2 Toward Renewing Society's Trust in S&T

Japan was hit by an earthquake and tsunami of an unexpected magnitude and nuclear power plant, which was a fruit of Japan's knowledge and technology, was seriously damaged during the accident. This made us realize that our good and easy life with the use of S&T is always adjacent to risks. In order to overcome the issues raised by the GEJE and to build a robust and resilient society, we need to formulate a policy which enables us to respond to various risks produced by the development of S&T.

In this section, we will first outline the development of S&T and the accompanying risks and uncertainties. Then, we will explain that in recent times Japanese Government is required to make decisions on complex and highly sophisticated policy issues, related to these risks and uncertainties. We will then consider the scientific advice in policy making taking the systems of the US and UK as an example. On that basis, we will illustrate various approaches to gain the broad consensus of our society through sincere dialogue concerning S&T accompanied by risks, and will describe agenda to implement the approaches.

(1) The Development of S&T Accompanied by Risks

S&T have so far brought about material wealth to people's lives and promoted employment opportunities by creating new industries. It exerted great impact on progress of society. For example, the spread of internet, improvements of reproductive medicine, progress of S&T could drastically change the future society. The relationship between S&T and society has deepened. On the other hand, with the development of S&T, ethical and social problems brought along by S&T have been raised in various fields. (Table 1-2-21) These issues will be increase in the future with development of S&T.

Table 1-2-21 / Examples of Matters, where Risks and Uncertainties Related to S&T are Considered Problematic

・Aircraft, railway and automobile accidents ・Reliability of scientific evidence in courts (i.e. false accusations based on inaccurate DNA tests) ・Drug and vaccine side effects, complicated surgeries ・Impact of residual agricultural chemicals ・Safety of space technology development (i.e. rocket launches) ・Systemic risks accompanied with progress of IT (i.e. millennium computer crisis, paralysis of financial system, cyber terrorism)	・Risk from radiation exposure on humans ・Impact of genetically -modified crops on ecosystems and humans ・Impact of electro-magnetic waves ・Identifying cause of diseases by environmental contamination ・Effect of the use of fossil fuels to global warming ・Safety of nuclear power plants ・Prediction of earthquakes and volcanic eruptions

Source: Created by MEXT

The GEJE reminded us of the risks and uncertainties related to S&T. As was explained in details in Chapter 1, Section 2, item 2, the scientific advice has not been appropriately provided to the government and public from academic society. For example, on the effects of radioactive substance to public health, divergent recommendations were supplied by lot of scientists. As a result, this is considered to have led to undermined public confidence in academia. The general public was confused because the scientific community failed to sufficiently communicate among themselves, and also failed to announce to the public systematic view or minority opinion.

However, since S&T always have certain risks and uncertainties, it is not always possible to present a clear-cut answer. Moreover, the way to grasp and evaluate such risks and uncertainties is different depending on the expert. "Recommendations from Science Council of Japan (SCJ) – with Confident Steps toward Reconstruction" published in April 2012 by SCJ, Committee on Supporting Reconstruction after the Great East Japan Earthquake," as for agenda for study on the countermeasures against radioactivity, indicated that "the scope and definition of objective "scientific facts" being unclear and the appropriate scientific data collection methods not having been established increased confusion with information." Due to this, "sufficient discussions will need to take place in the future on exactly how information can be appropriately provided when many people are worried but the risk involved was yet to have been sufficiently scientifically verified at that point."

Moreover, when deciding on S&T policy issues accompanied by risks and uncertainties, it is required to judge thoroughly socio-economic perspectives in addition to scientific knowledge[1]. For example, comparative study on how to evaluate the effects and benefits, as well as potential risks of such policy decisions, in a situation when opinions by different experts vary. The recommendation by SCJ mentioned above states: "It was once again clarified after the accident that no scientific discussions or examinations had taken place on the evidence which should rationally be used to make political decisions when scientific causal relationships and facts cannot be clearly identified." And "The ideal political decision making process that takes human values into account in cost-benefit analysis with these important issues, for which effectively referable precedents have rarely been available throughout human history, needs to be discussed by SCJ across the fields of humanities and science".

Furthermore, in recent years, the policy issues the government is facing, have become more complicated and complex, and the demand for reflecting the scientific knowledge has grown strongly in policy making. Under such circumstances, the Government needs to make decision in various policy fields, not only as a response to earthquake and various risks, using scientific knowledge and expertise as one of the basis. In the future, new policy making process adopting scientific knowledge is considered to be more important to build a robust and resilient society for Japan. The most crucial point when the Government makes policy forming based on the scientific knowledge, is how to secure the reliability of the policy forming process, when a variety of issues as mentioned above need to be taken into consideration.

(2) The appropriate system for a new policy making

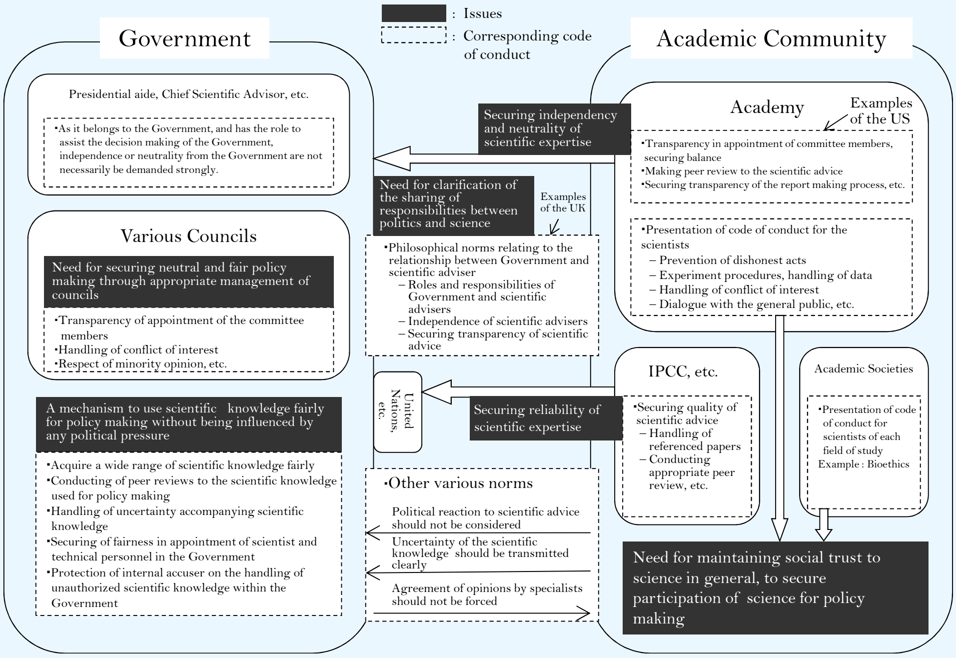
1) System of providing scientific advice to the Government

In various countries including the US and the UK, numerous studies have been conducted with respect

[1] On April 1, 2012, the new standard value of the radioactive substances contained in the foods was adopted under the Food Sanitation Act. To the above standard requested by the Minister of Health, Labour and Welfare to the Radiation Council of MEXT, the said Council submitted a report stating "allowable". At that time they added their opinion which became the basis for judgment. Concerning the ICRP's principle of "Optimization of Radioactivity Protection", they stated "the possibility of becoming exposed to radiation, number of people exposed and the amount of individual dose should be kept minimum so long as rationally attainable, taking into consideration the economic and social factors". This is one of the examples of discussions explained above.

to participation of science in policy formation, as the results of which the present systems have been constructed. (Figure1-2-22) In this section, we will introduce how the scientific advice is given to the Government and society in the US and the UK, how scientists, as experts, conduct their activities within and outside of the Government, and what kind of norms and mechanisms are in place corresponding to the position of the scientific advice. Based on them, we will consider what the "scientific advice" in the policy making process in Japan should be.

Figure 1-2-22 / Issues Relating to the Participation of Science to the Policy Formation and Corresponding Code of Conducts as Seen in the Examples of Various Countries



Source: Japan Science and Technology Agency Research Report "Codes of conduct for Ensuring the integrity of science in policy-makings" (May, 2011)

(i) Systems of scientific advice to the US government

In the United States, President's Science Adviser (PSA) who heads the Office of Science and Technology Policy (OSTP) gives advice concerning wide range of matters on S&T from the position nearest to the President. He/she also mediates between S&T community and the government, and has a big influence on determining the S&T budget. Response to the emergency in S&T is one of the PSA's duties. President's Science Adviser may also be given the position of Assistant to the President for Science and Technology (APST[1]) and normally acts as a co-chairman of President's Council of Advisers on Science and Technology (PCAST). PCAST composed of eminent persons from academy and industry in the United States gives advice to the President on important matters concerning STI policies. For example, in December 2010, the PCAST submitted a report for further strengthening of medical information systems to promote the efficiency and to improve quality of medical services. Reports on

[1] For example, John Holdren, Senior Adviser to President on Science and Technology Issues and Director of OSTP is also given the position of Assistant to the President for Science and Technology

education and advanced manufacturing fields were also submitted.

