“Integrated Water Resource Management addressing climate change and other risks”

(Interim report)

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Study Group on “Integrated Water Resource Management addressing climate change and other risks”

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Introduction

Today, Japan's national water demand remains unchanged or is slightly decreasing. The divergence between water demand and supply has narrowed as water resource development facilities have improved, and Japan's water supply now largely meets demand.

But Japan's approach to solving other water issues such as effective use of water resources, demand for safe, tasty water, consideration of a rich environment, and a decline in the water supply function at times of disaster is not sufficient. Japan must properly deal with these issues, which the public is realizing.

In addition, recent climate change has caused changes in rainfall patterns and increasing precipitation fluctuations. The fourth assessment report (2007) of the Intergovernmental Panel on Climate Change (IPCC) clarified that global warming is taking place at an accelerated pace. The effect of climate change appears mostly through "water," and climate change is forecast to exert a stronger influence on water resources in the future.

Japan must secure stable, good-quality water resources in any future social circumstances by solving potential issues and eliminating new risks associated with climate change. To do so, we should move from conventional water management, which stresses quantitative water supply by developing water resources, to integrated water resource management, which includes effective use of water resources, comprehensive control of water quality and quantity, and risk management.

For this purpose, a study group on "Integrated Water Resource Management addressing climate change and other risks" consisting of specialists and experts was established in July 2007. By March 2008, this group had held five meetings filled with animated discussions. This interim report was made so that the results of the discussions may be widely used.

1. Issues regarding water resource policy

(Background) - Quantitative catch-up by improving facilities mostly achieved -

- Water in Japan is a limited, vulnerable domestic resource. Japan has precipitous terrain and short rivers. Rainfall is concentrated in a certain period of time, i.e., the rainy season or the typhoon season. Therefore, the potential water quantity greatly differs depending on the area and the season. It is also depends on regional, social, and economic activities.
- During the period of high economic growth, rapidly increasing water demand was dealt with by improving facilities in major cities. That era of quantitative catch-up with water demand is mostly finished today as socioeconomic activities are entering a stable phase.

(Actual state and issues)

- Potential issues and climate change risk and its effect on water resources -

- Meanwhile, Japan's other water issues such as effective use of water resources, attainment of safe, tasty water, and consideration of a rich environment have not been given sufficient priority. The public's awareness of these issues is rapidly growing, so it is desired that they be properly dealt with.
- There is also concern about the water supply when drought, disaster, terror attack, or accidents take place. Thus, water supply in case of emergency is another issue.
- Moreover, available water supplies from water resource development facilities today are lower than expected because of the decreasing rainfall in recent years.
- The fourth assessment report (published in 2007) of the Intergovernmental Panel on Climate Change (IPCC) points out, with a higher degree of reliability than former reports, that climate change risk may increase.
- Climate change is reducing rainfall. Extremely small amounts of rainfall means increased drought risk, by which people's lives and economical activities may suffer. Drought risk depends on changes in social circumstances such as population decrease, change in water use, and improvement of water infrastructure. Elimination of drought risk may take a long time and be difficult in some cases.
- Therefore, new risks to water resources from climate change (which were not

considered serious in the past) should now be recognized and their effect researched and investigated immediately so that proper countermeasures can be taken. This is an important issue.

(Necessity for countermeasures) - Shifting to integrated water resource management -

- Under such circumstances, it is a national mission to secure stable, good-quality water resources no matter how the social situation changes so that people can relish a gift of nature -- safe, sufficient water. Water is essential to people's lives and socioeconomic activities.
- Although the country's ability to bear the public financial burden is weakened by the rapid aging of the population because of the declining birthrate, the necessary water infrastructure should be improved. If energy is severely restricted in the future, we should also cope with it.
- Based on the abovementioned principle, to solve potential issues and eliminate new risks to water resources from climate change, we should move from conventional water management, which stresses quantitative water supply by developing water resources, to integrated water resource management, which includes effective use of water resources, comprehensive water quality/quantity and surface water/groundwater control, and risk management.
- For this purpose, comprehensive, concrete measures should be established immediately together with implementation of system improvement, which is one of the nation's urgent issues.
- The main issues in water resource policy are shown below.

1.1 Quantity/quality comprehensive management

- Tap water mixed with harmful or unknown substances risks the health and lives of people. We should improve countermeasures against this issue.
- To improve the quality of water of lakes, reservoirs, rivers, etc., people living in watershed areas must attack the problem in an integrated manner under the responsibilities assigned to the government agencies concerned.
- In the past, water quantity and quality were considered separately. But today the importance of a comprehensive perspective on water quantity and quality is well known because the water environment has been improved by increasing flow volumes through raw water transmission.

- To secure the safety of tap water and the correct flow volume of rivers, the government agencies concerned should cooperate with each other to establish a proper intake/drain system as part of measures to obtain safe, tasty water from the whole water system.

