

THE REPUBLIC OF THE UNION OF MYANMAR
YANGON CITY DEVELOPMENT COMMITTEE (YCDC)

**PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR
THE IMPROVEMENT OF
WATER SUPPLY, SEWERAGE
AND DRAINAGE SYSTEM
IN YANGON CITY
IN
THE REPUBLIC OF THE UNION OF MYANMAR

VOLUME I
WATER VISION OF YANGON CITY**

MARCH 2014

JAPAN INTERNATIONAL COOPERATION AGENCY

**TEC INTERNATIONAL CO., LTD.
NJS CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.
TOKYO SUIDO SERVICES CO., LTD.
TOYO ENGINEERING CORPORATION**

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FINAL REPORT

MARCH 2014

GENERAL LIST OF REPORTS

VOLUME I: WATER VISION OF YANGON CITY
VOLUME II: WATER SUPPLY SYSTEM SUMMARY
VOLUME III: WATER SUPPLY SYSTEM MASTER PLAN
VOLUME IV: WATER SUPPLY SYSTEM FEASIBILITY STUDY
VOLUME V: SEWERAGE AND DRAINAGE SYSTEM SUMMARY
VOLUME VI: SEWERAGE AND DRAINAGE SYSTEM MASTER PLAN
VOLUME VII: SEWERAGE AND DRAINAGE SYSTEM FEASIBILITY STUDY

WATER VISION OF YANGON CITY
[CITIZEN PR VERSION]

Safe, Affluent, & Secure Water Cycle in Future Yangon

-Water Vision of Yangon City-

[Citizen PR Version]

1. Water which Cyclone Nargis brought ...
2. Valuable water and its roles
3. Current situation concerning water in Yangon
4. Problems concerning water environment in Yangon (Now and future)
5. Measures against problems water environment thereafter
6. To protect citizens' life and water environment

March, 2013

YCDC

Yangon City Development Committee

Water which Cyclone Nargis brought ...

A large-scale cyclone, Nargis, with maximum wind velocity of 190 km/hr, which had been formed in the central part of Bengal Bay, attacked Myanmar in May 2008. Nargis slowly moved across Myanmar for 12 hours and caused tremendous damages widely throughout the country. It was reported that farmland area flooded amounted to 600,000 ha, damaged houses to 490,000, and the number of dead and missing to 130,000 persons and finally the worst damages by a natural disaster in the history of Myanmar was recorded.

Affluent water as resource in Myanmar sometimes becomes a threat to and attack people mercilessly. **Then, what does water, which sometimes caused such heavy damages, have to do with our lives and living?**



Source: Private HP



Source: HP of JICA



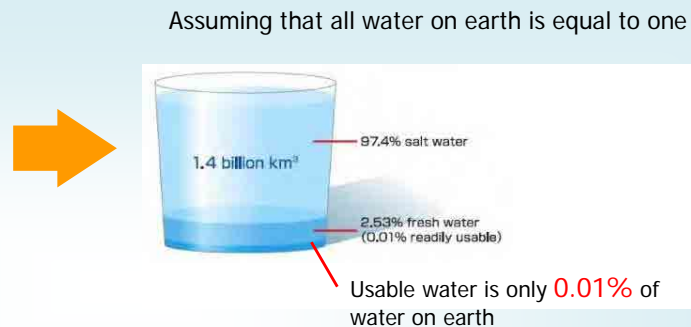
Source: HP of NASA

Valuable water and its roles

How much water do we have on earth, a planet of water?



Source: HP of NASA



Source: A figure in a HP of Japan Water Forum is modified.

Approximately 97% of all water on earth, 1.4 billion m³, is sea water and only 3% remainder exists in the form of fresh water. Besides, about 70% of fresh water exists in the form of glacier and thus only 0.01% of all water can be used in human activities on the earth as a whole, such as water in rivers and lakes.

As can be inferred from the described above, water is quite precious resource on the earth.

Water in our body and its function?

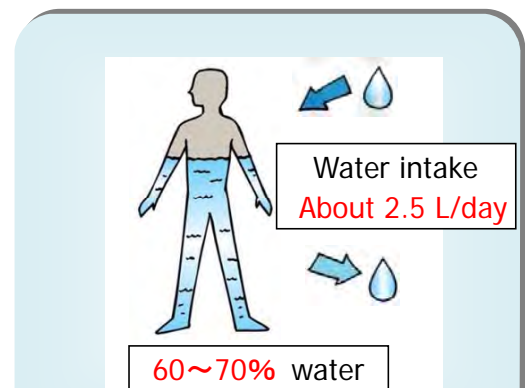
About 60 to 70% of our body is made up of water in weight.

Water works in our body in order to perform following functions.

- ① Protects body organs and tissues → To ease shocks from outside
- ② Regulates body temperature → To maintain even temperature by sweating, etc.
- ③ Transport oxygen and nutrients → To form 90% of blood plasma which is main liquid component of blood
- ④ Discharge wastes → To discharge disused substances in body as urine

As listed above, water has important functions for us to live, and shortage of water in a body causes diverse troubles in health. By losing 5% of water in a body, temperature will rise headache occurs, and losing more will cause convulsions and faint. Then it is said that losing about 20% of water will lead a man to death.

We cannot live without water.



Source: "Drink supplied water for your health" by Ministry of Health, Labor and Welfare

How can water be used in our lives?

We lead a life by receiving various blessings of water.

- 1) Water for life such as in cooking, washing, shower, toilet, etc.
 - ➡ We can lead a hygiene and healthy life with water.
- 2) Water for agricultural and industrial activities.
 - ➡ Food can be produced steadily and industries develop with water.
- 3) Water to foster water culture
 - ➡ Traditional water related culture such as water festival is created with water.
- 4) Water to maintain environment
 - ➡ Rich marine products can be produced by water.

Plenty of water is needed for living, agricultural and industrial activities every day. In order to live and to make living, water is indispensable. But available water amount is not unlimited.

In order to secure sanitary water with necessary amount, it is important to manage water in systematic manner.

Life

Life: Illustrations of a bathtub and a toilet.

Culture

Culture: Photo of a water festival with people and boats.

Source: Private HP

Industry

Industry: Photo of a rural landscape with a water pump and fields.

Environment

Environment: Underwater photo of a coral reef.

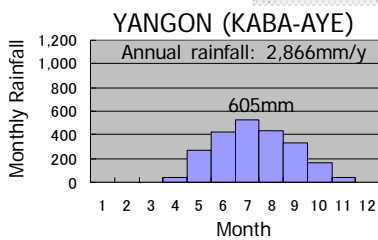
Source: "White paper on Fisheries FY 2010, MAFF, Japan"

Current situation concerning water in Yangon

Affluent water resources

Annual rainfall in Myanmar amounts to 2,091mm, quite high compared with the world average. Annual rainfall in Yangon is higher than that in Myanmar amounting to 2,866 mm, which is 3.5 times higher than the world average. From this data, it is recognized that Yangon City has quite affluent water resource brought by rainfall.

However, it should be noticed that there are both great advantages and disadvantages with risk to have affluent water.



COUNTRY	Rainfall (mm/year)
The world	807
Brazil	1,782
Russia	460
Indonesia	2,702
The United States	715
Thailand	1,622
France	867
Japan	1,718
Britain	1,220
China	627
South Africa	495
Egypt	51
Saudi Arabia	59
Myanmar	2,091
YANGON	2,866

× 3.5

Source: "AQUASTAT", FAO
 Source (Yangon): "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

What affluent water brings us ...

Advantages

Affluent water resources bring up diversified nature and give us living spaces and food. Moreover, water side spaces give us the space for relaxation for our body and soul, help to create culture and traditions, foster environment, and have precious value as tourism resource as well.

Food

Amenities

Living spaces

Disadvantages

Affluent water resources sometimes cause disasters. In 2008, Myanmar was attacked Cyclone Nargis and suffered from tremendous damages. In 2012, moreover, long rain over 2 weeks caused flooding and about 800 km² paddy field was damaged to be flooded.

Buildings destroyed by Nargis

Source: HP of JICA

Paddy field and town flooded

Source: HP of CNN

Source: HP of MSF

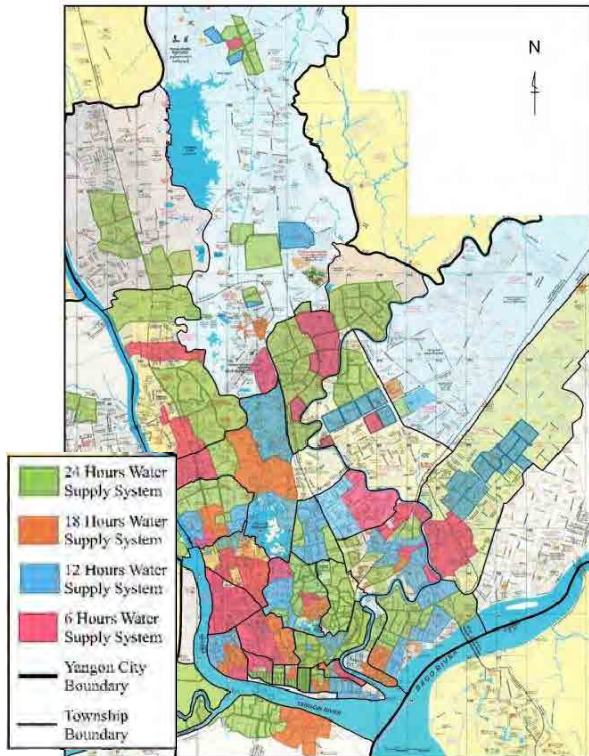
➔
It is important to fully utilize above advantages and to control disadvantages as possible and thus it is needed to comprehensively manage and use water resources.

Problems concerning water environment in Yangon (Now and future)

How is the current water environment in Yangon?

Supply of water

Due to the delay of infrastructure development, there are a lot of areas in which water is supplied in only several hours even in service areas. Although water is obtained from so-called tube wells in areas outside service area, the drying out of groundwater resources and the water pollution are being worried.



Source: Study on the Improvement of Water Supply and Wastewater Treatment in Yangon, 2013

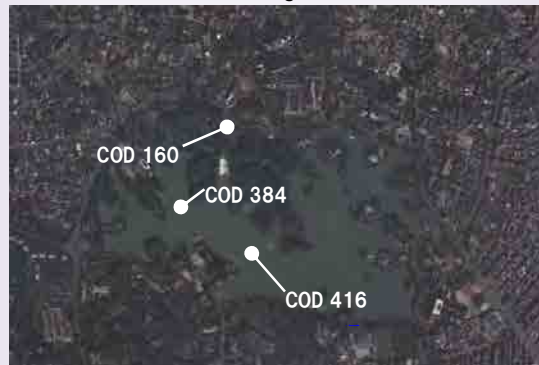
Sanitary treatment of effluent

Sewerage system is provided to 900 ha, which is less than 1% of total city area. Since sewerage system has not been developed for most of city area, wastewater, which flows into rivers and lakes by way of drainage ditches, is causing water pollution of the rivers and lakes.

Water quality of Kandawgyi Lake

The water quality index of water pollution* in Kandawgyi Lake is quite high, 160 to 416 mg/l. shown.

*Chemical oxygen demand (COD). COD standards in Malaysia and China are set to from 10 to 100 mg/l or less.



Source: "The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City", 2013, JICA

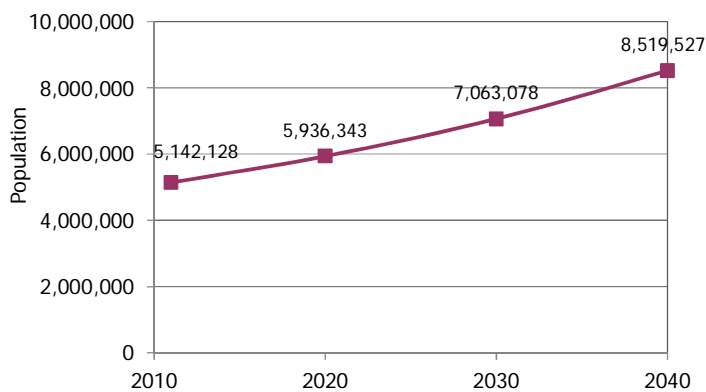
Removal of rainfall runoff

Rainfall in Yangon, a source of inundation as well as valuable water resource, is extremely large amounting to about 3,000mm annually and most of it takes place during rainy season from May to September intensively. Thus, frequent inundation occurs during rainy season with the effect of tide level of ocean, by which living environments are seriously threatened.

How will Yangon be in 2040 !

Population will increase

Population of Yangon City is 5.1 million in 2011 and is estimated to about 8.5 million in 2040, 30 years from now. Also, industrial growth is expected to occur along with population growth in the future.

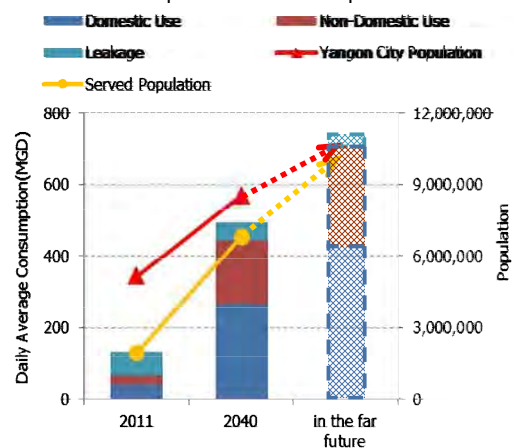


Source: Values are quoted from "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

Projected future population estimate of Yangon City

Water demand & pollution load will increase

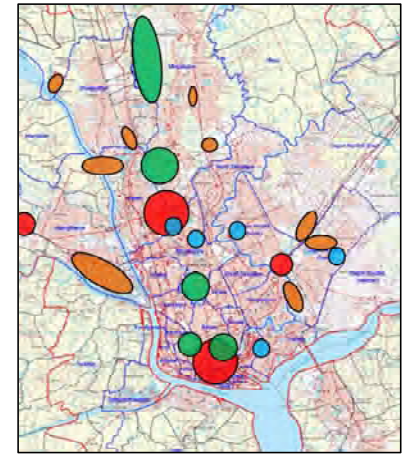
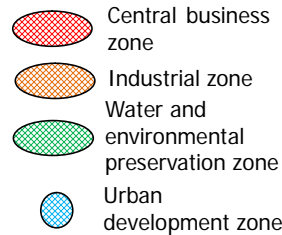
Due to such population and industrial growth, water demand is also estimated to increase dramatically and effluent discharged from urban area is expected to increase. Accordingly, pollution load as the cause of water pollution is also expected to increase.



Future population supplied with water and water demand

Land use will change greatly along industrial growth

Along with industrial growth, land use will be changing. Future land use of city area including central business zone, industrial zone and urban development zone where population will be concentrated and environmental preservation zone which will become foothold of water and greens is expected to be developed according to a city plan. Land use will change dramatically such that roads and buildings will be constructed on the land which used to be bare land or greens.



Source: "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

Water environment will be deteriorated !

Water source runs short and water supply becomes unstable.

Source water quality degrades and supplied water becomes less safe.

Pollution load increases and living and water front environments are deteriorates.

Permeable areas decrease and inundation damages increase.

Diverse risks are worried !

Insufficient and unstable water supply

In case of the development of water supply system is not sufficient, the instability of water supply will become worse and it may cause the decrease of industrial activity level, impossibility of attracting industries, loss of living convenience, *etc.* then ends up to the prevention of the development of the City.



Source: HP of NPO My hours international Society (MIS)

Less safe water supply

Due to water demand increase and the delay of water supply system development, supplied water will be less safe. Due to pollution load increase, moreover, quality of water source will deteriorate and supplied water will be further less safe.



Advancement of environmental degradation

Environmental destruction such as destruction of eco-systems, and extinction of water culture, say fisheries, festivals and recreation, is worried because of the degradation of water quality in ocean, rivers, lakes, groundwater, etc.



Source: HP of Environmental Science Dept. of Shiga Prefectural University,

Outbreak of infectious and pollution-related diseases

Water quality of ocean, river, lake and groundwater will be degraded, if the development of wastewater collection and treatment systems is insufficient. The outbreak of infectious and pollution-related diseases to threaten citizens' safety and health is worried.

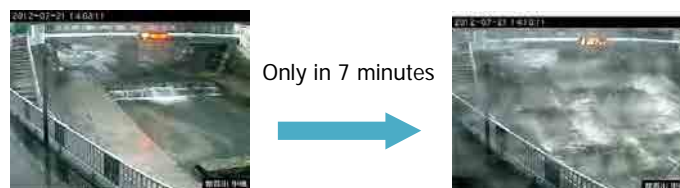


Death of fish such as pond smelts due to the occurrence of blue tide

Source: Explanatory material for reevaluation of Abashiri River environmental project, Japan

Increase of inundation occurrence

Roads and buildings are constructed along economic growth and permeable areas decrease. which results in the increase of rainfall runoff than before even for the same rain. Increase of rainfall runoff will make inundation easy to occur. This will threaten citizens' life.



Source: HP of River Development Section, Civil Works Bureau, Prefectural Development Division, Hyougo Prefecture, Japan

Measures against problems water environment thereafter

Implementation of measures is necessary

By securing water source, safe water will be supplied in stable manner,

By treating effluent, living and water side environment is protected.

By removing rainfall runoff, inundation will be decreased.

Your life will be improved

24 hour supply will become possible !

By developing water supply system, problem of water demand will be settled and everybody will be able to drink safe water with ease for 24 hours.



Source: HP of Akishima City, Japan

Rivers and lakes will become water amenity space !

By developing wastewater treatment facilities, water amenity spaces as the place of citizens' rest, where citizen can enjoy touching water, will be secured and water environment where living creatures can inhabit will be provided.



Water bloom by eutrophication in Suwa Lake, Nagano Pref., Japan, Sept. 1970

Recreation effect by water quality improvement in Suwa Lake, July, 2005

Source: HP of Environmental Comprehensive Research Center, Shiga University, Japan

Whole city will become safe and healthy !

By developing wastewater treatment facilities, street drains and rivers will become clean and bad smell will be gone. In addition, outbreak of infectious diseases will be decreased dramatically.

By preventing inundation, city will be safe !

By developing drainage system, rainfall runoff will be removed from urban areas quickly, and accordingly city will be safe with less inundation damages.

To protect citizens' life and water environment

Water vision is proposed

In order to solve issues and problems concerning future water environment in Yangon City, and to protect citizens' lives and water environment, water vision which is to be the basis of Yangon City's efforts from now on.

