 0 m above sea level	3	12	3	0	3	21
People and property are located on (steep) slopes	4	16	5	0	3	28
People and property are located on soft ground	2	12	5	0	2	21
People and property are located in river basins prone to flooding	5	14	5	1	2	27
People and property are located in flood zones	5	17	5	2	4	33
People and property are located on coasts prone to erosion	0	5	1	0	1	7
Urban design problems (few paths for wind, low green space ratios, high building coverage/floor-area ratios)	3	2	1	2	2	10
Deteriorating infrastructure	5	15	6	1	5	32
Depopulation	3	2	8	0	4	17
Crowding of factories and residences	0	1	0	2	3	6
Many vacant houses	1	1	0	1	1	4
Many single-person households	2	0	0	2	1	5
Housing problems (deterioration, bad insulation, shoddy construction)	2	1	0	3	0	6
Many physically vulnerable people (people receiving long-term care, elderly people)	3	4	1	9	0	17
Many socially vulnerable people (elderly people, people living in poverty, single mother families)	3	3	0	4	1	11
Inadequate reserves of water resources	3	1	4	1	0	9
Inadequate reserves of forests/undeveloped woodlands near populated areas	1	6	7	0	1	15
Presence of endangered or rare species	6	0	0	0	0	6
Single crop farming	1	0	2	0	0	3
Adaptability						
Administrative policies/plans for coping with climate change impact risks	8	10	10	4	5	37
Administrative resources (staffing, budget) to promote coping with climate change impact risks	9	10	10	4	4	37
Infrastructure (levees, tide embankments, flood gates, sewers, water reservoirs, retarding basins, etc.)	5	18	7	2	4	36
Monitoring (hourly rainfall, etc.)	6	10	3	1	1	21
Resident and business preparedness for and understanding of climate change impact risks	7	10	4	4	4	29
Warning systems (disaster prevention, summer heat, etc.)	0	12	0	2	2	16
Readiness of evacuation sites	0	10	3	0	3	16
BCP (business continuity plans)	2	10	2	0	9	23
Neighborhood relations, community bonds	0	4	1	2	0	7
Medical care/health services	0	1	0	5	0	6
Other	0	1	1	0	0	2

Outcomes to be prevented	Environmental administration bureaus	Disaster prevention bureaus	Agriculture-related bureaus	Health services bureaus	Industry /Tourism bureaus	Total
N of responses	20	24	21	13	15	93
Loss of life						
Loss of life due to overflowing rivers	6	14	5	1	7	33
Loss of life due to inundations inside levees	4	17	4	0	5	30
Loss of life due to landslide disasters	7	19	8	1	5	40
Loss of life due to storm surges/ high wave disasters	2	7	4	1	1	15
Loss of life due to complex disaster	3	13	5	1	5	27
Loss of life due to summer heat	5	2	6	9	3	25
Loss or damage affecting daily living or industry						
Long-term injury to physical or mental health	3	9	1	4	8	25
Interruption to the supply of food or infrastructure for living (electricity, water, gas, etc.)	7	11	5	1	12	36
Fragmentation or interruption of transportation or communication facilities	4	15	6	1	14	40
Suspension of financial service facilities	3	2	3	0	10	18
Suspension of production or supply chains	3	3	5	0	12	23
Buildings or homes being washed away, damaged or collapsing	5	10	3	0	10	28
Long-term living in evacuation shelters	3	12	3	2	4	24
Long-term deterioration of the food situation	4	3	4	1	4	16
Long-term deterioration of water resourcing	10	7	6	3	4	30
Long-term economic decline	3	5	6	0	10	24
Suspension of governmental administrative activities	5	9	3	0	8	25
Beach loss	1	4	1	0	0	6
Difficulty in sustaining agriculture	6	3	16	0	5	30
Difficulty in sustaining fishing	2	2	3	0	4	11
Difficulty in sustaining forestry	3	3	4	0	2	12
Outdoor activities becoming difficult due to heat	5	1	5	8	5	24
Daily living becoming difficult due to heat	3	1	1	8	3	16
Damage to biodiversity or culture						
Local populations becoming fragmented or being wiped out	7	2	3	0	3	15
The natural environment being irreparably damaged, lost	8	7	12	1	5	33
Traditional culture becoming difficult to sustain	5	2	1	0	3	11
Other	1	0	0	0	0	1

Figure 3-1-3: Vulnerability and adaptive capacity (left), and climate change impact outcomes that should be avoided (right)

Figures indicate the number of respondents indicating "this is a challenge."

3-2. Local Government Needs for the SI-CAT App

SI-CAT is developing a "SI-CAT app" as a tool for users to access the results of a variety of climate change impact assessments as well as the effectiveness of adaptation strategies. The web-based application will enable users to browse a variety of SI-CAT products and outcomes. Three levels are being considered: Level 1 mainly for local governments and businesses, Level 2 for local government research institutions and consulting companies, and Level 3 for universities, research institutions and other potential users. SI-CAT is considering permanent arrangements to enable users to access the content even after the SI-CAT program ends. Discussions are under way for the SI-CAT app to ultimately be hosted with and be one of the functions of DIAS (Data Integration and Analysis System, of the Ministry of Education, Culture, Sports, Science and Technology, or MEXT). We are seeking the continued operation of DIAS so that the SI-CAT app will also be permanently accessible.

As mentioned above, Level 1 of the SI-CAT app is intended for use mainly by local governments and by businesses. To pursue this, from July to September 2016, we visited 22 places nationwide, mostly local governments, to study local government needs related to the SI-CAT app. The destinations were selected based on a Hosei University questionnaire-based study that targeted 155 public bodies nationwide at the end of the 2015 fiscal year. Based on their responses, 21 organizations were selected to visit (**Table 3-2-1**). In November 2016, Osaka City participated in SI-CAT as a local government with needs, and when we visited there we implemented a similar study.

During the fiscal 2016 visits we focused mainly on the environmental departments of local governments, but in some cases we were also able to ask agricultural departments, disaster prevention departments, and local government research institutions about their expectations for the SI-CAT app.

For the visits we brought along an information sheet describing the SI-CAT app and providing examples of user screens so that interviewees could get a concrete idea of the proposed app (**Figure 3-1**). While they viewed the materials we asked the questions shown in **Table 3-2-2** one by one and noted their spoken responses (see summary results in **Table 3-2-3**, **Table 3-2-4**).

The responses varied significantly. For example, a respondent at one local government said, "We don't want our future projections to be seen outside of our local government." Another person responded "We want to see the future projections of comparable prefectures." Regarding temporal resolution for projections just in the agricultural sector, one respondent said, "For the quality of agricultural crops, we need annual increments," while another said, "For agricultural crops we need monthly increments, and we see the need for projections of high temperatures in September in relation to harvests," and yet another, "For agriculture we need cumulative temperatures, so we need daily temperature values." Relating to the topic of extreme heat there was also a request for the capacity to have hourly temperature breakdowns: "For the heat island effect we would like to have daily temperatures, and we also need hourly nighttime temperatures." Essentially, the temporal resolution needs depend on the category of climate change impact and intended use of the information.

The impacts of climate change will differ by region, so the topics of concern will also vary. In addition, depending on the stage of climate adaptation actions, the information required by stakeholders will also probably change. Thus, it is perhaps no surprise that we received a variety of responses to our questions.

Meanwhile, many local governments had similar requests. For example: "We would like to use this for budget requests within the agency internally, and to explain things externally." "We need materials that government staff are able to explain." "We would like the figures and tables designed so that we can paste them into a Word document and print it out nicely in black and white."

Here are examples of other comments: "It would help if we can tell others the data is solid and reliable, and the numbers are released by a reputable organization." "The use of projections will depend on the level at which they are authorized. Something more than just research results would be preferred."

The SI-CAT App Working Group established within SI-CAT sorted and classified the 702 comments received in terms of local government needs, and discussed whether or not they could be addressed as well as how a response could be done institutionally (**Table 3-2-5**). We are considering ways to design the SI-CAT app to serve as many users as possible, including through climate scenarios, climate change impact assessments, the user interfaces, and so on.

We also learned how different local government departments have different needs: for example, agricultural and disaster prevention compared to environmental departments. In fiscal 2017 we will plan visits to local governments to focus on studying the needs of these departments.

Table 3-2-1: List of local governments interviewed about their needs relating to SI-CAT app

Survey conducted in 2016. The 11 underlined are part of a Ministry of the Environment subsidy program to support climate adaptation. In addition, Osaka City is not listed here but was interviewed on November 28, 2016 as a local government with needs.

Date	Local government	Date	Local government	Date	Local government
7/6	Kawasaki City (incl. city research institutes)	7/28	Hyogo Prefecture (incl. govt. research institutes)	8/9	Nagasaki Prefecture
7/11	Sagamihara City (ord. desig. city)	8/1	Kashiwa City (core city)	8/10	Fukuoka City (ord. desig. city)
7/20	Miyagi Prefecture	8/1	Ibaraki Prefecture (env. dept.)	8/17	Kanagawa Prefecture
7/21	Yokohama City (ord. desig. city)	8/2	Tokushima Prefecture	8/19	Fukushima Prefecture
7/22	Hokkaido (incl. gov't research institutes)	8/3	Ehime Prefecture (env, fisheries, rivers dept.)	8/19	Iwate Prefecture
7/22	Hokkaido Regional Development Bureau (river dept.)	8/5	Sendai City	9/28	Ishikawa Prefecture
7/28	Kyoto City (env. disaster prevention dept.)	8/9	Fukuoka Prefecture (incl. govt. research institutes)	9/28	Kanazawa City

Table 3-2-2: Interview topics for input on SI-CAT app (from interview sheet)

Interview topics for input on SI-CAT app	
Q1	Parameters for spatial calculations besides 1 km mesh
Q2	Temporal resolution needed for projections
Q3	Average number of years of period for projection results
Q4	Year(s) targeted for near-term projections
Q5	Desired number of cases for projections
Q6	Usefulness of probabilistic representations or characterizations
Q7	Additional requests for climate indicators or impact assessment indicators
Q8	Existence and availability of data from individual local governments
Q9	File format of projection results for downloading
Q10	Functions to modify or control map display parameters
Q11	Requests for addition of any background maps
Q12	Additional requests for distribution information overlays on projection results
Q13	Scenarios envisioned for use of the SI-CAT app
Q14	Any other requests for functions or tools in the SI-CAT app

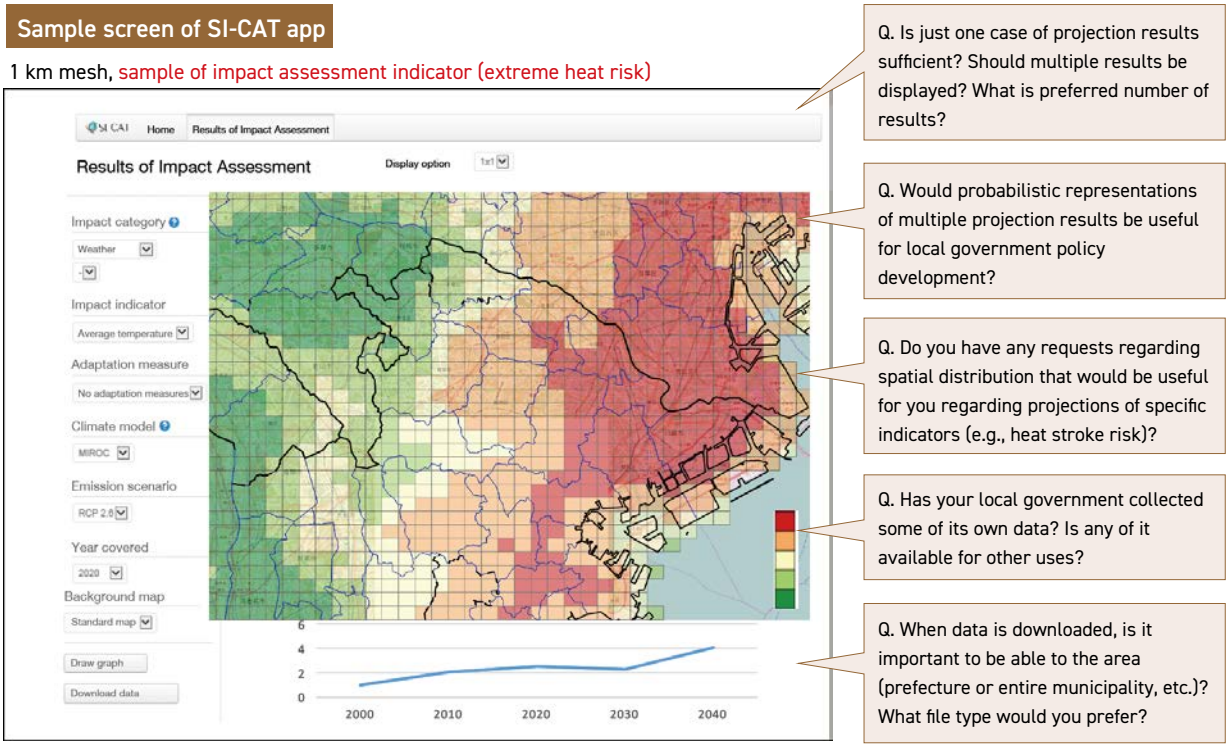


Figure 3-2: Example of SI-CAT app screen (from interview sheet for local governments)

Table 3-2-3: Summary of responses about SI-CAT app (from interview sheet) – Part 1

Q7 Additional requests for climate indicators or impact assessment indicators

Climate indicators	All temperature indicators, number of hot summer days (30°C or above)(3 responses), number of extremely hot days (35°C or above)(3 responses), cumulative temperature, precipitation indicators (2 responses), precipitation (20 mm in 1 hour, 50/80/100 mm in 24 hours), number of rainless days, typhoon indicators (including number making landfall, etc.), snowfall indicators, snow-melt period, wind speed, solar radiation
Water bodies, water quality indicators	Sea-level rise amount, seawater temperature (2 responses), water temperature (including offshore), water temperature of water bodies including dam reservoirs, sea ice indicators, wetland water quality, chlorophyll A concentrations
Disaster indicators	Flood-related indicators, flood damage predictions, urban flooding, inundation and river flooding, river runoff volume, river indicators, sediment disasters
Health indicators	Thermal environment indicators, heatstroke risk (2 responses), heatstroke patients (2 responses), WBGT and other apparent temperature indicators (2), intensification of extreme heat environment, heat island effect, contagious disease, contagious disease transmission risk, changes in potential distribution of mosquitos and other arthropods
Ecosystem indicators	Animals including deer and wild boar
Agriculture, forestry, fisheries indicators	Rice (Yamada Nishiki, sake rice); indicators for mandarin oranges; warm-climate fruit such as mandarin oranges, tankan, sudachi; pears and other regional specialties; vegetables; common trees such as pine and Japanese cedar; migratory fish species; indicators for aquaculture; marine fish and shellfish species (especially nori seaweed and oyster aquaculture)
Other	Local versions of standard information; options that are suited to prefectural differences; want all the information available; prioritize the most significant impacts; difficult to answer; need more time to consider; no requests at moment; none in particular; awaiting response after sending summary list of existing impact assessments (2 responses)
Interface	Easy operation, enhanced features to select geographical area (multiple cells, option to select multiple areas, etc.), option to select areas where temperature rise exceeds certain degrees Celsius, option to search by postal code, GIS data import function, data output options, drawing function within the app, various graphing functions, comparison screen by dual screens (comparison of maps with same criteria)
Content	Visual and easy-to-understand content posting, function to display changes in how the impact of greenhouse gas reduction efforts appears, function to show that our warmer prefecture in the future will have climate like [another] prefecture, diagnostic charting functions to display what governments should do based on impact assessment results, clear indication of adaptation options, integration of multiple impact assessments
App use	Free use of app, would like to try a prototype, would like to have user guidance and glossary, need user support and customer help service, would like it available for businesses, would like a trial period for area experts to test it, update functions to have the latest information

Table 3-2-4: Summary of responses about SI-CAT app (from interview sheet) – Part 2

· For many questions, multiple responses were permitted, so "Times selected" numbers in these tables do not match the number of governments interviewed.
· "Percent" in these tables indicates the percent of total responses for each question.

Q1 Parameters for spatial calculations besides 1 km mesh

Response	Times selected	Percent
Entire municipality (for prefecture, entire pref.)	16	28%
Administrative sub-units (for prefecture, municipalities)	13	23%
Zones divided into multiple municipalities	8	14%
By land use	5	9%
Higher administrative units (for city, the pref.)	4	7%
Densely inhabited districts, downtown areas	2	4%
Watershed units	2	4%
Other responses (1 each of above responses)	7	12%

Q2-1 Temporal resolution needed for projections

Response	Times selected	Percent
Yearly	13	34%
Monthly	11	29%
Daily	7	18%
3 months	4	11%
Hourly	2	5%
Different by impact category, impact item	1	3%

Q2-2 Yearly value or period average value: Which is better?