1.2 Consideration of a rich environment

- Various problems related to the water cycle system are surfacing. Such problems include decreased river flows in normal times, increased water contamination, and harmful ecosystem effects. They are caused by lack of consideration of the water environment (which is the living base of animate beings) and insufficient recovery of a good relationship between people and water. Therefore, it is essential to establish a healthy water circulation system by giving special consideration to the water environment.

1.3 How to deal with the decline in water supply function in case of emergency

- When a big earthquake occurs, the water supply function may decline because of damage to water resource development facilities and water supply facilities. Of particular concern are the effects on the lives of the elderly and on economic activities.
- Decline in the water supply function caused by malfunction or damage of aging water development/supply facilities due to aging also is of concern.
- Another concern is deterioration of the water supply function caused by facility destruction or harmful substances mixed in by terrorists. It is essential to handle the risk properly in case of emergency including large-scale drought.

1.4 How to handle new risk of climate change

(See referential drawing 1)

- Climate change has caused extremely low rainfalls, which leads to droughts and serious water shortages. In this case, safety of water use may be threatened more than ever.
- In addition, other factors such as deterioration of water quality, water utilization problems by groundwater salination, and water supply function loss by floods or tidal waves (which will be more frequent in the future) have a great effect on people’s lives and economic activities.
- Therefore, we should recognize new risks to water resources caused by climate change and take proper action as soon as possible.

2. New risk due to climate change and countermeasures

2.1 World's recognition of new risks due to climate change and countermeasures

2.1.1 IPCC's fourth assessment report

According to this report, which has been issued in series since Feb. 2007, climate change acts upon natural and living environments in each region all over the world. At the same time, the report states that the risks of climate change can be reduced by combining countermeasures against the unavoidable effects of climate change and mitigative measures to reduce greenhouse gases.

The key points related to water resources described in this report are as follows:

(1) Temperature and precipitation

- The world's average temperature rise, which has been observed since the middle of the 20th century, was most probably caused by a man-made increase in greenhouse gases.
- According to a scenario of the lowest greenhouse gas emission volume, the world average temperature will rise by 1.8°C; with a scenario of the highest greenhouse gas emission volume, it will rise by 4°C in 100 years.
- Therefore, there is a high possibility that extreme precipitation phenomena will occur in the future.
- Snow cover surfaces are predicted to decrease.

(2) Drought and water availability

- Global warming increases the risk of drought along with growing climate change.
- Early snowmelt sometimes increases drought risk in watershed areas where water is supplied by snowmelt in summer and fall, when water demand is highest.
- Areas affected by drought are most likely to increase.
- Some trial calculation models predict that the frequency of extreme drought phenomenon every 100 years will double, and the average drought length will increase six fold by the 2090s.
- In this century, water supply from glaciers and fallen snow will decrease and water

availability in regions where water is supplied by snowmelt from mountains (where more than one-sixth of the world population is living today) will also decrease.

- In most of the rivers into which melted glacier or snow water flow, the flow volume will increase and the flow peak in spring will come earlier.
- By the middle of this century, the yearly average river flow rate and water availability will increase by 10 - 40% in high-latitude regions and some humid tropical regions, and decrease by 10 - 30% in mid-latitude regions and some arid regions and dry tropical regions.
- Freshwater availability in Central Asia, South Asia, East Asia, and Southeast Asia, particularly in large river catchment basins, is most likely to be reduced by climate change.

(3) Rise in sea level

- The average sea level rise in 100 years is 0.08 m - 0.38 m under a scenario of the lowest greenhouse gas emission volume, while it is 0.26 m - 0.59 m under a scenario of the highest greenhouse gas emission volume.

(4) Groundwater

- Areas where groundwater and water at river estuaries is salinated by rising sea levels will expand and freshwater availability for the inhabitants and ecosystem of coastal areas will probably decrease.
- Under certain conditions in which rivers and aquifers are favorably related with each other and the groundwater recharge rate is low, changes in river water levels affect the groundwater level more than the groundwater increment does.

(5) Water quality and ecosystems

- Elevated water temperatures, increasing intensity of precipitation, and prolonged low water level periods affect the ecosystem and worsen water contamination in many forms. Water contamination is caused by deposits, nutrients, dissolved organic carbon, pathogenic bacteria, pesticide chemicals, salt, heat pollution, etc.

2.1.2 Tendency of countermeasures overseas

- According to a survey of the progress of adaptation measures against climate change in advanced countries (May 2006) conducted by the Organization for Economic Cooperation and Development (OECD), many advanced countries recognize the effect of climate change on water resources. Therefore, they are estimating the effects of climate change while studying countermeasures in the water resource field.