The National Academy of Science (NAS) which represents the scientific community also provides scientific advice to the government. As a non-government academic organization, its independence is secured. Presently, National Research Council (NRC), National Academy of Engineering (NAE) and Institute of Medicine (IOM) consist of the National Academies. While NAS is not a government organization, reports of scientific advice are financed by the government. At present, more than 6,000 experts give scientific advice free of charge in several hundreds of subjects every year. Its authority is widely recognized not only in the United States but also internationally and the NSA is now indispensable in formulation of policy by the U.S. government. Each Department or the Congress requests advice, and only the actual expenditure for research and survey is paid.

On the other hand, there are many private think tanks or NPOs and NGOs who give scientific advice in the United States, and their advising function is of great importance.

In the United States, various problems that could arise when the Government makes policy decisions using scientific knowledge have already been recognized in the Report of Congress House of Representatives Committee on Science "Unlocking Our Future" issued in 1998. In 2004, the Bulletin, which established government-wide guidance aimed at enhancing the practice of peer review of government science documents, was published by Office of Management and Budget (OMB). Moreover, code of conduct to provide scientific advice to the Government has been also established. Federal Advisory Committee Act enacted in 1972, stipulates on the management of various advisory committees. In particular, in the revision of the Act in1997, provisions concerning securing of independence and transparency of scientific advice by NAS were included. (Figure 1-2-23) In addition, NAS is disclosing detailed procedures for preparing reports to aim to secure integrity of scientific advice.

Table 1-2-23 / A Part of NAS-related Provisions in the Federal Advisory Committee Act (Partial excerpts)

(1) An agency may not use any advice or recommendation provided by the National Academy of Science or National Academy of Public Administration that was developed by use of a committee created by that academy under an arrangement with an agency, unless the committee was not subject to any actual management or control by an agency or an officer of the Federal Government.

(2) The requirements to appoint members of the committee are as follows:
1) The Academy shall determine and provide public notice of the names and brief biographies of individuals that the Academy appoints or intends to appoint to serve on the committee.
2) The Academy shall determine and provide a reasonable opportunity for the public to comment on such appointments before they are made or if the Academy determines such prior comment is not practicable, in the period immediately following the appointments.
3) The Academy shall make its best efforts to ensure that
(A) no individual appointed to serve on the committee has a conflict of interest that is relevant to the functions to be performed, unless such conflict is promptly and publicly disclosed and the Academy determines that the conflict is unavoidable,
(B) the committee membership is fairly balanced as determined by the Academy to be appropriate for the functions to be performed, and
(C) the final report of the Academy will be the results of Academy's independent judgment
4) The Academy shall require that individuals that the Academy appoints to serve on the committee inform the Academy of the individual's conflicts of interest.

Source: Japan Science and Technology Agency. Strategic Proposal "Towards the establishment of principles regarding the roles and responsibilities of Science and the Government in the policy making." (March 2012)

During the Bush Administration, handling of scientific knowledge was criticized by some members of the Congress and experts as inappropriate. Obama Administration, which started in January 2009, places much importance on scientific advice and efforts for ensuring the integrity of scientific advice have accelerated. President Obama recognized the importance of the roles performed by scientists in the policy decision process, appointed as Secretary of the Department of Energy (DOE) Nobel Laureate Steven Chu and as Director of National Oceanic and Atmospheric Administration (NOAA) Marine Ecologist, Jane Lubchenco.

In his memorandum on Restore scientific integrity in Government decision making: (March 2009), President Obama stated: "Political officials should not suppress or alter scientific or technological findings and conclusions. The public must be able to trust the science and scientific process informing public policy decisions. "If scientific and technological information is developed and used by the Federal Government, it should ordinarily be made available to the public." To the extent permitted by law, there should be transparency in the preparation, identification, and use of scientific and technological information in policymaking. President Obama pledged to ensure independence of the scientific advisors.

Accepting the intention of the President, John Holdren, APST and Director of OSTP issued on December 17, 2010 a notification on securing the integrity of science to each Department and government office based on the review mainly by OSTP. In this notice, US Department of the Interior and NOAA have already established code of conduct for securing scientific integrity. (Table 1-2-24)

Table 1-2-24 / Administrative Order by NOAA Administrator "Scientific Integrity" (December 7, 2011) (Partial excerpts)

Section 1. Purpose

1. To promote a continuing culture of scientific excellence and integrity, and to establish a policy on the integrity of scientific activities that the agency conducts and uses to inform management and policy decisions. In addition, the intent of the policy is to strengthen widespread confidence- from scientists, to decision-makers, to the general public- in the quality, validity, and reliability of NOAA science and to denote the agency's commitment to a culture of support for excellence of NOAA's principle science asset, its employees. (The following parts are omitted)

Section 4 NOAA Principles of Scientific Integrity

1. NOAA is an organization based upon science, scientific research, and providing and using scientific advice for decision-making. NOAA recognizes a clear distinction between the scientific process and the policy decisions made based on the results of science. (The following parts are omitted)

5. To be open and transparent about their work, and consistent with DAO 219-1 on (Public Communications) and their official duties, NOAA scientists may freely speak to the media and the public about scientific and technical matters based on their official work, including scientific and technical ideas, approaches, findings, and conclusions based on their official work. (The following parts are omitted)

6. NOAA scientists are free to present viewpoints, for example about policy or management matters that extend beyond their scientific findings to incorporate their expert or personal opinions, but in doing so they must make clear that they are presenting their individual opinions -not the views of the Department of Commerce or NOAA. (Omitted the following portion)

SECTION 6. Code Of Scientific Conduct

1. All NOAA employees and contractors, all NOAA financial assistance award recipients and other NOAA research partners and collaborators will, to the best of their ability, be:

a. Honest in all aspects of scientific effort and:
   - Clearly differentiating between facts, personal opinions, assumptions, hypotheses, and professional judgment in reporting the results of scientific activities and characterizing associated uncertainties in using those results for decision-making, and in representing those results to other scientists, decision-makers, and the public.

   (partially omitted)
   - Disclose any apparent, potential, or actual financial conflicts of interest or non-financial conflicts of interest of their own and others.

Source: Japan Science and Technology Agency. Strategic Proposal "Toward the establishment of principles regarding the roles and responsibilities of science and government in policy making." (March 2012)

Column 1-10

Scientific Advice in the United States ～Approaches by National Academy of Science

On November 26, 2011, at the Symposium jointly held by the Science Council of Japan and Japan Science and Technology Agency Center for Research and Development Strategy, Kevin Crowley, Senior Board Director of Nuclear and Radiation Studies Board, National Academy of Science gave a following speech on the roles of NAS concerning the scientific advice to the Government[1].

NAS is a non-government organization of scientists established in 1863 by the decision of the US Congress and the approval of President Abraham Lincoln. Its Act of Incorporation[2] stipulates that "the Academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art". Presently, they submit 200 – 300 study reports annually to the Government which cover wide-ranged topics.

Independence, neutrality and transparency are valued in scientific advice. The research process is controlled by the scientists themselves, and not affected by outside organizations such as the government. While it receives the actual cost required for study, it does not receive any remuneration. It is considered an honor and service to society to cooperate with NAS in its study. NAS keeps relations with both the Democrats and the Republicans.

When scientists intend to provide advice on policy issues, they should clearly distinguish between two types of issues: those to be handled by scientists, that "can be treated objectively based on scientific knowledge" and those to be dealt with by policy makers as "normative problems that cannot be judged by science." Suppose we have a policy issue such as "What should be the scale and place of evacuation area around Fukushima NPS?" This task can be divided into scientific issues, i.e. "how much radioactive emission there was (depending on the region) and what risk for human health there would be", and policy issues "how much health risk should be allowed when setting the evacuation area" If scientists are involved with the latter issue, it looks that a particular policy is going to be promoted, and as a result it could possibly damage the trust of the scientists themselves. This should be avoided by all means. To make such decisions is the role of policy makers, and in this case, various factors, such as culture, economy, general social trends, must be considered alongside the scientific advice.

