Promotion of Treated Wastewater Reuse in Okinawa —In search of local community without water shortage—

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1. Introduction

Okinawa Prefecture (OP), isolated island, has been historically suffering from water shortage by severe condition due to geographical feature and topography. Water rationing was repeated like an annual event, and especially, at the time of water shortage in 1987, it was performed over about one year, and it had a great influence on Okinawan's life. For this reason, many dams have been built on the mountains in the northern part of Okinawa main island, but the construction site of dam is restricted due to small OP's area. Therefore, they regarded seawater as new water resources, and constructed Desalination Plant in 1997. The Plant has played an important role as precious water sources for OP that has been suffering from water shortage.

People pay attention to Okinawa sightseeing. Because, TV programs dealing with Okinawa have been frequently broadcast recently. "Kyushu and Okinawa Summit" held in 2000 was successful. Therefore, tourist business has been in good condition for the reason that the number of tourist breaks through 5 millions. Moreover, while population decrease is indicated nationally, the population of OP is increasing in number. Therefore, it is expected that water demand will continue.

Although one hundred percent of sludge (145t/day) generated within prefecture plants was recycled for green farmland-return, treated water (270,000m3/day) was almost discharged to the sea. They have been expecting that the water is used effectively in OP that has been suffering from water shortage. Therefore, OP reuses treated wastewater which occurs constantly in urban environment as precious water resources. I introduce Sewerage Business of Recycled Water Use (SBRWU) implemented by OP to you.

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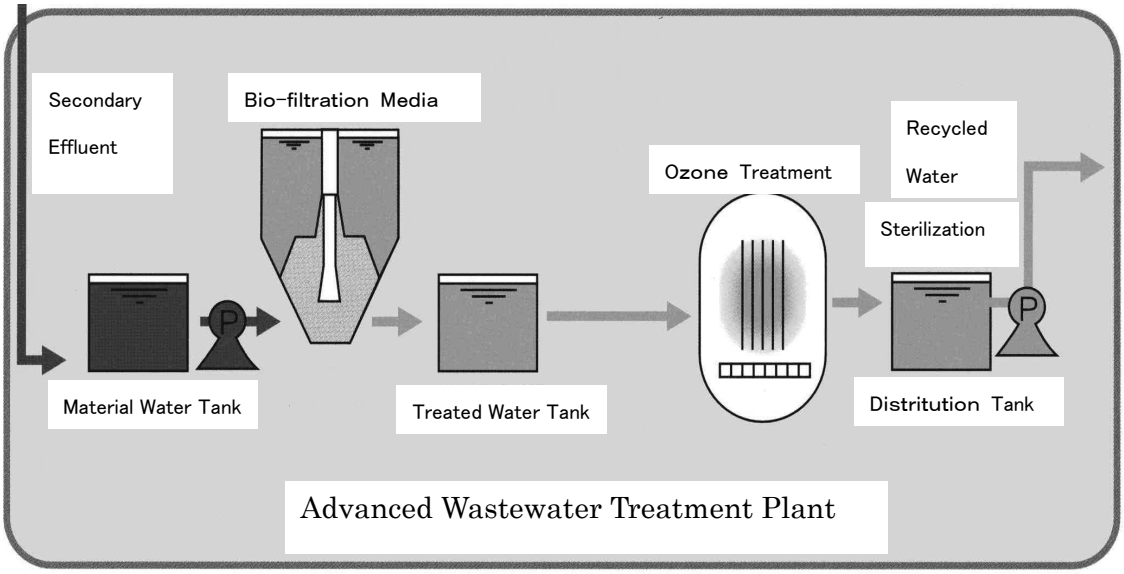
2. Sewerage Business of Recycled Water Use

SBRWU treats secondary disposal water discharged from Naha Sewage Treatment Plant (STP) highly, and supplies the water to Naha New Urban District (NNUD) mainly for flushing toilets and sprinkling in the parks.

Redevelopment enterprise was planned to utilize vast area of 4.4% of Naha-City and good location of NNUD which used to be U.S. Forces housing area. At present, a large-sized commercial store, a public facility, and a large-sized apartment are under construction at NNUD.

2.1 Advanced Wastewater Treatment Plant

Advanced Wastewater Treatment Plant (AWTP) was built in Naha STP in 2002. The flow of advanced processing is as follows:



2.2 Technical problems

A few technical problems have been caused over 4 years after supply. One of them is to secure residual chlorine 0.4 mg/litter or more. At the beginning of the supply, it was difficult to keep the density, because the water remained for a long time in the pipe for small-volume use. However, it was solved by releasing the water at the end of the pipe and by changing the current of water and by adjustment of the infusion quantity of sodium hypochlolite at AWTP.

