Monitoring Organic Loading of Onsite Wastewater Treatment Systems in the Songkhla Lake Basin
การติดตามภาระบรรทุกสารอินทรีย์ของระบบบำบัดน้ำเสียแบบติดกับที่ ในลุ่มน้ำทะเลสาบสงขลา

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Abstract

This project aims to determine the amount of carbon and nitrogen loading of a wastewater treatment plant as a case study during (1) initial installation and (2) setup for a period of 3-5 years in the Songkhla lake basin with the flow rate measured during the day. The highest flow rate of wastewater into the plant on 0.30 and 2.30 pm at is 1 and 1.1 l/sec. and the flow rate was at its lowest during the night time. The characteristics and properties of wastewater input compared with nutrients showed the needs of the microorganisms that the ratio of BOD_5 to N (TKN) was in the range of 24.8: 5 and 32.5: 5, respectively. Those show low of carbon to nitrogen ratio and nitrogen ratio higher than BOD_5 load and the amount of wastewater in the form of TSS COD BOD_5 and TKN loading into the onsite treatment plant are 19.4 to 22.7, 10.9 to 13, 6.3 to 9.7 and from 1.7 to 2.4 kg/day, respectively. The anaerobic initial installation tank has the highest organic loading, and second was aeration initial installation tank and the anaerobic setup for 3-5 years, respectively. Finally, the overall problem for wastewater management concerns engineering and management; first, personnel who control the system is the most important by the controller not understanding about the onsite treatment system, and secondly, the cooperation from workers in the building and the monitors for the onsite treatment system.

Keywords: organic loading, onsite wastewater treatment systems, and Songkhla lake basin

บทคัดย่อ

โครงการวิจัยนี้มีวัตถุประสงค์เพื่อตรวจสอบปริมาณภาระบรรทุกคาร์บอนและไนโตรเจนของระบบบำบัด น้ำเสียแบบติดกับที่กรณีศึกษาโดยมีอายุการใช้งาน 2 ช่วงคือ (1) ติดตั้งระยะเริ่มแรก (2) ติดตั้งมาได้ระยะหนึ่ง (3-5ปี)

ในพื้นที่ลุ่มน้ำทะเลสาบสงขลาจากการวัดปริมาณน้ำเสียในช่วงเวลาตลอดวัน พบว่าอัตราการไหลสูงสุดของน้ำเสีย
เข้าสู่ระบบคือช่วงเที่ยง เวลา 12.30 และ 14.30 น. เท่ากับ 1 และ 1.1 ลิตร/วินาที อัตราการไหลต่ำสุดคือช่วงเวลากลางคืน
จากการตรวจวัดลักษณะและสมบัติของน้ำเสียเปรียบเทียบกับธาตุอาหารเพียงพอกับความต้องการของจุลินทรีย์พบ
ว่าสัดส่วนของ BOD5 ต่อ N ในรูปของ TKN อยู่ในช่วง 24.8:5 และ 32.5:5 ตามลำดับ ส่งผลทำให้มีค่าอัตราส่วน
คาร์บอนต่อไนโตรเจนที่ต่ำ โดยมีสัดส่วนของไนโตรเจนสูง เมื่อเปรียบเทียบค่า BOD5 และปริมาณภาระบรรทุกน้ำเสีย
ในรูปของ TSS COD BOD5 และ TKN เข้าสู่ระบบบำบัดน้ำเสียแบบติดกับที่กรณีศึกษา อยู่ในช่วง 19.4-22.7, 10.9-
13, 6.3-9.7 และ 1.7-2.4 กก./วัน ตามลำดับ สำหรับน้ำเสียที่เข้าสู่ระบบบำบัดน้ำเสียแบบติดกับที่ ถังสำเร็จรูปแบบไร้
อากาศแบบแรกเริ่มมีภาระบรรทุกของมลพิษสูงที่สุด รองลงมาคือถังสำเร็จรูปแบบเติมอากาศแบบแรกเริ่มและถังสำเร็จ
รูปแบบไร้อากาศระยะหนึ่งตามลำดับ ท้ายที่สุดสามารถสรุปปัญหาในภาพรวมของการจัดการน้ำเสียคือ ด้านวิศวกรรม
และด้านการจัดการ โดยแบ่งเป็นด้านบุคลากร วัตถุดิบ เครื่องมือ กระบวนการ พบว่า ปัจจัยด้านบุคคลมีความสำคัญ
มากที่สุด คือ ผู้ควบคุมหรือดูแลระบบไม่มีความเข้าใจในเรื่องระบบบำบัด ไม่ได้รับความร่วมมือจากผู้ใช้อาคาร และไม่มี
การตรวจสอบระบบบำบัดอย่างต่อเนื่อง ตามลำดับ