Whenever scientific body utters "Unified Voice" on policy issues, it is followed by a certain significant confusion. What scientists should do first is to make sure that there is a consensus on the issues to be handled, but in much issues, consensus would not be achieved. What is important in such case, is to explain accurately the background for so many different viewpoints, where the difference exists, what knowledge is lacking, how it can be made up for, etc. Just knowing that there is no consensus, is an important factor in the scientific advice process. As long as the scientific research and its results are explained clearly with transparency, trust towards science is sure to grow.

(ii) Systems of scientific advice to the UK Government

In the UK, the Prime Minister appoints the Government Chief Scientific Adviser (GCSA), to provide the Government with advice on the important S&T issues. The GCSA role was established in 1964, and concurrently holds the position of Head of the Government Office for Science (commonly called GO-Science and is set up in the Department for Business Innovation and Skills (BIS)). GO-Science purpose is to support the GCSA in delivering his objective of ensuring that policy and decision making at all levels of government is based on sound scientific evidence and advice Furthermore, for almost every department and agency of the Government, a position called Chief Scientific Adviser (CSA) for policy or decision making based on scientific ground is set up. As a whole Government, depending on the contents of the issues handled, mutual communication and adjustment among Scientific Advisers with different fields of expertise are also being performed through the Chief Scientific Advisers Committee (CSAC).

GCSA and GO-Science are provided with a system for responding to emergency issues related to S&T.

1 The opinion expressed in his speech is Mr. Crowley's own view and does not represent the US National Academies or US Government.
2 An Act to Incorporate the National Academy of Sciences, 1863

On the occasion of an unexpected disaster, the Lead Government Department (LGD) and Government Chief Scientific Advisor will, together with Chief Scientific Advisor of each Department, including outside experts if necessary, organize Scientific Advisory Group on Emergency (SAGE) and preside over it. In case of an emergency of a certain level, when requested, this group is to provide the Cabinet Office Briefing Room (COBR) with information and advice. In addition, it is to explain to the general public, the scientific grounds for the Government's decision making. This system worked well at the time of outbreak of swine flu in 2009, and volcanic eruption in Iceland in 2010, when SAGE provided the Government with the scientific advice. At the time of the GEJE, apprehending the influence to the British citizens living in Japan caused by the accident of the nuclear power station, a series of processes was put in motion. They provided their expertise based on scientific grounds, on the issues concerning visiting and staying in Japan. Moreover, to secure transparency, the minutes of SAGE meetings were disclosed to the public in an appropriate manner.

The Royal Society (RS) was established as a scientific advising organization outside the government. Since its establishment in 1660, it has been active as an honorary organization for scientists, but in recent years, the importance of its scientific advising function has been recognized strongly. In 2010, 350 years after RS's establishment, Scientific Policy Center was set up for the purpose of strengthening such functions. The standards of conduct applied when the Royal Academy provides government organizations with scientific advice has not been made public, but Scientific Policy Centre , advocating for strengthening of "Voice of Independent Science" , indicated independence as the first of its strategic priorities. This demonstrates how crucial independence is to the Royal Society. The scale of budget of Royal Society is around 70 Million pounds a year, more than half of which is a grant from the Government. Its activities are supported by more than 100 of office staff members.

Apart from the system in the Government, the parliament also has an organization to rely upon for scientific advice. The Parliamentary Office of Science and Technology (POST) aims to provide "scientific and technological knowledge integral to public policy" on an all-party level. POST also publishes reports and other documents available to the general public and engages in activities raising the level of disclosure information.

Due to dissatisfaction to the Government's approach to Bovine Spongiform Encephalopathy (BSE) issue, the public became increasingly interested in the way the scientific advice is given to the Government. Problems resulting from scientific advice not having been handled accordingly were examined, which helped control the situation.

Column 1-11

Response to BSE issues in the UK

Response to BSE issues by the British Government cast a big doubt on the way scientific advice is provided, from the viewpoints of appropriate use of scientific advice within the government, rigorous distinction between scientific judgment and political judgment, and providing scientific knowledge to the general public. At the same time, the response by the British Government on this problem was also worth learning from the viewpoint of rebuilding trust between S&T and society.

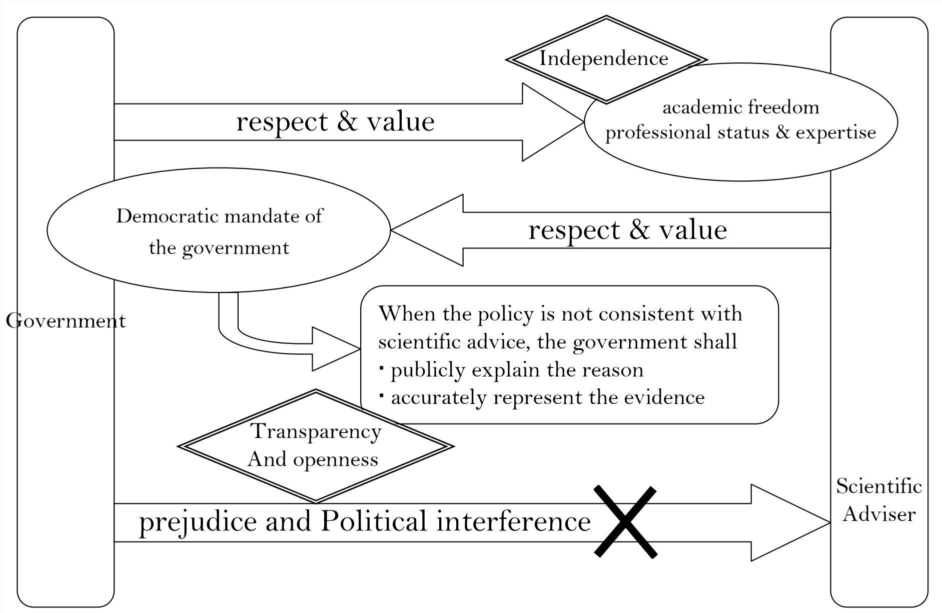
BSE is a bovine disease of the nervous system, where sponge-like change appears in the brain tissue. The brain cells are thus destroyed, and symptoms of astasia can be observed, followed by death. Kuru and Creutzfeldt-Jakob disease is known to have similar effects on the human brain. According to a report published in recent years, it is clear that these diseases are caused not by a bacterium or a virus, but by a mutation of a protein called "Prion." However, when infected cattle was first found in the UK in 1986, the cause of these disease and the possibility of infection from cattle to human were not known. The British Government, for the purpose of studying what impact BSE would have on health of humans and animals, established a panel of experts (Southwood Committee) in 1988. While the risk of infection to humans was uncertain, the report submitted by the Committee in 1989 stated as follows: "BSE does not seem to have the risk of infecting humans." Based on this, the British Government appealed to the general public the safety of beef. Even though the report had a reservation "If this estimate is wrong, the consequences may be very serious", this description was unnoticed, and the report used continuously as the ground for the message "Beef is safe."

However, in 1996, the British Government confirmed a variant type of Creutzfeldt-Jakob disease in a patient, and the public's trust to the government, scientists involved in the stock raising policy and meat industry was greatly shaken. The British Government then established an investigative committee in 1997 headed by Sir Philips, which after considering the scientific knowledge on BSE up to March 1996, checked appropriateness of the Government response during that period. In a report submitted in 2000 several recommendations were made, and with respect to decision making on the problem accompanying uncertain risks, and obtaining trusts of the citizens, it was pointed out that "Openness" and "Transparency" are of great importance. Based on this, in the United Kingdom, Ministry of Agriculture, Fishery and Foods was reorganized and "Department for Environment, Food and Rural Development" was newly established. It was also decided that the risk analysis would be performed jointly with Food Standard Agency[1]. Further, as described herein, with respect to handling of scientific knowledge within the government, a lot was achieved especially in the respect of establishing Standards of Conduct.

In 1997, Professor Robert May, then Government Chief Scientific Advisor (presently Lord May of Oxford) established "Use of scientific advice in the policy formulation", and indicated the guidelines for the government organizations receiving and using scientific advice. The said guidelines have been revised three times. The latest version "Guidelines on the use of science and engineering advice in policy making" enacted by BIS in March 2010, (Figure 1-2-25 and Table 1-2-26) secured independence of advisers and stressed that scientific advice is not necessarily infallible. The said principle had a significant effect on the revised version published in 2010.