(California, the USA)

- Along the West Coast, there is concern about increased damp or wet conditions in winter and prolonged dry conditions in summer. Also, it is predicted that the amount of snow cover in the Sierra Nevada range will decrease by 25% by 2050. The effect of climate change is estimated under certain emission scenarios, and adaptation measures are discussed. Predicted problems include water demand increases in all fields; the effects of decreasing snow cover on water supply, hydraulic power generation and the ecosystem; and, salinity intrusion into delta areas caused by rising sea level. Adaptation measures such as strengthening water-saving measures, collecting surface water, accumulating groundwater, enhancing the water control and delivery system including water supply facilities are being studied. Budgets have been proposed for flood control, reuse of sewage treatment water, groundwater accumulation, water saving, and other comprehensive regional water management approaches.

(Canada)

- Climate change is predicted to increase outflow in winter and decrease in outflow in summer. In British Columbia, damage caused by drought is currently surfacing. Therefore, adaptation measures against climate change are being studied and implemented.
- The predicted main effects of climate change include prolonged crop growth periods, increase in demand for agricultural water, seasonal water shortage, water quality deterioration, fish habitat deterioration, and more water conflicts. Adaptation measures such as water saving by users, emphasizing planning and preparation for drought, monitoring water quantity and quality and climate by the government, procedures for equal distribution of water considering the river ecosystem, breed improvement to create temperature-resistant crops, and developing irrigation systems are being studied and implemented.

(Australia)

- In southwest Western Australia, climate change has reduced precipitation by 15% since the middle of the 1970s, and it will presumably decrease by 20% by the 2030s and 60% by 2070. In this state, a diverse security strategy called the “Water Resource Development Plan 2005 - 2050” was established in 2005. It is designed to adapt to increased water demand and climate change by reviewing water resource options and measures not depending on rainfall, including desalination of seawater, sewage treatment water reuse, water resource management, water transactions, etc.

(Europe)

- In Northern Europe, annual precipitation is increasing by 1 - 2%, while in Southern Europe, it is decreasing and extreme drought is predicted to occur more often in the future. The Commission of the European Communities published a “green paper” to advocate the importance of adaptation measures, “Water Shortage and Measures against Drought” in 2007. In each country, technological procedures to increase water supply, improve water use efficiency (use of general service water, etc.), improve economical procedures (setting a water price), insurance systems, water use restrictions, country plans to improve hydrological balance, prediction/monitoring/information service adaptation measures, etc. are being studied and implemented.

2.2 Effect of recent climate change in Japan

- The average annual temperature of Japan increased by 1°C in the past 100 years. The fluctuation band of annual precipitation is widening each year. In some recent years, the rainfall amount decreased dramatically, compared with the first half of the 20th century.
- In addition, the amount of snowfall is also decreasing in recent years, and the snowmelt timing is getting earlier due to warm winters. For these reasons, water supplies in dry years have drastically decreased today, compared with those of the year in which dams were constructed. Accordingly, actual water supply is declining in Japan.
- If the water shortage in the past 100 years in the Tone River basin is simulated on the assumption that no drought management measures, such as cutting down on water intake were imposed, droughts that make dams dry up would occur in recent years more often than the past. Therefore, it can be said that drought risk is increasing.

2.3 New risk due to climate change in Japan

- The IPCC’s fourth assessment report points out that social change such as increased in water demand caused by regional population increase and economic development, enlarges the effects of climate change. To recognize the risk due to climate change in Japan, it is necessary to study not only natural phenomena but also water demand fluctuation along with the change of social circumstances such as population, economic growth, food self-sufficiency, etc. based on regional characteristics.

2.3.1 Drought risk

(1) Risk of natural phenomena

① Occurrence of the phenomenon of extremely small amounts of precipitation

- Comparing the simulated lowest and the second-lowest seasonal precipitations for 20 years in 100 years' time*[1] to those for 20 years today, precipitation-decrease areas will expand in the future. (See referential drawing 2).
- Concretely, the precipitation of the following areas will be much lower in 100 years than today according to a scenario using RCM20*[2] (A2 scenario*[3]).

  Winter*[4] (the second-lowest in 20 years): Area from eastern Japan to Kyushu

  Spring*[4] (the lowest and the second-lowest in 20 years): Area centering on western Japan
- Drought risk may be higher from the viewpoint of natural phenomena (the supply side), considering that droughts occur more often when seasonal precipitation is low (the lowest and the second-lowest in 20 years)*[5] and that extremely low seasonal precipitation is more likely in many areas.

② Decrease in amount of snow cover and earlier snowmelt

- It is predicted that the depth of snow will largely decrease in the Tone River basin in 100 years. According to estimation*[6], more water should be supplied from dams in the agricultural season or the soil-puddling season due to greatly decreasing snowfall , earlier snowmelt timing, and decreasing river flow rate. Meantime, water from early snowmelt cannot be stored behind filled dams.. River flows that cannot be used effectively will increase and droughts will occur if precipitation is low. For this reason, drought risk will be greater in snowmelt-dependent regions. (See referential drawings 3 and 4.)