Response	Times selected	Percent
Period average	7	37%
Yearly value	4	21%
Prefer yearly value over period average	4	21%
Prefer both yearly and period average	2	11%
Other responses (1 each of above responses)	2	11%

Other: Depends on impact category or impact item, need to ask research institutes

Q3 Average number of years of period for projection results

Response	Times selected	Percent
10 years	7	28%
Cannot decide on best period for average	5	20%
20 years	4	16%
5 years	3	12%
30 years	3	12%
Other responses (1 each of above responses)	3	12%

Other: 1 year, depends on the field, let user select

Q4 Year(s) targeted for near-term projections

Response	Times selected	Percent
Around 2030	11	37%
2050	7	23%
Around 2020 to 2030	3	10%
Around 2020	2	7%
2030 to 2050	2	7%
Let user choose near term target year(s)	2	7%
Other responses (1 each of above responses)	3	10%

Other: 2060, 2100, target year for near-term projections depends on impact category

Q5 Desired number of cases for projections

Response	Times selected	Percent
3 cases	9	26%
4 cases	8	24%
5 cases	6	18%
2 cases	5	15%
1 case	2	6%
Other responses (1 each of above responses)	4	12%

Other: 6 cases, more is better, difficult to answer, depends on criteria

Q6 Usefulness of probabilistic representations or characterizations

Response	Times selected	Percent
Useful	11	58%
Difficult to answer	3	16%
Somewhat useful	2	11%
Not useful	2	11%
Usefulness depends on purpose	1	5%

Q8-2 Existence and availability of data from individual local governments

Response	Times selected	Percent
Maybe but requires confirmation	9	41%
Public data can be used	7	32%
Do not know	4	18%
Yes, available (requires application)	1	5%
Will consider requests	1	5%

Q9 File format of projection results for downloading

Response	Times selected	Percent
Map format	18	33%
Numerical format	17	31%
GIS format	10	19%
PDF format	6	11%
Binary format	2	4%
No particular request	1	2%

Q10 Functions to modify or control map display parameters

Response	Times selected	Percent
Option to select maximums, minimums	14	25%
Option to change color selection	12	22%
Option to change number of display units	11	20%
Option to choose black-and-white vs grayscale printing	6	11%
Would like appropriate default settings	5	9%
Not needed	4	7%
Other responses (1 each of above responses)	3	5%

Other: Option to change font size, option to display 2+ maps side by side, consideration of Universal Design

Q11 Requests for addition of any background maps
Q12 Additional requests for distribution information overlays on projection results

Response	Times selected	Percent
All available map information, distribution info	9	15%
Standard maps	8	13%
"White map" (administrative boundaries)	7	11%
Land use map	7	11%
Rivers, watersheds	5	8%
Topographical info (flatland, manufacturing, slope), elevations	4	6%
Population distribution	4	6%
Vegetation distribution, ecosystem info	3	5%
Rail lines	2	3%
Major roadways	2	3%
Municipal mapping information	2	3%
Future projection maps of various distribution info	2	3%
No comment	3	5%
Other responses (1 each of above responses)	4	6%

Other: Watershed boundaries, distance from sea, commercial / tourist facilities, depends on impact indicator or type

Q13 Scenarios envisioned for use of the SI-CAT app

Response	Times selected	Percent
Resources and material for government internal discussions	20	43%
Lectures, awareness-raising, presentations (oral presentations)	12	26%
Public info, material for educational institutions (printed)	12	26%
Resources/material for research organizations	3	6%

Table 3-2-5: Summary of local government needs addressed by SI-CAT app

Summary table

Local government needs counts	Impact assessment side						
Climate scenario perspective	Yes	No	Needs changes	Review on climate scenario side	Difficult to judge	Comments/ questions	Total
◎ For FY2016			3	40	2	14	59
○ For FY2017 and later				31		8	39
— Database not supported				15	39	1	55
× Cannot register	4			1	24		29
△ Requires discussion			1	11			12
◇ DIAS/SI-CAT app	60	5	51	16	36	45	213
Difficult to judge	20	17	41		2	215	295
Total	84	22	96	114	103	283	702

Table of responsibilities

Responsibility	Number of needs
a. Climate scenario side response	95
b. Impact assessment side response	80
c. No response	102
d. Consider both	24
e. Climate scenario side review	11
f. Review by Hosei University	83
g. Review on impact assessment side	92
h. Not being considered	215
Total	702

3-3. Matching of Technology Resources with Government Needs (Co-Design Workshop)

(1) Co-Design Workshop

For local governments to develop administrative plans for adaptation strategies, it is essential to consider measures based on scientific information, such as near-term climate change projections and impact assessments on local communities. Research is under way at SI-CAT's technology development organizations, but the current situation is that there is not enough mutual sharing of "resources" (research products that technology development organizations can share) and "needs" (information required when local governments are considering adaptation strategies), as well as the challenges they face when trying to develop concrete adaptation measures.

Hosei University, with a role as on SI-CAT's Implementation Team, held the First Local Government Forum on Adaptation at Hosei University Ichigaya Campus on August 31, 2016. It was a co-design workshop aimed at matching "needs" and "resources" relating to climate change adaptation strategies. As shown in **Table 3-3**, the aim of the forum was to identify potential needs of local

governments, share topics for the development of concrete adaptation strategies, and discuss broader mainstreaming. In total, 76 persons participated from MEXT, the Ministry of the Environment, local governments, local environmental research institutions, technology development organizations, and implementation organizations.

The first half was in lecture format, with introductions of the Technology Development Team's "resources" and Hosei University's study on local government "needs," as well as the activities of SI-CAT model local governments and progressive local governments. Presentations included the Ministry of the Environment's adaptation strategies support programs as well as the policy processes and challenges experienced by program case studies including Kawasaki City. Another presentation was by Tokushima Prefecture, which is doing its own policy development, and Gifu Prefecture, a SI-CAT model local government. For example, in Tokushima Prefecture, bylaws and plans are progressing simultaneously and very quickly, supported by the national government's planning efforts as well as support of the prefectural assembly. Also, progressive local governments have completed work to identify inherent adaptation measures (existing policies and measures that can lead to adaptation), and their consideration of additional adaptation measures is now moving ahead.

In the second half, people formed groups of about ten persons, and a total of five breakout groups discussed disaster prevention, agriculture, or adaptation plans overall (Photo 3-3). With a topic of "What technological developments would be useful for the development of adaptation plans," people from local governments, local environmental research institutions, and technology development organizations discussed resources and needs directly with each other in the breakout groups. The results were summarized on poster paper and presented to the entire forum, and the words mentioned were visualized using their frequency and co-occurrence in real time and shared (**Figure 3-3-1**). Efforts were made to ensure that every breakout group included someone from each stakeholder group present, and expert facilitators facilitated discussions.

Table 3-3: Outline of Local Government Forum on Adaptation

Date and time	August 31, 2016 (Wednesday), 1 to 5 pm
Location	Hosei University, Ichigaya Campus
Affiliation of participants	Ministry of Education, Culture, Sports, Science and Technology, Ministry of the Environment, local government personnel from nationwide with interest in adaptation, regional environmental research institutes, SI-CAT Technology Development Team, SI-CAT Implementation Team, etc.
Purpose	· Identify potential needs of local governments · Share comments on challenges for developing concrete adaptation measures, consider how to expand mainstreaming of adaptation
Agenda	· First half - Lecture format >Introduce resources from SI-CAT Technology Development Team >Hosei University reports findings of survey on local government needs >Introduce local government initiatives · Second half - Divide into small groups for workshop format

Photo 3-3: Breakout group at Local Government Forum on Adaptation

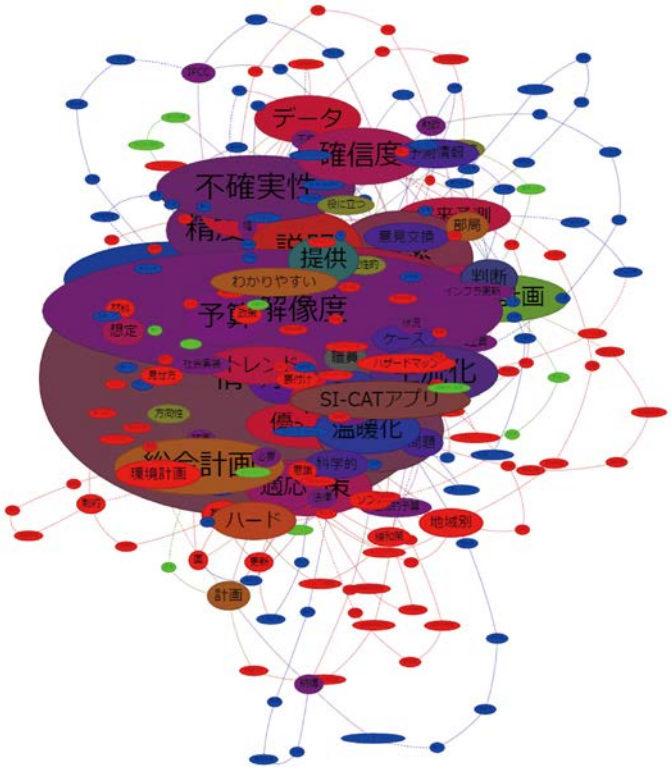


Figure 3-3-1: Trial visualization of key words in real time

(2) Visualization of Discussion Content Using Text Mining

Here we introduce the results of a research trial to analyze the discussions by the three breakout groups that addressed adaptation plans overall at the Local Government Forum on Adaptation. We tried to identify the themes discussed in the groups and differences in tendencies of remarks on the themes by affiliation (local government, local environmental research institution, or technology development organization) with text mining of the discussion transcripts. This framework is also one important component among a variety of social technologies introduced in the next chapter.

Text mining is a general term for a variety of computer-based methods to extract valuable information from text data through quantitative analysis. This analytical method enables a consistent approach for analysis of a large volume of data.

Specifically, we identified the words with high occurrence frequency in the three breakout groups and classified these words according to the frequency of co-occurrence in the same remarks. We interpreted the word groups thus classified as the keywords that express the details of what was spoken, and attempted to extract the topics that were discussed (**Figure 3-3-2**, bottom left). As a result, we were able to quantitatively determine the topics discussed in the groups, including the "precision of research outcomes," "prioritization of adaptation measures," and "explanations to other departments."

In order to ascertain any differences in the reference to the theme by the participants' affiliation, we also created a network graph in which the size of circles denotes the number of remarks, and the thickness of lines denotes the frequency of mention of each theme by affiliation (**Figure 3-3-2**, bottom right). The results showing which participants referred most frequently to which themes can thereby be understood visually. For example, for local government administrators one can see that frequently-mentioned topics were "staff reassignments and collaboration with other departments" and "explanations to other departments," while for researchers from technology development organizations, frequent topics included "climate change projections" and "precision of research outcomes."

These research results can support communication between the local government personnel and researchers from local environmental research institutions and technology development organizations, and can be utilized to show the contents of discussions objectively. In typical meetings, participants can check only the meeting notes. In contrast, by using this method, it is possible to confirm what theme was discussed frequently, and on what perspectives there were differences. This could therefore be an effective way to confirm mutual awareness and gaps in concern, and to find common points of interest. The possible uses of this methodology are vast, and as introduced in the next chapter, we use it extensively to detail online discussions as well as interview-based studies about the development of local adaptation scenarios using deliberative stakeholder dialogue methods.

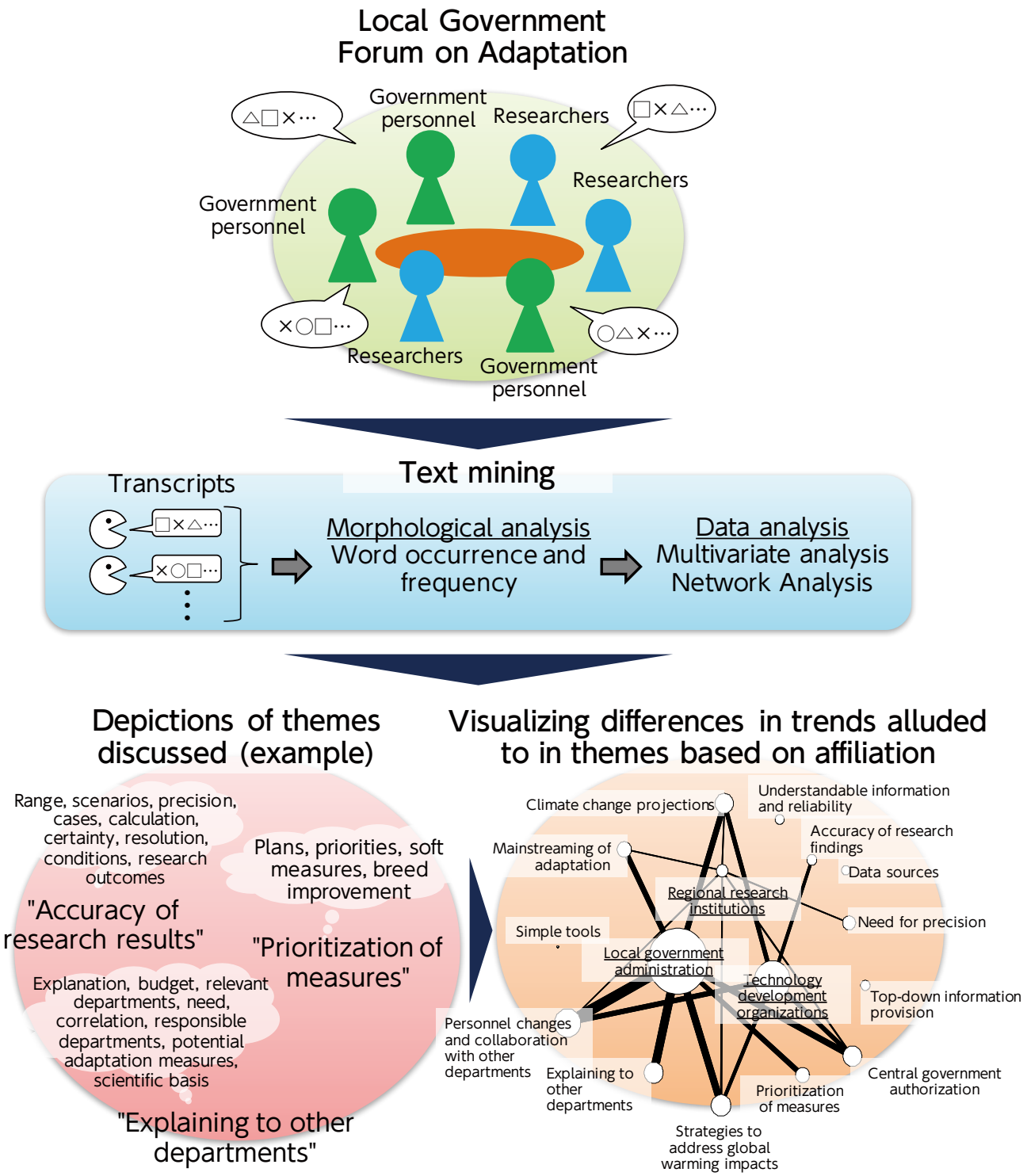


Figure 3-3-2: Flow of visualization of discussion content

Chapter 4
Progress on Approaches for Mainstreaming Climate Adaptation

4-1. Developing Local Adaptation Scenarios Using Deliberative Stakeholder Dialogue: Gifu Prefecture, Japan

(1) Introduction

Local governments can only be expected to formulate effective policies that are highly implementable and able to gain stakeholders' understanding and cooperation when they examine the local impacts of climate change and involve a variety of stakeholders. To date we have attempted to depict and share future visions of local communities (narrative-style local adaptation scenarios), starting with climate change, by working with experts, local officials, and stakeholders in some local communities, as shown in **Figure 4-1**. For example, there could be major challenges in building consensus within a given region when dealing with questions about the significance of a range of impacts portrayed in climate scenarios and how to decide on the time scales for policymaking premised on uncertainty. In order to integrate stakeholders' local and practical livelihood knowledge with expert knowledge in a mutually complementary way, it is crucial to have a forum for this process. Narrative-style local adaptation scenarios as the outcomes of such forums, thus, can help stakeholders understand climate change risk and other risks that local communities are likely to face, as well as approaches to respond to them through sharing a vision for the future.

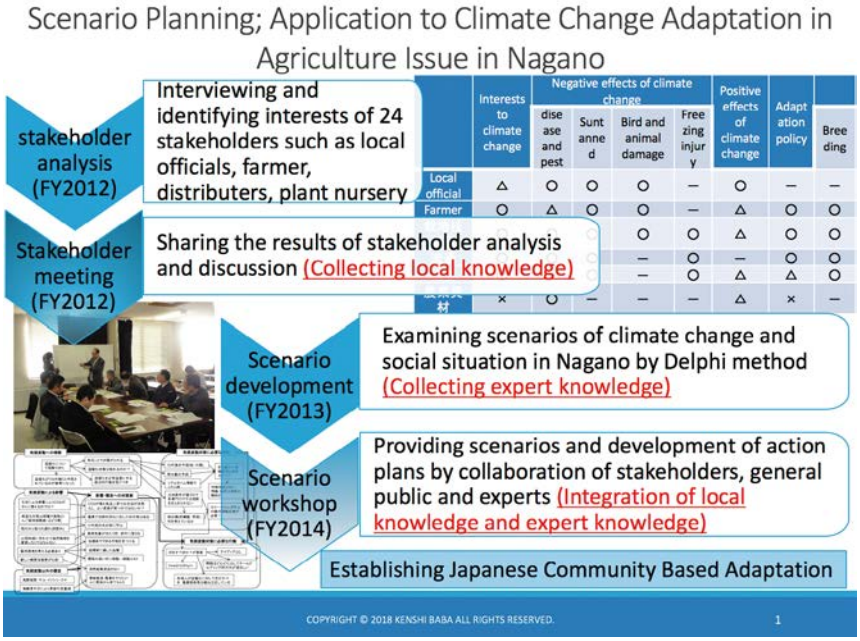


Figure 4-1: Process of development of local adaptation scenarios based on deliberative stakeholder dialogue

In this section, we introduce progress that has been made with approaches to develop local adaptation scenarios through deliberative stakeholder dialogue, for the Nagara River basin in Gifu Prefecture, which is one of the model local governments in the SI-CAT program. In the fiscal year of 2015, as a preliminary study, individual interviews were conducted with the stakeholders (at ten organizations) who will play a central role in the future of the Nagara River basin. Key issues were identified based on the results of the preliminary study, and a larger stakeholder list was developed corresponding to those issues.

(2) Overview of the methodology

1) Interviews

In the fiscal year of 2016, we conducted individual interviews at 30 organizations about their cognition of long-term risks such as climate change and societal changes (population decrease, infrastructure deterioration) and about their intentions for the future, and then analyzed the data thereby obtained to better understand the stakeholder interests in the key issues (the process is referred to as stakeholder analysis).

The interviews were conducted from November 2016 to February 2017 based on the needs of the model local government, Gifu University and Gifu Prefecture.

As the target stakeholders of this study, we chose the central and local governmental bodies concerned and people in occupations with a high likelihood of being affected by climate change and adaptation measures, as well as business associations and citizen organizations that are already engaged in actions to address various problems in the Nagara River basin. Thirty organizations were interviewed (one to three persons from each organization, for a total of 43 persons) as follows: Gifu prefectural government (fisheries development, *satokawa* promotion, tourism resources, planning departments), river management (1 organization), municipalities in the river basin (6), government-related bodies (3), fishing-related organizations (4), business associations (3), private companies and individual businesses (5), and citizen organizations (5).

The time for interviews was about an hour per organization, beginning with a general outline of this study and information provision on the possible long-term impacts of climate change, for about ten minutes, followed by an interview of about 50 minutes based on the following questions. As much as possible, the responses were expected to represent the affiliated organization, but for difficult questions personal views were also accepted, and the notes were summarized in a way that ensured the interviewees could not be identified.

<Questions>

1. Your work description and cognition of the current situation
2. The future vision of your work and the Nagara River basin under climate change and societal change (business as usual, desirable future, and measures to achieve a desirable future)
3. Key persons in the Nagara River basin who should be interviewed about these issues

2) Stakeholder Analysis

A stakeholder analysis is an assessment conducted by a third party to identify before deliberation what interests various stakeholders might have on a specific issue, what the key issues might be, and whether or not there is value in actually convening stakeholders for deliberation. To start, interviews are conducted with individuals and organizations who appear to have an interest, and through a "snowball sampling" approach, the target of interviewees is expanded. The interviews end when no new stakeholders are mentioned anymore, and next, the results of the interviews are analyzed and an interests matrix is created to summarize their interests.

For this study, stakeholders were classified into five groups (governmental bodies, fishing-related organizations, business associations, private companies and individual businesses, and citizen organizations) in terms of similarities and special characteristics of the organizations they were with, and these five groups were used as the horizontal axis in the interests matrix. For the vertical axis, four categories that derived from the answers to Question 1 "Perception of long term changes," and Question 2 "Business-as-usual future," "Desirable future," and "Measures to achieve a desirable future" (hints for adaptation measures). We developed the matrix after carefully reviewing the data from individuals several times, then grouped and integrated the data.

