# Chapter 3 Response to Critical Issues Facing Japan

## Section 1 Promotion of Measures Taken to Solve Critical Issues

### 1 Realization of a Safe, Comfortable and High-quality Life for the Japanese Public

The Fourth Basic Plan lists "a safe, comfortable and high-quality life for the Japanese public" as one of the goals at which Japan should aim. It is important to promote efforts to increase experiences that will enrich people's minds and spirits, in addition to protecting them from large-scale natural disasters, grave accidents, and terrorism. It is also important to improve people's safety by securing the stability of food and water resources, so that the Japanese public can live a safe and comfortable life, both now and in the future.

(1) Enhancement of safety and convenience in life

Concerned authorities make efforts described below in order to secure the safety of people's daily lives against natural disasters, accidents and crimes; to preserve human health and the ecosystem; and also to balance improvements in safety, convenience and comfort.

1) Promotion of the survey and observation of earthquakes, volcanoes, tsunamis, high waves and high tides, storm and flood damages, and landslide disasters, as well as research and development to improve prediction abilities, disaster prevention, disaster mitigation and the capabilities to respond to such disasters.

In FY 2012, an earthquake off the Pacific coast of Tohoku caused many aftershocks and induced earthquakes. Other various natural disasters also occurred in many regions; for example, damages caused by the 2012 May Tornado in Ibaraki and Tochigi prefectures and heavy rain disasters caused by "the 2012 July Rain Storm in Northern Kyushu." In regard to countries overseas, there were also severe damages caused by natural disasters all over the world; for example, the earthquake in Northeastern Italy in May 2012, the earthquake in Northwestern Iran in August 2012, the landslide disaster caused by the June 2012 rain storm in Bangladesh, the large-scale hurricane in the U.S. in October 2012, and the heavy rain disasters caused by Typhoon No. 24 in Philippines. It is extremely important to promote the research and development of disaster preventions in response to various natural disasters in order to mitigate potential damages caused by future natural disasters.

(i) Promotion of research and development in the seismic field (MEXT)

The survey and research of earthquakes in Japan are conducted in close collaboration and cooperation with related administrative offices under the management of the Headquarters for Earthquake Research Promotion (Administrative Chief: Minister of Education, Culture, Sports, Science and Technology). In September 2012, in response to the GEJE, the Headquarters for Earthquake Research Promotion reviewed the "Promotion of a New Survey and Research on Earthquakes" that was established in April

2009, and which summarizes basic policies in regard to surveys and the research of earthquakes, and decided to steadily enhance the seabed-monitoring to improve the instantaneous prediction of earthquakes and tsunamis.

The Headquarters for Earthquake Research Promotion has conducted long-term evaluation of the probability and scales of earthquakes but could not evaluate a massive earthquake caused by multiple areas linking together such as occurred in the 2011 Earthquake which occurred off the Pacific coast of Tohoku. Therefore, in June 2011, it was determined they would review the evaluation method and consider a way of evaluation that can be practically used for disaster prevention, and so the investigation of a new evaluation method is in progress. In addition, the headquarters evaluated active faults on a regional basis for the first time and published a "Long-term Evaluation of Active Faults in Kyushu area" in February 2013 (Figure 2-3-1).

The "Promotion of Observation and Research Program for Seismic and Volcanic Eruption Prediction (Proposal)" (Council for Science and Technology (CST), July 2008) summarizes the research plans of earthquakes and volcanic eruptions and is performed by related organizations, such as universities and the CST. The proposal contains surveys and research about extremely powerful earthquakes, such as the 2011 Off the Pacific Coast of Tohoku Earthquake, which had not been taken into consideration at the time. Therefore, in November 2012, the CST reviewed the program so that it includes observation and research that can be used to understand the mechanism of extremely powerful earthquakes and made a proposal to the related ministers including the Minister of Education, Culture, Sports, Science and Technology). The CST is studying the formulation of the program for next term that starts in FY 2014

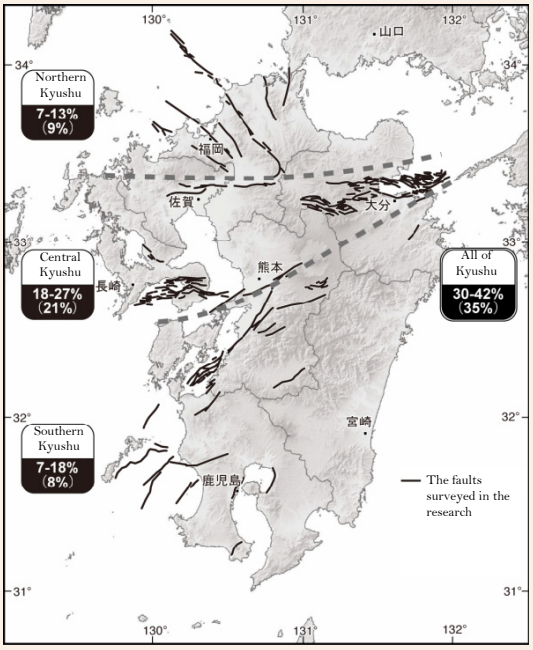
MEXT drives surveys and research focusing on areas where social and economic damage could be significant when an expected earthquake hits. These include the "Special Project for Mitigation of Great Disaster which the Vulnerability of Cities Causes," which focuses on epicentral earthquakes beneath cities, urban-area earthquakes and other earthquakes, and the "Research on Evaluation of Linkage between Tokai/Tonankai/Nankai Earthquakes," which focuses on the Nankai Trough Earthquake. In the "Research on Evaluation of Linkage between Tokai/Tonankai/Nankai Earthquakes (project term FY 2008 through FY 2012)," the observation and simulation research of earthquakes, tsunamis and diastrophism, as well as research on the prediction of damages, were conducted in the expected hypo-central region of the Tokai/Tonankai/Nankai Earthquakes. The result of the project was employed by the government's study on the future probabilities of these earthquakes occurring in linkage. The result was also employed by a study done by the Cabinet Office on models for the expected hypo-central region. In addition, MEXT conducted the study of "Focused Survey and Research in Areas Where the Strain is Concentrated (project term FY 2008 through FY 2012)," which focused on the eastern fringe of the Sea of Japan. In the study, an observation using underwater cable seismometers and an integrated survey of land and ocean using a controlled source were conducted in order to understand the occurrence mechanisms of earthquakes occurring in areas where the strain is concentrated in the eastern fringe of the Sea of Japan where no surveys or observations of earthquakes were conducted. A source faults model was established based in this study.

After the Great Hanshin-Awaji Earthquake, dense coverage of earthquake observation networks was established on land. On the contrary, far fewer monitoring points were available on the observation networks of the seabed as compared to the number of those on land, although some monitoring

networks had been built, such as the offshore Tokai/Tonankai 24-hour Underwater Cable Earthquake Monitoring System built by the Japan Meteorological Agency.

In an attempt to find a solution, MEXT started the full-scale operation of a high-density underwater network system that was equipped with a seismograph and a water-pressure gauge at the expected hypo-central region of a predicted Tonankai earthquake, and MEXT continues the development of technology in order to build a similar system for the expected hypo-central region of a predicted Nankai earthquake. MEXT is enhancing an underwater- cable earthquake and tsunami monitoring network around the hypo-central region of the 2011 Off the Pacific Coast of Tohoku Earthquake where larger aftershocks and tsunami could occur in the near future (refer to 1 (3) of Part 2 Chapter 2 Section 1).

Figure 2-3-2/ Long-term Evaluation of Active Faults in the Kyushu area (based on the probability that an earthquake of M6.8 or greater might occur in next 30 years.




Source: Created by MEXT

(ii) Promotion of S&T for disaster prevention (National Research Institute for Earth Science and Disaster Prevention (NIED))

The National Research Institute for Earth Science and Disaster Prevention (NIED) conducts seismic engineering research involving the practical use of E-defense, research on the precise prediction of rainfall, the prediction of landslides/storms/flood damages through the use of next-generation high-performance radar, and research of damages caused by natural disasters, such as volcanic disasters or snow hazards. The institute also promotes research to develop a system that can integrate, and practically use information from various disasters. In FY 2012, the institute improved the functions of E-defense so that it could reproduce long-period/long-term motions caused by extremely powerful earthquakes such as the 2011 Earthquake that occurred off the Pacific Coast of Tohoku. The institute also conducted research and development to understand the occurrence mechanism of ocean-trench earthquakes, which also occurred in the 2011 off the Pacific Coast of Tohoku Earthquake.

