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Water Quality Conservation in Rural Areas of Japan
-Case Study of Rural Sewerage Project-

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Abstract □ In this presentation I would like to introduce the Rural Sewerage Project, subsidized by the Ministry of Agriculture, Forestry and Fisheries (MAFF), for the purpose of water quality conservation and improvement of life in rural areas of Japan. Specifically, it will cover background information on the inauguration of the Project, its strong points, wastewater technology and some of its problems, systems of the Project, etc.

Keywords □ water quality, rural sewerage project, wastewater

I. Introduction

1. Background concerning the inauguration of the Project

(1) Characteristics of rural areas and the role it plays

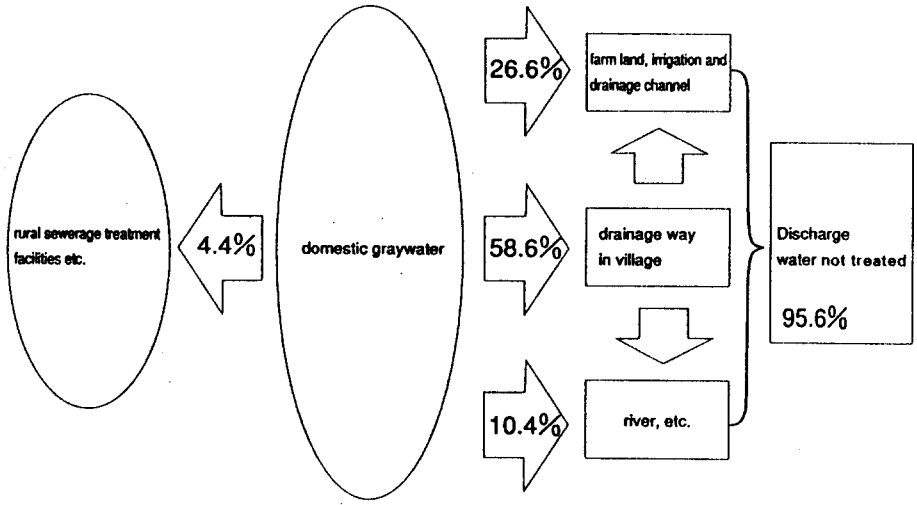
Rural areas, comprising about 90% of the total area of Japan in which a large percentage of the population live(48 million inhabitants; about 40% of Japan's total population) play a very important role in providing living and working space. Rual areas also play an important and diversified role in furnishing a steady supply of provisions, preserving land and the natural environment, providing the population with recreational green space and so on.

By comparing the characteristics of Japan's rural areas which play such roles with that of urban areas the following can be seen.

- rural areas are sparsely populated
- small villages are located at a distance from each other
- many villages are surrounded by farm land where exist a net of irrigation and drainage canals
- the canals and its surrounding banks serve as habitation for many precious animals and plants while forming green open areas

(2) Changes in the rural environment

Looking back upon the water quality environment in rural areas, until the 1950's, domestic graywater from houses was discharged into the canals or rivers and human and animal excreta was reused as precious fertilizer for the farm land. At that point, it was not



※ It is the rate in the rural area.

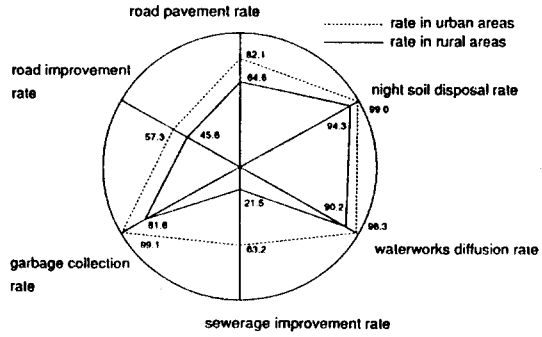
the data quotes from the inv. of actual situation by the National Land Agency in March '95.

Fig. 1. Discharge of domestic graywater in the rural areas

necessary to take any conservational measures as the quantity and pollutant load of the discharged water was still inconsequential and thus the balance between the total load of discharged water and the natural purification ability in the rural areas was main- tained.