คำสำคัญ: ภาระบรรทุกสารอินทรีย์, ระบบบำบัดน้ำเสียแบบติดกับที่, ลุ่มน้ำทะเลสาบสงขลา

Introduction

A major problem of pollution in the Songkhla lake basin has been caused by wastewater entering from communities, industrial factories, farms and shrimp ponds resulting in degraded water quality in streams and lakes. The evaluation of the dirtiness of the water drained from the community can be calculated and reported as organic loading and organic waste from water sources. The type of wastewater with "simple Carbohydrate or complex proteins and fats, soluble and particulate matter, organic or inorganic concentrations, and nutrients" (Water Environmental Federation, 2009). Organics in wastewater can measured in terms of BOD_5 (Biochemical Oxygen Demand) or COD (Chemical Oxygen Demand) in the amount of effluent water next to the onsite treatment, such as the treatment of septic waste from toilets in individual households, wastewater collection systems, including water used by the local administration. It makes the concentration of organic matter in the wastewater become low but organic compounds are present, especially in the form of nitrogen and phosphorus that will effectively contribute to eutrophication due to the nitrogen and phosphorus, finally, algae is used for rapid growth (Chislock et al., 2013). For the organic compounds of nitrogen, no treatment will affect water salinity due to nutrient limitation (Thomann & Linker, 1998). Arranging a proper sewage system of local government is one of the main measures to control and prevent pollution.

Over the course of 20 years in Thailand, the government has allocated a budget for managing municipal wastewater. In particular, wastewater treatment and collection systems have been constructed 87 plants for communities, of which have many are faced with problems in

commissioning and maintenance that cannot be operated effectively that survey of 77 of wastewater plants that have only a the 13 of wastewater plants are in the good criteria (Pollution Control Department, 2015), it also has limitations in terms of the budget for the construction of wastewater treatment plants and wastewater treatment cannot be provided to all communities, such as in the area of the Songkhla lake basin (SLB), which is regarded as a large source of wastewater that covers three provinces, namely Songkhla, Phatthalung and Nakhon Si Thammarat. The Songkhla wastewater discharges into the lake in the equivalent amount of 13,595 kg BOD_5 per day and discharges from communities is 7,086 kg BOD_5 per day. There are only four sewage systems, located in the Hat Yai municipality, Songkhla municipality, Sadao municipality and Tambon Klonglee Administration Organization. However, the amount of contaminated wastewater in small communities in Songkhla lake basin is unable to be managed.

The major cause of the deterioration of water quality is due to the discharge of waste into the water was not along by law, which wastewater from sewage, community wastewater and agriculture wastewater showed 70, 20, and 10 percentage, respectively. (Pollution Control Department, 2007) of the data suggests that the deterioration of water resources is mainly due to wastewater and is continuing to rise. As long as the causes of the deteriorating quality of water resources has not been fixed correctly or decreased by a system and wastewater treatment less effective, this will be a major cause of immediate cause spoilage source.

The municipal wastewater treatment evolution that have nutrient removal regulation for ecological reasons (U.S. Environmental Protection Agency, 2008) and the small communities were focused in case of onsite wastewater treatment (clustering) for the loading of nutrients and asset management as a tool to improve regulatory compliance; lower operation and maintenance (O&M) costs and life cycle costs of key facilities (Water Environment Federation, 2007) and support environmental sustainability and stewardship in local governments (Water Environmental Federation).

In this study, we measured carbon and nitrogen loading as a case study during (1) initial installation and (2) setup for a period of 3-5 years and monitoring operation and maintenance. We also hypothesized that goals of the causes from engineering and management of onsite wastewater treatment plant in the Songkhla lake basin.

Research Objectives

1. To evaluate and analyze the performance of wastewater treatment plant adjacent to the area of Songkhla Lake Basin.

2. To determine the amount of carbon and nitrogen loading of the onsite treatment as a case study during (1) initial installation and (2) setup for a period of 3-5 years in the Songkhla lake basin.

3. To evaluate the causes and solutions of problems onsite wastewater management systems in Songkhla lake basin.

Conceptual Framework

The research is adopts an applied research technique to examine the loading of carbon and nitrogen in a wastewater treatment system mounted over a short-term period, or within 24 hours, divided into four stages to goal of causes and solutions of wastewater management systems, the amount of carbon and nitrogen loading and efficiency of onsite wastewater treatment system in the Songkhla lake basin.

