Addressing technological and socio-economic aspects of greywater management on Sichang Island

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Abstract

This study evaluated the impact and benefits of implementing Zyclonic, a new wastewater treatment technology, on Sichang Island. In collaboration with local municipalities, SCG Chemicals aims to enhance sustainable greywater management on the island by transitioning from the existing system to the Zyclonic technology.

The research examined this transition by analyzing current greywater management practices and comparing them with the capabilities of the Zyclonic system to assess its practicality. The findings highlighted the improved treatment efficiency of the Zyclonic system while identifying challenges related to implementation and community adoption. These insights were used to formulate recommendations for developing and optimizing the Zyclonic system on Sichang Island.

บทคัดย่อ

งานวิจัยนี้ประเมินผลกระทบและประโยชน์ของการนำเทคโนโลยีบำบัดน้ำเสีย Zyclonic มาทดแทนระบบที่ใช้บนเกาะสีชังในปัจจุบันภายใต้ความร่วมมือของเทศบาลเกาะสีชังกับ SCG Chemicals เพื่อปรับปรุงการจัดการน้ำเสียบนเกาะอย่างยั่งยืน

คณะผู้วิจัยได้ศึกษาเปรียบเทียบระบบจัดการน้ำเสียในปัจจุบันกับระบบ Zyclonic โดยประเมินกระบวนการและประสิทธิภาพของการบำบัด นอกจากนั้นแล้วยังมีการประเมินการยอมรับของธุรกิจและชุมชนอีกด้วย ผลการวิเคราะห์ข้อมูลชี้ให้เห็นความท้าทายที่ยังจะต้องพัฒนาและปรับปรุงระบบ Zyclonic ให้เป็นที่ยอมรับบนเกาะสีชังก่อนนำมาปฏิบัติจริง

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Executive Summary

SCG Chemicals (SCGC) is working with the municipality of Sichang Island to enhance wastewater management by implementing the Zyclonic system. Sichang Island, located in Chonburi province, has faced challenges in managing greywater due to limited land, reliance on rainwater, and insufficient wastewater treatment infrastructure. As a result, many households and businesses are discharging untreated wastewater into the sea, which negatively impacts the environment and local water resources.

The municipality and SCGC have launched a kitchen wastewater collection project, but participation has been low due to a lack of awareness. The introduction of the Zyclonic system aims to provide a sustainable solution for treating wastewater by converting kitchen waste into reusable water. Although the system has proven beneficial, there are operational challenges, such as inconsistent wastewater collection, overflow incidents, and dependence on manual transport. To enhance participation and ensure long-term adoption, our team collaborated with SCGC and the municipality to analyze community engagement strategies, optimize data collection processes, and promote awareness of the environmental and economic benefits of sustainable wastewater treatment on Sichang Island.

Our approach includes conducting surveys and interviews with local residents, businesses, and municipal officials to identify the main barriers to participation. We found that many households were unaware of the existing wastewater collection project and held misconceptions about its benefits and feasibility. Moreover, logistical challenges such as irregular collection schedules and a lack of resources for manual transport contributed to operational inefficiencies.

Objective and Methods

To gather data on the implementation of the Zyclonic wastewater treatment system on Sichang Island, the team aimed to achieve three key objectives:

1. **To understand the Community Wastewater Management (CWM) situation on a small island and its limitations.**
2. **To investigate how the sustainable wastewater treatment system operates on Sichang Island.**
3. **To evaluate the practicality and benefits of transitioning from traditional Community Wastewater Management to a sustainable wastewater treatment model, using the Zyclonic system on Sichang Island as an example.**

1) Our team conducted a study on wastewater management on Sichang Island by interviewing local officials and residents. These interviews provided valuable insights into the island's current wastewater infrastructure, community challenges, and perspectives

Interviewed with Mr. Puvanut - municipality

on greywater reuse. We surveyed several residents across different age groups to assess their awareness of wastewater management and their willingness to engage in sustainable solutions. Additionally, we observed the wastewater collection and transportation processes to identify inefficiencies, including inconsistent participation behaviors. We employed descriptive statistics and classification methods to analyze the collected data, revealing trends and primary community concerns regarding wastewater treatment.

2) In objective two, our team gathered information about the implementation of the Zyclonic wastewater treatment system by engaging with representatives from SCGC and local authorities. SCGC provided

insights regarding the system and its maintenance during on-site visits, while municipal officials discussed how it could be integrated into the existing infrastructure. Additionally, our team observed wastewater collection and treatment operations, assessing transport inefficiencies, overflow issues, and community participation. These efforts helped identify key barriers and opportunities for improving the system's sustainability and effectiveness.

3] In relation to objective three, our team conducted semi-structured interviews with community members to gauge their willingness to adopt the system, their understanding of wastewater treatment, and any potential barriers to participation. Additionally, we analyzed water parameters such as Total Dissolved Solids [TDS], pH, and ammonium concentration to evaluate the effectiveness of the Zyclonic system in treating greywater. These methods provided valuable insights into both community engagement and the system's technical performance, aiding in the assessment of its feasibility for long-term adoption on Sichang Island.

Interviewed with Mr. Stafford - SCG Chemicals representative

Water samples collected for measuring water parameters

Results and Analysis

Our research results enabled us to evaluate the effectiveness of the Zyclonic wastewater treatment system, assess community participation in wastewater management, and compare the feasibility of transitioning from traditional methods to a sustainable system on Sichang Island. The team examined local views on wastewater disposal, identified challenges in greywater collection, and explored the viability of integrating the Zyclonic system as a long-term solution.

1] Our team gathered insights into community wastewater management practices and identified key challenges in wastewater disposal on Sichang Island. Currently, there is no centralized wastewater treatment system, which forces most households and businesses to rely on soak pits or to discharge wastewater directly into the sea.

Through our interviews and surveys, we discovered that community awareness regarding wastewater management is low. For instance, only 43.8% of residents reuse greywater, and just 87.7% are aware of its environmental impact. Participation in the municipality's kitchen wastewater collection program is also very limited, with only about 2% of households actively contributing. Many residents are unaware of the program's purpose, but interest in participating significantly increases when they learn about the Zyclonic system's role in wastewater treatment.

2] The team investigated the operation and impact of the Zyclonic wastewater treatment system through interviews with representatives from SCGC and municipal authorities. The implementation of this system on Sichang Island has provided a structured and systematic approach to greywater management. By collecting wastewater from 30 to 40 households and restaurants and transporting it to the SCGC Zyclonic treatment site, the system facilitates the reuse of wastewater for non-potable purposes. This

initiative significantly helps in reducing wastewater discharge and lessening the dependence on purchased water.

However, during the collection process, kitchen wastewater often spills from the containers while being transported to the treatment site. This spillage leads to unpleasant odors, hygiene concerns, and environmental pollution, indicating that the current method of collecting greywater may be inefficient.

3) Interviews were conducted with community members alongside water quality assessments. The interviews revealed that only 28% of households were participating in the greywater collection program. However, after learning about the program's purpose, interest in participation increased to 64%.

To evaluate the effectiveness of the Zyclonic system, water quality was analyzed using three key parameters: Total Dissolved Solids (TDS), pH, and ammonium levels. Eight samples were collected, indicating that the treated water stored in the tank had lower quality compared to the area's natural usable water, it still met acceptable standards for non-potable use.

A comparison was made between the Zyclonic system and traditional wastewater management methods, specifically soak pits. While soak pits are easier to operate and passively absorb wastewater into the ground, the Zyclonic system offers a more scalable and adaptable solution. Additionally, Zyclonic actively treats wastewater to improve its quality, while soak pits rely solely on soil absorption for treatment.

Interview with community members

Recommendation

This report provides recommendations for improving wastewater management on Sichang Island, with an emphasis on enhancing greywater collection and treatment. The objective is to develop a more efficient and sustainable system that will conserve water and protect the environment over the long term.

1] Enhancing community engagement is essential for involving residents. Workshops should be organized to educate the community, particularly regarding greywater management. These workshops can include hands-on activities, such as constructing simple filtration systems. Additionally, offering incentives like free water can motivate both residents and businesses to participate in sustainable practices.

2] The greywater collection process still needs improvement. A digital platform, such as a website or app, should be developed to facilitate easy scheduling of greywater collection. This platform include a rewards system that allows residents to earn points for each request, which can be exchanged for various benefits. Additionally, there should be more greywater disposal bins and containers with lids provided to enhance the convenience of collection.

3] If these changes are implemented effectively, the system will need to expand in order to meet demand. This entails incorporating larger tanks, more trucks, and enhancing the Zyclonic treatment system. These measures will ensure that the wastewater management system remains sustainable and efficient.

บทสรุปผู้บริหาร

เกาะสีชัง จังหวัดชลบุรี ต้องเผชิญกับความท้าทายในการจัดการน้ำเสียจากลักษณะทางภูมิศาสตร์ที่ไม่อำนวยเกาะสีชังมีพื้นที่จำกัด ไม่มีแหล่งน้ำจืดเพียงพอ และต้องพึ่งพาน้ำฝน ในปัจจุบันเกาะสีชังขาดโครงสร้างพื้นฐาน ในการบำบัดน้ำเสีย ครัวเรือนและธุรกิจจำนวนมากปล่อยน้ำเสียที่ไม่ได้รับการบำบัดลงสู่ทะเล ส่งผลกระทบเชิงลบต่อสิ่งแวดล้อมและแหล่งน้ำจืดบนเกาะ บริษัท เอสซีจี เคมีคอลส์ (SCGC) ร่วมกับเทศบาลเกาะสีชังได้นำเทคโนโลยีใหม่มาทดลองใช้ในการบริการจัดการน้ำเสียของเกาะ

เทคโนโลยี Zyclonic ของ SCGC สามารถบำบัดน้ำเสียจากครัวเรือนให้เป็นน้ำดีที่นำกลับมาใช้ประโยชน์ใหม่ได้ แม้ว่าเทคโนโลยีนี้ได้ผ่านการพิสูจน์มาแล้วว่ามีประสิทธิภาพในการบำบัดน้ำเสียครัวเรือนในหลายพื้นที่ แต่ยังต้องปรับการดำเนินงานให้เหมาะสมกับบริบทของเกาะสีชัง งานวิจัยนี้เป็นการค้นหาปัจจัยที่มีอิทธิพลต่อการยอมรับการบำบัดน้ำเสียครัวเรือนของเกาะสีชัง เพื่อสร้างกลยุทธ์ให้เกิดการตระหนักรู้ระดับชุมชนถึงประโยชน์ด้านสิ่งแวด ล้อมและเศรษฐกิจของการบำบัดน้ำเสียอย่างยั่งยืน แนวทางการวิจัยใช้การสำรวจและสัมภาษณ์ครัวเรือน ธุรกิจ และเจ้าหน้าที่เทศบาลเพื่อระบุปัจจัยและอุปสรรคของการสร้างความเข้าใจและความร่วมมือในชุมชน

วัตถุประสงค์และวิธีการ

คณะผู้วิจัยได้ตั้งวัตถุประสงค์ไว้ 3 ประการ ดังนี้

1. ทำความเข้าใจสถานการณ์การบริหารจัดการน้ำเสียชุมชน (CWM) บนเกาะสีชังและข้อจำกัดต่างๆ
2. ศึกษาระบบบำบัดน้ำเสียของเกาะสีชัง
3.ประเมินความเป็นไปได้และอุปสรรคของการเปลี่ยนการจัดการน้ำเสียชุมชนแบบดั้งเดิมไปการบำบัดน้ำเสีย แบบยั่งยืนโดยระบบ Zyclonic บนเกาะสีชัง

คณะผู้วิจัยได้สัมภาษณ์เจ้าหน้าที่เทศบาลและผู้อยู่อาศัยในพื้นที่เพื่อสร้างความเข้าใจพื้นฐานเกี่ยวกับการบริหารจัดการน้ำเสียในปัจจุบัน ปัญหาและมุมมองเกี่ยวกับการนำน้ำเสียที่ได้รับการบำบัดกลับมาใช้ใหม่ คณะผู้วิจัยได้ประเมินความตระหนักรู้เกี่ยวกับการจัดการน้ำเสียของประชาชนในกลุ่มอายุต่างๆ เพื่อประเมิน

พฤติกรรมและความกังวลของชุมชน ความสนใจที่จะมีส่วนร่วมในการแก้ปัญหาน้ำเสียครัวเรือนอย่างยั่งยืน คณะผู้วิจัยได้สังเกตการณ์กระบวนการเก็บและขนส่งน้ำเสียไปบำบัดอีกด้วย

