

Application of Reverse Osmosis Membrane Technology in Trans Malakoni Village, Enggano Island

Ashar Muda Lubis¹, Fachruzzaman Fachruzzaman², Rini Indriani³, Sipriyadi Sipriyadi⁴, Darmawan Ikhlas Fadli^{5*}

^{1,2,3,4,5}Universitas Bengkulu

*Corresponding author, e-mail: ikhlasfadli@gmail.com.

Abstract

Trans Malakoni Village, located on Enggano Island, Bengkulu Province, faces significant challenges in providing access to clean, potable water. Limited access to adequate freshwater sources and water quality that frequently fails to meet health standards are major obstacles to the community's sustainable livelihood. This research aims to explore the potential and implementation of household-scale reverse osmosis (RO) technology as an innovative solution for producing clean, potable water in Trans Malakoni Village. The research methodology involves raw water quality analysis, the design of a household-scale RO system suitable for local conditions, and an evaluation of system performance and community acceptance. Initial results indicate that existing water sources in Trans Malakoni Village, although limited, can be effectively treated using RO technology to achieve established drinking water quality standards. The proposed household-scale RO system design emphasizes energy efficiency, operational ease, and affordable maintenance costs, thereby enabling sustainable adoption by households. The implementation of RO technology is expected not only to enhance access to clean water but also to contribute to improved public health, self-reliance in water resource management, and sustainable living in Malakoni Village. This study recommends further research on system optimization and community education programs to maximize the positive impact of RO technology in other remote island regions.

Keywords: Enggano; Reverse Osmosis; Trans Malakoni.

How to Cite: Lubis, A. M. et al. (2025). Application of Reverse Osmosis Membrane Technology in Trans Malakoni Village, Enggano Island. *Abdi: Jurnal Pengabdian dan Pemberdayaan Masyarakat*, 7(3), 683-690.



This is an open access article distributed under the Creative Commons Share-Alike 4.0 International License. If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. ©2025 by author.

Introduction

Enggano Island is one of Indonesia's outermost islands, located in the Indian Ocean. Enggano Island is part of the government area of North Bengkulu Regency, Bengkulu Province, and is a sub-district. Enggano Island is one of the Disadvantaged, Outermost, and Frontier (3T) islands in Indonesia to be developed (Perpres, 2020), located southwest of Bengkulu city with coordinates 05° 23' 21" LS, 102° 24' 40" BT (Nurhimat & James Hellyward, 2023). The 3T regions, in a sense, have a low quality of development, where the community is less developed compared to other regions both on a national scale and in terms of its geographical location in the forefront and outermost regions of Indonesia. Most of the 3T areas are the gateways to Indonesia's borders. The location of the area, far from the provincial capital, is also a factor in stunted economic growth due to uneven infrastructure development. The problems that exist in the 3T areas are education, clean water, and proper sanitation, as well as clean and affordable energy, which in the 3T areas have not fully reached all levels of society, especially the people who live on Enggano Island, a remote island that is geographically difficult to reach from the provincial capital.

One of the top priorities in ensuring the basic needs of society is the provision of clean water to meet the needs of the community. Unfortunately, while there may be plenty of water available, many communities face difficulties in obtaining and meeting their water needs for daily life. It is not only the local government that is responsible for providing clean water for the community, but also the shared responsibility of all parties, including the private sector, the central government, and the general public. Each does what they

can, keeping in mind that the availability of clean water requires everyone to work together to keep existing water sources sustainable and avoid using existing clean water wastefully.

Water sources are easily available to people in Malakoni Village in Trans Malakoni. Almost everyone around the world uses surface wells or dug wells. The results of the Trans Malakoni Community Consultation in Malakoni Village show that poor water quality is one of the problems faced by the community. Because it contains manganese and iron deposits, the water is yellowish in color. In addition, the current condition of the water is not suitable for drinking. However, people usually do not utilize the water for their daily needs. Residents buy water in jerry cans and gallons for drinking. So, this community service will concentrate on two problems: increasing the knowledge of the community of Trans Malakoni Village, Enggano Island, and encouraging the community to provide clean water independently by using a simple reverse osmosis water filter.