Basic idea

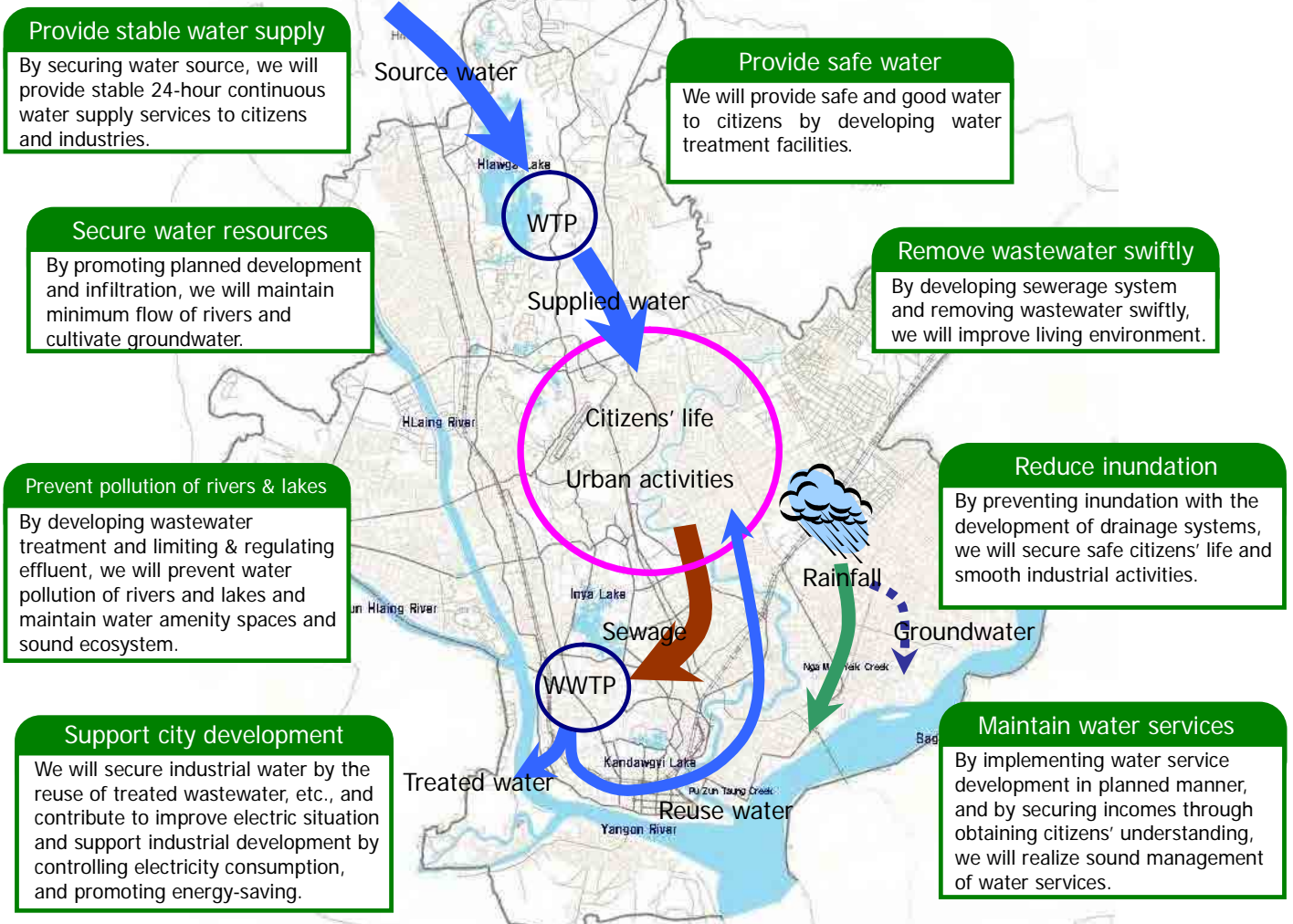
Creation of water environment supporting urban development with the succession of water culture in Yangon
-Handover of water festival to the later generation-

Concept



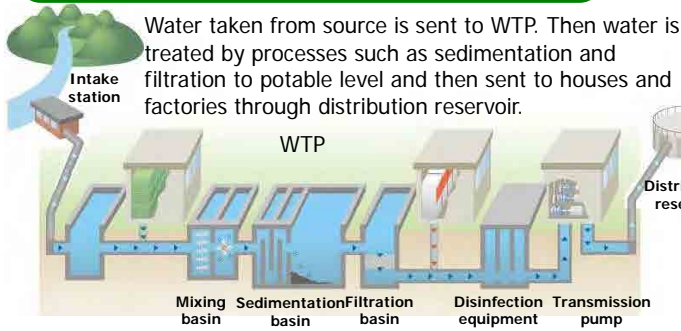
Policy themes and action programs

Concepts	Policy themes		Action programs
Safety and health	Provide safe water	Water supply service ratio increase Improvement of supplied water quality Decrease of infectious diseases	<ul style="list-style-type: none"> Development of water supply pipelines Thorough chlorination disinfection Development of WTP Development of WWTP Development and improvement of septic tanks Development of drainage system WTP: Water treatment plant WWTP: Wastewater treatment plant
	Remove wastewater swiftly	Sewerage service ration increase	
	Reduce inundation	Reduction of inundation damages	
Security and convenience for use	Provide stable water supply	24-hour water supply realization	<ul style="list-style-type: none"> Securement of water source Decrease of water leakage Decrease of other non-revenue water Proper partitioning of distribution areas
Environmental conservation	Secure water resources	Securement of minimum water to maintain rivers and lakes Groundwater recharge	<ul style="list-style-type: none"> Preservation of forests Establishment of development prohibition areas Active introduction of storage & infiltration facilities Limit & regulation of inflow to sewerage Purification of rivers and lakes, etc.
	Prevent water pollution in rivers and lakes	Securement of water amenity spaces Maintenance of ecosystem	
Sustainable development	Support city development	Water resource and energy saving Securement of industrial water	<ul style="list-style-type: none"> Reuse of treated wastewater Construction of energy-saving system Implementation of services in planned manner Promotion of understanding to collection of charges Promotion of understanding to investment to services
	Maintain water services	Financially sound management Enlightening activities	



We will actively struggle to realize water vision !

How is safe water produced?



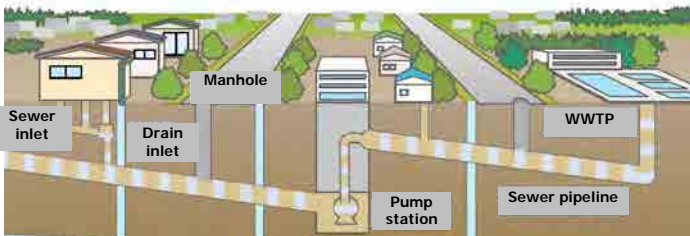
Intake station	Source water is taken from water source and sent to WTP.
Mixing basin	Coagulant is mixed with water to make minute floc of soils is made.
Sediment. basin	Floc is settled and separated by gravity in basins.
Filtration basin	Small floc not removed in sedimentation is filtered by sands, etc. By this process, water is purified further.
Disinfection	Purified water is then disinfected by chlorine.
Transmission	Water is sent to distribution reservoir located in high elevation.
Distribution	Water to be sent to taps of houses and factories is stored.

Source: HP of Maiduru City, Japan

How is wastewater treated clean?

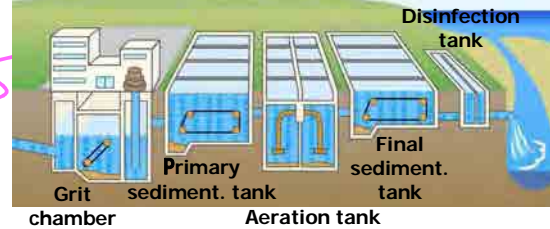
Wastewater discharged from houses and industries is transported through sewerage pipelines to WWTP. Pollution matters are removed by the function of microorganisms and sedimentation at WWTP and treated clean water is discharged to rivers, etc.

-From houses to Wastewater treatment plant (WWTP)



Sewer inlet	Wastewater discharged from houses and factories enters into sewerage pipeline through sewer inlet.
Sewer pipeline	Collected wastewater is transported to WWTP. So as wastewater to flow by gravity, sewers are laid slanted.
Pump Station	In case pipe is laid too deeply, water is pumped up and is discharged into a following sewer laid in shallow depth.

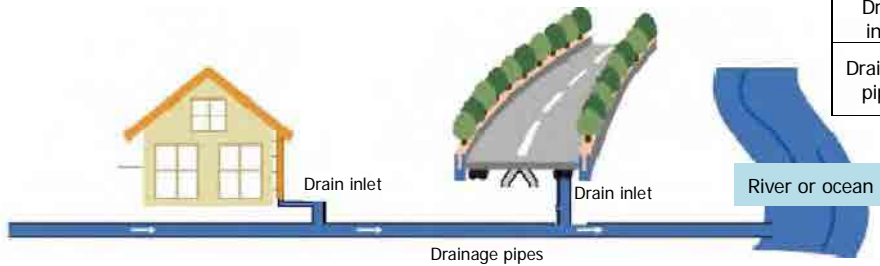
-Treatment system of WWTP-



Grit chamber	Large-sized grits and sands in sewage is removed
Primary sedimentation tank	Small pollutants hard to be removed in grit chamber is removed by sedimentation.
Aeration tank	Microorganisms eat pollution matters in sewage.
Final sedimentation tank	Microorganisms which become bigger by eating pollution matters sink in a tank.
Disinfection tank	Treated wastewater is disinfected by chlorine before being discharged to rivers or oceans

Source: Japan Sewage Works Association

How is rainfall runoff drained?



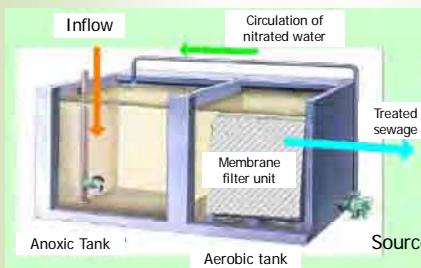
Drain inlet	Rain falling on roofs and roads is collected to drain inlets and then to drainage pipes.
Drainage pipes	Drainage pipes collect rainfall runoff and discharge it to river or ocean. Such as sewers, drain pipes are laid slanted for gravity flow.

Source: Shikoku Regional Development Bureau, Ministry of Land, Infrastructure, Transport & Tourism (MLIT), Japan

What technologies are adequate to Yangon City?

Membrane bio-reactor (MBR)

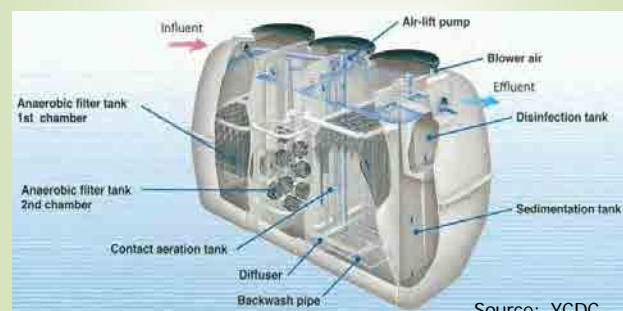
This is a wastewater treatment technology by using membrane filter as a substitute for final clarifier. With this, clean and safe treated water can be obtained and final clarifiers and disinfection facilities can be omitted and thus space for installation can be saved.



Source: HP of Japan Sewage Works Agency

Compact on-site treatment unit (Joukasou)

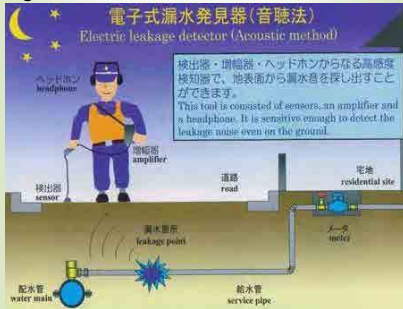
This is a treatment technology which can be installed by household. Since the pipes are not needed, this is less costly than sewerage in areas where houses are located less and scattered.



Source: YCDC

Leakage survey (Acoustic method)

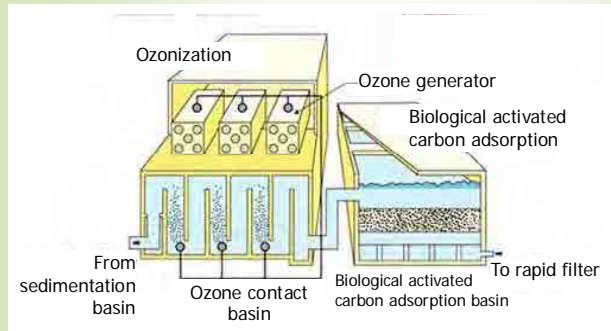
Sites of leakage can be identified by detecting the sound of leakage while investigators specialized in leakage detection check water supply and distribution pipes with an electric leakage detector. (Acoustic method)



Source: Materials of Bureau of Waterworks, Metropolitan Tokyo

Advanced water treatment

Advanced water treatment is provided to treat pollutants which cannot be treated by ordinary sedimentation and sand filtration. With additional treatment processes such as ozonization and biological activated carbon adsorption, odorous compounds such as molds and carcinogens can be removed and safer and better water can be provided, though additional costs are needed.

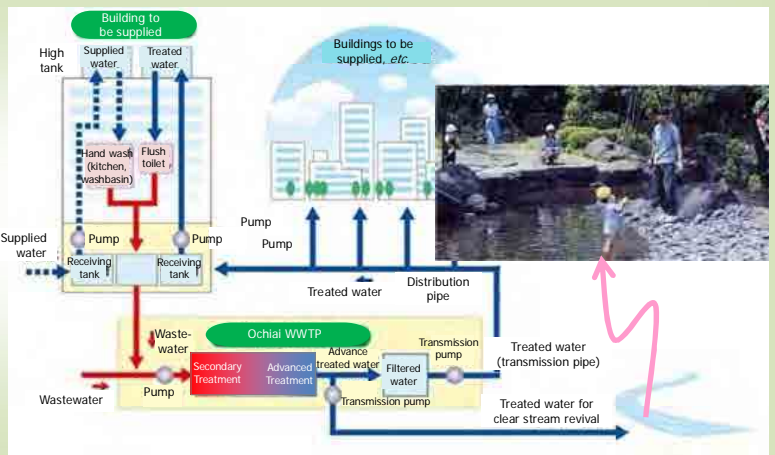


Source: HP of Water Supply Bureau of Metropolitan Tokyo

Reuse of treated wastewater for various use

Treated wastewater can be reused for various purposes. Some additional treatment processes may be needed depending upon the type or purpose of reuse, such as sand filtration, ozonization, activated carbon adsorption, etc. Some of the types of reuse are: water for flush toilets and sprinkling water for greens (dual water supply for a newly developed region), water for industrial use, cooling water for thermal power generation, supply of water to small stream with low flow, etc.

Reuse of treated wastewater can be effective water source in city as well as can bring about water-saving mind to citizens.



Source: HP of Bureau of Sewerage, Metropolitan Tokyo

Cooperation of you as citizen is needed and highly appreciated !

In order to achieve the target water environment, citizens' cooperation and their voluntary activities for environmental preservation are indispensable. For this purpose, required actions to enhance citizens' awareness to environment are taken.

Citizens' cooperation

- Payment for service charge
- Proper O & M for individual treatment equipment

Citizens' voluntary activities for environment

- Water saving
- Observance of rules for use
- Cleaning of ditches and drains

Facility visiting trip



Source: Sewerage vision, Chiryu City, Japan

PR activities by holding events



Source: Sewerage plan of Kunitachi City, Japan

Cleaning of open channel



Source: HP of Voluntary Group for Kawamukou Suiro, Japan

PR by HP (Do not let oil flow)



Source: HP of Bureau of Sewerage, Metropolitan Tokyo



After the relaxation of economic sanction by western countries, many countries have come to the City of Yangon to help the City develop urban infrastructures. Especially with the aid of Japanese Government, we have prepared "The Strategic Urban Development of the Greater Yangon" in 2013. According to the Report, the population of Yangon City is estimated to reach to 8.5 million in 2040 whereas 5.1 million in 2011. With our basic

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In 2010, 38% of citizens are served by YCDC water supply system and remaining 62% obtain water from private wells and the others like pond and rain. Although the collection system for the sewerage system was developed in 1888, however, only 900 ha out of city area of approximately 89,000 ha are served by the existing sewerage system. Sewage from remaining area is various types of onsite disposal system such as septic tank, pour flush toilets, etc.

With due consideration to the above situation concerning water, I, as the Mayor of Yangon City, would like to express my firm determination to provide safe water, hygienic living, and sound water environment to not only all citizens now but also in the future with my recognition of the significance of this Water Vision as city polies concerning water. In order to achieve the target of the Vision, I sincerely requests citizens' understand and cooperation as well which are prerequisite for the City to move water related projects forward from now to create new modern City of Yangon.

U Hla Myint

Mayor of Yangon City



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WATER VISION OF YANGON CITY

Safe, Affluent, & Secure Water Cycle in Future Yangon

-Water Vision of Yangon City-



YCDC

Yangon City Development Committee

Preface



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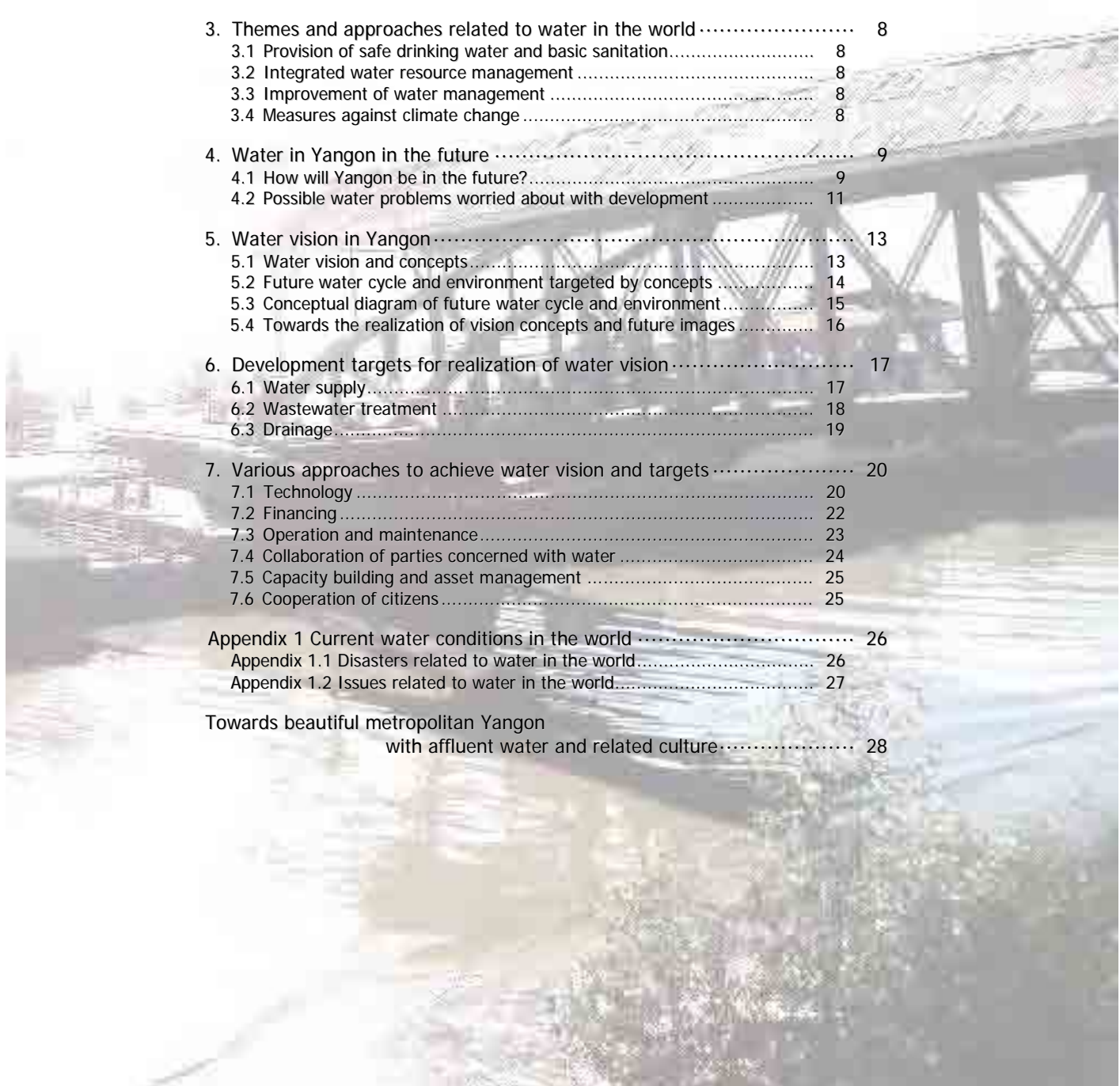
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U Hla Myint
Mayor of Yangon City

Water Vision of Yangon City

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What Cyclone Nargis brought about



Source: HP of NASA



Source: Private HP



Source: HP of JICA

A large-scale cyclone, Nargis, with maximum wind velocity of 190 km/hr, which had been formed in the central part of Bengal Bay, attacked Myanmar in May 2008. Nargis slowly moved across Myanmar for 12 hours and caused tremendous damages widely throughout the country. It was reported that farmland area flooded amounted to 600,000 ha, damaged houses to 490,000, and the number of dead and missing to 130,000 persons and finally the worst damages by a natural disaster in the history of Myanmar was recorded.

It turned out that affluent water as resource in Myanmar sometimes becomes a threat to and attack people mercilessly. On the other hand, our lives and livings are closely related to water and we cannot live without water. Integrated management of water supply, sewerage and drainage is important to use benefit of water as much as possible and to control disaster damages caused by water.

1. Scarce water and its roles

Basic knowledge of water is reviewed and its importance is made clear by understanding the scarcity and characteristics of water and benefits which we obtain from water.

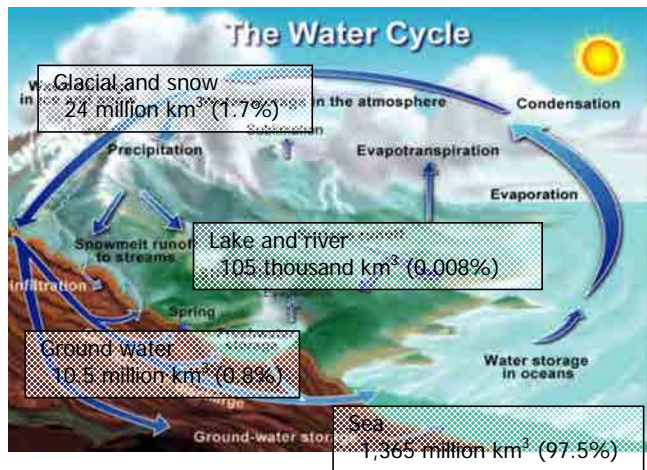
1.1. How much water do we have on earth, a planet of water?