However, with the 1960's high economic growth in Japan, modernization and diversification of life-style in the rural areas brought about an increase of the quantity and pollutant load of domestic graywater. The resultant domestic graywater has been the cause of bad influences not only to the agricltural production environment like water pollution, growth impediment to crops and functional decline of irrigation and drainage facilities but also to the life environment like an increase in mosquitoes and flies and malodarous odor in the irrigation and drainage canals.

On the other hand, along with the rise of



※ the spread of the wastewater treatment facilities includes the sewerage and the rural sewerage facilities

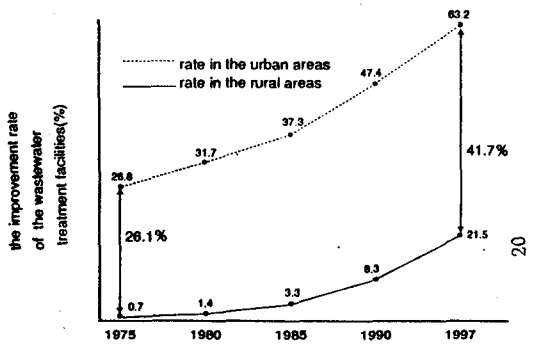
※ the urban areas are the cities with a population of 100,000

※ data: the investigation of the public facilities(in march 1998)

Fig. 2. Improvement of the living environment in the urban areas and the rural areas

especially in the construction of wastewater treatment facilities.

Under these circumstances, in 1970, the "Water Pollution Control Law" was enforced x



※ the spread of the wastewater treatment facilities includes the sewerage and the rural sewerage facilities

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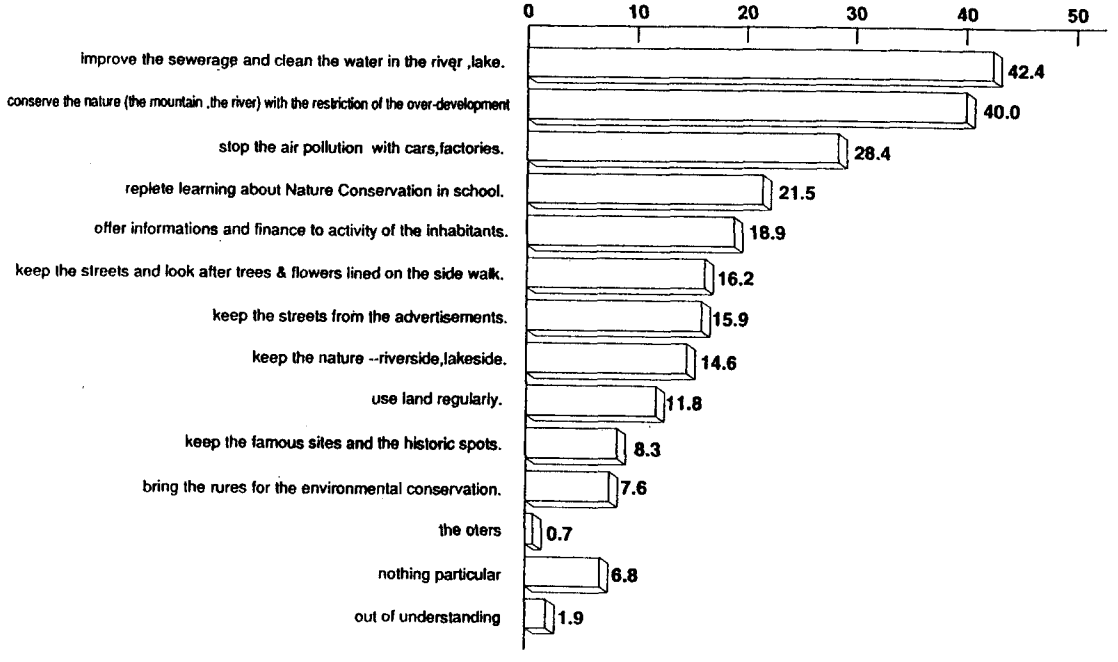
Fig. 3. Spread of the wastewater treatment facilities

especially in the construction of wastewater treatment facilities.

Under these circumstances, in 1970, the "Water Pollution Control Law" was enforced for the purpose of water quality conservation in public water body and MAFF established the "Water Quality Standards for Agriculture". The trend of the environmental administrative offices has clearly changed from quantity to quality.