Research Hypothesis

Each type of onsite wastewater treatment system shows that carbon and nitrogen loading were different.

1. The independent variable; aeration tank, the anaerobic tank and a filter tank with attached microorganisms with a case study during (1) initial installation and (2) setup for a period of 3-5 years in the Songkhla lake basin

2. The dependent variable; variables of the amount of carbon and nitrogen loading.

Finally, conclusion the causes of onsite waste water treatment and management in Songkhla lake basin.

Research Methodology

1. Survey of Onsite wastewater treatment systems in the Songkhla Lake Basin.

This step aimed to monitor the amount of carbon and nitrogen loading of the wastewater treatment system with the aeration tank, the anaerobic tank and a filter tank with attached microorganisms. This is an issue of concern for water management, wastewater treatment system mounted in the Songkhla lake basin in the systems and control systems and the management of wastewater management.

2. Sampling influent water and effluent water in the wastewater treatment plant and sludge in the Aeration tank, the anaerobic tank and a filter tank with attached microorganisms as a case study during (1) initial installation and (2) setup for a period of 3-5 years in the Songkhla lake basin.

This step is aimed to study and trials of the system in the short-term, or within 24 hours. The collected data parameters such as flow rate and the effluent of a wastewater treatment plant with every second hour (12 samples/day) to collect a composite sample were analyzed for a total BOD_5, soluble BOD_5, total COD, soluble COD soluble, TKN, SS, NO_3^-, and NO_2^- and analyzing samples analyzed by standard methods (American Public Health Association, 2005). In step two, which is derived from the monitoring system, wastewater treatment was examined as well as the problem of wastewater treatment.

3. Analyze water quality, sludge and the insights of a wastewater treatment plant

This step is aimed to report results of the analyzed water quality and sludge for the loading of carbon and nitrogen, and the efficiency of onsite wastewater treatment in the Songkhla lake basin, which is the result of the analysis and characterization of water consumption and

wastewater treatment system integrated as a case study of the transformation of water into the sewage system is equipped with a case study characteristics of wastewater before treatment systems analysis. The effluent treatment efficiency of wastewater treatment will show the cause of the problem and the data collection system and wastewater treatment plant adjacent to the case study.

4. Conclusion of the results of the causes and solutions to manage wastewater.

From the three steps taken to conclude the analysis of the causes and solutions to manage wastewater treatment system with a case study to analyze the cause of the problem, the management of wastewater treatment systems by Ishikawa's techniques.

Finally, all steps will analyzed in terms of the goals of the causes from engineering and management for solutions of onsite wastewater management systems, the amount of carbon and nitrogen loading and efficiency of wastewater treatment in the Songkhla lake basin.

Results

1. The situation of the problem regarding water management with an onsite wastewater treatment plant in the Songkhla Lake Basin.

The result of management with six onsite wastewater treatment plants in the Songkhla lake basin are intended to inform about the general context of the management of wastewater, with onsite wastewater treatment plants, including general information. Wastewater management control system problems and suggestions from the past and present and the data were obtained from the officer in charge of wastewater. The owner installed a septic system and controlled the system. The data was collected during the months of July, 2014 - July, 2016 by using a questionnaire and survey technique employed throughout the areas that will be included in the process as well with various factors and related to wastewater management then summarized and presented in order to analyze the reasons that led to the problems of onsite wastewater treatment. The details are as follows.

1.1 Treatment and control systems.

The result of treatment and control systems with six of onsite wastewater treatment plants in the Songkhla lake basin are located in separate buildings each of which may have 1-3 units or be as a separate unit. Because the buildings are well-spaced or are very large in order to process more water that may have to install more treatment systems.

The results of the analysis of the parameters that are able to control the conditions that may influence the performance of the system.

The pH in the septic tank, anaerobic filter treatment system equipped with advanced show the chemicals used in the washing process. If the pH is higher than 7.5 to 8.0, a type of bacteria will produce methane (CH_4) less frequently and slowly. When the pH reached 9.0, the system used to decompose organic matter will not work and the organic removal process is greatly reduced (Udomsinroj, 2000).

The amount of dissolved oxygen in the aeration tank and a tank with an adherence of microorganisms less than 1 mg/L will contribute to the growth of microbes that use oxygen which grows low volume and slow and the effectiveness of the treatment is reduced. The general control of dissolved oxygen is between 1-2 mg/L; if the amount is too much, it does not affect the effectiveness of the treatment but it does increase the demand for electricity with highly cost engineering (Environmental Engineering Association of Thailand, 1997).