There exists about 1.4 billion km³ of water on earth.



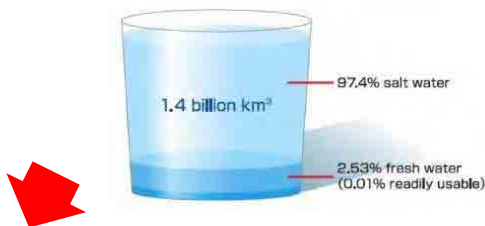
Source: HP of NASA

1.4km³ of water exists on earth in the form of



Source: HP of USGS (U.S. Geological Survey)

Assuming that all water on earth is equal to one cup of water,



Usable water is only 0.01% of water on earth (105,000 km³)

Source: A figure in a HP of Japan Water Forum is modified.

Approximately 97% of all water on earth 1.4 billion m³ is sea water and only 3% remainder exists in the form of fresh water. Besides, about 70% of fresh water exists in the form of glacier and thus only 0.01% of all water can be used in human activities on the earth as a whole, such as water in rivers and lakes

As can be inferred from the described above, water is quite precious resource on the earth.

1.2. Functions which water has

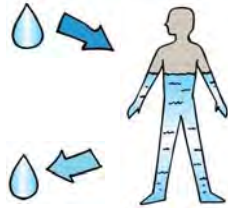
Function 1
Protects body organs and tissues

Constitutes 60 - 70% of human body
Changes 25 l/d by intake and discharge

Function 3
Transports substances by the use of high solubility

Carries nutrients and oxygen to cells
Flushes out waste products

Function 5
Provides living space for living things



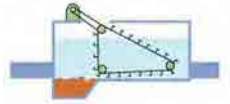
Source: "Drink supplied water for your health" by Ministry of Health, Labor and Welfare (MHLW), Japan

Function 2
Regulates temperature by the use of high specific heat and vaporization heat

Regulates body temperature

Function 4
Separation of substances by the use of the difference of specific gravities

Removes wastes by sedimentation and separation



Function 6
Forms scenery of the nature



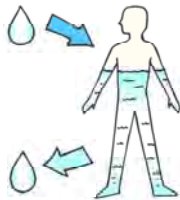
Living activities are maintained and supported by the function of water.

1.3. Benefits obtained from water

Securement of water for agricultural and industrial use
Water supports secure supply of foods and contributes to industrial development.



Maintenance of health
Intake of clean water makes metabolism in a body sound and contributes to maintain health.



Securement of water for domestic use
Sanitary and healthy environment can be maintained the use of clean water for toilet, bathing, cooking, and cleaning.

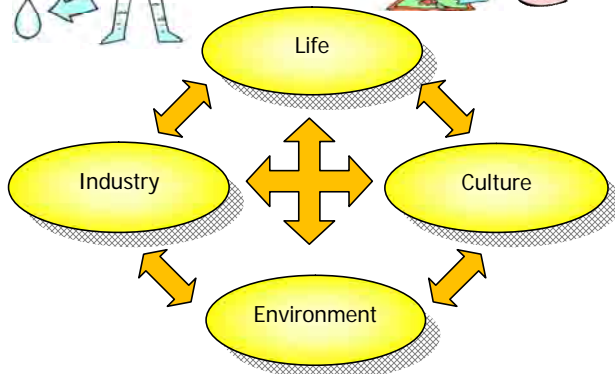


Creation and maintenance of water culture and
Water contributes to create various cultures such as festival and legends.



Source: Private HP

Benefits from water transport
Water transport has been contributing to developments as transportation and distribution means from old times.



Creation of waterside
Waterside spaces can give rest and peace in mind and body for citizens.



Source of marine resources
Water can provide good environment for fisheries, products from which are indispensable foods for people.



Source: "White paper on Fisheries FY 2010, MAFF, Japan

Constitution of diversified ecosystems
Water is indispensable to maintain life for all living things.



Source: HP of World Water Forum

Value as tourism resource
New business is developed by the movement of people searching for water for bathing and tourism.



2. Current situation concerning water in Yangon

2.1. Rainfall amount – existence of water resources -

Water is provided to the earth as rainfall falling down to the earth by the cooling of water evaporated from the surface of the earth up in the air. Although all water falling down as rainfall cannot be given to the earth as usable water, this amount of water is considered as base for fundamental water resource for the country and the region.

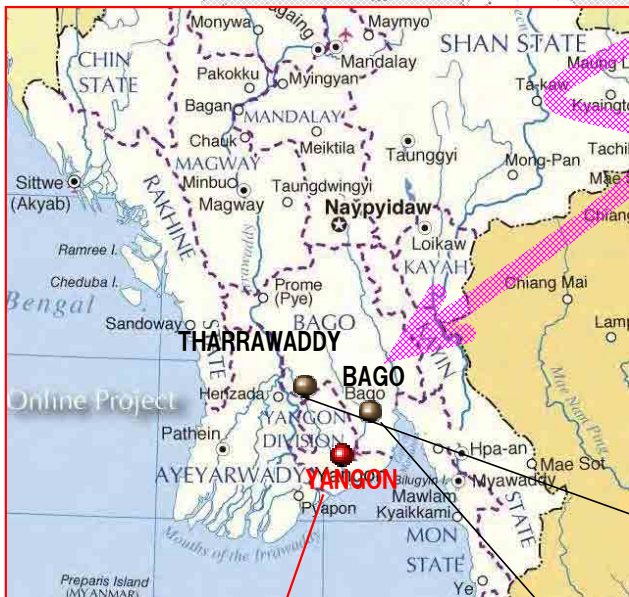
Rainfall amount in Yangon City

- ◆ Annual rainfall in Myanmar amounts to 2,091mm, which is quite high compared with the world average.
- ◆ Annual rainfall in Yangon City is higher than that in Myanmar amounts to 2,866 mm, which is 3.5 times higher than the world average.
- ◆ From this data, it is recognized that Yangon City has very large rainfall amount compared with other countries in the world and that potential water resource is quite affluent.

COUNTRY	Rainfall (mm/year)
The world	807
Brazil	1,782
Russia	460
Indonesia	2,702
The United States	715
Thailand	1,622
France	867
Japan	1,718
Britain	1,220
China	627
South Africa	495
Egypt	51
Saudi Arabia	59
Myanmar	2,091
YANGON	2,866

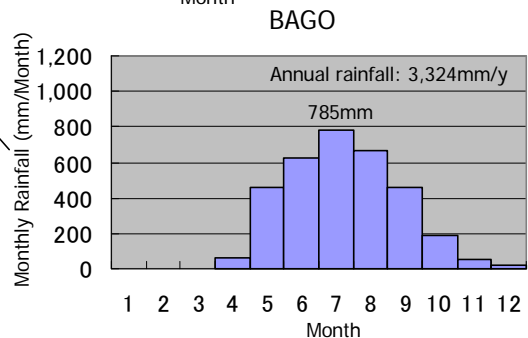
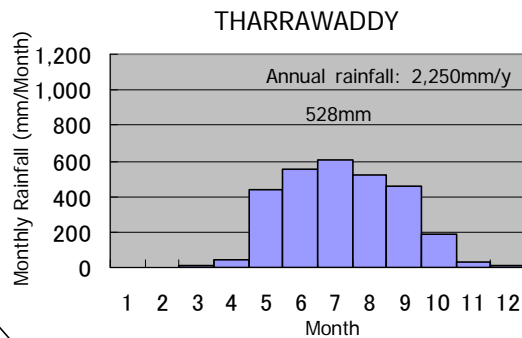
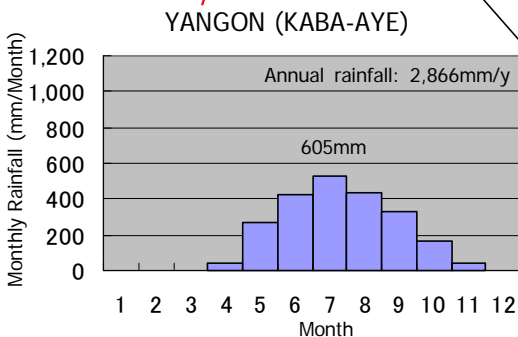
× 3.5

Source: "AQUASTAT", FAO
 Source (Yangon): "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA



Characteristics of rainfalls in Yangon City

- ◆ At Kaba-aye observatory in Yangon City, annual rainfall height is 2,866 mm and monthly maximum rainfall of 605 mm was recorded in July, in average from 2001 to 2010.
- ◆ Rainfalls are concentrated from May to September.
- ◆ Based on the comparison between data observed in Bago and Tharrawaddy observatories, there is a tendency that eastern part has more rainfall than western part for Yangon City and surrounding region.
- ◆ Annual maximum rainfall height is 3,592 mm recorded in 2007 and monthly maximum of 914 mm was recorded in July 2009.
- ◆ Rainfall tends to be of high intensity during short duration.



Note: Rainfall is average value for ten years from 2001 to 2010.

Annual Max. rainfall	3,592mm (2007)
Monthly Max. Rainfall	914mm (Jul/2009)

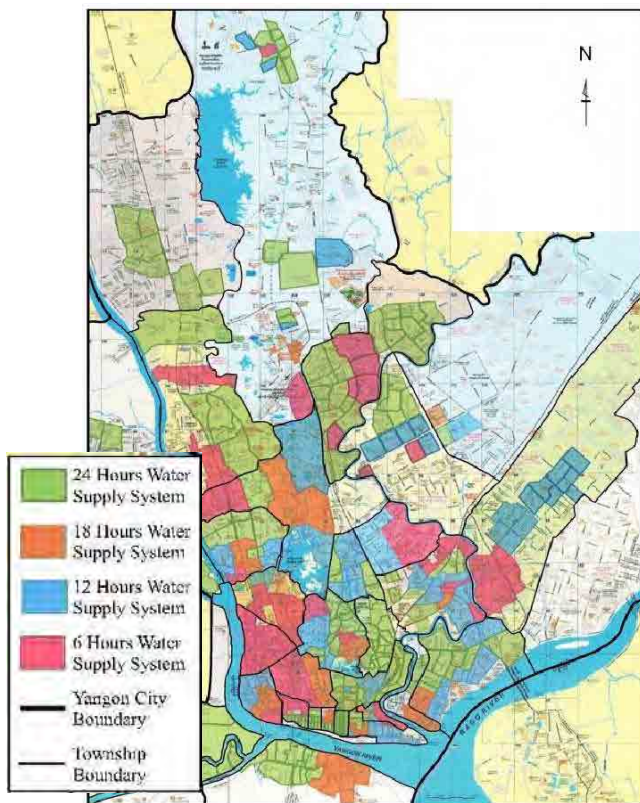
Source: "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

2.2. Current situation of water environment in Yangon

Yangon used to be known as “Garden city in the East” where harmony among extensive parks and lakes, and modern and traditional wooden buildings was observed. By the beginning of 20th century, Yangon had become a city comparable to London in terms of its public services and social infrastructures. Recently, however, the development of sanitary treatment facilities is hardly making any progress in spite of the increase of population due to the expansion of the urban area and the extension of industrial activities and thus the water quality of rivers and lakes is gradually getting worse.

Supply of water

Due to the delay of infrastructure development, there are a lot of areas in which water is supplied in only several hours even in service areas. Although water is obtained from so-called tube wells in areas outside service area, the drying out of underground water resources and the water pollution are being worried.



Source: Study on the Improvement of Water Supply and Wastewater Treatment in Yangon, the Republic of the Union of Myanmar

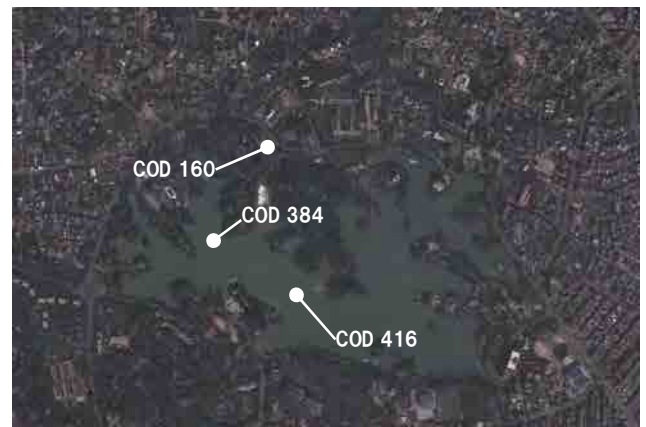
Removal of rainfall runoff

Rainfall which can be source of flood as well as valuable water resource amounts to quite large value, a little bit more than 3,000 mm in a year. Moreover, most of rainfalls are concentrated to occur in rainy season from May to September. Accordingly, living environment is threatened by the frequent occurrence of inundations in conjunction with tidal level of downstream ocean.



Sanitation (sewage treatment)

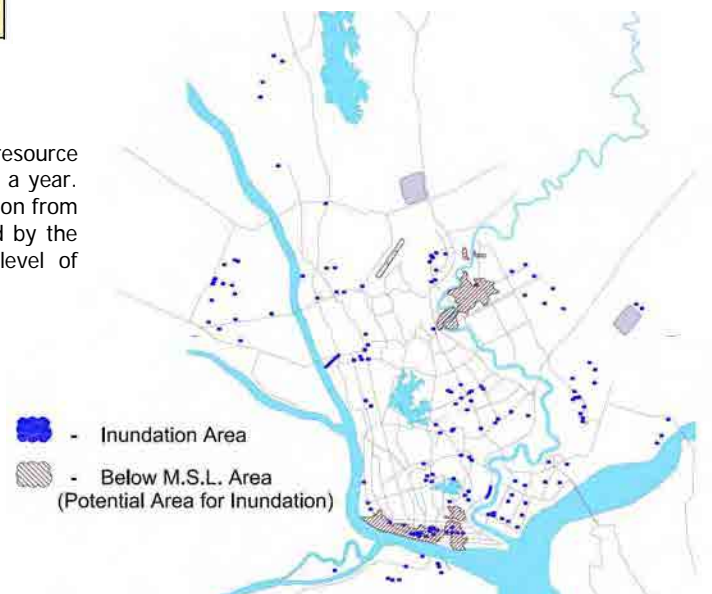
Sewerage system is provided to 900 ha, which is less than 1% of total city area. Since sewerage system has not been developed for most of city area, wastewater, which flows into rivers and lakes by way of drainage ditches, is causing water pollution of the rivers and lakes.



Source: “The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City”, 2013, JICA

The water quality index of water pollution* in Kandawgyi Lake is quite high, 160 to 416 mg/l. shown.

*Chemical oxygen demand (COD). COD standards in Malaysia and China are set to from 10 to 100 mg/l or less.



Source: “The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City”, 2013, JICA

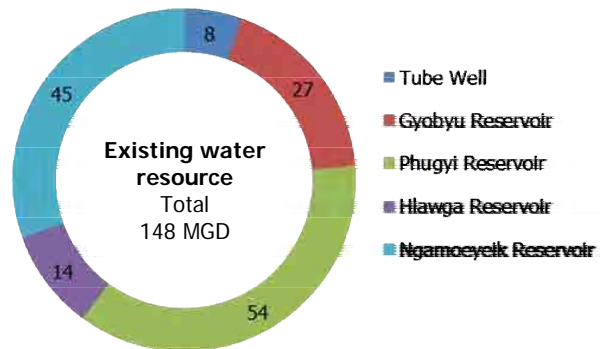
2.3. Current situation of water use in Yangon

Current conditions of water source

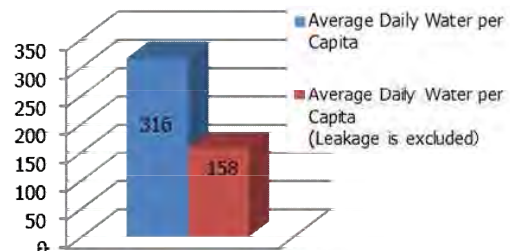
- ◆ 148 MGD of water is secured by 4 reservoirs and 414 tube wells. However, this is 1.10 times of daily average supply of 135 MGD and thus it cannot be said that there is enough water resources allowance.

Increase of water demand

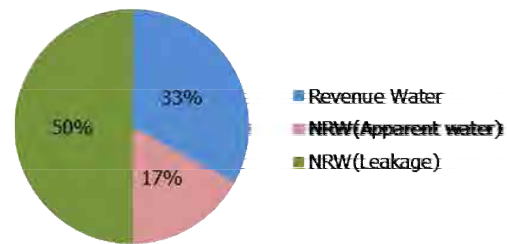
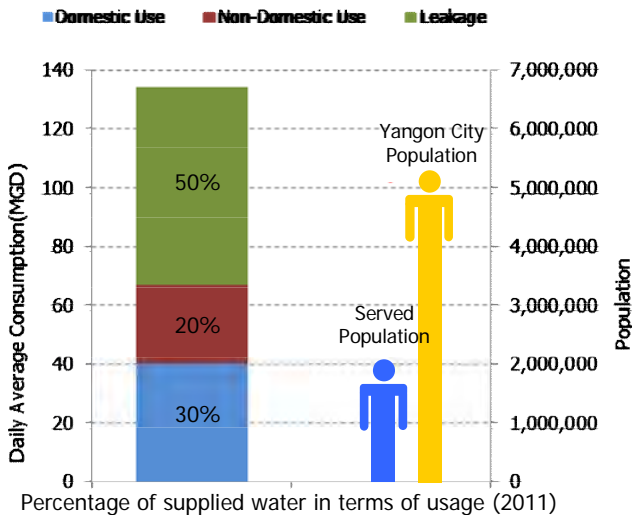
- ◆ Based on components of water use by sectors in 2011, it can be seen that water demand of domestic use is about 30 % and revenue water is relatively low, about 20 %.
- ◆ On the other hand, since leakage rate is quite high of 50 %, measures to prevent leakage are urgently needed.
- ◆ Actual water consumption per capita is 158 l/d. Since leakage rate is high, however, 316 l/d per capita is supplied in total.
- ◆ Ratio of non-revenue water (NRW) including apparent water is high of 67 %. Collection of appropriate water charges as well as the decrease of leakage rate is quite important.



Amount of water source (2011)



Supplied water amount per capita (2011)

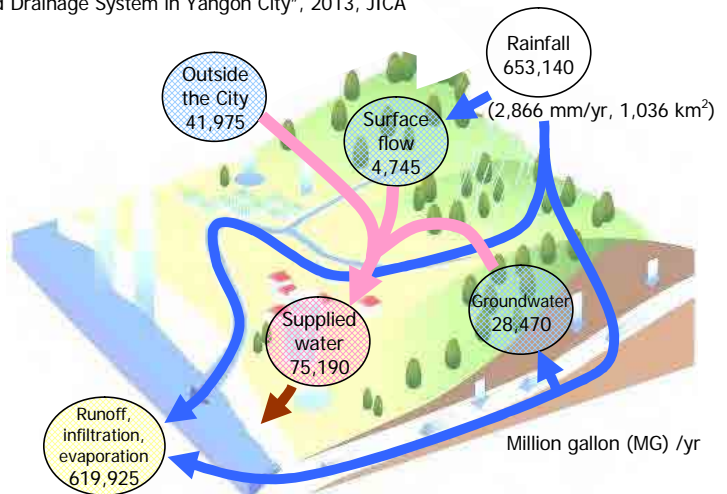


Revenue and Non-revenue water (2011)

Source: All of the above figures and data are quoted from "The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City", 2013, JICA

Rough water balance in Yangon (Estimated)

- ◆ Potential water resource (rainfall amount) of Yangon City is 653,140 MG/yr.
- ◆ From this amount, water from source in the City (Hlawga Lake) and that as groundwater are taken amounting to 28,470 MG/yr.
- ◆ Based on this rough estimate, 95% of potential water resource is estimated to evaporate, run off to ocean, and infiltrate to underground.



Rough water balance in Yangon (Estimated)

2.4. Water related culture in Yangon

Since water is a source of human life, civilization of human beings has been developing where water exists since ancient times. Therefore water has something to do with culture which men have been established from old times in other words. Relationship between historical and cultural heritages and that between customs and festivals and water are examples to name a few. Moreover, water has significantly related to our recreation activities as a familiar example.

