A century-long strategy for wastewater-system management in Japan; concept shifts from Wastewater System to The Road Toward Recycling Society

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Abstract: When we entered into the 21st century, we noticed many changes in various fields, such as meteorological change on a global scale, the soaring price of crude oil, frequent droughts and floods, overt heat-island phenomena in big city areas, a falling birthrate and a rapidly aging population. These changes are not temporary mutations, but are transformations based on long-term trends that we cannot ignore to plan and re-imagine the future state of wastewater systems. Starting from such understanding of present circumstances, we have formed a new concept of the role of wastewater systems: to make them the key infrastructure of a recycling society as a national strategy. This is "The Road toward Recycling Society." This paper describes the new concept of The Road toward Recycling Society along with its implementation policy.

Keywords: Recycle, the 21st century, wastewater system policy, improvement of systems

Introduction

Looking ahead to the 21st century, we can predict great changes that will emerge in many fields in Japan. We must change our living systems to prepare for the future. Our systems consist of many sub-systems. A wastewater system is these, but one that plays an important role in keeping our society healthy and comfortable. This means that we need to have a new concept adapting our society to future situations. To set a new concept and policy for both wastewater systems and wastewater works, a special committee was convened and it carried out intense discussions for about one year, announcing its conclusion in a report titled, Wastewater System Vision 2100. The subtitle of this report is From Wastewater System to The Road toward Recycling Society as a100-years strategy. This paper describes this new strategy and new concept of The Road toward Recycling Society.

A new concept of wastewater systems adapted to the 21st century

Among these future changes, serious ones that we will face in the latter part of the 21st century may include climate change caused by the greenhouse effect and shortages of natural resources such as the fossil fuels, oil and natural gas. These changes will be caused by our lifestyle in the late 20th century, a period of mass production and consequent mass waste-production. In recent years we already suffered from abnormal climate that has caused terrific flooding, unusually hot summers and abnormally heavy snowfalls. Another

precursor of future problems is the present historically high oil prices. When these difficulties become extreme, our lives will be threatened by these problems. In view of this, we must change our society to a sustainable one that can achieve future prosperity.

Other problems in Japan that we will face in the relatively near future are social problems caused by our decreasing population. Although the decline of our population was predicted and in fully recognized a relatively long time ago, it was a great shock for Japan when the regular census showed an actual reduction of the population last year. This reduction is due to the recent low birth rate that is actually below the death rate. On the other hand, life expectancy in Japan is high. One consequence of these conditions is an aging society and structural changes in both industry and economy. In the aging society, government will have smaller resources to provide new infrastructure than it does now, so we need to prepare for the future at an early stages.

Along with these future changes in the natural environment and society, we also wonder about the direction of future society. In this respect, wastewater systems also must change so we can create a bright future. We need to have a clear image of wastewater systems that provide new functions and play new roles in the 21st Century as key infrastructure for a better world, by freeing ourselves from conventional images of these systems. From these perspectives, our vision of wastewater systems for the 21st century should focus on three goals: a beautiful environment, safe community and vigorous society. The crucial question we must answer to realize these three goals is how our wastewater systems will contribute to new era. By contemplating these conditions, we have created a new concept of the 21st century wastewater systems as "**The Road toward Recycling Society**" to provide a new strategy for the central government.

Besides the above-mentioned future problems, we are already struggling to resolve problems in our fields. Some of these are categorized as water problems and others as facility management problems. One example of a water problem is the quick run-off of storm water and another is the drying up of waterways in the dry season. These cause frequent flooding and environments with reduced amenities. These phenomena are caused by the reduction of the permeable area in our communities. Another water problem is instability of water resources: the inability of big cities to secure their water resources within their water basins for example. These are not sustainable situations in terms of water resources. A typical example of a facility-managing problem is the aging of facilities. This not only raises the demand for rehabilitation works and thereby increases budget needs, but also increases road deterioration such as sudden cave-in caused by corroded sewers. The new policy also accounts for these present problems.