คณะผู้วิจัยได้ข้อมูลเชิงลึกเกี่ยวกับการบำบัดน้ำเสียด้วยเทคโนโลยี Zyclonic โดยการสัมภาษณ์และสังเกตุการณ์ในสถานที่จริง โดยคณะผู้วิจัยได้สังเกตการณ์กระบวนการรวบรวม การขนส่ง และการบำบัดน้ำเสีย ตัวแทนจาก SCGC และเจ้าหน้าที่ท้องถิ่นได้ให้ข้อมูลเชิงลึกเกี่ยวกับหลักการทำงานของระบบ การบำรุงรักษา ปัญหาที่พบ และการมีส่วนร่วมของชุมชน เจ้าหน้าที่เทศบาลได้ให้ความเห็นถึงการผสมผสานเทคโนโลยีใหม่เข้ากับโครงสร้าง พื้นฐาน คณะผู้วิจัยนำข้อมูลไปประมวลเพื่อหาแนวทางเพิ่มประสิทธิภาพของระบบ ลดอุปสรรค เพื่อความยั่งยืน

การสัมภาษณ์ชุมชนเพื่อประเมินความรู้และทัศนคติต่อการบำบัดน้ำเสียครัวเรือน สามารถระบุปัจจัยและอิทธิพลในการนำเทคโนโลยีใหม่มาใช้เพื่อวางแนวทางป้องกันอุปสรรคที่อาจเกิดขึ้น คณะผู้วิจัยใช้ผลการวิเคราะห์คุณภาพน้ำ เช่น ปริมาณของแข็งที่ละลายได้ทั้งหมด (TDS) ค่า pH และความเข้มข้นของแอมโมเนียม ในการประเมิน ประสิทธิภาพของระบบบำบัดน้ำเสียด้วยเทคโนโลยี Zyclonic เทียบกับการบำบัดพื้นฐานอื่นๆ เพื่อใช้ชี้วัดประสิทธิภาพของการบำบัดน้ำเสียในการประเมินความคุ้มค่าและประสิทธิภาพระยะยาว

การวิเคราะห์และผลการวิจัย

1) **ไม่มีการกำจัดน้ำเสียบนเกาะสีชังในปัจจุบัน** ครัวเรือนและธุรกิจส่วนใหญ่ใช้บ่อบำบัดน้ำเสียหรือปล่อยน้ำเสีย ลงสู่ทะเล โดยตรงชุมชนมีความตระหนักเกี่ยวกับการจัดการน้ำเสียในระดับต่ำ ตัวอย่างเช่น มีเพียง 43.8% ของผู้อยู่อาศัยที่นำน้ำใช้แล้วไปใช้ซ้ำ แม้ว่าประชากร 87.7% ตระหนักถึงผลกระทบต่อสิ่งแวดล้อมจากการทิ้งน้ำเสียที่ไม่ถูกต้องแต่มีจำนวนครัวเรือนเพียง 2% ที่มีส่วนร่วมในโครงการบำบัดน้ำเสียครัวเรือนของเทศบาล ประชาชนจำนวนมากไม่ ทราบการดำเนินการของโครงการนี้ อย่างไรก็ดีเมื่อคณะผู้วิจัยได้ให้ข้อมูลเกี่ยวกับโครงการ Zyclonic บนเกาะสีชัง พบว่ามีประชาชนสนใจเข้าร่วมโครงการในการมากขึ้น

2) ระบบ Zyclonic เป็น**การริเริ่มระบบของการจัดการน้ำเสียครัวเรือนของเกาะสีชัง** ในปัจจุบันมีการรวบรวม น้ำเสียจากครัวเรือน

และร้านอาหาร 30-40 แห่ง เพื่อขนส่งไปบำบัดที่ศูนย์ Zyclonic น้ำเสียที่ผ่านการบำบัดสามารถนำกลับมาใช้ซ้ำเพื่อวัตถุประสงค์อื่นที่ไม่ใช่เพื่อการบริโภคได้ โครงการนี้ช่วยลดการปล่อยน้ำเสียสู่ธรรมชาติและลดการพึ่งพาการซื้อน้ำอุปโภคได้อย่างมาก อย่างไรก็ตามจำต้องมีการปรับปรุงกระบวนการรวบรวม น้ำเสียจากครัวเรือนและการขนส่ง ให้มีการรั่วไหลน้อยที่สุดเพื่อลดกลิ่นไม่พึงประสงค์ ปัญหาสุขอนามัย และการปนเปื้อนในสิ่งแวดล้อม

3) ผลวิเคราะห์**คุณภาพน้ำที่ผ่านการบำบัด**จำนวน 8 ตัวอย่าง โดยประเมินจากปริมาณของแข็งที่ละลายอยู่ในน้ำ (TDS) ค่า pH และระดับแอมโมเนียม พบว่าน้ำที่ได้จากการบำบัดด้วยเทคโนโลยี Zyclonic มีคุณภาพใกล้เคียงกับน้ำจากแหล่งธรรมชาติในพื้นที่ เช่น น้ำฝนในถังเก็บน้ำ อย่างไรก็ดีแม้ว่าการบำบัดน้ำเสียด้วยเทคโนโลยี Zyclonic จะมีขั้นตอนยุ่งยากกว่าการบำบัดแบบพาสซีฟของบ่อซึมที่อาศัยการดูดซับลงดิน Zyclonic เป็นระบบโมดูล่าที่สามารถปรับให้เหมาะสมกับขนาดพื้นที่ ปริมาณและคุณภาพน้ำเสียได้ นอกจากนี้ Zyclonic ยังมีประสิทธิภาพสูงในการปรับปรุงคุณภาพน้ำ

ข้อเสนอแนะ

การพัฒนาระบบการบำบัดน้ำเสียครัวเรือนที่มีประสิทธิภาพในการอนุรักษ์และปกป้องสิ่งแวดล้อมของเกาะสีชังอย่างยั่งยืนควรคำนึงถึง

1) **การให้ความรู้แก่ประชาชนและให้ประชาชนมีส่วนร่วมในทุกขั้นตอน** เทศบาลเกาะสีชังควรประชาสัมพันธ์ถึงโครงการเพื่อให้ความรู้แก่ประชาชน จัดการอบรมเกี่ยวกับการจัดการและบำบัดน้ำทิ้ง การอบรมเหล่านี้อาจรวมถึงกิจกรรมปฏิบัติจริงเพื่อเสริมสร้างความเข้าใจ เช่น การสร้างระบบกรองน้ำ แบบง่าย นอกจากนี้ควรมีโครงการสร้างแรงจูงใจ เช่น น้ำอุปโภคฟรีสำหรับผู้เข้าร่วมกิจกรรม เพื่อจูงใจให้ครัวเรือนและธุรกิจมีส่วนร่วมในการพัฒนาแนวทางปฏิบัติที่ยั่งยืน

2) **การปรับปรุงกระบวนการเก็บน้ำทิ้งครัวเรือน** ประชาชนส่วนใหญ่ของเกาะสีชังไม่มีความรู้เกี่ยวกับตารางเก็บน้ำทิ้ง เทศบาลเกาะสีชังควรพัฒนาแพลตฟอร์มดิจิทัล เช่น เว็บไซต์หรือแอปในการกำหนดตารางการ เก็บน้ำเสียจากครัวเรือน แพลตฟอร์มนี้อาจผสม

ผสานคะแนนรางวัลสำหรับการนัดหมายผ่านแอป โดยเจ้าของบัญชีสามารถรวบรวมคะแนนไปแลกรับสิทธิประโยชน์ต่างๆ ได้ คณะผู้วิจัยแนะนำให้เทศบาลเกาะสีชังปรับปรุงถังเก็บน้ำเสียในการขนส่งเพื่อก่อให้เกิดภาพลักษณ์ที่ดี โดยใช้ถังที่มีฝาปิดเพื่อเพิ่มความปลอดภัยและลดการปนเปื้อนระหว่างการขนส่ง

3) **การขยายระบบบำบัดน้ำเสียให้ครอบคลุมพื้นที่ต่างๆ** ของเกาะ เทศบาลเกาะสีชังควรพิจารณาขยายศูนย์ Zyclonic ให้ครอบคลุมพื้นที่แออัดรอบเกาะ เพิ่มขนาดถังบำบัดให้เหมาะสมกับความต้องการของครัวเรือน เพิ่มจำนวนเที่ยวเก็บน้ำเสียในแต่ละวัน ปรับปรุงระบบบำบัดให้เหมาะสมกับสภาพภูมิอากาศและภูมิศาสตร์ของเกาะ มาตรการเหล่านี้จะช่วยให้ระบบการจัดการน้ำเสียมีประสิทธิภาพสูงและยั่งยืน

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Introduction

Water is essential to human life. While it covers 70% of the Earth's surface, only 3% is freshwater, and just 0.06% is readily accessible. However, rapid population growth and human activities continue to strain water resources, mainly through pollution from household and industrial wastewater.

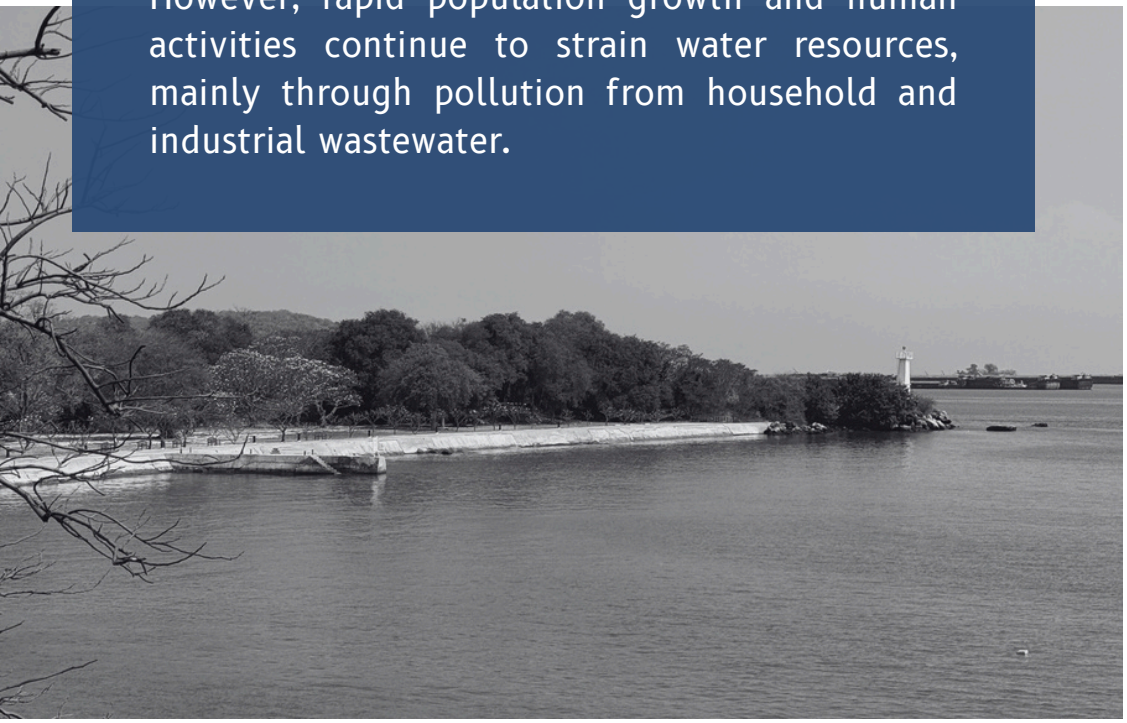


Figure 1 – Sichang Island's shore

Among various types of wastewater, greywater—originating from sinks, showers, and kitchen drains—is relatively cleaner than blackwater, which contains sewage. If not properly managed, greywater can still pose environmental risks. It often carries organic matter, food particles, grease, soaps, and detergents, which, when released untreated, can pollute water bodies, disrupt aquatic ecosystems, and contribute to nutrient overloading. Over time, stagnant greywater can also become a breeding ground for harmful bacteria and pathogens, posing public health risks.

Bangkok

75.1 Km

Sichang Island

Located in Chonburi Province, Thailand, Sichang Island generates a considerable amount of greywater daily from households and restaurants. However, limited wastewater treatment infrastructure and seasonal droughts, especially in the dry season, highlight the island's need for sustainable greywater management. In response, the local government of Sichang Island has partnered with SCG Chemicals (SCGC) to enhance sustainable wastewater management approaches.

In small developing communities and islands, with limited wastewater treatment, greywater mismanagement is a major issue. Without proper facilities or regulations, households, hotels, and restaurants discharge greywater directly into the environment, causing eutrophication, algal blooms, and oxygen depletion. This harms environment, marine life, corals, and biodiversity, threatening fishing, tourism, and water resources.