Water festival (Thingyan)

Thingyan is a traditional festival event before a New Year of Myanmar calendar. Since Myanmar calendar is determined based on how a moon waxes and wanes, the date of Thingyan festival changes year by year. However, the festival is usually held in the middle of April. This festival is held in the meaning of flowing away evils and evil spirits in our mind in greeting a New Year.

Inya Lake

This is an artificial lake to store water to be supplied to Yangon City and used to send water to Kandawgyi Lake. Currently, it is not used for this purpose. There are restaurants and amusement parks on water side and it is now serving as the space for citizens' rest, leisure and recreation.

Yangon River

River plays important role for Myanmar economy, since ocean ships can navigate. Moreover, river has close relation to citizens and tourism by river crossing and river cruise to upstream.

Kandawgyi Lake

Lake has become places of recreation and relaxation for citizens. In recent years, however, excessive eutrophication has been observed in Kandawgyi Lake and the surface of the Lake is often covered with algal bloom. Because of this, the Lake is losing its function as recreational space for citizens.

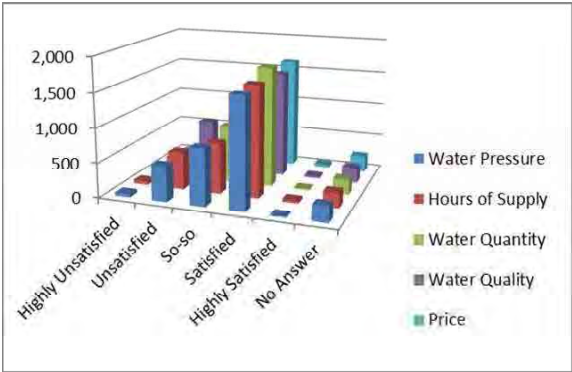
Ferry transportation

Inland waterway transport (IWT) public corporation operates ferries in Dala area opposite side of Yangon City across Yangon River. Ferry carries about 30,000 people in a day and acts as important public transport connecting Dala area and Yangon City.

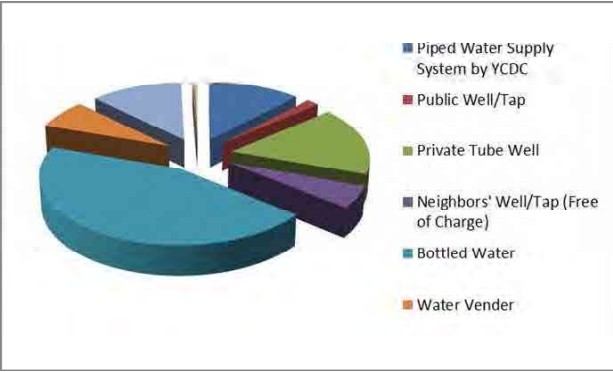
2.5. Actual status of environment concerning water for people in Yangon

Yangon City conducted questionnaire survey to more than 10,000 citizens in order to grasp how they feel about current infrastructures and what they want in the future including water supply, sewerage and drainage system in the "Project for the Strategic Urban Development Plan of the Greater Yangon". Some of the results concerning water related infrastructures are introduced here to reflect citizens' voices in water vision.

Satisfied with current service level of water supplied by YCDC?



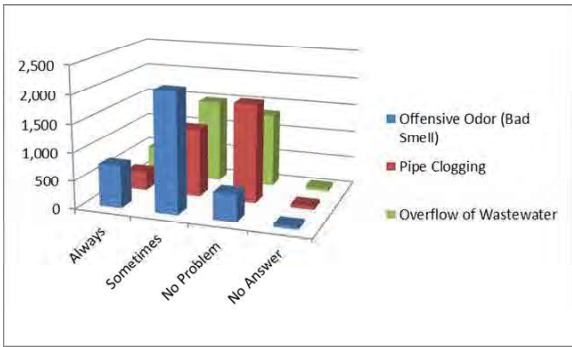
What is the source of drinking water in your house?



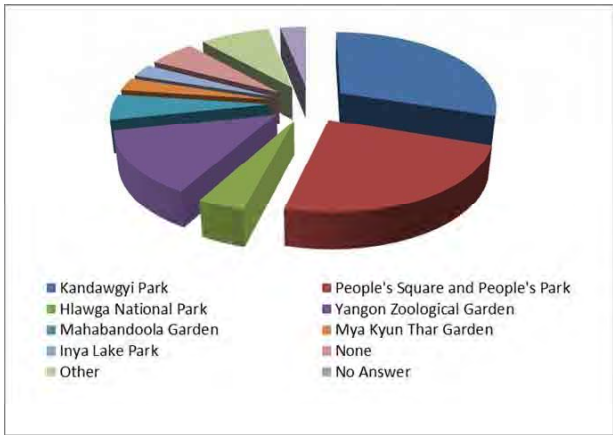
Based on the survey, more than 40% of citizens are not necessarily satisfied with water supplied by YCDC in terms of water pressure, hours of supply, and water quality. As far as water quality is concerned, turbidity and insanitation are noticed as problem. Although more than 50% of citizens who are supplied by YCDC water supply service are satisfied, it should be noted that 44.5% of water users buy pet bottles for drinking purpose.

According to the survey results, more than 90% of citizens have access to pit latrine or pour-flush toilet and only 5.8% has flush toilet. There are 34% of citizens who fell some kind of problems about their sanitation conditions such as offensive odor, overflow of wastewater, and pipe clogging. As a most favorite park, Kandawgyi Park gains greatest popularity. It is inferred from this result that improvement of the water quality in the lake is considered quite important in order to preserve the place of relaxation for citizens.

If you have problems with sanitation, what are they?



What are your most favorite parks and/or green spaces?



3. Themes and approaches related to water in the world

Initiatives, themes and targets concerning water environment and water cycle currently discussed in the world are overviewed in order to refer to develop future water vision, image, and target of Yangon City almost in compliance with world trend.

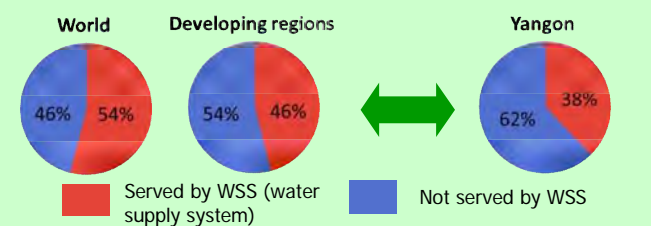
3.1. Provision of safe drinking water and basic sanitation

The United Nations have proposed Millennium Development Goals to be achieved by 2015 and established targets as follows:

Target → Halve, by 2015, the proportion of population without sustainable access to safe drinking water and basic sanitation

Target achieved → Service ratio in Yangon is low compared with world average for both water supply and basic sanitation and further development is needed.

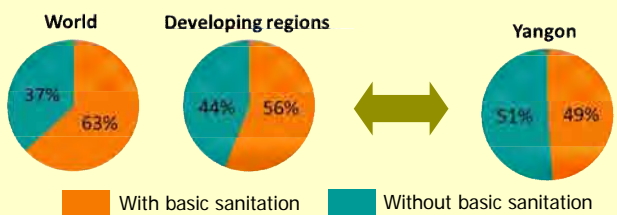
Coverage of water supply system in terms of population (World and developing regions: 2010, Yangon: 2011)



Served by WSS: water supplied by service pipes and taps laid in residence
Not served by WSS: water taken from underground such as tube wells

Source: "The Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City", 2013, JICA for Yangon, and "The Millennium Development Goals Report 2012" for others

Coverage of basic sanitation in terms of population (World and developing regions: 2010, Yangon: 2011)



With basic sanitation: facilities with wastewater treatment such as sewerage, septic tank, toilets with night soil removal, etc.

Without basic sanitation: facilities without wastewater treatment such as bucket latrine, hanging latrine, or outside excretion

3.2. Integrated water resource management

Integrated water resource management (IWRM) → IWRM is a process to develop and manage water resources over making adjustment among water, land and related resources, which has become international common recognition as an effective method to cope with world water problems

Action standard proposed in the 6th World Water Forum

→ In the World Water Forum, international conference to deal with water issues, concrete prioritized action issues and conditions for success were presented. These are related to "equality", "economical efficiency", and "sustainability of environment and ecosystem", also the standard of IWRM.

- ◆ Action standard: "guarantee health and happiness to all people", "contribute to economic development", and "maintain blue earth".
- ◆ Conditions for success: "good governance", "financing water for all", and "enabling environments".

3.3. Improvement of water management

Improvement of water management is discussed as a basic idea to use limited water effectively.

- ◆ Integrated water resource management is required in "ADB's Water for All Policy".
 - Integrated approach across sectors is needed for water resource development and management.
- ◆ World water forum proposes integrated water management for economic growth.
 - Diverse water uses is to be balanced by integrated management of water.

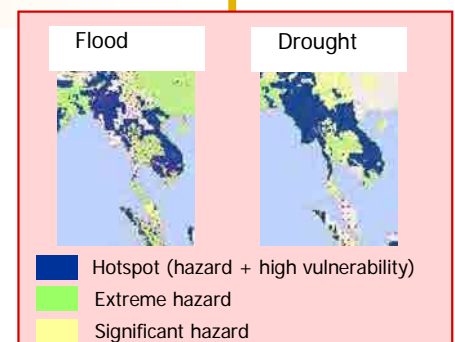
"ADB's Water for All Policy" (partially quoted)

- ◆ Promote integrated water resource management
- ◆ Promote regional cooperation and increase the mutually beneficial use of shared water resources within and between countries
- ◆ Improve governance and capacity building

3.4. Measures against climate change

"VISION 2030" published by WHO warns that peoples' access to safe drinking water and basic sanitation may be threatened by the climate change in the future.

- ◆ Risks by climate change
 - Flood (Risk that flooding occurs more frequently by climate change)
 - Due to floods, water treatment facilities may be heavily damaged. And peoples' health is threatened by deterioration of sanitation environment with overflow of polluted matters on the ground
 - Drought (Risk of frequent droughts due to dry season and dry areas extension)
 - Securement of safe drinking water becomes difficult due to droughts.
- ◆ How to be prepared
 - Integrated management of water facilities is needed to handle variable climate.
 - Technological progress is needed by clearing the lack of hydrological and water data.



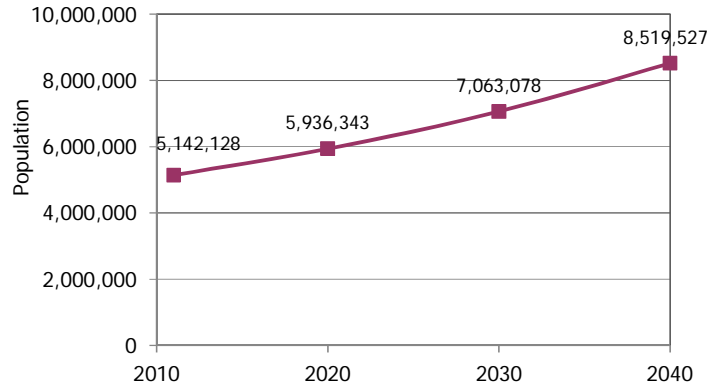
Source: "Climate change and human vulnerability", OCHA

4. Water in Yangon in the future

4.1. How will Yangon be in the future?

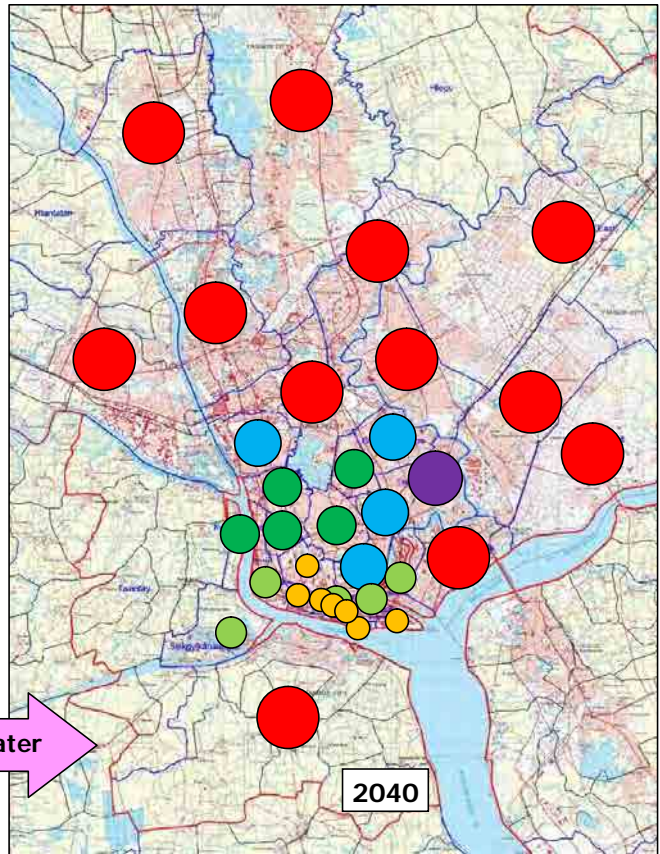
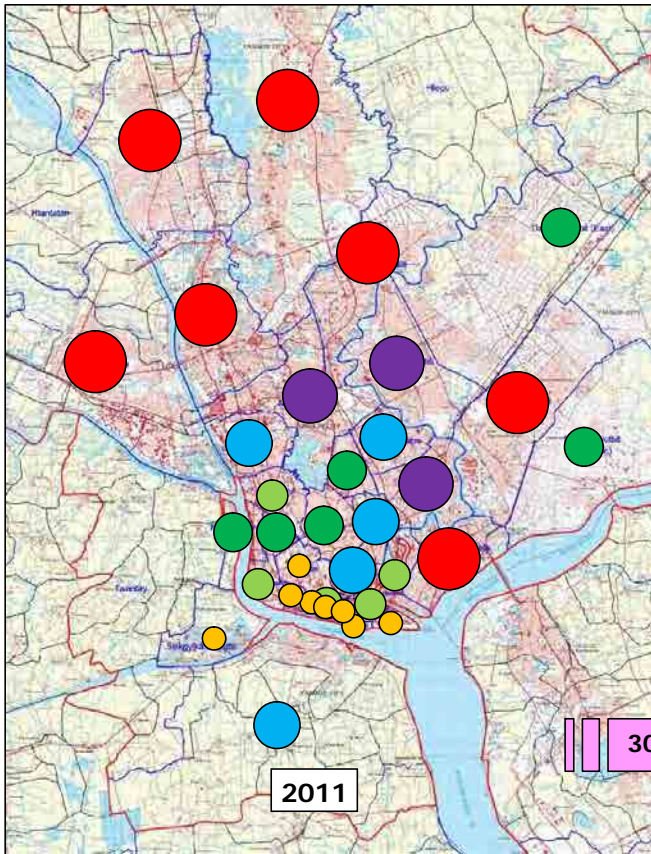
Population projection

- ◆ Population of Yangon City is approximately 5.1 million in 2011 and is projected to 8.5 million in 2040, 30 years from now.
- ◆ Referring to population distribution by township, the number of townships with population more than 250 thousand increases from 8 in 2011 to 13 townships in 2040.
- ◆ The trend shows that there is not a dramatic increase in population in townships in northern area located along Yangon River, though there is in townships in inland area.



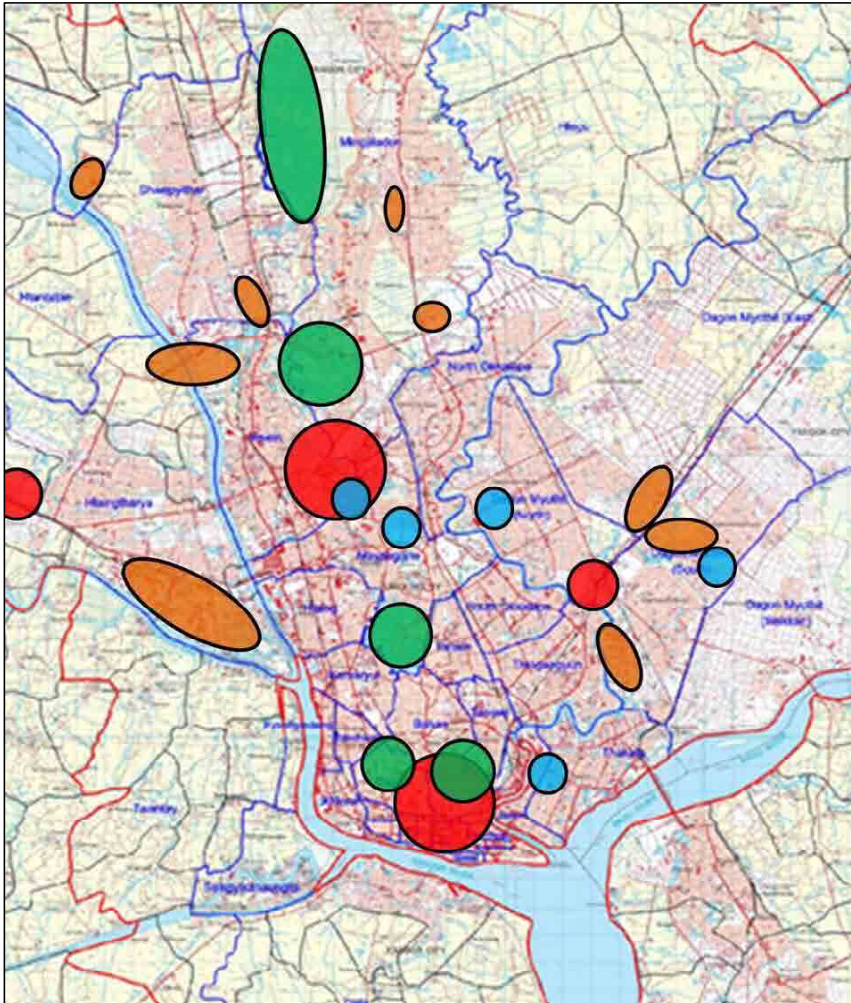
Source: Values are quoted from "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

Projected future population estimate of Yangon City



Source: Values are quoted from "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

Map of future population distribution in Yangon City



Future land use plan

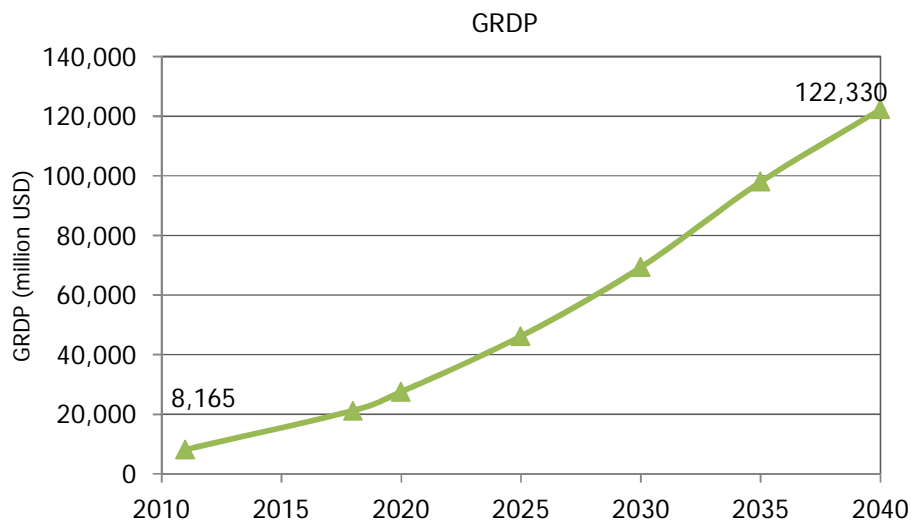
- ◆ There are a lot of areas where people live or gather densely as commercial centers, industrial area and urban development areas.
- ◆ On the other hand, areas to become a base for waters and greens such as environment preservation areas are placed among them.

- Business District
- Industrial Zones
- Water Bodies and Environmental Conservation
- Urban development area

Source: Produced based on "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

Economic growth

- ◆ GDP per capita of Myanmar in 2035 is expected to reach the level of Thailand in 2011. And GRDP of Yangon City is estimated to amount to about 15 times the current level in 2011.
- ◆ While the high growth in commerce and industries is expected, process and manufacturing sector in particular is expected to grow sharply by 11.1 % annually in the coming 5 years.



Source: Values are quoted from "The Project for the Strategic Urban Development Plan of the Greater Yangon", 2012, JICA

4.2. Possible water problems worried about with development

At the time of high growth of economy in 1960s, Japan experienced serious environmental problems such as severe water pollution and land subsidence due to excessive intake of groundwater and it took Japan a long time to cope with these problems. In cities which will be developed from now on, therefore, it is quite important to estimate the environmental impacts which may possibly occur and promote the measures to cope with these impacts as well as developments based on Japanese experiences. Possible future problems are identified and listed in terms of citizens' life and urban activities, and water environment here.