(3) Inauguration of the Project

With this background, MAFF has acknowledged the importance of water quality conservation in irrigation and drainage canals and the improvement of life environment in rural areas. With the coordinated arrangement of the agricultural produc- tion infrastructure and agricultural life environment as a goal, the much behind wastewater treatment facilities

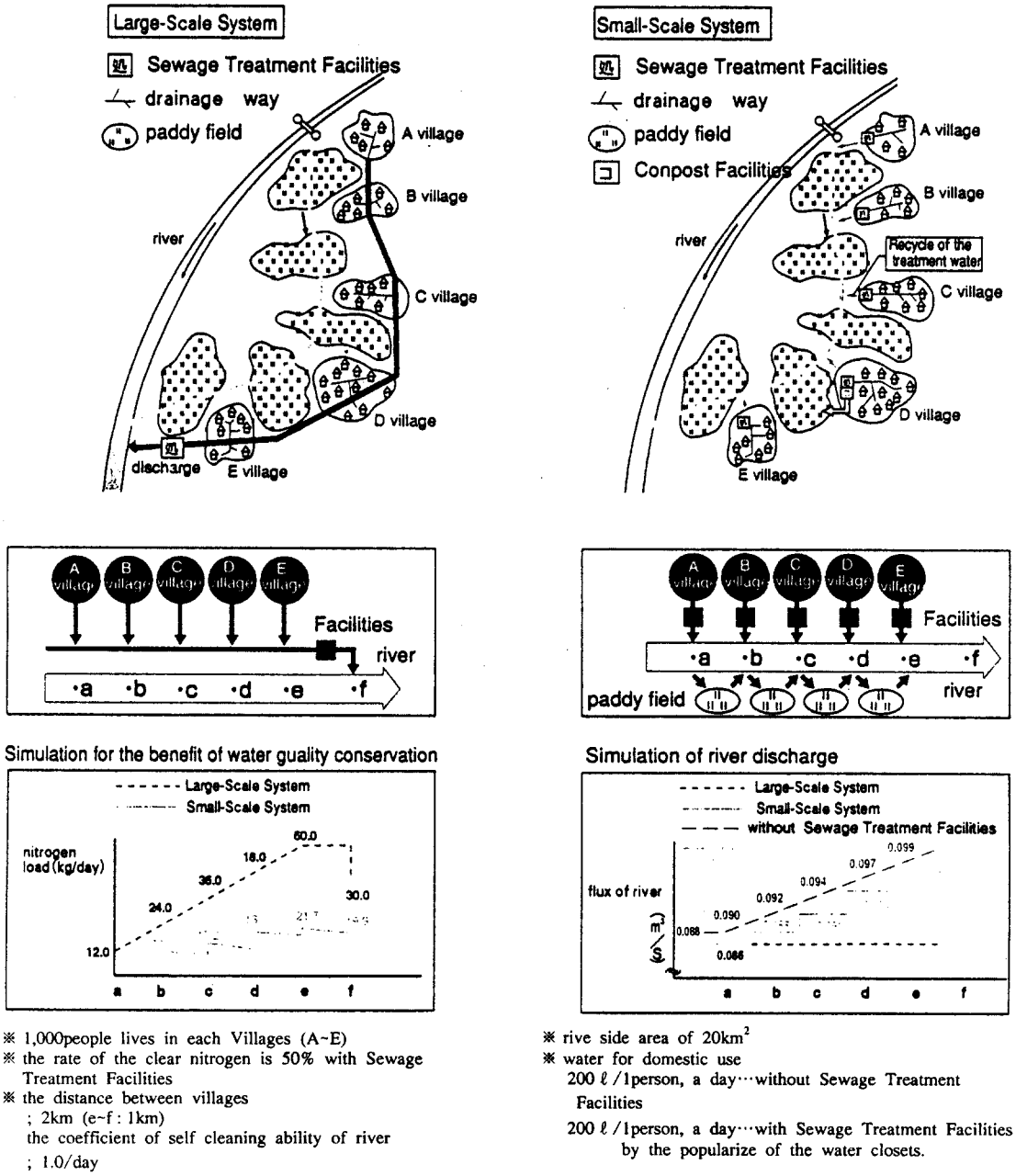


※ It is the total of 2,011 panelists, and 1 person answers some questions.
data : cited the public opinion poll in January 1995 Prime Ministers office

Fig. 4. Function of administration for the conservation in the districts

have become an area for active improve- ment.