(iii) Research on earthquake monitoring/forecasting, tsunami forecasting, and Earthquake Early Warning technology (Japan Meteorological Agency)

The Japan Meteorological Agency processes and analyzes the monitoring data collected through their own earthquake monitoring facilities in conjunction with monitoring data from other related institutions in order to provide other organizations with the results. The agency conducts the development of technologies that improve Earthquake Early Warning Systems in cooperation with the National Research Institute for Earth Science and Disaster Prevention (NIED) and other institutions.

The Meteorological Research Institute at the Japan Meteorological Agency conducts 1) research and development on tsunami forecasts through the practical use of instantaneous estimations of massive earthquake scale and offshore tsunami-monitoring data to mitigate disasters caused by tsunami, 2) research on seismic-intensity estimation methods, in order to increase the accuracy of the Earthquake Early Warning System, and 3) research on monitor/analysis technology of diastrophisms, in order to improve the accuracy of Tokai earthquake prediction.

(iv) Improving monitoring and analysis of diastrophism ((Geospatial Information Authority of Japan (GSI))

Geospatial Information Authority of Japan (GSI) carries out researches and improvement of techniques for monitoring land deformation or plate motion by using data derived from such as GNSS based control stations[1], Very Long Baseline Interferometry (VLBI[2]) and Synthetic Aperture Radar (SAR[3]). Besides processing its own data, GSI launched a new integration analysis for more detailed monitoring of volcanic deformation by using continuous GNSS data around volcanoes collected by other agencies like the Japan Meteorological Agency (JMA) and the National Research Institute for Earth Science and Disaster Prevention (NIED) since FY 2010 and the National Institute of Advanced Industrial Science and Technology (AIST) and the Hot Springs Research Institute of Kanagawa Prefecture since FY 2012.

v) Enhancement of surveys and observations of the seafloor for diastrophism research (Japan Coast Guard (JCG))

The Japan Coast Guard (JCG) has been carrying out GPS/acoustic[4] seafloor diastrophism observations and topographic surveys of submarine active faults around Japan. Based on the experience of the 2011 Earthquake that occurred off the Pacific Coast of Tohoku, the JCG has improved the observation system for seafloor diastrophism in the Nankai Trough region.

(vi) Geological surveys of volcanoes, active faults and tsunami deposits (The National Institute of Advanced Industrial Science and Technology (AIST))

AIST performs geological surveys of active volcanoes, active faults and tsunami deposits to enhance geological information for disaster management, and publishes the results of these surveys.

In regard to major active fault zones across the nation, AIST conducted geological surveys of nine fault zones (six fault zones on land and three fault zones in costal sea areas) in order to understand their

1 There were a total of 1,240 stations nationwide as of the end of March 2012.
2 Very Long Baseline Interferometry: Technology used to accurately measure a distance of several thousand kilometers within a few mm by using radio waves that reach the earth from a far distance.
3 Synthetic Aperture Radar: Technique used to monitor changes in the earth's surface from a satellite(Advanced Land Observing Satellite "DAICHI" (ALOS) stopped its service in May 2011)
4 Measures the distance between points on the ships and seafloor reference points.

positions and the history of their activities. AIST also carried out a refraction seismic survey, test borings, and a physical property test of collected samples in order to enhance the data on subsurface structure of the Fukaya Fault and the Ayasegawa Fault, both of which are located in the Kanto Plain, and conducted a simulation for fault slip based on these data. In addition, AIST continues to enhance integrated ground water observation points and continues to measure groundwater levels, groundwater temperatures, crustal strain and seismic waves for short-term prediction of Tokai/Tonankai earthquakes. AIST also performed geological surveys in the Shimokita Peninsula, the Sendai Plain, Northern Ibaraki, and the Boso Peninsula, which are located along the Japan Trench in the Sea of Japan, and along the coast of Shizuoka Prefecture near the Nankai Trough in order to understand histories of huge tsunamis and earthquakes causing the tsunamis.

In regard to active volcanoes, in order to understand accurate mechanism of volcano eruptions, AIST continues to observe falling ashes and to conduct lithological analyses of Mt. Shinmoe (Kirishima Volcano) which erupted in 2011, and the Sakura-jima volcano which is currently active. AIST has also conducted geological surveys in order to understand eruption histories of Mt. Kuju, Mt. Zao and Hachijo-jima, all of which will be required a monitoring/observation system going forward.

Automatic volcanic-ash observation equipment

It is currently installed at two locations in Sakura-jima and three locations in Kirishima, sending data about the volume of falling ash in real time to Tsukuba (in a test run).
Courtesy of AIST

(vii) Research and development on the monitoring of waves and tide levels and on disaster prevention to alleviate damages caused by natural disasters (Ministry of Land, Infrastructure, Transport and Tourism (MLIT))

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) establishes and operates the Nationwide Ocean Wave Information Network for Ports and Harbours (NOWPHAS) under mutual cooperation with the Port and Airport Research Institute. They also collect wave and tide level monitoring data that has been acquired throughout the nation and discloses it to the public in real time through the Website. In FY 2012, MLIT improved the real-time monitoring information process system of sea states.

Under cooperation with related MLIT departments, the National Institute for Land and Infrastructure Management (NILIM), a division of MLIT, conducts research to contribute to the planning and proposal of disaster prevention policies and research related to the development of technical standards, in order to secure safety against natural disasters that affect housing/real estate and social-capital infrastructure, such as roads, rivers, and ports. This includes the disaster prediction/prevention plan to prevent or mitigate natural disasters such as earthquakes, tsunamis, floods and landslides. In FY 2012, taking the GEJE into account, NILIM performed research on the structure of a coastal dike and breakwater that would continuously work even if, for example, a tsunami higher than the tsunami hypothesized for the design flooded over the dike and the breakwater. In regard to liquefaction of housing land, NILIM developed software tools that easily calculate the effect of applying the Lowering-Groundwater-Levels

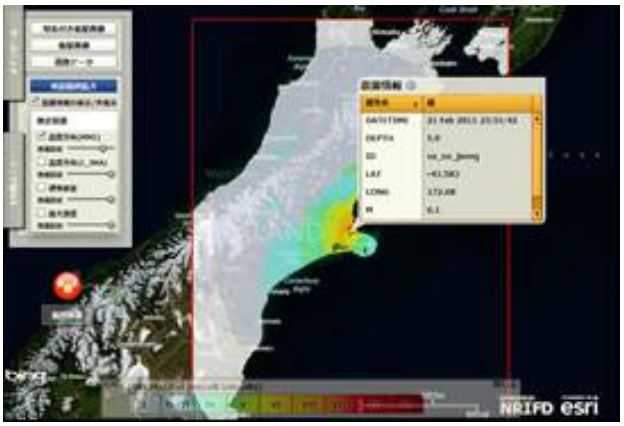
Method and the Grillwork-Underground-Walls Method in response to the ground conditions of each site. NILIM put them downloadable in its homepage in order to offer technical support to local authorities afflicted by the GEJE

(viii) Research to prevent, mitigate and promptly recover from greater and more diversified natural disasters (Public Works Research Institute)

The Public Works Research Institute conducts research and development that contributes to preventing, mitigating and recovering from damages caused by earthquakes, tsunamis, eruptions, storm and flood disasters, landslide disasters and snow and ice disasters. For example, in FY 2012, the institute carried out research on an integrated countermeasure technology, combining countermeasures for infiltration of river dikes and earthquake resistance.

ix) Collection and analysis of disaster information, development of a training system to prepare for disaster (Fire and Disaster Management Agency (FDMA))

Considering the issues around information gathering at the GEJE, the Fire and Disaster Management Agency (FDMA) started research and development on a wide-area earthquake-damage estimation system that supports the decision-making of those who work in the areas of emergency support, such as fire departments sending emergency fire response teams to afflicted regions. The FDMA also started to develop an emergency support system that contributes training in regard to team operations and instructs how to issue evacuation orders to residents when a large disaster occurs, which includes methods learned by leveraging empirical knowledge gained from emergency support teams during the GEJE and the tsunami that followed and using it to improve emergency support during future disasters.