[1] Provide advice on the safety of foods to the government and general public

Figure 1-2-25 / Conceptual Diagram of "Principles concerning scientific advice to the Government" by BIS



Source: Japan Science and Technology Agenc.y Strategic Proposal "Toward the Establishment of Principles Regarding the Roles and Responsibilities of Science and Government in Policy Making" (March 2012)

Table 1-2-26 / Main Points of "Principles of scientific advice to government" by BIS

- Government should respect and value the academic freedom, professional status and expertise of its independent scientific advisers.
- Government and its scientific advisers should not act to undermine mutual trust.
- Scientific advisers should be free from political interference with their work.
- Scientific advisers should respect the democratic mandate of the Government to take decisions based as a wide range of factors and recognise that science is only part of the evidence that Government must consider in developing policy.
- Government should publicly explain the reasons for policy decisions, particularly when the decision is not consistent with scientific advice and, in doing so, should accurately represent the evidence.

Source: Japan Science and Technology Agency. Research Report "Codes of conduct for Ensuring the Integrity of Science in Policy-Making" May 2011

In December 2007, GO-Science formulated again "Code of Practice for Scientific Advisory Committees" (CoPSAC) that stipulates management of Scientific Advisory Committees and its relation with the Government. (Table 1-2-27) This document is commonly applied to advisory committee of the Government and describes such issues as the procedures to secure balance of the Advisory Board Members, methods to avoid conflict of interests in each committee, responsibilities of the Chairman. Accordingly, it can be said that this document incorporates in a more concrete manner the principles of "Guideline relating to scientific analysis in the policy formulation" mentioned above. This document is also a revised version of a similar document issued in 2001. As indicated herein, attempts to secure integrity of science in formulation of policy have been continued through trial and error, and taking into account changes in the actual situation.

Table 1-2-27 / Principal Items of "Code of Practice for Scientific Advisory Committees" (November 2011) (Established by, Government Office for Science in the UK)

- Clarification of role and remit of Scientific Advisory Committee, balance of expertise, responsibilities of chairs, Independence and Objectivity, Maintenance of Expertise
- Rights and responsibilities of Committee Members, Handling of Remuneration and Necessary Expenses, Declaration of Conflict of Interest, Liabilities and indemnity
- Roles of Secretariat, Relationship with sponsor department(s)/ bodies, Relationship with Departmental Chief Scientific Advisor and Ministers, Relationship with chairs of other Scientific Advisory Committees, Roles of other officials
- Working practices, Early Identification of issues, Reporting of risk and uncertainty, Procedures arriving at conclusions. Dealing with dissenting views in committee, Communication with public, open meetings, Public consultation, peer review, Information exchange, dealing with confidential information, use of non-disclosure agreements, engaging the broader academic community, Handling disagreement with sponsoring body or ministers
- Communication and transparency, Publication of documents, meeting agendas, publication of minutes of meetings, Submitting and publishing a Committee's advice, Frequency of publication Contents of regular reports, stand-alone reports on specific issues, publication of background documentation, Working papers, Communication with the Media, dealing with national emergency

Source: Japan Science and Technology Agency. Strategic Proposal "Towards the establishment of Principles regarding the roles and responsibilities of science and Government in policy making" (March 2012)

Column 1-12

Introducing the approaches in the UK ～Approaches by Sir John Beddington and the UK Government

Source: British Embassy Tokyo

Faced with the Great East Japan Earthquake, it was necessary to obtain experts' advice on the risks of radiation exposure to British citizens living in Japan and the British Embassy in Tokyo, which Sir John Beddington, British Government Chief Scientific Advisor, was actively involved in. Sir Beddington summoned Scientific Advisory Group on Emergency composed of Chief Scientific Advisor of each ministry and agency and outside experts, and engaged in providing the government and the general public with appropriate advice, based on scientific grounds. On May 30, 2011, he gave a lecture in Tokyo, reflecting on a series of events and activities of scientific advice in the UK.

Sir Beddington, was asked by the Prime Minister "Will it be necessary for the UK Government to consider evacuating British citizens living in Japan?" He collected scientific knowledge and facts from within and outside of SAGE, and then drew out the "Reasonable Worst Case Scenario." "We checked the most serious forecasts, where with the increase of radiation, human intervention is no longer possible and all power generation units melt down. We also calculated, based on a different worst case scenario that the wind would continuously blow in the direction of Tokyo. However, we judged that such probability is rather low, and reached the conclusion that it is not necessary to evacuate British citizens from Tokyo, and this was transmitted to the Government."

The government needs advice based on scientific knowledge in many policy issues, such as climate change, volcanic eruptions, contagious diseases, anti-terrorist measures, financial crises, etc. In the UK the Government Chief Scientific Adviser plays such a role. This system was established immediately after the second world war. It is feasible not only with the Chief Scientific Adviser but also by collecting the power of Chief Scientific Advisers versed in various fields in each ministry and experts from outside the government.

Sir Beddington stressed that in order to secure confidence in the scientific advice, transparency and independence are indispensable, and indicated that faced with the Great East Japan Earthquake, not only did he provide advice to the Government, but also made his own information available directly through the internet, and had an opportunity to talk directly with British citizens living in Japan. The discussions and the conclusion at SAGE, were disclosed quickly in an appropriate manner, including the arguments concerning the risk of accident at the nuclear power plant. Further, he indicated that when the government makes a decision, not only the scientific advice but also economical, ethical and political factors are taken into consideration and that to provide unified scientific advice would be difficult in some cases. Quoting a known epigram "Only one thing is certain: nothing is certain," he stated that the knowledge of scientists should be utilized, leaving the room for criticism from others.

(iii) Direction of development of scientific advisory system in Japan

The approaches in the US and the UK introduced previously, are considered to be performed in order to keep a certain distance between scientists and the government, when providing scientific advice and securing confidence. As explained in Chapter 1 Section 2 2, considering the experience of the GEJE, particularly, the accident at TEPCO Fukushima NPS, it is important for Japan to also develop a system for obtaining appropriate scientific advice, trusted by the general public, not only under regular circumstances, but also in emergency situations.

Normally, not only the scientific knowledge, but also economic, social and cultural factors are taken into consideration in making the policy decisions. Therefore, in the US and the UK, scientific advice and policy decision are clearly distinguished while maintaining free communication of scientists with the general public. That is explained in "Principles of Scientific Advice to Government" of BIS which state that they "should respect the democratic mandate of the Government to take decisions based as a wide range of factors and recognize that science is only part of the evidence that Government must consider in developing policy." "Government should publicly explain the reasons for policy decisions, particularly when the decision is not consistent with scientific advice and, in doing so, should accurately represent the evidence." Even though policy making is based on various factors other than science, stressing only "science" as the ground for policy making, could be regarded as avoiding dialogue with public on different viewpoints between risks and benefits, or on how to grasp the uncertainty of S&T.

Looking at the efforts made in the US and the UK, it is considered necessary for the Japanese Government to build up its own ideas and rules concerning the importance of maintaining neutrality and independence of scientists and gaining society's trust, after clarifying the position of scientific advice.

As discussed in Chapter 1 Section2-2, SCJ, in its statement of the Executive Committee of Science Council of Japan issued on September 22, 2011 "Reconstruction from the Great East Japan Earthquake and Responsibility of Science Council of Japan" states "What was needed in the unprecedented disaster, was providing precise advice and suggestions to the Government based on scientific knowledge." "If an individual scientist expresses his expertise knowledge only separately, this may not be an appropriate advice that would fulfill its responsibility to the public or the Government" the statement appeals. In addition, the academic community "is requested to neutrally form an integrated wisdom, based on many expert opinions and that could serve as a base, on which provide advice and suggestions to society and the Government."

Particularly, with respect to the relation with the Government, the statement insists that "The Science Council of Japan should compile effective and appropriate advice and recommendation from the scientific community as one voice (including presentation of several options) as its obligation to the people of Japan." Further, the board states that "Under the principle of doing its own work independently, we are determined to study more deeply the ways and principles for formulating integrated knowledge from the scientific community, and try to build a relationship of mutual trust with the Government, and provide advice to the Government in order to solve matters troubling society." It also suggests that the government should reconsider positioning of the scientific advice.

Furthermore, the arrangement for reorganizing Council for Science and Technology Policy to "Science and Technology Innovation (STI) Strategy Headquarters" (tentative name) was discussed at the "Expert panel for the promotion of STI policies" held by the Minister of State for S&T Policy and its report was compiled on December 19, 2011. In this report, it is proposed to appoint "Science and Technology Innovation Advisor" (tentative name), who would offer Scientific Advises. The advisor is expected to "make timely and appropriate advice, from a position independent from the government," "supply unified information in emergency situations" and "secure the neutrality of scientific advice" because he or she is selected not from existing councils or independent administrative institution. In giving advice to the government, such advisor shall share the role with the minister, vice minister and parliamentary secretary in the Ministry, and also "take the role to let the public know well the administration's promotion of the STI, which the public is highly interested in." It is also presented that the advisor needs to play external roles concerning the Government's S&T policy. Furthermore, "From the viewpoint of recovering the public's trust of S&T policy, it is necessary to make rules, stipulating the relationship between the advice within the 'leader' and scientific advice of Science and Technology Innovation Advisor (tentative name) and the political decision-makers in reference to the British examples." It is also regarded as important to reconsider reliability of scientific advice, which was questioned in the disaster.