In answer to various expectations, MAFF commenced, in 1972, the rural sewerage project as one menu of the integrated rural improvement projects. But with the swift rise of the need to fill the gap in the rural life



※ 1,000people lives in each Villages (A~E)
※ the rate of the clear nitrogen is 50% with Sewage Treatment Facilities
※ the distance between villages
; 2km (e~f : 1km)
the coefficient of self cleaning ability of river
; 1.0/day

※ rive side area of 20km^2
※ water for domestic use
200 ℓ /1person, a day···without Sewage Treatment Facilities
200 ℓ /1person, a day···with Sewage Treatment Facilities by the popularize of the water closets.

Fig. 5. Comparison small scale system with large scale system

environment when compared to that of urban areas, its allotted budget and technological skills were determined to be insufficient. Thus in 1983, MAFF established the present project system, the Rural Sewerage Project(RSP), enlarged its budget, built up the organizations which systematically support it, founded the association which technically supports it and is promoting it in order to contribute to the water quality conservation in rural areas.

2. Characteristics of the Project (RSP)

(1) Originality of the Project (RSP)

There are many projects for treating domestic wastewater being put into operation now in Japan : the Rural Sewerage Project (RSP) subsidized by the MAFF, the Sewage Works Construetion (SWC) subsidized by the Ministry of Construction and the Johkasou Installation Promotion Project (JIPP) subsidized by the Ministry of Health & Welfare.

The RSP looks more like the SWC than the JIPP because some performances of RSP are almost the same as SWC, such as after gathering domestic wastewater sending it to the treatment plant by sewers and treating it there. Johkasou is different from RSP in that it is installed in individual homes or buildings as private equipment. SWC also differs from RSP in the following ways :

① SWC construts intensive, large scale treatment facilities in mainly densely populated urban areas.

② Without being reused, SWC's treated sewage water is discharged into a river or the sea as soon as possible.

③ SWC targets not only domestic wastewater but also storm water, industrial wastewater and so on.

SRP's originality lies in the fact that it takes into account and used to its best advantage the roles and characteristics of the rural areas when planning designing, etc. For example :

① Though Japan's rural area is sparsely populated when compared to urban areas, when looked at from the basis of individual settlements, these may be considered densely populated. Setting up one or more villages located in close vicinity to each other as a treatment district, it becomes possible to install a wastewater sewer and treatment plant cheaply.

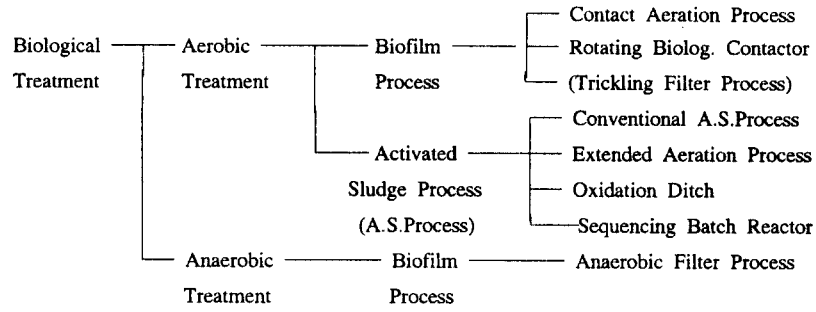
② Settlements are surrounded by farm land, where there is a network of irrigation and drainage canals. By discharging the final effluent from the plant directly into these canals, the water's natural process of purification ability can be used to further cleanse the it's water quality level. Thus, small scale treatment in each settlement has been verified as being more efficient than intensive large scale treatments.

③ As settlements often function as an independent communal society, the support system necessary for operation and maintenance of a treatment plant is established and the background for joint labor is already laid.

(2) Conditions necessary for separate small scale treatment plants

Instead of intensive large scale treatment system that SWC uses, RSP has chosen to use separate small scale treatment system to take advantages of the merits stated above.

Table 1. A list of wastewater treatment processes



Figuring from the average population of a settlement and the number of settlements in a treatment district, the scale of a treatment plant comes to little less than a thousand persons in principle. For such a rural wastewater treatment plant to function, several conditions need to be met as wall as the technology which applies to these conditions need to be developed. Among the conditions needed to be met are the following :

① Easy operation and maintenance

In case of a small scale treatment plant of little less than a thousand persons in principle, stationing an operator at each plant becomes difficalt and usually a circuit operator is employed, making a plant simple and easy to operate and maintain essential.