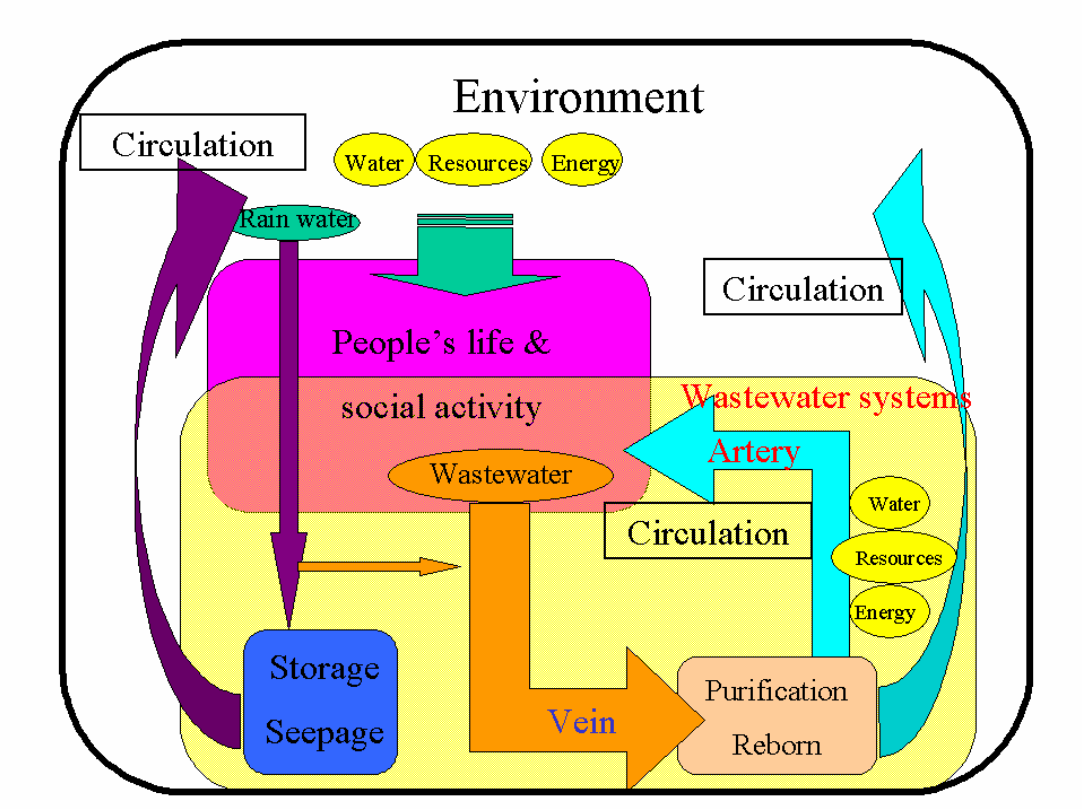

Figure 1. Schematic image of the role of wastewater system in 21st century society. A wastewater system is infrastructure with a key role in sustaining a limited resource society.

What is The Road toward Recycling Society?

The term, The Road toward Recycling Society, implies not only the venous system but also the arterial system including the heart that function as key organs in the circulation of necessary materials and the transportation of waste in humans. In another words, The Road toward Recycling Society suggests that wastewater systems become key facilities in hydrologic circulation and resource cycles. This concept aims to replace the 20th-century-type wastewater systems with a new kind of system, and also seeks new functions and images of systems for the 21st century. And specifically from the viewpoint of the healthy circulation of resources, the committee's discussions of wastewater systems extend to basic questions: what is wastewater system, what kind of substances should we collect and not collect with such a system, how can we recover and reuse the collected substances, and how we create healthy recycling systems in our society? Based on our reconsideration of these matters, the following three key sub-concepts were presented to achieve the main image or metaphor of The Road toward Recycling Society:

- Creation of New Water Passages,
- Creation of New Resource Passages and
- Revitalization of the Systems.