(3) Results of the Analysis

The interests matrix is shown in **Tables 4-1-1 to 4-1-3**. A circle (◯) in the matrix indicates that there is some form of interest.

Table 4-1-1: Cognition of long term changes

Interests \ Stakeholders		Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
Diverse changes	Recognized	○	○	○	○	○
	Causes of changes	○	○		○	○
River management	Nagara River	○	○			
	Estuary barrage	○	○			
	Planning frameworks	○	○			
River activities	Fisheries	○	○	○	○	
	Tourism, leisure businesses	○	○			○
River-related jobs	Forestry works				○	○
	Agriculture				○	
	Local industries			○		
	Private companies			○	○	
Towns near river	People and infrastructure	○	○	○	○	

Table 4-1-2: Business-as-usual future

Interests \ Stakeholders		Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
Environmental change	Change in nature	○			○	○
	Change in society	○				
	Adaptation	○				
Watershed management	Regional management	○				○
	River management	○				
	Regional infrastructure	○				
Economic, industrial activity	Private companies	○			○	○
	Fisheries	○	○			
	Agricultural, forestry industries	○				
Livelihoods	Region				○	
	Individuals, families	○			○	

Table 4-1-3: Desirable future

Interests \ Stakeholders		Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
Environmental change	Change in nature	○				
	Change in society	○				
Individual livelihoods	Individuals, families	○		○	○	○
	Region	○			○	○
	Relocation, settlement	○	○			○
Societal activity (Economic, industrial activity)	Private companies	○				
	Fisheries	○	○			
	Agricultural, forestry industries					
	Future work			○		○
Interconnections within the watershed	Nature, people				○	○
	Human society					○
	State of river		○			
	Change	○				
Watershed community management	Regional economy	○				
	River management	○	○			
	Regional infrastructure				○	
	Tourist area management	○		○		

*Text in red is the concept and information generated when "Desirable future" was considered.

Regarding "Cognition of long term changes," **Table 4-1-1** summarizes the responses to the question "Do you sense that long-term changes are occurring in your personal livelihood or work?" All interviewees sensed some form of change; e.g., temperature, rainfall or snowfall patterns, water quantity, shape of the river, or biology of *ayu* (sweetfish). In particular, people engaged in work that interacts directly with nature, such as agriculture, forestry, fisheries, appear most likely to be sensitive to changes. As for the causes of changes, the interviewees stated that they may be more due to complex anthropogenic causes than climate change.

The "Business-as-usual future" in **Table 4-1-2** refers to the future that would be expected if no action is taken. Interviewees from governmental bodies smoothly referred to the "business-as-usual future" arising from the current issues of concern. On the other hand, the business associations, private companies and individual businesses, and citizen organizations tended to refer to the "desirable future" rather than the "business-as-usual future." Regarding fishing, the fishing-related and government-related interviewees in particular had a variety of interests, including sweetfish, fish catches, timing of fishing seasons, amount of resource, *ukai* (cormorant fishing), boat making, aging of facilities, fishery management, and more. Interviewees from citizen organizations had a broad perspective encompassing the river basin, and were concerned about the region's business-as-usual future.

The "Desirable future" (**Table 4-1-3**) is the most desirable future freely portrayed by interviewees with no relation to the present situation and no thought about feasibility. Compared to the "Business-as-usual future," there was a stronger depiction of individual livelihoods for individual, family, or community. Also, the "Desirable future" includes the concept of "Watershed community management" which is an integration of "Watershed management" and "Tourist area management." In addition, by adding and incorporating "Future work," which has a high social aspect, into "Economic and industrial activity," the "Desirable future" expanded to include economic and industrial activity as a component of "Societal activity."

Finally, "Interconnections within the watershed" was added as a major component of the "Desirable future," because interviewees frequently mentioned many interconnections — rivers, mountains, sea, climate, human livelihoods, work, housing, and urban areas, etc.

In terms of special observations relating to individual categories, most government-related interviewees felt the status quo was desirable in terms of the natural environment. Fishing-related interviewees thought that changes in nature and society were to be expected, and premised upon that assumption they imagined the "Desirable future" for fishing, river, and river management. Business association interviewees had a strong interest in the "Individual and family," "Future work," and "Tourist area management." Private company and individual business interviewees appeared to have a steady interest in "Measures to realize a desirable future," beyond the "Desirable future." Citizen organization interviewees portrayed a clear picture of the "Desirable future" and had a broad scope of interests, from nearby "Individual and family" to the "Region and watershed." They also had interests in categories such as "Future work," "Relocation and settlement," "Relationship with nature," and "State of human society," as they were thinking about things that were new and philosophical, as well as taking practical action.

(4) Discussion

1) Points of Attention

In terms of considering local adaptation scenarios with each stakeholder, here we introduce three important points that should be shared.

First, interviewees often responded that climate change adaptation measures were too vague, so it is important to provide people with specific examples of environmental changes in the Nagara River basin to enable having an image of "How will my life or work environment change due to climate change?" Based on that, a good approach would be to have them look at the issues from various perspectives, asking what impacts each stakeholder might experience, and whether they would be seen as risks or as opportunities. People who live in the mountains responded as follows with a specific image: "If temperatures increase by X degrees, the place where I live will be the same an elevation of Y meters lower, right? That would mean less snow, which would make life easier, but ski hills would probably suffer." This type of thinking and talking about change is relatively easy for

people to understand.

Second, it is necessary to summarize regulatory and planning frameworks that underlie aspects such as basic policies and plans for river infrastructure improvements, as well as decision makers and decision-making processes, and to present them visually in ways people can understand. Clarifying the underlying policy constraints helps to define the range of possible choices, which makes it possible to have discussions that consider policy feasibility. In particular, for climate change and societal change, since the assumptions will change, it is probably necessary to revise the actual regulatory and planning frameworks that are constraining factors.

Where it is difficult to cover regulatory and planning frameworks in all sectors, it is still worth investigating specific themes. For example, in terms of existing systems, in cases where fishery management has become difficult due to a decline in the membership of fisherman's unions, the prefecture is supposed to take over, but where it cannot actually manage, reportedly the area must be closed to fishing. Going forward, it would be useful to share information and assess the key issues, among governmental bodies and experts to begin with, about the implications for local communities if more areas are affected by bans on river use, and how the rivers can be used safely and securely.

Third, in accordance with the above mentioned two points, it would be meaningful to talk about (1) business-as-usual scenarios and (2) desirable future scenarios. Some stakeholders wondered, "What would we do to rebuild from zero in the event of catastrophic damage to the Chubu region from a major disaster?" Thus, it might be wise to expand the discussion to also develop (3) crisis scenarios. For themes such as these, stakeholders can speak without temerity, because they can talk about the future in terms of individual desires, even if the specialized and complex nature of the underlying information makes it difficult to understand. People don't need to be held back by past difficult experiences and current obligations.

If people feel familiar with the themes and sense their importance, after understanding any underlying assumptions and constraining factors, we believe that by establishing their own objectives, it becomes easier to think about and act on what needs to be done to achieve them, and it becomes possible to create realistic and functional, workable local adaptation scenarios.

2) Potential for Use in Development of Climate Change Adaptation Scenarios

By imagining the "Business-as-usual future" and "Desirable future" in the context of climate change and societal change, and then asking about "Measures to achieve a desirable future," we were able to identify many key words and sentences that could then be converted into hints of adaptation measures. All of this is summarized in **Table 4-1-4**.

Table 4-1-4: Measures to achieve a desirable future (hints of adaptation measures)

Large category	Medium category	Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
Environmental change	Change in nature	What will happen?	Those who adapt will survive		How to respond to changes	
	Change in society	Depopulation	Humans are the cause	Introduction of IT	Issues of creating compact cities	Increasing those who adapt individually
Individual livelihoods	Individual and family	Survival ability	Those who adapt will survive		New life	Response capability, self-sufficiency plus something extra, zest for living, techniques and philosophies of the elderly, trial and error over the centuries, determined to live
	Region				Inheritance of wisdom, sharing comfort of places	Autonomous capability, collaborative capability
	Relocation and settlement				Momentum	Techniques and philosophies of the elderly, option to come and go, setting down roots, inexpensive eco-houses
Societal activity	Private companies	Workers' wisdom and innovative ideas, working environment		Difficulties in responding to changes	Overseas, business management, interest in social problems, careful top-down	
	Fisheries	Number of fishermen	Fisherman's wisdom and innovative ideas, occupation, types of fish		To new jobs	
	Agricultural and forestry industries	Wisdom and innovative ideas		Effective utilization of thinned wood	Banned work and technology, training new workers, improving work environment, interesting aspects, low scientific input	Transplanting
	Future work			Capable of supporting family, finding sales channels, students getting employed at local businesses, self-fulfillment	Technological development incorporating ancient wisdom, new life, new industries	Connection with technologies, urban areas as customers of rural areas, nurturing people, collaboration
	Education, teaching tradition, dissemination	Fieldwork, economic benefits, attracting educational institutions, adaptation measures contest, from children to parents		Craftworkers' wisdom and innovative ideas		Aims and means, view of forest industry, nurturing educators, appealing to religious sense
	Regulatory frameworks	Fines, penalties, laws and regulations if serious			Difficulty in utilization of farmland, creativity of youth	
	Public land management				Wisdom and innovative ideas to revise operations, sharing and using idle land, revising the operations by Ministry of Land, Infrastructure and Transport	

Large category	Medium category	Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
Interconnections within the watershed	Nature and humans				No natural disasters, causal correlation, scientific investigation of causal correlation, low input	
	Human society	Measures from the perspective of connections			Decreasing energy consumption, creating face-to-face relationships	Sustainable society, attraction is people, restructuring of transportation system (reconnecting with towns), getting more people to take issues personally
	Changes	Modifying municipality scope, continuing search, changing business as usual, change as a burden, rapid change increasing anxiety				Places where those who notice can act, governors who will not nominate themselves again, connections among towns, teleworking, personnel exchanges
	Serving a useful function mutually	Sending out weather information, delivering messages while listening, moral improvement, features of universities	Different perspective between academics and practitioners, *usho* (cormorant fisherman), universities, governments, fishery cooperatives	Entrust to private sector on a voluntary basis	Work with universities (forestry); to make local issues relevant to activities	Those who can accomplish, people who are settled down and people who migrate, university professors practicing in rural areas, university researches
Watershed community management	River management	Enhancing know-how and experience, flood forecasting, timeline, wide-area evacuation, building ditches, equipment & facilities and know-how & experience, revising plans and operations, mutual understanding				
	Regional management	Investment in human resource development, sending out information, connection with family finances, securing energy, mitigation measures, vertically-splintered government organizations	Flood control and environmental conservation		Infrastructure improvements in depopulated areas, changing management bodies and styles of common land	Sending out and receiving quality information, bold policy by leaders
	Regional infrastructure	Renewable energy, downsizing, public facilities, regional infrastructure, irrigation, simulation			Revising operations, restoring common land	
	Tourist area management	Nagara River system, sales, brand power, human resource development, collaborative approach, bringing money into region, secure tourist spots, management decision based on simulation results	Globally Important Agricultural Heritage Systems, attention	Solving labor shortages, collaboration with universities		

Large category	Medium category	Governmental bodies	Fishing-related organizations	Business associations	Private companies and individual businesses	Citizen organizations
	Watershed management	Various stakeholders, Nagara River system, simulation technology to prevent major disasters, self-help, mutual help, public help		Thinning of forests	Thinning of forest, healthy forest, investment in mountain areas, preventative conservation, planning approach, utilizing database	Designing, part-time farmers, part-time forestry workers
	National strategy	Economic benefits for individuals, partially mandatory policies based on citizens' good intentions, all handling by authorities as required by law, measures that go beyond the frameworks of ministries and agencies			Mitigation measures, increasing burden of adaptation measures, improvement of businesses, eliminating redundant infrastructure	Population migration policy, energy policy, basic science research

Specifically, some government-related interviewees commented on the need for flexible reviews of existing operational plans, as well as for regulatory adjustments. Fishing-related interviewees mentioned that "only those who have adapted will survive." Business association interviewees had positive expectations for regional management, along with continuous business expansion as well as cooperation among industry, government, academia and citizens. Among the private companies and individual business interviewees, some were involved in new initiatives in which local residents utilize public lands under the responsibility of a manager. Citizen organization interviewees were able to articulate a future vision and possessed a considerable amount of local and practical livelihood knowledge obtained through day-to-day trial and error and hands-on work.

These results suggest that even if stakeholders have no opportunity to think about climate change in the course of regular living and working, they can examine adaptation measures when they start from their current situation and are asked about how to achieve a desirable future.

3) Effectiveness for Future-Oriented Policy Formulation Processes

The stakeholder analysis identified concepts and policies that were not obvious as a simple extension of the current situation. Specifically, within "Societal activity," which is a core part of the "Desirable future," the new concepts added included "Education, teaching tradition, dissemination," "Regulatory frameworks," and "Public land management." Within "Interconnections within the watershed," "Serving a useful function mutually" was added, and within "Watershed community management," "Watershed management" and "National strategy" were added. Conversely, even if future projections of climate change were made and responses considered as a simple extension of the present without considering a "desirable future," it would probably be difficult to achieve any "desirable future," because that future is not clear and it is difficult to discover ways to make it happen.

Also, one feature of the Nagara River basin is that some sentiments still remain from what was at the time the construction of a controversial estuary barrage on the river. Today, forward-looking

initiatives are being taken from various perspectives regarding the impacts of the dam, but it is still a sensitive topic, so many people probably still refrain from publicly expressing their true thoughts about it. However, because we are talking about what could be a very different environment 50 to 100 years in the future, it might be easier for people to make a step forward into new discussions.

4) Expectations and Challenges for Dialogue Space Creation

In interviews, we heard a lot about the need to consider and reexamine various relationships and create new ones. For example, there are interconnections between rural and urban, scientist and fisherman, cormorant and cormorant fisherman, upstream and midstream and estuary, flood control and fishing. Also, fisheries consist not only of fish, fishermen and river authorities; they are also premised upon boatmen and boat makers, engine manufacturers and vendors, people involved in food preparation, food processing industries, fish markets, customers, and more. Thus we need to set up forums for deliberation which have meaning and value as places to meet people with different affiliations, as opportunities to face each other and look for ways to serve in useful roles.

On the other hand, there are many different stakeholders in the Nagara River basin not only in affiliation but also in geographical distance, so it may be not so simple to create connections. In particular, the sharing of perspectives may be very difficult because of the huge variety of perspectives to see one's own livelihood, work, and local area, or municipality, watershed, nation, and world. The world as viewed by a fisherman who catches fish for his own survival and for his family's wellbeing is probably very different from the world as viewed by a scientist conducting a global-scale simulation. There is a need to create forums for mutual understanding of diverse peoples' perspectives, and to be willing to accept all the knowledge that the participants have. Local adaptation scenarios will be a starting point to attain this.

(5) Conclusion

This section introduced the results of interviews and stakeholder analysis for the development of local adaptation scenarios based on deliberative stakeholder dialogue methods. Going forward, we plan to work with many stakeholders, including experts and local officials, to articulate narrative-style local adaptation scenarios based on the information obtained so far, following the process shown in **Figure 4-1**. Through dialogue with stakeholders, we would like to further deepen our analysis and consideration, looking at how to best utilize the ideas and wisdom of the people who live and work in the Nagara River basin, how science and technology can contribute to society, and what kinds of policies should be developed by national and local governments.

In closing, we express our heartfelt appreciation to the many people who provided their cooperation.

4-2. Using Online Deliberation to Discover Stakeholder Attitudes on Adaptation Measures Nationwide

(1) Introduction

When trying to utilize projections of climate change in local communities, it is important to understand what kinds of attitude changes can be caused by the provision of scientific evidence among stakeholders and the general public. The potential needs identified in such "arenas" can be used in technological development and in assessments for communicating about risk. Also, the results obtained are often summarized into policy recommendations. In terms of climate change, one example worth mentioning in this regard is the "World Wide Views" held on the same day around the world and used to make policy recommendations from citizens during the Conferences of the Parties (COPs) to the United Nations Framework Convention on Climate Change in 2009 and 2015. Besides this kind of participatory approach, various other methods like consensus conferences and joint fact-finding are also being applied around the world, but online approaches are also gradually gaining traction as a tool to expand the opportunities for participation. Below we introduce examples of online deliberation on issues in the sectors of agriculture and disaster prevention, where climate change impacts tend to appear.

(2) Overview of Online Deliberation

We designed the procedures for online deliberation as shown in **Figure 4-2-1**. This study was implemented over a period of 14 days from March 11 to 24, 2016. To begin with, as the participants of this study, for agriculture we identified 84 persons associated with agriculture, from production to consumption, and for disaster prevention, 86 local residents in the regions where some kind of water damages have occurred in recent years. However some were not able to complete the full two weeks, so eventually 60 persons participated to the end for agriculture and 61 for disaster prevention. In each sector, they were separated into three groups, with care taken to ensure no imbalance in characteristics such as age and gender, and moderators guided the proceedings of deliberation. Also, when technical questions arose from participants, experts for each sector from the SI-CAT Technology Development Team who were observing the deliberations responded via the moderators.

The expert knowledge provided in both sectors as general materials on climate change was publicly available from sources such as the National Institute for Environmental Studies, the Japan Center for Climate Change Actions, and the Meteorological Agency of Japan. In addition, for agriculture, participants were presented with local adaptation scenarios which describe future visions of rural communities based on projections of climate change and the impacts on the agricultural sector and adaptation measures, prepared by Hosei University by integrating expert knowledge and local knowledge of the stakeholders. For disaster prevention, participants were presented with information on climate change impacts and future options for adaptation measures, based on examples from local governments nationwide as well as input from experts affiliated with the SI-CAT Technology

Development Team. These materials were prepared using presentation software, and participants were then able to read and write in discussions via an Internet forum, while accessing the materials on a website.

