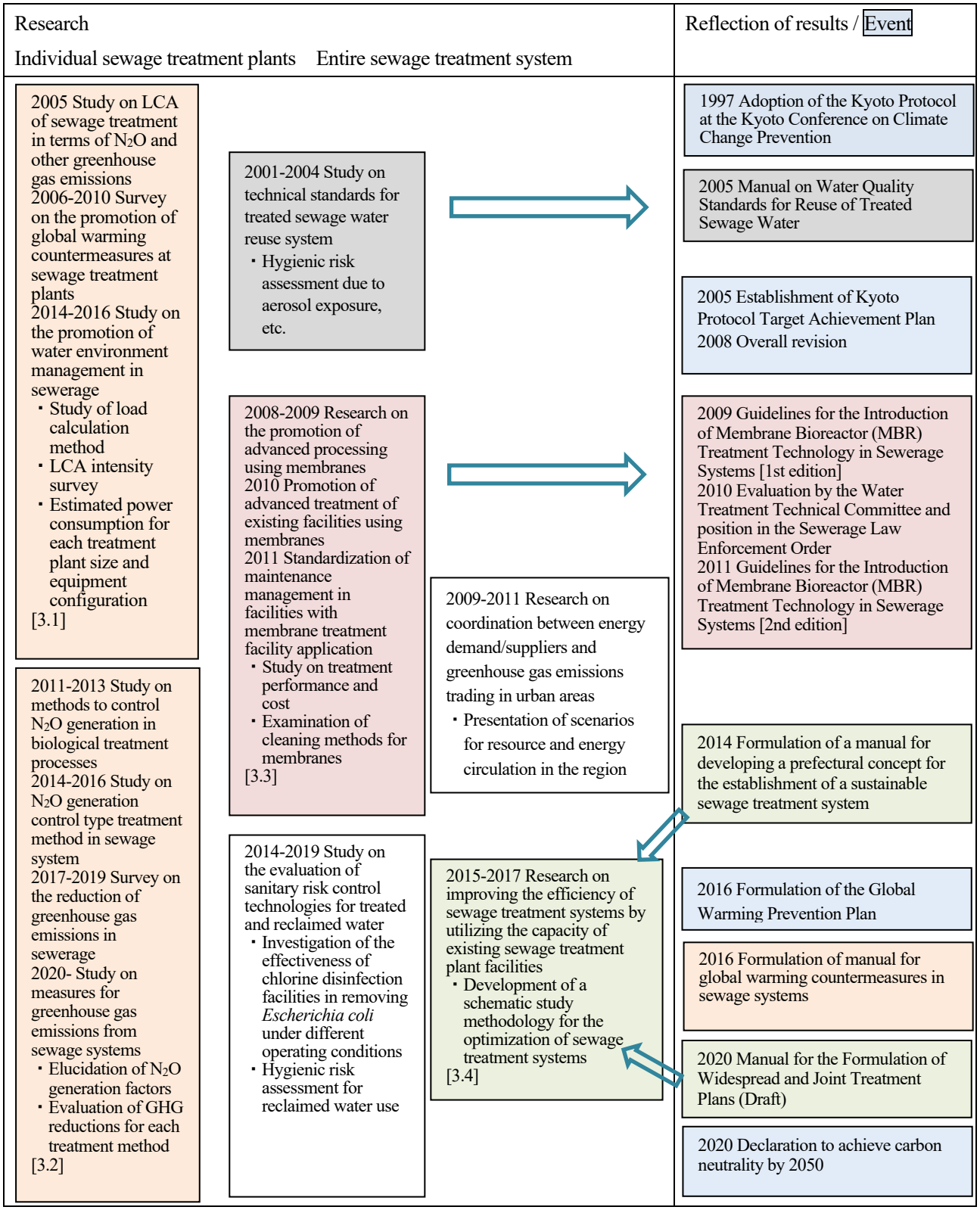
Sophisticated and efficient sewage treatment

1. Outline of Studies and Activities



Background/Issues

- The decrease in the volume of water treated by sewage treatment systems due to the decline in population is expected to further increase in the future, and there are concerns about inefficiency in business management due to a decrease in sewerage fee revenue and a decline in the utilization rate of sewage treatment facilities.
- Furthermore, the "Economic and Fiscal Revitalization Plan Reform Process Chart 2017 Revision" sets specific numerical targets for the consolidation and elimination of wastewater treatment facilities (sewage treatment facilities, agricultural community drainage facilities, etc.) as well as the formulation of plans for widespread and joint sewage treatment in all prefectures by FY2022, and there is a need to improve the efficiency of regional treatment facilities as a whole.
- On the other hand, since the Kyoto Protocol was adopted at the Third Conference of the Parties to the United Nations Framework Convention on Climate Change in December 1997, there have been calls for reductions in greenhouse gas emissions, and the Green Growth Strategy associated with carbon neutrality by 2050 calls for energy creation measures such as sewage heat utilization.

Research Overview

Based on the above situation, the following surveys and studies are being conducted.