The first sub-concept, Creation of New Water Passages, means the creation of new water-networks and passages to exploit the manifold functions of water in the field of wastewater works. The second sub-concept, Creation of New Resource Passages, refers to active efforts to recover resources, such as bio-solids or

nutrients, followed by supplying recovered resources. This sub-concept also includes exploiting land sites of wastewater works to create new energy ---solar power, wind turbine, and micro-hydro-power generation--- to end our dependence on oil. The third sub-concept, Revitalization of the Systems, differs from the previous two concepts in that it supports them, but includes more active meanings of upgrading existing facilities to meet the social requirements of wastewater works.

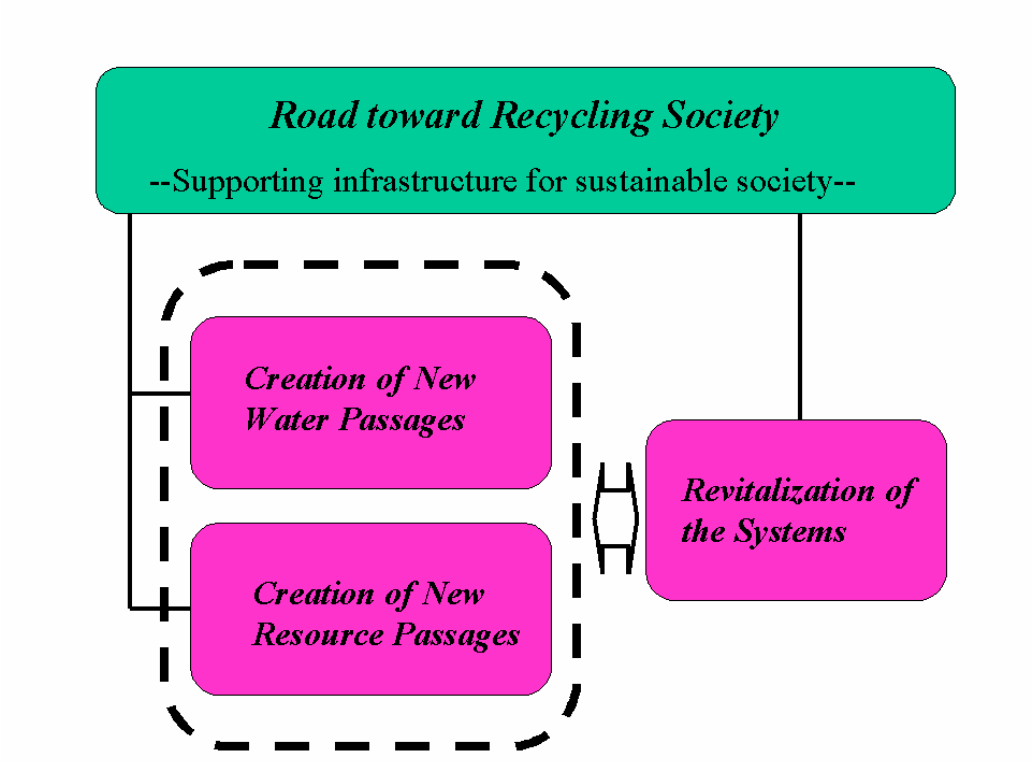

Figure 2. The relationships between the main concept and three sub-concepts

The Creation of New Water Passages and development of this policy

The Creation of New Water passages implies recovering healthy water cycles in basin areas by improving wastewater systems. This will be attained by evolving the following three core-ideas:

-Thoroughly recycle and reuse stored rainwater, purified wastewater and incoming ground water in the systems,

-Optimize facility locations to aim for water reuse and

-Redesign facility structures so they are suitable for reusing water.

Healthy water cycles will be realized by encouraging infiltration of storm water into the ground accompanied by reusing stored storm-water and treated-wastewater. Storm-water infiltration can be realized by designing storm -water systems based on infiltration first instead of draining first. Along with the infiltration first policy, the introduction of storm-water storage facilities to systems will stimulate the increased reuse of water. Direct reuse of treated wastewater should also be promoted by introducing advanced treatment.