※1: In 100 years' time：20 years of 2081〜2100. Today: 20 years of 1981〜2000

※2: Regional Climate Model 20: Regional climate model using the area surrounding Japan as the area of calculation. The horizontal resolution is 20 km×20 km

※3: Multiple Society Scenario: The world economy and politics are blocked and trading and movement of persons is limited. Economic growth is low and people's interest in the environment is lower.

※4: Winter: Dec. - Feb. Spring: Mar. - May

※5: According to past data (for 46 years from 1961 to 2006) and future simulation (for 20 years from 2081 to 2100), drought occurs more often when seasonal precipitation is low (lowest and second-lowest in 20 years) in the Tone River basin.

※6: The depth of snow in Fujiwara of Minakami Town in 100 years was calculated by the Water Resources Department of Ministry of Land, Infrastructure, Transport and Tourism by using RCM20 (A2 scenario).

(2) Effect of demand fluctuation

① Effect of social circumstance change

- Social circumstances will change drastically in the mid term (in 30 years)*[7] and in the long term (50 years and 100 years)*[7]. Here, we made bold assumptions about the decrease in population and food production without considering dramatic engineering innovation to perform a rough trial calculation*[8] of the effect on the amount of the water used across the country. (See referential drawing 5.)

(Results of the trial calculation)

- The amount of water used across the country will be about 90% of the present value in the mid term and in the long term. Agricultural water demand will remain unchanged because of a decrease in population (high-level assumption and middle-level assumption) and steady food production.
- Although the regional population estimate in the long term is not announced publicly, the population of the Kanto region will be 6% higher than the national average according to our regional population estimation in 30 years (middle-level assumption). Therefore, unevenly distributed population may increase drought risk.

② Change of social circumstances in each basin and the effect of change of water use

- Due to the temperature rise caused by climate change, irrigation timing will change and the amount of water evaporation from paddies will increase. For the Ishikari River basin, the Tone River basin, and the Chikugo River basin, a rough trial calculation*[9] was made by assuming the change of water utilization and the change of social circumstances (population decrease in each region (high-level and middle-level assumptions)) when food production is assumed to maintain the status quo.

※7: In 30 years：2035　In 50 years：2055　In 100 years：2105　(The present time is 2005.)

※8: For daily life water, "decrease in population" and "decrease in the basic unit by diffusion of water-conserving equipment" was considered. For population, the high- and mid-level assumptions of "Japan's Estimated Population in the Future" by the National Institute of Population and Social Security Research are used. The basic unit decrease is by 20% in 30, 50, and 100 years.

The production of agricultural water is estimated to maintain the status quo in 30, 50, and 100 years.

Fresh water for industrial use will increase by approx. 0.5% annually in 30 and 50 years. The collection rate is estimated to be approx. 82% and 85%, respectively.

The amount of use in 100 years will be same as that in 50 years.

(Results of the trial calculation)

- In the Ishikari River basin and the Tone River basin, drought risk will be mitigated by changing the irrigation timing in 50 years or 100 years. However, drought risk in general may increase in the future. In the Matsubara/Shimouke dam area of the Chikugo River basin, drought risk may increase in 50 and 100 years. In such areas as the Egawa/Terauchi dam where the ratio of municipal water used to other water resources is comparatively large, drought risk may be mitigated. (See referential drawing 6.)
- Studies for each basin should be promoted in the future. In some regions, drought risk may increase even after taking into consideration the effects of social change and water use.

2.3.2 Effect on water quality and ecosystems

- The effect on water quality and ecosystems is mostly unclarified, but the following effects can be considered qualitatively. (See referential drawing 7.)
- Concerns are arising about elution of heavy metals (iron, manganese, etc.) and nutrient salts attributable to dissolved oxygen consumption in the bottom layer caused by changing water circulation at the source and increase of remains by proliferation of phytoplankton. Bad odors and tastes caused by phytoplankton and murky water produced by frequently occurring floods are also concerns. Therefore, more future measures to secure safe, tasty water will be required.
- In addition, there is another public health and safety concern: infectious diseases by increase of *bacillus coli* caused by rising water temperatures.
- One example of the effect on the ecosystem is a decrease in the freshwater fish distribution area. Biodiversity may be undermined. In addition, changes in the dominant species of zooplankton and phytoplankton living in fresh water may affect the ecological chain or ecosystem.

※9: Industrial water will decrease by 10% in 50 and 100 years in the three basins. Agricultural water will maintain the status quo. (However, there will be an increase of 5% when water loss is considered.)

In the Ishikari River basin, daily life water will decrease by 35% (high-level assumption) and 40% (mid-level assumption) in 50 years and by 55% (high-level assumption) and 70% (mid-level assumption) in 100 years when the irrigation period is changed to -20 - 0 days.