The combination of severe droughts, melting glaciers, seawater intrusion into groundwater, and increasing water demand has led to a global water deficit of 40% by 2030 ([United Nations, 2015](#); [Peng et al., 2025](#); [Zimmermann et al., 2025](#)). Ensuring that the growing demand is met is critical, and this requires not only improvements in water conservation, distribution, and management, but also the availability of additional freshwater. To meet the growing demand, one way to achieve this is by utilizing well water through reverse osmosis (RO) membrane technology, which increases the availability of clean and potable water for the global population. Desalination can also help fulfill the UN's 6th sustainable development goal (SDG6), "to ensure the availability and sustainable management of water and sanitation for all." ([United Nations, 2023](#)). It also plays an important role in other SDGs, including the sustainable use of marine resources (SDG 14), promoting sustainable agriculture (SDG 2), and the development of safe cities (SDG 11) ([United Nations, 2023](#); [Herrfahrdt-Pähle et al., 2025](#)). Many cities in Indonesia, especially big cities with dense populations and many activities, face the problem of limited availability of clean water due to the adverse effects of high air pollution and acid rain on the quality of water consumed. However, there are still many areas that do not have access to clean water, especially water that is fit for consumption. One of the reasons for this is that there is no knowledge of the technology that can solve the problem or the human resources needed to deal with the problem.

As a household-scale water purification system, RO has proven to be very effective in overcoming water quality problems compared to other purification methods such as activated carbon, water softener, distillation, UV, and neutralization ([Kamrin et al., 1999](#); [Sedlak, 2019](#); [Elmaadawy et al., 2020](#); [Davey et al., 2022](#); [Suar et al., 2025](#)). RO systems can separate unwanted components such as organic and non-organic components, bacteria, viruses, particulates, and dissolved ions or salts. RO systems are also known as filter media that have the smallest pores compared to other filters, namely 0.0001 microns (HomePlus, 2024). Several studies and patents on the effectiveness of RO systems with various designs and configurations have supported the development of household-scale RO systems ([Bowman, 1997](#); [Chen, 1999](#); [Walker et al., 2008](#); [Van de Walle, 2022](#); [Pishkar & Gohari, 2025](#)).

This research aims to explore the potential and implementation of household-scale reverse osmosis (RO) technology as an innovative solution for producing clean, potable water in Trans Malakoni Village. The application of energy-efficient household-scale RO systems is emphasized, designed to operate with minimized energy consumption without compromising water quality. The implementation of RO technology is expected not only to enhance access to clean water but also to contribute to improved public health, self-reliance in water resource management, and sustainable living in Trans Malakoni Village.

Methods

Water sources are easily available to people in Malakoni Village in Trans Malakoni. Almost everyone around the world uses surface wells or dug wells. The results of the Trans Malakoni Community Consultation in Malakoni Village show that poor water quality is one of the problems faced by the community. Because it contains manganese and iron deposits, the water is yellowish in color. In addition, the current condition of the water is not suitable for drinking. However, people usually do not utilize the water for their daily needs. Residents buy water in jerry cans and gallons for drinking. So, this community service will concentrate on two problems: increasing the knowledge of the community of Trans Malakoni Village, Enggano Island, and encouraging the community to provide clean water independently by using a simple reverse osmosis water filter.

Community service activities in Trans Malakoni, Malakoni Village are conducted through the counseling method. This means providing community groups with an understanding of the importance of clean water and how to treat and utilize it. Researchers used a qualitative approach to investigate the process of community empowerment through counseling to increase the productivity of critical land. According to [Moleong, \(2017\)](#); [Padgett \(2016\)](#) and [Silverman et al., \(2021\)](#), "qualitative method as a research procedure

that produces descriptive data in the form of written or spoken words from people and observable behavior" refers to a qualitative approach.

In detail, the stages of implementing the activity are as follows : (1) Counseling activities, which are used to explain the material that has been prepared by the service implementation team. Counseling is carried out to provide additional knowledge to the community and partners about the importance of clean water for life, the requirements for drinking water, and water management and purification systems. (2) Question and answer activities, which are used to respond to the extent of the level of understanding of what has been conveyed by the Community Service Implementation Team. (3) Discussion activities, namely presenters and participants conducting dialogues that discuss the use and utilization of tools to produce clean water. (3) Simulation and practice/workshop activities, which are used to show the installation and use of tools to produce clean water and ready-to-drink water in a safe way. Implementation of the workshop model when practicing making water purification equipment using the filtration method and adding reverse osmosis technology to produce ready-to-drink water.

