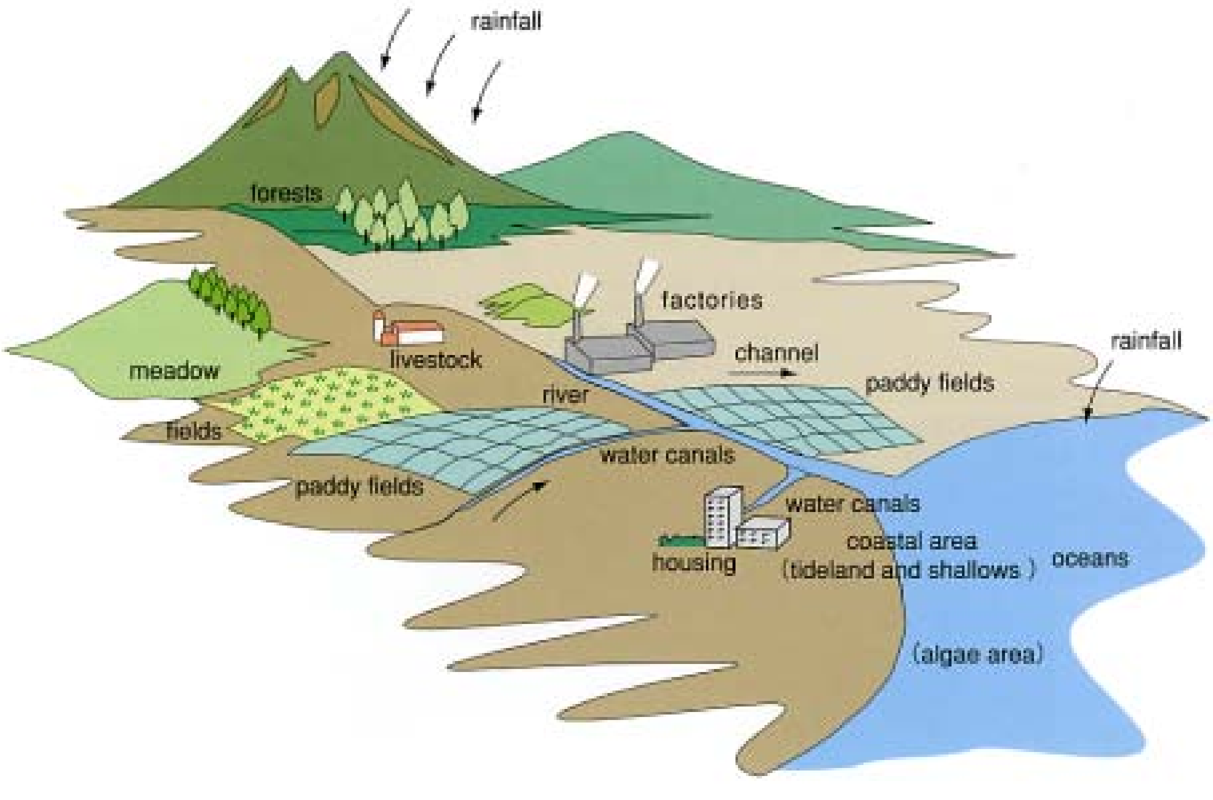
Tokyo Bay is to reduce the pollution load from the land areas, but countermeasures involving the dredging of bottom sediment and preserving or creating tide land and shallows are also important. However, under the present circumstances where the population in the basin has reached 26 million people, about three times that of the pre-war period, it is extremely difficult to restore water quality to a level as high as in the 1920s, even if the above-mentioned countermeasures are taken. In the 21st century, a closer examination into problems such as population concentration into urban areas will be necessary. Restoring the system for recycling resources and waste in the basin and building a balanced society based on the recycling of material in the basin will lead to a fundamental solution to the environmental problems.

An important challenge will be to develop energy-conserving and effective water treatment technologies. At present, various techniques are being studied, developed, and put into practical use on sites, including a method for cleaning underground water or soil polluted by chemicals that employs the decomposing capacity of microorganisms and plants.

Citizens must take an interest in preserving the environment close to them, examine its actual state, and take proper countermeasures. The environment of a river needs long-term continuous surveys, and such surveys will be conducive to practical operations for solving various environmental problems. It will be a big challenge for the future to recover a "stream in spring" where Medaka (killifish) swim, as sung in a children's song, in rivers in urban districts.