In the Tone River basin, daily life water will decrease by 35% (high-level assumption) and 40% (mid-level assumption) in 50 years and by 55% (high-level assumption) and 70% (mid-level assumption) in 100 years when the irrigation period is changed to -20 - +60 days.

In the Chikugo River basin, daily life water will decrease by 40% (high-level assumption) and 40% (mid-level assumption) in 50 years and by 60% (high-level assumption) and 70% (mid-level assumption) in 100 years when the irrigation period is changed to -100 - +40 days.

The calculation result by the high-resolution whole atmosphere-ocean coupled model of the Center of Climate System Research, University of Tokyo (CCSR), is used.

2.3.3 Effect on groundwater

- It is difficult to estimate regional sea-level rises correctly because they are strongly influenced by natural factors such as changed atmospheric flow over several decades and changed tidal currents. Regional sea-level rise may accelerate groundwater salination in coastal zones.
- In inland areas, river-level change caused by increased or decreased precipitation may affect underground-water recharge.

2.3.4 Decline in water supply function by submergence by floods or tidal waves

- As strong floods occur more often and the amount of precipitation increases, the risk of submergence damage caused by floods or tidal waves becomes higher. Increased risk of defective function of water supply facilities is also of concern.

2.4 Measures against new risks caused by climate change in Japan

2.4.1 Basic idea

Promotion of integrated water resource management addressing climate change risk

- In the mid term (30 years) and long term (50 - 100 years), drought risk may increase in some areas even taking into consideration the effect on water demand (decrease in population, change of water use, etc.). Adaptation measures such as promotion of comprehensive water resource development in addition to new water resource development are needed. (See referential drawing 8.)

2.4.2 Basic viewpoint

In addition to integrated water resource management based on the necessity to resolve issues in the past (effective use of water resources, comprehensive quantity/quality management, and risk management), the following viewpoints are required to eliminate climate-change risk.

(1) Adaptive measures

- Climate-change risk cannot be eliminated by conventional facility plans, which set a target value using past data, because climate change will be greater in the future. It is necessary to establish the necessary adaptive measures in the early stage based on a long-term assumption that climate change will grow.

- Whenever new knowledge is obtained, it is necessary to reestimate the effect of climate change, set quantitative targets based on the reestimation, and propose and implement adaptive measures.
- In this case, population decreases, low birthrates and longevity, social circumstance change such as food self-sufficiency, change of water utilization, change of water demand, etc. should be taken into consideration.
- For adaptive measures, discussions should be conducted at an early stage to clarify how the beneficiary balance among individuals is changed when pursuing the maximum effect as a whole, and how to share the risk if the probabilistic method fails.

(2) Building a society to use water well

- Building a society in which citizens, users, and companies use water efficiently is an effective adaptive measure. By reducing water and wastewater treatment energy and reducing CO_2 emission, it also is a mitigation measure. Building a society that uses water efficiently should be promoted and treated as a problem to be solved by the whole nation.

2.4.3 Concrete measures

(Measures against drought risk)

① Improvement of surveys and researches

- Based on the surveys and researches toward IPCC's fifth report, the following studies should be conducted.
- Prediction of the effect of climate change by considering natural fluctuation, water utilization/management forms, and change in demand
- Preparation of facility planning based on the above, etc.

② Promotion of development of new technologies

- To deal with future climate change, the following new technologies to use water resources effectively and respond to water use change should be developed.
- Water use rationalizing technology and water management technology based on meteorological forecasting
- A wet rice culture system of the water-saving type and improvement of high-temperature-resistant breeds
- Possibility of a new, unconventional method of water use and its effect (for example,

cooling by water and the energy-saving effect), etc.

(Eliminating each kind of risk)

① Dealing with the effect on water quality

- Data accumulation, verification of effect of existing measures, and prediction by simulation
- Effective measures to improve the quality of water in reservoirs, etc.

② Measures against water supply function decline due to floods and tidal waves

- Prediction of effect by simulation of flooded areas and the three largest ports consisting of zero-meter regions
- Planning measures to maintain the function of water and wastewater equipment
- Measures for building water-resistant facilities, etc.

③ Measures against underground water salination

- Estimation of sea-level rise and effect on groundwater salination
- Warning for coastal local governments
- Reinforcement of monitoring
- Utilization of groundwater shut-off technology, etc.

④ Measures against the effect on ecosystems

- Promotion of survey, research, and monitoring of the effect on ecosystems, etc.

3. Promotion of integrated water resource management

3.1 What is integrated water resource management?

(See referential drawing 9.)

Principle: "Establishment of a lasting water-using society and a healthy water circulation system"

Basic purpose: "All the people can enjoy safe, untroubled, and rich water blessings"

- Toward achieving the abovementioned principle and purpose, we should recognize circulation of water as an important resource for conducting social activities. Water should be used and controlled in a manner whereby the proper quality and quantity can be secured, and optimal water distribution should be promoted by combining social activities based on their purposes.

3.2 Basic point of view

(See referential drawing 10.)