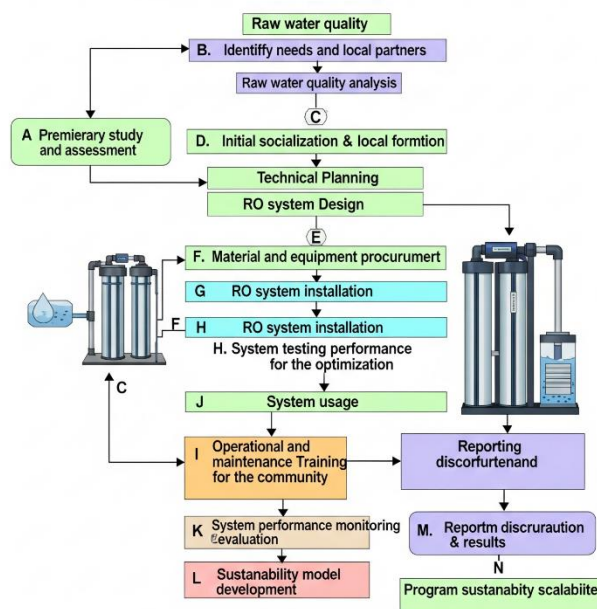


Figure 1. Flowchart of Community Engagement Methodology

This process involves women and men, as well as adolescent girls from the local community. The aim is to remember the role of the community as a driver of change. The community is expected to play a more active role in driving major changes. This community engagement will be implemented through a participatory and sustainable approach (see Figure 1), ensuring the effective adoption of RO technology and providing long-term impact for the community of Trans Malakoni Village. This method is expected to ensure that the RO technology is not only installed but also operated and maintained independently by the Trans Malakoni Village community, thereby providing sustainable clean water benefits for a better life.

Result and Discussion

The service preparation activities in Trans Malakoni began with the initial coordination of the team with the Head of Enggano Sub-District and the Head of Malakoni Village (Figure 2). Coordination as well as field surveys to find a work post for the service team during community service activities and to obtain permission to go to the field. We need a post or place to store tools, assemblies, and training activities. The results of the initial coordination were that the Head of Enggano Sub-District and the Head of Malakoni Village were willing to accept community service activities to be carried out from August 8–18, 2023, and gave permission to use the post location, which is Anwar's brother's house, which has often been used as a post for outside agency activities in Malakoni Village, and the location for the placement of drinking water treatment equipment in RO Trans Malakoni, Malakoni Village, which is the source of raw water for drinking water treatment for the Trans Malakoni community. The team has been designing preparatory activities for community service in Trans Malakoni since June 2023, specifically collecting data on the needs of tools and materials for use in community service activities. The aim of the program is to apply science and technology

to the community, especially in the field of clean water supply that is suitable for drinking, in order to answer the problems that occur in Trans Malakoni, namely that the Household Scale Clean Water Supply System has not been fulfilled in quality and quantity for household needs and community drinking water.

The service was carried out through socialization, training, and making a simple water filtration system (reverse osmosis) for potable water (Figure 3). Residents of Trans Malakoni Village were involved in this process. After the materials and equipment were arranged in accordance with the previously socialized order, the installation of the piping system was continued, and then a series of water filtering devices were arranged to meet the drinking water needs of the restricted system. Field results showed that residents of Trans Malakoni Village have the ability to create a simple water filtration system known as reverse osmosis, both in terms of hard skills and soft skills. The counseling went smoothly and as expected. The number of counseling participants was 16. The counseling enhanced community awareness regarding the necessity of clean water for daily activities. [Permenkes No. 32 of 2017 \(2017\)](#); [Komarulzaman et al, 2017](#) and [Arcipowski et al., 2017](#) stipulates that the community must use clean water with a minimum level of 1 mg/l. Physical, biological, and chemical parameters, as well as additional parameters that may be required, form the Environmental Health Quality Standard for Water Media for Sanitary Hygiene Purposes.



Figure 2. Initial discussion of implementation activities with the Enggano Sub-District Head.



Figure 3. Counseling activities with the Trans Malakoni community.

Before beginning the socialization and counseling, we asked service participants to fill out a questionnaire. Participants received the questionnaire before the service. It consists of twelve questions with "yes" and "no" options. The participants' answers are counted to determine their frequency, and then the percentage is calculated. The focus of the questionnaire questions was the participants' basic knowledge of water treatment and use. Table 1 presents the results.

Table 1. Questionnaire on Community Knowledge, Attitude, and Behavior on Clean Water.