Pollution Sources at the River Basin



2 Preservation of Water Environment

Sayuri Megumi Professor, Department of Environmental Design, College of Sociology, Edogawa University

Summary

In order to preserve the waterside and water environment, a sense of basin management by entities that differ a little from those in the past is required. It is essential to create a water culture where people, goods, money and information would circulate based on a new sense of values, and to foster those people, so-called "Mizugaki" (water kids), whose capabilities are based on their actual experience of playing joyfully at the waterside.

It is impossible to continue promoting environmental preservation projects that are hard to pay off in the traditional economic mechanism, such as a project to return Japanese crested ibises to the wild, only through the power of the administration, assuming the input of tax money.

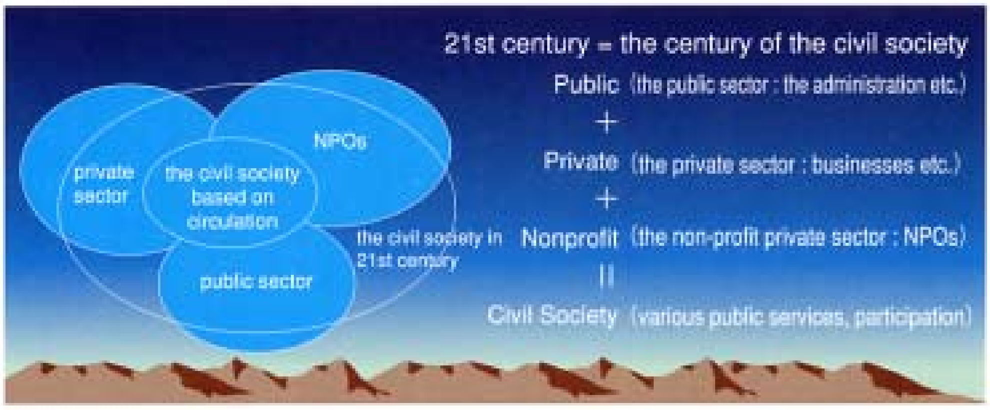
The functioning of environmental NPOs as interpreters, so to speak, giving explanations of the environment, is important. With a sense of wonder, that is, the sensitivity to the wonder or threat relating to the natural world and human acts, one can prevent large accidents and come to know the meaning of "at one's own risk" through small danger experiences and injuries. Then one can come to think and act from the viewpoint of mankind or living creatures in the natural world.

It is just as difficult to restore "Mizugaki" as Japanese crested ibises, through temporary, event-like and artificial measures. If the hardware and software for water - such as the waterside quality, quantity and network, culture of associating with water, wisdom or knowledge of water, social customs and systems on the relationship with water, and awareness of water - have changed over 50 years, it will take 50 years to restore "Mizugaki". It is also necessary to change the way of thinking, or sense of values, giving first priority to economic mechanism in the modern society.

From the viewpoint of basin management, it is desirable to realize, under the awareness of the basin community by the citizens in the basin, the circulation of resources in the basin and the circulation of economic and non-economic values (exchange of expressions of mutual aid and gratitude, such as local currencies) which have been limited under the traditional vertical administrative structure. Green procurement to purchase resources within the basin, even if a little more expensive, and commitment to use timbers from thinning for building schools and public facilities as semi-public works will lead to a gradual formation of a system where investment in maintenance and management of forest resources in the upper river basin and the areas with headwater forest at the riverhead is induced and supported by large consumer cities and towns.

How can Japanese, long accustomed to thinking only about things in Japan and around themselves, become aware of, think of and take actions on the world water problems with the World Water Forum as a start? The environmental NPOs and citizens' organizations are faced with diverse and enormous tasks. These tasks cannot be carried out without cooperation of businesses and the administration, but they are challenges worth tackling.

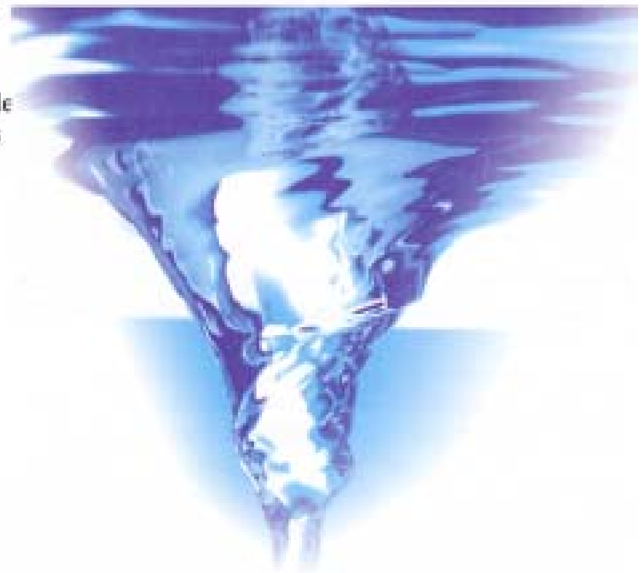
a cooperate triangle of public sector, private sector and NPOs