(1) Measures for social demand

① Effective use of water resources

- From the viewpoint of effective use of water resources, measures should be taken from both the demand and the supply sides. In terms of demand, building a society that uses water more effectively should be promoted by changing the basic social structure. In terms of supply, existing stocks should be used optimally and the necessary water resources secured. Comprehensive management of surface water and groundwater should also proceed.

② Quantity/quality comprehensive management

- New comprehensive water quantity/quality management (unlike the former approach that stresses water quality only) should be conducted that considers that the quality of water greatly affects people's lives and health, the taste of water, the relationship between people and water, and the survivability base of animate beings,

(2) Measures against potential risks caused by change of natural and social conditions

① Viewpoint of risk management

- Risk management should work to minimize the risk to people by guaranteeing security against declines in the water supply function caused by large earthquake, facility damage by aging, harmful substances mixed in by terrorists, etc.

② Measures against new risks due to climate change

- For new risks due to climate change, nontraditional adaptive management should be conducted at an early stage.

3.3 Concrete method of integrated water resource management

3.3.1 Building a society to use water effectively and attaining stable water resources

3.3.1.1 Water resource management on both the demand and the supply sides

- Building a society that uses water effectively and attaining stable water resources are both needed to stabilize water resources from the viewpoints of demand and supply.
- In terms of demand, rational sharing of water resources should be promoted by water saving by users and smooth transfer of water between users. Introduction of a system for a desirable relationship between benefits and burdens for water users should also be studied considering the actual situation of each regional river system to promote users' self-motivated attainment of water resources. Such a system will improve end users' water use stability, fairly share the cost burden, and the public interest will also increase for end users.

(1) Enhancement of water-saving consciousness

- It is essential to enhance people's consciousness of water saving by changing the social structure. Measures to give people and companies incentives to save water and to develop water-saving-type equipment should be taken.

(2) Rationalization of water use

① Improvement of water leakage measures and water-recycling rates

- To prevent water leakage, old aqueducts, water line facilities, etc. should be rebuilt.
- It is necessary to improve the industrial water-recycling rate.

② Promotion of use of rain water and recycled water

- Use of rain water and recycled water is effective in reducing the quantity of tap water consumed in normal situations and maintaining adequate water levels of water resource development facilities.
- Promotion of use of rain water and recycled water (expansion of use and application) contributes to increase in the diluted amount of rivers when the quantity of water intake declines, and it is thus effective in securing stable water resources as well as safe water

quality.

- Using rain water and recycled water to maintain a good environment in the city is an effective disaster prevention method as emergency water supplies can be secured.
- Reused sewage water can be an alternative water resource of water development facilities at time of drought.
- Use of rain water and recycled water is an effective method of closing the gap between water demand the supply in seriously-water-demanding areas.

(3) Rational water supply by active use of existing stocks

- From the viewpoint of supply, existing stocks should be used effectively because water resources are limited. When existing stocks are used, facilities should be considered an asset. Asset management through the following measures can achieve and improve the functions and services demanded based on the durable years of facilities. From the viewpoint of global warming, existing stocks should be used efficiently as water resource energy.

① Measures for normal situations

- Planned sediment storage excavation, repair of gates, and establishment of asset management
- Expansion of the capacity of water resources by raising dam banks and redeveloping dams
- Promotion of efficiency of reservoir operation by dam linkage or integration, etc.

② Measures against drought

- Mutual accommodation among water users from the same water system during drought and broad-based mutual accommodation of water among water systems
- Utilization of the sediment storage capacity and dead water capacity of dams exclusively used for electricity generation as an emergency evacuation measure against abnormal drought, promotion of utilization of recycled water, etc.

3.3.1.2 Promotion of rational distribution of water resources

(1) Review of drought control

- For drought control such factors as the actual regional situation, maintenance of facilities, and past progress should be considered. Because efforts to secure water resources may not be reflected in drought control, reviewing drought control rules to secure the public interest and fairness is an important issue.
- Drought control rules should be discussed thoroughly to share responsibilities for regional issues at an early stage from the viewpoint of the relationship between benefits and burdens and users' interests. However, it should be considered that a water use system has been formed based on regional agreement for a long time. The actual situation and past progress of safe water use in each water system should also be taken into consideration when discussing drought control rules.

- Therefore, controlling drought by reducing water intake depending on the quantity of the newly usable water and water saved and fed back should be studied. As a result, users' efforts in water saving and water resource attainment in each region can be reflected. At the same time, the government should start discussions about a system that allows users to use unused water during drought, or a safety net system for small-quantity water users who cannot afford to secure sufficient water resource.

(2) Promotion of diversion of unused water

- When diverting unused water, the cost burden should be shared among the facilities concerned. To promote smooth operations, the construction cost at the time of building, which can be the basis of sharing the present cost burden, should be considered. Such factors as the cost to build facilities to obtain the same quantity of newly usable water, durable years of facilities, deterioration of facilities due to climate change, and water resource measure costs should also be considered. In other words, a plan of sharing the cost burden for unused water diversion should be established. However, data should be disclosed at the facility owner's discretion.