Meanwhile, in March 2012, Center for R&D Strategy, Japan Science and Technology Agency announced a proposal titled "Toward the establishment of principles regarding the roles and responsibilities of Science and Government in policy making." In this proposal, in light of the discussions concerning the installation of Science and Technology Innovation Advisor (tentative name) within the Government, it is stated: "Through realization of this proposal, we have to aim at securing effectiveness and soundness of policy formulation in Japan based on scientific knowledge."

In face of the disaster, the failure of the system for collecting the expert scientific and technical knowledge and responding to the situation, and the failure to respond to the situation promptly, had been shown in Japan. Reflecting this, while securing interdisciplinary collaboration linking various scientific fields including human and social science fields, strengthening of advising function of SCJ, and the structuring of the system which provides scientific advice to the government and local public organizations, and further to society, is an urgent issue for Japan to be reborn as a resilient country.

2) Facing the risks ~The necessity of various initiatives on risks~

(i) Risk communication

In the GEJE, we saw that policy judgment on risks caused by S&T relates directly to the health and lives of the public.

According to the proposal by the SCJ, of the Japan Prospective Committee, Safety and Risk Subcommittee, announced on April 5, 2010, prior to the earthquake, "Towards society that can respond to risks": Scientific research and technology development aiming to avoid or decrease risks is being carried out in many fields such as natural disasters, industrial products, agricultural products, medicine, social security and economy, and in any field, the risk analysis is introduced. The risk analysis consists of 3 factors including risk assessment, risk management and risk communication. Risk assessment evaluates literally the magnitude of the risks scientifically to provide information for making decision on the response to the risk. It is a general practice to multiply the safety coefficient[1] to such calculated tolerable

[1] When applying the data of animal experiments to human being, by avoiding the possibility of making underestimation of the risk and stand to safer side. By using this method, uncertainty is supplemented and the risk by uncertainty is further diminished.

amount to obtain the actual safety standard. Normally, the risk assessment is made on the basis of "evaluation on the safe side", thus this is often updated by new scientific knowledge[1]. The risk management system is established taking into account many complex factors such as technical possibilities of the management method, costs effectiveness, etc together with the result of risk assessment. On the other hand, risk communication is a method of reaching a consensus among the parties involved on the risks. It also includes supplying sufficient information to the citizens, and deepening their understanding of the problems.

Even before the GEJE, the Government was promoting the risk communication in various ways. Among them, we can cite "Direction of our present approach toward the improvement of information supply at the Food Safety Committee", published in September 2009 as an example of compiling the reflection and points for improvement of the risk communication activities, Since risk awareness of the sender and the recipient of the information may differ, it is of crucial importance to improve the information method supply and public information, as well as the process and results of deliberations conducted on these matters. Securing transparency of information and ways of responding during emergency are also important.

As explained herein, in the risk communication processes, it is considered indispensable to create a relationship based on trust between the sender and the recipient of information, by disclosing the results of risk assessment and the process reached to the risk assessment results, and the limit of the present risk assessment in an appropriate manner.

Furthermore, the role of the media is also of crucial importance. Various information on S&T accompanying risks and variety of opinions on them are expected to be presented in a fair and neutral style to the public, even more if the problem is controversial among experts.

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[1] In the case of food, for example, chemical substance which was considered carcinogenic could become non-carcinogenic or with the introduction of new knowledge, the substance tolerated by that time could be restricted.

Column 1-13

Activities of the Science Media Centre ~ Appropriately transmitting S&T information to the Media~

Since 2005, the National Institute of Science and Technology Policy has been selecting researchers who have made remarkable contributions to S&T, and awarding them with the title "Researchers with Nice Step". In 2011, Mikihito Tanaka, Associate Professor at Waseda University, Graduate Study, Political Science Research Course, General Incorporated Association—Science Media Centre (hereafter called "SMC"), SMC Research Manager, Miho Namba, Associate Professor of the above center (SMC Manager) , Motoko Kakubayashi , Research Assistant of the above center (SMC Media Officer and in charge of international affairs) were selected in the scientific communication sector. They were recognized for "the activities of the Science Media Centre as a hub to transmit S&T information to the media".

While conducting contract research from the Japan Science and Technology Agency and the Research Institute of Science and Technology for Society, the SMC was established in October 2010 as a General Incorporated Association with an objective to support people who talk about science. The center has been engaged in activities such as ① Quickly collecting expert comments on scientific news on controversial and supplying them to journalists ② Running training programs to help journalists and researchers understand one another, ③ Internet broadcasting of academic meetings and lectures to open them to wider communities. One of their important activities is releasing a Science Alert, expert comments on S&T the SMC collects for journalists. The aim is to transmit independent expert knowledge to journalists in a short time, and on controversial issues involving S&T. The SMC supplies them with information explaining the science and their social significance. The comments come from a variety of experts and researchers who understand the nature of the topic. The Science Alert provides the media with a sketch drawing for discussion on a particular subject, and for the researchers, it helps reduce the stress caused by reporters who talk to the wrong experts and write biased articles on the topic.

The SMC, also works collaboratively with other Science Media Centers in other countries such as the UK and Australia. In fact, the world's first Science Media Centre was set up in London, UK, following the major scandal where a scientific paper suggested that MMR[1] causes autism (contradicted by a study conducted in later years, and withdrawn from the magazine that originally published the article). After an investigation ordered by the British government, it was concluded an independent body needed to be established which could become a voice for researchers, the media, and ultimately the public. The SMC has already translated and introduced a report by the UK Science Media Centre, titled "Learn from 'MMR: Learning Lessons".

In regards to the Great East Japan Earthquake and the nuclear accident at TEPCO Fukushima NPS, the SMC tried to raise the quality of information flowing on the media by sending out accurate information on the effect of radiation in a more diversified manner. Information collected and papers contributed from researchers were immediately uploaded to the Internet. On top of this, they translated comments from experts overseas, and introduced Japanese experts to the international media, providing service to both the overseas and domestic media. As a result, the comments of the scientists who helped the SMC network were quoted in around 4,000 articles and programs around the world.

Considering the experience gained through this earthquake, it is not sufficient to only supply information on the risks and deepen the understanding on policies or standards. Further fostering of risk literacy[2] to consider with their own judgment accordingly to the situation is indispensable for each individual.

Attacked by the tsunami exceeding a tide embankment which was believed to be quite safe, the limit of the counter-risk measures by hardware was exposed. It is necessary to create a society, in which every individual judges the situation out of their own initiative, by implementing risk communication properly and accurately to improve its risk literacy.

1 Vaccines for Measles, Mumps and Rubella..
2 Ability to accurately comprehend information on risks, judge the situation act accordingly out of one's own initiative.

Column 1-14

"It is quite difficult to be afraid to the right degree" ~ From the words of Torahiko Terada ~

Torahiko Terada, physicist, essayist and haiku poet (1878〜1935) was well-versed in seismology. He left many aphorisms suggesting importance of preparedness against natural disasters. Some of them can serve as warnings applicable also to the issues raised by the recent earthquake.