Chapter 4 Various Applications Utilizing the Properties of Water

In order to ensure the sustainable development of mankind under various limitations of resources, it is necessary to realize a society based on circulation. For that purpose, it is required to promote science and technology for solving water problems, and to make effective and widespread use of water, a resource based on natural circulation and with low environmental load when used, while giving consideration to energy conservation and paying attention to its properties.

It seems, therefore, that the water treatment technology needs to meet the following requirements:
① To be technology with low environmental load;
② To ensure that processed or used water can be recycle
③ To be technology that brings out potential capabilities of water.



Our country, with its limited land area and scarce resources, is particularly dependent on the science and treatment technology of water, which is relatively abundant, inexpensive, and exerts a low environmental load when used. It is very important for Japan to take the lead in developing such science and technology.

From these points of view, the following four cases (new water treatment, supercritical water, water as a solvent and water as scenery) are taken up as examples worth special attention, in respect of various applications making use of water properties.

Chapter 4 Various Applications Utilizing the Properties of Water

1 New Water Treatment

Tsuneo Watanabe Professor, Graduate School of Engineering, Tokyo Metropolitan University

Summary

From the viewpoint of securing sustainable development of mankind, it seems that water treatment technology in the 21st century needs to meet the following requirements:

① To be technology with low environmental load; to move away from water treatment technology that uses large amounts of chemicals so as to promote recycling of water;
② To ensure that processed water can be the object of recycling; to make assessment from the viewpoints of risk management and cost management, and develop water treatment technology on the assumption that water is recycled;
③ To be technology that brings out the potential capabilities of water; to develop water treatment technology, with emphasis on the fact that water can contain many substances and can display various capabilities according to the three states of matter.

Looking at existing water treatment technology, suspended solids are separated and removed with precipitation and filtration. As for colloids and dissolved substances, their sizes are increased through chemical reaction by injecting chemicals, and solid-liquid separation is made in the process of precipitation, absorption and filtration using microorganisms and membranes. Harmful soluble substances are separated or made harmless before microbiological treatment. The remaining soluble substances are finally removed by activated charcoal adsorption treatment.

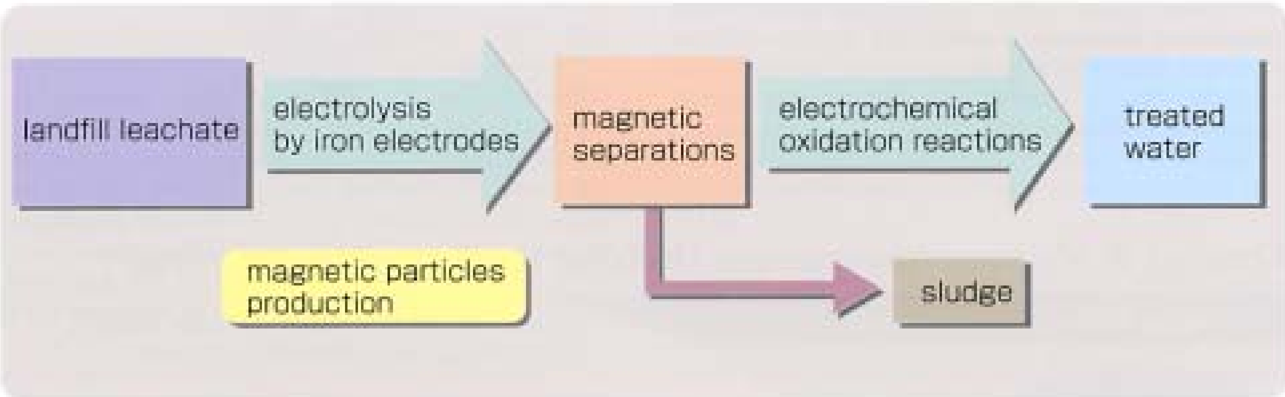
However, such water treatment has many problems, including vast sedimentation ponds, long treatment times, large amounts of chemicals input, and large amounts of sludge produced. In order to solve these

problems, a water treatment technology using a strong magnetic field is currently being studied as a promising new water treatment technology.