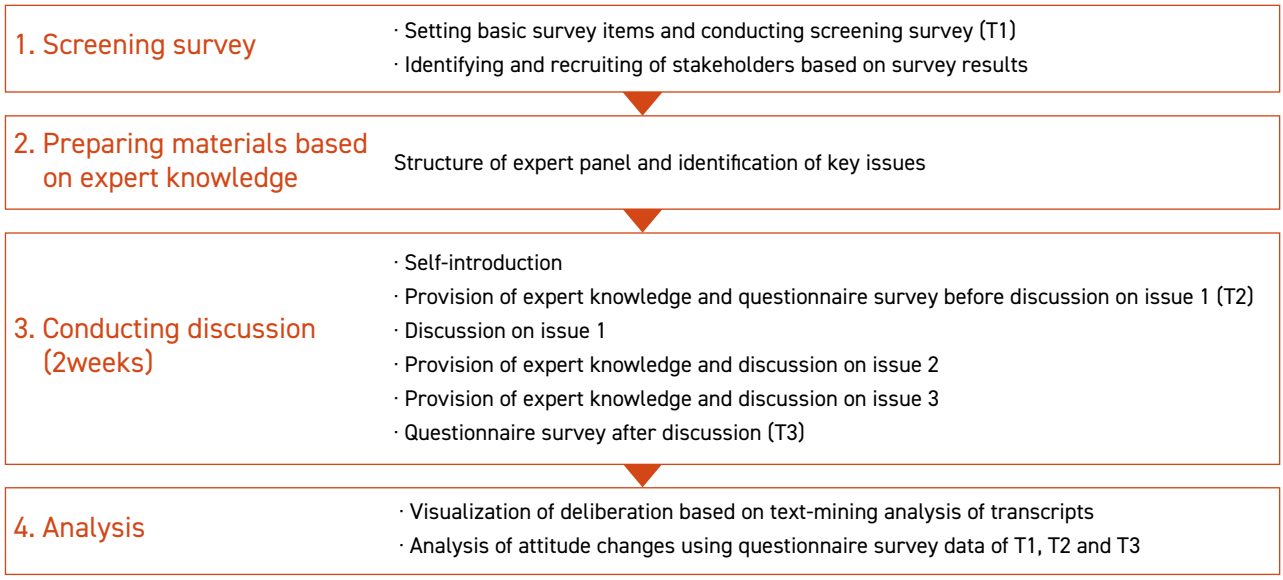


Figure 4-2-1: Process of online deliberation

(3) Overview of Attitude Change in the Agricultural Sector

In terms of climate change risks, many participants were concerned about events such as rising average summer temperatures, changes in rainfall, and increased intensity of typhoons. In terms of important policy options, most participants tended to choose measures to address unexpected extreme weather events and crop breed improvements (**Table 4-2-1**). Meanwhile, more than a few participants responded that it would be difficult to prioritize and narrow the policy options, with comments such as "All policies are important because they all affect each other in agriculture," and "It is hard to say which one is most important."

Table 4-2-1: Adaptation measures regarded as important in agricultural sector

	Number of respondents
Crop breed improvements to withstand the impacts of global warming (frost, heat, extreme weather, etc.)	13(4)
Measures for extreme weather events such as water shortages and torrential rains	15(5)
Sending out information on environmental issues	4(2)
Supporting new farmers and workers	15(2)
Social and environmental improvements to tackle climate change	6(3)
Measures for natural disasters such as flood damage and mudslides	5(1)
Management of forests, *satoyama* (traditional managed landscapes) and abandoned farmland	3(2)
Nurturing leaders and human resources	6(0)
All is important and it is hard to choose one.	8(4)

Figure 4-2-2 shows the degree of agreement with certain adaptation policy options, comparing participants' responses before and after deliberation on agricultural sector options, broadly classified as protection, adaptation, transformation and transferring. The higher the score on the horizontal axis, the higher degree of agreement. The changes from before to after deliberation in general were larger for participants who had a low level of involvement with agriculture, and notably, their degree of agreement decreased for the policy options "We should protect the current form of agriculture (protection)" and "No particular policies are needed." Meanwhile, regardless of the participant's relationship with agriculture, there was also a tendency for the degree of agreement to increase for the policy option "There should be compensation by insurance and mutual aid systems (transferring)."

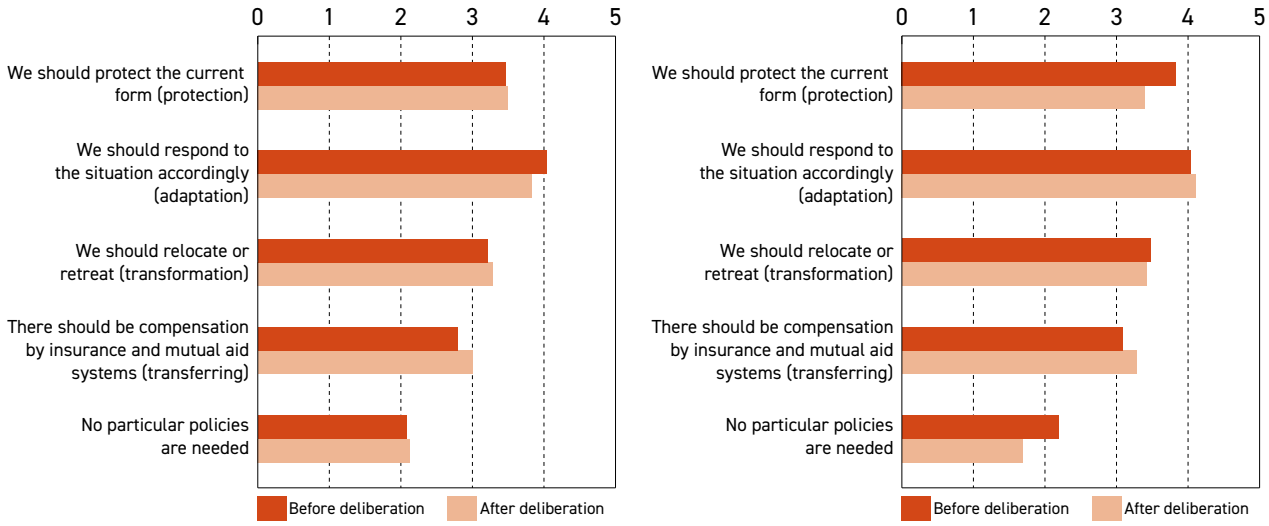


Figure 4-2-2: Changes in degree of agreement with agricultural adaptation policies (participants with high involvement in agriculture in left graph, low involvement in right graph)

(4) Overview of Attitude Change in the Disaster Prevention Sector

As for the changes in participants' attitudes before and after deliberation, there was greater awareness of the increased frequency and magnitude of every category of impacts (crops, water resources, health, wind and water damage, ecosystems, livelihood damage, and sea level rise) after deliberation. In particular, awareness of the risks relating to water resources, that is, "Water shortages and water quality deterioration" was low before deliberation, but became higher afterwards. The awareness of an increase in the magnitude of wind and water damage was high both before and after deliberation, and this is evident from the fact that many participants mentioned during the deliberation that they anticipated torrential rains and typhoons.

Also, regarding protection, adaptation, and transformation policies, we provided 18 specific adaptation measures that could be implemented by local governments and 19 by individuals, and asked participants to rate their degree of agreement for implementation (the lower the score, the higher the degree of agreement). An excerpt of the results is presented in **Table 4-2-2**. For most of the adaptation measures, the ratings shifted toward agree, but the attitude shifted toward

disagree to local government measures #5 (Natural environment protection) and #15 (Fundamental transformation measure such as relocation or retreat), and individual measure #18 (Move away from frequently damaged areas). On the whole, agreement for local government measures was strong, but after deliberation, the degree of change was greater for individual measures. Finally, among local government measures the degree of agreement was highest for #5 (Natural environment protection) before deliberation, but afterward, agreement to the three measures #8 to #10 (Adaptive adaptation measures) became the highest, while agreement to #11 (One's self-help measures during a disaster) became the highest both before and after deliberation among individual measures.

Table 4-2-2: Degree of agreement for adaptation measures in disaster prevention sector

Local governments		Before deliberation	After deliberation
5.	Natural environment protection measures	1.95	2.05
6.	Promoting preservation of traditional culture	2.59	2.59
8.	General adaptive adaptation measures	2.30	1.84
9.	Enhancing the lifeline functions	2.11	1.84
10.	Enhancement and improvement of initial responses such as shelters	2.21	1.84
15.	Fundamental transformation measures such as relocation or retreat	2.43	2.44
Individuals			
11.	One's self-help measures during a disaster	2.15	1.80
18.	Move away from frequently damaged areas	3.25	3.36

Thus, we can conclude that there were increases in the degree of agreement to climate change adaptation policies in the disaster prevention sector (especially adaptive measures), and in awareness of the greater magnitude of disasters, and that these increases were a result of participating in deliberation. Meanwhile, the degree of agreement to transformation measures such as relocation or retreat decreased; that is, through deliberation, the participants gained an awareness of challenges involved in implementation of the measures. This suggests that it might be necessary to treat transformation measures separately from other measures.

(5) Overview of Structure of Deliberation on Both Sectors of Agriculture and Disaster Prevention

Figure 4-2-3 provides a view of the structure of deliberation regarding the agricultural sector by using text-mining. For further details of methodology, please see Chapter 3, Section 3. Near Issue "Climate change impacts on Japan" words include "Warming," "Experts" and "Causes"; near "Japan 30 years later affected by climate change" words include "Typhoons" and "Crop varieties"; near "Future scenarios" words include "Responses," "Apples" and "Farmers"; and near "Policy options I think are most important" words include "National government" and "Measures" are allocated. From these observations it can be surmised that the content of deliberation evolved from climate change causes and impacts, to specific impacts and responses, and then to adaptation measures at the national level. A similar trend is evident with the disaster prevention sector.

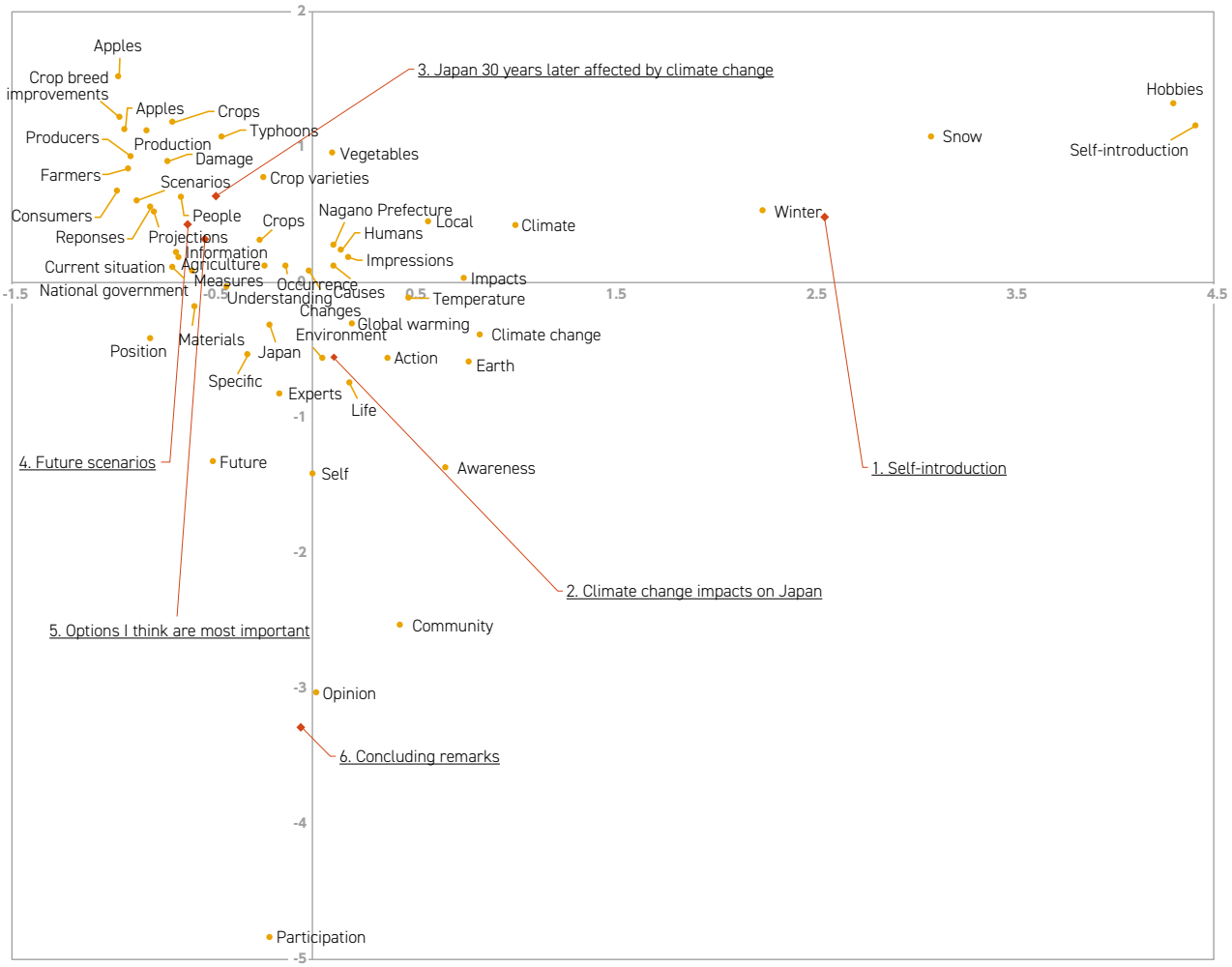


Figure 4-2-3: Structure of deliberation on adaptation in agricultural sector

(6) Conclusion

As seen above, the attitudes of participants shifted through the process of deliberation, and the change tended to be larger particularly for participants who had little prior knowledge of, or involvement in, the issue. This can come from the provision of expert knowledge and discussion among participants. In the future, we plan to clarify points such as how to provide information to minimize misunderstanding, and how to enable people to use tools like the SI-CAT app (a web based tool to visualize the impact of climate change) most effectively.

4-3. Overseas Case Study on Mainstreaming of Climate Science and Technology: NECAP

(1) Introduction

Below we take a look at role-play simulation, one among the social technologies that take broad view of the relationship of society and technology and can contribute to the resolution of societal problems through dialogue and the cooperation of diverse and wide-ranging stakeholders. We introduce the outcomes of the New England Climate Adaptation Project (NECAP), a project in the United States that

dealt with mainstreaming of climate change adaptation measures. The description below is based on our own literature review and in-person interview with Prof. Lawrence Susskind at the Massachusetts Institute of Technology (Environmental Policy and Planning Group in the Department of Urban Studies and Planning) on September 15, 2016.

Role-play simulation (negotiation simulation) is a policy development support tool in which participants conduct a negotiation experiment based on information, rules, and roles they have been given and perform as the various actors that make up a simulated community. The MIT-Harvard Public Disputes Program has had many achievements, and in Japan as well one can find examples where these simulations have been applied by the authors in environmental conflicts associated with the siting of wind power turbines.

(2) Steps to Apply for Climate Change Adaptation

NECAP as part of a public research project by the National Oceanic and Atmospheric Administration (NOAA) in the United States, a project proposal led by MIT was selected and then implemented from 2012 to 2014. This project targeted four local governments in the New England region, and was an attempt to look at mainstreaming of climate change adaptation measures, based on scientific knowledge from NOAA-affiliated organizations and the University of New Hampshire. MIT played a key role by raising awareness of stakeholders through the role-play simulation with the scientific knowledge. Here we introduce a case study from the town of Wells in the state of Maine. The steps to apply these techniques are shown in **Figure 4-3-1**.

(3) Stakeholder Assessment

To begin, in the stakeholder assessment (stakeholder analysis), individual interviews were conducted with about 20 stakeholders, including selected town officials, public contractors, business owners, environmental organizations, and property owners. This method was introduced in Section 4-1 for the case of Gifu Prefecture in Japan. The main results for the NECAP case are described here. First, the climate change risks attracting most concern included beach erosion, the loss of coastal property due to sea level rise, and increases in severe storms. Second, many stakeholders believed that climate change would have negative impacts on coastal tourism, and this could lead to a deterioration of infrastructure and economic problems for the town as a whole. Third, regarding adaptation measures, stakeholders had the highest interest in flood risk management, and supported the protection of critical infrastructure using regulations as a flood prevention measure, and the construction of breakwaters as a fundamental solution. Fourth, the biggest obstacle in terms of promoting adaptation measures was a lack of knowledge among citizens about climate change and that people did not actually believe climate change existed. However, public opinion surveys found that residents' concern about climate change was higher than the stakeholders expected. Fifth, there was a high level of concern that the high cost of many adaptation measures could be an obstacle.

(4) Risk Assessments

Next, for the risk assessments, the University of New Hampshire calculated two emissions scenarios (high and low) for each local government, with short-term (2010 – 2039), medium-term (2040–2069), and long-term (2070–2099) average annual minimum and maximum temperatures, numbers of days of extreme heat and extreme cold temperatures per year, average rainfall, days of extreme precipitation, and sea level rise, etc. Then, based on these climate change projections, potential risks (e.g., floodplains, sea level rise, hurricanes) were shown on a map along with the adaptation measures that could be taken (e.g., for flood risk, adaptation measures were shown in terms of the community, infrastructure, and the environment). In addition, qualitative descriptions were provided for risks and adaptation measures relating to heat waves and higher temperatures, impacts on tourism and finances, droughts, and ecosystems.

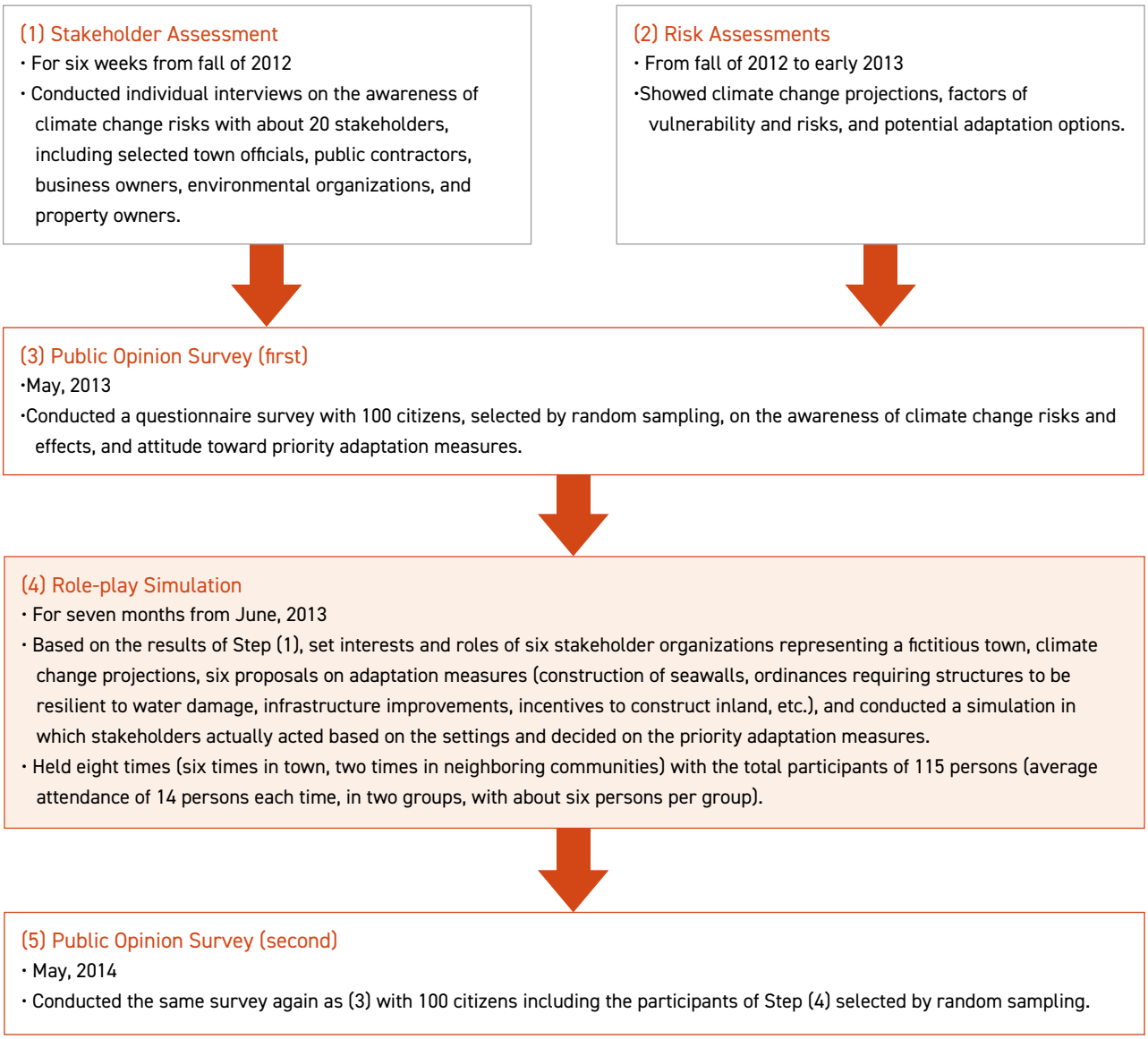


Figure 4-3-1: Process of the New England Climate Adaptation Project (NECAP)

Note that the scientific knowledge prepared in parallel with the stakeholder assessment was not presented to the stakeholders during the assessment, but it was used when preparing scenarios for role-play simulations. The contents of the scenarios are as follows. First, Wells can expect temperature increases, increased precipitation, and rising sea levels due to climate change. Wells is likely to experience more days of extreme heat and less extreme cold. Second, Wells faces increased flooding from intense precipitation events, coastal storm surges, and sea level rise, and over the long term more than 1,900 parcels of land will be at moderate to high risk of flooding. Third, the higher likelihood of heat waves and heat events may increase the risk of drought. Fourth, changes in temperature and salinity in marine waters could damage the area's marine habitats. Fifth, degradation of regional beaches, coastal wetlands, and other natural areas would threaten the tourism industry. Sixth, residents, public infrastructure, and private properties could all face significant risks from severe storms and flooding.