No	Question	Answer Options	Frequency	Percentage (%)
1.	What are the consequences of not filtering well water?	Yes No	6 10	37.5 62.5
2.	Do you filter the water before cooking?	Yes No	2 14	12.5 87.5
3.	Do you know how to treat water well to make it clean?	Yes No	14 2	87.5 12.5
4.	Do you use well water to wash vegetables, fish, and meat (food ingredients)?	Yes No	14 2	87.5 12.5

No .	Question	Answer Options	Frequency	Percentage (%)
1.	What are the consequences of not filtering well water?	Yes No	6 10	37.5 62.5
5.	Do you use clean water in your daily life?	Yes No	14 2	87.5 12.5
6.	Do you use well water as a source of clean water?	Yes No	14 2	87.5 12.5
7.	Do you use murky well water?	Yes No	10 6	62.5 37.5
8.	Do you know that when well water is cooked, it should be filtered?	Yes No	6 10	37.5 62.5
9.	Do you know the symptoms of not filtering water after boiling?	Yes No	14 2	87.5 12.5
10.	Do you filter the water after cooking?	Yes No	10 6	62.5 37.5
11.	Do you wash your hands with soap before treating and serving drinking water?	Yes No	12 4	75 25
12.	Did you know that filtering well water with palm fiber can make the water clean?	Yes No	14 2	87.5 12.5

The questionnaire results shown in the table above indicate that "don't know" was the most common answer choice, suggesting that the community still lacks knowledge about clean water issues. After conducting counseling, providing materials, demonstrations, and practicing the use of tools, it is expected that the community will have a better understanding of healthy lifestyles, particularly regarding the use of clean water, and more people will be aware of the importance of clean water. Counseling provides information that increases people's knowledge about the importance of clean water. To prevent waterborne diseases, the community will always try to fulfill the need for clean water. A person's intention towards health problems, the amount of support from the surrounding community, the amount of information about health, the freedom of individuals to make decisions and act, and the circumstances that allow them to behave or not behave (Notoatmodjo, 2014; Ogunbode et al, 2024; Yang et al.,2024; Isukuru et al., 2024).

Table 2. Distribution of pH and TDS values in water samples.

Water Samples	pH	TDS
Reverse osmosis membrane filtration results in water	5.9	24
Sample Water from Malakoni Water Depot	4.9	210



Figure 4. Water Trans Malakoni RO water sample before the treatment process and water after the RO process

After assembling the device, we carry out performance testing to determine if it functions properly. The indicator that the tool works well is the production of clean water according to the standards of Permenkes RI No. 32 of 2017 (2017) and drinking water according to the standards of Permenkes RI No.

492 of 2010 (2010). Sampling of clean water taps is done at the output nanofiltration process, while drinking water samples are taken at the output tap RO process. The results of the water quality analysis, which includes pH and TDS test parameters, show a very high decrease in contaminants and have met the environmental quality standards so that they can be used as clean water and drinking water (Table 2). The large hydraulic pressure (5 bar) during the filtration process pushes river water molecules through the nanofiltration membrane wall, blocking contaminants with larger particle sizes in the membrane pore (Qiblawey et al., 2009; Sisnayati et al., 2022; Friedman et al., 2024). A comparison of water before and water produced from the RO process is shown in Figure 4. There is a change in color; initially, the water before the treatment process is slightly yellowish and cloudy, but after the RO process, the color of the water becomes clear or colorless and has met its environmental quality standards, so this process has achieved indicators of success in producing clean water and drinking water in Trans Malakoni. To increase the pH of water, it can be done by adding alum to the coagulation-flocculation process (Guida et al., 2009; Sisnayati et al., 2023; Tahraoui et al., 2024; AlMuhanna et al., 2025).

Conclusion

Trans Malakoni community service activities in Malakoni Village, Enggano Island, and North Bengkulu Regency have been completed and have the potential to increase community awareness about the importance of clean water. In addition, the community can obtain clean water independently by using a simple reverse osmosis filter. To achieve self-sufficient clean water supply and benefit the entire community, the Enggano Island Community Health Center and Malakoni Village government must work together across sectors. To ensure the right and need of all people for clean water, the next community service activity should provide training on clean water management or maintenance management of waterways to continue the maintenance and improvement of the clean water facilities that have been built.