Figure 2 – Sichang Island's shore

Figure 3 – Sichang Island's sea

One of the municipality and SCGC's initiatives focuses on treating and reusing kitchen greywater from households and restaurants by using their new wastewater treatment technology. Implementing new technology in island communities, however, presents challenges, as a well-structured system, involvement of the community members, and government support are essential. Raising public awareness of greywater management and demonstrating its environmental, social and economic impacts and benefits are crucial steps in ensuring long-term adoption. By assisting SCGC in deploying sustainable greywater treatment technologies on Sichang Island, they can create a scalable model for other islands, reducing environmental impacts, conserving freshwater, and promoting long-term water security.

Overall, the project aims to evaluate the sustainable impact and benefits of a new greywater treatment technology on a small island, focusing on its practicality to Sichang Island.

Objectives

01 To understand the Community Wastewater Management (CWM) practice on Sichang Island and limitations.

02 To understand how a sustainable wastewater treatment system works and its benefits on Sichang Island.

03 To assess the practicality and benefits of transitioning from traditional CWM to a sustainable wastewater treatment model using a Zyclonic system on Sichang Island.

Figure 4 – locals use truck to collect kitchen wastewater

Figure 5 – Survey a local

The team employed semi-structured interviews, site observation, surveys, and water parameters analysis to achieve the objectives. These methods provided findings that aligned with the project's objectives and contributed to the goal. Based on the findings, the team defined essential recommendations for developing a sustainable wastewater treatment system on the island and encouraged community involvement.

Background & Literature Review

Waste management is vital for sustainable development but remains a global challenge, especially in developing countries. In Thailand, rapid economic growth, urbanization, and tourism worsen the issue.

One important type of waste is wastewater which is water used from households, industry, and agriculture, contains pollutants and microorganisms that pose health and environmental risks. Effective wastewater management is essential for healthy living, especially in resource-limited communities.

Figure 6 – locals use truck to collect kitchen wastewater

Geographic and Resource Limitations of Sichang Island

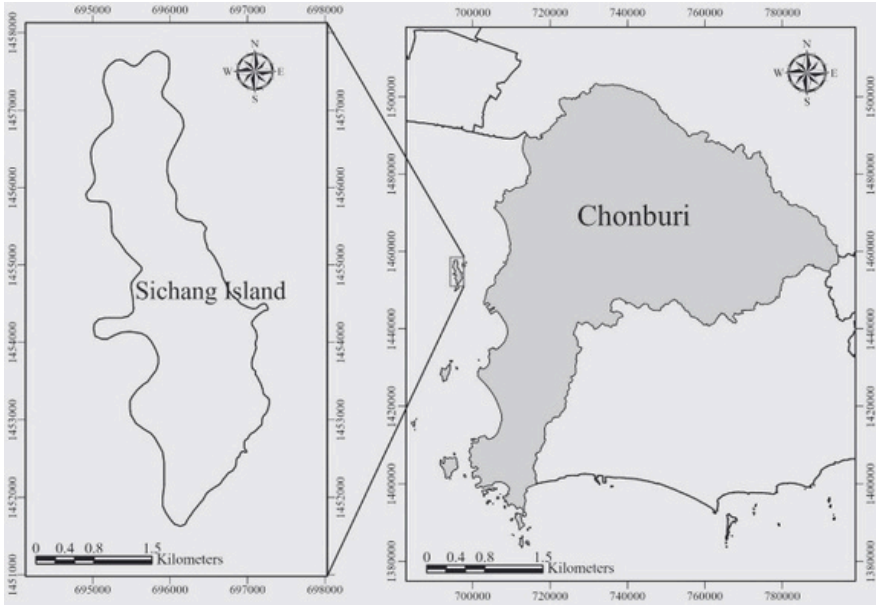


Figure 7 – Map of Sichang Island and Chonburi Province, Thailand

Koh Sichang is a small island in the Gulf of Thailand, about 12 km off the coast of Sri Racha District, Chonburi Province. It covers 7.9 square kilometers with around 4,500 residents [TEI, 2023] engaged in fishing, small-scale agriculture, and tourism. Tourism is a major economic driver, with 484,000 to 523,000 annual visitors from 2016 to 2022 [Sakcharoen et al., 2024].

As an isolated island, Koh Sichang faces infrastructure and resource limitations, making waste management costly and challenging [Tyedmers et al., 2020]. Increasing tourism worsens waste issues, raising concerns over environmental degradation and resource conservation. Efforts to promote sustainable tourism include eco-friendly tours, waste reduction programs, and green infrastructure [Sakcharoen et al., 2024].

What is Greywater?

The term describes wastewater generated from house holds and restaurants without fecal contaminations, including showers, bathtubs, dishwashers, laundry tubs, washing machines, and kitchens.

Greywater in Sichang Island

Sichang Island faces greywater management challenges due to its limited space and resources.

Figure 8 – Greywater from restaurant in Sichang

Improper disposal harms the environment and worsens water scarcity, making treatment essential. Many small islands lack adequate collection and treatment systems, leading to direct sewage dumping, which degrades water quality and marine ecosystems (Reef Resilience Network, 2021). Given limited freshwater resources, reusing treated greywater can help reduce water scarcity, lessen freshwater demand, and support sustainability.

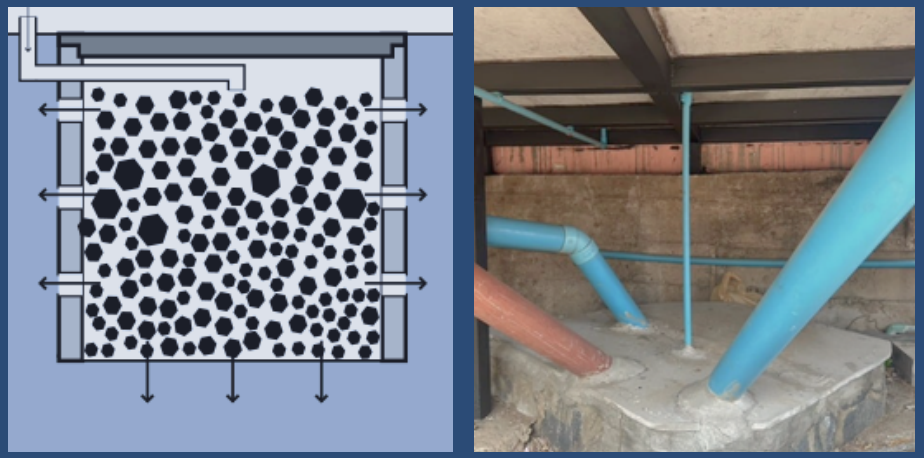


Figure 9 – Soak pits

Most households in Sichang Island use a soak pit system, which relies on soil absorption for wastewater disposal. Installed underground, it allows pre-treated effluent to seep through perforated walls into the surrounding soil. Soil particles filter suspended solids, while microorganisms break down organic compounds. (Pollution Control Department, 2012).

However, if the soil has poor permeability, the soak pit may overflow. Over time, clogging can also cause surface overflow.

Zyclonic System in Sichang Island

SCG Chemicals Public Company Limited (SCGC), a petrochemical company that aligns its innovations with sustainability trends and Corporate Social Responsibility (CSR) efforts, actively supports Sichang Island's development.

Due to Sichang Island's limited water resources, SCGC partnered with the government to implement Zyclonic technology for greywater treatment, particularly for kitchen wastewater.

Zyclonic aligns with Sustainable Development Goal (SDG) 6, aiming to improve water management, sanitation access, and water quality worldwide (Martin, 2023).

Figure 10 – Zyclonic

After creating the first version of the Zyclone Cube, SCGC was able to convert grey or black water into pathogen-free water using biological and electrochemical processes. SCGC developed a new modular version that disassembles the Zyclone Cube into three compartments: the Zyclone Separator, soil treatment, and liquid treatment units.

The liquids treatment compartment evolved into the Aquonic 600 tank, which provides increased flexibility by enabling scalability and providing compatibility with septic tanks system.

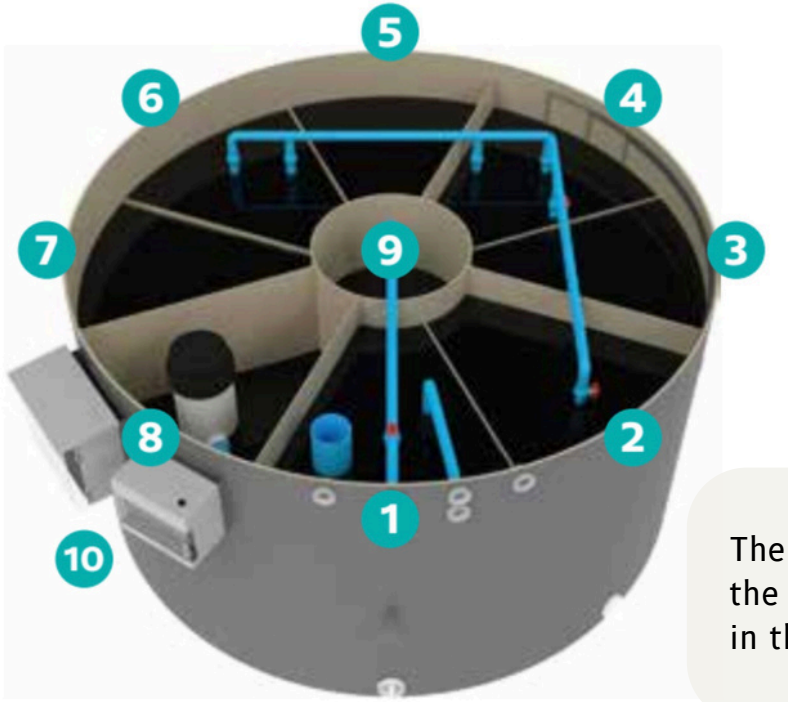
In some cases that greywater contains high content of oil or fats, **grease traps** will be installed, functioning as pre-treatment.

Aquonic Tank in Zyclonic System

The Aquonic Tank, developed by SCGC, is a prefabricated modular wastewater treatment unit designed to treat greywater. It uses advanced biological and electrochemical treatment processes to produce high-quality, pathogen-free effluent suitable for applications, such as toilet flushing and irrigation. Available in two capacities (0.6 m^3/d and 1 m^3/d per unit), the system incorporates several treatment steps, including anaerobic, aerobic, and anoxic processes, followed by electrochemical disinfection (SCGC, 2020).

1. *Up-flow filter chamber*
2. *First sedimentation chamber*
3. *Anaerobic chamber*
4. *Aerobic chamber*
5. *Anoxic chamber*
6. *Recirculation chamber*
7. *Secondary sedimentation chamber*
8. *Chlorine dosing disinfection*
9. *Treated water chamber is the final chamber*

Instead of using electrochemical disinfection in the eighth chamber, SCGC use regular **Chlorine tablets** to eliminate the pathogen in the water in the final step before sending it to the water storage tank to promote energy efficiency.



Biomedia is created by the microbial consortium by SCGC to treat water in the Zyclonic system. This will break down organic matter, use oxygen, and remove nitrogen through denitrification.

The **Plastic media**, will trap the remaining solid matter in the Aquonic tank

Figure 11 – Internal Layout and Treatment Cycle of Aquonic Tank

Zyclonic System in Sichang Island (continue)

However, the system also has some limitations. It requires regular maintenance and a consistent electricity supply to operate effectively. If the system is inactive for over six months, a start-up phase is needed to restore its functionality. Furthermore, its electrical components must be protected from water damage, which should be considered when planning its deployment.

The first installation of the Zyclonic system was at Khlong Phlapphla in 2019 (SCGC, 2019), at that time, the Zyclonic technology was mainly aimed at treating toilet wastewater, and blackwater (SCGC, 2021). However, the Zyclonic system can also adapt to use with different types of wastewater.

For instance, in 2021, SCGC installed a Zyclonic system at Khlong Sam Wa, aiming to reduce wastewater disposal into natural water sources by treating greywater and blackwater produced from the child development center of Kamalun Islam mosque community into pathogen-free water (SCGC, 2022).

Figure 12 – Zyclonic system at Khlong Sam Wa

In Sichang Island, SCGC uses this technology to treat kitchen water and household grey water, and pathogen-free water for further purposes and support the water scarcity problem.

Despite the potential of this technology, their adoption faces several obstacles, including community awareness, infrastructure limitations, and the adaptability of the technology to different local conditions.