(3) Promotion of sharing the cost burden for temporary accommodation of water during drought

- Certain rules for sharing the cost burden should be established by diffusing the idea of cost burden sharing and setting a drought control conference to obtain the proper relationship between benefits and burdens.

3.3.2 Comprehensive quantity/quality management

(1) Promotion of comprehensive water quality improvement

- Water quality monitoring should be conducted for lakes, reservoirs, rivers, etc. (which are the raw water source for tap water) for evaluation. Water contamination management should also be conducted by considering the water contamination mechanism, progress of water quality improvement measures, and the cost-benefit performance of the measures. As a result, safe, good-quality water resources should be secured by comprehensively improving the water quality in the basin.
- For this purpose, a plan for improving water quality should be made regionally and actions taken by the parties concerned through cooperative arrangement. So that the

operation proceeds smoothly, a water quality conference should be held as a setting for cooperation and coordination by the parties for the purposes of (1) monitoring water quality, sharing the database, and analysis, (2) setting a comprehensive standard or target for water quality in the basin, and (3) conducting water-quality conservation and improvement measures. At the national level, approaches for sharing water quality conservation awareness among related governmental agencies and setting a conference to discuss cooperation and linkage among agencies should proceed.

- In closed water resource areas such as lakes and reservoirs, contaminants fly into them and build up. In this case, water quality improvement at an early stage is difficult to realize. Therefore, long-term, comprehensive, lasing approaches for water quality improvement should be promoted by the whole basin. Comprehensive measures such as bottom mud dredging, water quality purification, reduction of sludge loading inflow at the beginning of rain, making a sewage system and advanced process in the basin, point source measures for factory/office effluent regulations, application of proper fertilizer to agricultural land, proper forest management, etc. should be promoted.

<u>(2) Measures for securing safe water</u>

- Risk should be eliminated by properly treating the drainage discharged from offices and homes, upgrading the water purifying method, monitoring, etc.
- Based on the social demand for high-level risk approaches and the characteristics of river water intake and drainage as well as cost-benefit performance, proper drainage treatment and advancement of water purification should be conducted to reduce causative substances and avoid future risks. As one of the approaches, a water intake/drain system should also be reorganized as necessary for avoiding risk by directing tributary streams with causative substances into their main rivers at a downstream water intake point considering the effect on the waterfront environment and the ecosystems along with the reduced river flow rate.
- To prepare for a decline in the function of water purification and sewage treatment due to facility damage caused by earthquake, measures such as anti-seismic reinforcement of facilities, facility networking, building backup facilities, and improvement of combined sewer systems should be promoted. Assuming that contaminated or harmful substances generated by a disaster enter upstream, use of various water resources, reorganization of the intake/drain system, and emergency measures should be studied so that poor-quality river water is not be used. To conduct such measures properly,

the information linkage system by the agencies concerned should be enhanced.

- In the integrated water resource management plan for the whole basin, issues and solutions related to water resources in terms of water quality should be recorded to conduct the approach toward solution of the issues by the parties concerned.

(3) Issues to solve when reorganizing the intake/drain system

- A model area should be selected and the following points discussed toward solving the issues of the model area through cooperation of the parties concerned.
- In terms of cost-benefit performance, both direct and indirect effects should be estimated such as the effect of risks affecting people’s lives and health, the effect of preventing water quality accidents, and the effect on tasty water because the raw water transmission cost is increased by changing intake and drainage points.
- A joint system for river projects and irrigation projects and utilization of existing facilities
- Investigation and countermeasures against the influence on water quantity and quality, the waterfront environment, and ecosystems, assuming that areas in which river flow is lessened are generated, etc.

3.3.3 Measures against decline in water supply function in emergency settings of earthquake or accident

(1) Basic idea

- For unanticipated situations, risk management measures should be taken to minimize the effect on people from a hardware and software standpoint.

(2) Securing the reliable functions of facilities by asset management

- Considering facilities as an asset, asset management to renew and repair facilities should be conducted through the following measures so that functions and services demanded can be achieved based on the durable years of facilities.
- Making an asset management plan (by considering the CO_2 reduction)
- Clarifying the quake-resistant standard, inspection of quake resistance, and promoting the antiseismic reinforcement
- Securing the capacity to conduct large-scale maintenance and repair of dams effectively, etc.

(3) Establishment of a system with redundancy

- Measures such as broad-based accommodation of water (emergency connecting duct), broad-based application linkages, doubling water supply facilities, effective use of old facilities as backup facilities, and multiplexing and networking water resources should be promoted.