The amount of sludge in the aeration tank at the MLSS was found to be SV_{30} which means that only a small amount of microbes are present. As a result, the treatment efficiency is reduced as it was found that for the wastewater entering the treatment system, the amount of organic matter and nutrients was at its lowest (low ratio of carbon to nitrogen). The conditions are not suitable for microorganisms include when the pH is lower than 6.6 or higher than 8.0, dissolved oxygen is below 1 mg/L, as in a tank with attached microorganisms that cannot measure the MLSS and SV_{30} because bacteria sticks to the surface media. As a result, it may be required to measure the respiration rate of the microbes that occur in the system.

The amount of sediment in the water is too heavy for the aeration tank. Often, this is due to the volume flow rate of water being too much for the duration of time and the layers of sediment in the sedimentation tank to simulate the high fog settling in the tank.

While chlorine added to water at adequate and consistent level can be relatively effective for disinfection of virus by damaging nucleic acids, the viral coat protein, or both (Hoff, 1986; Dennis, Olivieri & Krusé, 1979; Kim & Min, 1979; Tenno, Fujioka & Loh, 1980). In this study showed the residual chlorine in the water cannot be detected because the chlorination process is not efficient. A general control of chlorine for disinfection added at 2-8 mg/L and required 15-30 minutes (Korich et al., 1990).

2. Analysis and characterization of wastewater.

Because this step aims to study and perform trials of the system in the short-term, or within 24 hours, the collected data parameters system like flow rate and the effluent of a wastewater treatment plant with every second hour (12 samples/day) to collect a composite sample were analyzed for total BOD_5, soluble BOD_5, total COD, soluble COD soluble, TKN, SS, NO_3^-, and NO_2^- and analyzing samples analyzed by standard methods (American Public Health Association, 2005) that can be attributed to the information supplied and guidelines for the right way to effectively manage wastewater.

2.1 Data on water use of the onsite wastewater treatment system.

The data from the survey showed that the amount of wastewater only in respect of the activities in the building connected to the sewage system and influent wastewater enters the treatment

system during the day is not significantly different and some of the wastewater did not enter the sewage system, such as wastewater from washing floors and vascular damage that causes the water to flow out. Thus, the external monitoring with transports water and wastewater collection system can save water consumption. The resulting wastewater is critical to manage water more efficiently with advanced of cost engineering (AACE International, 1997).

2.2 Typical hourly variations in flow and strength of wastewater into the onsite wastewater treatment system.

The maximum flow rate of wastewater into the sewage system in the cases at 0.30 and 2.30 pm is showed at 1 and 1.1 l/sec. The flow rate was lowest during the night as most of the wastewater from the use of toilets, bathing, washing, and other wastewater is reduced when there is a break or the service drop is behind schedule at 2.30 and 6.30 pm that have generally been found to rang of hourly variations in flow and strength of domestic wastewater (Tchobanoglous, et al., 2004).

2.3 Characteristics of influent wastewater.

Physical appearance: From the physical sample of influent wastewater, it was found that the wastewater coming into the onsite wastewater treatment system has similar characteristics with turbidity and sedimentary in basin and has a brown and dark color, and smells. At certain times, there is a layer of fat on the surface water that contains food with a slight odor, and in some buildings there was foaming and a smell of disinfectant.

Chemical characterization: Noting the chemical characteristics of the wastewater is very of critical to achieve effective treatment because the microorganisms that each type needs requires optimum conditions that are different from one another. In particular, wastewater with a low carbon to nitrogen ratio and needs adequate nutrients for the micro-organisms (Metcalf & Eddy, 2004) that defined the nutrients in proper form of BOD5: N: P ratio of 100: 5: 1. The result show the ratio of BOD5: TKN in the range of 24.8: 32.5 and 5: 5, respectively. The wastewater from other buildings have a high nitrogen to carbon ratio that is appropriate to the function of the microorganisms for being nutrients for plants.

The loading of wastewater: The wastewater that flows into the treatment system will vary according to the pollution of water sources which can be used to calculate the amount of pollution in the form of loading at volume (weight: kg) of pollutants into the system at any given time. The pollution load multiplied by the rate of flow of wastewater into the sewage system at each time (days), each system can support a load of pollution which varies depending on the design of the system. The loading rate of the treatment system, which determines the rate of loading, shows that the system can handle the volume

of wastewater pollution as well. For the loading rate of pollution, it is defined as the design of the wastewater treatment plant. The formula for the pollution load of wastewater into the onsite wastewater treatment system (Environmental Engineering Association of Thailand, 2002) is:

$$L = Q \times S$$

When L = load (kg/day).