Methodology and Findings

This project aimed to evaluate the sustainable impact and benefits of a new greywater treatment technology and practicality on Sichang Island. The project incorporated qualitative and quantitative methods to assess the current situation of greywater management and evaluated how a new treatment technology can be implemented to enhance sustainability on the island. A comprehensive literature review explore fundamental concepts in greywater management and the current situation on Sichang Island. The problem of limited infrastructure and environmental concerns due to improper greywater disposal were examined. The following were the objectives:

1. **To understand the Community Wastewater Management (CWM) situation on a small island and its limitations.**
2. **To investigate how the sustainable wastewater treatment system operates on Sichang Island.**
3. **To evaluate the practicality and benefits of transitioning from traditional Community Wastewater Management to a sustainable wastewater treatment model, using the Zyclonic system on Sichang Island as an example.**

Objective 1

This section explores the present-day practices and limitations of greywater management on Sichang Island, including their perspectives on wastewater management. The findings were derived through multiple approaches, including direct observations, semi-structured interviews with related stakeholders, and survey locals. These efforts helped provide a well-rounded understanding of the current system, as well as the challenges it faces.

3.1 To understand the Community Wastewater Management (CWM) situation on a small island and its limitations.

Figure 13 – Interview with community members

Method

1. **Semi-structured interviews with municipality and community members**

The team conducted semi-structured interviews with municipal authorities and community members to assess the community's wastewater management, particularly regarding greywater. Municipal authorities explained the current waste management practices and challenges, while community members shared their views on greywater reuse and local wastewater issues.

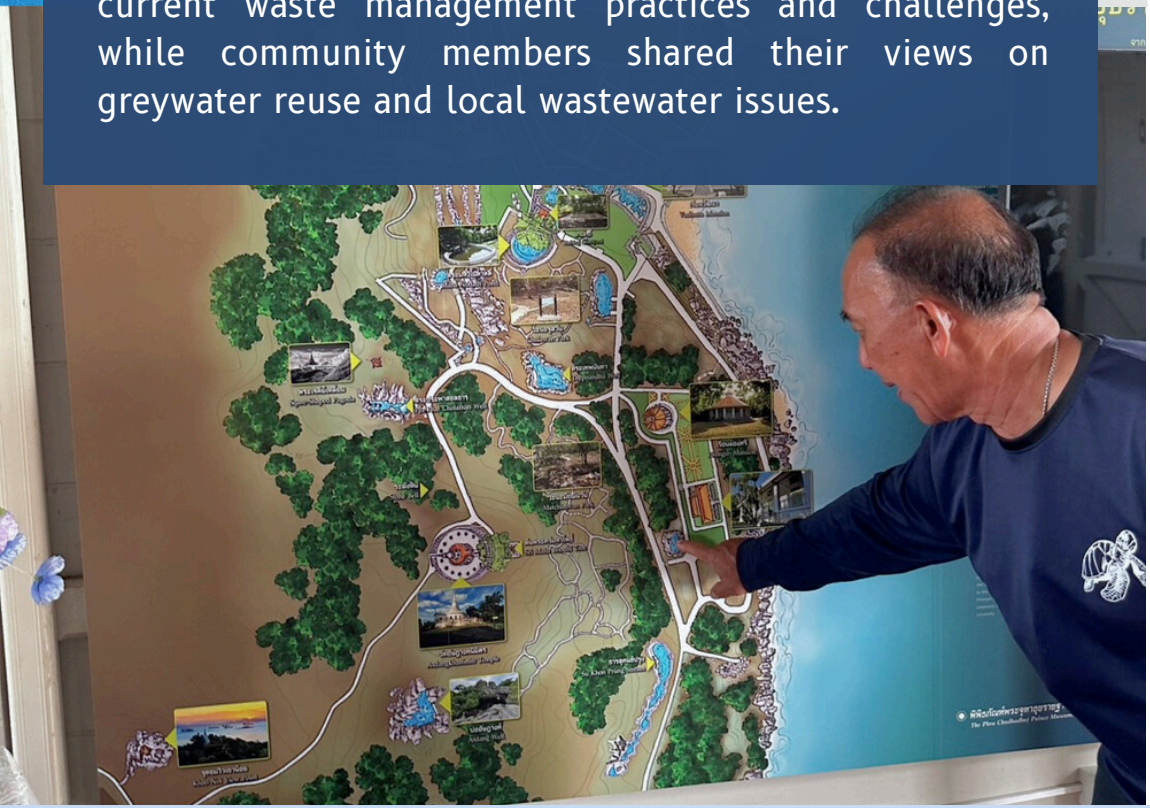


Figure 14 – Interview with community members

The interviews also explored cultural factors influencing attitudes toward sustainable water practices. Participants were chosen based on convenience, and interviews were conducted with households, restaurants, and accommodations. The data from these interviews were analyzed using qualitative content analysis. The interview questions can be found in Appendix A.

Figure 15 – Interview with community members

2. Survey local residents

Figure 16 – A local with team members

The local survey aimed to assess greywater knowledge, waste treatment awareness, environmental impacts, green behavior, and the effect of greywater on the community. It explored the community's understanding of greywater, disposal practices, and openness to improved systems. Participants received a brief explanation of greywater and its benefits before completing the survey. The survey also examined attitudes toward sustainability and community involvement in waste management. Responses were analyzed to understand interest in new greywater technology, community practices, and environmental awareness. Participants aged 25–55 were selected for a broader perspective. The survey included both closed and open-ended questions and collected demographic information. The results were cross-referenced with interview and observational data to provide a full understanding of community needs and involvement in wastewater management.

Findings

Figure 17 – Map of Sichang Island

In this objective, the team found information on the challenges of community wastewater management on Sichang Island and the limitations impacting water supply and treatment.

1) Geographical limitations of Sichang Island affect the water supply and wastewater treatment

Sichang is a small island surrounded by seawater, with limited land area and resources. Interviews with the local municipality indicated that connecting the island to mainland water pipelines is impractical, The data were coded and categorized into themes based on the recurring topics that emerge from participants' responses, such as current practices, challenges faced, and attitudes toward new solutions. The responses were systematically categorized into key themes related to wastewater management practices, challenges, cultural concerns, and areas for improvement to effectively capture and contextualize insights from both municipal authorities and community members.

2] Sichang struggles with water source problems, relying on rainwater and costly alternatives.

There are three natural fountains, but only one is available year-round. During the rainy season from May to October, 60% of the 25 locals interviewed collect rainwater for daily use. Most households have storage tanks under their homes, ensuring enough water for the year. However, only 16% depend entirely on collected rainwater, while 44% still require additional sources. The remaining 40% lack personal storage tanks and must purchase water from suppliers or have it transported from the mainland at 300–500 Baht per truck (1,800 liters). Delivery times vary from a few hours to 2–7 days in droughts.

Purchased water comes from rainwater, mainland freshwater, or a mix of both and may contain dust and sediment. Residents avoid the lower portion due to red sediment that can cause skin irritation. During extreme droughts, supply depletion makes purchasing water impossible.

Figure 18 – Water supply truck

To assist during shortages, the municipality delivers two trucks of water per house weekly, charging only 150 Baht per truck. However, this remains costly compared to Bangkok, where water costs just 20–30 Baht per 1,000 liters. Unlike Bangkok's regulated system, Sichang Island's reliance on rainwater and transported supply makes prices unpredictable and a burden for residents, especially in drought seasons. Without sustainable solutions, rising costs and water shortages will continue to affect local livelihoods.

3) Most places on Sichang Island lack wastewater treatment

The island relies on an on-site system, but most households lack septic tanks, using individual soak pits where untreated wastewater is absorbed into the rocky terrain. Larger facilities, like government buildings, use Septic Aerobic Treatment (SAT) tanks before disposal, while the hospital employs septic tanks, aerated lagoons, and chlorine treatment, with water quality monitored every 4–5 months.

Interviews with five hotels found that 80% rely entirely on soak pits, with older hotels lacking treatment systems. Despite regulations prohibiting direct wastewater discharge into the sea, some households and stores near the coast still do so. The absence of a centralized treatment system worsens the issue.

Organizations like the Wastewater Management Authorities (WMA) are assessing the island's needs, but sustainable solutions remain unsuccessful. Continuous efforts are needed to improve wastewater management.

Figure 19 – Septic Aerobic Treatment systems at Sichang Hospital

4] Greywater survey from community members' opinions and awareness

A survey of 73 respondents aged 30–50, including business owners, restaurant and hotel entrepreneurs, fishermen, government officials, locals, and interns, provided insights into greywater awareness and reuse willingness. The findings, summarized in charts, highlight community perspectives on greywater management and adoption of treated greywater.

1] Community Perspectives on Greywater Management

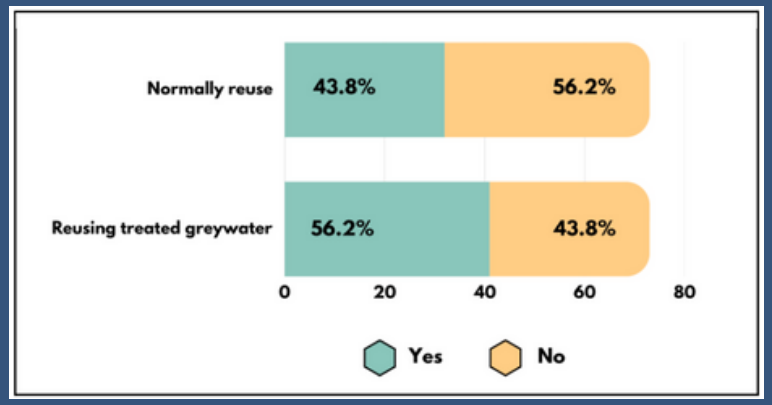


Figure 21 – Community Willingness to Reuse Greywater

According to the data in *Figure 6*, responses to the questions "Do you normally reuse greywater?" and "If the greywater has been treated, will you reuse it?" revealed that only 43.8% of respondents are currently reusing greywater for secondary purposes. However, when treated greywater is considered, the percentage increases to 56.2%, respectively, indicating a conditional willingness to adopt reuse practices.

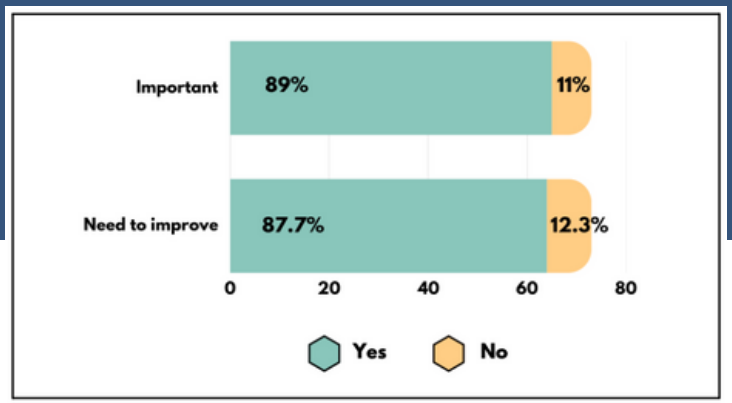


Figure 20 – Community Awareness and Support for Greywater Management

Furthermore, as illustrated in *Figure 20*, responses to the inquiries "Do you think managing greywater is important?" and "Do you think the community should improve on managing greywater?" disclosed that 89% of respondents

The study investigated the potential benefits of reusing greywater and current waste disposal methods. Based on *Figure 22*, responses to the questions “Do you separate solid and liquid waste when disposing of food waste?”, “Do you think reusing greywater can help conserve water resources?”, and “Do you think using treated greywater can help reduce water bills?” revealed that approximately 86% of respondents separate solid and liquid waste, demonstrating a level of environmental responsibility that could be implemented to promote better water-saving practices. Furthermore, there is substantial support for the potential advantages of reusing greywater, with 53.4% agreeing that it can help conserve water and 69.9% thinking that consuming treated greywater can lower water bills. These findings represented that with appropriate treatment systems and awareness campaigns in place, people are generally willing to support greywater reuse practices.