Storm-water utilization and treated-wastewater recycling may require facility configurations and locations that

differ from those now in uses. Although the conventional way of deciding the location and capacity of a treatment plant is to consider how effectively we can collect wastewater at the plant, its location and capacity should be decided according to the demand for water. Determined in this new way, its location and capacity may be greatly different those of existing plants. The same idea should also be applied to storm water systems. Considering how effectively we can create a recycling system facilitates the reorganization and rehabilitation of water networks.

The structure of storm water systems may also be transformed when we introduce the new concept to the design of structural details. For example, changing storm water drains to open channels from pipe systems and applying percolating structures and ecologically friendly configurations, in another words, near natural systems and nature friendly systems.

The Passage for Resources and development of this policy

The Passage for Resources aims to recover resources through wastewater works and thus supply recovered resources to communities. Introducing this scheme is intended to release less global worming gas from wastewater systems by promoting energy saving in the systems and by boosting the use of greenhouse-gas-free energy such as biomass energy by local communities.
This will be realized by following three ideas:

-Realize self-supporting in energy use by treatment systems,
-Become a top runner in the application of new-energy by wastewater works and
-Supply energy & resources actively to local communities from wastewater works.

These three ideas need to be explained more specifically. The first idea, realizing self-supporting energy use by treatment systems, aims to promote energy saving, produce new energy in the systems, and then attempt to operate the facilities independent from external energy supplies. The second idea, becoming a top runner in new energy, proposes that wastewater works be a top runner in new-energy use and production. The third idea, supplying energy & resources that are recovered from wastewater woks to local communities, is intended to transform wastewater works into energy and resource centers.

The Revitalization of the Systems and development of this policy

The Revitalization of the Systems proposes effective maintenance of existing facilities and improvement of the systems to support the two other sub-concepts, Creation of New Water Passages and Creation of New Resource Passages. Basic policies for realizing this concept include the following three ideas:

-Transform maintenance policy from reactive to preventive type,
-Improve facilities to meet social demands including multi purpose usages and
-Integrate new facility constructions and maintenance works into asset management.

For these purposes, the actual applications of the following three work categories are considered: works to ensure safety, works to exploit facilities and works to improve functions. “Works to ensure safety” suggests proactive measures to prevent accidents caused by poor maintenance works such as road cave-in caused by

corroded pipes, to install earthquake resistance configurations into the systems, and to provide evacuation sites for the local communities. “Works to exploit facilities” means promoting the multipurpose usage of existing facilities. “Works to improve functions” implies not only simply improving facilities but also active management in accordance with the overall review of system plans including reviews intended to realize the new concept, Road toward Recycling Society.

Conclusion

The 21st century will be an era when we will face many difficulties related to the shortage of resources and climate changes. To cope with theses situations we need a new concept and policy for our wastewater systems to mitigate their impacts. As the new concept for 21st century wastewater systems, The Road toward Recycling Society has been proposed based on one-year committee discussions. The new concept is divided into three sub-concepts that are Creation of New Water Passages, Creation of New Resources Passages, and Revitalization of the Systems. Each sub-concept includes specific policies to promote actual works. We have just begun to evolve wastewater works based on this new concept. Therefore, the actual promotion is limited at this moment but we hold great expectations that in a future, it will be a key infrastructure of the recycling society.

References

Ministry of Land Infrastructure and Transport: Report on Wastewater System Vision 2100; The Road toward Recycling Society (in Japanese). September 2005.