② Stable and high water quality of final effluent

Treated sewage from rural wastewater treatment plants is frequently discharged in rivers or irrigation and drainage canals and is reused downstream as irrigation water. In this way, teated water becomes part of the rural district's water recycled system. Therefore, a stable and high water quality of final effluent is required.

The following fulfill the minimum requirements for the water quality standards of final effluent from rural wastewater plant :

BOD 20mg/l(daily average value)

SS 50mg/l(daily average value)

③ Adaptation to small scale treatment

Because the influence fluctuation is big in a small scale treatment plant of little less than a thousand persons in principle, a strong adaptability is indispensable against the hourly fluctuations.

Also, since SWC uses intensive large scale treatment and Johkasou is for private use, the unit equipment, machinery used are either too big or too small for RSP's standards. Consequently, RSP needs to create an original total system adapted to small scale wastewater treatment.

3. Domestic wastewater treatment processes and JARUS type plants

(1) Domestic wastewater treatment processes

According to the principle of treatment, I'll classify and introduce some treatment processes that have been mainly applied to small domestic wastewater treatment plants now in Japan. The processes are as follows.

Table 2. JARUS type sewage treatment facilities

JARUS-Type Name	Treatment Process	Target treatment water guatiy					The Number of Facilities (1998)
		BOD mg/ ℓ	SS mg/ ℓ	COD mg/ ℓ	T-N mg/ ℓ	T-P mg/ ℓ	
I Type	Contact Aeration Process [Prepositioned Sedimentation/Septic Tank Type]	20	50	-	-	-	492
II Type	Contact Aeration Process [Combined Anaerobic Biofilter Type]	20	50	-	20	-	26
III Type	Contact Aeration Process [Combined Anaerobic Biofilter Type]	20	50	-	-	-	1,171
IV Type	Contact Aeration Process [Combined Anaerobic Biofilter Type]	20	50	-	20	-	74
IV, Type	Contact Aeration Process Convensional Activated Sludge Process	20	50	-	20	-	0
V Type	Contact Aeration Process [Combined Anaerobic Biofilter Type]	20	50	-	-	-	142
S Type	Contact Aeration Process [Prepositioned Sedimentation/Septic Tank Type]	20	50	-	-	-	74
XI Type	Sequencing Batch Reactor Process	20	50	-	-	-	516
XII Type	Sequencing Batch Reactor Process	20	50	-	15	-	115
XII Type	Sequencing Batch Reactor Process	10	15	15	15	3	126
XIII Type	Sequencing Batch Reactor Process	10	15	15	10	1	0
XIV Type	Intermittent Aeration Process	20	50	-	15	-	373
XIV_p Type	Intermittent Aeration Process	20	50	-	15	3	0
XV Type	Intermittent Aeration Process	10	15	15	10	3	31
OD Type	Oxidation Ditch Process	20	50	-	-	-	252

[Note 1] Secondary treatment & Biological treatment

Secondary treatment is a process removing pollu- tant that cannot be removed by primary treatment. By this definition, physical or chemical treatment like filtration, absorption, coagulation, ion exchange and so on is put under the category of second treatment. But today in Japan, these treatments need high installation cost or high grade technique, therefore, biological treatment is mainly applied as a secondary treatment.

[Note 2] Biofilm process & Activated sludge process

Biofilm process is a kind of treatment method in which raw wastewater and microorganisms are mixed, oxidized and purified under dissolved oxygen. In this process, microorganisms are fixed above filter media as a biofilm. Therefore, the characteristic of this process depends on an absolute quantity of microorganisms in a reactor as a fixed biofilm.