(5) Role-play Simulation

The typical process of a role-play simulation is shown in **Figure 4-3-2**. Based on the two assessment findings, scenarios reflecting the situation in Wells were depicted in general instructions as well as confidential instructions for each actor. The assumed situation was that the local government was considering implementation of climate change adaptation measures and asking stakeholders to comment on the adaptation measures from the perspective of increasing the resilience of the coastal area.

Part 1 (advance preparation): about 30 minutes

· Explanation by organizer on the purpose of simulation and the background of topics to be covered
· Distribution of general instructions and confidential instructions to participants
· Responses to pre-survey
  => Organizing background information of the topics, understanding the roles of actors and Best Alternative to Negotiated Agreement (BATNA) points, and examining negotiation strategies.

▼

Part 2 (conducting negotiation): about 60 minutes

▼

Part 3 (follow-up after negotiation): about 30 minutes

· Responses to post-survey
· Debriefing
  => Discussing what they had learned from the negotiation while presenting what was agreed, sharing the secrets behind the roles they played and negotiation strategies, and exchanging comments and questions.

Figure 4-3-2: Process of role-play simulation

Six types of stakeholders were defined, including citizens, state and federal governments, business owners, and environmental groups, etc. In terms of adaptation measures, there were six alternatives (construction of seawalls, ordinances requiring structures to be resilient to water damage, infrastructure improvements, incentives to construct inland, etc.), and for each one, the future

risks and costs were shown in detail. The participants were assigned their roles as the respective stakeholders, and after all received town maps and specific language related to climate change adaptation, and basic explanations of the risk assessment findings, they then received confidential instructions focused on their specific roles. During about one hour of role-playing, the participants were required to consider ideas that at least five out of six stakeholders could agree on, and in the debriefing, there was a discussion about how the things they had learned with this experience could be applied in their own communities. The total of 115 participants included not only individuals from the stakeholder assessment, but also persons who responded to notices in various media including local papers, e-mail, Facebook, flyers, and word of mouth. Meetings were held eight times (six times in town, two times in neighboring communities) over the course of seven months (average attendance was 14 persons each time, in two groups, with about six persons per group).

The major findings were as follows. First, participants' perspectives were enriched, and the simulation helped them think about climate change through the eyes of others. Second, the participants showed an increased level of concern about climate change and assigned increased responsibility to actors at the local level. Third, a majority of participants felt that planning decisions for climate adaptation should be integrated into the daily work of local government. Fourth, the main challenges identified by participants in rank order, include: (1) challenges associated with reaching agreement among so many stakeholders; (2) lack of public interest or concern about climate change in Wells; and (3) budget limitations. Fifth, participants generally expressed a strong interest in undertaking a collaborative problem-solving process, and the suggested process solution was to educate the public about climate change risks and adaptation options. Therefore, sixth, the confidence gap between what people hoped their government would do and what they thought would actually be done was narrowed.

(6) Conclusion

The NECAP project has already ended, but we have not heard of any particular outcomes in planning climate change adaptation strategies by the local government reflecting the outcomes of the role-play simulations. However, one could say that the fact that stakeholders were able to understand the perspective of specific climate change adaptation measures in order to reduce long term risks and address problems for sustainable community development was in itself effective in terms of creating a model for collaborative decision-making. In the future, while incorporating several elements of social technologies like those used here, our team intends to use co-design for mainstreaming of climate science and technology in ways that are meaningful for local communities, working together with experts, governments and other stakeholders.

4-4. Planning for Adaptive Management in Climate Adaptation Strategies : Procedures and Results

(1) Adaptive Management in Climate Adaptation Strategies: Introduction

Climate change adaptation measures can be divided into responses to current and short-term impacts that have a high level of certainty, and responses to medium and long-term impacts that are associated with uncertainty in the magnitude of their impacts and the timing of occurrence. Responses to the former may be already be in the process of being implemented or considered even if not seen as adaptation, but in terms of additional adaptation measures that should be implemented, the latter medium- and long-term responses are important. However, planning methods for adaptation to uncertain medium- or long-term impacts are not sufficient. In this context, the need for "adaptive management" has been pointed out in the area of climate change adaptation.

In Japan, adaptive management was originally introduced for uses such as fisheries resources where the resource quantities are uncertain, and for the management of natural ecosystems where there was only a limited understanding of phenomena (Matsuda 2008). Regarding climate change adaptation, the need for adaptive management was proposed due to the need to shift from reactive to proactive adaptation to the impacts of climate change (Mimura 2012). Researchers created a theoretical framework for climate change adaptation and presented an approach for adaptive management of medium- and long-term impacts (Shirai et al. 2014).

(2) Research Trends in Adaptive Management for Climate Change Adaptation

Chapters 12 and 15 of the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) touch upon the importance of adaptive management based on impact projections. Chapter 18 says that responses to impacts through existing organizations and management plans in the water sector in North America are examples of adaptive management. Similarly, Chapter 18 of the IPCC's Fourth Assessment Report explains that adaptive management is "the 'act, then learn, then act again' approach."

The term "adaptive management" eventually appeared in the glossary of the IPCC Fifth Assessment Report, defined like this: "A process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables."

For examples of planning based on concepts of adaptive management, one can look at the Delta Program for flood risk management in the Netherlands, and the Thames Estuary 2100 Plan in the UK. Within Japan, we cannot see research outcomes or practical examples of adaptive management in the area of climate change adaptation.

As indicated above, in many countries, research and practical efforts are being made in adaptive management for climate change adaptation in areas such as water resources, water disasters,

natural ecosystems, and measures to address extreme heat. In Japan, however, related research and concrete planning examples are almost non-existent. Also, with regards to adaptive management for climate change adaptation in other countries, methods are not easy to adopt as policy because they have been treated as research, and consequently developed as complex planning methods. Adaptive management planning methods do require theoretical development, but they also require methodologies that are capable of being implemented by the bodies responsible for implementing adaptation measures (i.e., local governments).

(3) Planning Framework for Adaptive Management to Climate Change

Figure 4-4 shows a planning framework for adaptive management for climate change adaptation, based on papers listed in the IPCC's Fifth Assessment Report and later papers. Here we describe five key features of the framework.

First, adaptive management is divided into two phases, the planning phase and implementation phase. The implementation phase involves not only implementation, but as shown in Steps 3 to 5 in **Figure 4-4**, it also includes elements related to learning, communication, monitoring, feedback to science, and these elements are the planning target of adaptive management. Where adaptive management is not being considered, in many cases these elements are not made sufficiently specific in advance but only applied or reviewed periodically or as required while measures are being implemented. But with adaptive management, there are merits to learning and monitoring, so it is important to adequately plan for them.

Second, the alternative adaptation measures considered in Step 1B (Establishment and assessment of alternative adaptation measures) include some that are immediately and seriously implemented, but these can also include measures that are introduced on a trial basis and the results observed, or measures with gradual introduction, or measures that start first with research and development due to problems with practical feasibility. One feature of this planning method is that it includes measures that are not implemented, although preparations are made for them as alternatives from the medium and long-term perspective.

Third, the consideration of four elements is done with a careful effort for consistency: Step 1A (Development and review of scientific information), Step 1B (Definition and assessment of alternative adaptation measures), Step 4A (Preventive action by the selection and implementation of appropriate alternative measures), and Step 4B (Monitoring and assessment of projections, assessment of effectiveness of implementation of alternative measures, etc.). In other words, in the planning phase, the bodies involved in both the science and the adaptation measures work together on the development of alternative proposals and their assessment. In the implementation phase as well, based on monitoring results, the bodies involved in both science and adaptation measures work together on the implementation of preventive measures in the alternative plan that was prepared. Also, it is important to measure the effectiveness of implementation of the alternatives that were

implemented.

Fourth, Step 1A (Development and review of scientific information) and Step 1B (Definition and assessment of alternative adaptation measures) both emphasize not only climate change but also the socioeconomic dimension. In other words, the impacts of climate change are not only from climate change, so impact assessments are defined to also include social change, and responsive adaptation measures are established and assessed accordingly. Also, adaptation measures are established not only to increase the adaptive capacity of society and the economy in the sense of treating symptoms, but also in the sense of improving socioeconomic sensitivity. In other words, as shown by Shirai et al. (2014), alternative adaptation measures are established with three levels in mind: protection, adaptation and minimization of impacts, and transformation and reconstruction. Protection, adaptation and minimization of impacts correspond to improvements in adaptive capacity, while transformation and reconstruction correspond to improvements in sensitivity.

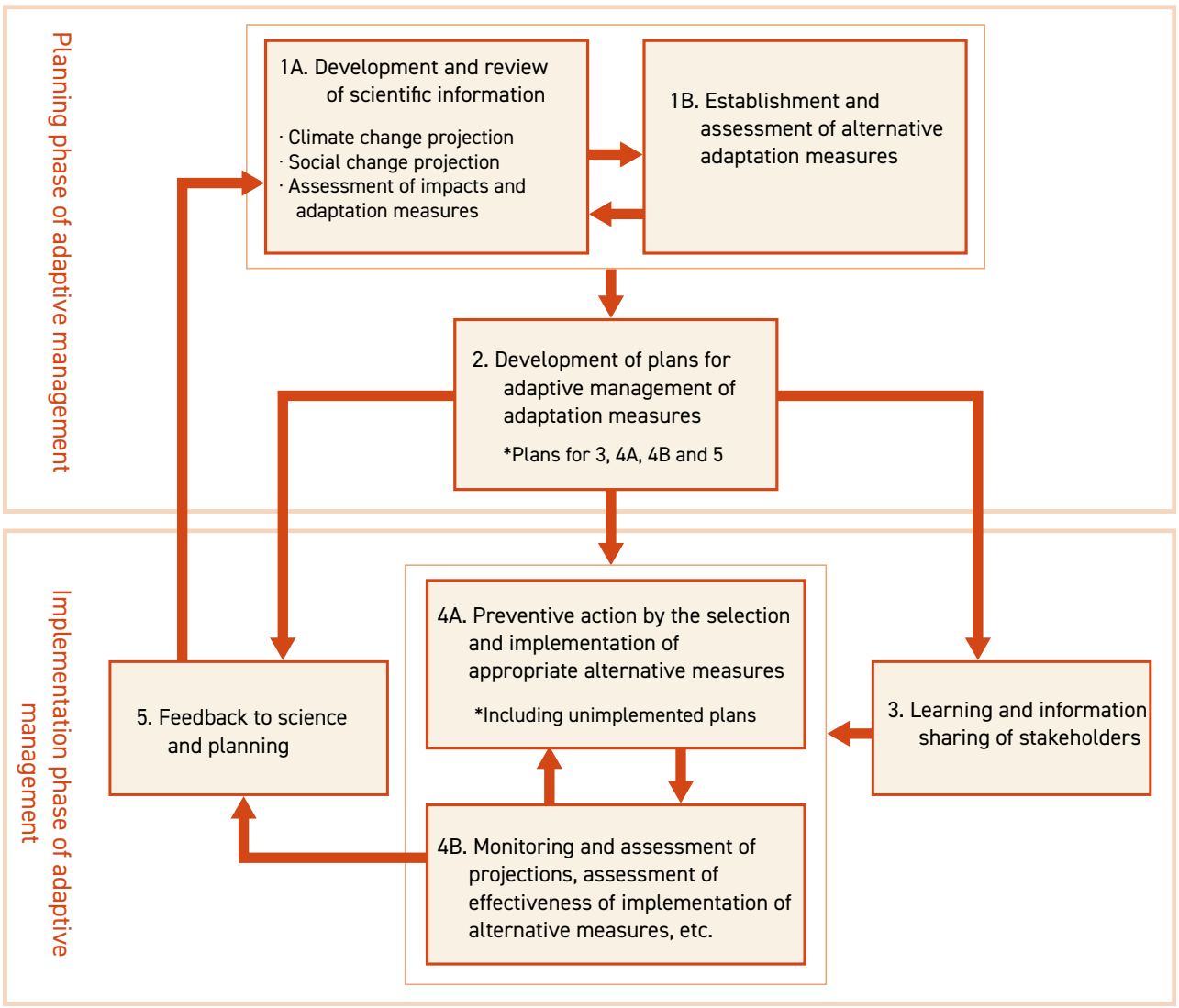


Figure 4-4: Process of adaptive management in climate adaptation strategies

(4) Pilot Study of Planning with Adaptive Management to Prevent Heat Damage to Paddy Rice

Based on the planning framework established, we conducted a modest pilot for this planning phase, regarding heat damage to paddy rice in Saitama Prefecture.

1) Preventive Planning Through Selection and Implementation of Appropriate Adaptation Measures

Regarding prevention of impacts through selection and implementation of appropriate alternative measures (corresponds to Step 4A in **Figure 4-4**), the results of setting guidelines for adaptive management are shown below. In the short term (until about 2030), assuming a potential maximum temperature increase of at least 1°C, the following adaptation measures would be implemented (or prepared for).

(a) Aim for effective diffusion of crop season shifting and fertilizer management during implementation. When doing so, consider providing assistance if barriers arise such as older age of farmers in implementation of adaptation measures.
(b) Introduce weather prediction information systems, revise crop mix, encourage consideration of shifts to collaborative systems with consumers and sustainable management systems, and conduct trials to test such systems.
(c) Continue promoting the development of heat resistant crop varieties, which takes time for development and preparation.

In the medium and long term, assuming a potential maximum temperature increase of at least 2°C around 2040 and maximum over 4°C by around 2090, promote the following gradual actions for implementation or preparation toward implementation.

(a) Introduce heat-resistant crop varieties and associated branding, and encourage farmers to restructure business operations.
(b) If preparations are begun in order to shift to advanced water management methods and to other crops, and climate change advances rapidly (or is projected to do so), besides shifting those crops to heat-resistant varieties, promote an early shift to other crops.

2) Planning for Learning, Monitoring, Feedback

The following guidelines are set for learning and information sharing of stakeholders (corresponds to Step 3 in **Figure 4-4**), monitoring and assessment of projections, assessment of implementation effects of alternatives (Step 4B), and implementation guidelines for feedback to science and planning (Step 5).

(a) Regarding learning and information sharing of stakeholders, it is necessary to create the attitude for awareness raising and to work autonomously to conduct information sharing with government

personnel and farmers, processing and logistics stakeholders, including implementation guidelines for adaptation measures indicated in (1) as well as monitoring and scientific feedback relating to adaptive management. For this, offer ongoing opportunities for information sharing and awareness-raising to uninterested farmers, including regular council meetings on adaptation measures in the region. Create posts for coordinator positions with responsibility for organization-building and organizational operations, so that even when the government's managers responsible are transferred, everyone can understand adaptive management approaches and pass on the implementation guidelines.

(b) Regarding monitoring and alternative selection, it is important to set the monitoring items and make decisions on the alternative selection guidelines based on them. Monitoring items include temperature increases and future trends and socioeconomic trends such as trends of farm management and consumers, and trends in other producing areas, plus the effects of adaptation measures implemented based on the directions established in (1), and also farmer understanding and motivation, etc. Alternatives are selected based on consensus with stakeholders comprehensively considering the results of the above monitoring, and from the perspective of the need to introduce alternatives based on the pace of impacts appearing, and from the perspective of ease of introduction such as practicality and versatility at that point.

(c) Regarding feedback to science and planning, if there is a gap when comparing the projected versus measured values of climate change, or the calculated versus measured values of effects of adaptation measures, it is necessary to elucidate the factors and to promote a review of the methodology for climate projection and impact assessment. To do so, maintain close relations between scientists and the community, such as by having scientists participate in local councils on adaptation in the region. The plans should be reviewed regularly (about every five years). Also, based on the scientific opinions provided as feedback, depending on when need arises from scientific requests, in some cases speed up the review timing, and in other cases delay the review timing.

References:

· Nobuo Shirai, Tanaka Mitsuru, Tamura Makoto, Yasuhara Kazuya, Harasawa Hideo, Komatsu Toshimitsu. 2014. "Kiko hendo tekio no rironteki wakugumi no settei to gutaika no shiko" (Building and Verification of a Theoretical Framework for Climate Change Adaptation: Strategy of Climate Change Adaptation), *Environmental Science*, 27(5), 313-323.

· Mimura Nobuo. 2012. "Shorai no risk e no yokenteki taio no jyuyosei" (Importance of proactive responses to future risks). *Civil Engineering* (Japan Society of Civil Engineers), 97(3), 137.

· Matsuda Hiroyuki. 2008. "Seitai Risk Nyumon" (Introduction to biological risk). *Kyoritsu Shuppan*, 228 pp.

4-5. Creating an Adaptation Community as an Entry Point to "Local Studies in Climate Change"

(1) "Local Studies in Climate Change"

Shirai (2016) writes that "At the regional level there is growing tendency to mention climate adaptation in planning, but in many cases the style is simply to list up related measures that correspond to adaptation measures from related departments." He also points out that "In many cases they are only identified as adaptation measures within the government, and are just at the beginning stage of preparation as basic guidelines, and they do not go as far as considering information from future impact projections or being detailed considerations of policies for action."