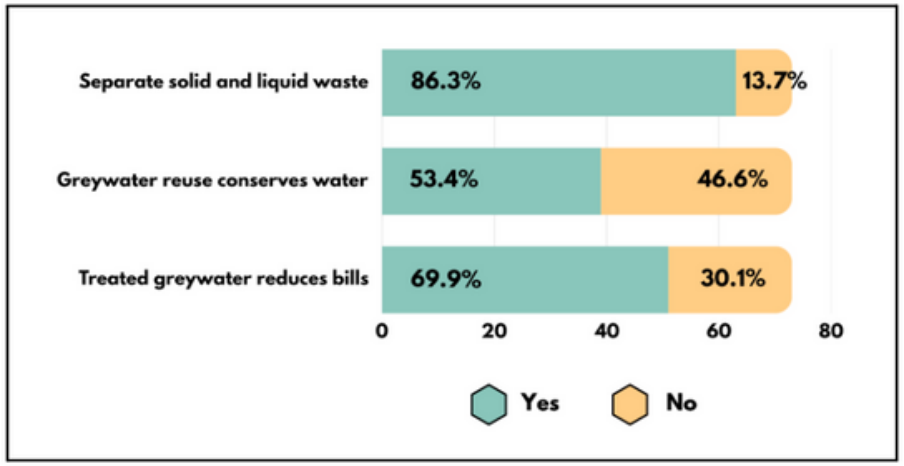


Figure 22 – Public Awareness for Greywater Reuse and Waste Management

2] Age and Occupation- Based Analysis of Greywater Management Perspectives

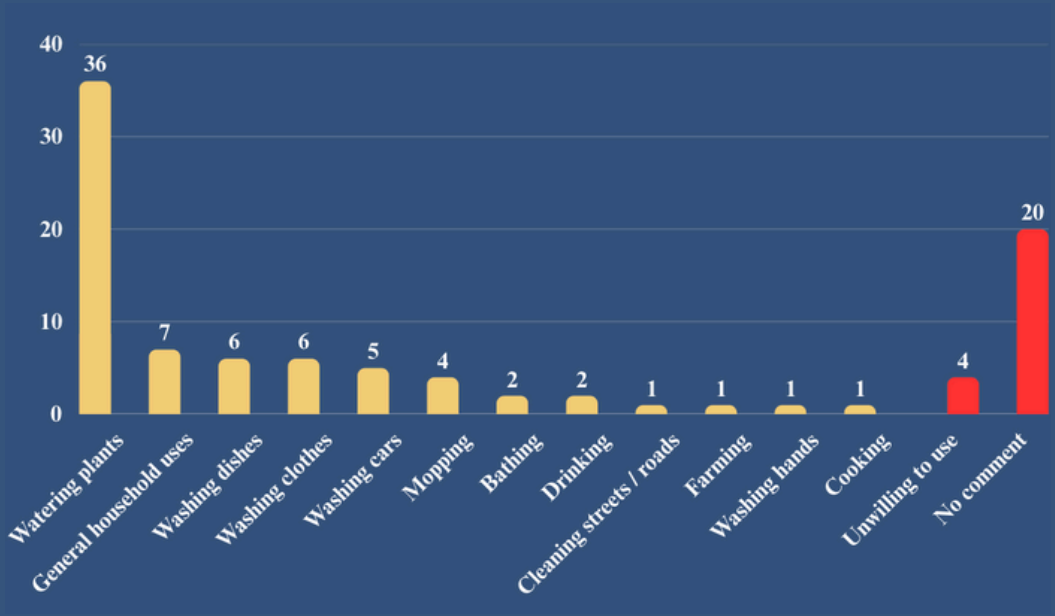


Figure 23 – Distribution of preferred uses of treated water among Sichang Island residents

Survey results show most respondents prefer using treated greywater for watering plants, followed by household tasks like washing dishes and clothes. Fewer participants are open to using it for bathing, drinking, or cooking. While four respondents refuse greywater reuse, and 20 provided no comment, non-contact uses are generally more accepted.

Despite awareness of greywater benefits, reuse remains low due to water concerns. Expanding treatment infrastructure, community education, and policy support could improve adoption. Analyzing responses by age and occupation (Figure 23) reveals that while business owners and restaurant entrepreneurs recognize greywater reuse, some remain hesitant despite past initiatives.

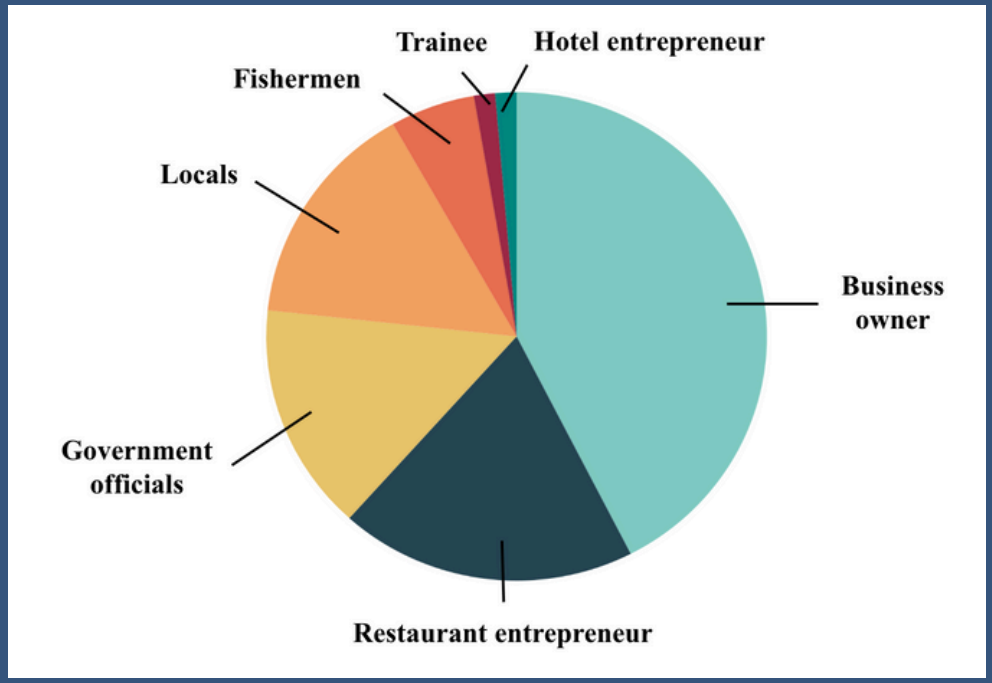


Figure 24 – Community Occupations in Greywater Management Survey

Greywater management acceptance varies across age groups on Sichang Island. Those aged 45–55 are more likely to reuse greywater, while younger groups, especially 25–34 and 35–44, have mixed views. Restaurant entrepreneurs show more openness to treated greywater reuse than business owners.

Most respondents recognize the importance of greywater management, but some in the 35–44 and 45–55 age groups see no need for additional effort. Many business owners and restaurant entrepreneurs acknowledge its environmental impact, though some in the 35–44 group remain uncertain. A significant portion has experienced environmental effects from greywater, with widespread concerns about health risks, though a few older respondents do not see it as a major issue.

Water scarcity is a common problem, highlighting the need for effective conservation and reuse.

Objective 2

3.2 To investigate how the sustainable wastewater treatment system operates on Sichang Island.

In this section, the team identified the sustainable impacts and benefits of Zyclonic technology, its processes, problems occurring in the greywater treatment, and problems that SCGC might face such as limited funding and community resistance, by using semi-structured interviews and observation methods. The evaluation provided insight into how the Zyclonic system aligns with the island's environmental goals and its integration into local infrastructures.

Figure 25 – Local collect greywater by using truck

Figure 26 – Interview with SCGC's staff

Methodology

1. Semi-structured interview with SCGC team and municipality

To understand Zyclonic system processes, sustainable impact, and benefits. Through these interviews, the team gained insights into potential barriers to adoption and factors that could facilitate the implementation of the Zyclonic system. The information obtained would help to determine impact of Zyclonic technology in both positive and negative aspects.

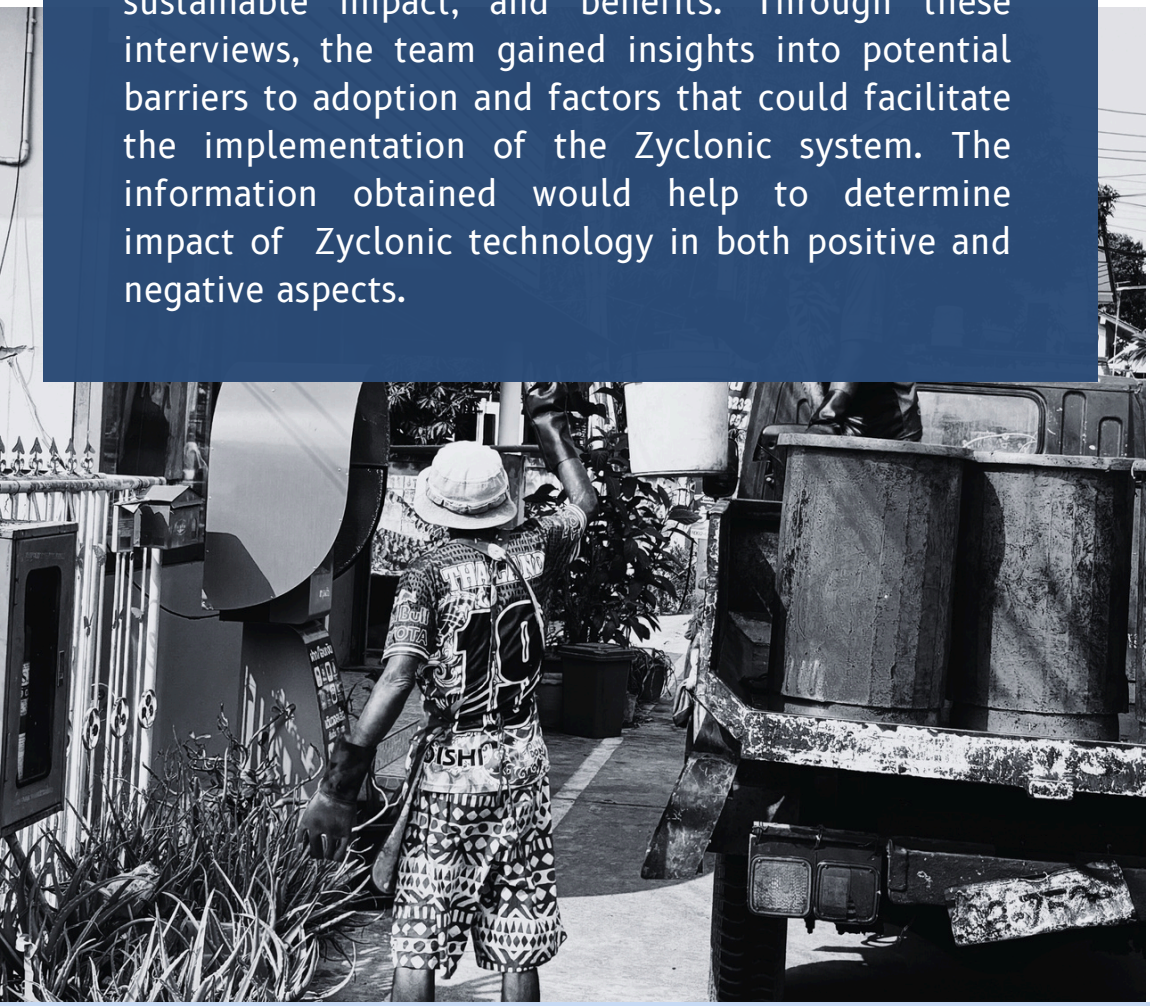


Figure 27 – SCGC staff and Zyclonic

Moreover, interviewing municipal authorities provided information about the working process of other subjects such as how the municipality managed to collect wastewater from the locals.

The analysis was done to summarize and describe the operational aspects, and challenges in the greywater treatment system to obtain a clearer understanding of the system's practical application and the operational barriers that need to be addressed when considering its implementation on Sichang Island.

Figure 28 – Locals use truck to collect kitchen wastewater

2. Observation of the involved organization

The team observed the municipal wastewater collecting at Sichang Island to understand the process of collecting greywater and transporting greywater to SCGC Zyclonic sites, including how many households around the island are involved and participate in giving out greywater to the municipality for further water treatment. Moreover, the team visited the Zyclonic site at Sichang Island to understand more on how the system runs and operates.