The characteristic feature of such water treatment by magnetic separation is that it is possible to treat various water solutions by physical treatment using hardly any chemicals, with the use of a small, easy-to-use superconducting magnet that produces a strong magnetic field. In addition, as this is essentially physical treatment, the object water will change little in quality after treatment. As a result, it will be possible to treat and reuse water of various qualities.

The future is expected to bring support for the research and development of such new water treatment technologies and industry-academia cooperation for the development of new measuring and analytical equipment. Also, the cooperation among researchers in various disciplines is indispensable to the development of technologies for developing potential capabilities of water. And for this purpose, interdisciplinary research organizations are needed.

Treatment of landfill leachate by electrolysis and magnetic separation



Chapter 4 Various Applications Utilizing the Properties of Water

2 Supercritical Water

Yoshito Oshima Associate Professor, Environmental Science Center, The University of Tokyo

Summary

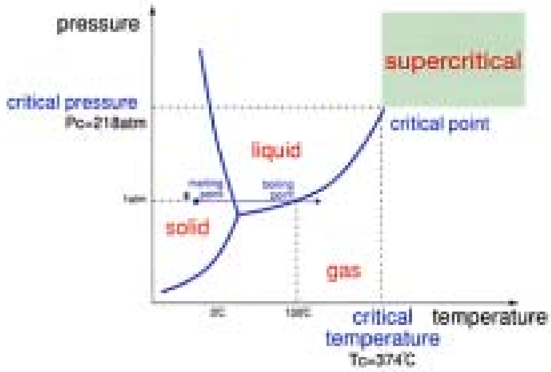
The density of water changes continuously and significantly around its critical point (water critical temperature is 374℃ and critical pressure is 22.1 MPa (218 atmospheres)) with a slight change in pressure. For example, the ability of water as a solvent to dissolve things (dissolving power) is closely correlated with water density. So, even at the same temperature, a slight change in pressure can cause a rapid change in dissolving power. The same applies to other physical properties correlated with density (viscosity, thermal conductivity, etc.), and in principle, it is possible to widely control various physical properties of water with only pressure and temperature as operational factors.

Using the supercritical state, the intermediate state between gas and liquid, as a field of chemical reaction, it is possible to increase the rate of chemical reaction significantly. In addition, as supercritical water can dissolve organic compounds, it is promising as a new substitute solvent for conventional organic solvents in industrially important organic syntheses. Water is a non-toxic, low-cost solvent found in abundance in nature, and in an expectedly increasing tendency toward environment-friendly technologies, chemical reaction using supercritical water as a solvent should be given attention as one of the basic technologies to realize low risk and low load on the environment.

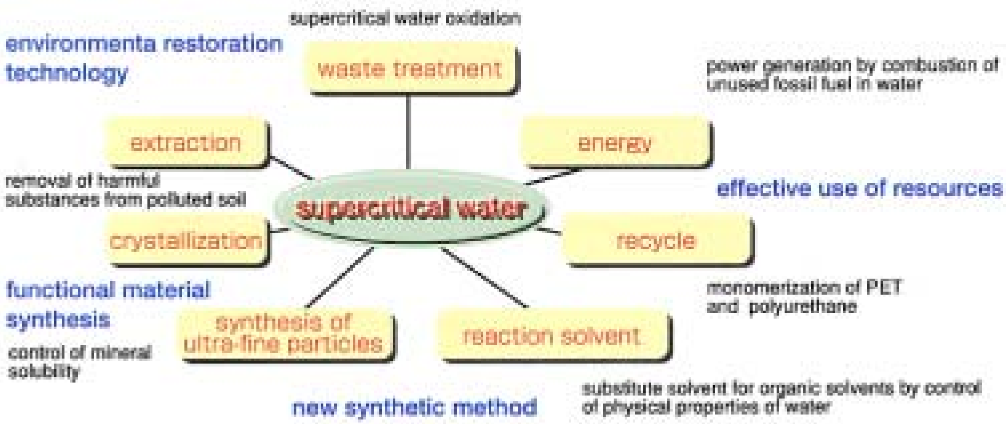
Further, most organic substances are decomposed almost 100% completely to generate carbon dioxide quickly, within seconds, by the supercritical water oxidation, "combustion" in the high-temperature high-pressure water. This reaction has the following characteristics: (1) reaction rate is very high; (2) because it can maintain temperature with its own reaction heat, energy conservation is promising; (3) because of combustion in water, risk of uncontrollable temperature increase and explosion is low; and (4) treatment of exhaust gas is not required while space saving is promising.