> My long-cherished desire to see the eruption of Asama with my own eyes suddenly came true. According to what I heard from Minakami, Bachelor of Science at Asama Volcano Observatory, today's eruption was around the 10th in the grade of intensity among many small eruptions since the big one occurred on April 20th. Probably because of minor eruptions of such a scale, my feelings toward this phenomenon were rather simple and mechanical, not mysterious or astounding. I had an impression that this was a slightly bigger scale of the work made by people breaking rocks of the mountain with explosives.
>
> However, this is what I witnessed from a safe area 7 kilometers away from the crater. If I had been in a place close to the crater, it is certain I would have been killed within several minutes with the falling of burnt red-hot stones with diameter as big as 1 meter.
>
> When I was waiting at Kutsukake Station to return to Tokyo on the train leaving after 10 o'clock, the station attendant was listening to a student who seemed to have just come down from Asama, who was talking about the status at the time of explosion. When the eruption occurred, the student was already on the foot of Ko-Asama and there was nothing to worry about. At that time he saw a party of 4 people was ascending the mountain trail, without fearing the explosion. "Well, not to worry. They should be all right" when the student said confidently, the station staff suddenly said with an austere expression and shaking his head quietly from side to side "No, It is not all right, not all right—Well, thanks anyway." While saying this, he put his notebook, he was putting something down in.
>
> While it is easy to not be afraid of something or to be afraid excessively, it seems that it is quite difficult to be afraid to the right degree. I feel the same about ○○'s fear of ○○○○ and about △△'s fear of △△△△△[1]
>
> (From Torahiko Terada's essay "Two Small Eruptions" published in November 1935 on "Bungaku (Literature)")

In this essay, Torahiko Terada incidentally encountered with eruption of Asama at the safe zone 7 Km away from the crater. He described his own impressions and the student's reaction, who was confident that the party of 4 climbers, who had gone up without fearing the eruption, would be all right, comparing it to the attitude of the station employee. The station staff knew well the topology on the foot of Mt. Asama and its nature, and considered that securing passengers and being prepared for risks is his mission. His thoughtfulness is really the attitude that can be described as "to fear to the right degree." It is easy not to be afraid or to be afraid excessively, but it is fairly difficult to be afraid to the right degree.

The epigrams of Terada, even in the modern times in which S&T have been developed, the person who needs to prepare for risks as their mission of work, and every individual has to comprehend the possibilities and limitations of S&T and be afraid of these risks and uncertainties to the right degree. Terada suggests we should gain such wisdom.

(ii) Promotion of "Science for safety" and development of the method for "Evaluation of the social impact of advanced technology"~ Based on the advice of the Science Council of Japan

In order to address the risks and uncertainties of S&T revealed by the disaster, it is now necessary to strengthen the scientific approach toward the establishment of risk assessment and management. At the same time, the improvement of the risk communication, it is necessary to strengthen public participation in the process for formulating S&T policy concerning these risks.

Regarding risks and uncertainties of S&T, SCJ states "The progress of science and Technology has

[1] This portion is blank also in the original.

contributed to bring about convenient and comfortable life and industrial society. However, the industrial society also has provided new risks at the same time. Although hereafter, we create the society that is sensitive to the risk, our knowledge on risks and the methods to respond to such risks are not systematically organized." SCJ, in its proposal mentioned above "Toward society that can respond to the risks" (Table1-2-28) suggests;

a) Establishment and promotion of "Regulatory Science", and

b) Institutionalization of "Evaluation of the impact of advanced technologies on society"

Table 1-2-28 / Science Council of Japan "Toward Society that can Respond to Risks" (April 5, 2010) Excerpts from the Proposal Part

4 Proposal Toward society that can respond to risks

For the appropriate control of the risks, it is necessary to promote the following 2 points:

(1) Establishment and promotion of "Science for safety"

To build a society that can respond to risks, it is necessary to grasp the risks existing in the actual society comprehensively, and to assess the magnitude of such risks. It is also necessary to structure "Risk index" to assess the magnitude of such risks. However, for occurrence of some risks is difficult to predict and their causes and later developments are unknown. To such risks, while diminishing uncertainties using the best science available at the time, the countermeasures have to be established promptly. Furthermore, risk assessment, prior to evaluation of the effects of the measures and the budgetary and human costs required for their implementation, post evaluation of the policy are required. Development of scientific reasoning is required for communication introducing opinions of the parties involved and obtaining their understanding. "Regulatory Science (Science for risk management)": comprehensive support of these safety measures requires close collaboration between natural sciences and human and social sciences.

It is necessary to generalize the importance and need of such new science, and foster new researchers to study this field.

(2) Institutionalization of "Evaluation of the impact of advanced technologies on society"

As for the advanced technologies, difficult to conform to conventional R&D, innovation system and legal system, it is necessary to forecast, at an early stage of technical development, various social impacts in the future, and raise problems how technology and society should be, and to institutionalize evaluation of the impact of advanced technologies on society (technology assessment) to support decision making. This has already been practiced in the US and Europe. In Japan, while it is fragmentarily practiced, from the perspective of grasping the problems broadly and on considerations of diversity of uncertainty and value, it cannot be said we are fully responding to the demands of the parties, who will decide on the policy and trust of society. This system will contribute to the introduction and spreading of advanced technology to society from a long-term, strategic viewpoint, and is expected to take a supplementary role to the existing policy decision system. The Government should make steady support including establishment and activities of new special organizations corresponding Japan's political and social environment.

a) Science for Safety (Risk Management Science: Regulatory Science)

For some risks, it is difficult to forecast the arising and predict the causes or later development. While diminishing uncertainties by using available science at the time, it is necessary to establish countermeasures quickly to those risks. The development of the prior evaluation methods for the economical or personal cost of risk assessment and the risk countermeasures, post evaluation methods for the policy is necessary. In addition,, method to reflect the opinions of the parties involved in these processes, is also required. In that proposal, SCJ called the scientific field of safety estimation to support safety policy as "Regulatory Science (Risk Management Science)", particularly targeting the subject where safety is highly regarded such as foods, pharmaceuticals, environment, etc. and urged to strengthen such efforts. This can be said to include the research field on how to bridge the gap between scientific knowledge and governmental regulatory measures (regulatory research), and the efforts to seek international harmonization of regulatory measures for securing safety (regulatory affairs). It can be said that regulatory science is a procedure to adjust the fruits of S&T to meet the benefit of the people, because the drawing up of safety rule is indispensable for the implementation of new scientific technology. Otherwise it will not be accepted by society. In view of such significance, in the 4th Basic Plan, it is stipulated "The government will improve the regulatory science so as to formulate examination guidelines and criteria based on grounds concerning scientific reasonableness and social validity."

b) Evaluation of the social impact of advanced technology (Technology Assessment)

In the 4th Basic Plan, it is stipulated "The government will consider the way technology assessment should be, (omitted) and promote efforts to ensure broad consensus-building based on technology assessments, etc. in making decisions on policies, etc."

The proposal above by Science Academy of Japan, also points out the necessity of institutionalizing Technology Assessment for advanced technologies, at an early stage of its technical development forecasting various social impacts in the future. It is also required to support the raising of issues and decision making, and how the technology and society should be.

This will contribute to introduction and spread of advanced technology in society from a long term strategic point of view. This will also play a supplementary role for the existing policy decision process. For example, the participatory technology assessment, what can be observed widely in the US and Europe as one of the measures to raise the fairness of decision making, is expected to increase opportunities for public participation in the discussion on S&T, and at the same time, to make it possible for experts to listen to the requests from society. It would contribute to the shift of the policy making process with one way explanations to the new process bidirectional dialogue with detailed discussion,, through consensus in a convincing way.

At the present moment, the technology assessment has been conducted only on an experimental level in few cases in Japan. However, to promote society's participation in S&T policy formulation, concrete approaches toward its introduction are necessary.

Column 1-15

Promotion of mutual understanding on the risks
~ Trial of Deliberative Polling looking for the citizens participation to S&T ~

Deliberative Polling® was devised by Professor James S Fishkin of Stanford University in 1988 as a method for discussion making use of citizens' deliberations. In this type of opinion polling, citizens randomly selected from the general public, receive a material for discussion and sufficient information from the experts, and take an opinion survey before and after the discussion. In the "Deliberative Polling on the BSE issues" held in November 2011 by Executive Committee for Deliberative Polling on BSE issues and Communication in Science and Technology Education and Research Program (CoSTEP) of Institute for the Advancement of Higher Education in Hokkaido University, out of 3,000 citizens randomly selected from the city of Sapporo, 151 persons participated in the event and replied to questionnaire three times. This event was not intended to get the poll results, but it aimed to look at the significance of "Citizen's participation in S&T," as society needs to be familiar with S&T and their risks. This showed the possibility of using "Deliberative Polling" in Japan, too. While the Japanese Government declared in 2005 that the BSE infection to the cattle ended, and total inspection would not be required any more, many of the local governments in Japan were still conducting total inspections of cattle, at their own judgment and spending their own money and human resources. This project was held to discuss whether the total inspection of BSE infection was required or not. Opinion survey was made three times; 1) prior to the supply of information and discussion, 2) after a small brochure of only 24 pages with easily understandable illustrations was supplied and 3) after the supply of materials, discussion by the participants and experts was conducted. From the results of the survey, it can be noticed that the answers changed. For example, the number of those who answered that total inspection is required decreased after the discussion. This kind of approach is taken in many countries with regards to S&T, and for the discussion of choosing future energy sources, this system has been applied in Vermont, Nebraska and Texas in the United States.