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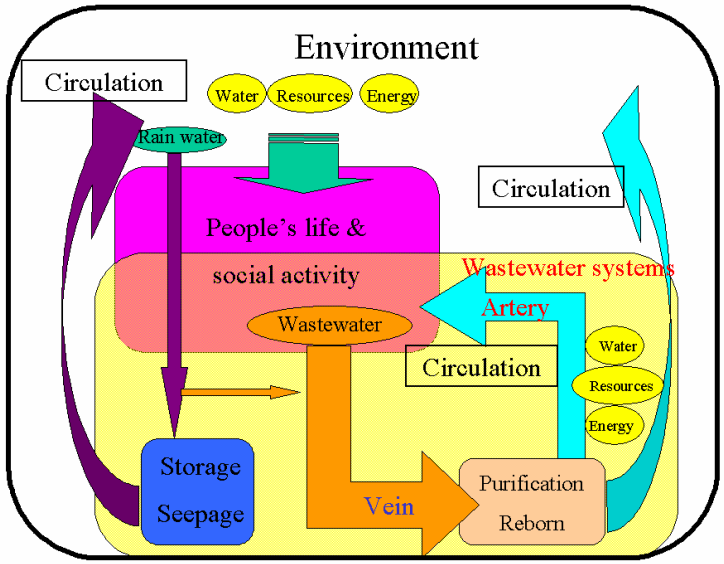

Problems about wastewater system management

- Frequent flooding due to quick runoff of storm water
- Dried up of waterways in dry weather period
- Changing global climate
- Reducing amenity on water environment
- High energy cost due to diminishing fossil fuel
- Increasing aging facilities
- Requirement of high reliability on systems
- Decreasing populations and aging society
- Great deficit on central and local government

3

▲博多駅筑紫口

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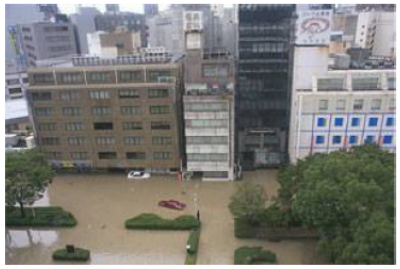

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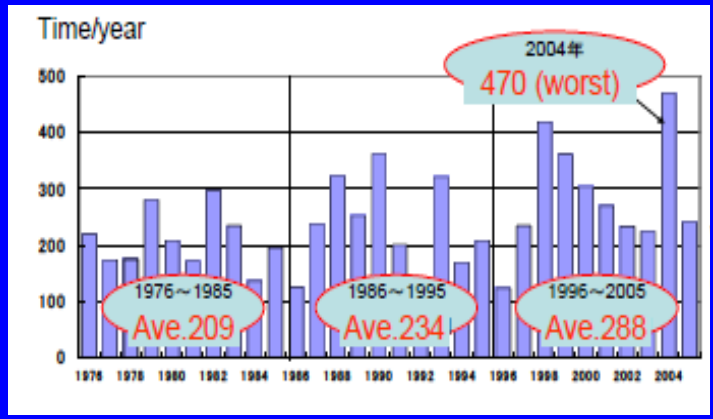
Frequency of high intensity of rainfall (more than 50mm/hour)