Q = flow rate (m^3/day).

S = concentration of pollutants in wastewater (kg/m^3)

Table 1

The pollution load of wastewater into the sewage system is attached to the case

System	Case	Organic loading (Kg/Day)			
		TSS	COD	BOD_5	TKN
Aeration tank	- initial installation	7.6	22.5	12.3	1.7
	- setup for 3-5 years	6.3	22.7	12.9	1.7
Anaerobic tank	- initial installation	9.7	21.5	10.9	2.2
	- setup for 3-5 years	7.8	21.7	11.5	2.4
Filter tank with attached microorganisms	- initial installation	8.9	19.4	13.6	2.1
	- setup for 3-5 years	7.6	20.0	11.8	1.9

The loading of wastewater in the form of TSS, COD, BOD_5 and TKN into the onsite wastewater system at 6.3 to 9.7, 19.4 to 22.7, 10.9 to 13.6, and 1.7 to 2.4 kg / day, respectively. The onsite wastewater system in the case of an initial installation of anaerobic tanks performs by receiving the pollution load is highest. The second is an initial installation of aeration tank and setup for 3-5 years of anaerobic tanks, respectively.

The criteria of design for the anaerobic capacity is able receive the loading rate of 3.2 to 32 kg COD/m3 - day and 0.5-3.2 kg BOD5/m3 - day in Environmental engineering association of Thailand (2002).

The loading of wastewater can be used to analyze the performance of the wastewater treatment plant by comparing the design of the system in the form of organic matter such as the septic have BOD5 of 40 percent and a loading rate of aeration tank is in the range of 0.8 kg BOD_5 /m3 - day. This is shown in table 2.

The results of the analysis show the design of onsite wastewater treatment system in the case study can support a load of more than BOD5 and be used to perform treatment which must use other factors such as flow rate, and characterization of wastewater.

Table 2

The performance of the loading system in the form of BOD$_5$ (continue)

System	Case	Volume (m³)	Loading of BOD$_5$ (kg/day)		
			Influent wastewater	Wastewater from septic tank	Criteria design of aeration tank
Aeration tank	- initial installation	2.56	12.3	0.12	2.05
	- setup for 3-5 years	2.56	12.9	0.16	2.05
Anaerobic tank	- initial installation	8.28	10.9	0.39	6.62
	- setup for 3-5 years	8.28	11.5	0.27	6.62
Filter tank with attached microorganisms	- initial installation	2.56	13.6	0.36	2.05
	- setup for 3-5 years	2.56	11.8	0.26	2.05

2.4 Analysis the quality of effluent water from onsite wastewater treatment system.

The analysis looked at the average quality of the effluent water from the onsite wastewater treatment system to measure the effectiveness of pollution in wastewater and provide information for the planning and control system, as shown in table 3 and 4.

From table 3, the data from the analysis of average wastewater from onsite effluent wastewater shows that most parameters passed the effluent quality standard. However, in the group of organic loading, such as carbon and nitrogen, the data is slightly higher than the effluent quality standard, therefore, it is necessary to track down and identify the cause in order to solve this problem.

From table 4, Biological nitrogen removal typically increase solid production as a result of the nitrification and denitrification processes and the oxygen and nitrogen (CHON) composition and is formulated in mole units, based on conservation of C, H, O, N and COD in sludge (Koch et al., 1990) this research showed sludge from all system led to a significant oxygen uptake, indicating the importance of aerobic biodegradation and significant to produce methane with sludge digestion by anaerobic processes, conventional rate digestion and high rate digestion (Dilek et al., 2011).

2.5 The performance of onsite wastewater treatment system.

The characterization of influent wastewater and effluent wastewater from treatment systems. Sampling was conducted on the same day in which the composite sample was analyzed and the effective

treatment and wastewater management planning. This research conducted an analysis of polluted wastewater treatment efficiency in terms of total BOD_5, soluble BOD_5, total COD, soluble COD, SS, TKN, NO_3^- and NO_2^- as shown in table 5.