(iii) Overcoming further issues raised after the disaster

There are many challenges in how to convey risks in risk communication. Because the recipient of the information judges the obtained information based on their situation, and the recognition of the risk is different depending on the recipient. Therefore, risk communication based on the background or situation of the public, is necessary. Because there is a difference between scientific risk assessment and emotional awareness to the risk, some recipients would consider "peace of mind," others take it as "uneasy" to the estimation based on the scientific viewpoint. Thus, factor analysis of the psychology of anxiety or analysis of its forming mechanism is important from the aspect of human and social sciences such as social psychology. Based on this, it is necessary to improve the quality of risk communication.

For example, in selecting the appropriate risk management measures, cost-benefit analysis and social science data necessary for risk assessment such as distribution channel of foods or frequency of eating, are indispensable in regulatory science. In technology assessment, forecast of impact on society, manner of formulation of policy, adjustment with democratic processes with city councils etc., is also required. In many points, collaboration with researchers of human and social sciences is necessary.

Moreover, through the experience gained in the in recent earthquake, it became apparent that much needs to be done with respect to communication in emergency situations (crisis communication). In the further, Japan needs to be well prepared to perform prompt and effective measures to minimize damages in case of another natural disaster of a great scale. This crisis communication is made with the purpose to minimize damages. In this respect, it is important to establish in advance the roles of experts, administration, journalists and the disaster information network between residents to make judgment quickly based on an accurate grasp of the situation. It is advisable to consider emergency rules in advance, including their social and ethical aspects, in order to avoid a greater crisis arising during emergency situations. For example, "Tsunami Tendenko[1]" or "Triage[2]," which do not work under normal circumstances, may be applicable only in an emergency situation.

Since the first Basic Plan started in 1996, S&T communication and its approach have been strengthened consistently in Japan. A lot of events such as "science café" were held in various areas. This can be said to have played a certain role for improving people's literacy for S&T. Many people look forward to S&T as the moving force to carve out the future. Thus, it is important to strengthen further approaches, where children, who shoulder the next generation, would entrust their dreams and hopes. On the other hand, S&T communication up till now, was principally based on supplying information on the "Bright side" of S&T, and sincere approach to the "darker" aspect has not been sufficient. Concerning the "darker" aspect, namely the risks and uncertainties of S&T, it is required to strengthen various approaches as mentioned above.

Strengthening these approaches will be necessary efforts to overcome various dangers and

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1 An expression handed down in Tohoku Region meaning only at the time of Tsunami, even parents and children escape as fast as possible without caring for others. This expression reflects the hope of people to avoid by all means perishing of the entire family or falling together by Tsunami. The lesson to be learned is that each and every individual needs to look after themselves. If everyone behaves following this lesson, it will eventually lead to increase the survivors in the region or communities.

2 A system to decide the priority of treatment, based on the level of emergency or seriousness of the injured to treat the maximum number of people with the best treatment under the situation of limited human and material resources. Under regular circumstances, the priority is given to patient with highest emergency level, and in the event of accidents, the medical resources will be put to the injured with the highest possibility of survival

vulnerability of society, and for building up a robust and resilient nation, and continue to enjoy sustainable prosperity.

Column 1-16

History of Science and Technology Policies Traced in White Papers on Science and Technology – The releases reached the 50th volume–

This year's White Paper on Science and Technology marks the 50th volume since the first white paper was published in 1958. This column retrospectively overviews the contents of former white papers on S&T (hereinafter referred to as "white papers") along with development of Japan's economy and society.

From the late 1950s through the 1960s: From technology import to independent technological development

Following the rapid economic growth era beginning in the late 1950s, Japan's economy made a giant leap in the 1960s, entering the open economic structure. Under the influence of high-speed economic-growth policies, such as an income-doubling plan introduced in 1960, the nation's gross national product (GNP) nearly tripled, surpassed European countries, became the second largest economy in the world after the U.S.A., and the per-capita national income approached the level of European countries.

As for the export structure, textile, a major item in the 1950s, rapidly decreased and was replaced by heavy goods such as machinery, metal, and chemical products, which contributed to strengthening Japan's international competitiveness.

(White papers published in those days)

Against the abovementioned historical background, the white papers mainly took up topics such as "Catch-up to the Western level in S&T," "Departure from technology import," and "Promoting Development of Japan Technology."

Both the first 1958 white paper titled, "Departure from dependence on foreign technologies to independent technological development" and the 1969 white paper titled, "Promotion of independent technological development", stated the importance of self-sustaining development without depending on imported foreign technologies. Based on the problem awareness such as "While we depended on the imported technology, we have been remiss in creating our own original technology, and not exerting fully to develop our technology by ourselves," these white papers emphasized the necessity of efforts for developing our own technologies commensurate with Japan's situation, in order to promote export by considering the difficulty of importing high-technology in the intensifying fully-globalized competition; and the improvement of nations' health and in order to solve pressing issues such as welfare by enhancing sanitization, earthquake-resistance and fire-resistance of buildings, escalating urbanization, traffic jams, air and water pollutions, etc.

The first White Paper on Science and Technology (1958)

Horizontal launching experiment at Kokubunji

Dr. Hideo Itokawa and a pencil rocket

Experiment at rocket launch complex in Akita

Pencil rocket research (1955)
Material: The 2005 White Paper on Science and Technology
The article can be seen in Column in p.44

The 1970s: High-economic-growth era and its end – Occurrence of environmental pollution and oil shock -

The 1970s was the era when the framework of world economy was drastically swayed and Japan was also affected profoundly by it, wherein social problems hidden behind the economic growth emerged.

The Bretton Woods system having supported the postwar economy collapsed, following the August-1971 statement by U.S. President Richard Nixon, resulting in the abolishment of fixed exchange rate system. And the two oil shocks beginning in 1973 and 1978 impacted our nation's inexpensive oil prices and stable oil supply systems.

In Japan, pollution-related laws and regulations, such as the Basic Law for Environmental Pollution Control (Act No.132 in 1967) and Water Quality Pollution Control Act (Act No.138 in 1970) were enacted, and the Environmental Agency was established in July 1971, thus, Japan took measures against deepening pollution problems caused by economic expansion and congestion by the labor force migration beginning in the 1960s.

(White papers published in those days)

The main theme of white papers in those days was to promote S&T in order to solve emerging social problems, such as pollution and energy issues, after the high-economic growth era.

The 1972 white paper titled, "New Demands and the Response to Them," evaluated the negative fallout of technologies, based upon the movement of research on pollution prevention measures. When any adverse impacts were found, the white paper clarified the situation toward the implementation of R&D on the issues from the viewpoints not only of economy but also of coordination between the social environment and humans. One of the approaches, technology assessment[1], which was not yet established as a system in those days, was taken up and recommended to be solidified as a norm through 1) cooperation among various sectors, and 2) objective evaluations by a group of fair and neutral specialists.

The 1975 white paper titled, "Effort for a New Need Arising with the Stabilized Growth," required the promotion of S&T contributing to the improvement of people's living quality, such as physical health, ecological preservation, and stable supply of energy and resources, based on the recognition that "important issues are to promote ecological preservation, to secure people's healthy and safe living, and to secure stable energy supply supporting social and economic activities, while to move away from mass-production and mass-consumption wasting inexpensive and voluminous resources."

National Institute of Environmental Pollution Research (Now called the National Institute for Environmental Studies) was established in 1974
Source: The National Institute for Environmental Studies

Tsukuba Science City
Source: The 1992 white paper on science and technology

1 The 1971 White Paper on Science and Technology mentioned that "The primary of objective of technology assessment is to identify overall impacts of science and technology, assess merits and demerits of alternative programs and make the results of assessment available to the decision maker."

The 1980s: The era of trade and economic frictions – International contributions through science and technology -

Despite the influence of the second oil crisis in the early 1980s, thanks to the dollar appreciation against the yen, Japan's export competitiveness remarkably increased. Since Japan's manufacturing industry already had a strong competitive edge mainly in the high-tech sector, this cost and technological competitiveness rapidly boosted Japan's export volume, and at the same time raised Japan's economic status in the world, produced a large trade surplus, and caused trade and economic frictions with the world's industrialized countries.

Although the 1985 Plaza Accord brought out the yen appreciation and led to a high-yen recession, this slowdown ended shortly, after introduction of aggressive fiscal policies, such as the official discount rate and the public investment expansion. From around the end of 1986, an economic expansion centered domestic consumption started, and during that time, asset prices, such as stocks and land, skyrocketed and rushed into the bubble economy.