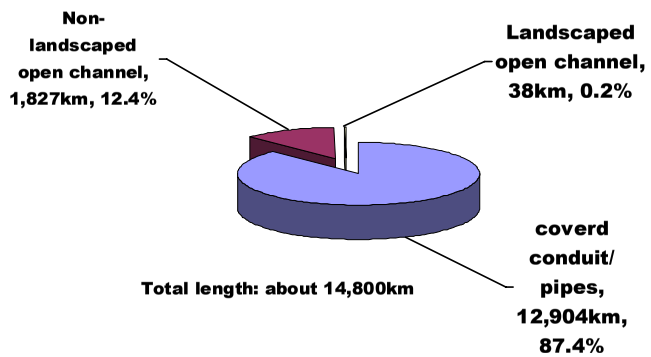


Changing storm water management policy

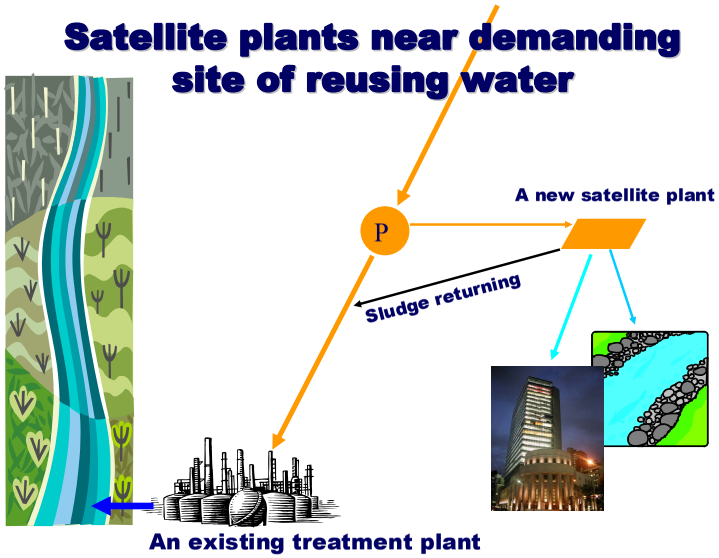
- Managing difficulty on drainage first policy
  - Climate change
  - Increasing runoff due to increasing impermeable area and dried up in dry weather
- Storage and infiltration first policy
  - Reduction of peak flow
  - Restoration of dry weather flow in streams

7

Storm water drains & channels in urban areas



Satellite plants near demanding site of reusing water



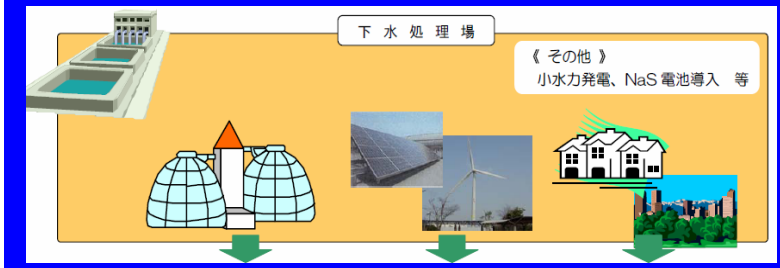
An example of recovered waterways by treated wastewater in suburban area of Tokyo

Creation of Water Passages

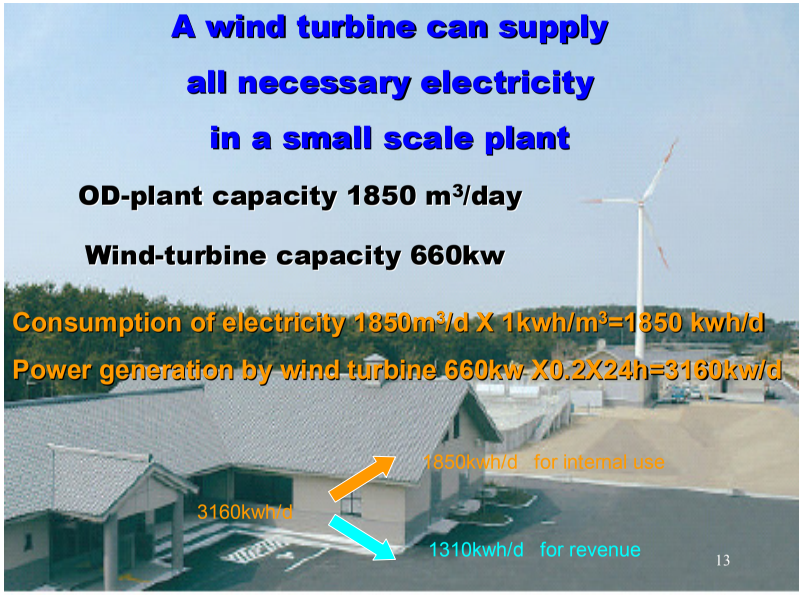
- 100% recycling
  - Stored rain water, treated wastewater
- Optimization of facility location for reusing
  - Reusing-oriented location planning
- Redesigning of facility structure for easy reusing
  - Open channel, ecology concern, near nature structure