Figure 29 – Observation Zyclonic with SCGC staff

Figure 30 – Zyclonic system in Klong Sam Wa

The SCGC team's representative guided and brought us to see each part of the system to let us see a clearer picture of the system. The observations will focus on the technical challenges faced during collecting greywater and at the site, such as system breakdowns or maintenance issues, and how the community interacted with the system, with the information gathered, the team would be able to identify operational future such as its adaptability, and its effectiveness to help assess its potential for successful implementation on Sichang Island

Findings

The process of using Zyclonic system in Sichang Island

Figure 31 – Zyclonic system in Sichang Island

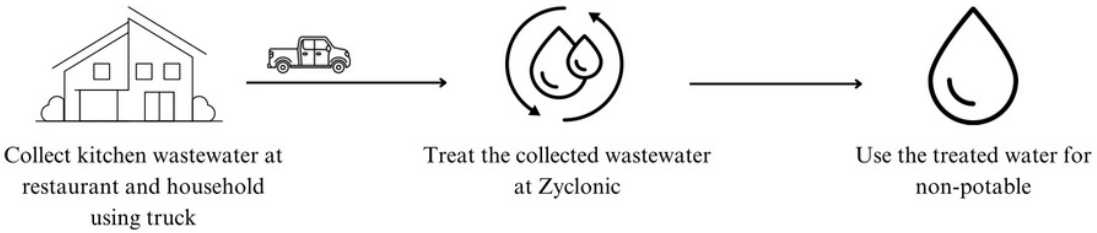


Figure 32 – Diagram of Zyclonic Wastewater Treatment and Reuse Process

Based on interviews with the municipality and staff who collected the greywater, which provides how the Zyclonic process operates on Sichang Island with an organized and systematic method. Greywater was collected from 30 to 40 locations, including households and restaurants, then the greywater was transported to SCGC Zyclonic treatment site using trucks for pick-up and delivery. The set-up of the treatment system consists of a septic tank, a 1000 litres Aquonic tank and two storage tanks. At the site, the water undergoes treatment, making it suitable for non-potable purposes such as irrigation, cleaning, or other secondary uses. This process helps reduce wastewater discharge into the environment and promotes water reuse.

1) The added kitchen water to the Zyclonic technology caused the overflow of the septic

Figure 33 – Septic tank overflow

In the interview with SCGC staff, it was mentioned that a septic tank operates by the introduction of new water forces the expulsion of the existing water, with the fluctuation of collecting kitchen wastewater each day, greywater should be added to the septic tank in an appropriate amount to prevent greywater overflow out of the septic tank. However, as the team observed, the local staff poured too much kitchen waste into the system, and the existing water in the septic tank spilled out causing pollution and environmental concerns.

2) Using trucks to collect kitchen wastewater to the SCGC site

Figure 34 – Vehicles to gather kitchen wastewater

Based on the team's observation, Sichang Island lacks a centralized water supply and sewage pipeline system, the municipality currently relies on trucks to collect greywater from restaurants and households and transport it to SCGC Zyclonic treatment sites. From our observation, the collection process involved three staff members collecting the kitchen wastewater into six buckets. After collecting, the kitchen wastewater often spilled out of the containers while transporting to the treatment sites. The spillage caused odors and hygiene concerns, as well as environmental pollution, so this method of collecting greywater is inefficient.

Objective 3

3.3 To evaluate the practicality and benefits of transitioning from traditional Community Wastewater Management to a sustainable wastewater treatment model, using the Zyclonic system on Sichang Island as an example.

We examined operational efficiency, the experience of involved locals, and community engagement to ensure that the system aligns with local needs and conditions.

Figure 35 – Interview with the community member

Figure 36 – SCGC staff explain about Zyclonic's operation

Methodology

1) Semi-structured interview with community members

The team interviewed the community members randomly to learn about their willingness to change, acceptance of the new technology, their participation, current practice on water usage and involvement of the kitchen wastewater collection process. The responses were analyzed using descriptive statistical analysis by categorizing responses into common themes and calculating the percentage of participants who shared similar thoughts. The responses were grouped based on recurring patterns and community trends. The results provided insights into key factors influencing water usage, community participation in wastewater management, benefits and effectiveness to Sichang Island, and potential barriers to adopting sustainable greywater treatment technology.

2) Analyzed water parameters to ensure the effectiveness of the Zyclonic system

The team conducted preliminary water quality testings to compare water from many sources with treated water from the Zyclonic system. The selected samples were:

i) Treated water from the Aquonic tank of Zyclonic system
ii) Treated water from the storage tank of Zyclonic system
iii) Untreated water from the septic tank
iv) Treated water from Ko Sichang Hospital
v) Water from the Wooden House by the Sea
vi) Water from Chula Aquatic Resources Research Institute
vii) Rainwater from Vadhana mansion

Key water quality testing parameters, including Total Dissolved Solids (TDS), pH and amount of Ammonium ions were conducted. TDS meters were used to detect harmful contaminants.

Figure 37 – TDS meter

Figure 38 – pH strips

These contaminants are anthropogenic pollutions entering the environment via runoffs and wastewater discharges. pH values of the water sources were collected to obtain their acidity or alkalinity, water in acidic condition could worsen metal toxicity, while basic water hinders disinfection, threatening environmental balance (Hancock, 2022). Determining the amount of ammonium using the colorimetric with test strips and reagent method in water is essential for protecting aquatic life and assessing treatment efficiency since ammonia could irritate human eyes and nose and affect water taste and Odor, and disrupts ecosystems, including in wastewater, bacterial action may increase ammonia levels (Palintest, 2024).

Figure 39 – Ammonium test kits

Findings

Most households do not participate in giving kitchen wastewater to the municipality

We interviewed 25 households out of approximately 2,270 households (Buakli, 2023), which revealed that 28% of people participated in the kitchen wastewater collection project while 72% did not participate.

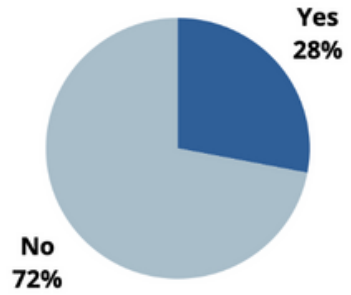


Figure 40 – Household participation in collecting kitchen wastewater

There are several reasons that 72% of the sample did not participate. 11.1% did not know about this project, 11.1% managed their kitchen wastewater by pouring it into a soak pit, 72.2% did not have a lot of water in the restaurants, and 5.6% did not answer. Therefore, we concluded that the main reason that locals did not give kitchen wastewater to municipalities was due to small amounts of kitchen wastewater. This concordance with our observation that most participants were restaurants.

Our interviews with the municipality and local staff, along with observations of kitchen wastewater collection, showed that only 30–40 households and restaurants leaved their kitchen wastewater for collection. This means that only 2,270 households , about 1.32 to 1.76% , took part in the program. We are confident that the data is valid with an acceptable level of interview bias . The interviews were conducted in the community area with many local restaurants and shophouses. The high participation percentage aligns with our observations, confirming that participation is primarily from businesses rather than individual households.

1) Increased local interest in kitchen wastewater collection after understanding its purpose

We surveyed 25 out of around 2,000 households, asking, "What do you think the municipality does with the collected kitchen wastewater?" The results showed that 54.2% had no idea, 8.3% believed it was used to feed worms, and 29.2% thought it was used for composting—both of which are incorrect. Only 4.2% correctly knew that the municipality collects it for water treatment.

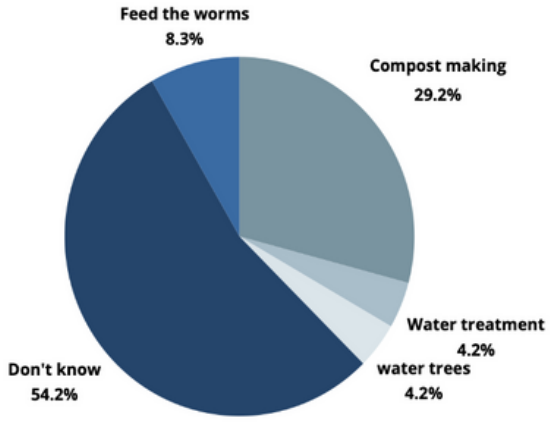


Figure 41 – Household knowledge of purpose of collected wastewater

To increase the amount of the collected water, we hypothesized that participation could increase if locals understood the purpose of wastewater collection. To test this, we informed participants that the municipality treats the collected wastewater using Zyclonic technology from SCGC. After learning this, they were asked again about their willingness to participate.

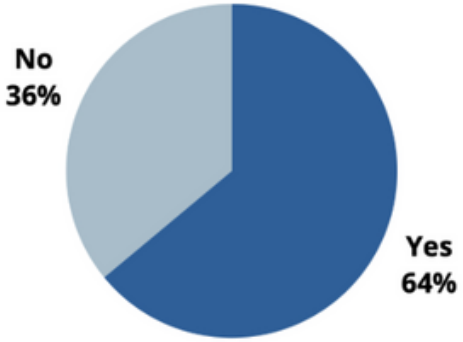


Figure 42 – Household participation after understanding kitchen wastewater collection

The intention to participate rose to 64%, compared to the initial 28% participation rate. The remaining 36% declined, primarily due to generating only small amounts of kitchen wastewater. This data supports our hypothesis that awareness significantly increased participation, though household wastewater volume remained a limiting factor.

Comparison between Zyclonic and the traditional wastewater management method

Table 1 – Comparison between Zyclonic and soak pits

Criteria	Soak pit	Zyclonic system
Wastewater input	Individual sewage systems direct wastewater into soak pits	Handle manually since wastewater must be collected from different places
Operation complexity	Simple passive system with low maintenance.	The system operates with automated treatment processes, requiring manual intervention only for initial grease separation.
Scalability and adaptability	Fixed infrastructure	Modular and scalable; can be expanded based on demand.
Treated Water Quality	No treatment before disposal into nature relies on soil filtration.	Pathogen-free water with chemical disinfection, making it suitable for reuse.

Comparing Zyclonic and soak pits helped highlight key differences in operation, adaptability, treatment effectiveness , and determine how Zyclonic technology is practical to install on Sichang Island compared to other existing practices.

From Table 1, Zyclonic is more complex, it offers superior wastewater treatment and adaptability for reuse. Soak pits, though simpler and maintenance-free, are less effective in treating wastewater and pose potential environmental risks. The soak pit system is a wastewater disposal method suitable for households, primarily relying on soil absorption. (Pollution Control Department, 2012). However, Sichang Island has a rocky underground regardless of the soil which can exacerbate the environmental issue. The different between these systems depends on factors such as wastewater volume, and long-term sustainability goals. Given these factors, the Zyclonic is a better option for, improving wastewater management, and promoting water reuse. By ensuring proper treatment and disinfection, it minimizes the negative environmental impact and has the long-term benefits of cleaner water and reduced contamination risks, which is more sustainable for Sichang Island

The water quality treated by the Zyclonic, the treatment system in the hospital, and rainwater on Sichang Island

Water samples were collected and analyzed based on multiple parameters. We collected three samples of usable water. One rainwater sample was from the Vadhana mansion, while two mixed water samples from rainwater and purchased water were from the Wooden house by the Sea and the aquatic resources research institutes.

Moreover, the treated wastewater was collected from wastewater treatment at Sichang hospital and the effluent from Zyclonic, three samples are collected , including treated water from the Zyclonic system, effluent from the septic tank within the Zyclonic system that had not yet undergone treatment in the Aquonic tank, and the treated water that is stored in storage tanks. The results are shown in table 2.

Table 2 – Water quality from water collected from Sichang Island

Types of water	pH	TDS	Ammonium Test
Untreated water: Zyclonic [Septic tank]	8	2.79	400 NH_4^+ mg/l
Zyclonic [Aquonic tank]	7	553	10 NH_4^+ mg/l
Treated water: Zyclonic [Storage tank]	6	289	10 NH_4^+ mg/l
Treated water: Hospital	6	632	60–80 NH_4^+ mg/l
Rainwater: The Vadhana mansion	7	169	0 NH_4^+ mg/l
Tap water: Wooden house by the sea	7	231	0 NH_4^+ mg/l
Tap water: Research institutes	6	122.9	0 NH_4^+ mg/l

All three sources of usable water show mostly neutral pH, no ammonium detected, and low to moderate TDS level which indicates relatively clean water. For treated water in Sichang Hospital, the pH is slightly acidic, but the ammonium level is high, indicating that the treatment may not be adequate for the reuse of water. TDS level is also high but acceptable for some non-potable purposes.

The effluent that is untreated by the Aquonic tank also contains extremely high ammonium and insufficient TDS. Once stored in the final storage tank, the treated water shows a slight decrease in TDS. This indicates that the Aquonic treatment effectively removes ammonium and improves water quality for non-potable applications.

Figure 43 – Water sample from water storage tank

1) Comparing water quality

The Zyclonic system improves wastewater quality but retains a slightly lower pH, detectable ammonium (10 mg/L), and higher TDS than rainwater or aquatic institute water, making it suitable for non-potable use. Compared to the hospital's treatment, which leaves ammonium at 60–80 mg/L and TDS at 632 mg/L, the Zyclonic system is more effective, reducing ammonium to 10 mg/L and lowering TDS to 289 mg/L in storage. While both systems concentrate dissolved solids, the Zyclonic system produces water with lower contamination levels, making it a more sustainable and preferable option for water reuse on Sichang Island.