(White papers in those days)

The themes of white papers in those days were stated in line with the S&T policies encouraging the promotion of creative R&D through basic research and international cooperation, against the background of Japan's economically heightened status and its top level in various fields of S&T in the world.

Especially 1981 was the year when the Exploratory Research for Advanced Technology (ERATO) Program, an epochal research system in those days, was established by recruiting cross-organizational researchers centered the project director, by aiming at the promotion of innovative S&T which would have a large ripple-effect and in which Japan was behind; also the Special Coordination Funds for Promoting Science and Technology were earmarked in order to proceed with a comprehensive and promoting adjustment of the critical research projects including advanced and basic research according to policy of the Council for Science and Technology. Therefore, by understanding the necessity of creative and self-sustaining technological development, the 1982 white paper titled, "In Pursuit of Creativity in Science and Technology," stated the necessity of exploring and nurturing the seeds of innovative technologies based on the accumulated achievements in basic research, and of promoting R&D in the leading and fundamental fields of S&T.

Also, in the 1988 white paper titled, "Toward the Internationalization of Japan's Science and Technology", stated that it is important for Japan, as one of the industrialized nations, to make international contribution through S&T, by means of active international exchanges and promotion of international collaborative research so as to achieve qualitative fulfillment of research activity.

The international Exposition, Tsukuba, Japan (1985)
Donor: Tsukuba EXPO'85 Memorial Foundation

Shinkai 6500
(Delivered in 1989 and completed in 1990)
Material: The 1993 White Paper on Science and Technology

The 1990s: The end of the Cold War – In the advancing globalization

While the Eastern European countries moved to the market economy regime following the end of the Cold War in the end of the 1980s and the Soviet Union's dismantling in 1991, "globalization" went on and the free-trade bloc expanded.

Japan's economy encountered a great turning point in the 1990s following the so-called "bubble economy burst". The growth rate drastically declined both in real and nominal terms, entering the long-lasting economic stagnation.

In the demographic structure, the total fertility rate fell below 1.5in 1993 and the ratio of population over 65 years of age exceeded 15% in 1996, while the falling birthrate and the aging population rapidly increased. In November 1993, the Environment Basic Law was established by aiming at building a sustainably-developing society with fewer burdens on the ecology, in the midst of growing concern about environmental issues in the world, such as depletion of the ozone layer, global warming, acid rains, desertification, etc. over the late 1980s to the 1990s.

(White papers in those days)

In those days, the weak economy plagued people after the bubble economy burst; globalization and telecommunications revolution accelerated; the falling birthrate and the aging population increased; and global warming sped up. Japan showed the willingness to confront national and social issues as a frontrunner, promoted new policies, based on the basic framework represented by the enactment of the Science and Technology Basic Law and the layout of the Science and Technology Basic Plan. . Thereby the white papers also pursued such themes.

The 1999 white paper titled, "New Development of Science and Technology Policies – In Response to National and Social Needs", overviewed various issues faced by Japan, such as industrial revival and maintenance of competitiveness; construction of vital society in the continuing falling birthrate and the aging population; solution of global-scale issues; promotion of good health; assurance for safety, etc. Additionally, the white paper confirmed the expected role of S&T in light of the progress of the Science and Technology Basic Plan, and, based on the issues revealed from it, discussed the easy-to-follow goal-setting for S&T to meet the national and social demands; the necessity of the promotion of basic research; and how to promote S&T policies in the future.

The 1993 white paper titled "The Relationship between Young People and Science and Technology" analyzed the tendency and background of social phenomena in Japan, such as a prevalent satisfaction with material affluence; a mood shift to prioritizing materialism; and shying-away of young people (a source of scientific and technological potential) from S&T in the days of the falling birthrate and the aging population, for which the white paper emphasized that shying-away of young people from S&T should be addressed proactively on a long-term basis before the impact becomes serious.

Enactment of the Science and Technology Basic Law (1995)

H-II rocket launch (1995)
Material: The 1994 White Paper on Science and Technology

Institute for Cosmic Ray Research, University of Tokyo

Super-Kamiokande
Material: The 1999 White Paper on Science and Technology

From the 2000s through the early 2010s: Toward science and technology for innovation

Although the economic stagnation following the bubble burst continued even in the 21st century, Japan's economy entered an expansion course from 2002 as a result of the financial institutions' bad-debt disposal using public funds, the monetary easing measures for zero interest, the economic recovery in the U.S., and the growing export in the developing countries including China. However, though the economic growth rate slightly improved in the early 2000, the commodity prices and salaries expressed in the consumer price index and the cash wages remained stagnant. Triggered by Lehman's fall beginning with the subprime loan crisis in the U.S., the world entered an economic recession, and Japan's economy also rapidly worsened from 2008. Thus, the periods of the 2000s and the 1990s are often called "the lost two decades." During this period Japan experienced increased unemployment, exodus to abroad of manufacturers faced by globalization, escalated social burden due to the falling birthrate and the aging population, etc.

Although the world was anticipated to have stabilized after the end of the Cold War in 1989, the simultaneous terrorist attacks in the U.S. in September 11, 2001, and the break-out of the Bird Flu, SARS, etc. in some countries and regions occurred, the impacts of which loomed over the rest of the world, threatening people with the possibility of rapid spread.

(White papers in those days)

The white papers in the 2000s stated the necessity of both the innovation creation by taking advantage of S&T and the prioritized and effective distribution of the investments on S&T, by considering Japan's situation still troubled with a chronic low-economic growth in the new era of the 21st century.

The 2005 white paper titled "Japan Ten years after the Enactment of the Science and Technology Basic Law and its future" analyzed and introduced Japan's scientific and technological ability and level in the world, the past achievements, and the future potential from broad and various angles, by referring to the significance of the past accomplishments.

The 2008 white paper titled, "Towards Japan's Own Innovative Science and Technology across the Threshold of Global Transition," regarded those days as "an era of mega-competition" becoming ever more fierce, and pointed out that it was essential to create innovations, especially through S&T, in order to respond to our weakening global competitiveness and shrinking economic dominance anticipated due to the falling birthrate and the aging population since the period of the so-called "lost decade", and summarized appropriate S&T policies needed to overcome this turning point by innovation.

The 2004 white paper titled, "Science and Technology and Society in the future," focused on the relation between S&T versus society, and analyzed the methods of appropriate communications between them, by recognizing the close and their inseparable relation and the growing expectations and concerns about S&T associated with new social problems, such as earth's environmental issues and bioethical issues, etc., that surfaced along with the expanding spheres of human activity and aggressiveness through the development of S&T.

Establishment of General Council for Science and Technology Policy (2001)
Material: The 2001 White Paper on Science and Technology
*Photo shows the plenary session of General Council for Science and Technology Policy in May 2001

Human Genome Plan for complete reading (2003)
Material: The 2004 White Paper on Science and Technology

Earth Simulator
(The operation started in 2002)
Material: The 2004 White Paper on Science and Technology

Looking back at 50 volumes

Reflecting on Japan's S&T policies described in the white papers over 50 years, we can see that the history of S&T is divided mainly into two eras: one is the late 1950s through the 1980s, when Japan aimed at "catching up with the West" and transformed itself from a technology importing country to a technologically independent country, and thus acquired the competitiveness comparable to the West in S&T.; The other era is the 1990s and onward when Japan has been required to respond to global-scaled issues through S&T as a "frontrunner" in the globalization after the end of the Cold War.

As seen above, Japan's S&T policies have been converted from the "catch-up type" to the "frontrunner type" in the context of its economic and social situations and its position in the world. However, several issues to be solved remain, such as the economic recession after the bubble burst, the worsening job climate, and the heavy burden due to the falling birthrate and the aging population. As described in the first part of this white paper, the Great East Japan Earthquake, which occurred when social and economic issues still accumulated, posed a major challenge to our S&T policies. Especially, this disaster revealed that the past R&D had not responded properly to the reality of social issues and that sufficient consideration had not been given to risks and uncertainty involved in S&T. In the future, important challenges would be to reconstruct the relation between S&T versus society and to promote innovations enabling R&D to link closely to the solution of social issues.

In the aftermath of the disaster (the 2010s and onward), Japan will be required to actively promote such scientific and technological innovation policies as to overcome the issues raised by the disaster, and, as a "true frontrunner," to contribute through S&T to resolving various issues faced by human society.

The full-texts of 50 volumes of the white papers on science and technology have been made public on the website of MEXT.

(http://www.mext.go.jp/b_menu/hakusho/html/kagaku.htm, Japanese only)

(http://www.mext.go.jp/b_menu/hakusho/html/kagaku_e.htm, English since 1998)