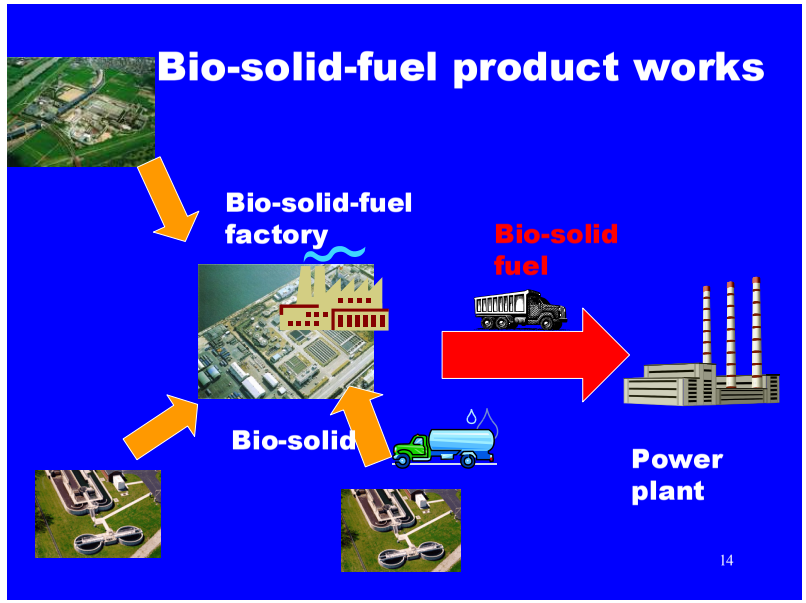
11

A trial calculation for self supplying of power in a 50,000 m³/day plant



Consumption of power **19,035 kwh/day** ⟷ 90 % ⟷ Total power generation **16,616 kwh/day**



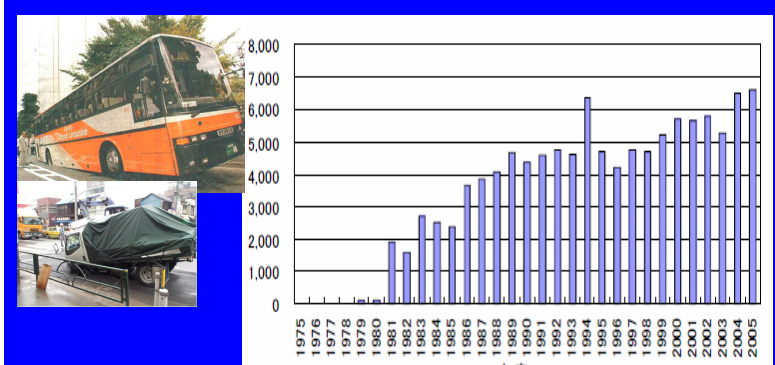


Creation of resource passages

- Self-supporting in energy use
  - 100% self-supplying energy for treatment
- A top-runner of new energy user
  - Biomass center collecting kitchen garbage and wood refuse
- Supplying energy and resources to communities
  - Supplying biomass energy for local communities
  - Wind turbine and solar energy generation