Though it is water, supercritical water manifests characteristics totally unlike those of solid, liquid and gas, as it is in the special environment of high temperature and high pressure. There remain problems yet to be solved toward more practical technology, but supercritical water is attractive enough and highly promising as one of the basic technologies for realizing a sustainable society.

The Phase Diagram of water



application of supercritical water to environment-friendly technologies



3 Water as a Solvent

Shū Kobayashi Professor, Graduate School of Pharmaceutical Sciences, The University of Tokyo

Summary

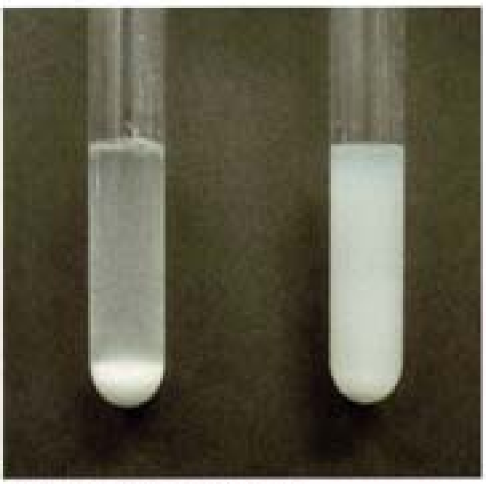
In conducting chemical reactions of organic compounds, organic solvents such as toluene and chloroform are generally used to dissolve the compounds. However, because some organic solvents are harmful to the human body and the environment, it is desirable to reduce their use as much as possible. In recent years, therefore, environment-friendly solvents as substitutes for organic solvents have been sought. The most attractive of them is water. Water is not only non-toxic and harmless, but also offers the advantage of being much cheaper than ordinary organic solvents. On the other hand, there are problems. Many reagents and catalysts react with water and decompose, and many organic compounds for reactions are not soluble in water.

Thus, we have proceeded with the study of organic synthesis using Lewis acids as catalysts, and developed a Lewis acid-surfactant-combined catalyst (LASC). The LASC can effectively cause Lewis acid catalysis in water, which has previously been deemed difficult.

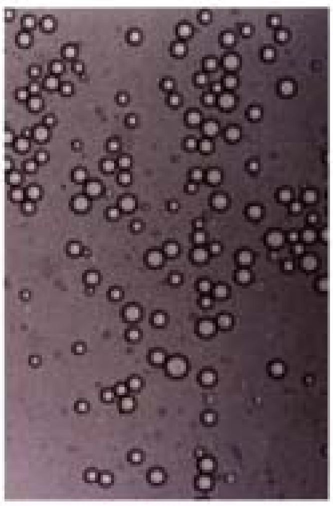
When applying a reaction mixture to centrifugal separator, organic compounds aggregate in the lower part, water is separated in the upper part, and LASC is extracted between them. After that, it is easy to take out organic compounds alone. With this centrifugation method, therefore, it has become possible, in principle, to develop a reaction process without using any organic solvents at all. It can safely be said that we have made a step forward toward the realization of a reaction process using only water as a solvent.

However, the study of organic synthesis in water has just started, and there remain many unknowns and much to be improved. For example, as compared with the conventional Lewis acid-catalyzed reactions in organic solvents, the reactions in water are still limited both in the kinds of reactions and in available reactive substrates.

At the beginning of the 21st century, when environment-friendly sustainable development is called for, it is sure that synthesis reaction in water will grow increasingly important, and further development with the aid from industry, government, and academia is desirable,.



Left: What mixed water with LASC
Right: what added reactive substrate to left liquid further



50 μm
micrograph of solution of LASC
and reactive substrate dispersed underwater

4 Water as Scenery

Mikiko Ishikawa Professor, Department of Environment and Information, Keio University

Summary

A beautiful, lively piece of scenery that includes water calms one's mind. In contrast, a deserted, dirt-drifting, bad-smelling scene at the waterside desolates one's mind. The scenery at the waterside is just like a mirror reflecting the sense of values of the people and community living there.