2.3 Supply achievement

The Number of Supply Places and Water Use per Day is the following figure:

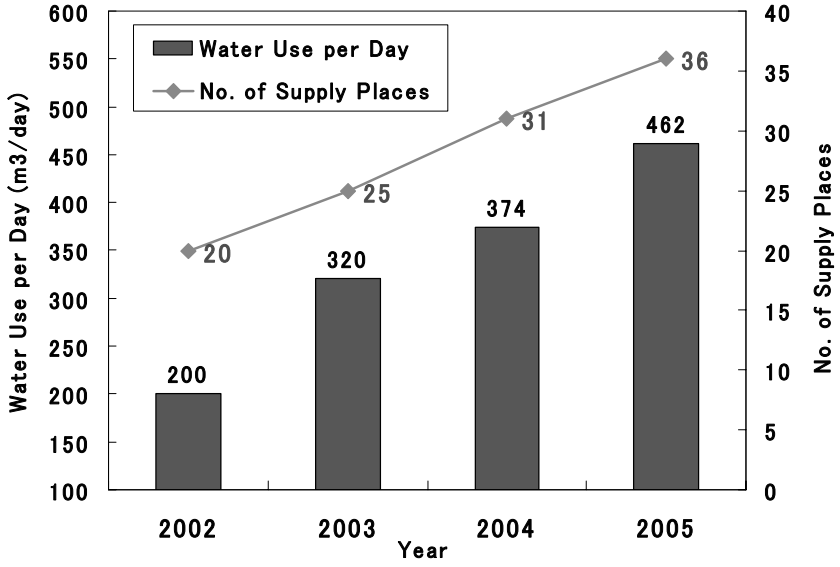


Fig. The Number of Supply Places and Water Use per Day

According to the figure, after supply, between 2002 and 2005 fiscal year, supply places increased from 20 to 36. Amount of water consumption per day also increased steadily from 200 to 462 cubic meters. Naha Water Resources Effective Use Promotion Outline created by Naha City, which encourages citizens to use recycled water. OP is also going to examine whether the demand can be increased further.

3. Conclusion

If water shortage happens in OP, a local newspaper begins to indicate the number of water rate of dams. Moreover, the number is also indicated on Okinawa Prefectural Enterprise Bureau Homepage, to which Okinawans pay attention. Fortunately, water rationing has never happened by hard work of the persons in charge of water works and sewage works since March, 1994. But, reservation of water resources is an important subject for our island prefecture. As stated in the introduction, it is expected that the water demand of OP will has been increasing.

STP plays a part of constantly-available dam in urban environment. It is the best to treat secondary effluent and to utilize it. We think that SBRWU is very important when water condition is considered in OP that has been suffering from water shortage, and that it is indispensable to promote and spread "Recycled Water Use without water shortage" from now on.

References

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Department of Planning, Statistics Data Reading Room in Okinawa Prefecture, Statistics Division Home Page

Urban Renaissance Agency of Japan, Naha New Urban District

Home Page of Meteorological Agency of Japan, Meteorological Information

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Location of Okinawa

Distance Between Naha & Each City

Naha - Taipei	630 km
Naha - Kagoshima	656 km
Naha - Shanghai	820 km
Naha - Fukuoka	861 km
Naha - Seoul	1,260 km
Naha - Hong Kong	1,440 km
Naha - Manila	1,480 km
Naha - Tokyo	1,554 km

Naha:capital city in Okinawa

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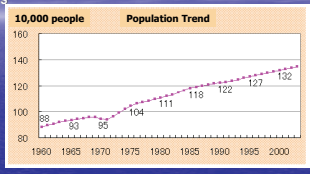
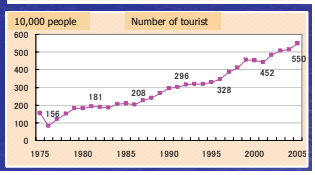
Okinawa's Main Features

- **Land** Consists of about 160 islands
  Total area: 2,274km²
- **Population** 1.37 million as of 2005
- **Tourism** Tourism is one of the main industries



- **US Army Base**
  Presently, 75% of US Army bases in Japan are situated in Okinawa, taking up about 10% of the total land area.