Example of display of earthquake damage estimation system (FDMA)
Courtesy of National research Institute of Fire and Disaster

2) Promotion of research and development in measures against fires, grave accidents and crimes

The National Research Institute of Police Science conducts various types of research to support investigation and crime prevention. In FY 2012, the institute particularly focused on the following subjects: 1) the development of methods for forensic drug testing on cannabis and its related substances,

2) the development of a facial aging system on the face captured in photographs, 3) research on the individual identification of biological samples using haplotype [1] analysis to support criminal investigations, 4) behavioral science research on the techniques for interviewing suspects and victims, and 5) research on the practical application of simulation techniques used in analyzing root causes of accidental fires and as proof in arson cases.

MEXT promotes the research and development of science and technology that meet the requirement of users or government offices in order to contribute to the establishment of anti-crime and anti-terrorism technology by cooperating with related ministries and agencies. Since FY 2010, MEXT has been conducting the "R&D Program for Practical Application of Anti-Crime and Anti-Terrorism Technologies for Safe and Secured Society," which is funded by Special Coordination Funds for Promoting Science and Technology (from FY 2011: Strategic Funds for Science and Technology Promotion), and is used to promote the practical application of research and development. Also, MEXT held a Japan-U.S. biosecurity symposium, based on an S&T cooperative framework entitled the "U.S.-Japan Framework Initiative for a Safe and Secure Society," which provides feedback to related-government offices and researchers, while sharing knowledge and technology.

3) Promotion of research and development aimed at human health protection and ecosystem preservation

The Public Works Research Institute performs research on evaluating, managing and controlling the risk of environmental contaminants in water in order to protect human health and to preserve ecosystems.

The National Maritime Research Institute performs research on fundamental technologies that contribute to the realization of environmental regulations that significantly reduce environmental impact and that possess social rationality aimed at zero-emissions, all as a means of preserving marine environments.

4) Promotion of research and development to balance improvements in safety, convenience and comfort

(i) Research and development on the upgrading and safety evaluation of traffic/transportation systems

Rebuilding the safety and reliability of traffic/transportation systems as a daily commuting tool for the Japanese public is an urgent issue, and it is necessary to focus on and promote the practical use of new technologies in order to completely ensure preventative safety, while also considering future increases in air traffic needs, the human factor of operators in traffic organization, and the discovery, judgment and operation of vehicle drivers.

The National Police Agency, the Ministry of Internal Affairs and Communications (MIC), and the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) promote efforts aimed at the practical application of a Driving Safety Support System that uses both vehicle-to-infrastructure cooperation and vehicle-to-vehicle communication.

MIC established technical standards for intelligent transport systems for vehicle-to-vehicle and vehicle-to-infrastructure communication with 700 MHz radio band, in order to introduce a driving safety support system. MIC also developed technical standards for 79GHz radio band high-resolution radar to protect pedestrians and is conducting research and development on improvement these technologies.

[1] haplotype: a combination of single nucleotide polymorphism alleles on a single DNA strand.

MLIT implemented ITS spots[1] in approximately 1,600 locations, mainly on highways, and started ITS nationwide spot service in 2011. The ministry also promotes technological development that contributes to further safety in the railway field, such as new platform doors. This can support cost reduction and improve safety amongst the various train cars whose doors are placed in different positions.

The National Maritime Research Institute conducts research that contributes to the realization of a "safe and secured society" by establishing safety regulations that can significantly reduce marine accidents and yet possess social rationality in order to secure the safety of marine transportation. The institute also conducts research on efficiency measures of maritime logistics and transportation systems that support the promotion of modal shift[2] and smooth transfer.

The Electronic Navigation Research Institute is selectively implementing R&D on the effective utilization of airspace and capacity expansion of flight routes, R&D on capacity expansion of congested airports, R&D of improved safety and efficiency achieved by preventative safety, and technologies for ensuring the security and smoothness of air traffic.

In FY 2012, the National Research Institute of Police Science conducted research on identifying problem of drink driving offenders from a medical-psychological perspective, in order to prevent driving under the influence.

(ii) Promotion of research and development on advanced and more durable housing and on social infrastructure, in order to confront the aging and wear of such infrastructure.

MLIT conducts the development of technologies that can contribute to the management of prevention and preservation efforts by taking measures prior to the occurrence of fatal damage in order to prevent accidents and disasters caused by the aging and wear of housing and other social infrastructure, and so as to reduce life-cycle costs.

The Public Works Research Institute conducts 1) development of technologies that can contribute to efficient maintenance and management in order to support the prevention of aging in social infrastructure, and 2) development of technologies that can contribute to the improvement and longer life of social-capital functions based on the progress of material technologies.

(2) Stable securement of food, water, resources and energy

Related organizations make the efforts described below in order to improve the safety of food, water, resources and energy that are essential to daily life, all of which must be provided in a stable and sustainable manner.

The Ministry of Agriculture, Forestry and Fisheries (MAFF) attempts to accelerate gene function elucidation to solve food, water, resources, and energy problems. MAFF also conducts research on the generation of super high-yielding crops, defective environment-resistant crops, environmental purification plants, and high quantity biomass plants, in order to contribute to solving various issues in these fields. In addition, the Ministry makes efforts on 1) the development of food crops and feed crops

1 An area where Dynamic Route Guidance (A service used to distribute traffic jam data over a wide area so that a car navigation system can select a route wisely), Driving-Safety Support System and ETC are available with a radio device installed at a roadside location.
2 To replace freight transportation with railroad and marine transportation whose impacts on the environment are lower.

that possess breakthrough characteristics in quality and processing suitability, and 2) the development of livestock-products technology, such as producing high quality meats using domestic foodstuffs, in order to achieve a target rate for becoming more self-sufficient in regard to food production.

MAFF also makes efforts to develop technology that supports more precise and more efficient epidemic-prevention measures, in order to reduce potential risks to humans and to reduce the economic losses of livestock farmers due to critical domestic animal diseases, such as avian flu and foot-and-mouth disease. Furthermore, the ministry makes efforts to develop technologies that reduce risks in the production, distribution and manufacturing processes of agricultural products by targeting hazardous chemicals and hazardous microorganisms.

In addition, the ministry makes efforts to develop methods to capture scientific evidence on the functions of disease prevention in agricultural, forest and fishery products, and food ingredients. The ministry also works to develop breeds that are rich in functional ingredients and which can be cultivated in a way that results in a healthy, long-living society.

MEXT promotes research and development to advance exploration techniques for ocean mineral resources and preservation techniques for marine organisms, in order to stably secure marine resources (refer to Part 2 Chapter 3 Section 1, 4(2)). MEXT also promotes the research and development of breakthrough technologies for renewable energy and for distributed-energy systems that would significantly contribute to the creation of green innovation and toward a low-carbon society (refer to Part 2 Chapter 2 Section 2, 1 (1) and (2)).

The National Maritime Research Institute conducts research on the development and improvement of safety-evaluation methods for offshore structures and of environmental load mitigation methods that are the foundation of basic technologies related to marine resources and energy development.

METI assisted the efforts to expand the collection of used carbide tools and to the development of technology/demonstration systems used to reduce costs and improve efficiency in the recycling of used carbide tools into cemented carbide materials. METI also promoted the recycling of carbide tools into tungsten, an indispensable material for auto manufacturing. This was done in order to establish a recycling system for used products and was aimed at the conquest of resource restrictions and the formation of a sustainable, recycling-based society that lives in harmony with the natural environment.

(3) Enhancing the comfort level of the Japanese lifestyle

Related organizations continue the efforts described below in order to contribute to the enhancement of quality and comfort in everyday life and in order to create experiences that will enrich people's minds and spirits via S&T.