- Citizens' life and urban activities -

Various risks such are worried as obstructing safe, convenient and affluent urban activities as well as threatening citizens' safety and health.

◆ Less safe water supply [Become worse]

Present

According to the questionnaire survey to citizens, 44.5% of users of water supply system purchase bottled water for drinking purposes.

Future

Due to water demand increase and the delay of water supply system development, supplied water will be less safe. Due to pollution load increase, moreover, quality of water source will deteriorate and supplied water will be further less safe.



◆ Outbreak of infectious and pollution-related diseases [Become worse]

Due to increase of pollution loads from urban areas, water quality of ocean, river, lake and groundwater will be degraded, if the development of wastewater collection and treatment systems is insufficient.

By the accumulation of pollution matters in human bodies through drinking water, foods, fish and shells, for which water of river, lake, and ocean is used as source material, habitat environment, etc., the outbreak of infectious and pollution-related diseases to threaten citizens' safety and health is worried.



Death of fish such as pond smelts due to the occurrence of blue tide

Source: Explanatory material for reevaluation of Abashiri River environmental project, Japan

◆ Deterioration of environment around living [Become worse]

Present

Since sewerage system has not been developed for most of city area, wastewater flows into rivers and lakes by way of street drains and drainage ditches without treatment.

Future

Increase of water demand results in increase of wastewater. Thus it is feared that problems such as bad smell from street drains and drain ditches may be more tangible and hygienic conditions worse in case of insufficient development of wastewater treatment systems.



Picture in Yangon City

◆ Increase of inundation [Become worse]

Present

In conjunction with tide level of downstream ocean, frequent flooding occurs and threatens the living environment in rainy season.

Future

Due to economic growth, roads and buildings are constructed and permeable areas decrease, which results in the increase of rainfall runoff than before. Increase of rainfall runoff will make inundation easy to occur. This will not only threaten citizens' life but also cause heavy damages on industrial activities.



Source: HP of River Development Section, Civil Works Bureau, Prefectural Development Division, Hyogo Prefecture, Japan

◆ Insufficient and unstable water supply [Become worse]

Present

Time in which water is supplied is limited to a few hours even in service areas.

Future

Due to population increase and the industrial growth, water demand increases. In case of the development of water supply system is not sufficient, the instability of water supply will become worse and it may cause the decrease of industrial activity level, impossibility of attracting industries, loss of living convenience, etc. then ends up to the prevention of the development of the City.



Source: HP of NPO My hours international Society (MIS)

- Water environment and water cycle-

Various risks are worried such as advancement of environment destruction with by wasting energy.

◆ **Decrease of river flow [New problem]**

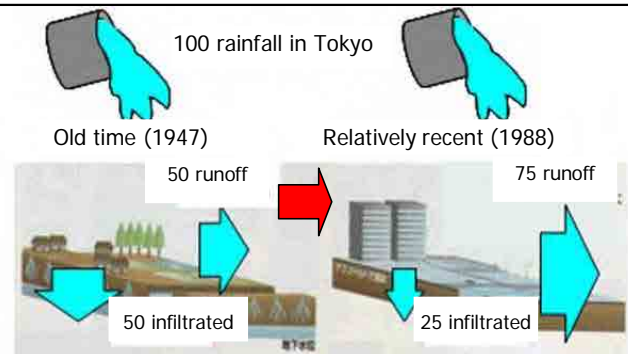
Increase of water intake from public water bodies in order to deal with growing water demand may cause the decrease of river flow. This may cause environmental impacts on such as water resource securement and the change of eco-systems.

Source: Material for press announcement by Omono River Drought Information Liaison Group

◆ **Lowering of groundwater table [New problem]**

Due to the decrease of permeable surfaces in urban areas caused by the construction of roads and buildings according to industrial growth, infiltration of water to underground will decrease and thus lowering of groundwater table is worried. Lowering of groundwater table may stop groundwater to well out from existing wells and cause the decrease of spring water amount. Furthermore, groundwater may become salty due to the intrusion of ocean water in areas near seashore. As such, the lowering of groundwater table may cause serious problems to citizens' life. In addition, land subsidence may occur by the increase of groundwater withdrawal as well as the lowering of groundwater table.

Source: HP of Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan

◆ **Water quality deterioration of public water bodies [Become worse]**Present

Since sewerage system has not been developed for most of city area, wastewater, which flows into rivers and lakes by way of drainage ditches, is causing water pollution of the rivers and lakes.

Future

Due to population increase and industrial growth, pollution loads discharged from urban areas increase. Along with the above, it is worried that further deterioration of water quality in ocean, rivers, lakes and groundwater.



Picture showing river in 1970 in Tokyo polluted by domestic effluent, etc. due to the delay of development of sewerage system during high economic growth

Source: HP of Environment Bureau, Metropolitan Tokyo

◆ **Advancement of environmental destruction [Become worse]**Present

Eutrophication in Kandawgyi Lake has advanced excessively. It is in the condition that the surface is covered with algal bloom and sound water side environment is being lost.

Future

Due to population increase and industrial growth, pollution loads to be discharged from urban areas increases. Environmental destruction such as destruction of eco-systems, and extinction of water culture, say fisheries, festivals and recreation, is worried because of the degradation of water quality in water bodies caused by the above.



Source: (left) HP of Environmental Science Dept. of Shiga Prefectural University, (right) HP of Faculty of Agriculture and agricultural Science, Kochi University

◆ **Waste of water resource and energy [Become worse]**Present

Leakage rate is high of 50% and valuable water resources are wasted.

Future

Due to the increase of water pressure with water demand increase and the aging of water supply facilities, mainly water supply pipes, further increase of leakage amount is worried. The increase of leakage amount not only wastes valuable water resource more but also may cause the increase of chemicals and energy consumption required for treatment.



Source: HP of Water supply Bureau, Saitama City, Japan

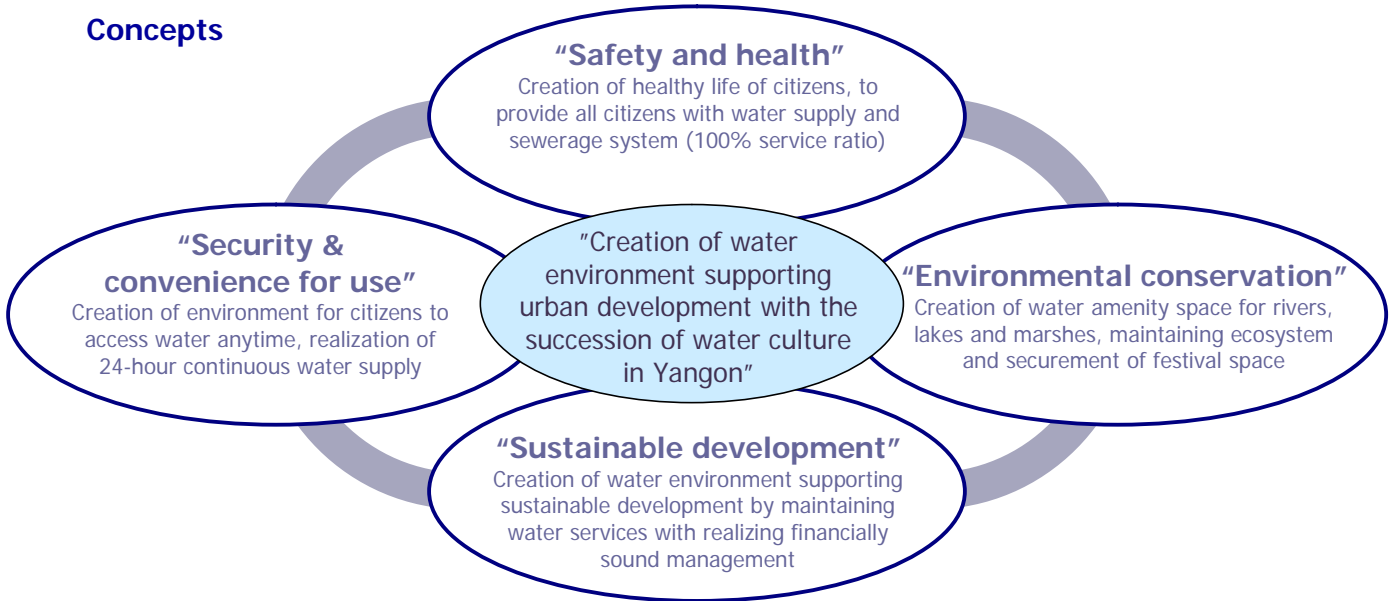
5. Water vision in Yangon

In order to cope with various problems to be concerned due to city development and to avoid risks possibly incurred, Yangon City prepared water vision and implement programs based thereon.

5.1. Water vision and concepts

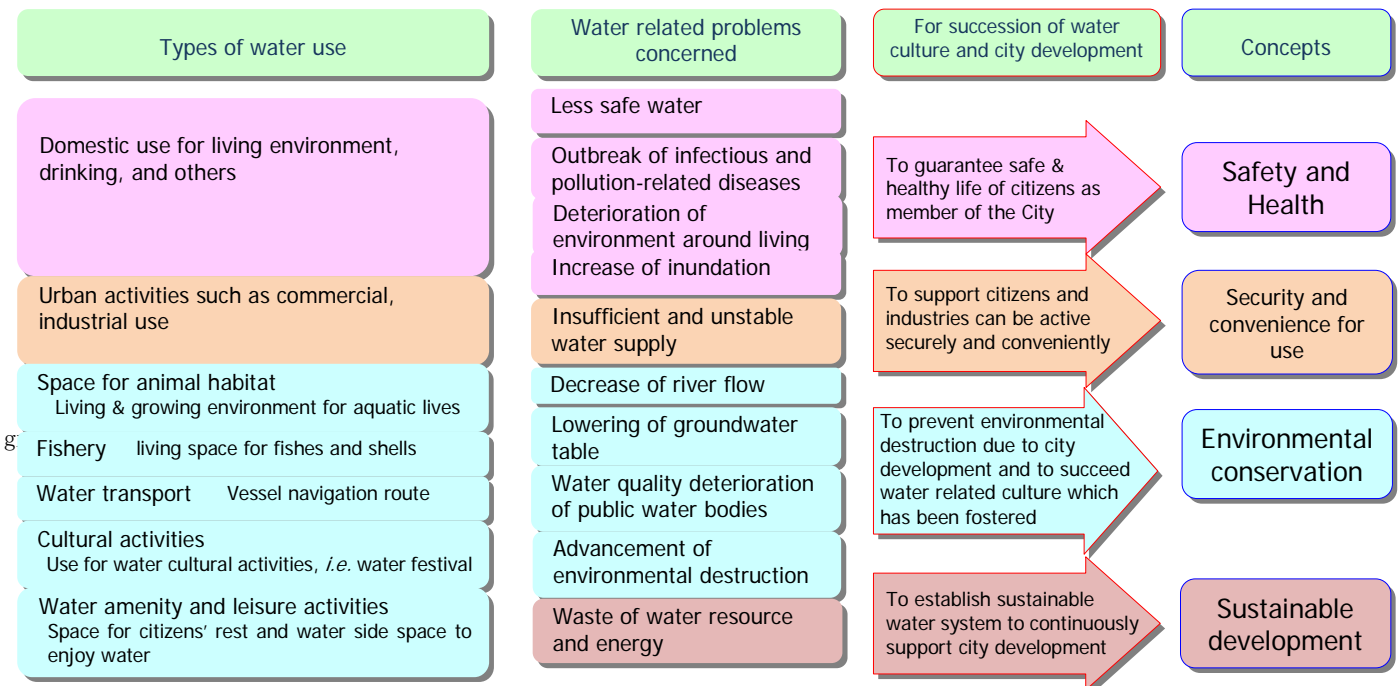
Basic idea Creation of Water Environment Supporting Urban Development with the Succession of Water Culture in Yangon
-Handover of Water Festival to the Later Generation-

Concepts



In order to support development of Yangon City, it is necessary for the City to guarantee that citizens as members of the City can lead safe and healthy life and citizens and industries can be active securely and conveniently. It is important, moreover, that environment will not be destroyed by the city development, ecosystem will be maintained, and that water culture which has been fostered will be succeeded. In addition, it is necessary to maintain water services, to save water resources and energy, and to realize sustainable water system for maintaining water cycle to support the development of the City.

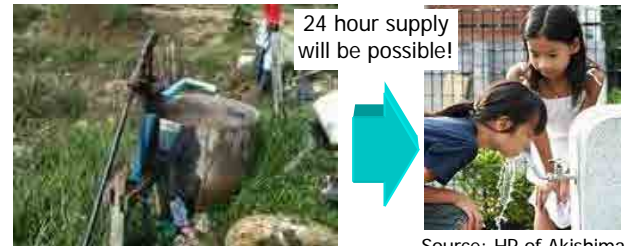
Thus, concepts of Water Vision in Yangon are set to "safety & health", "security & convenience for use", sustainable development", "environmental conservation" as keywords.



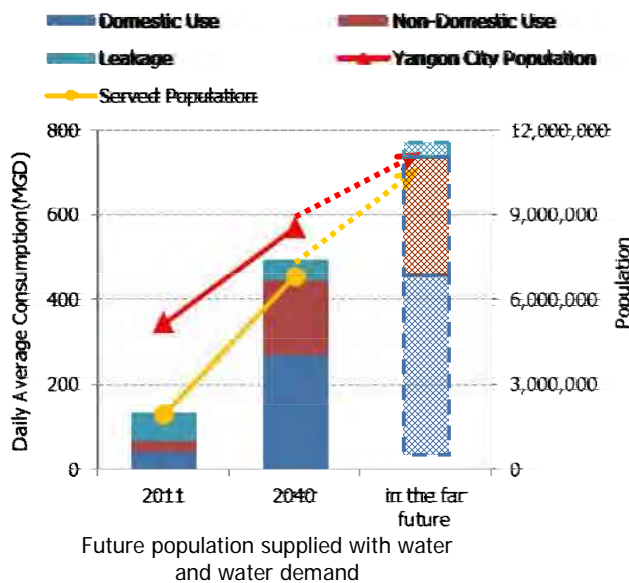
5.2. Future water cycle and environment targeted by concepts

"Safety & health" - Improvement of living environment -

- ◆ Supply of safe water
 - To supply to all citizens safe water in compliance with drinking water quality standards to secure citizens' healthy living
- ◆ Swift removal of wastewater from living space
 - To promote the provision of sanitary toilets and to remove wastewater from living space swiftly to promote Citizens' sanitary living
- ◆ Prevention of inundation
 - To prevent the occurrence of inundation to secure citizens' safe living



Source: HP of Akishima City, Japan



"Security & convenience for use" - Maintenance of urban activities -

- ◆ Stable and secure supply of water
 - To cope with water demand for urban activities estimated to increase by population growth, activation of commercial activities, and industrial development
 - To supply water securely to maintain citizens' life and other urban activities

"Environmental conservation"

- Succession of water culture & creation of watersides friendly to men and living creatures -

- ◆ Securement of water sources
 - To cope with the decrease of public water bodies and groundwater by the increase of water for urban activities and by the decrease of permeable surfaces due to urban development
 - To maintain river flow required for fisheries, habitat for aquatic organisms and for water transport
 - To maintain permeable surfaces by the establishing areas prohibiting development, the promotion of well planned development, and the promotion of infiltration in development areas
- ◆ Improvement of water quality in rivers, lakes, etc.
 - To cope with water quality degradation in rivers and lakes by the increase of pollution loads caused by population growth and industrial development
 - To achieve good water quality for men and all creatures
 - To provide watersides for citizens' rest and recreation where they can touch and enjoy water
 - To preserve water side space to maintain ecosystem



Water bloom by eutrophication in Suwa Lake, Nagano Pref., Japan, Sept. 1970

Recreation effect by water quality improvement in Suwa Lake, July, 2005

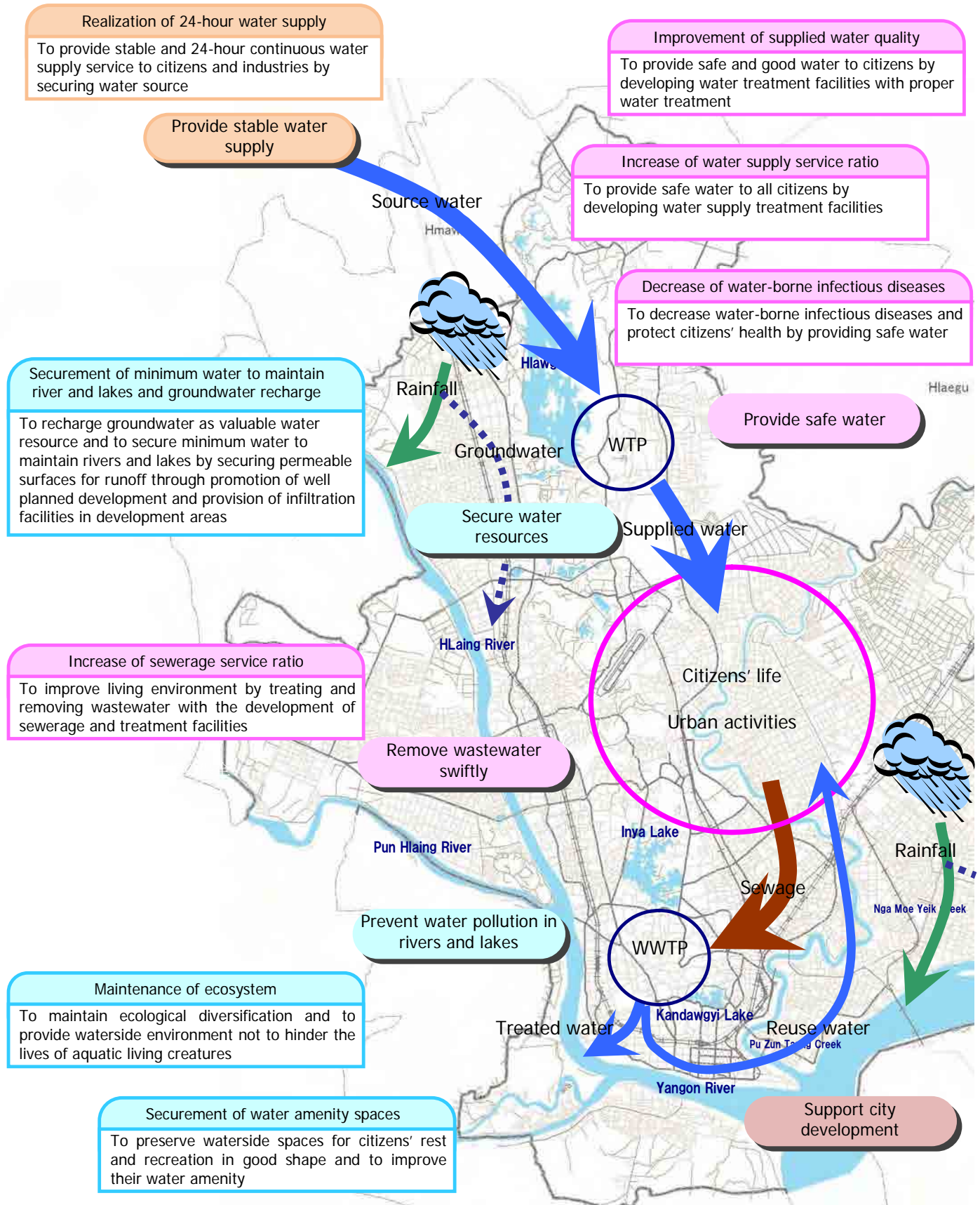
Source: HP of Environmental Comprehensive Research Center, Shiga University, Japan

"Sustainable development"