What is created by finding a utopia in water as scenery and drawing it close at hand is water in the garden.

In the mid-19th century, when rapid urbanization began, people in towns and cities around the world produced various ingenious plans to create waterside scenery in their towns and cities. In Europe, they made it a basic policy to make the waterside a space open to the public when remodeling their old city centers. In the U.S.A., based on the concept of park system type urban infrastructure improvement, they designated greenbelts to be preserved and created with water systems as the axis, and created beautiful watersides according to plans that were integrated with main street plans. One feature common to both cases above is integrated land use of waterside and its neighboring areas have been featured continuously for more than a century.

In Japan, the land adjoining to a river is called riverbank land. In the Edo era, such land was owned by the Shogunate government, and it was mandatory to secure open space there. In the Meiji era, too, space at the waterside was public space, and free access by the general public was allowed. But the old urban planning law enacted in the 8th year of the Taisho era (1919) opened the way for redevelopment of riverbank land in the densely populated areas to raise funds for urban planning projects. In the later Showa era (1975-1985), riverbank land sales surged dramatically.

The concept of park system type urban infrastructure improvement that attached importance to the waterside was introduced in urban planning for protection against natural disasters after the Kanto Great Earthquake of 1923. It was applied nationwide to the war-damaged cities and towns in the rebuilding projects after World War II. Based on such an urban planning concept, the waterside scenery representing various parts of Japan, such as Yokohama (Yamashita Park), Tokyo (Sumida Park), Sendai (the Hirose River), and Hiroshima (the Ohta river), have been developed from the scorched land.

Mizumoto Park

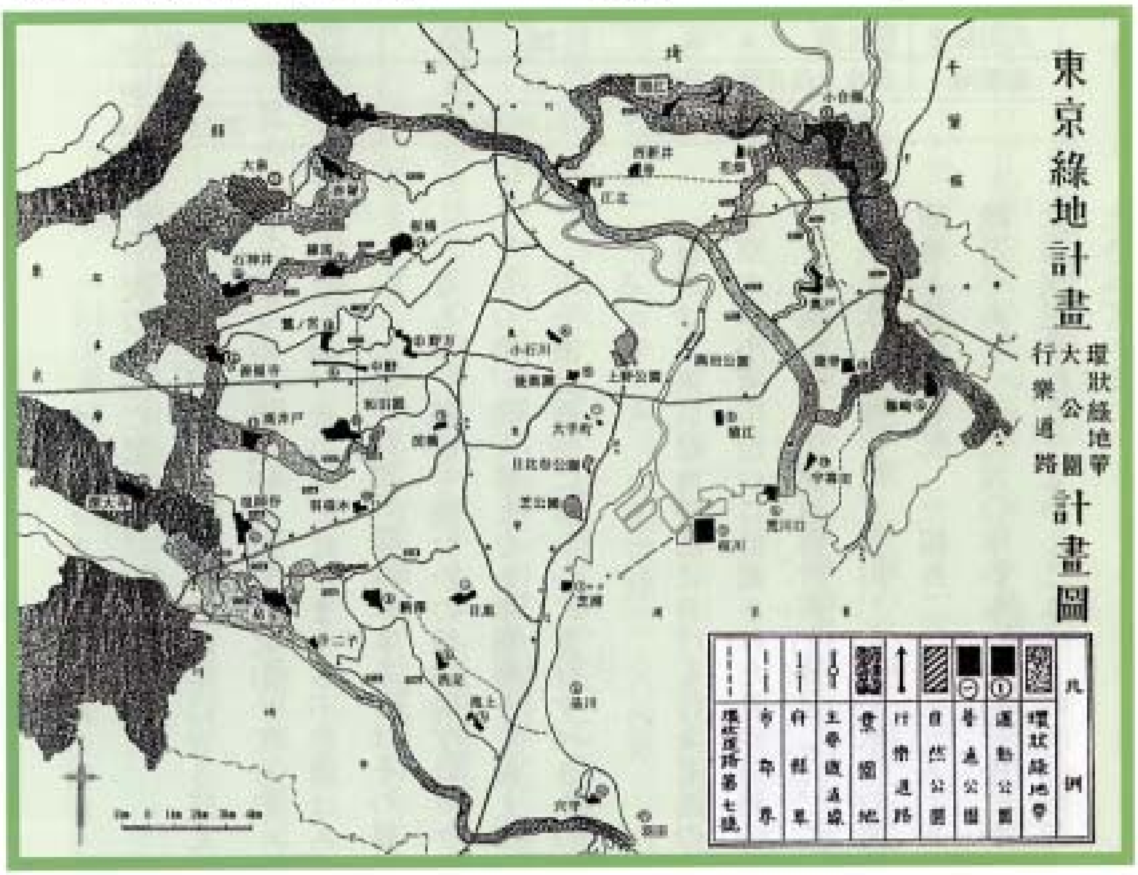
The scenic zone system introduced in the old urban planning law enacted in 1919 was applied to 108 cities before World War II, and such scenic zones are now the symbols of their respective cities. Local waterside scenery from older times has been maintained under this system.