Thus, what is needed is a bottom up approach to complement the top down approach, which starts with scientific knowledge in the form of future projection results. The bottom up approach emphasizes the learning of local government personnel and local community members, local businesses, which are the actor who actually implement adaptation measures. By mobilizing local knowledge at a level that is close to the community, the further details of adaptation measures are considered while also empowering local entities and sharing information on the impacts that are locally specific. The establishment of this bottom up approach will become the driving force to become more specific with adaptation plans.

A bottom-up approach could also be referred to as Community Based Adaptation. CBA is a learning process that encourages local actors to take the lead and encourages self-initiated adaptation.

As a bottom-up approach or CBA, Shirai (2015) describes an approach that starts with "Local Studies in Climate Change" concept that he has proposed. "Local Studies in Climate Change" is a learning program for residents and others involved in climate change impacts and adaptation at the community level, and is an entry point for practical citizen-led adaptation processes. It was developed and piloted as a project supported by the Ministry of the Environment program entitled "S-8 Comprehensive Study on Impact Assessment and Adaptation for Climate Change."

"Local Studies in Climate Change" involve investigating examples of impacts of climate change that are occurring locally, then sharing that information, and co-designing adaptation measures. "Local Studies" (*jimoto-gaku* in Japanese) is a resident-led local community development approach that leads people think about how to serve the local community by investigating the assets is in the region (community resources), and was piloted by Tetsuro Yoshimoto of Minamata City (Kumamoto Prefecture). Referring to this Minamata-style of "Local Studies," Shirai decided use the name of "Local Studies in Climate Change" (*Kiko Hendo no Jimoto-Gaku*).

(2) Pilot Study of "Local Studies in Climate Change"

In fiscal 2015, this pilot was implemented in seven areas (four prefectures, three cities), as "Local Studies in Climate Change." The prefectures were Aichi, Tottori, Miyazaki, and Okinawa, and the project was implemented in the form of trainings for personnel at each prefecture's Japan Center for Climate

Change Actions. For the cities, it was implemented as a project of the Kinki Region Environmental Office, and the cities were Otsu in Shiga Prefecture, Takarazuka in Hyogo Prefecture, and the Tanba area of Hyogo Prefecture. Participants were members of the general public who responded to public announcements from the respective prefectural and municipal governments. The numbers of participants in the seven regions are shown in **Table 4-5-1**.

Table 4-5-1: Number of participants in the regions Unit: persons

		First workshops	Second workshops	Participated in both workshops
Prefectures	Aichi	21	22	12
	Tottori	6	12	4
	Miyazaki	44	13	10
	Okinawa	12	12	6
	Total	83	83	83
Cities	Otsu	35	19	18
	Takarazuka	21	23	13
	Tanba area	23	13	13
	Total	79	55	44
Total		162	138	127

At the first workshops, PowerPoint presentations were made on the regional impacts of climate change, adaptation measures, and an explanation of a survey sheet about impact examples. The presentations included definitions of adaptation measures, the need for adaptation measures, the state of introduction of adaptation measures, basic approaches to adaptation measures, good and bad kinds of adaptation, and actual examples of local studies in climate change.

The second workshops included a review of the first workshop, reporting of information on climate change impact assessments gathered previously, and then discussions in groups of four to six persons each. Discussions included (1) examples of impacts, causes of socioeconomic impacts, and adaptation measures they would like to add, (2) three adaptation measures that deserved the highest priority, and (3) budget allocation ratios for adaptation and mitigation as well as the rationale for those ratios. The groups summarized their discussions using sticky notes and poster paper, and then each group reported back to the larger meeting.

(3) Effectiveness for Identifying Impact Examples and Socioeconomic Factors

After tallying the examples of impacts gathered in responses from the seven regions, the most common responses were changes in flora and fauna, impacts on agriculture, water- and sediment-related disasters, impacts on living and livelihoods, and health impacts including heat stroke.

Also, socioeconomic factors were identified as causal factors for the manifestation of climate change impacts, and included built infrastructure, forests and *satoyama* (traditional managed landscapes),

lifestyle awareness, and local communities. Shirai et al. (2012) defined adaptation measures as "improvements in specified factors of vulnerability to climate change impacts" and endeavored to classify them (socioeconomic factors). They classified them as land use factors such as urbanization and lack of forest management, and local community factors such as the aging of society and deterioration of social capital. The responses from each of the seven local studies produced similar results.

(4) Awareness Change of Participants

For each assessment item, participants were asked to use a six-point ordinal scale to assign scores, which were later analyzed. The scoring was as follows: "Completely agree" (6 points), "Agree" (5 points), "Slightly agree" (4 points), "Don't really agree" (3 points), "Disagree" (2 points) and "Completely disagree" (1 point).

Table 4-5-2 shows the results of a t-test corresponding to the awareness change before and after the two workshops. Below is a summary of the results of awareness change, before and after the first workshop, before and after the second workshop, after the first and before the second, and before the first and after the second.

Regarding awareness changes from before to after the first workshop, scores increased significantly due to participation in the workshop, for awareness of impacts, support for the necessity of mitigation and adaptation measures, and intention to act on adaptation. Within awareness of impacts, in particular, the score rose significantly in particular for the comment, "In the future, society will be more vulnerable due to socioeconomic factors." This change could be a result of a presentation at the first workshop, which said, "The impacts of climate change will increase due not only to changes in climate factors but also to socioeconomic factors. For example, heat stroke patients include many seniors, and this is not only due to higher temperatures but also an increase in patients as a result of the aging of society and weakening of neighborhood connections." Also, the intention to act on adaptation increased significantly, and mitigation intention also increased, but not significantly. This too may be a result of the fact that the main focus of explanations of new measures in the lectures was about adaptation.

Regarding awareness changes from before to after the second workshop, major increases in scores were for awareness of current impacts on the community, future impacts on the community, and vulnerability due to socioeconomic factors. Consideration of adaptation measures that involved sharing of impact examples in the workshops and improvements in socioeconomic factors are believed to have resulted in increased awareness on these points. The intention to act on adaptation also increased from before to after the second workshop. However, the increase was less than the increase from before to after the first workshop.

(5) Future Topics

From the results of implementation in the seven regions, "Local Studies in Climate Change" are effective for identifying examples of impacts and local knowledge about socioeconomic factors, and we also confirmed that they promote participants' learning about climate change.

However, when seen as a CBA process, the achievements of "Local Studies in Climate Change" are limited. For example, there are inadequacies in the comprehensiveness of examples of impacts, socioeconomic factors, and the scientific basis. Also, the learning effect and awareness of impacts are effective, but when it comes to forming the intention to take action on adaptation or mitigation measures, further learning processes are required. In addition, as the rebound of changes in awareness between the first and second workshops is large, and there is probably a rebound after the second workshop as well, it would be important to establish learning processes that raise adaptive capacity on an ongoing basis, in an effort to securely establish the awareness gains.

In this respect, "Local Studies in Climate Change" should be seen as an entry point for the ongoing implementation of CBA processes.

If we look at these processes, "Local Studies in Climate Change" are at an initial stage in the development of local adaptation measures by the bottom-up approach, and are a way to share local knowledge relating to examples of local impacts and socio-economic factors. However, this local knowledge does not have a scientific basis, so it is crucial at the next stage to incorporate a scientific review of the local knowledge thereby obtained. In contrast to the top-down approach, by using local knowledge as the starting point, there is meaning in this approach in terms of identifying detailed examples of impacts and socio-economic factors that are closely connected to the local area, but scientific reviews involving scientists then become essential.

Next, the task is to share the integrated contents of local knowledge and expert knowledge with local actors and create competency among local actors. Then, local actors themselves can consider adaptation action plans and proposals for local governments. Local governments should receive them, and then prepare local government adaptive management plans for climate change adaptation. The above steps can be seen as a formative process for adaptation plans, with "Local Studies in Climate Change" as an entry point.

This formative process can at the same time be an active learning process for local actors. Through the sharing of local knowledge, the actors can see climate change impacts and adaptation as local challenges, so this becomes a lesson in the reality of the impacts (directly personal). By also obtaining scientific knowledge, actors can have a more precise understanding, and by preparing action plans, get a new self-directed perspective on concrete actions. Next is to get into practical action in cooperation with local governments. In this way, these efforts are meaningful as a formative process for the development of adaptive capacity through learning.

Table 4-5-2: Awareness change before and after the two workshops (corresponding t-test)

Assessment item			Before vs after 1st		Before vs after 2nd		After 1st vs before 2nd		Before 1st vs after 2nd	
Awareness of impacts	a	Recent impacts on the world and Japan	0.088		0.083		-0.297	**	-0.162	*
			b		108		64		74	
	b	Recent impacts on my community	0.348	**	0.364	**	-0.397	**	0.459	**
			d		74		63		74	
	c	Future impacts on the world and Japan	0.172	**	-0.056		-0.188		-0.095	
			134		107		64		74	
	d	Future impacts on my community	0.148	*	0.243	**	-0.359	**	0.189	*
			135		107		64		74	
	e	Future vulnerability due to socioeconomic factors	0.552	**	0.257	**	-0.548	**	0.417	**
			134		108		62		72	
Mitigation intention	a	Government-led mitigation measures are needed.	0.128	*	0.037		-0.169		-0.141	
			133		107		65		71	
	b	Business-led mitigation measures are needed.	0.227	**	0.194	**	-0.200		0.139	
			132		108		65		72	
	c	Mitigation measures by community and family are needed.	0.203	**	0.037		-0.231	*	-0.014	
			133		108		65		73	
	d	Mitigation measures by each of us are needed.	0.092		0.019		-0.292	**	-0.181	
			131		108		65		72	
	e	Drastic mitigation measures are needed.	0.174		0.102		-0.308	**	-0.208	*
			132		108		65		72	
	f	Preventive/proactive mitigation measures are needed.	0.167		0.102		-0.246		-0.056	
			132		108		65		72	
	g	I want to do some mitigation measures.	0.130		0.102		-0.292	**	-0.125	
			131		108		65		72	
Adaptation intention	a	Government-led adaptation measures are needed.	0.075		0.056		-0.123		-0.082	
			133		108		65		73	
	b	Business-led adaptation measures are needed.	0.165	*	0.065		-0.172		0.000	
			133		108		64		73	
	c	Adaptation measures by community and family are needed.	0.195	**	0.055		-0.138		0.068	
			133		109		65		73	
	d	Adaptation measures by each of us are needed.	0.144	*	0.139	*	-0.185		0.000	
			132		108		65		72	
	e	Drastic adaptation measures are needed.	0.138		0.110		-0.328	**	-0.194	
			130		109		64		72	
	f	Preventive/proactive adaptation measures are needed.	0.115		0.110		-0.292	**	-0.282	*
			131		109		65		71	
	g	I want to do some adaptation measures.	0.237	**	0.130	*	-0.338	**	-0.083	
			131		108		65		72	

Note: In each cell, the upper-line value is the difference in averages for the assessment item indicated, and the lower-line value is the number of responses. After the corresponding t-test, asterisk are used to indicate the significance level (** for 1% and * for 5%). Shading of cells indicates that the average difference is positive and that the significance is * or **.

References:

· Nobuo Shirai. 2016. "Chiiki ni kitai sareru kiko hendo tekio to torikumi jokyo, tsugi naru mondai" (Locally expected climate change adaptation and status of efforts, next challenges), *Environmental Management* (Japan Environmental Management Association for Industry), 52(9), 30-34.

· Nobuo Shirai. 2015. "Kiko hendo tekio ni okeru bottom up approach: Kiko hendo no jimotogaku o kiten toshite" (Bottom up approaches to climate change adaptation: As the starting point of Local Studies in Climate Change), *Review of Environmental Economics and Policy Studies*, 8(2), 55-59.

· Shirai Nobuo, Tanaka Mitsuru, Onoda Shinji, Kimura Hiromi, Baba Kenji, Kajii Kumiko. 2012. "Zeijakusei no gainen to kiko hendo tekio ni okeru zeijakusei no kozo ni kansuru bunseki" (Concepts of vulnerability and analysis of the structure of vulnerability in climate change adaptation), Compendium of Lectures from Environmental Systems Research Paper Presentations, 40, 309-317.

Chapter 5
Local Adaptation Initiatives in Japan

5-1. Hokkaido: Snow Compaction in Agriculture (Kitami Region)

In the eastern area of Hokkaido, soil-frost depth has been getting increasingly shallow in recent years with rising ground temperatures in winter. The reason for this is that changes in snowfall patterns due to climate change are resulting in greater snow accumulation than in the past. Snow acts as an insulator, impeding cold winter temperatures from reaching the ground surface.

In this region, to deal the changes in climate, a technique is being promoted to freeze the soil to a target depth in winter for the benefit of farming.

The fiscal 2015 edition of SI-CAT's Report on Local Climate Adaptation in Japan (in Japanese) introduced the *yukiwari* (snow plowing) technique that is being used to control the soil-frost depth in the Tokachi region of Hokkaido. In this year's report we introduce a technique known as *yukifumi* (snow compaction), which emerged in the Tokachi region but has been spreading rapidly to Hokkaido's Kitami region in recent years.

In the Tokachi region *yukiwari* is the main technique being used, and it involves a tractor pushing aside the accumulated snow and exposing the ground surface to freezing air. This is in contrast to the *yukifumi* technique in the Kitami region, which involves a tractor pulling a heavy roller to compress the snow. This thereby increases the snow's heat transfer rate. In this region, it is not unusual for the minimum air temperature to drop below minus 20°C, so by compressing and hardening the snow, farmers are allowing the cold to reach the soil and freeze it.

What are the actual agricultural benefits of snow compaction? After the winter freezing, when the soil thaws in the spring, soil clumps break up more easily, and when that happens the soil texture is more consistent. The primary reason that this *yukifumi* technique was so well accepted here is that it improves the performance of soil pulverization.

This snow compaction technique reduces soil clumps, so the field preparation goes more quickly in the spring. With the soil more consistent and finer in texture, tractors can plow more easily, which significantly reduces the springtime working hours and fuel costs. During the autumn harvest, clumps of soil the same size as the crop item being harvested often come out of the ground together with the harvest. Separating the soil from the harvest requires considerable effort, but this technique reduces the amount of work required. Also, any delay in the timing of start of work in spring due to the snow compaction is well within acceptable limits.

In effect, snow compaction done by equipment for a short amount of time in winter has resulted in a significant increase in farm productivity from spring through to autumn.

This innovative approach, adopted as a response to changes in the climate, is spreading rapidly in

the region. During field visits in the spring of 2016, it was learned that the area treated by *yukifumi* snow compaction had approximately tripled in just one year.

Photo 5-1: Snow compaction roller
Truck tires connected together, pulled by a tractor to compact the snow. Sometimes also used for wheat compaction.

5-2. Ibaraki Prefecture: Agriculture

Ibaraki Prefecture ranks second in Japan in terms of agricultural output. With a focus on agriculture, Ibaraki University is working with local governments in this prefecture to identify crops that could be affected by climate change and suggest adaptations based on impact assessments. We aim to have this work reflected in the prefecture's adaptation policies.

The expected main output of this work is a "Comprehensive Climate Change Adaptation Plan for Agriculture in Ibaraki Prefecture (Proposal)" as shown in **Figure 5-2**, to be jointly prepared and published by the Ibaraki University, collaborating with the Agriculture, Forestry and Fisheries Department of Ibaraki Prefecture and the Ibaraki Prefectural Agriculture, Forestry and Fisheries Agricultural Center. Major contents to be incorporated into the plan include (1) projections of climate change in Ibaraki Prefecture, (2) quantitative impacts and risks for agricultural crops, and (3) a package of adaptations to mitigate adverse impacts. Items (1) through (3) will be provided for five areas within the prefecture (central, north, Rokko, south, west). Item (3) will be an "adaptation package," a compilation of effective "hard" (physical) and "soft" (institutional) adaptations. For example, a major adaptation strategy to deal with heat damage to rice is to develop heat-tolerant cultivars, but for any new cultivar developed to have any effect it must be disseminated (used by farmers). For new cultivars to be adopted by farmers, various actions need to be taken, such as securing sales channels for the rice, advertising and promotions, guidance and outreach, and subsidies for introducing the new cultivars, etc. Thus, adaptation should not simply be considered alone. It is important to create a package that includes all the associated measures.

By the end of fiscal 2016, we had constructed a model to estimate the ratio of chalky rice grains (CRGs) in Ibaraki Prefecture, which corresponds to (1) and (2) above. To assess the crop impacts of climate change it is important to assess both the volume and quality of crop harvests, because the occurrence of CRGs reduces the quality grade and leads to economic losses for producers. By analyzing rice-growing data and weather data obtained from the Ibaraki Prefectural Agriculture, Forestry and Fisheries Agricultural Center, we developed a model to estimate the occurrence of CRGs for Koshihikari and Akitakomachi rice from daily average temperature and cumulative solar radiation. Going forward, there are plans to verify the accuracy of this methodology and assess the impacts of

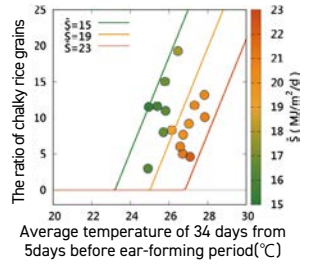
disseminating it broadly, as well as to consider combinations of adaptations including promoting the cultivation techniques of good producers, adjusting crop seasons, and introducing heat-tolerant crop varieties.