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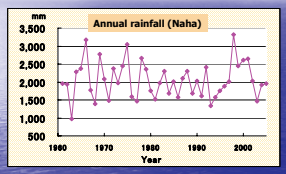
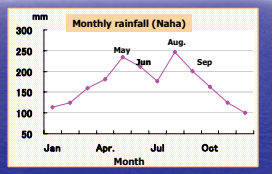
Okinawa's Rainfall

The Only Semi-Tropical Region in Japan





Annual rainfall: 2,037mm Average temp.: 72.7 degF(22.7 degC)

Periodically Hit by Typhoons

7 typhoons per year on the average

Lots of annual rainfall occurs during typhoon and rainy seasons

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Available Water Resources

Okinawa

- Average rainfall
  2,037 m3/year
- High population density
- Available water resources
  1,973m3/year・person

National average

- National average rainfall
  1,718m3/year
- Low population density
- Available water resources
  3,337m3/year・person

Without typhoon, water shortage happens in Okinawa

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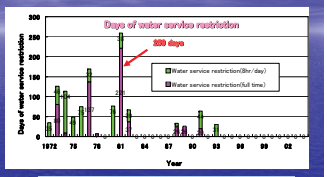
Okinawa's Water Situation

Unstable Water Sources

Low rainfall per capita
Large seasonal fluctuation in rainfall
Short river length & steep riverbed



Water Demand

Water demand increases due to:
increasing population
increasing tourists

Water Rationing

14 out of 32 years from 1972 to 2004

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Water Resources Development

Dam

The construction site is restricted due to small area

Seawater Desalination Plant

The plant is operating as important water sources

Advanced Wastewater Treatment Plant

Okinawa Prefecture has been suffering from water shortage. Sewage Treatment Plant plays a part of constantly-available dam in urban environment. It is the best to treat secondary effluent and to utilize it.

Advanced Wastewater Treatment Plant

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Beginning of Sewage Works

1935 Sewage lines constructed in Naha (but not developed for public use)

1964 Okinawa City set out on a sewage works project & formulated the Okinawa Central/South Districts Integrated Sewage Works Plan

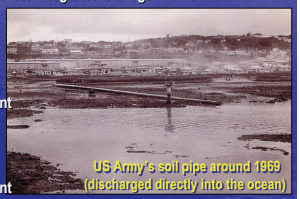
1969 Primary treatment began at Naha Sewage Treatment Plant

1970 Primary treatment began at Ginowan Sewage Treatment Plant

—1972: Okinawa restored to Japan—

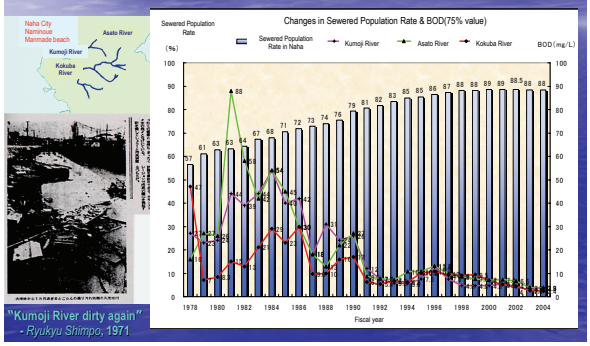
1976 Secondary treatment began at Ginowan Sewage Treatment Plant

1977 Secondary treatment began at Naha Sewage Treatment Plant



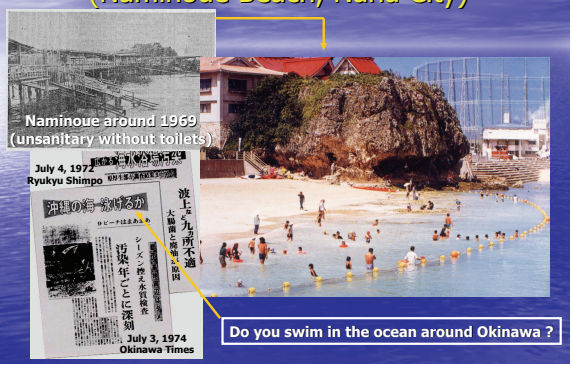
US Army's soil pipe around 1969 (discharged directly into the ocean)

Effect of Sewage Works(river water quality vs Percentage of Sewered Population)

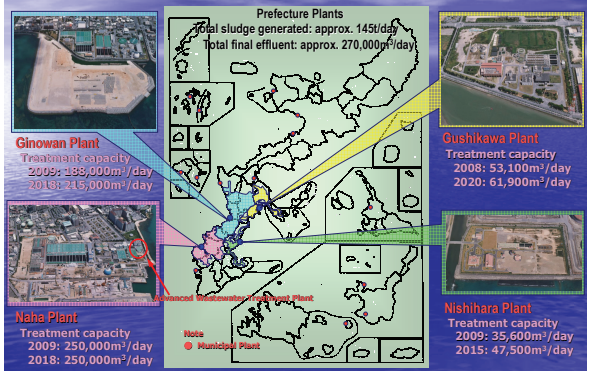


"Kumoji River dirty again"
- Ryukyu Shimpo, 1971

Effect of Sewage Works (Naminoue Beach, Naha City)



Present Status of Sewage Works in Okinawa



Reuse of Highly Treated Water (treatment process)