- Upgrading and efficiency improvement at individual sewage treatment plants

  Performance evaluation of new sewage treatment methods and points to keep in mind during their introduction; research on technical standards for hygienic safety of treated sewage water; research on LCA methods and greenhouse gas emissions as basic data for evaluation; research on the technical potential of sewage treatment plants as resource and energy centers
- Improvement and efficiency of the entire wastewater treatment system

  Research on methods for evaluating the economic and technical aspects of the consolidation of sewage treatment facilities, and the linkage between the energy demand and the suppliers in urban areas

Social Implementation

- The performance evaluation of new sewage treatment methods and points to consider during their introduction were compiled into the "Guidelines for the Introduction of Membrane Treatment Technology in Sewerage" and placed in the Sewerage Law Enforcement Order as a general treatment method that can be applied nationwide.
- The evaluation method for consolidation is used when formulating prefectural concepts based on the "Prefectural Concept Formulation Manual for Establishing a Sustainable Sewage Treatment System" (January 2014, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Ministry of Agriculture, Forestry and Fisheries (MAFF), and Ministry of the Environment (MOE)).
- In the "Manual for the Formulation of Widespread and Joint Treatment Plans (Draft)" (revised April 2020) by the Ministry of Internal Affairs and Communications (MIC), MAFF, MLIT, and MOE, to be formulated by each prefecture, the research results[3)] are positioned as reference materials when considering facility consolidation/elimination, etc.

2. Main Research Results

1. Concept of LCA application in sewerage

・While environmental impact assessment has been institutionalized in the evaluation of the business impact on the environment,

there is an increasing need to clarify the environmental impact of facilities throughout their life cycle, including construction, maintenance, and even demolition and disposal, in order to build a sustainable society, and the life cycle assessment (LCA) is considered an effective tool for this purpose.

・NILIM has prepared a method for sewerage operators to quantitatively grasp the amount of environmental impact by applying the LCA in the planning and design stages and to comprehensively evaluate projects not only from a cost standpoint but also from an environmental standpoint,[1)] enabling evaluation over the entire life cycle.

・Specifically, the method consists of the following concepts: setting the scope of study (Figure-1), inventory analysis, environmental impact calculation method, impact assessment, interpretation, and reporting.

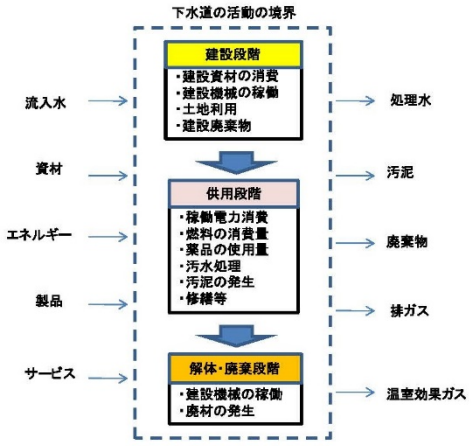


Figure-1 Scope of life cycle when focusing on sewerage facilities

2. Survey on reduction of greenhouse gas emissions in sewerage

・Since the adoption of the Kyoto Protocol, there have been calls for reductions in greenhouse gas emissions to prevent global warming.

・However, methane (CH_4) and nitrous oxide (N_2O), which have a large greenhouse effect (25 times greater greenhouse effect for CH_4 and 298 times for N_2O compared to CO_2), are also emitted in water treatment and sludge incineration, accounting for about 10% and 20%, respectively, of the CO_2 equivalent.

・It is known that N_2O is generated from water treatment as a byproduct or intermediate product of biological reactions (Figure-2), but the factors and mechanisms of N_2O generation remain unclear and have not led to emission control.

・NILIM has been conducting annual surveys of emissions at sewage treatment plants using various treatment methods, such as the conventional activated sludge method and the circulating nitrification and denitrification method, to determine the actual emissions and emission trends.

・In addition, the bench scale reactor is operated with raw sewage flowing into it under different conditions to investigate the factors involved in N_2O generation and the amount of N_2O generated.

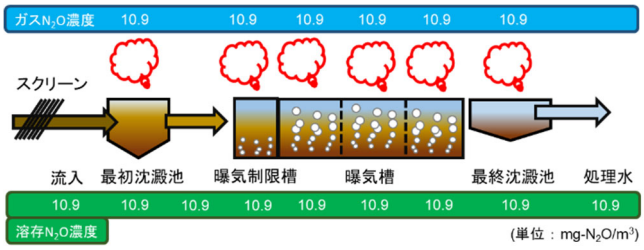


Figure-2: Image of nitrous oxide generation

3. Membrane treatment technology - Guidelines and general evaluation

・Changes in social conditions raised concerns about inefficiencies in business management, and individual sewage treatment plants were required to become more sophisticated and efficient.

・ The membrane bioreactor (MBR) eliminates the need for sedimentation tanks and disinfection facilities, requires less land, and offers advanced treated water quality and simplified maintenance and management (Figure-3).