Recommendation

A successful wastewater management system on Sichang Island requires public collaboration and an efficient collection process. We recommend that SCGC and the municipality enhance system efficiency for long-term sustainability.

Enhance Community Engagement

To encourage local communities to engage in wastewater and greywater management

1) Conduct workshops

- Simple greywater filtration
- Compare treated / untreated water

2) Provide Benefits for Locals

- Offer free water
- Tax reductions as rewards

1 Conduct workshops

The team found that municipalities are unaware of greywater issues. To raise awareness, the team may propose workshops for teenagers to build filtration systems, demonstrate treatment differences, and emphasize the benefits of treatment and environmental protection for long-term impact.

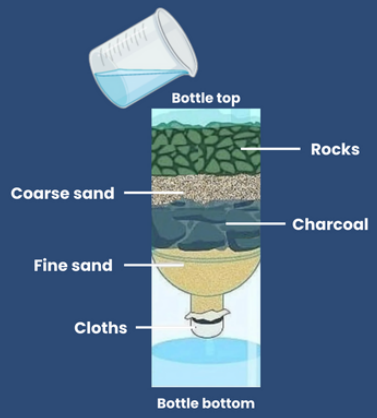


Figure 44 – Simple greywater filtration

2 Provide Benefits for Locals

Offering tangible incentives can boost local participation in sustainable practices. Providing free water quotas or tax reductions for residents and restaurants that practice water conservation has proven effective. Increased participation enhances the collection of greywater for the Zyclonic system, ultimately improving the island's water sustainability.

Recommendation

Effective Methods for Greywater Collection

According to the team's findings, many households lack adequate infrastructure for greywater disposal due to the unavailability of accessible disposal bins and convenient greywater transfer systems. Additionally, some small households hesitate to place their kitchen waste outside their homes, believing the small amount they generate will not be collected.

1) Create Digital Platform

Booking system	Earn points for greywater donations, redeem rewards

2) Provide Sufficient Equipment

Disposal Bin and Lidded containers	Add filter to containers on truck

1 Create Digital Platform

A digital platform, like a website or Line Official, can streamline greywater collection by allowing residents to easily schedule pick-ups, track appointments, and receive reminders. The platform can also offer tips on proper greywater storage and conservation. Additionally, users would earn points for each collection request, which could be redeemed for rewards like free water, food, or fuel. This system would increase participation and make greywater collection more accessible and convenient for all participants.

Figure 45 – Example of Digital Platform

Recommendation

2 Provide Sufficient Equipment

Concerns have been raised about the inadequate number of greywater disposal bins and the collection process. The team suggests that municipalities should install filtration equipment to facilitate the easy separation of solid and liquid waste. This approach will enhance collection efficiency and reduce contamination during transportation and treatment.

Additionally, the team observed that the greywater containers do not have lids, often leading to spills during transport. It is recommended that these containers be replaced with lidded versions to prevent spills on the roads. Figure 46 illustrates a lidded container. This change will improve hygiene and cleanliness while also reducing odors and health risks.

Figure 46 – Example of container with lid

Future Recommendations

If the recommendations are implemented and residents actively participate, the next step will be to expand and optimize the system for greater capacity and efficiency. Adding Aquonic tanks will allow for the storage and treatment of more greywater while increasing the number of greywater collection trucks will enable more frequent pickups. By increasing the number of Zyclonic systems to one for every two districts (Moo) across four systems, we will enhance the treatment process.

These measures will improve wastewater management and provide long-term environmental and economic benefits for Sichang Island. Installing the Zyclonic systems in schools or hospitals—both of which are government-owned—will ensure smoother implementation by avoiding land conflicts. These sites generate high volumes of wastewater, making them strategic hubs for treatment. Schools will benefit from improved sanitation, while hospitals will see enhancements in their less efficient wastewater treatment processes.

Conclusion

Figure 47 – Aquonic tank

Freshwater scarcity continues to be a significant issue on Sichang Island due to its reliance on rainwater, limited natural water sources, and the high costs associated with purchasing freshwater. The lack of a centralized water distribution system further complicates access, making efficient water management crucial for long-term sustainability. This study assessed the potential of greywater treatment to reduce freshwater demand, specifically evaluating the feasibility of implementing Zyclonic technology to reclaim and reuse treated greywater for non-potable purposes.

The research identified key challenges within the island's wastewater management system through field observations, stakeholder interviews, and water quality assessments. Public awareness regarding greywater reuse remains low, which limits community participation in collection programs. The findings suggest that adopting a greywater treatment system, such as Zyclonic, could help alleviate these challenges by providing an alternative water source for irrigation and cleaning, ultimately reducing dependence on costly freshwater supplies.

Moreover, strategically placing decentralized treatment units in high-wastewater-generating areas could lower transportation costs and improve operational efficiency.

Despite the challenges, the Zyclonic system has shown a positive environmental impact by reducing pollution and enhancing greywater management, which, in turn, supports nature-based tourism—a vital aspect of Sichang Island's economy. For the long-term success of this system, municipalities should focus on improving greywater collection infrastructure, raising public awareness, and encouraging community involvement through incentives and workshops.

Conclusion

Addressing these barriers will enhance the system's operational efficiency and ensure the sustainability of Sichang Island's water management practices. Future research should explore the long-term performance of the Zyclonic system, including its cost-effectiveness, public acceptance, and potential expansion into other sectors, such as sanitation, to provide valuable insights for optimizing the system and extending its benefits to other regions.

Sichang Island generates 16,000 liters of greywater each day; however, its wastewater infrastructure is inadequate, particularly during dry seasons. The Zyclonic system, developed by SCGC, provides solutions by treating water for reuse. Nevertheless, there are challenges, including high levels of grease in kitchen wastewater, low community participation, and inefficient collection and transportation systems.

The study highlights the importance of public engagement in improving greywater treatment. Implementing educational campaigns and offering incentives can enhance participation in wastewater collection from households and businesses.

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Appendix A

A.1 Interview questions to understand greywater management of Sichang Island and Zyclonic technology.

For SCGC

English	Thai
How does SCG modify the process so that the community can adopt it?	SCGC มีการปรับเปลี่ยนกระบวนการอย่างไรเพื่อนำไปปรับใช้กับชุมชนได้ง่ายมากยิ่งขึ้น
How much is the daily production of greywater produced on Sichang Island?	เกาะสีชังมีปริมาณน้ำทิ้งจากกิจกรรมต่างๆเท่าไรต่อวัน
How much greywater is treated per day by SCGC?	SCGC มีการบำบัดน้ำทิ้งบนเกาะสีชังในปริมาณเท่าไรต่อวัน
How did the islands manage greywater before this project?	ก่อนที่จะมีโครงการนี้ เกาะสีชังมีการจัดการน้ำทิ้งอย่างไร
What is the scope of work undertaken by SCG in its collaboration with the municipality?	ขอบเขตงานที่ SCGC ดำเนินการในการร่วมกับเทศบาลมีอะไรบ้าง
How far has SCGC's technology been used now?	เทคโนโลยีของ SCGC ถูกนำมาใช้ในเกาะสีชังเป็นระยะเวลาเท่าไหร่แล้ว
What is your goal in collaboration with authorities?	เป้าหมายของ SCGC ในการทำงานร่วมกับหน่วย งานภาครัฐคืออะไร
What technical challenges have you encountered while implementing the SCGC Zyclonic system on Sichang Island?	มีความท้าทายทางเทคนิคอะไรบ้างที่พบในการติดตั้งระบบ SCGC Zyclonic บนเกาะสีชัง
Does the implementation of SCG create job employment for local people?	การดำเนินโครงการ Zyclonic ของ SCGC ช่วยเพิ่มโอกาสในการจ้างงานให้กับคนในท้องถิ่นหรือไม่ อย่างไร

English	Thai
Have you noticed any changes in public awareness or behavior regarding water management since implementing this technology?	ตั้งแต่มีการดำเนินการเทคโนโลยีของ SCGC มีการเปลี่ยนแปลงด้านการตระหนักรู้เรื่องการบำบัดน้ำมากขึ้นหรือไม่ อย่างไร
How has this project impacted the island's long-term sustainability goals?	โครงการนี้ส่งผลต่อเป้าหมายด้านความยั่งยืนในระยะยาวของเกาะสีชังอย่างไรบ้าง
What determinations are in place to ensure the ongoing efficiency of this technology?	มีมาตรการอะไรบ้างเพื่อวัดว่าเทคโนโลยีนี้มีประสิทธิภาพอย่างต่อเนื่องในระยะยาว
How different is the system operating in Sichang compared with the system in Khlong sam wa and other systems?	ระบบ Zyclonic ที่ใช้บนเกาะสีชังแตกต่างจากระบบที่คลองสามวาและพื้นที่อื่น ๆ อย่างไร
What is the cost of the whole system of Zyclonic and the maintenance of the system?	ค่าใช้จ่ายของระบบ Zyclonic ทั้งระบบรวมถึงค่าบำรุงรักษาอยู่ที่ประมาณเท่าไหร่
Zyclonic installation cost and other related cost	ค่าใช้จ่ายในการติดตั้งเครื่อง Zyclonic และส่วนอื่นๆที่เกี่ยวข้องมีอะไรบ้าง
Are there any limitations for installing the Zyclonic in each area? [i.e. How much space does it need?]	มีข้อจำกัดอะไรบ้างในการติดตั้งเครื่อง Zyclonic ในแต่ละพื้นที่ เช่น ใช้พื้นที่มากแค่ไหน ต้องเป็นพื้นที่ราบ
Where can zyclonic be installed in Sichang Island?	มีพื้นที่ตรงไหนในเกาะสีชังที่สามารถนำเครื่องไปวางได้บ้าง
What is the zyclonic installation process? Is it necessary to use workers with specific knowledge or experts of the machine to install?	กระบวนการติดตั้งของ Zyclonic คืออะไร ต้องใช้คนงานที่มีความรู้เรื่องเครื่องหรือผู้เชี่ยวชาญไหม
After installing the machine, how is the machine maintained?	โดยปกติแล้วหลังจากการติดตั้งเครื่องจะมีการ maintanance อย่างไร

For Municipal

English	Thai
Can you elaborate on the historical practices used for greywater management in this community?	ช่วยอธิบายแนวทางการจัดการน้ำทิ้งของชุมชนในอดีตได้หรือไม่
How did the islands manage greywater before this project?	ก่อนมีโครงการนี้ เกาะสีชังมีการจัดการน้ำทิ้งอย่างไรบ้าง
What is the scope of work undertaken by the municipality in its collaboration with SCGC?	ขอบเขตงานที่เทศบาลดำเนินการร่วมกับ SCGC มีอะไรบ้าง
What is your goal in collaboration with SCGC?	เป้าหมายของภาครัฐในการร่วมมือกับ SCGC คืออะไร
What challenges have you encountered while implementing the SCGC Zyclonic system on Sichang Island?	มีความท้าทายใดบ้างที่เทศบาลพบเจอในการดำเนินการใช้งาน Zyclonic ในเกาะสีชัง ที่เทศบาลพบเจอกับการดำเนินการ
Does the implementation of SCGC create job employment for local people?	การดำเนินโครงการ Zyclonic ของ SCGC ช่วยเพิ่มโอกาสในการจ้างงานให้กับคนในท้องถิ่นหรือไม่ อย่างไร
How does water scarcity affect the community, environment, and economy on Sichang Island?	ปัญหาการขาดแคลนน้ำส่งผลกระทบต่อชุมชน สิ่งแวดล้อม และเศรษฐกิจบนเกาะสีชังอย่างไร
Have you noticed any changes in public awareness or behavior regarding water management since implementing this technology?	หลังจากนำเทคโนโลยีนี้มาใช้ สังเกตเห็นการเปลี่ยนแปลงด้านความตระหนักรู้หรือพฤติกรรมของคนในชุมชนที่เกี่ยวกับการจัดการน้ำหรือไม่
How has this project impacted the island's long-term sustainability goals?	โครงการนี้ส่งผลต่อเป้าหมายด้านความยั่งยืนในระยะยาวของเกาะสีชังอย่างไรบ้าง