- Creation of water environment supporting sustainable development of the City -

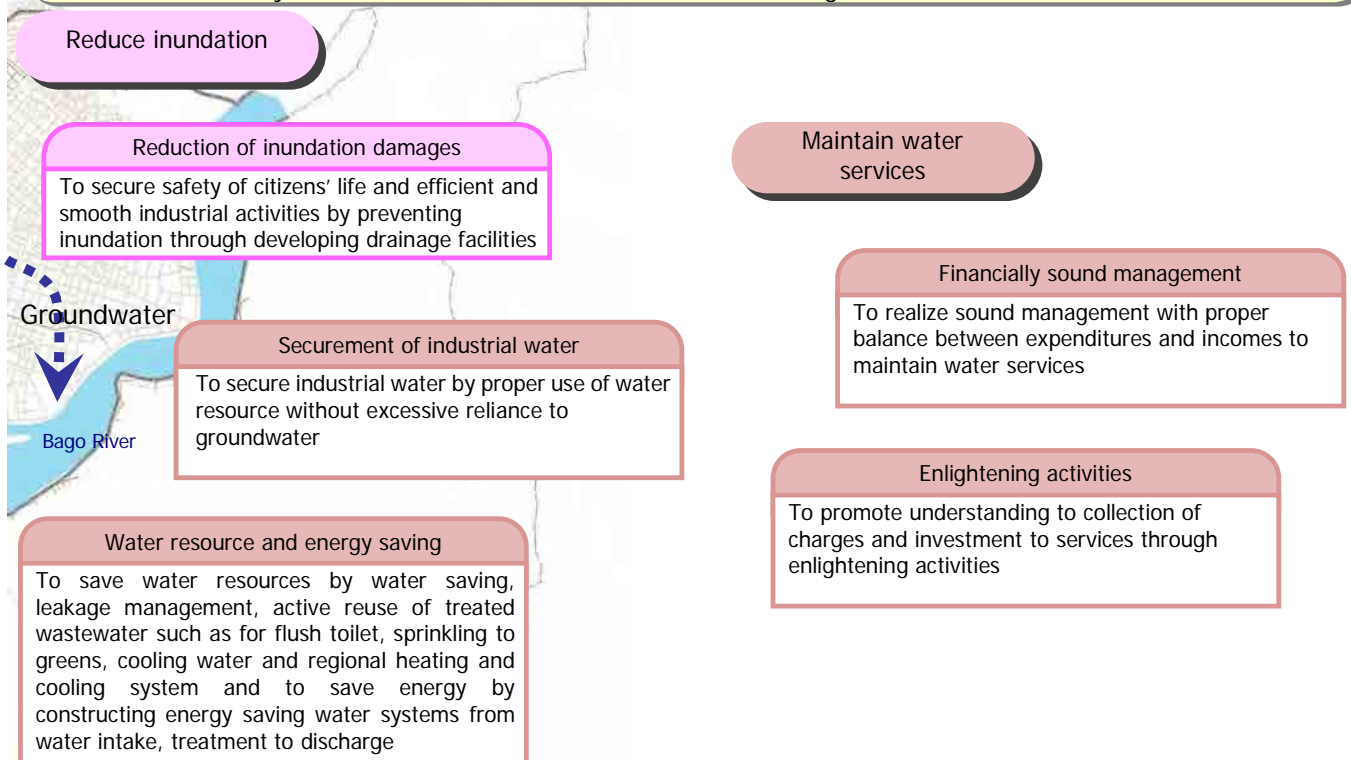
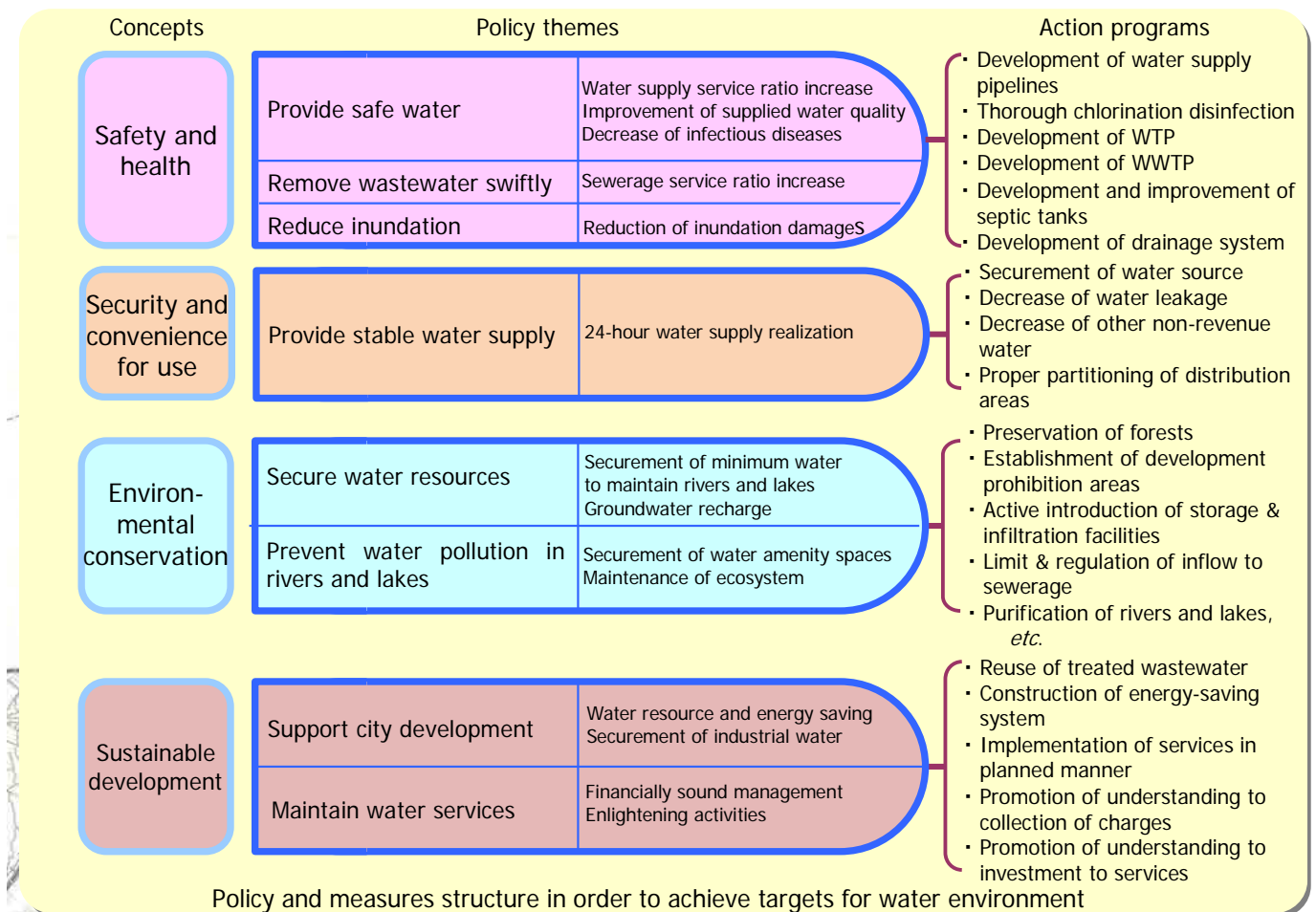
- ◆ Support of sustainable development of the City
 - To contribute to the development of the City by water resource and energy saving with water saving leakage management
 - To secure industrial water, etc. by realizing proper use of water resource without excessive reliance on groundwater with water resource saving and reuse of treated wastewater
- ◆ Maintenance of water services
 - To realize sound management with proper balance between expenditures and incomes to maintain water services
 - To implement services in planned manner
 - To promote understanding to collection of charges and investment to services through enlightening activities

5.3. Conceptual diagram of future water cycle and environment



5.4. Towards the realization of vision concepts and future image

Policy themes to be carried out by YCDC in order to realize Target image of water environment are articulated systematically.

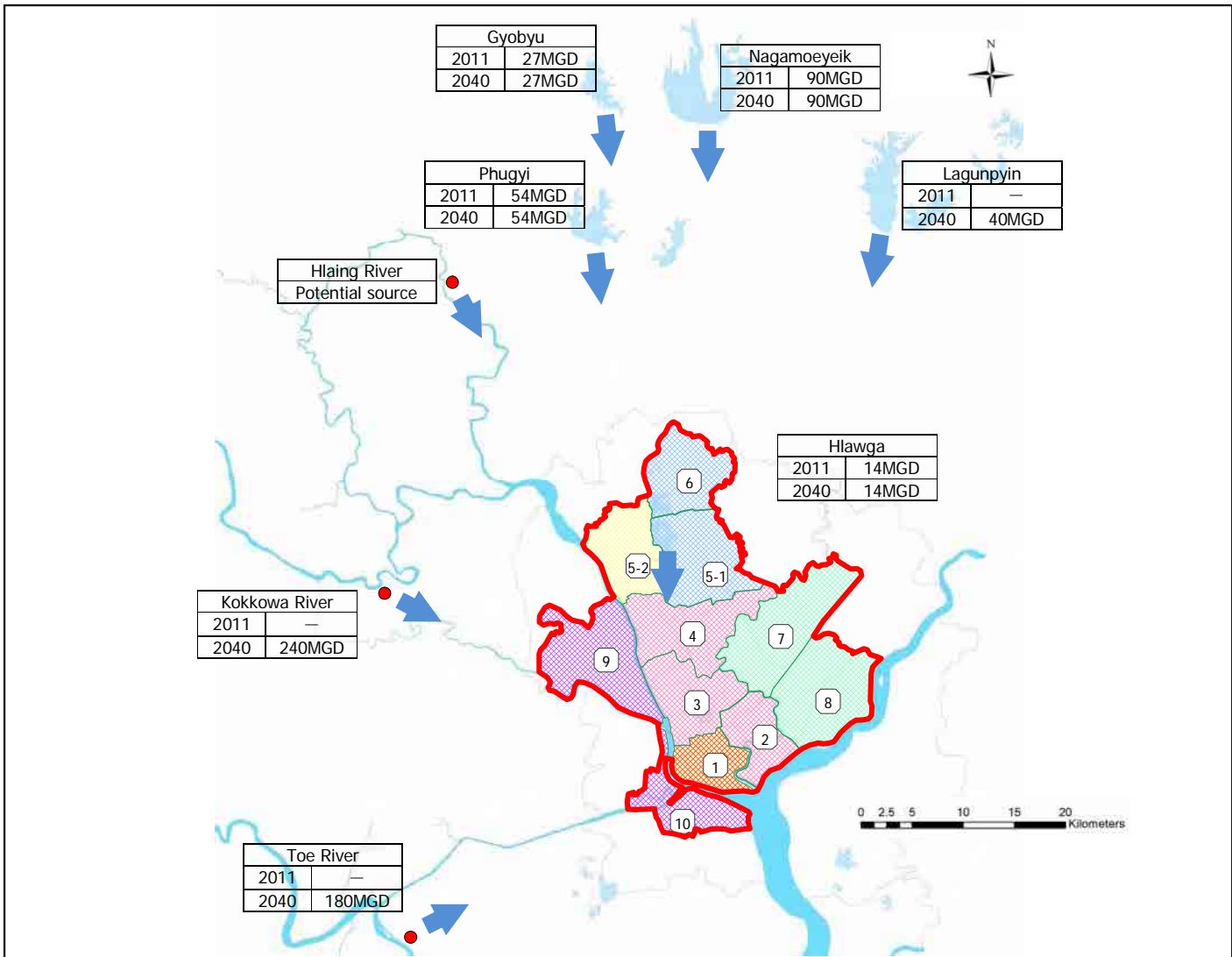


6. Development targets for realization of water vision

It is important to develop facilities in planned manner with targets to achieve water vision. Concrete development targets for facilities related to water for the realization of water vision are presented below:

6.1. Water supply

Development target	2040: Ratio of population in service area of water supply system to 100% Far future: Ratio of population to whom water is supplied by water supply system to 100% (Service coverage)
Development policy	Supply of water by water supply system with supplementary supply of treated wastewater



Service coverage in terms of service population

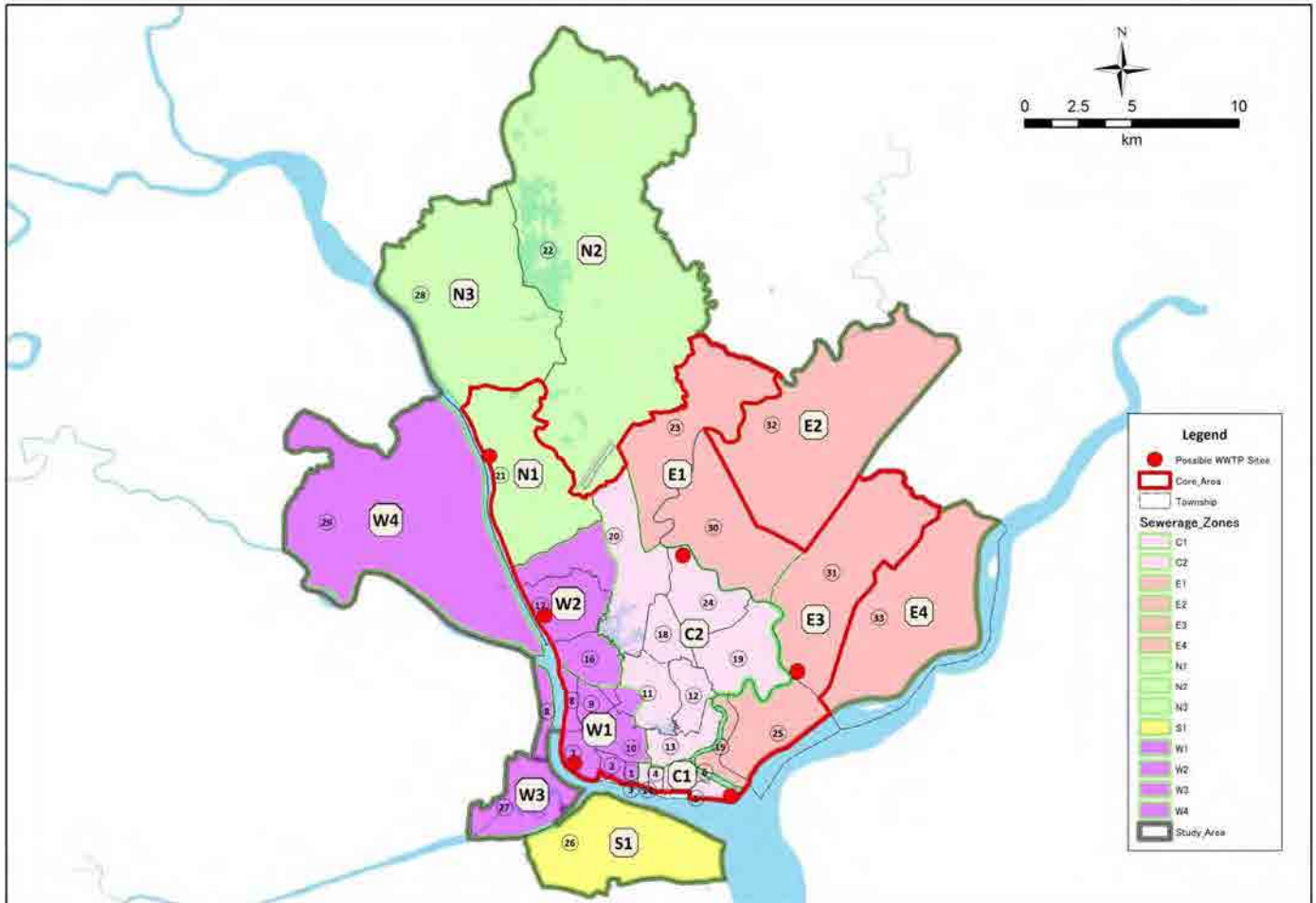
	2040			Far future		
	Service population	Service coverage (%)	Service coverage (%)	Service population	Service coverage (%)	Service coverage (%)
1	925,906	97	100	6	273,113	75
2	682,901	89	100	7	1,029,356	70
3	749,649	91	100	8	652,245	69
4	798,760	90	100	9	590,179	80
5-1	323,472	75	100	10	475,785	78
5-2	308,972	60	100	Total	6,810,338	80

Water supply system development

Indicators	2040	Far future
Chlorination	Achieved as soon as possible	
NRW rate (leakage) (%)	10	10
NRW rate (others) (%)	5	5

6.2. Wastewater treatment

Development target	2040: Sanitary toilet provision ratio to 100% Far future: Wastewater treated population ratio 100%
Development policy	Area of population density of 100 people/ha or more (2040): centralized treatment by sewerage system Area of population density of 100 people/ha or more (2040): on-site treatment by compact treatment unit



Wastewater treated population

	Development method ⁽¹⁾	Projected population	2040		Far future
			Sanitary toilet provision ratio (%)	Wastewater treated pop. ratio	Wastewater treated pop. ratio
C1	Other	178,129	100	100	100
C2+E1	Sewerage	1,902,155	100	90	100
W1	Sewerage	483,058	100	70	100
W2	Sewerage	349,512	100	65	100
W3	Other	74,419	100	100	100
W4	Other	737,724	100	60	100
N1	Sewerage	377,188	100	60	100
N2	Other	906,748	100	60	100
N3	Other	514,954	100	60	100
E2	Other	1,183,320	100	60	100
E3	Sewerage	920,933	100	60	100
E4	Other	399,111	100	60	100
S1	Other	490,032	100	60	100
Out of S.Z.	Other	2,241	100	60	100
Total		8,519,524	100	70	100

Note 1: Other corresponds to on-site treatment unit (Joukasou) and community plant.

Water quality

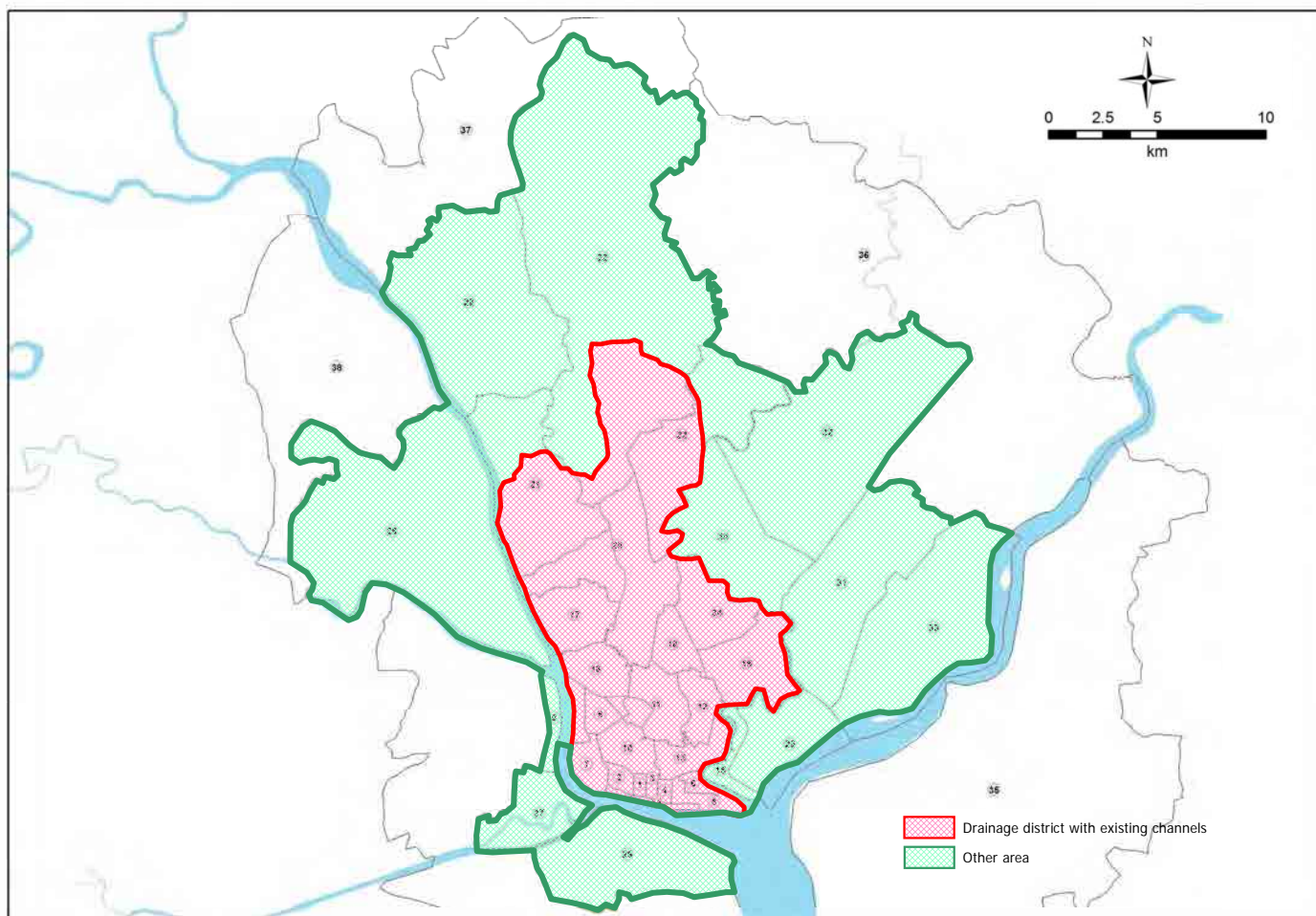
Water body type	Name	Water quality target
River	Yangon Hlaing Pun Hlaing	Similar level as generally required in other advanced countries (BOD: about 15mg/l or less)
Lake	Hlawga Kandawgyi Inya	Similar level as generally required in other advanced countries (COD: about 10 to 100 mg/l or less)

Sewerage system development

Indicators	2040	Far future
Water reuse ratio (%)	2.5	5.0

6.3. Drainage

Development target	2040: Number of inundation occurrence in urban area to 0 (for rainfall of 5 year return period) Far future : Number of inundation occurrence to 0 (for rainfall of 5 year return period)
Development policy	0 m area: Discharge of rainfall runoff by pumps Other areas: Discharge of rainfall runoff by gravity Area to be newly developed: Development of storage and infiltration facilities



		2040		Far future	
		Provision of drainage facilities (%)	Number of inundation (5-year rainfall) (time)	Provision of drainage facilities (%)	Number of inundation (5-year rainfall) (time)
Drainage district with existing channels		100	0	100	0
Other area	Area already developed	-	-	-	0
	Area to be newly developed	100	0	100	0

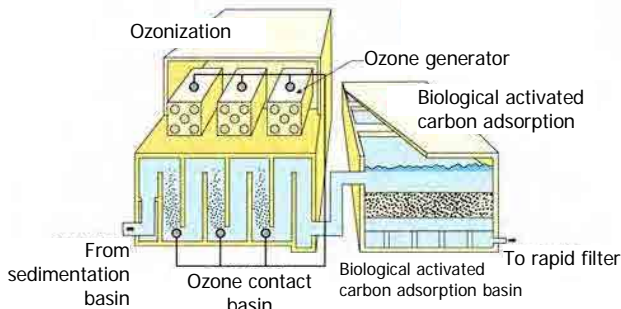
7. Various approaches to achieve water vision and targets

7.1. Technology

Varieties of technologies exist for functions necessary for water supply, sewerage and drainage such as treatment, transport, etc. Each technology has unique characteristics such as inexpensiveness, high energy saving, high performance, etc. and the selection of technologies conforming to local conditions is quite important.