1) Efforts aiming at the enhancement in quality and comfort of daily life

The Ministry of Internal Affairs and Communications built a network environment using ICT devices such as tablet PCs and interactive whiteboards at 20 schools nationwide (10 elementary schools, 8 junior high schools, and 2 special-needs education schools), and conducted a "Future School Promotion Project," empirical research to extract and analyze issues around information and communication technology at school sites in collaboration with MEXT and in order to promote the practical use of ICT in education fields. In the area of welfare, subsidies to cover part of research and development costs are provided to

those who perform research and development of communication and broadcasting technologies for the development of a communication/broadcasting service that will contribute to improvements in convenience to elderly/disabled people. In medical and long term care areas, verifications for experimental proof were performed on the function, technology and effects of Ubiquitous Net Technology[1] and on medical information linking infrastructure which allowed for the secure and smooth circulations of medical information owned by local communities. In the administrative field, the ministry promotes efforts to enhance services in the public sector in each community with information and communication technology. The ministry also conducts the investigation and verification of link data items and link function/methods that enable smooth operation of data links between organizations using a data cloud environment.

The Research Institute of Science and Technology for Society (RISTEX) promotes research and development of social technology with a problem solving style in order to apply solutions to on-site problems; this is done in cooperation with researchers at universities and public research institutions and with "stakeholders" who have various backgrounds and who are familiar with the situations and issues at each working site, such as local residents, NPOs and the local government. The research and development of social technology involves five areas and two programs. The five areas are as follows: 1) the "Design of a new-aged society created with community," 2) an "Anti global-warming and environmental-friendly society rooted in community," 3) "Protecting Children from Crime," 4) "Science, Technology and Humanity," and 5) the "Creation of safe and secure cities and local communities linked by community," all of which were newly started in FY 2012. The two programs are the "Problem-Solving-Based Service Science Research and Development Program" and the "Science Research and Development Program for Science and Technology Innovation Policies."



1 Technology used to automatically identify the behavior of healthcare workers and patient-status by practically using electric tags and sensors that are attached to patients, medical supplies and medical equipment.

Column 2-2

## Working for life by cultivating persimmons – efforts made by the Tochihara District in Shimoichi Town, Nara Prefecture

"Developing low-burden farming methods which support farming by elderly people" is a project (Representative: Assistant Professor Shingo Tereoka, Nara Women's University) conducted in the Tochihara District of Shimoichi Town, Nara Prefecture, and is one of the efforts that the Research Institute of Science and Technology for Society (RISTEX) of Japan Science and Technology Agency made for "Designing a new aging society by community" in the areas of research and development. Many farming communities in the hilly and mountainous areas of Japan face the high risk of a discontinued existence in the near future due to the progress of a graying population and the lack of a workforce for next generation. Therefore, how to sustain these farming communities in which elderly people live and how to maintain an active workforce is an immediate issue.

The Tochihara District of Shimoichi Town, Nara Prefecture is a hilly and mountainous farming area which has a long history of development and spacious persimmon fields. The district has limited public transportation infrastructure and 80% of the district is made up of persimmon fields with an inclination of over 20 degrees. Therefore, the concern is that, due to the hard labor required, the workforce for cultivating and harvesting persimmons may significantly decrease within ten years and that the community may be fragmented.

In response to this situation, a team consisting of Nara Women's University, the Nara Prefectural Agricultural Experiment Station, the Nara National College of Technology, a local agricultural machine manufacturer, and local residents is aiming at establishing an environment for low-burden farming methods so that elderly farmers can continue farming actively. These efforts include 1) the development of a new electric farming vehicle for transporting persimmons, with a focus on its usability by elderly people, 2) low-burden cultivation which produces persimmon leaves as well as the cultivating of persimmons, and 3) the production of sushi using persimmon leaves. The team is promoting the project in collaboration with the community residents so that each member of the community can easily envision the future.

Source: An electric farming vehicle used for transporting persimmons was developed during the project.
Courtesy of Research Institute of Science and Technology for Society (RISTEX) of Japan Science and Technology Agency

### 2) Efforts for developing experiences that will enrich people's minds and spirits

In order to promote the production and circulation of digital contents, MIC investigates economic revitalization by sending out Japan-made products, by enhancing the production and circulation of these products, and by creating a new platform in which to circulate these products.

MEXT tries to contribute to the creation of a new culture by combining culture with Science and Technology; thus, MEXT is conducting research and development for the realization of a digital museum where the audience can interactively experience the tangibles and intangibles of cultural heritage through all five senses.

Table 2-3-2/ Measures taken to realize a safe, comfortable and high-quality life for the Japanese public (FY 2012)

| Ministries and agencies | Conducting organization | Measures |
|---|---|---|
| The National Police Agency | National Research Institute of Police Science | Development of the methods for forensic drug testing on cannabis and its related substances |
| | | Development of a facial aging system on the face captured in photographs |
| | | Research on the individual identification of biological samples with haplotype analysisResearch on the individual identification of biological data with haplotype analysis |
| | | Research on the practical application of simulation techniques to fire investigation |
| | | Behavioral science research on techniques for interviewing suspects and victims |
| | | Research on identifying problems of drink driving offenders from a medical-psychological perspective |
| Ministry of Internal Affairs and Communications (MIC) | MIC | Research and development of IT to collect energy from electromagnetic waves |
| MEXT | MEXT | Project for the mitigation of great disasters caused by the vulnerability of cities |
| | | Comprehensive promotion of the active faults survey |
| | | Research on Earthquake and Tsunami off the Pacific Coast of Tohoku<br>Surveying and monitoring of earthquakes/tsunamis that occurred in the earthquake off the Pacific coast of Tohoku |
| | National Research Institute for Earth Science and Disaster (NIED) | Scientific research focusing on monitoring and prediction |
| | | Scientific research focusing on experiment of disaster mitigation |
| | | Scientific research focusing on disaster social prevention systems |
| Ministry of Agriculture, Forestry and Fisheries (MAFF) | MAFF | Development of Efficient Technology for Risk Reduction Measures Against Avian Influenza, Bovine Spongiform Encephalopathy, Foot and Mouth Disease |
| | | Practical Technology Development Program for the Promotion of New Agricultural, Forestry and Fishery Policies |
| | | Genomics for Agricultural Innovation |
| | National Agriculture and Food Research Organization | Basic Research Promotion Program for the Creation of Innovation |
| METI | National Institute of Advanced Industrial Science and Technology(AIST) | Geological survey and research in urban areas and coastal zones, and enhancement of geological information and environmental information |
| | | Improvement in the earthquake forecast with active fault surveys and earthquake observations |
| | | Improvement in the prediction of changes in volcano eruptions |
| Ministry of Land, Infrastructure, Transport and Tourism (MLIT) | MLIT<br>National Institute for Land and Infrastructure Management | Realization of improvements in safety and convenience by the strategic maintenance and reconstruction of housing and infrastructure – development of inspection and monitoring technology for preventive control - |
| | National Institute for Land and Infrastructure Management | Research on enhancement and management standard of social capital facilities by considering aging variation of functionality and performance |
| | | Research on measures for seamless international-ferry transport in response to the expanding network in Asia |
| | Port and Airport Research Institute | Study to protect regional society against large-scale earthquakes and tsunamis |
| | | Study on the evaluation of and measures against the influences of climate change due to high-waves, high-tides and geomorphic change<br>Research on technologies against spilled oil in coastal zones<br>Research on the functional improvement of ports and airports in order to strengthen international competitiveness<br>Study on the strategic maintenance and management of port and airport facilities |

## 2 Strengthening Japan's Competiveness in Industries

### (1) Strengthening common infrastructure in order to strengthen competiveness in industry

Since manufacturing (MONODZUKURI) is Japan's most competitive industry, and since it greatly influences other industries and can be a fundamental driver for economic growth, measures to strengthen manufacturing technology were aggressively taken in the past. Due to the occurrence of the GEJE, however, research and development, as well as production activities in the private sector, slowed down, and thus, the supply chain of products/parts/materials was badly affected. Because of the drastic rise of the yen in recent years and because of procurement limitations on materials such as rare-earths, in addition to the impacts caused by the earthquake, people became concerned with the hollowing out of industry due to the manufacturing base being shifted abroad and due to reduction in research and development investment caused by a tougher business conditions. In response to these situations, necessary measures were taken to rebuild a more powerful system, as well as an infrastructure that will support manufacturing in order to achieve sustainable economic growth by improving the competitiveness of Japanese industry.