Acknowledgements

Thanks to LPPM Bengkulu University for the financial support in the implementation of community service activities through the Unib Mandate Service Scheme in 2023 with contract number 5892/UN30.15/PM/2023. Our thanks also go to the government officials of Malakoni Village, Enggano District, and North Bengkulu Regency, who have helped a lot with this service activity in the Trans Malakoni Area.

References

- Al-Muhanna, K. J., Asiri, F., Abu-Arabi, M., & AlMansour, H. (2025). Treatment of Paper and Pulp Wastewater Using Coagulation-Flocculation with Alum: Optimization and Performance Evaluation. *Water, Air, & Soil Pollution*, 236(1), 1-10.
- Arcipowski, E., Schwartz, J., Davenport, L., Hayes, M., & Nolan, T. (2017). Clean water, clean life: Promoting healthier, accessible water in rural Appalachia. *Journal of Contemporary Water Research & Education*, 161(1), 1-18.
- Bowman, D. E. (1997). Reject Water Drain Line Installation System and Apparatus for Under Sink Reverse osmosis Filter System (5635058).
- Chen, K. R. (1999). Reverse osmosis Drinking Water Treatment System with Backwashable Precise Prefilter Unit (5958232).
- Davey, C. J., Thomas, N., & McAdam, E. J. (2022). Downscaling reverse osmosis for single-household wastewater reuse: towards low-cost decentralised sanitation through a batch open-loop configuration. *Water Reuse*, 12(2), 191-205.
- Elmaadawy, K., Kotb, K. M., Elkadeem, M. R., Sharshir, S. W., Dán, A., Moawad, A., & Liu, B. (2020). Optimal sizing and techno-enviro-economic feasibility assessment of large-scale reverse osmosis desalination powered with hybrid renewable energy sources. *Energy Conversion and Management*, 224, 113377.
- Friedman, A., Boselli, E., Ogneva-Himmelberger, Y. et al. (2024). Manganese in residential drinking water from a community-initiated case study in Massachusetts. *Journal of exposure science & environmental epidemiology*, 34(1), 58-67.