It is important that the problems with waterside scenery in cities and towns today should be solved by taking care of land use relations with their neighboring land. Urban areas have their own respective contexts, and their mosaic assemblies have produced waterside scenery in cities and towns.

Water is indispensable to human life, and people have exerted ingenuity in fostering waterside scenery in their life, though water can cause serious disasters at times. In the garden space created as a utopia, the concept of waterside space as culture is condensed.

The 20th century, a period of urbanization through rapid technological revolution, has passed, and we are at the turning point from the times of function to the times of life, from the times of nations to the times of cities and towns taking care of their own local culture. For the reinstatement of beautiful scenery in the life of citizens, thinking and policy-making that take into account the land use of neighboring land in urban areas are essential. They vary in different localities, and the people and administration in each place must exercise wisdom as they think out specific courses to take. This is a time that requires us to clear away the existing framework and exercise flexible thinking.

The planning map of annual green belt in Tokyo green-tract-of-land plan



Council for Science and Technology Subdivision on Resources List of Members

Subdivision chairperson:

Hisashi Ishitani
Professor, Graduate School of Media and Governance, Keio University

Deputy Subdivision chairperson:

Ikuko Tanioka
President, Chukyo Women's University

Members:

Michiko Imai
Director, LE VERSEAU INC.

Masahiro Kawasaki
Adviser, Japan Science and Technology Corporation

Tomoyo Nonaka
Journalist

Council for Science and Technology Subdivision on Resources Water Resources Committee List of Members

Members:

◎ **Hisashi Ishitani**
Professor, Graduate School of Media and Governance, Keio University

Michiko Imai
Director, LE VERSEAU INC.

Masahiro Kawasaki
Adviser, Japan Science and Technology Corporation

Ikuko Tanioka
President, Chukyo Women's University

Tomoyo Nonaka
Journalist

Expert members:

Mikiko Ishikawa
Professor, Department of Environment and Information, Keio University

Yoshito Oshima
Associate Professor, Environmental Science Center, The University of Tokyo

Taikan Oki
Associate Professor, Research Institute for Humanity and Nature

Norio Ogura
Professor, Graduate School of Agriculture, Tokyo University of Agriculture and Technology

Shû Kobayashi
Professor, Graduate School of Pharmaceutical Sciences, The University of Tokyo

○**Riota Nakamura**
Professor, College of Bioresource Sciences, Nihon University

Sayuri Megumi
Professor, Department of Environmental Design, College of Sociology, Edogawa University

Teruo Yoshino
Professor, Department of Chemistry, Division of Natural Sciences, International Christian University

Tsuneo Watanabe
Professor, Graduate School of Engineering, Tokyo Metropolitan University

(◎: Chief examiner; ○: Deputy chief examiner)

The process of deliberations at the meetings of the Subdivision on Resources, the Council for Science and Technology

The 1st meeting of the Subdivision on Resources, May 23, 2001

(1) On the election of chairperson and deputy chairperson

(2) On the rules for running the Subdivision on Resources meetings

(3) On making public the content of deliberations at the Subdivision on Resources meetings

(4) On the procedures of examinations and deliberations at the Subdivision on Resources meetings

(5) Others

The 2nd meeting of the Subdivision on Resources, July 12, 2001

(1) Lecture by Prof. Katumi Musiake, Institute of Industrial Science, The University of Tokyo
"Water circulation and water resources - from local viewpoints to global view"

(2) Free discussion

The 3rd meeting of the Subdivision on Resources, November 2, 2001

(1) Lecture by Prof. Tomonori Matsuo, Faculty of Regional Development Studies, Toyo University
"Development of water quality problems in water resources"