MIC conducts research and development of technology that enables the efficient use of radio frequencies and the use of higher frequencies to precisely support new communication demands in order to create new industry using radio.

MEXT promotes the development of one-and-only, leading-edge measurement and analysis technology- that supports the needs of the world's cutting-edge researchers and manufacturing sites (refer to Part 2 Chapter 3 Section 1, 5(1)).

METI aims at strengthening the competitiveness of industry and promotes the following research and developments in order to build common infrastructure in manufacturing areas that can support the creation and growth of new industry.

#### 1) Development of fundamental technology in the manufacturing process

Carbon fiber is expected to be in great demand as it is used in structural materials for aircraft and automobiles because of its lightness and tremendous strength. In cooperation with universities and carbon fiber manufactures, METI was involved in the development of fundamental technology in the manufacturing process. Such technology can reduce environmental burdens, such as carbon dioxide emissions, and can significantly increase the efficiency of production by taking a completely different approach from previous methods.

Based on this fundamental technology, METI also conducted research on basic manufacturing technology aimed at the practical application of the fundamental technology.

#### 2) Development of semiconductor technology

Regarding semiconductor technology, METI conducts the following research: 1) fundamental evaluation technology necessary for next-generation EUV (extreme ultraviolet radiation[1]) lithography systems that realize a semiconductor manufacturing process in 10-nm technology, 2) ultra-lower-power technology with new materials/structures, 3) Normally off computing "Normally OFF—instantly ON

1 EUV is the ultraviolet radiation with 13.5 nm of wavelength, and is promising as the wavelength light for next generation lithography system.

computing," a fundamental technology that consumes electric power only when data processing is required, by embedding nonvolatile elements into the semiconductor, and 4) three-dimensional integration technology for semiconductors.

3) Development of embedded systems

In order to secure the reliability and safety of embedded systems that are the source of Japan's industrial competitiveness, METI supports 1) the development of guidelines that support the functional safety standard that is being discussed for standardization in Europe and 2) the development and evaluation of the development/evaluation/verification tools used for basic-control software.

4) Development of energy-saving technology at data centers

In order to realize the enhancement and energy-saving of information processing capabilities at data centers, METI conducts the "Green IT Project," which includes the development of green cloud-computing technology and next-generation power devices, in addition to the "Future Pioneering Projects," which includes the development and application of technology used in hybrid optical and electronic circuits.

5) Support of activities for the reduction and possible elimination of rare-earth elements

Regarding rare-earth elements that are essential for high value-added industries such as hybrid and electric cars, METI conducts the development of technologies for substitution materials and for the reduction of their use. This is done in order to respond to the supply risk that arose from growing resource nationalism.

In FY 2012, METI launched a new project called the "Development of Magnetic Materials for High-efficiency Motors Used in Next-generation Vehicles" as the first project under the J Recovery Plan, which promotes the practical application of innovative technologies through the cooperation of universities, industry and the government, and which will be conducted for the next ten years. In response to an increasing demand for high-performance magnetic material used in next-generation vehicles and for motors used in wind-power generation, this project aims at developing magnetic materials which are more powerful than ever without using rare earth such as dysprosium[1], which is unevenly distributed. Also, the project aims at developing high-performance motors without using rare earth through designing and experimentally manufacturing high-performance motors.

In the project to develop rare-metal-substitution materials, METI carried out the development of substitution materials that realize rare earth functions by using materials which are abundant and by using various technologies to significantly reduce the use of rear earths, while also supporting the project to recycle the rare earth contained in the motors of vehicles and air-conditioners.

6) Support of an innovation center

METI conducts the "Innovation-center location promotion project" to support the enhancement and development of facilities necessary for empirical research, and to support prototype manufacturing and

1 Rare earth is added to high-performance neodymium magnets as an ingredient to improve heat-resistance. The high-performance neodymium magnet is used for motors in hybrid cars, electric cars and air-conditioner compressors.

performance/safety evaluations aimed at the practical application of the fruits of research and developments that have been accomplished in the past by various companies.

7) Efforts to promote research and development by small and medium enterprises

In regard to the Enterprise Power Working Group of the Small and Medium Enterprise Policy Making Council, of the Small and Medium Enterprise Agency which operates under METI, METI reported that the guideline for enhancing specific core-manufacturing technologies, which is based on the "Act on Technology Advancement of SMEs," (2006 law No.33) should be reviewed in order to respond to the demands of the times, such as technology trends, while it considers specific policies to further strengthen those technologies. The "Guideline for Enhancing Specific Core Manufacturing Technologies" (2009 METI public notice 22) was thus entirely revised, and two additional technologies (refrigerating and air-conditioning technology, and painting technology) were added to the list of specific core manufacturing technologies. In addition, in order to promote research and development by small and medium enterprises, METI conducted the "Project for Strategic Promotion of Advanced Basic Technologies," in which the research and development plan (specific research and development plan) authorized pursuant to the "Act on Technology Advancement of SMEs" is contracted to small and medium enterprises. Also, METI provided low-interest loans through the Japan Finance Corporation, as well as reducing royalty fees which SMEs paid on the outcomes of specific research and development plans. METI also supported the upgrading of basic techniques in small-business manufacturing, such as casting, forging, and cutting.

8) Development of innovative technology for the semiconductor manufacturing process

METI conducts the research and development of fundamental technology used for "minimal fabrication," an innovative manufacturing process used for semiconductors. The technology is suitable for small-lot production because it attempts to achieve significant energy-savings by eliminating clean rooms, and because it requires less capital expenditure as it uses small-sized equipment.

(2) Creation of new industrial infrastructure by leveraging Japan's strengths

Against the backdrop of intensifying international competition in end-product markets, such as machinery, automobiles and electronics, the government promotes the establishment of comprehensive systems, such as next-generation transportation systems and smart grids aimed at the creation of a new, added value. To be successful, the government promotes the research and development of combined services, including even maintenance and operation through synchronization with field tests and international standardization. The government also promotes efforts in research and development for the efficient and practical use of S&T in order to increase productivity in the service industry. Furthermore, the government promotes research and development in information and communication technology in order to build a next-generation network and to realize a highly reliable cloud-computing system. Such efforts are aimed at improving the efficiency of the economic and social system as a whole, as well as at the creation of new industries, and the government promotes the practical use of them in a various areas.

MIC developed standards for intelligent transport systems for vehicle-to-vehicle and roadside-to-vehicle communications by using a 700 MHz radio band, aiming at the practical application

of a driving-safety support system. MIC also developed technical standards for 79 GHz radio band high-resolution radar in order to protect pedestrians while also conducting research and development on upgrading these technologies. In regard to smart grids, MIC conducts research and development on communication platform technology that remotely controls various appliances with high-accuracy and high-reliability in order to realize the optimal energy management of each region while promoting international standardization activities. Also, MIC promotes research and development/field tests on new generation network technology and new applications, aiming at 1) the cultivation of ICT capable personnel, 2) the revitalization of industries, 3) the improvement of international competitiveness, and 3) the enhancement of international collaboration through New Generation Network Testbed, Japan Gigabit Network-eXtreme (JGN-X) developed and operated by the National Institute of Information and Communications Technology.

METI promotes research and development aimed at improving the efficiency of the entire economic and social system. Aiming at the establishment of a smart community, METI has conducted the development of smart-grid related technologies by starting large-scaled field tests in four regions nationwide and by conducting field tests in eight different areas in order to solve the technical and systemic issues that occur nationwide by using the technology and ideas complementing those large-scale field tests (refer to Part 2 Chapter 2 Section 2, 1(1)).

Furthermore, METI conducts development projects that create new added value and industries by utilizing IT and data. Those projects include the development of a diagnostic support system that uses medical information and an efficient cultivation system that is supported by environmental and biological information.