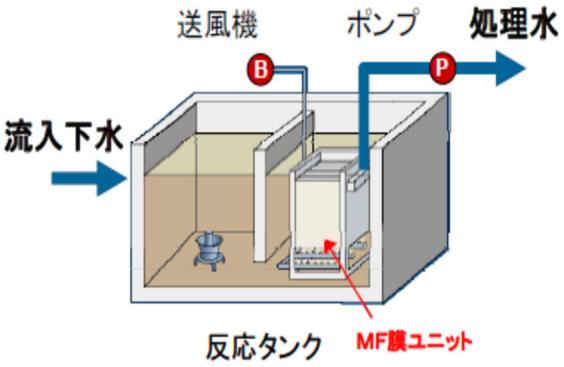


Figure-3 Outline flow of membrane bioreactor (MBR)

・ In 2009, the MLIT compiled the "Guidelines for the Introduction of Membrane Bioreactor (MBR) Technology in Sewerage Systems (1st Edition)," which provides basic information on membrane treatment technology, the significance of its introduction into sewage systems, and considerations and points to keep in mind when introducing the MBR into new and existing treatment plants, in order to promote the use of this technology, especially in medium- and large-scale sewage treatment plants that will be in increasing demand for reconstruction.

・ In 2011, based on the results of the MBR demonstration project at an actual facility, the Guidelines (2nd Edition)[5] were updated to enhance technical elements such as installation costs and maintenance and manageability.

・ In addition, the Water Treatment Technology Committee, which evaluates new water treatment technologies on an individual basis and determines their conformity with the water discharge quality classifications stipulated by law, evaluated that the MBR method could achieve the planned discharge water quality of 10 mg/L BOD, etc., and it was positioned in the Sewerage Enforcement Order as a general treatment method applicable throughout the country. NILIM, which managed the committee, conducted a study on the long-term treatment performance of MBR facilities and summarized the items to be considered when introducing MBRs.

4. Improving the efficiency of wastewater treatment systems under a declining population

・ In order to build a sustainable wastewater treatment system, efficient operation and management is required through the integration and wide-area expansion of facilities.

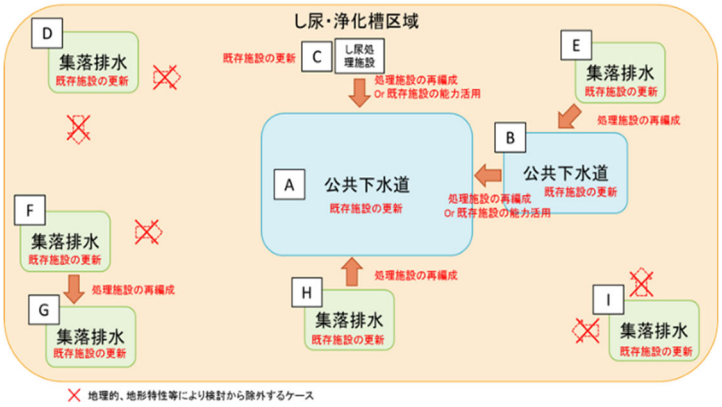


Figure-4: Image of setting up a study case

・ Wastewater treatment systems include sewage systems, agricultural community drainage systems, night soil treatment plants, etc. The decline in the volume of treated water due to the decrease in the population has led to a decline in operating rates and service charge revenue, and the aging of facilities has increased the cost of reconstruction and renewal. Therefore, a method for selecting the optimal consolidation case based on an evaluation of the economic efficiency, technical aspects, and environmental aspects was composed as a technical document[3] (Figure-4). In addition to providing cost functions applicable to small treatment facilities, this document also allows the estimation of future costs and energy consumption based on how changes in facility operating rates associated with changes in treated water volume impact costs and energy consumption, allowing for more accurate economic comparisons.

3. List of Related Reports and Technical Documents

1) “Guideline for Life-Cycle Assessment of Sewerage Systems,” NILIM Technical Note No. 579
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0579.htm
2) “Research on greenhouse gas emissions and on collaboration between energy suppliers and consumers in cities,” NILIM Project Research Report No. 44
https://www.nilim.go.jp/lab/bcg/siryou/kpr/prn0044pdf/kp0044.pdf
3) “Technical document on improving the efficiency of wastewater treatment systems,” NILIM Technical Note No. 1071
http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn1071.htm
4) Manual for Prefectural Concept Development for Building a Sustainable Sewage Treatment System
https://www.mlit.go.jp/mizukokudo/sewerage/mizukokudo_sewerage_tk_000277.html
5) Guidelines for the Introduction of Membrane Treatment Technology in Sewerage [2nd Edition]
https://www.mlit.go.jp/mizukokudo/sewerage/crd_sewerage_tk_000045.html

4. Future Outlook

It is necessary to continue to conduct surveys and research on the economic and environmental sophistication and efficiency of individual sewage treatment plants, as well as to conduct surveys and research and develop technologies for sewage treatment systems that can cope with the decrease of treated water volume due to changes in social conditions, and for the joint use of facilities and joint operation and management.