English	Thai
What determinations are in place to ensure the ongoing efficiency of this technology?	มีมาตรการอะไรบ้างที่ใช้เพื่อวัดว่าเทคโนโลยีนี้มีประสิทธิภาพอย่างต่อเนื่องในระยะยาว
Do you have any other ongoing projects about wastewater treatment besides collaboration with SCGC?	มีโครงการอื่นที่กำลังดำเนินการในเรื่องของการจัดการและบำบัดน้ำเสียหรือไม่
Where should we distribute the survey?	พวกเราสามารถไปสำรวจคนกลุ่มไหนไหนและพื้นที่ส่วนใดในเกาะสีชัง

A.2 Interview questions on semi-structured discussions with locals and hotel owners on greywater management

For Local people

English	Thai
Monthly, how much is your water expense?	โดยปกติแล้วคุณจ่ายค่าน้ำเท่าไหร่ จากส่วนไหนบ้าง
How much water do you use in one month? (in litres)	ในหนึ่งเดือนคุณใช้น้ำปริมาณเท่าไหร่ กี่ลิตร
Where does your water source come from? (eg. rainwater, water from the mainland)	ปกติน้ำที่คุณใช้ได้มาจากไหนบ้าง เช่น น้ำฝนที่เก็บ ซื้อน้ำจากฝั่ง
Do you buy water from a water truck? If yes, how often?	ปกติคุณซื้อน้ำจากรถขนน้ำไหม ถ้าซื้อ ซื้อบ่อยแค่ไหน
How much water do you usually buy?	ถ้าซื้อ ซื้อน้ำปริมาณเท่าไหร่
How much do you have to pay for water and transportation?	ถ้าซื้อ มีค่าน้ำและค่าขนส่งน้ำเท่าไหร่

English	Thai
What determinations are in place to ensure the ongoing efficiency of this technology?	มีมาตรการอะไรบ้างที่ใช้เพื่อวัดว่าเทคโนโลยีนี้มีประสิทธิภาพอย่างต่อเนื่องในระยะยาว
Do you have any other ongoing projects about wastewater treatment besides collaboration with SCGC?	มีโครงการอื่นที่กำลังดำเนินการในเรื่องของการจัดการและบำบัดน้ำเสียหรือไม่
Where should we distribute the survey?	พวกเราสามารถไปสำรวจคนกลุ่มไหนไหนและพื้นที่ส่วนใดในเกาะสีชัง
How long do you have to wait for water after you order it?	ถ้าซื้อ สั่งน้ำแล้วใช้ระยะเวลาเท่าไหร่ ในการขนส่ง
Do you leave kitchen waste in front of your house for the municipality?	ปกติแล้วน้ำที่คุณใช้แล้วได้นำมาวางไว้ให้เทศบาลเก็บหรือไม่
What do you normally use water for?	ปกติคุณใช้น้ำทำอะไรบ้าง เยอะไหม
Do you know what the municipality uses the kitchen waste collected for?	คุณรู้ไหมว่าเทศบาลนำน้ำทิ้งไปทำอะไร
Do you think greywater treatment is important?	คุณคิดว่าการบำบัดน้ำทิ้งจำเป็นไหม
Do you know who SCG is?	คุณรู้จัก SCG ไหม
Do you know that the municipality is now cooperating with SCG to treat greywater?	คุณรู้ไหมว่าตอนนี้ เทศบาลกำลังทำโครงการเรื่องการบำบัดน้ำกับ SCG
If the municipality wants to collect greywater from the community for treatment and reuse for other purposes, would you be interested in joining the project?"	ถ้าเทศบาลต้องการน้ำทิ้งจากคนในชุมชน เพื่อนำไปบำบัดน้ำทิ้งให้เป็นน้ำที่สามารถใช้ประโยชน์อื่นๆได้ คุณจะสนใจเข้าร่วมโครงการไหม

For Hotel entrepreneurs

English	Thai
Does the hotel have a water treatment system?	ทางโรงแรมมีระบบบำบัดน้ำหรือไม่
If there is no water treatment system, what method did you use to manage wastewater?	ถ้าไม่มีระบบบำบัดน้ำ ใช้วิธีใดการจัดการน้ำทิ้ง
What system do you use for treating wastewater?	ถ้าหากมีระบบบำบัด ใช้ระบบอะไรในการบำบัดน้ำ
How much daily capacity is that system?	ระบบบำบัดน้ำนี้สามารถรองรับน้ำได้เท่าไหร่ใน หนึ่งวัน
How many liters of water can this water treatment system treat per day?	ระบบบำบัดน้ำนี้สามารถบำบัดน้ำได้กี่ลิตรต่อวัน
After water treatment, is the treated water used for any purpose?	หลังบำบัดน้ำได้นำน้ำที่บำบัดแล้วไปใช้ประโยชน์ใดหรือไม่
What do you use the treated water for?	โดยปกติคุณใช้น้ำที่บำบัดแล้วทำอะไรบ้าง

Appendix B: Survey questions on Greywater practices

Greywater consists of kitchen wastewater and water from agricultural run-off, which is generated from household and commercial activities. This term is used to explain all domestic wastewater from showers, bathtubs, dishwashers, laundry tubs, washing machines, and basins. The survey will be conducted using physical paper questionnaires to ensure thorough data collection and engagement of participants. The following are all the questions that will be in the survey:

1. What is your primary role on Sichang Island?
   - ❍ Local people
   - ❍ Business owner
   - ❍ Fisherman
   - ❍ Government officials
   - ❍ Local people
   - ❍ Others (please specify): _____

2. How old are you?
   - ❍ 25 – 34 years old
   - ❍ 35 – 44 years old
   - ❍ 45 – 55 years old

3. Do you normally reuse greywater?
   - ❍ Yes
   - ❍ No

4. If the greywater has been treated, will you reuse it?
   - ❍ Yes
   - ❍ No

5. Do you think managing greywater is important?
   - ❍ Yes
   - ❍ No

6. Do you think the community should improve on managing greywater?
   - ❍ Yes
   - ❍ No

7. Do you know you may receive health impacts caused by improper greywater management?
   - ❍ Yes
   - ❍ No

Appendix B: Survey questions on Greywater practices

8. Do you know the environment may receive impacts caused by improper greywater management?
   - ❍ Yes
   - ❍ No

9. Have you experienced any impact from improper greywater management or disposal?
   - ❍ Yes
   - ❍ No

10. Have you ever experienced unclean water?
   - ❍ Yes
   - ❍ No

11. Have you ever experienced bad odors from untreated greywater in your area?
   - ❍ Yes
   - ❍ No

12. Have you ever experienced water scarcity?
   - ❍ Yes
   - ❍ No

13. Do you separate solid and liquid waste when disposing of food waste?
   - ❍ Yes
   - ❍ No

14. Do you think reusing greywater can help conserve water resources?
   - ❍ Yes
   - ❍ No

15. Do you believe that using treated greywater can help reduce water bills?
   - ❍ Yes
   - ❍ No

16. For what purpose would you like to use the treated water?
Ans. _____

Appendix B: Survey questions on Greywater practices

น้ำทิ้ง (greywater) น้ำทิ้งนั้นประกอบไปด้วย น้ำทิ้งจากครัว น้ำไหลบ่าจากการเกษตกรรม และ น้ำจากครัวเรือน เช่น น้ำจากเครื่องซักผ้า น้ำจากที่ล้างจาน ที่อาบน้ำ และห้องน้ำนอกเหนือจากน้ำจากชักโครก

1. บทบาทหลักของคุณบนเกาะสีชังคืออะไร
   - ❍ ชาวประมง
   - ❍ ค้าขาย
   - ❍ ธุรกิจร้านอาหาร
   - ❍ เจ้าหน้าที่รัฐ
   - ❍ ผู้อยู่อาศัยทั่วไป
   - ❍ อื่นๆ: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

2. คุณอายุเท่าไหร่
   - ❍ 25 – 34 ปี
   - ❍ 35 – 44 ปี
   - ❍ 45 – 55 ปี

3. โดยปกติ คุณนำน้ำทิ้ง [greywater] กลับมาใช้ใหม่หรือไม่ (เช่น รดน้ำต้นไม้, ถูพื้น)
   - ❍ ใช่
   - ❍ ไม่ใช่

4. หากน้ำทิ้งได้รับการบำบัดแล้ว คุณจะนำกลับมาใช้ซ้ำหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

5. คุณคิดว่าการบำบัดน้ำทิ้งสำคัญไหม
   - ❍ ใช่
   - ❍ ไม่ใช่

6. คุณคิดว่าชุมชนควรพัฒนากระบวนการบำบัดน้ำทิ้งหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

7. คุณทราบไหมว่าคุณอาจได้รับผลกระทบทางด้านสุขภาพจากการบำบัดน้ำทิ้งอย่างไม่ถูกต้อง
   - ❍ ใช่
   - ❍ ไม่ใช่

Appendix B: Survey questions on Greywater practices

8. คุณทราบไหมว่าสิ่งแวดล้อมอาจได้รับผลกระทบจากการบำบัดน้ำทิ้งอย่างไม่ถูกต้อง
   - ❍ ใช่
   - ❍ ไม่ใช่

9. คุณเคยได้รับผลกระทบจากการที่น้ำทิ้งไม่ถูกบำบัดหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

10. คุณเคยประสบปัญหาน้ำไม่สะอาดหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

11. คุณเคยได้รับกลิ่นไม่พึงประสงค์จากน้ำทิ้งหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

12. คุณเคยประสบปัญหาการขาดแคลนน้ำหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

13. คุณแยกเศษอาหารจากของเหลวก่อนนำไปทิ้งหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

14. คุณคิดว่าการนำน้ำทิ้งกลับมาใช้จะทำให้การใช้ทรัพยากรณ์น้ำลดลงได้หรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

15. คุณคิดว่าการนำน้ำทิ้งกลับมาใช้จะช่วยลดค่าน้ำหรือไม่
   - ❍ ใช่
   - ❍ ไม่ใช่

16. คุณอยากนำน้ำที่บำบัดแล้วไปใช้ทำอะไรบ้าง
ตอบ _____

Appendix C: Interview questions for second visits on Greywater practices

C.1 Interview questions on water supply and kitchen wastewater collection process

English	Thai
How old are you?	คุณอายุเท่าไหร่
How much is your water expense monthly?	โดยปกติแล้วจ่ายค่าน้ำเดือนละเท่าไหร่
How much water do you use in one month? (in litres)	ในหนึ่งเดือนใช้น้ำปริมาณเท่าไหร่ กี่ลิตร
Where does most of your water source come from? eg. rainwater, water from the mainland	โดยปกติน้ำที่ใช้ได้ส่วนมากมาจากที่ไหนบ้าง เช่น น้ำฝนที่เก็บ ซื้อน้ำจากฝั่ง
Do you buy water from a water truck? If yes, how often?	ปกติซื้อน้ำจากรถขนน้ำไหม ถ้าซื้อ ซื้อบ่อยแค่ไหน
How much water did you usually buy?	ถ้าซื้อ ซื้อน้ำปริมาณเท่าไหร่
How much do you pay for water and transportation?	ถ้าซื้อ มีค่าน้ำและค่าขนส่งน้ำเท่าไหร่
How long do you have to wait for water after you order it?	ถ้าซื้อ สั่งน้ำแล้วใช้ระยะเวลาเท่าไหร่ ในการขนส่ง

English	Thai
Do you leave kitchen wastewater in front of your house for the municipality?	ปกติแล้วน้ำที่ใช้แล้วได้นำมาวางไว้ให้เทศบาลเก็บหรือไม่
If not, why?	หากไม่เอามาวาง เพราะเหตุใด
Do you know what the municipality uses the kitchen waste collected for?	รู้ไหมว่าเทศบาลนำน้ำทิ้งไปทำอะไร
Do you think greywater treatment is important?	คิดว่าการบำบัดน้ำทิ้งจำเป็นหรือไม่
Do you know who SCG is?	รู้จัก SCG หรือไม่
Do you know that currently the municipality is collaborating with SCG on a wastewater treatment project?	รู้หรือไม่ว่าตอนนี้ เทศบาลกำลังทำโครงการเรื่องการบำบัดน้ำกับ SCG
Would you join a municipal project to treat wastewater for reuse?	ถ้าเทศบาลต้องการน้ำทิ้งจากประชากรในชุมชน เพื่อนำไปบำบัดน้ำทิ้ง ให้กลายเป็นน้ำที่สามารถใช้ประโยชน์อื่นๆได้จะสนใจเข้าร่วมโครงการหรือไม่

Appendix D: Annual running cost of Zyclonic system

Item description	Estimate cost (Baht per month)	Remarks
Petroleum	2,500	
Electricity bills	3,000	
Labor	0	*cost is paid regularly
Truck maintenance	0	*cost is paid regularly
Total cost	5,500 x 12 = **66,000**	

*The cost is paid regularly even with or without Zyclonic system