- Guida, M., Mattei, M., Della Rocca, C., Melluso, G., & Meriç, S. (2007). Optimization of alum-coagulation/flocculation for COD and TSS removal from five municipal wastewater. *Desalination*, 211(1-3), 113-127.
- Herrfahrdt-Pähle, E., Houdret, A., Dombrowsky, I., Cullmann, J., Mukherji, A., Unver, O., & Varady, R. (2025). Empowering global water governance: taking the 2023 UN Water Conference outcomes forward to address the current water crises. *Water International*, 1-7.
- HomePlus. (2024). *Water filters & purifiers for your home and business*. HomePlus. <https://www.home-water-purifiers-and-filters.com/>
- Isukuru, E. J., Opha, J. O., Isaiah, O. W., Orovwighose, B., & Emmanuel, S. S. (2024). Nigeria's water crisis: Abundant water, polluted reality. *Cleaner Water*, 100026.
- Kamrin, M., Hayden, N., Christian, B., Bennack, D., & D'Itri, F. (1999). Reverse osmosis for Home Drinking Water. *Bulletin WQ24*, Michigan University.
- Komarulzaman, A., Smits, J., & de Jong, E. (2017). Clean water, sanitation and diarrhoea in Indonesia: Effects of household and community factors. *Global public health*, 12(9), 1141-1155.
- Moleong, L. J. (2017). *Metodologi Penelitian Kualitatif*. Jakarta : Remaja Rosdakarya.
- Notoatmodjo, S. (2014). *Ilmu Perilaku Kesehatan*. Jakarta : Rineka Cipta.
- Nurhimat, & James Hellyward. (2023). Pengujian Krokos Pada Pulau Terluar di Provinsi Bengkulu. *Journal of Civil Engineering Building and Transportation*, 7(1), 218–226.
- Ogunbode, T. O., Esan, V. I., & Akande, J. A. (2024). Water resources endowment and the challenge of underutilization in a tropical community in Nigeria. *Sustainable Water Resources Management*, 10(2), 72.
- Padgett, D. K. (2016). *Qualitative methods in social work research* (Vol. 36). Sage publications.
- Peng, H., Tang, Z., Chen, Z., Wu, Y., Yuan, Y., Shi, Q., Li, L., & Chen, H. (2025). Geospatial perspective for monitoring SDG 6.6. 1 based on spatial and temporal analysis of lake water storage variations in Dongting Lake, China. *Journal of Hydrology: Regional Studies*, 57, 102175.
- Permenkes. (2017). Standar Baku Mutu Kesehatan Lingkungan dan Persyaratan Kesehatan Air Untuk Keperluan Higiene Sanitasi, Kolam Renang, Solus Per Aqua, dan Pemandian Umum, Permenkes No. 17 Tahun 2017.
- Permenkes. (2010). Persyaratan Kualitas Air Minum, Permenkes No 492 Tahun 2010.
- Perpres (2020). Rencana Pembangunan Jangka Menengah Nasional Tahun 2020-2024, Perpres No. 18 Tahun 2020 (2020).
- Pishkar, I., & Gohari, E. M., (2025). Sustainable Water Supply Solutions: Examining the Feasibility of Reverse Osmosis Systems in Shahrekord City. *Iranica Journal of Energy & Environment*, 16(2), 240-252.
- Qiblawey, H., Banat, F., & Al-Nasser, Q. (2009). Laboratory setup for water purification using household PV-driven reverse osmosis unit. *Desalination and Water Treatment*, 7(1-3), 53-59.
- Silverman, R. M., & Patterson, K. (2021). *Qualitative research methods for community development*. Routledge.
- Sedlak, D. L. (2019). The unintended consequences of the reverse osmosis revolution. *Environmental science & technology*, 53(8), 3999-4000.
- Sisnayati, Komala, R., Intang, A., & Faizal, M. (2023). Penerapan Teknologi Membran Nanofiltrasi-Reverse Osmosis Untuk Produksi Air Bersih dan Air Minum di Pesantren Kiai Marogan Palembang. *Madaniya*, 4(2), 443–452.
- Sisnayati, Putri Yuniarti, D., Komala, R., Hatina, S., Sari Dewi, D., & Winoto, E. (2022). Pengolahan Air Permukaan Menjadi Air Bersih Menggunakan Teknologi Membran Di Kelurahan Talang Betutu Palembang. *Jurnal Pengabdian Masyarakat Pamong*, 1(1), 1–8.
- Suar, H. P. N., Sari, I. R., Ramadhan, M. F., & Muda, F. V. (2025, April). Addressing Water Inequality in Rural Indonesia: A Community-Based Approach with Clean Water Intervention Mechanism. In Asia Pacific Sociological Association Conference (APSA 2024) (pp. 4-20). *Atlantis Press*.
- Tahraoui, H., Toumi, S., Boudoukhani, M., Touzout, N., Sid, A. N. E. H., Amrane, A., Belhadj, A.-E., Hadjadj, M., Laichi, Y., Aboumustapha, M., Kebir, M., Bouguettoucha, A., Chebli, D., Assadi, A. A., & Zhang, J. (2024). Evaluating the Effectiveness of Coagulation–Flocculation Treatment Using Aluminum Sulfate on a Polluted Surface Water Source: A Year-Long Study. *Water*, 16(3), 400. <https://doi.org/10.3390/w16030400>
- United Nations. (2015). *Transforming our World: The 2030 Agenda for Sustainable Development*. In *United Nations (Vol. 16301)*. <https://sdgs.un.org/2030agenda>
- Unitd Nations. (2023). *Blueprint for Acceleration: Sustainable Development Goal 6 Synthesis Report on Water and Sanitation 2023*. <https://www.unwater.org/publications/sdg-6-synthesis-report-2023>

-
- Van de Walle, A., Torfs, E., Gaublomme, D., & Rabaey, K. (2022). In silico assessment of household level closed water cycles: Towards extreme decentralization. *Environmental Science and Ecotechnology*, 10, 100148.
- Walker, M., Seiler, R. L., & Meinert, M. (2008). Effectiveness of household reverse-osmosis systems in a Western US region with high arsenic in groundwater. *Science of the total environment*, 389(2-3), 245-252.
- Yang, X., Zhou, Y., Xia, R., Liao, J., Liu, J., & Yu, P. (2024). Microplastics and chemical leachates from plastic pipes are associated with increased virulence and antimicrobial resistance potential of drinking water microbial communities. *Journal of Hazardous Materials*, 463, 132900.
- Zimmermann, K., Abadi, A. M., Brauman, K. A., Maestu, J., Oude Essink, G., Schuster-Wallace, C., Smith, R., Madani, K., Adeel, Z. & Gribble, M. O. (2025). Addressing water scarcity to support climate resilience and human health. *Integrated Environmental Assessment and Management*, , 21 (2), 291–300