(4) Establishment of a mobile water supply system for emergency

- To transfer and supply water to areas where water is critically insufficient in case of emergency, the following measures should be taken.
- Establishing a specialized system to supply water on a huge scale (ocean water bags, deployment of mobile seawater desalting equipment)
- A system to dispatch workers to disaster sites and reserving emergency aid resources and equipment
- Studies on measures for giving incentives to companies and inhabitants to participate as volunteers
- Clarification and maintenance of an emergency manual and standard and introduction of measures (example of the excellent Hiyari hat)
- Emergency training, training in broad-based water supply activities, and training by using “Water Weeks”
- Studies on various fiscal measures, etc.

(5) Promotion of stockpiling

- In addition to water resource development facilities such as dams, various stockpiling methods such as stockpiling by users, use of underground spaces of public facilities, accumulation of water in the factory and home, stockpiling in various distribution processes, etc. should be conducted.

(6) Promotion of security measures

- Clarification of the security standard for accident and terror attack, total inspection, and reinforcement of countermeasures

3.3.4 Promotion of comprehensive surface water/groundwater management

(1) Basic idea

- Underground water is an important water resource and a component of the water circulation system. Effective use of water resources should be promoted by fully understanding the effect of groundwater use.
- Water use in normal situations and in case of emergency should be researched separately and properly. Lasting use of groundwater should be pursued by taking adaptive measures in terms of quantity and quality through proper combination of surface water and groundwater.
- Integrated water resource management should be conducted from the viewpoint of the basin such as diffusion of water accumulation, maintenance, and recovery of recharging ability of the basin or the place of water circulation.

(2) Proper use of emergency water resources

- To use groundwater as an emergency water resource in areas where subsidence may be caused by use of groundwater, the effect of groundwater use should be well analyzed. It is also necessary to promote the proper use of groundwater within a range that maintains the groundwater inlet/outlet balance by setting a target groundwater level, evaluating it by observation, and conducting numerical simulation.
- To maintain underground water resources that are not used in normal situations as an important water resource, it is necessary to work out a maintenance and control plan to properly maintain them.

(3) Underground water resource management operation measures

- A system that will be monitored should be established for standardizing the information necessary for underground water resource management to be used effectively, converting such information into easily understandable information, and officially providing such information including data related to groundwater intake exceeding a certain volume.

(4) Building a social consensus for groundwater resource management

- Although there is a private right to underground water attached to the land, underground water should be treated as a public resource because underground water is an important component of water circulation. For this reason, it is necessary to establish a monitoring system and promote the positioning of a sound water circulation plan worked out in a basin or region.

3.3.5 Conservation and creation of an abundant water environment

(1) Consideration for ecosystems

- As water is the living base of animate beings, an abundant water environment should be maintained and created considering not only human life and health but also ecosystems by securing a flow rate to keep the environment of rivers and channels clean, conserving and maintaining the waterfront environment, and improving water quality.

(2) Recovery of the relationship between people and water and conservation and creation of water culture

- Recovery of the relationship between people and water and conservation and creation of water culture should be pursued through improvement of the water quality and hydrophilic function of rivers and lakes and recovery of springs. In particular, attainment of water for maintaining a clean environment in the city is effective for recovery of the relationship between people and water and prevention of the heat-island phenomenon, and it should thus be promoted in a positive manner.

3.4 Measures to promote integrated water resource management

(1) Systematic framework and its content

- Based on the relationship between the national government and the local government controlling the basin, not only conventional institutional frameworks to catch up with demand stressing water resource development but also other institutional frameworks or organizations to promote integrated water resource management should be studied.

(2) Plan for integrated water resource management as a substitute for a basic plan for water resource development (full plan)

- Today, a full plan to create water systems that requires development of water resources and rationalization of water use is being worked out to secure stable water supply to areas where water is required due to rapidly growing population and industrial development.

- In the full plan, which will be published in the future, basic matters such as estimated water demand for each application, target supply quantity, and construction of facilities to achieve the target amount of supply are recorded. The plan also plays the role of building the consensus of the parties concerned.
- After the basic demand and supply balance is secured upon completion of building water resource development facilities based on the full plan in the future, a framework for integrated water resource management to eliminate new risks of climate change should be established and consensus on this framework obtained.

(3) Matters to specify in the abovementioned plan

- In this framework, maintenance and control of water resource facilities, water demand control, how to deal with emergency cases, and cautions related to water quality and groundwater should be specified. Through the framework establishment process, drought control should be reviewed and discussed thoroughly by the parties concerned.

Study Group on "Integrated Water Resource Management addressing climate change and other risks"

List of Members

As of March 2008

	Taikan Oki	Professor of Institute of Industrial Science, the University of Tokyo
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	Kazuaki Tsuda	Director of Japan Arts Council
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	Yoshinori Morino	Urban journalist / Chief researcher of Nikkei Advertising Research Institute
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(Titles are omitted from names; in the order of the Japanese alphabet;
◎ refers to chairman.)