Table 2-3-3/ Major measures to strengthen Japan's industrial competitiveness (FY 2012)

| Ministries and agencies | Conducting organization | Measures |
|---|---|---|
| Ministry of Internal Affairs and Communications (MIC) | MIC | Research and development to expand radio wave resources |
| | | Technical examination of measures against frequency stringency |
| | National Institute of Information and Communications Technology | Research and development of network-platform technology |
| METI | METI | The project to develop super light/high-strength, innovative, integrated material in order to realize a low carbon society (except those funded by NEDO); the development of international-leading safety evaluation technology used to ensure safety and security |
| | | Development of a world-leading noxious examination method required for the new regulation of chemical substances, such as oil refining materials |
| | | Development of innovative manufacturing process technology (minimal fabrication) |
| | | Practical application support program for venture companies |
| | | Project for the Strategic Promotion of Advanced Basic Technologies |
| | Institute of Advanced Industrial Science and Technology (AIST) | Material that is functional at the nano level, multi –functional materials |
| | | Measurement standards that support global business industries |
| | | Promotion of open innovation in the nano-electronics field |
| | | Technology to add more functionalities and higher value to devices |
| | | Enhancement of high-performance computing platforms |
| | New Energy and Industrial Technology Development Organization | Project to develop IT integrated systems |
| | | Innovation commercialization support project |
| | | Project for the development of laser processing technology for next generation materials |
| | | Project for international research and development/verification in the field of environmental studies and medicine |

## 3 Contribution to the Solution of Global Issues

### (1) Promotion of responses to global issues

Japan's S&T has achieved a high level of respect in the world due to the promotion of measures taken in the past. Measures for research and development are promoted, focusing on the response to various global-level issues, and in cooperation with universities, public research institutions, industrial sectors, other nations, and international organizations.

Regarding large-scale climate change in particular, Japan promotes global observation, prediction and influence evaluation. Japan also promotes the research and development of measures against large-scale natural disasters, in addition to the research and development of new resources, the survey and cyclical use of energy, and creation of alternative sources for the stable supply of resources and energy. Furthermore, Japan promotes research on the understanding of pathogens (i.e. disease-causing agents), and for the prevention, diagnosis, and treatment of emerging and reemerging infectious diseases.

#### 1) Research and development on climate change

##### (i) Promotion of earth observation

In order to understand global warming status, nations and organizations across the world use satellites to conduct various observations of the earth, land and sea. In order to improve worldwide efforts to solve climate change problems, it is important to 1) link the information gained through these observations by

means of international cooperation, 2) establish useful scientific knowledge as a basis of policy making in each nation through the consolidation and analysis of the information, and 3) establish an international system (Global Earth Observation System of Systems (GEOSS)) comprised of multiple systems that allow each nation and organization to easily access the observation data and scientific knowledge. An intergovernmental meeting Group on Earth Observations (GEO) was established as an international framework for the promotion and establishment of GEOSS. 157 nations and organizations participated, and Japan plays a leading role as one of the executive committee members of GEO.

a) Observation by satellites

Earth observation by satellites is an extremely effective observation method that allows for repeated and continuous information gathering over a broad range. Therefore, in order to solve global environmental problems, Japan comprehensively promotes such observation in cooperation with domestic and overseas related organizations.

The Greenhouse Gases Observing SATellite "IBUKI" (GOSAT) that was launched in January, 2009 has measured the concentration, distribution and changes of global greenhouse gasses and has performed global observations that are necessary to improve the estimation accuracy of the absorption and discharge of greenhouse gasses, all of which contribute to the further promotion of measures against global warming. IBUKI was highly successful in, for example, improving the understanding of global concentrations and distributions of carbon dioxide and methane and their seasonal deviations. In addition, in December 2012, it released estimated data about global carbon dioxide absorption/emission volumes on a monthly and regional (subcontinent) basis, as well as 3-D distribution data of carbon dioxide concentrations. The National Institute for Environmental Studies steadily operates the processing system of GOSAT (data process/provision and data verification). Furthermore, in FY 2012, the institute started to develop a successor satellite of "IBUKI" that is aimed at further improving observation accuracy.

The Global Change Observation Mission – Water Satellite "SHIZUKU" (GCOM-W) was launched in May 2012, in order to understand the global climate change and the hydrological cycle mechanism. "SHIZIKU" began observations in July and has provided data on sea ice to the Japanese Antarctic Research Expedition (JARE), "SHIRASE" and "UMITAKAMARU" so that JARE can utilize the data for navigation and observation planning. As such, "SHIZUKU" is expected to be utilized in various areas such as climate prediction and fisheries identification, not only in the area of climate change for research use.

The Japan Aerospace Exploration Agency (JAXA) has performed observations with the Advanced Land Observing Satellite "DAICHI" (ALOS) (the operation ended in May 2011) and conducts research on the reduction of greenhouse gas emissions resulting from the reduction/deterioration of forests in developing countries (Reducing Emissions from Deforestation and forest Degradation - plus (REDD+)). JAXA also processes and provides the data acquired from the Precipitation Radar (PR) loaded on the Tropical Rainfall Measuring Mission (TRMM) and the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) (the operation ended in October 2011) loaded on the Earth Observation Satellite (Aqua). Furthermore, in order to further contribute to improvements in climate-change prediction accuracy and the understanding of the hydrological cycle mechanism, JAXA promotes earth observations through its practical use of satellites; JAXA also uses Earth observation

satellites and sensors that can collect and provide various data from around the globe in regard to Earth's environment, including the effects of clouds, aerosols, and vegetation.

The Ministry of the Environment, in cooperation with related ministries, agencies and organizations, promotes observation on the global circulation of carbon in order to help better understand climate change and its impacts. In concrete terms, the ministry performs continuous observations by aircraft and other vessels. Also, using GOSAT, the ministry performs observations of forests, in addition to the development of observation techniques to observe the global effects of carbon dioxide and methane.

Greenhouse gases Observing SATellite "IBUKI" (GOSAT)
Courtesy of Japan Aerospace Exploration Agency (JAXA)

b) Observation with electromagnetic wave sensing

MIC conducts research and development using a harmonic radar system that consists of several stations working as a transceiver, receiver, or a combination transmitter receiving station and a transmitting station that can enable high-precision 3-D observations without additional frequency bands being used. Also, MIC and the National Institute of Information and Communication Technology drive the research and development of aircraft-loadable, synthetic-aperture radar (Pi-SAR2) that enables the understanding of land-surface situations in damaged areas whenever a disaster occurs, regardless of time or weather conditions. MIC also conducts analyses of scientific data on atmospheric composition as observed by the Superconducting, Submillimeter-Wave, Limb-Emission Sounder (SMILES[1]) that was loaded onto the exposed section of the Japanese Experiment Module (KIBO) of the International Space Station, which was jointly developed by JAXA, and which sequentially releases the results as each analysis finishes[2]. Furthermore, the ministry conducts research and development on electromagnetic environments and the use of radio waves in the geosphere and in space; it also comprehensively collects, manages, analyzes and distributes space and earth environmental observation data. The mystery also promotes the development of space environment informatics[3] technology in order to upgrade observation and sensing technologies and numeric calculation technology, and to process great amounts of data.

c) Ground observation and oceanographic observation

Since environmental changes such as global warming are significantly influenced by oceans, continuous surveys on oceans are necessary. The Japan Agency for Marine-Earth Science and Technology

1 It measures the amount of ozone by directing its antenna toward the atmosphere rim to receive sub-millimeter wave (Radio of frequency between 200 GHz through 3,000 GHs is called sub-millimeter wave. SMILES uses sub-millimeter waves ranging from 624 GHz through 650 GHz) which are radiated from a very small amount of molecules in the atmosphere. A high sensitivity low noise receiver with a super-conduction sensor is used.
2 http://smiles.nict.go.jp/pub/data/index-j.html
3 Technology used to process and extract information from great amounts and various data generated by simulations and observations on the space environment.

(JAMSTEC) promotes oceanographic observation on a global basis and conducts research on predictions and simulations based on the observed data, while also developing technology such as observation buoys. In FY 2012, JAMSTEC developed a profiling float for use in deep-ocean environments and started the world's first long-term observation of the Atlantic Ocean, in order to better understand how water at the bottom of the Atlantic influences environmental changes. MEXT and the Japan Meteorological Agency make efforts to maintain the Advanced Ocean Observing System (ARGO project), which constantly observes oceans around the world by means of international cooperation; these observations are used in order to monitor and understand the situation of world-wide oceans in real time. This project intends to build a system that constantly observes entire oceans by setting 3,600 units of observation equipment (ARGO float) into oceans all over the world.