Advanced water treatment

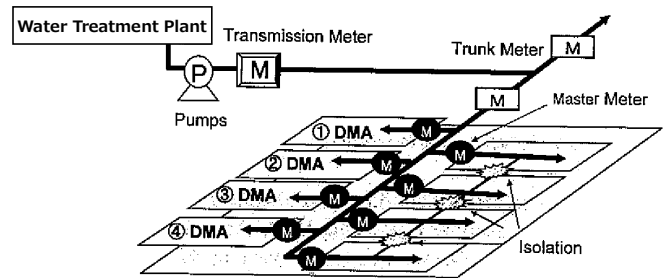
Advanced water treatment is provided to treat pollutants which cannot be treated by ordinary sedimentation and sand filtration. By providing additional treatment processes such as ozonization and biological activated carbon adsorption, odorous compounds such as molds and carcinogens can be removed and safer and better water can be provided, though additional-costs are needed.



Source: HP of Water Supply Bureau of Metropolitan Tokyo

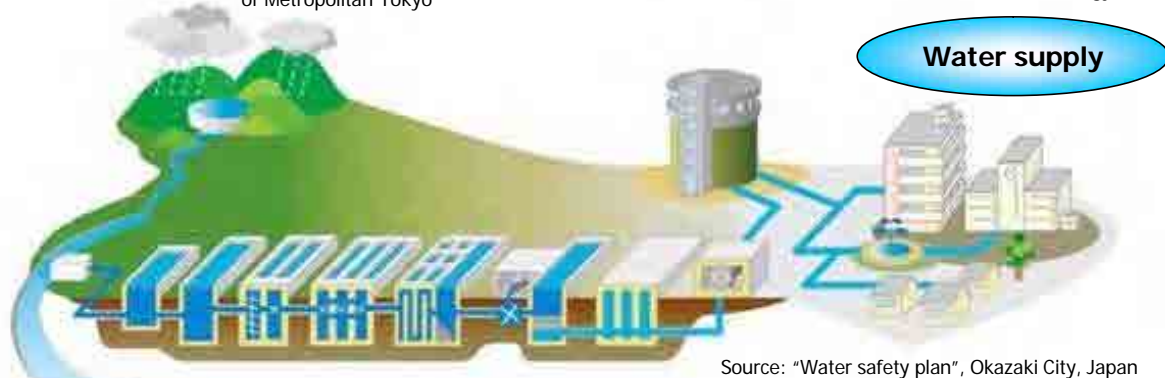
Segmentation of distribution districts (DMA)

By segmenting distribution pipe networks into several district metered areas (DMA), the impact at the time of accidents such as leakage of distribution pipe can be minimized. As well, leakage management in a district can be implemented efficiently by providing flow measurement for each district.



DMA: District Metered Area

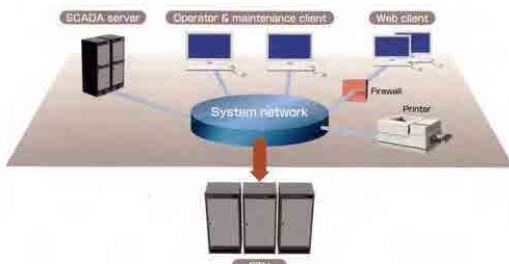
Source: "Non-Revenue Water Management (Considering Developing Countries)", Shuzo Yamazaki, Suido Sangyo Simbun



Source: "Water safety plan", Okazaki City, Japan

SCADA System

SCADA system provides a unified management of water and wastewater treatment systems by collecting data such as operational conditions of equipment and flow measurement data. With this system, understanding of situation at the time of accident and the change of water operation and control can be done by watching a system as a whole and management and analysis of measurement data such as flow, water pressure, and water quality can be easily achieved.

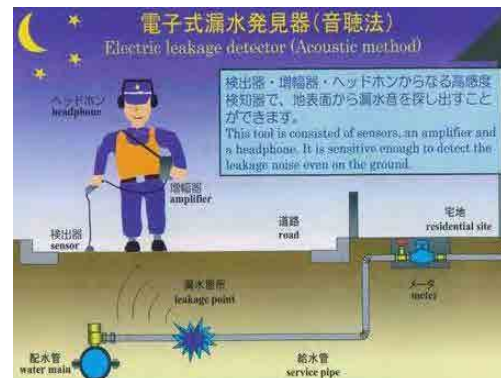


Source: HP of Toshiba Corporation

SCADA: Supervisory Control And Data Acquisition

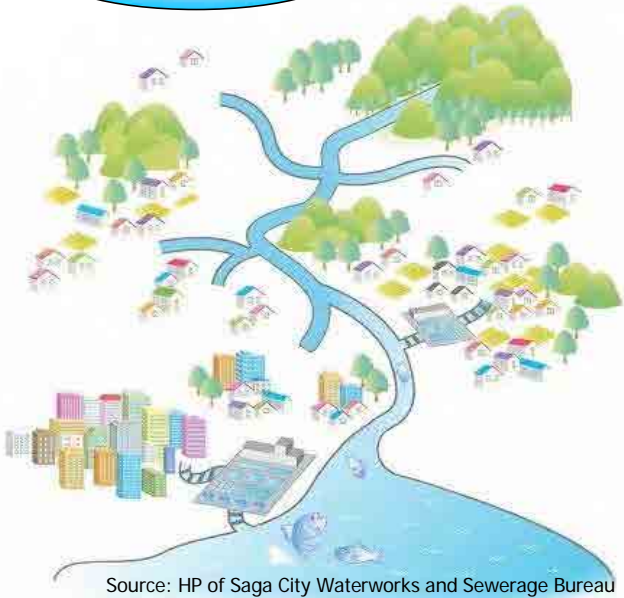
Leakage survey (Acoustic method)

Sites of leakage can be identified by detecting the sound of leakage while investigators specialized in leakage detection check water supply and distribution pipes with an electric leakage detector. (Acoustic method)



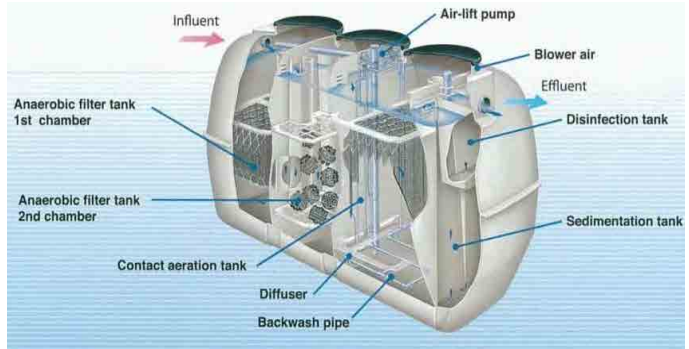
Source: Materials of Bureau of Waterworks, Metropolitan Tokyo

Wastewater treatment



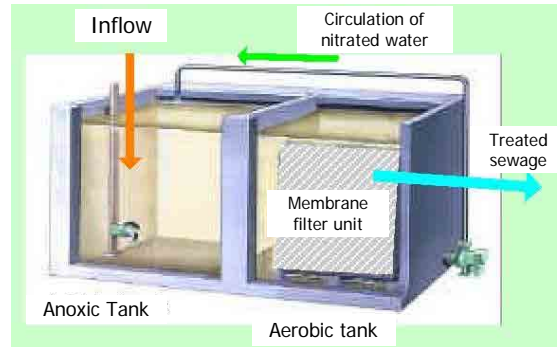
Compact on-site treatment unit (Joukasou)

This is a treatment technology which can be installed by household. Since the pipes are not needed, this is less costly than sewerage in areas where houses are located less and scattered.



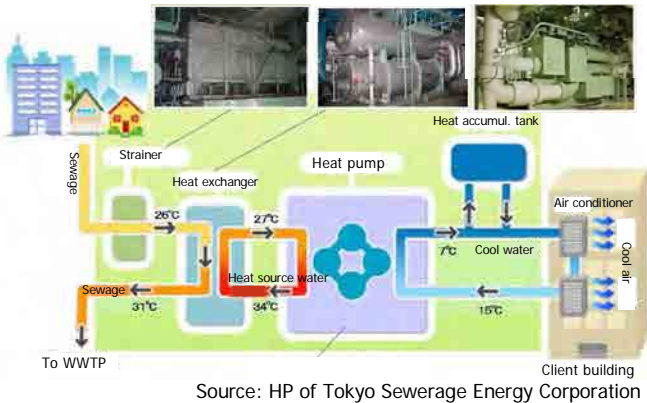
Membrane bio-reactor (MBR)

This is a wastewater treatment technology by using membrane filter as a substitute for final clarifier. With this, clean and safe treated water can be obtained and final clarifiers and disinfection facilities can be omitted and thus space for installation can be saved.



Regional cooling and heating system

This is technology to utilize the difference of temperatures between sewage and atmosphere by the use of heat pump. Cool air is provided to the surrounding regions by producing cool water by the use of sewage, temperature of which is lower than atmospheric temperature in summer, while warm air in winter.

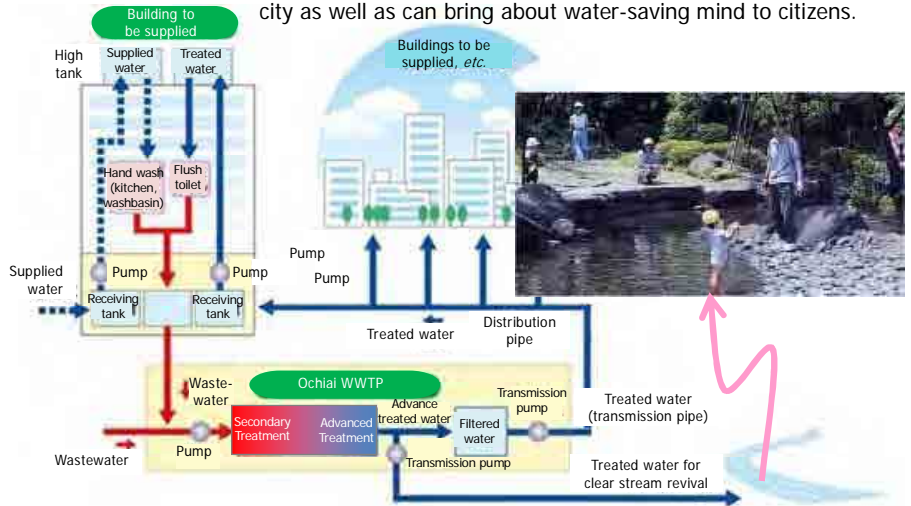


Reuse of treated wastewater for various use

Treated wastewater can be reused for various purposes. Some additional treatment processes may be needed depending upon the type or purpose of reuse, such as sand filtration, ozonization, activated carbon adsorption, etc. Some of the types of reuse are: water for flush toilets and sprinkling water for greens (dual water supply for a newly developed region), water for industrial use, cooling water for thermal power generation, supply of water to small stream with low flow, etc. Reuse of treated wastewater can be effective water source in city as well as can bring about water-saving mind to citizens.

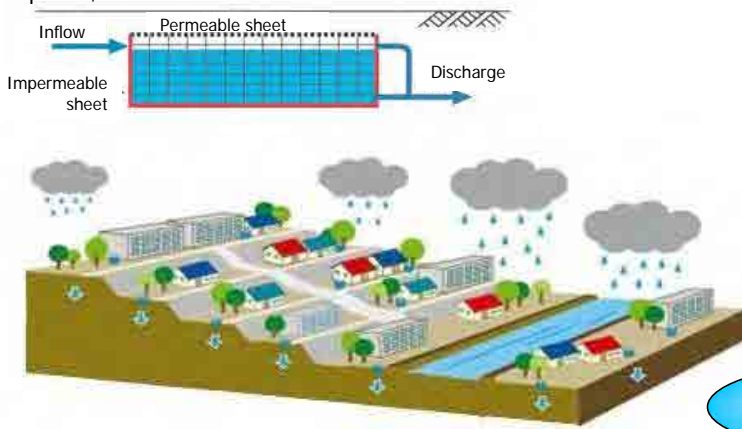
Digested gas generation

By using gas generated from sludge digestion process as fuel, electricity is generated with gas engine, micro gas turbine.



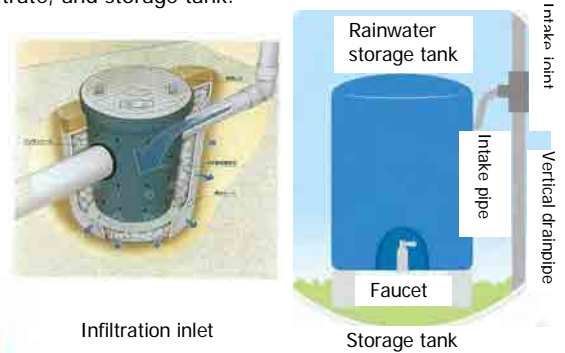
On-site storage facility

This is a facility to store rainfall runoff at a site where it rains and control runoff to drainage and is installed in parks, playing ground, parking lot, space between housing complexes, etc.



On-site residential storage and infiltration

This is a unit to be installed at residence, housing complex, and public facility such as inlet to let rainfall fallen on roof infiltrate, and storage tank.

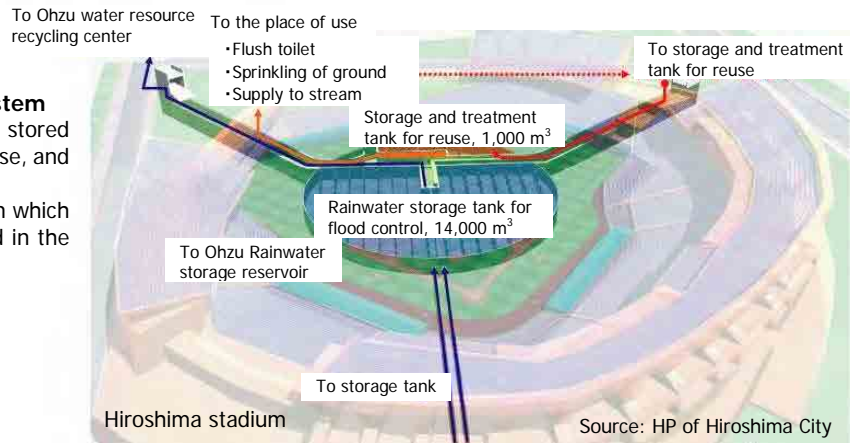


Source: HP of Association for Rainwater Storage and Infiltration technology

Drainage

Large-scale rainwater harvesting system

Rainwater fallen on large-scale facility is stored and used for toilet flush use, sprinkling use, and use for stream supply. The following example shows the case in which 14,000 m³ storage reservoirs is installed in the underground of a baseball stadium.



Source: HP of Hiroshima City

7.2. Financing

In order to operate water supply, sewerage and drainage services, not only construction cost for the development of systems and facilities but also running costs are required. For the purpose of maintaining and continuing the services in appropriate level, financial sources should be secured by various schemes.

- Service costs consist of construction costs and running costs including redemption of bonds
- Construction costs consist of constructing pipelines, and facilities of pump stations and treatment plant.
- Various costs as for pipelines, pump station and treatment plant are incurred as running costs.
- Current financial sources in Yangon are public expenses in construction cost and public expenses and service tariff in running cost (service tariff only for water supply)
- In future, foreign investments such as official development assistance and private finance are to be studied.
- As for running cost, tariff schedule is to be renewed and revised for water supply, if necessary, the collection of service tariff for sewerage, and basic system to finance costs are to be studied.