(2) Free discussion

The 4th meeting of the Subdivision on Resources, February 28, 2002

On priority issues in future deliberations

The 5th meeting of the Subdivision on Resources, September 25, 2002

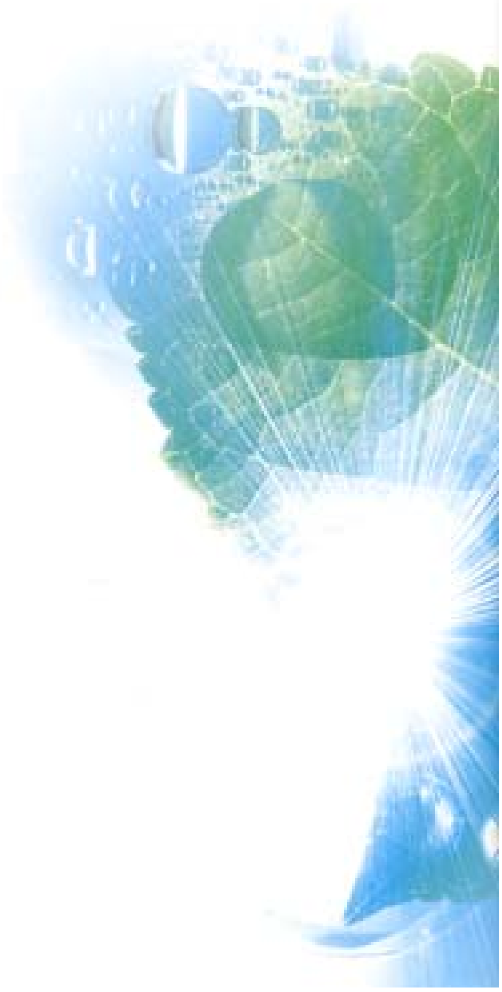
(1) The state of deliberations at the Water Resources Committee

(2) Matters to be deliberated in the future

The 6th meeting of the Subdivision on Resources, December 19, 2002

(1) On the draft report

(2) Others



The process of deliberations at the meetings of the Water Resources Committee, the Subdivision on Resources, the Council for Science and Technology

The 1st meeting of the Water Resources Committee, June 5, 2002

(1) On the procedures of the examinations and deliberations at the meetings of the Water Resources Committee

(2) On the properties and roles of water, by Prof. Teruo Yoshino, Department of Chemistry, Division of Natural Sciences, International Christian University

(3) Others

The 2nd Meeting of the Water Resources Committee, June 20, 2002

(1) On the supply and demand of water

①Prediction of water circulation, by Associate Professor Taikan Oki, Research Institute for Humanity and Nature

②Supply and demand of water (uneven distribution of water), by Prof. Riota Nakamura, College of Bioresource Sciences, Nihon University

(2) Others

The 3rd meeting of the Water Resources Committee, July 11, 2002

(1) Preservation of water quality and water environment

①Preservation of water quality, by Prof. Norio Ogura, Graduate School of Agriculture, Tokyo University of Agriculture and Technology

②Preservation of water environment, by Prof. Sayuri Megumi, Department of Environmental Design, College of Sociology, Edogawa University

(2) Others

The 4th meeting of the Water Resources Committee, July 30, 2002

(1) On the various applications making use of water properties

①New water treatment, by Prof. Tsuneo Watanabe, Graduate School of Engineering, Tokyo Metropolitan University

②Water as a solvent, by Prof. Shū Kobayashi, Graduate School of Pharmaceutical Sciences, The University of Tokyo

(2) Others

The 5th meeting of the Water Resources Committee, September 19, 2002

(1) On the various applications making use of water properties

Water as scenery, by Prof. Mikiko Ishikawa, Department of Environment and Information, Keio University

(2) Roundup

(3) Others

The 6th meeting of the Water Resources Committee, September 25, 2002

(1) On the various applications making use of water properties

Supercritical water, by Associate Professor Yoshito Oshima, Environment Science Center, The University of Tokyo

(2) Others

The 7th meeting of the Water Resources Committee, October 16, 2002

(1) On the draft report

(2) Others

The 8th meeting of the Water Resources Committee, December 19, 2002

(1) On the draft report

(2) Others

Report of the Subdivision on Resources,
The Council for Science and Technology
(Outline)

Office for Resources,
Policy Division,
Science and Technology Policy Bureau,
Ministry of Education, Culture, Sports, Science and Technology
3-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8959, JAPAN
Telephone: +81 3 5253-4111
Fax: +81 3 5253-4010
E-mail:kagseis@mext.go.jp