The Japan Meteorological Agency collects and analyzes various observed data through various vessels, ARGO floats and satellites and releases information on Earth's environment, as well as conducting the observation and analysis of greenhouse gasses, the ozone layer, and ultraviolet rays in the atmosphere and ocean. (refer to 1(3) in Part 2 Chapter 2 Section 2)

(ii) Promotion of research that contributes to the adaptation to climate change

The Meteorological Research Institute of the Japan Meteorological Agency built a global-warming prediction model that can simulate the effects of aerosol on clouds, and the changes in ozone and carbon circulation. It also conducts near-future predictions of an approximately 10-year range in regard to climate changes and conducts long-term predictions based on an IPCC emission scenario. The institute has also developed a precision cloud, local-climate model that possesses enough resolution to simulate Japan's unique local phenomena; it can also perform global-warming and regional predictions in specific detail.

In order to understand the actual conditions of global warming and to take further administrative measures based on scientific knowledge, the Ministry of the Environment comprehensively promotes research on the elucidation of phenomena, future predictions, and on impact evaluations and measures by practical use of the fund for comprehensive environmental research promotion[1]. The following activities were conducted within the fund:

- "Comprehensive research on the development and prevalence of methods to plan, predict and evaluate medium-to-long term policy options aimed at an Asian 'lower-carbon society'" (FY 2009 to FY 2013). This research is conducted in order to establish a low-carbon society in the Asian region and in order to achieve the goal of keeping the global temperature increase within 2°C as compared to pre-industrialization levels, and to develop a road to realize the goal.
- "Comprehensive research on the impact evaluation/adaptive policy regarding global warming" (FY 2010 to FY 2014) This research is conducted in order to realize a safe and secure climate-change-adaptive society by predicting the detailed impacts of global warming in Japan and Asia, and by avoiding or mitigating adverse impacts with adaptation measures.
- "Comprehensive research on the establishment of risk management strategy against global climate

1 Competitive research fund that is policy oriented with the purpose of contributing to environmental preservation and to the establishment of a sustainable society by the promotion of surveys, comprehensive research and technology development while involving all available researchers in various fields, from both an interdisciplinary and an international perspective, and based on the consideration that environmental problems can cause a critical and important impact to the foundations of human survival.

changes" (FY 2012 to 2016) This research is conducted in order to understand the risks and the uncertainties of global warming for the world and Japan and to provide a risk-management strategy against climate changes for both the Japanese public and international society as a whole.

In order to steadily promote adaptation measures against climate changes, the ministry has coordinated knowledge on the impact of climate changes and the measures against these changes and has organized a basic attitude towards the promotion of those adaptation measures. In FY 2012, the ministry, in cooperation with MEXT and the Japan Meteorological Agency, has prepared and released a "Comprehensive Study on the Observation, Prediction and Impact Evaluation of Global Warming," which summarizes the latest scientific knowledge on the impacts of global warming. The ministry plans to hold a conference for experts who evaluate the impacts of global warming; the ministry also plans to conduct impact predictions and evaluations of global warming as they affect Japan. Based on the evaluation, the ministry intends to zero in on the areas and issues on which adaptation measures should be focused in the short, medium, and long terms, and to organize them as comprehensive and deliberate government approaches for FY 2014.

In order to establish the recycling of food production in response to climate change, the Ministry of Agriculture, Forestry and Fisheries (MAFF) promoted 1) the development of technology that can reduce emissions and improve the absorption of greenhouse gasses, 2) the development of a manufacturing technology system than can realize low investment, recycled agriculture, 3) the development of a system in order to support measures against the reduction and deterioration of forests in Asian tropical forests, and 4) the development of a stable production technology, and breeds of agricultural, forest and fishery products that are adapted to global warming.

The National Institute for Land and Infrastructure Management is considering the establishment of applied, basic technology, in order to select and perform the most optimally practical measures of the various types of river basins in order to reduce large-scale flood-disaster risks.

2) Research and development for stable supply of energy and resources

The National Institute for Land and Infrastructure Management (NILIM) is considering the establishment of applied, basic technology, in order to select and perform the most optimally practical measures of the various types of river basins in order to reduce large-scale flood-disaster risks (refer to 1(1) and (3) in Part 2 Chapter 2 Section 2, and 1(2) in Part 2 Chapter 3 Section 1).

3) Research on emerging and reemerging infectious diseases

MEXT and the Ministry of Health, Labour and Welfare promote research on the understanding of pathogens (i.e. disease-causing agents), and on the prevention, diagnosis, and treatment of emerging and reemerging infectious diseases (refer to Part 2 Chapter 2 Section 3, 1(1)).

Table 2-3-4/ Major measures for contributions to solve global issues (FY 2012)

| Ministries and agencies | Conducting organization | Measures |
|---|---|---|
| MIC | National Institute of Information and Communications Technology | Research and development of the platform technology of electromagnetic wave sensing |
| Ministry of Foreign Affairs | International Cooperation Agency | Scientific and Technical Cooperation for Addressing Global Issues |
| MEXT | Japan Aerospace Exploration Agency (JAXA) | Satellite observation and monitoring system |
| METI | National Institute of Advanced Industrial Science and Technology (AIST) | Evaluation of potential underground resources |
| | | Strengthening and promotion of international cooperation |
| | New Energy and Industrial Technology Development Organization | Advanced industry technology-creation project, advanced energy-saving industry-creation project, advanced non-fossil energy industry-creation project |
| MLIT | National Institute for Land and Infrastructure Management | Development of platform technology to support setting/selecting a set of measures against large-scale flood disaster caused by climate change |

## 4 Conservation of the Foundation of the Nation's Existence

In order to maintain Japan's international leading position and to realize safety in the lives of the Japanese public, it is necessary for the government to promote R&D on the foundation of the nation's existence and to continuously accumulate the fruits of its efforts over the long-term.

### (1) Strengthening national security and key technologies

The government promotes the R&D of 1) technologies to develop and use space transportation, satellites that can contribute to national security, and the realization of a safe life for the Japanese public through activities such as intelligence gathering and communication, 2) technologies on the early detection of earthquakes and tsunamis, and 3) the world's most advanced high-performance computing technologies created and developed in Japan.

Regarding the R&D of nuclear power, necessary efforts are made by considering the direction of discussions on the review of Japan's nuclear power policies as well as by focusing on the efforts of recovering from the nuclear power disaster like the one which occurred at the TEPCO Fukushima Daiichi NPS. At the same time, R&D is expected to contribute to the government's response in the case of any potential troubles or accidents that might occur with the extremely advanced and complicated technology systems that are used in cyber space and in ocean environments. R&D is also expected to contribute to the safety of people's daily lives.

#### 1) Space development and utilization as related to space transportation and satellites

Space transportation technology is the first step for space utilization since it is responsible for the launching of satellites. Therefore, in order to maintain Japan's independence in space activities, it is important for Japan to secure its own ability to transport necessary satellites to desired spots in space

whenever necessary. Space utilization is expected to contribute largely to the realization of an even richer life for the Japanese public by utilizing artificial satellites in the field of telecommunications, broadcasting, and weather. The "Basic Plan for Space Policy" (January 2013, Strategic Headquarters for Space Policy), states that the space transportation system and artificial satellites are the projects that the government should conduct in a planned and comprehensive way as a means of improving social infrastructure, in order to realize the promotion of space utilization and to secure independence in space activities.

(i) Space transportation system

Regarding Japan's space transportation technology, rockets No.21 and No.22 of Japan's flagship rocket fleet, the H-IIA, and rocket No. 3 of the H-IIB fleet, were launched successfully in FY 2012; this makes nineteen successful launches in a row. Furthermore, a success rate of 96% (24 out of 25 flights), means that these fleets have reached world-class levels, and that they have achieved the same high quality launch record as the world's other leading rocket fleets. Now, the development of solid-fueled rockets is being pursued, in order to meet future demands for small-sized satellites in a prompt and efficient manner.