Purpose of advanced water treatment at Naha Sewage Treatment Plant

To stabilize & conserve water resources toward the establishment of 'recycling society' by reusing treated sewage water that is abundant & constantly available in urban environment for flushing toilets and other purposes. Highly treated water means recycled water

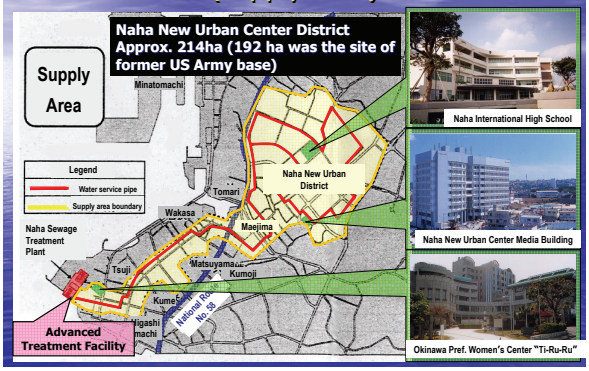
Advanced water treatment at Naha Sewage Treatment Plant (capacity: 2,130m³/day)

From sewage treatment → Bio-filtration → Ozone treatment → Chlorine sterilization → To new urban district, etc.

Reuse of Recycled Water (quality of recycled water)

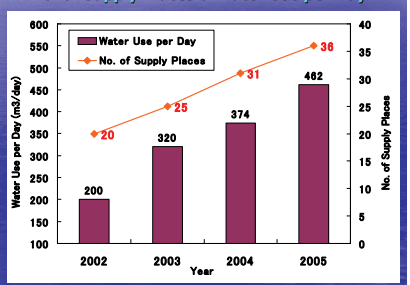
	Secondary treated water	Recycled water
pH	7.2	7.3
Chromaticity (degree)	20 or higher	2 or less
Turbidity (degree)	0.5 or less	0.5 or less
BOD (mg/L)	2.8	1.2
Cl^- (mg/L)	650	660
NH_4-N (mg/L)	9.2	0.2
NO_2-N (mg/L)	0.7	N.D.
NO_3-N (mg/L)	2.0	7.5
Coliform (count/100mL)	66×10^4	0

Reuse of Recycled Water (supply area)

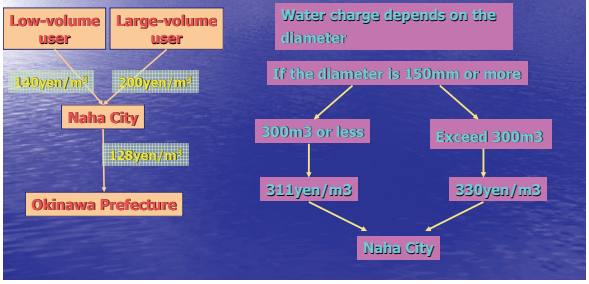


Reuse of Recycled Water (change of consumption, etc.)

No. of Supply Places & Water Use per Day



Comparison of Charge



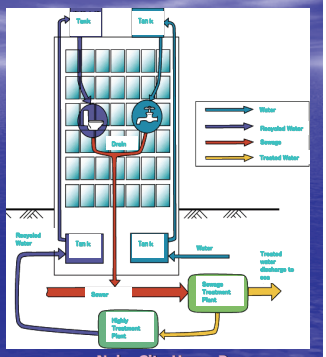
Promotion of Recycled Water Use

Naha City Water Resources Effective Use Outline

Mayor must try to promote reuse of treated waste water and treated drain water.

Naha City Home Page for recycled water

On the homepage, they try to promote and spread recycled water by introducing people the meaning of recycled water and the system of the business of recycled water use and the area in which they can use it.



Naha City Home Page

Reuse of Highly Treated Water for creating soothing cityscape

● Itoman City (capacity: 400m³/day)

Secondary treated water

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Bio-filtration process

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Chlorine sterilization

↓

Send water to Nishizaki Aquatic Park

● Nago City (capacity: 4,000m³/day)

Secondary treated water

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Bio-filtration process

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Ozone treatment

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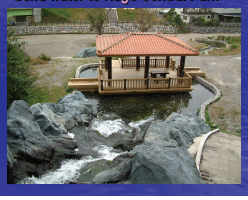
Send water to Nago Central Park



Plan of Treated Water Reuse

● Planning for Agricultural Water

Secondary treated water

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Advanced water treatment

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Sterilization

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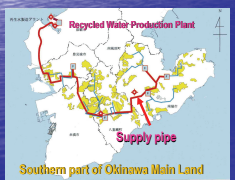
Send the water to farmland



● Proposal

Secondary treated water or highly treated water

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Send the water to the upstream of the river that flows through Naha City for purification