Table 3. Actual results of JARUS type plants

type	BOD		SS		T-N		T-P	
	inflow water	treatment water	inflow water	treatment water	inflow water	treatment water	inflow water	treatment water
JARUS - I	195	14	194	8	43.3	23.6	5.4	3.0
	(63)	(63)	(63)	(63)	(63)	(63)	(63)	(63)
- II	199	13	174	6	40.4	19.0	5.1	3.1
	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)
- III	156	15	168	6	37.9	27.3	4.7	2.7
	(50)	(50)	(50)	(50)	(50)	(50)	(50)	(50)
- IV	168	7	145	4	35.5	14.7	4.5	2.8
	(44)	(44)	(44)	(44)	(44)	(44)	(44)	(44)
- V	153	13	142	5	33.3	24.6	4.8	3.4
	(40)	(40)	(40)	(40)	(40)	(40)	(40)	(40)
	173	13	167	6	38.4	22.4	4.9	3.0
total of Biofilm-process	(217)	(217)	(217)	(217)	(217)	(217)	(217)	(217)
JARUS - XI	156	4	206	4	32.2	5.9	4.5	1.4
	(45)	(45)	(45)	(45)	(45)	(45)	(45)	(45)
- XII	171	5	192	5	39.1	7.4	4.7	1.7
	(67)	(67)	(67)	(67)	(67)	(67)	(67)	(67)
- XIII	217	3	157	3	38.6	5.6	4.3	1.4
	(22)	(22)	(22)	(22)	(22)	(22)	(22)	(22)
	174	4	191	4	36.7	6.6	4.6	1.6
total of Activated Sludge Process	(134	(134)	(134)	(134)	(134)	(134)	(134)	(134)

※ 1. It is Actual results of treated effluent of 87 JARUS type plants from 1985 to 1994.

2. It is shown in units of mg/l and daily average value.
Numbers in ( ) show the analyzed data number value.

3. Numbers on the space of total of Biofilmprocess & total of Activated Sludge Process include the analyzed data number value.

In activated sludge process. microorganisms are suspended in a reactor as activated sludge. Therefore, the characteristic of this process depends on return sludge volume to a reactor.

These processes shown in Table 1 have such characteristics. In the Rural Sewerage Project, it's very important to select the process after consideration of these characteristics and the necessary conditions for small scale wastewater treatment plant.

The JARUS type plants as follows are concretely developed cases.

(2) The JARUS type plants

The Japanese Association of Rural Sewerage (JARUS) adopted contact aeration process among many biofilm processes and sequencing batch reactor among many activated sludge

processes as the main processes of the JARUS type plants. The reasons are as follows :

Contact aeration process has many advantage ; i.e., getting a stable efficiency for wastewater treatment against changeable discharge volume, operating a plant easily without returning sludge, the quantity of excess sludge is minimal. It's because this process can store an absolute quantity of microorganisms in a reactor as a fixed biofilm that it is advantageous.

Sequencing batch reactor (process) has many advantages ; i.e., this process doesn't need return sludge equipment because a reactor can be used both as a sedimentation and a aeration tank, getting a stable efficiency for wastewater treatment without bulking because anoxic & aerobic condition and nitrification & denitrification can occur independently and sedimentation can also occur without flow of influent & effluent, also getting high nitrogen removal efficiency by batch opera- tion.

JARUS has already developed many JARUS type plants. JARUS type – I to JARUS type – V were mainly composed of contact aeration process with sedimentation-storage tank or anaerobic filter tank for the purpose of adding some efficiency, i.e., decreasing influent load or biological nitrogen removal. JARUS type – XI and XII were mainly composed of sequencing batch reactor process with flow regulating tank against changeable discharge volume.

(3) Target water quality and Actual results of treated effluent of JARUS type plants

Referring to the list, target water quality and actual results of JARUS type plants which have already been developed.

From Table 3, the actual results of JARUS type plants are all under the water quality standards of treated effluent(BOD 20mg/l SS 50mg/l) and particularly the actual results of T-N.T-P removal efficiency of JARUS type XI to XIV are very excellent.

4. Project System and Achievements

(1) Project System

The Project is put into operation by the municipality in principle. Part of the construction cost is funded by both MAFF and the prefectural government. In 1983, under the authorization of MAFF, the Japanese Association of Rural Sewerage(JARUS) was established as a public corporation, having many municipalities as members. JARUS has since provided technical development activities, investigation/research activities, publicity activeities and consultation to the municipalities in every stage of RSP.

After construction of the plant, the municipality has the responsibility for the operation and maintenance of the plant and sewer, but simple and daily maintenance is put into the hand's of organizations comprised of residents from settlements.