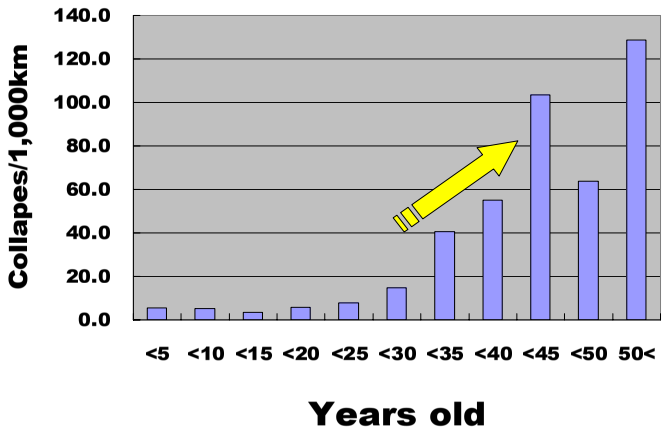
15

The numbers of cave-ins on roads by sewer collapse

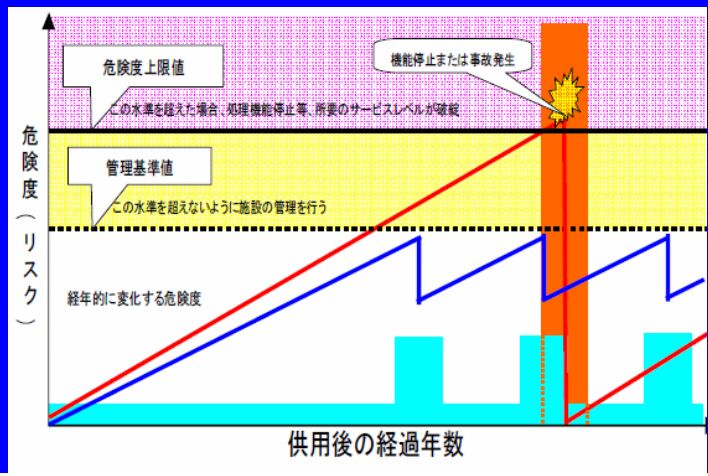


16

Aged pipes tends to make problems



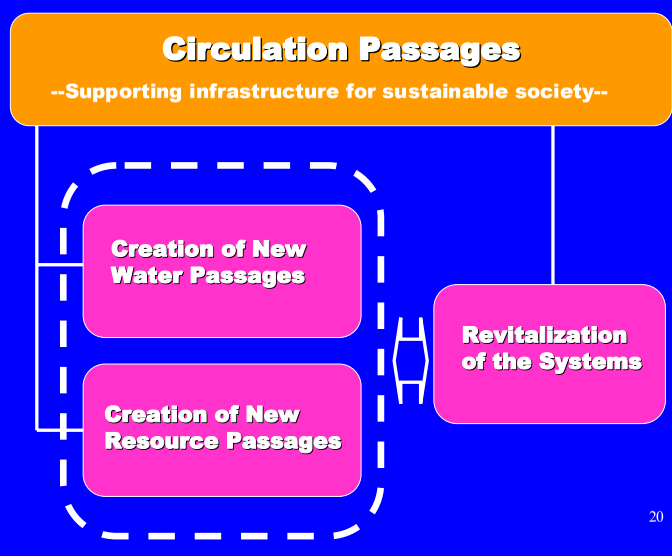
Reactive maintenance vs. Preventive maintenance



Revitalization of the systems

- From reactive to preventive maintenance
  - Quake, collapse, blackout, etc
- Multi-purpose use of facilities
  - Artificial ground over plants, fiber optical cables in sewers, etc
- Integration of facility construction and maintenance by asset management policy
  - Rehabilitation and new concept adaptation

19



20

Conclusions

- New policy for century long targeting to be circulation passages
  - Water recycling
  - Resource recovering
  - System restoring upon new concept

22

From wastewater systems to circulation passages

- Wastewater systems = 'Gesui-dou' in Japanese
- Circulation Passages= 'Junkan-dou' = 'Junkan no michi' in Japanese

23

Problems in wastewater work field

- 24 million of un-serviced population
- Requirement for high reliability on systems
- Reducing amenity on water environment
- Weakening financial backgrounds
- Increasing stocks of facilities
- Changing global environment, reducing resources, and energy problems

24

The 21st Century

- Existing problems
  - Quick run-off of storm water
  - Drying up of waterways
  - Instability of water resources
  - Aging of facilities
  - Huge deficit on central and local governments
- Emerging problems in the new century
  - Climate change by greenhouse gas
  - Shortage of fossil fuels
  - Huge waste production
  - Decreasing of population
  - Aging society

25