Accumulation of scientific knowledge

Example: Model to estimate the ratio of chalky rice grains

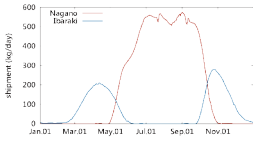
- ✓ Growth data provided by Ibaraki Prefectural Agriculture, Forestry and Fisheries Agricultural Center
- ✓ Problem increases with warmer temperatures
- ✓ Rate of increase depends on cultivar
  → Use the knowledge in adaptation measures

Model to estimate the ratio of chalky rice grains



Other topics being researched

- ✓ Analysis of chalky rice grains data for Koshihikari and Akitakomachi
- ✓ Preparation of yield prediction models for lettuce and "hakusai" (type of cabbage)
- ✓ Analysis of data for various types of eggplant

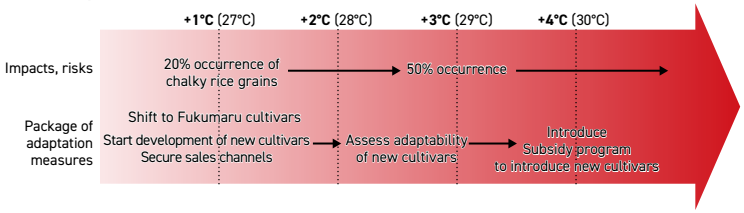


Seasonal changes in lettuce shipments to the market for Ibaraki Prefecture (blue) and Nagano Prefecture (red)

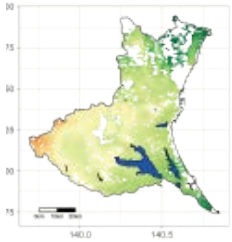
Information interpretation, refinement

Impact assessments, adaptation measures

Impacts, adaptation measures in response to climate change (Concept)



Growing area and risk map (Concept)



Risk of occurrence of chalky rice grains in Koshihikari rice

Integration

Goals

Preparation of "Comprehensive Climate Change Adaptation Plan for Agriculture in Ibaraki Prefecture"

1. Projections of climate change in Ibaraki Prefecture
2. Quantitative impacts and risks for agricultural crops
3. A package of adaptation measures to mitigate the impacts

Reflect in policies, measures, action plans of Ibaraki Prefecture

Figure 5-2: Climate Change Impact Assessments and Adaptation Measures for Agriculture in Ibaraki Prefecture (2015 – 2019)

5-3. Ibaraki Prefecture, Tottori Prefecture: Coastal Areas

This project investigates adaptation measures in coastal areas of Ibaraki Prefecture and Tottori Prefecture. In Japan, each local government has a responsibility for coastal infrastructure improvements based on their Master Plan for Coastal Protection, in accordance with the national Coast Act and the Basic Policy on Coastal Protection which are under the jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism and the Ministry of Agriculture, Forestry and Fisheries. The current Master Plans for Coastal Protection stipulate coastal infrastructure improvement projects from the three dimensions of disaster prevention, environmental protection, and utilization, however, they do not consider the impacts of climate change. Therefore, this project aims to investigate adaptation measures against various impacts which are expected to be induced by changes of external forces due to climate change. The projects are conducted at coastal areas in Ibaraki and Tottori prefectures by cooperating with researchers of various fields and managers of the local governments. By referring to physical environmental parameters such as waves, seawater levels, and water temperatures calculated by near-future projections targeting the year 2030 with a scenario of global average temperatures rising by 2°C, we reveal the factors and mechanisms which determine impacts on disaster preventions, the environment and utilization at the coastal areas, such as changes in external forces for design, coastal topography, fisheries, and disaster risks. Based on the investigation, we are going to propose adaptation measures. In the coastal areas of both prefectures, there is a need to review external forces for design for future revision of the Master Plan for Coastal Protection, as well as concrete scenarios which can be used to make decisions when upgrading facilities and structures. For example, we are going to investigate coastal erosion and other impacts from tide levels and waves under normal weather, the frequency of high wave occurrence and magnitude and frequency of typhoons, as well as impacts under worst-case scenarios such as a storm surge occurring simultaneously with flooding. The ultimate goal of the project is to describe concrete steps to consider climate change impacts and adaptation measures in documents to support the preparation of the Master Plan for Coastal Protection.

In fiscal 2016, a joint project conference and field tour was held in Ibaraki Prefecture with coastal researchers from various universities and institutes and managers of Ibaraki and Tottori prefectures. Thanks to the participation and information exchanges among a lot of experts, including researchers who are using supercomputers for climate change projections and technical experts of the prefectures who are responsible for planning, designing, and maintaining coastal structures, all participants developed a deeper understanding of the interests and needs of each other as well as the required data formats. In order to propose concrete adaptation measures, preliminary investigations are currently under way about coastal zone impacts based on results of the near-future projections, together with the monitoring of changes in coastal topography.

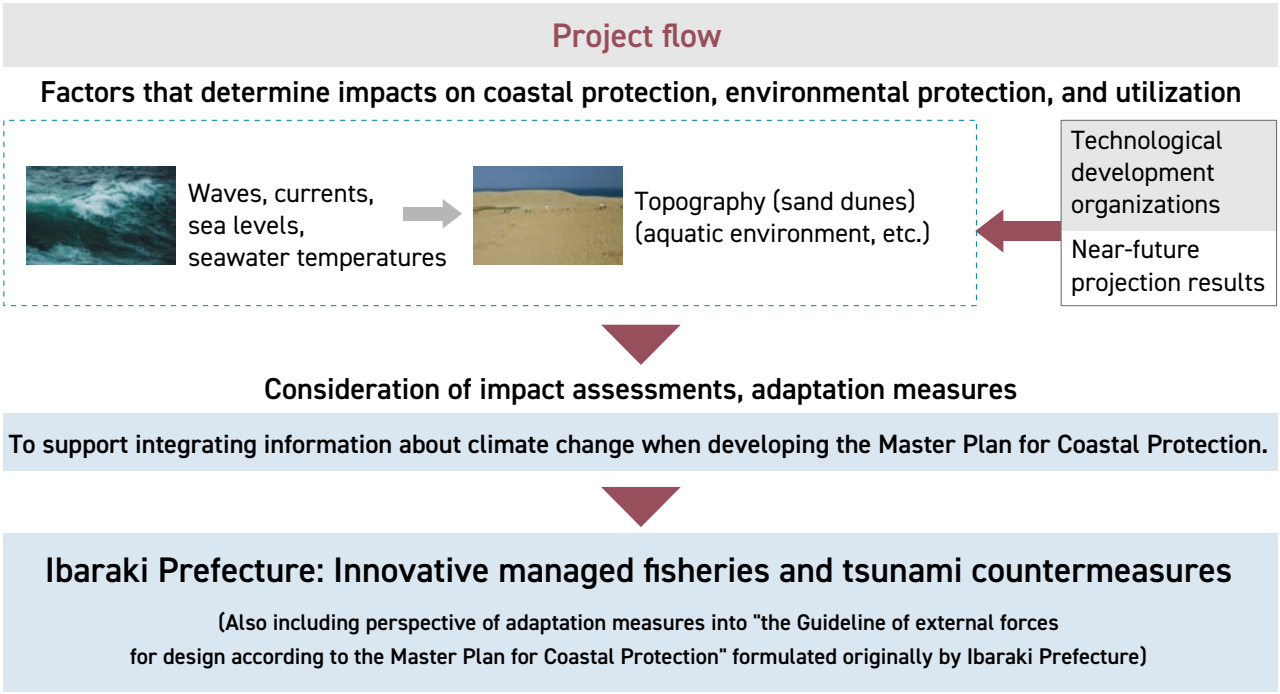


Figure 5-3: Flow for consideration of adaptation measures at coastal areas in Ibaraki Prefecture and Tottori Prefecture

5-4. Saitama Prefecture: Adaptation Initiatives

Saitama Prefecture has a reputation as one of the hottest prefectures in Japan, and Japan's 74-year daily maximum surface air temperature record was broken here at 40.9°C on August 16, 2016. The temperatures are still rising and the trend from 1897 to 2016 is an increase of 2.1°C per century at the Kumagaya Meteorological Observatory. The trend from 1980 to 2016 has been 5.0°C per century, and the temperature rise has become more pronounced. The impacts of warming on crops and the natural environment are already obvious. The warming trend is caused by not only global climate change, but also urban heat island effect. In discussing climate change adaptation, we need to consider both global climate change and the urban heat island.

In this context, Saitama Prefecture began considering climate change adaptation as an important issue earlier than other prefectural governments, and included climate change adaptation strategy as a part of its global warming strategy action plan ("Stop Global Warming: Saitama Navigation 2050") adopted in 2009. In 2015, Saitama Prefecture revised its action plan based on scientific information about climate change and impact assessments such as the results of S-8 research program done by the Ministry of the Environment on climate change adaptation, and added "climate change adaptation mainstreaming" and "promoting adaptive adaptation" to the action plan. In March 2016, based on the revised action plan, Saitama Prefecture also compiled its future directions on climate change adaptation into the document "Toward Adaptation to Global Warming: The Direction for Initiatives" (referred to below as "Direction for Initiatives") after reviewing climate change impact assessments

and existing measures in Saitama Prefecture. The "Direction for Initiatives" reflects information on global warming impacts that was provided as one aspect of the SI-CAT program. This "Direction for Initiatives" is based on Japan's National Adaptation Plan and is a guideline for promoting Saitama Prefecture's adaptation strategy, so it is regarded as the prefecture's adaptation plan.

Going forward, Saitama Prefecture will undertake further climate change adaptation mainstreaming, mainly through the Adaptation Expert Committee established within the prefectural offices as a platform for discussing climate change adaptation. Simultaneously, because of an obvious worsening of the thermal environment here due to the urban heat island effect and global climate change, Saitama Prefecture will also be working to develop ways to optimize technologies to address the urban heat island effect in street canyons and public facilities, etc.

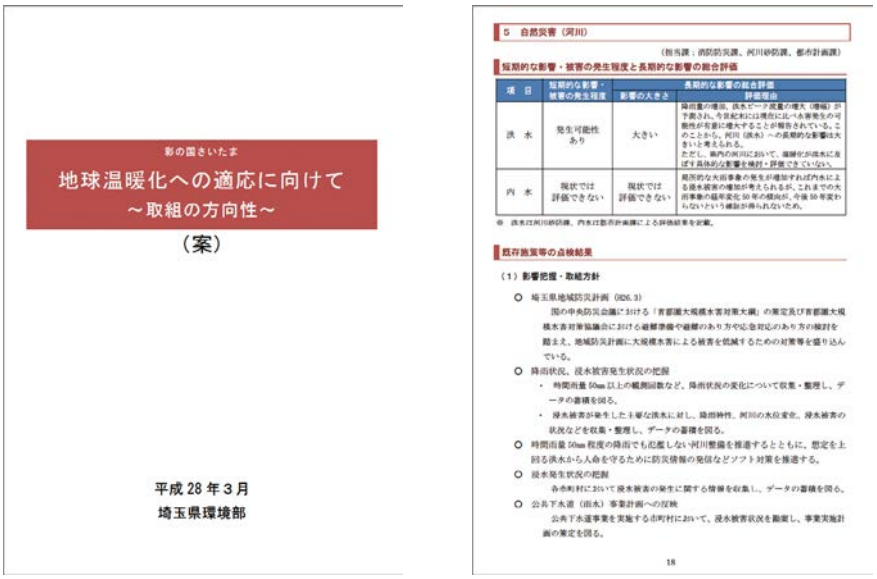


Figure 5-4: Saitama Prefecture's adaptation strategy action plan, "Toward Adaptation to Global Warming: The Direction for Initiatives"

5-5. Nagano Prefecture: Disaster Prevention, Agriculture, Ecosystems, etc.

Nagano Prefectural Government research is underway relating to climate change impact assessments and adaptation technologies for agriculture, disaster prevention, ecosystems, and urban health, with the aim of creating frameworks to promote adaptation to climate change. One of them is the Shinshu Monitoring Network for Climate Change, established in 2014. This network aims to gain a detailed understanding of climate change and its impacts in the prefecture, and has the participation of about fifty organizations, including some that are affiliated with national and prefectural governments, universities, and other connections. The network centralizes in one place the meteorological and other information collected from member groups, and disseminates or offers information on climate change based on that data plus information on climate change impacts in various fields.

The Shinshu Climate Change Adaptation Platform was established in October 2016 by Nagano

Prefecture, as an organization to share information provided by the monitoring network about climate change impacts, and to consider adaptation measures and promote the development of adaptation technologies and other work. Currently, about 70 organizations are involved, including not only the prefectural departments associated with the platform, but also universities, businesses, medical institutions, and other organizations.

Under the framework of the platform, subcommittees were also formed for disaster prevention, agriculture, and ecosystems, so that each subcommittee could share expert information and discuss adaptation its respective field. The disaster prevention subcommittee has already met twice, and the agricultural subcommittee once. Each subcommittee, university and research institute affiliated with the SI-CAT Technology Development Team introduces research findings on climate change impact projections for disaster prevention and agriculture, and shares information with the participants. From fiscal 2017 onward, the ecosystem subcommittee will start meeting and there are plans to move ahead with preparations to establish urban and health subcommittees.

With the establishment of the platform and network mentioned above, the foundations for promoting climate change adaptation have been established. Going forward the Nagano Prefectural Government hopes to link the monitoring network and platform well together and develop them with sustainable operations. At the same time, it is hoped that they will put some effort into sharing risk information on climate change with the general public, and help transform this into resilient society with adaptation to climate change.

Photo 5-5: A scene at meeting to launch the Shinshu Climate Change Adaptation Platform

5-6. Gifu Prefecture: Flooding and Sediment-related Disasters

In Gifu Prefecture, a model prefecture in SI-CAT activities, Gifu University and the prefectural government are cooperating with the aim of promoting adaptation to both climate change and societal change (such as population decline). They are mainly promoting the development of risk assessment methodologies for flooding and sediment-related disasters, as well as consideration of adaptation scenarios. Here, we look at initiatives of the prefectural government in processes for considering adaptation measures.

In order to effectively promote climate change adaptation in Gifu Prefecture, departments of the prefectural offices are in discussions with experts in Gifu University, and holding internal liaison committee meetings jointly among prefectural departments that have any connection to adaptation. Many departments still had limited familiarity with the concept of climate change adaptation, so to promote an understanding of the connections between the prefectural government and climate change, it was decided to start by looking at the measures already being implemented by each department that inherently included potential climate adaptation measures. This is because, having received the information on near-term climate change projections and impact assessments (outputs of the SI-CAT program), researchers felt that to consider additional adaptation measures, it would first be necessary to identify the adaptation measures that are already being implemented, and to assess the current situation. At the prefectural government's internal liaison committee meeting this fiscal year, organizations participating in the SI-CAT program were invited to speak, so the SI-CAT Implementation Team presented topics about the findings of studies on government needs regarding climate change adaptation. It also explained the pioneering climate change adaptation initiatives of Saitama Prefecture. Through the meeting, the government's climate adaptation measures were classified as either "potential" (inherent in existing measures) or "additional." Besides realizing that they were already implementing "potential" adaptation measures, by learning about the innovative initiatives of other prefectures, many departments were able to develop the foundations to explore further directions for climate adaptation that would be best-suited to the situation in Gifu Prefecture.

As a result of an explanation of the concepts of "potential" adaptation measures for the prefectural internal liaison committee, Gifu University made a tentative listing of such measures existing with prefectural policies and measures, with cooperation from Gifu Prefecture. Among approximately 11,000 items listed in the prefectural operating budget, an initial screening found more than 300 to be associated with climate change mitigation or adaptation. Many of these were policies and measures that did not explicitly mention climate change, but there were various levels of linkages with climate change. In fiscal 2017 there are plans for the initiative to continue and, through careful review by prefectural personnel, to promote the visualization of potential adaptation measures in Gifu Prefecture, and to refine the approaches and develop versatile techniques that can be applied by other government organizations.

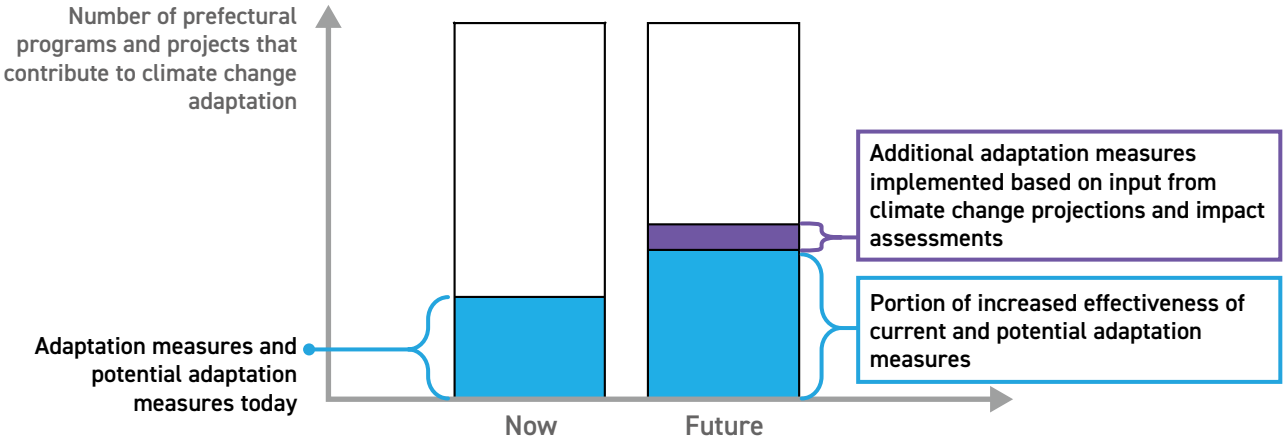


Figure 5-6: Concept of "visualization" (identification) of potential adaptation measures in prefectural programs, policies and measures

5-7. Shiga Prefecture: Integrated Scenarios for Climate Change Mitigation and Adaptation Measures

(1) Introduction

Until recently, measures to address climate change in Shiga Prefecture focused mainly on mitigation, but with recent revisions of Japan's national energy strategy and greenhouse gas emission reduction targets, the Prefecture also reviewed its plans for realizing a low-carbon society and clearly stated the need to include adaptation measures. Signs of global warming are already evident, including an increase in the number of extremely hot days and warmer winters, and it is necessary not only to reduce GHG emissions but also to consider adaptation measures for potential climate change despite mitigation efforts. Using core information such as more advanced climate change projections and impact assessments, Shiga Prefecture now aims to review and visually portray factors such as citizens' sense of wellbeing, awareness of climate risk, and receptivity to adaptation measures, and then develop new integrated scenarios for climate change and future society in the prefecture.

For developing future society scenarios, numerical models are used that quantitatively express the relationships of various activities in the household, industrial, and transportation sectors with the associated energy consumption and GHG emissions. Parameters for the numerical models are determined based on existing government plans and comments on the future of the region from workshops, in which stakeholders (including residents, businesses, government, etc.) discuss various social dimensions (lifestyle, industry, transportation and energy, etc.) and share a common qualitative and concrete image for 2030. Based on all of this, the qualitative image of future society as visualized by participants can then be depicted quantitatively in terms of socioeconomic dimensions (**Figure 5-7**).

To introduce climate change adaptation measures into future scenarios, it is necessary to develop an adaptation policy package and make describe it quantitatively, but the standard policy package of adaptation measures is not yet clear. Thus, researchers gathered information on policies that are

already being implemented for mitigation and weather changes, and classified them and created a database of mitigation measures, adaptation measures, and measures that are effective for both mitigation and adaptation. Going forward, after quantifying the policies and measures in this database and by reflecting them in numerical models, researchers plan to conduct a climate change impact assessment that considers the regional characteristics of Shiga Prefecture, and to assess the balances of mitigation and adaptation from the viewpoint of costs and risks.