Column 2-3

### Domestically-developed solid-propellant rockets (Epsilon)

The history of Japan's space development started in 1955 with the successful launching of a pencil rocket. In February 1970, a domestically-developed satellite was launched successfully by using a solid-propellant rocket, entirely developed domestically, and launched from a range in Japan. Japan was the fourth country that launched a domestically-developed satellite. Since then, the technology of solid-propellant rockets has progressed toward the launch of small scientific satellites rockets used for space science and earth observation, and toward the successful development of the M-V rocket series which has the ability to launch asteroid explorers. In regard to the launching of small satellites, independent launching and readiness are required and opportunities for their use are expected to increase further. Japan's original technology for solid-propellant rockets systems has grown and has been maintained even after the operation of the M-V series was discontinued,


Epsilon
Courtesy of Japan Aerospace Exploration Agency (JAXA)

The first launching of a new solid-propellant rocket, "Epsilon," is under development and is planned to debut in FY 2015. "Epsilon" is a new type of rocket which inherits and develops the system technology that was cultivated in the development of the M-V series; it is intended to reduce costs by sharing equipment and parts with H-II A/B rockets which have a world-class success rate.

(ii) Regarding telecommunication satellites systems, MIC and MEXT cooperate and conduct experiments with 1) the Engineering Test Satellite-VIII, KIKU No.8 (ETS-VIII), in order to develop and verify large-scale satellite bus technology, Large-scale Deployable Reflectors and mobile satellite communications technology, and 2) Wideband Inter-Networking engineering tests and the Demonstration Satellite, "KIZUNA" (WINDS), in order to develop and verify Gigabit-rate satellite Internet communication technology.

Regarding the positioning, navigation and timing (PNT) of satellite systems, MIC, MEXT, METI and MLIT cooperate and conduct field tests with the Quasi-Zenith Satellite-1, "MICHIBIKI," which is capable of precision positioning without being affected by mountains or tall buildings. The Cabinet Office of the Government of Japan started the development of the operational system in FY 2012.

Regarding satellite observation and monitoring systems, the Advanced Land Observing Satellite, "DAICHI" (ALOS), was operated to observe areas hit by large-scale natural disasters, such as the GEJE and to provide disaster-prevention related organizations with the observed images. "DAICHI" ended its operation in May 2011. However, the R&D of the Advanced Land Observing Satellite-2 (ALOS-2), whose radar performance is dramatically improved over that of "DAICHI," is in progress, and the ALOS-2 satellite is to be launched in FY 2013.

(iii) Efforts to promote the use of space

Although space plays a common role in the daily lives of the Japanese public in areas such as weather forecasting and communication/broadcasting, the use of space over a wider range is not necessarily sufficient in other areas. In response to this situation, in FY 2009, MEXT created entrustment-expenses fees for a commission on the promotion of space usage, in order to build a system to leverage a wide spectrum of knowledge from the industry, academia and government; this is aimed at expanding the range of space usage, such as in the development of potential markets and other applications using satellites. Furthermore, MEXT continues R&D that contributes to the promotion of space usage through the creation of markets related to the usage of space in various areas of industry, such as disaster prevention, agriculture, forestry, fisheries, medicine, and education.

METI promotes the R&D of high-performance, small-size satellites and small-size ground systems that can realize better functionality, lower costs and quicker delivery than bigger satellites, thus improving the infrastructure of Japan's space industry. METI also drives the development of 1) sensors that contribute to mineral exploration by using remote sensing technology via the practical use of satellites and 2) technology to apply data processing and analysis technology to satellite technology.

Column 2-4

## A mission to Deploy a Small Satellite from Japan Experiment Module "KIBO"

Since satellites are usually loaded onto rockets and transported into space, durability technologies against vibration during transportation have been major issues for universities and companies who intend to newly enter the space field. The Japan Aerospace Exploration Agency (JAXA) conducted a "mission to deploy a small satellite" for the first time in the world. As part of the mission, satellites are embarked as cargo on an unmanned cargo transfer spacecraft, the H-II Transfer Vehicle "KOUNOTORI," or on the other countries' cargo transfer spacecrafts in order to mitigate vibration of the satellites. Then, the satellites are launched from the International Space Station (ISS) into orbit. The technology demonstration was successful.

"KOUNOTORI 3" (HTV3) carried 5 ultra-small satellites, developed by universities in Japan (three satellites JAXA invited and two satellites supplied by National Aeronautic and Space Administration (NASA)), as well as food and supplies for astronauts staying at the ISS. It was launched from the Tanegashima Space Center on July 21, 2012, and successfully docked to the ISS on July 27, 2012. On October 4 and 5, 2012, Astronaut Hoshide operated the robotic arms of "KIBOU" and successfully deployed five ultra-small satellites into space from the ISS.

In January 2013, JAXA started to invite full-year applications for funding the ultra-small satellites deployed from "KIBOU" and based on the result of this technology demonstration. The mission to deploy satellites has established a new structure that allows Japanese private companies and universities to launch and operate ultra-small satellites much easier than before, and it also offers opportunities to launch ultra-small satellites. It is expected that the mission will contribute to the cultivation of human resources in the space field and that it will expand the use of space.

Astronaut Hoshide preparing for the deployment of ultra-small satellites
Courtesy of JAXA (left photo), JAXA/NASA (right photo)

Deployed ultra-small satellite
Courtesy of JAXA/NASA

2) Technology for the dense observation and monitoring of ocean areas where efforts for early detection of earthquakes and tsunamis are underway

MEXT has progressed in the development of technology used to build and operate a submarine-earthquake and tsunami monitoring network that focuses on the expected hypocentral regions of a possible Tonankai/Nankai earthquake and the hypocentral region of the 2011 Off the Pacific Coast of Tohoku Earthquake. MEXT also conducts improvements of the technology used for the early detection of earthquakes and tsunamis by utilizing the monitoring network. (Refer to 1(3) in Part 2 Chapter 2 Section 1, and 1(1) in Part 2 Chapter 2 Section 1).

3) Establishment of an Innovative High-performance Computing Infrastructure (HPCI)

Nowadays, in addition to theory and experimentation, simulation with a supercomputer is an indispensable third method that is used for the enhancement of scientific technology and competitiveness. Supercomputers can perform large-scale simulations at high speeds and can contribute to the alleviation of damages by earthquakes and tsunamis, and to the development of new drugs. MEXT establishes an innovated computing environment (HPCI: Hi-Performance Computing Infrastructure) that supports the various needs of its users by having its "K computer," a supercomputer with world-leading computing

performance, as the core of supercomputing so that Japan will continue to lead the world in various areas, such as S&T, academic research, industry, and medicine. MEXT also promotes the use of the supercomputer and urges strategically important organizations to conduct "R&D" in the strategic areas[1] and the "establishment of a system to promote S&T based on computation" with the aim of 1) creating innovative results, 2) creating capable personnel who can master high-performance computing environments, and 3) the formation of a leading-edge computing research and education center (Figure 2-3-5). Regarding the "K computer," the development of its system was completed in June 2012 and the service started at the end of September 2012. Efforts are steadily taken to increase the benefits generated by the "K computer." For example, the "Simulations of the gravitational evolution of two trillion dark matter particles from the early universe" were evaluated as the world-leading result and awarded the ACM Gordon Bell Prize[2]. The research using the "K computer" received the award two-years in a row. Other results from various areas are expected to result in the future; for example, the improvement of a new drug development process, the development of energy-saving, next-generation semiconductors, innovations in manufacturing, the alleviation of damages from earthquakes and tsunamis, and an improved understanding of original matter and space.

R&D to acquire the knowledge required for improvements of the HPCI system started in FY2012, and the promotion of the HPCI plan over the next 10 years has been surveyed and studied, in order to strategically promote R&D over the long-term, so that Japan can further its development of future computational S&T (refer to 5(2) in Part 2 Chapter 3 Section 1).



1 As a field where the maximum use of HPCI having K computer as a core can lead to innovative results and bring great breakthrough socially and academically, five fields are listed. Field 1: Prediction of life science, medical and drug development platform. Field 2: New material, energy creation. Field 3: Prediction of earth change contributing to disaster prevention/mitigation. Field 4: Next generation manufacturing. Field 5: Origin and structure of substance and space.

2 The ACM Gordon Bell Prize: Prizes awarded annually the best report in hardware and application development by the Association for Computing Machinery (ACM).