Composition of service costs

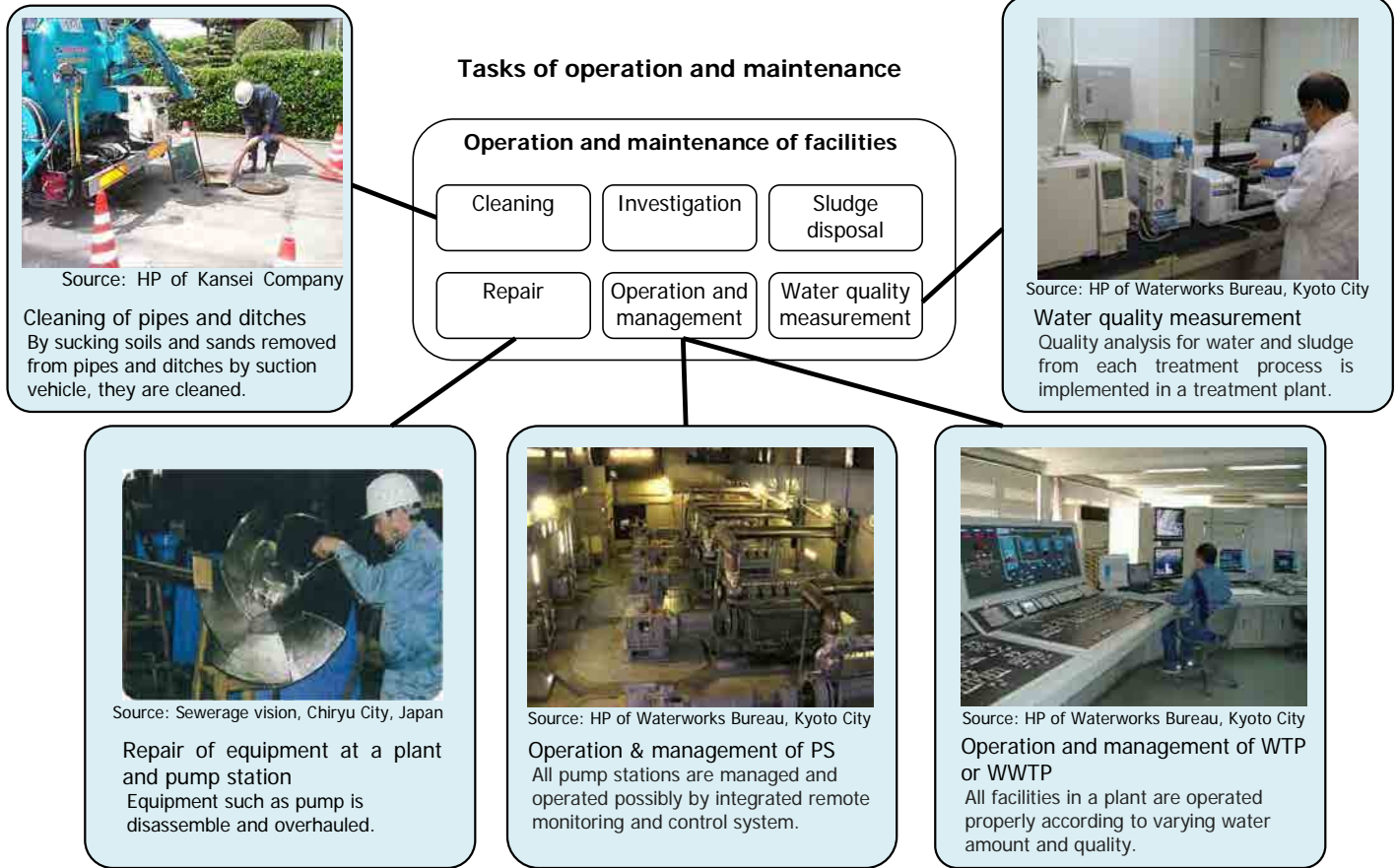
Service costs	
Construction costs • Pipeline • Pump facilities • Treatment facilities	Running costs • Personnel expenses • Redemption of bonds • Electricity & chemicals • Repair • Miscellaneous

Composition of financial sources

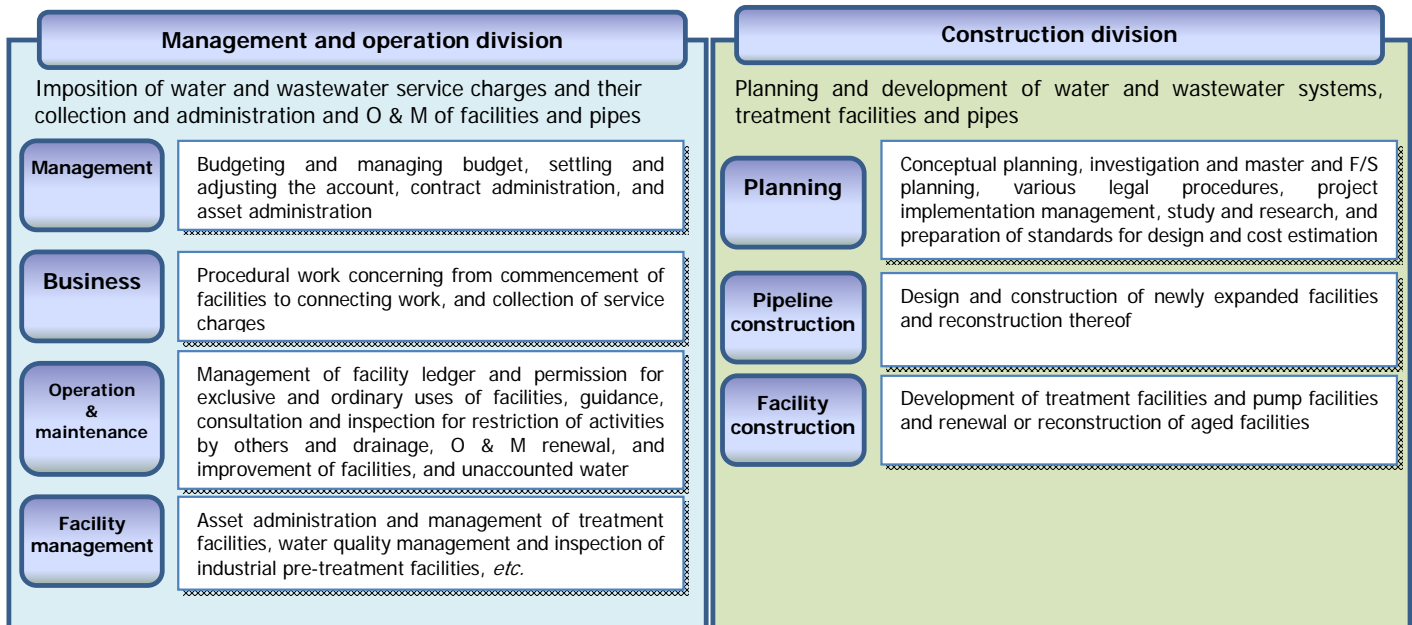
Financial sources	
Construction costs • Public expenses (national subsidy, etc.) • Introduction of foreign investment such as ODA	Running costs • Public expenses (national subsidy, etc.) • For each service, system to finance service is to be studied. [Examples of other countries] • In sewerage in Japan, basic financing principle is that drainage is funded by public and sewage by both public and service tariff (private). • In Germany, running costs of sewerage and drainage are almost all financed by service tariff. Tariff for drainage is charged by impermeable land area.

7.3. Operation and maintenance

Management, operation and maintenance of facilities are to continuously be implemented over the future. Unless appropriate operation and maintenance is implemented, facilities cannot function properly as they are expected and accordingly serious deterioration of water environment due to the degradation of water quality may be caused. Furthermore, insufficient operation and maintenance may quicken aging of facilities and the running costs may be increased by the increase of energy consumption and frequent renewal of facilities required. Development of O & M organization will be promoted to implement proper operation and maintenance.



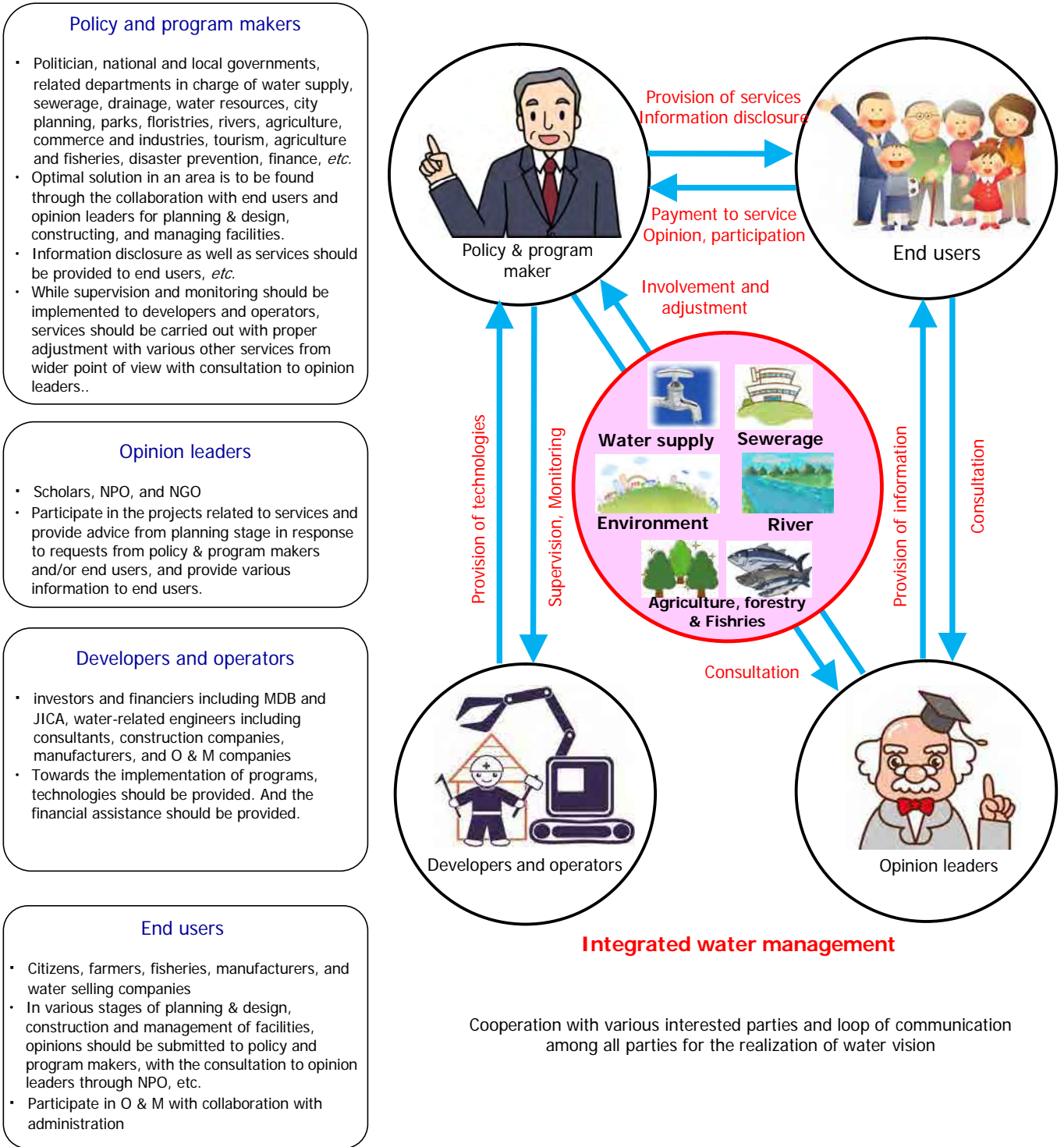
Example of O & M Organization



7.4. Collaboration among parties concerned with water

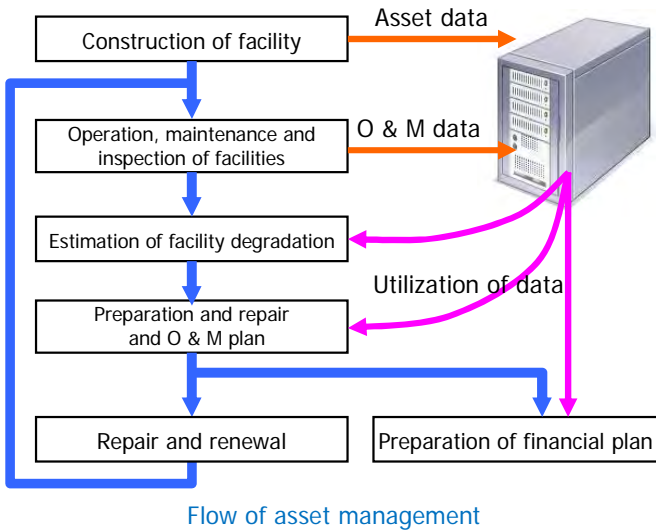
For planning & design, construction, and management of facilities of water supply and sewerage systems, it is needless to say that leadership and guidance of administration is important. However, the development of safe and secure infrastructures cannot be advanced only by them. Various issues concerning integrated water management, enormous number of sectors are concerned such as not only water supply and sewerage but also environment, river, agriculture, forestry, and fisheries, tourism. In order to cope with these issues, it is definitely needed for all of them in a river basin to cooperate with common vision and targets in common.

Since water itself has essential roles for wide varieties of activities as well as its basic function of maintaining our lives, moreover, various groups such as end users, engineers & manufacturers, and opinion leaders should work together to promote the development of water infrastructures in integrated and multi-disciplinary manner.

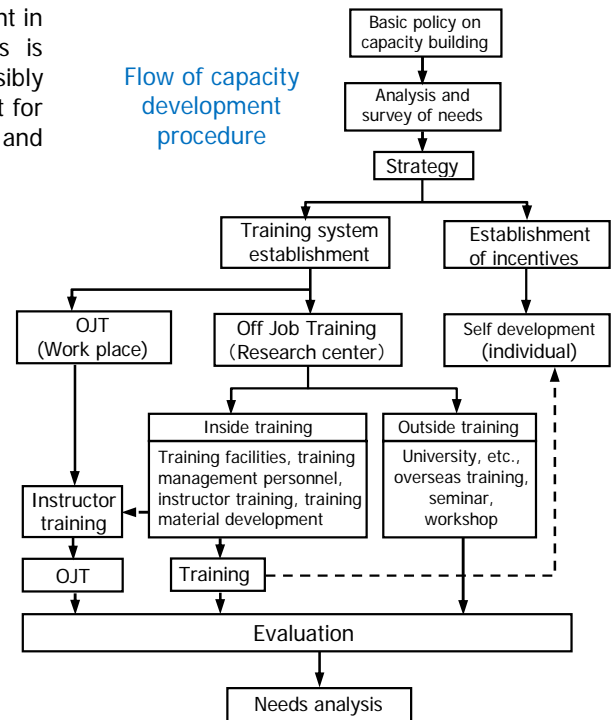


9.5. Capacity building and asset management

In order to operate services smoothly, systematic capacity development in response to the objectives of services and required technologies is prepared and provided. For the beginning of service operation possibly without sufficient human resources, methods of capacity development for personnels with the support from other countries are studied and introduced.



Flow of capacity development procedure



- ◆ Knowledge and experiences concerning operation management and maintenance are possessed by engineers in charge and it is hard to continuously succeed these among generations. However if these knowledge and experiences is not handed over to the next generation, it brings about lowering of technological level and bad effect on service level as well.
- ◆ Asset management is the system to make condition of facilities, service operation management, idea of O & M, etc. observable by anybody and thus to make the succession of knowledge and experiences relatively easy.
- ◆ With the introduction of asset management system from the beginning of service operation in mind, facility information and data are accumulated.

Source: "Case analysis on capacity development in water human resource development sector", JICA Research Institute, March 2008

7.6. Cooperation of citizens

In order to achieve the target water environment, citizens' cooperation and their voluntary activities for environmental preservation are indispensable. For this purpose, required actions to enhance citizens' awareness to environment are taken.



- Payment for service charge
- Proper O & M for individual treatment equipment



- Water saving
- Observance of rules for use
- Cleaning of ditches and drains

Actions to enhance citizens' environmental awareness

Facility visiting trip



Source: Sewerage vision, Chiryu City, Japan

PR activities by holding events



Source: Sewerage plan of Kunitachi City, Japan

PR by HP (Do not let oil flow)



Source: HP of Bureau of Sewerage, Metropolitan Tokyo

Citizens' voluntary environmental preservation activities

Cleaning of open channel



Source: HP of Voluntary Group for Kawamukou Suiro, Japan

Appendix 1. Current water conditions in the world

Current issues and problems concerning water in the world are overviewed by putting an eye on the current water situation in the world and then important viewpoints for tackling future water problems in Yangon and Myanmar are articulated.

Appendix 1.1. Disasters related to water in the world

May 2008 in Myanmar and Yangon
Cyclone Nargis landed on Myanmar. The number of dead and missing amounted to 130,000 and 2.5 million people were damaged.



Source: HP of JICA

July 2011 in northern and central Thailand
Thailand was attacked by several typhoons and Chao Phraya River was flooded. More than 400 people died and more than 6 million ha of land was inundated.



Source: HP of JICA

August 2009 in Aral Sea
Though Aral Sea used to be the 4th largest lake in the world, water level was lowered by the excessive water intake for irrigation from 1960s. Finally eastern part of South Aral Sea dried out.



2000/8/19



2009/8/21

Source: Environmental white paper FY 2009, ME, Japan



December 2008 in Zimbabwe
More than 10,000 people were infected by cholera and the government of Zimbabwe declared the state of emergency. Reason of this outbreak was the intake of polluted water and more than 4,000 people were dead.



Source: HP of Médecins Sans Frontières (MSF)

July 2011 in Somalia
United Nations declared the occurrence of famine in the southern part of Somalia. By the lack of food caused by drought, life of more than 12 million people was threatened.



Source: HP of FAO

Appendix 1.2. Issues related to water in the world

Water crisis due to climate change

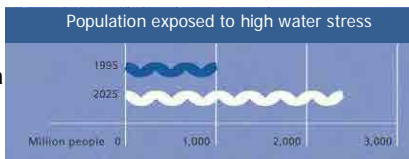
Water risk in the world according to the 4th ICPP evaluation report

- Africa: Increase of water stress for 75 to 250 million people
- Asia: Increase of floods from coasts of oceans
- Europe: Flash floods, floods in coasts, and the increase of erosion risk
- North America: Intensification of water resource competition due to the decrease of snowfall and river flow

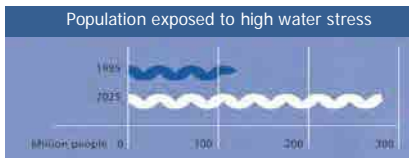
Increase of water stress

Due to the increase of per capita water consumption with economic growth and dramatic increase of population density, water stress will increase. This will occur evidently in Southeastern Asia and Eastern Asia, and African area south of Sahara Desert.

Southeastern Asia & Eastern Asia



African area south of Sahara Desert



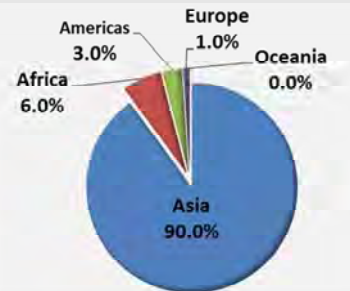
Source: World Water Vision



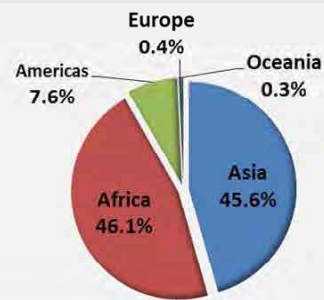
Damages by water disasters in Asia

46% of people who died and 90% of people suffered due to floods are concentrated in the Asian regions. Though the development of industrial and housing complexes have been advancing along with economic growth, flood prevention infrastructures cannot catch up with the above development.

Ratio of people damaged by water related disaster (by continent) (1980 – 2006)



Ratio of people died by water related disaster (by continent) (1980 – 2006)



Source: Values are quoted from "5th World Water Forum Asia Pacific Region Document".

Lack of safe water and sanitation equipment

Peoples' health is threatened by insanitary environment. About half of the people living in less developed countries have health problem attributable to the lack of safe water sanitation equipment and 1.8 million kids died of diarrhea every year.

884 million people – 37% of whom live in Sub-Saharan Africa – still use unimproved sources for drinking-water



2.6 billion people – 72% of whom live in Asia – do not use improved sanitation facilities



Source: "PROGRESS ON SANITATION AND DRINKING-WATER 2010"

Towards beautiful metropolitan Yangon with affluent water and related culture

As a committee member in charge of the project in relation to water, I am pleased to present Future Water Vision in Yangon City to citizens. In order to realize this water vision in near future, I would like to show my sincere and strong determination to do our best on behalf of all the city officials in charge of developing water supply, sewerage, and drainage systems.

We promise you that we will do our best for establishing strong partnership among related departments of Yangon City and other governments and other related organizations to realize quick implementation of system development for citizens' convenience, and for developing professional education system to secure human resources with sufficient professional expertise in order to continuously provide reliable water services. We also promise you that we will do our best for securing financial resources to maintain financially sound water services, and for rolling plans continuously towards the realization of efficient and responsive water services. Of course, maximum efforts will be made for PR to citizens to obtain understanding, support, and cooperation for water services.

By realizing this water vision, which will guide us to the direction we should take concerning water, sanitation, and drainage, we believe that various benefits will be provided to all citizens in various sectors, such as decrease of water-borne infectious diseases by continuous safe water supply, improvement of living environments in terms of sanitation due to the development of sewerage systems, clean and beautiful watersides as the places for rest and recreation for citizens by the improvement of water quality in rivers, lakes, marshes and ocean, and protection of lives, properties and fortune by the decrease of flood occurrence.

Although we will do our best to realize this Future Water Vision as the success of our elaboration of water system in Yangon City, citizens' positive cooperation and understanding are indispensable. For obtaining citizens' understanding, we will make maximum efforts to disclose information concerning water service and try our best to be open to your opinion. I hope that our efforts will succeed in gaining citizens' cooperation such as water saving, removal of garbage from drains, payment for the proper water charge, *etc.*

I can imagine that Yangon City will be a clean, safe, modern, energetic, and beautiful city as one of leading cities in Southeast Asia in the near future, in the process of realizing future water vision through the joint efforts among citizens, the City, and other related organizations.



Soe Se
Chairman of Vision Committee
Committee Member 7, YCDC



VISION COMMITTEE

Chairman

Soe Se (Committee Member 7, YCDC)

Committee members

From YCDC

Myint Oo (Chief Engineer, Water and Sanitation Dept.)

Tin Maung Kyi (Chief Engineer, Road and Bridge Dept.)

Aung Sann Win (Deputy Chief Engineer, Water and Sanitation Dept.)

Kan Myint (Deputy Chief Engineer, Water and Sanitation Dept.)

Myint Thein (Deputy Chief Engineer, Public Relation & Information Dept.)

Kyaw Thar Sein (Deputy Chief Engineer, Pollution Control & Cleansing Dept.)

Toe Aung (Deputy Chief Engineer, Urban Planning Unit)

Myo Thein (Assistant Chief Engineer, Water and Sanitation Dept.)

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Other Experts

Se Maung (Retired – Professor)

Dr. Kyaw Latt (Advisor)

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Saline Myo Myint (Retired Director)

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