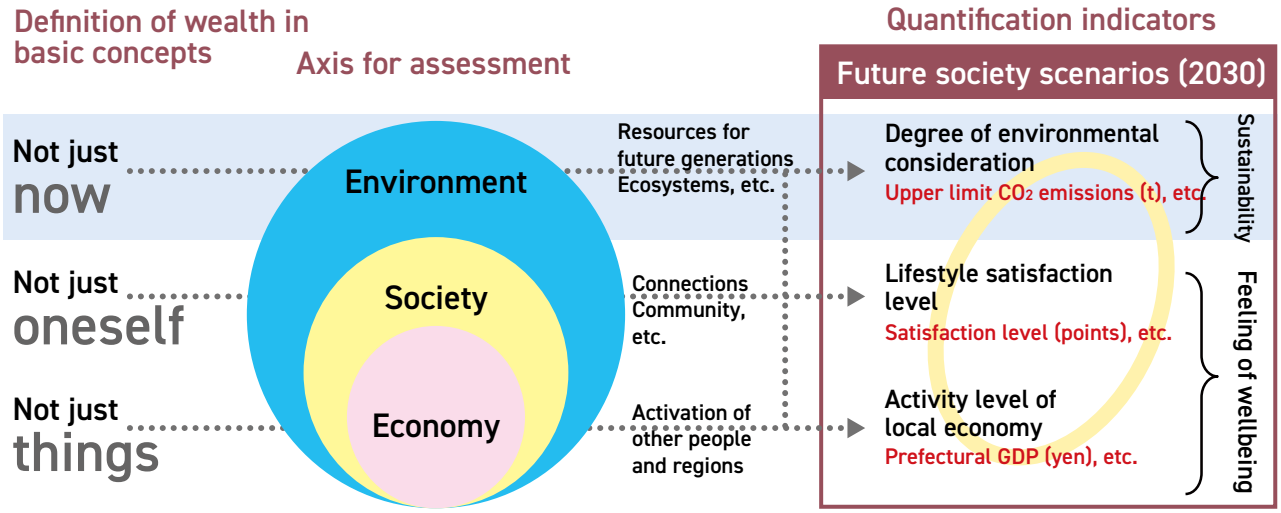


Figure 5-7: Framework for developing scenarios for future society

5-8. Osaka City: Heat Stress

The region around Osaka City is an area with high population density on a flat topography about 20 kilometers across, facing Osaka Bay to the west. As a result of these features, the heat island effect has been significant, and the city has been tackling it for years. Monitoring studies since 2005 have shown that the air temperature distribution depends on location and time frame, and is affected by topographical features especially on the small city land area, plus land uses, population, and artificial waste heat conditions. In addition, the studies showed that it would be effective to consider more detailed measures with quantitative assessments done area by area, using not only the number of very hot nights (daily minimum air temperature exceeded 25°C, "nettaiya") and hot summer days (daily maximum air temperature exceeded 30°C, "manatsubi"), but also a scaled measure of degree-hours (a cumulative index calculated from the degrees above a certain threshold temperature and the amount of time).

In March 2015, Osaka City and Osaka Prefecture together formulated the Osaka Heat Island Measures Promotion Plan which specified basic approaches and targets, plus details of initiatives to deal with heat island issues, and has been promoting initiatives to reduce the number of very hot nights, which is one target of the plan, as well as the creation of "cool spots."

This program is participating in SI-CAT as a local government with needs, to understand the status of technical information about measures to deal with heat stress, as well as the efforts of other local governments, to gather and exchange information, and to have all of this reflected into the initiatives of Osaka City.

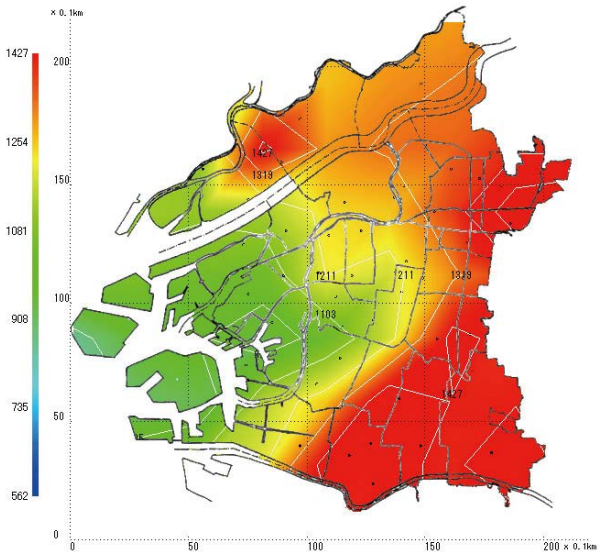


Figure 5-8-1: Contour map of degree-hours for hot summer days (daily maximum air temperature exceeded 30°C, "manatsubi")
Total degree-hours (°C-hours) July–Sept 2008

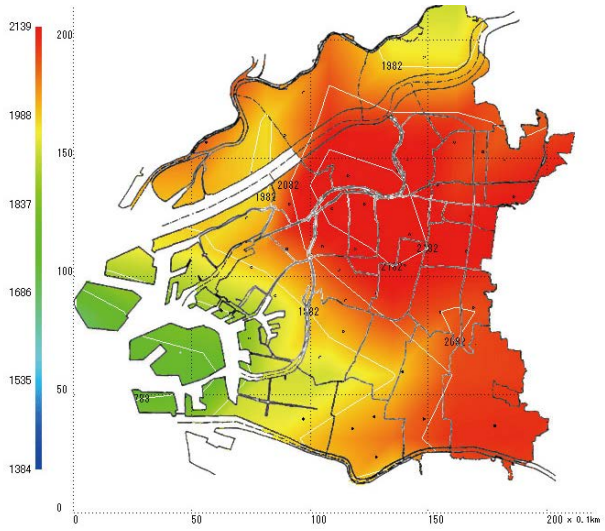


Figure 5-8-2: Contour map of very hot nights (daily minimum air temperature exceeded 25°C, "nettaiya")
Total degree-hours (°C-hours) July–Sept 2008

Osaka Heat Island Measures Promotion Plan (March 2015)

Goal 1 To reduce number of very hot nights by 30% compared to 2000 (excluding impacts of global warming) by lowering the summer night temperatures in residential areas

Goal 2 To improve the summer daytime thermal environment in outdoor spaces by utilizing existing outdoor cool spots and creating new ones

5-9. Shikoku Region: Flooding and Storm Surge

The Kochi University of Technology is aiming to develop and propose policies for climate change adaptation measures on the island of Shikoku, mainly focusing on flood disaster prevention. Currently it is working mainly in collaboration with Kochi Prefecture and Kochi City on the Kochi Plain, and the town of Ishii in Tokushima Prefecture, in the Yoshino River basin.

For the Kochi Plain, they used rainfall data and water level data provided by Kochi Prefecture (the river management authority) and analyzed past rainfall events. They then looked at various aspects

including the characteristics of spatial and temporal rainfall distribution in rainfall events that involved water damage risk, and then applied the rainfall patterns where disaster risk was identified to a near-term statistical downscaling model that had been provided, to conduct an impact assessment for flood control and water management on the Kagami River. They are also analyzing complex disaster risks in the context of climate change, including flooding and earthquakes, and proposing adaptation measures.

In the town of Ishii (Tokushima Prefecture) in the Yoshino River basin, they analyzed the risk of damage from flooding using inundation simulations and other methods. They held meetings to discuss the findings with municipal emergency preparedness officials and residents' disaster prevention organizations, and promoted more in-depth discussions about disaster risks and strategies to address them.

They also introduced a forest management model as an impact assessment model, and analyzed reproducibility of actual conditions. Now they are using the forest management model to understand how important the ecosystem functions of forests are in terms of adaptation measures and how they can be ensured through sustainable forestry. They are also analyzing the roles of biomass power generation plants in the context of adaptation measures. In addition, they are conducting field studies on the effectiveness of agroforestry, paying attention to the multiple functions of forests.

As the final layer of an integrated model of impact assessment models, to assess economic impacts they developed a monetary model of the regional economy, and from that extracted a hybrid industrial input-output (inter-industry relations) table from a physical model, with a focus on new businesses and industrial sectors. Looking at biomass power plants, they then used the hybrid industrial input-output model as a physical model to analyze the economic effects, as well as the economic effects in scenarios where material prices were determined based on policy.

They have already developed systems to analyze the economic damage of water shortages on municipalities in the Yoshino River basin, especially in cities, and are promoting discussions about how municipalities can use them. Meanwhile, they have proposed a structural model for hybrid input-output tables that can be used to analyze not only direct damage but also indirect damage affecting a large region, and are working to further develop the details.

The prevention of flood disasters as a climate change adaptation measure is an important theme affecting life and property, and there is a need to think about the linkages with conventional river infrastructure improvement legislation and planning concepts, as well as future river infrastructure improvements. The parties involved will work to incorporate the disaster prevention philosophy of "preparing for the worst" based on knowledge of flood damage in recent years, plus policy trends based on that knowledge, and constraints such as population decline and financial factors.

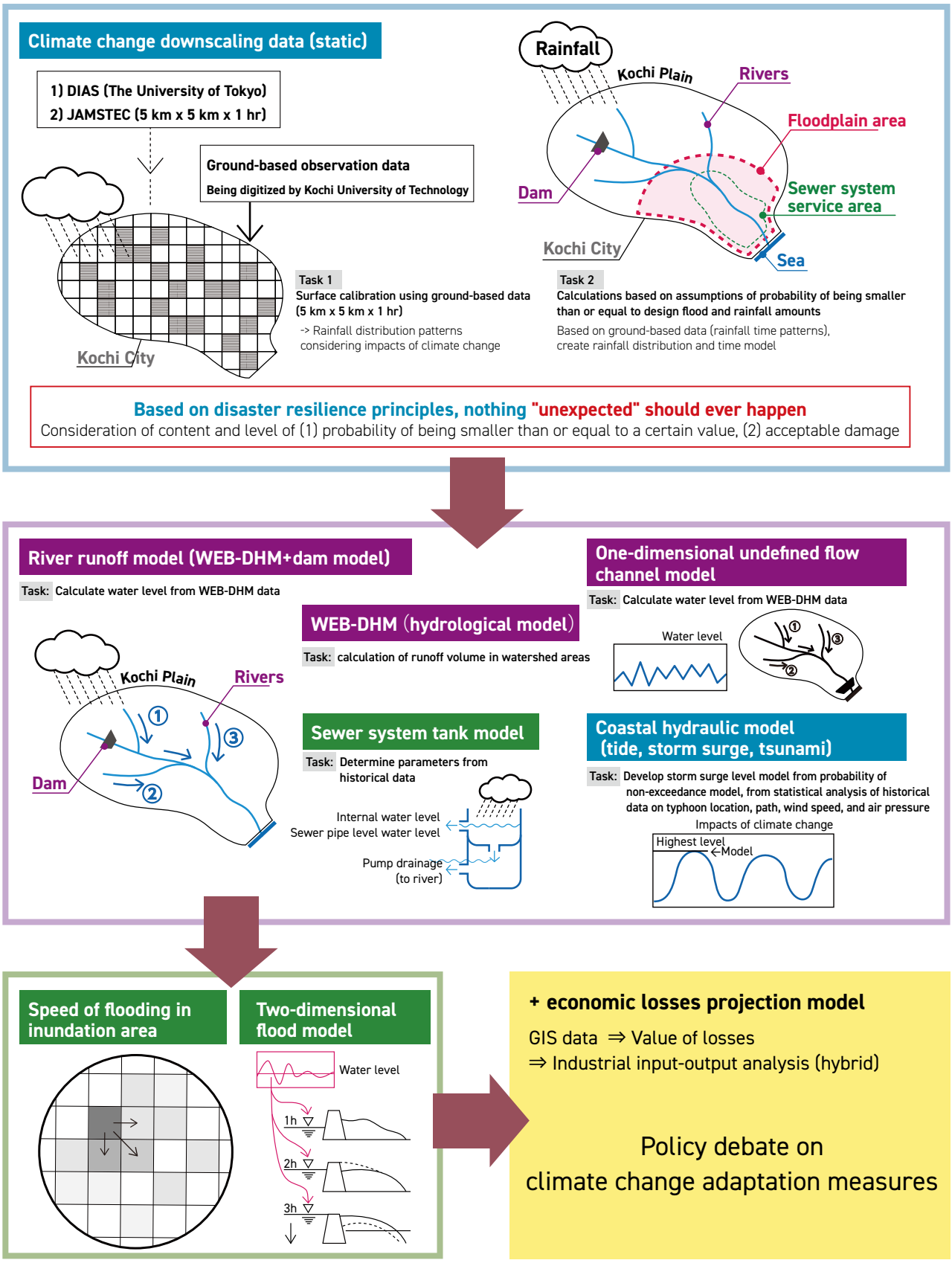


Figure 5-9: Integrated model to link climate change impact assessments with policy

5-10. Saga Prefecture: Flooding and Storm Surge

The broad and low-lying Saga Plain located at the inner reaches of the Ariake Sea, which experiences the largest tidal range in Japan, and has an extensive and deep foundation layer of soft clay sediment. This region is extremely vulnerable to flooding and storm surges, and for the future climate scenario there are concerns about intense rainfall events and stronger typhoons due to global warming. Thus, the impacts of climate change are an urgent matter for discussion. Among the impacts of climate change on the Saga Plain, Kyushu University is focusing on impact assessments of storm surge, flooding, and geotechnical disasters, and working to consider adaptation measures and quantify their effectiveness. The aims of this study going forward are to provide information that will contribute further to disaster prevention measures.

To look at inundation from storm surges, they developed a simulation model to consider various adaptation measures in significant detail. Going forward, they plan to run simulations under various conditions to consider climate change impact assessments and the effectiveness of adaptation measures. To look at flooding, Kyushu University has started simulations to consider the effectiveness for flood control by using a series of dams distributed in a cascading effect. The work is showing that the cascade approach is able to enhance flood control performance. The cascade approach is thus a new flood control concept they are now proposing. Compared to conventional dam configurations, this approach can significantly improve flood control by using a continuous line of dams (arranged in a direct series) and intentionally allowing the overflow of excess water from emergency spillways. As for geotechnical disasters, research is moving ahead with the aim of proposing methods to assess the soundness of river embankments and effective adaptation measures.

Figure 5-10 shows the results of a simulation of inundation from a storm surge accompanying a very powerful typhoon making landfall on the Saga Plain. The figure on the left shows water depth immediately after the typhoon passes, with a large portion of the Saga Plain under water. The figure on the right shows the increase in flood water depth in a scenario with failed embankments. Used this way, the simulation makes it possible to calculate changes in damages from inundation due to embankment failure. It also enables consideration of adaptation measures that can generally be considered, such as constructing seawalls, raising ground levels, and installing drainage pumps.

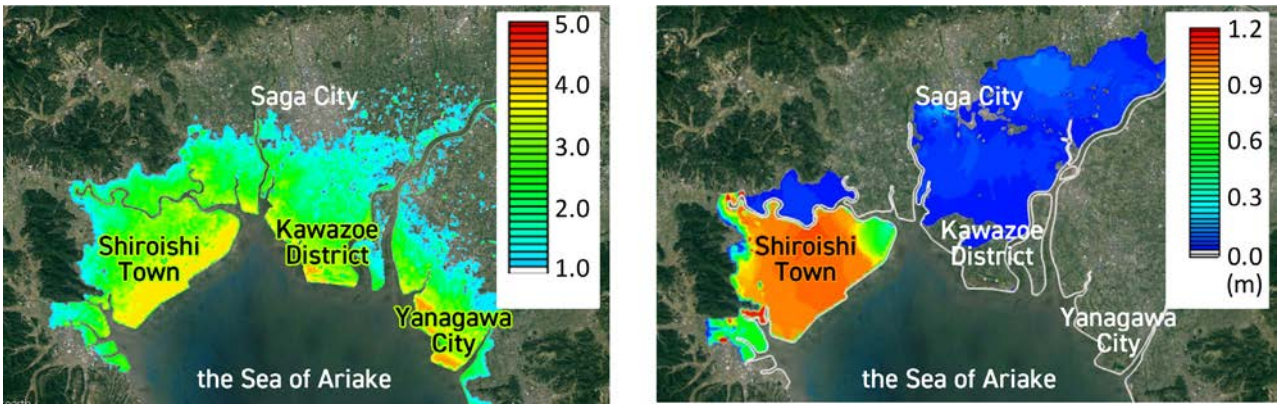


Figure 5-10: Example of simulation results for storm surge inundation from a very powerful typhoon making landfall on the Saga Plain

Water depth immediately after typhoon passes (left), and changes in water depth due to embankment failure (right)

Authors

Editor

Hosei University Center for Regional Research

* This English edition was prepared with cooperation from e's Inc.

Authors

· Preface: Publication of the FY2016 Report on Local Climate Adaptation in Japan

Fujio Kimura (University of Tsukuba)

Mitsuru Tanaka (Hosei University)

· Chapter 1

[1-1] Yoshiaki Ishibashi (Ministry of Education, Culture, Sports, Science and Technology)

[1-2] Mitsuru Tanaka (Hosei University)

· Chapter 2

[2-1] Shingo Watanabe (Japan Agency for Marine-Earth Science and Technology)

[2-2] Yoichi Ishikawa (Japan Agency for Marine-Earth Science and Technology)

[2-3] Yasuaki Hijioka (National Institute for Environmental Studies)

· Chapter 3

[3-1] Taiko Kudo, Shigeru Watanabe (Japan Weather Association) and Kenshi Baba (Hosei University and Tokyo City University)

[3-2] Hiroharu Tanaka (Hosei University)

[3-3] Asako Iwami (Hosei University) and Kenshi Baba (Hosei University and Tokyo City University)

· Chapter 4

[4-1] Kaori Mizutani (Public Hearts Inc.), Kenshi Baba (Hosei University and Tokyo City University) and Asako Iwami (Hosei University)

[4-2] Kenshi Baba (Hosei University and Tokyo City University), Asako Iwami (Hosei University), Motoko Kosugi (Shizuoka University) and Eri Aoki (Keio University)

[4-3] Kenshi Baba (Hosei University and Tokyo City University), Mitsuru Tanaka (Hosei University), Takashi Otsuka and Manami Yoshikawa (ICLEI-Japan)

[4-4/4-5] Nobuo Shirai (Hosei University)

· Chapter 5

[5-1] Hiroharu Tanaka (Hosei University)

[5-2] Makoto Tamura, Yuji Masutomi and Takahiro Takimoto (Ibaraki University)

[5-3] Satoshi Takewaka (University of Tsukuba)

[5-4] Tomohide Shimada (Center for *Environmental Science* in Saitama)

[5-5] Takashi Hamada (Nagano Environmental Conservation Research Institute)

[5-6] Morihiro Harada (Gifu University)

[5-7] Michinori Kimura, Jaegyu Kim and Reina Kawase (Lake Biwa Environmental Research Institute)

[5-8] Keiko Masumoto (Osaka City Research Center of Environmental Science)

[5-9] Kohei Yoshimura (Kochi University of Technology)

[5-10]Noriaki Hashimoto (Kyushu University)

The affiliation at the time of writing

June 2018 (Japanese edition was issued in May 2017)

Center for Regional Research, Hosei University

Address: 2-16 Ichigaya tamachi, Shinjuku-ku, Tokyo 162-0843, Japan
E-mail: si-cat-lg-help@ml.hosei.ac.jp

SI-CAT

Ministry of Education, Culture, Sports, Science and Technology
"Social Implementation Program on Climate Change Adaptation Technology (SI-CAT)"

* The term "social implementation" is a literal translation of the term "*shakai jisso*", part of the program name, which is also close to "mainstreaming" in English. This report uses both terms interchangeably.