(2) Achievements and Goals of the Project

① Project's budget results

In 1983, subsidized by MAFF, the Project

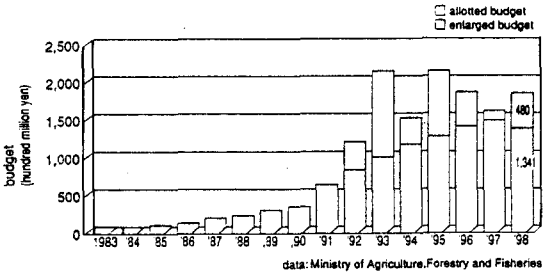


Fig. 6. Change of the budget of projects

started with a budget of about two billion yen. In 1998, fifteen years later, 134.1 billion yen had been appropriated its budget. In total, over the past fifteen years, MAFF has subsidized about 2.9 trillion yen for the Project.

② Achievement in the number of the treatment districts

By 1992, about 4100 treatment districts had adopted as RSP. Of these, by March of 1988, about 2000 districts have had their plants and sewere completely finished.

As to the number of settlements, by 1998, about twelve thousand had been adopted with about 4800 completed. In total, with the number of inhabitants covered under RSP coming to about 1,290,000, RSP's is proud of it contribution to the
conservation of water quality in rural areas.

③ Goal for the year 2006

According to MAFF's plan, by the year 2006, implementation of RSP in 35 thousand settlements of the 122 thousand in agricultural promotion area is given as its goal.

5. Points to be further developed

Concerning domestic wastewater treatment in rural areas, the arrangement ratio of constructing plants is steadily improving according to the promotion of RSP, SWC, Johkasou, etc. Conse- quently, the following are necessary :

- More positive promotion of RSP (not only the construction of new plants but also the renewal of old ones)
- Establishment of a system for proper operation and maintenance of the plants
- Continuation of technical development to create an advanced treatment plant able to totally remove nitrogen, phosphorus, etc. cheaply in order to reduce even further the pollution load in the natural environment.

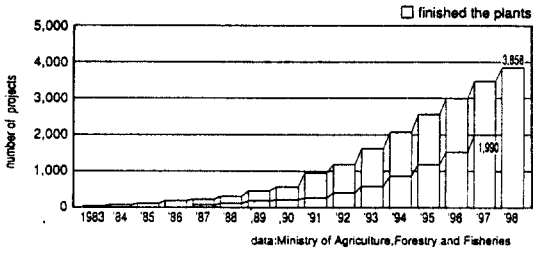


Fig. 7. Change of the number of projects

MAFF, and organizations and persons concerned have promoted RSP as a land improvement project, and it has contributed to the advancement of life-style and water quality conservation in rural areas. It is generally agreed that in the near future the following points will become more important to the promotion of this land improvement project.

(1) The establishment of a circulatory system for regional resources

In order to change from the heretofore mass production, mass consumption, mass scrap society to a resourcce circulatory oriented one, it becomes imperative to establish a sustainable resoure circulatory system that can coexist with the modern prduction process and life-style. To this end the following are required :

① sustainable water circulatory system
② sustainable organic resources circulatory system
③ clean energy utilization system

(2) The realization of comprehensive control of water resources in rural areas

Up to now, for the realization of efficient

and stable agricultural produciton, the main emphasis has been upon securing absolute quantity of water resources in rural areas. In recent years, an increase in new limiting factors for further water resource developments along with a prominent deterioration of water quality in all districts is the present state of the matter.

In order to realize advanced water use in rural areas, it becomes essential to set up a comprehen- sive water control system that fulfills the require- ments for water quality as well as quantity.

(3) Active application of natural purifiation ability

With the help of aquatic plants, etc. irrigation and drainage canals possess a natural spurification ability. It is needful to investigate reasonable and efficient treatment processes; for example, a process that actively employs nature's purification ability by using the canals and idle paddy fields to be found in all areas.

In ending, I would like to say ;

While or daily life becomes more convenient through economic growth and technical innovations, the environment suffers from an ever increasing pollution load. As we are so blessed, we must, then find a way to lighten the environment's load, a solution through technology and administrative skills. RSP is Japan's way of addressing this challenge. In Asian countries, enriched by their paddy field agriculture, the implementation of rural sewerage projects adapted to their own climates, state of affairs, etc. is the common challenge to be addressed.

Finally, I would be most happy if this presentation is in anyway of any help to any of you.