The efficiency of the wastewater treatment plant in this case study in terms of total BOD_5, soluble BOD_5, total COD, soluble COD, SS, TKN, NO_3^- and NO_2^- that total BOD_5 included in the range of 77-91 percent, soluble BOD_5 in water in the range of 78-91 percent, in the total COD 80-88 percent, soluble COD in water in the range of 82-90 percent, SS in the range of 71-92 percent, TKN in the range of 88-94 percent, respectively. When the efficiency of the wastewater is compared to the criteria design of the wastewater treatment system, it is shown that the treatment is effective under the design of the system as there is a high rate of removal of BOD_5 and soluble BOD_5, according to the data characteristics of influent wastewater when compared together. The Environmental Engineering Association of Thailand (1997) suggests that to determine the effectiveness of treatment BOD5 in anaerobic tank is in the range of 30-60 and an aerobic tank is in the range of 85-95 percent, and 25- 100 percent (Metcalf & Eddy, 2004).

3. The analysis of the causes and solutions to manage onsite wastewater treatment system.

From the primary and secondary data obtained by questioning and monitoring onsite wastewater treatment system, two issues can be presented that are common for managing wastewater by applying a participatory approach and using Ishikawa's (Ishikawa, 1968) technique also including an analysis of the problems and the priorities with suggested solutions. This work presented the problem of storage and advice on the technical engineering environment to engage in management practices to handle the wastewater treatment system of wastewater with the appropriate local case studies.

3.1 Analysis of the causes of the problem of managing onsite wastewater treatment system.

The main causes of inefficient water management are shown in figure 1

Table 3

Analysis the quality of effluent water from onsite wastewater treatment system

Sample*	Temp (°C)	pH	BOD₅ total (mg/L)		BOD₅ soluble(mg/L)		COD total (mg/L)		COD Soluble(mg/L)		SS (mg/L)		TKN (mg/L)	
			Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff	Inf	Eff
(1)	29.0	7.4	225.3	43.5	218.4	23.1	466.8	74.4	387.6	57.6	158.4	49.2	35.7	3.1
(2)	30.3	7.9	269.1	33.9	232.8	25.9	472.8	64.8	438	51.6	130.8	38.4	36.2	3.7
(3)	28.9	7.5	227.2	52.2	195.6	43.6	446.4	90	410.4	73.2	201.6	19.2	45.7	5.6
(4)	29.9	7.9	239.4	47.1	206.4	37.9	451.2	70.8	403.2	63.6	162	15.6	49.5	4.9
(5)	28.9	8.1	283.5	26.5	235.2	22.3	403.2	56.4	356.4	34.8	186	21.6	43.6	3.7
(6)	30.6	8.3	245.7	23.2	219.6	20.8	415.2	51.6	362.4	39.6	158.4	13.2	39.2	2.5

Parameters

*Sample is (1) Aeration tank initial installation (2) Aeration tank setup for 3-5 years (3) Anaerobic tank initial installation (4) Anaerobic tank setup for 3-5 years (5) Filter tank with an attached microorganism initial installation (6) Filter tank with an attached microorganism setup for 3-5 years

Table 4

Analysis the CHONS in sludge (% Elements) from onsite wastewater treatment system

Sample*	CHONS in Sludge (% Elements)				
	C	H	O	N	S
(1)	0.58	9.42	48.60	< 0.01	< 0.01
(2)	0.57	9.78	55.23	< 0.01	< 0.01
(3)	0.38	10.06	33.52	< 0.01	< 0.01
(4)	0.43	10.09	26.07	< 0.01	< 0.01
(5)	0.64	10.96	43.95	< 0.01	< 0.01
(6)	0.67	11.18	46.20	< 0.01	< 0.01

*Sample is (1) Aeration tank initial installation (2) Aeration tank setup for 3-5 years (3) Anaerobic tank initial installation (4) Anaerobic tank setup for 3-5 years (5) Filter tank with an attached microorganism initial installation (6) Filter tank with an attached microorganism setup for 3-5 years

Table 5

The performance of onsite wastewater treatment system

Sample	Percent Reduction (%)					
	BOD_5 total	BOD_5 Soluble	COD total	COD Soluble	SS	TKN
(1)	83	89	84	88	71	90
(2)	87	89	86	82	90	88
(3)	77	78	80	84	90	90
(4)	80	82	84	90	88	91
(5)	91	91	86	89	92	94
(6)	90	90	88	88	71	90

*Sample is (1) Aeration tank initial installation (2) Aeration tank setup for 3-5 years (3) Anaerobic tank initial installation (4) Anaerobic tank setup for 3-5 years (5) Filter tank with an attached microorganism initial installation (6) Filter tank with an attached microorganism setup for 3-5 years
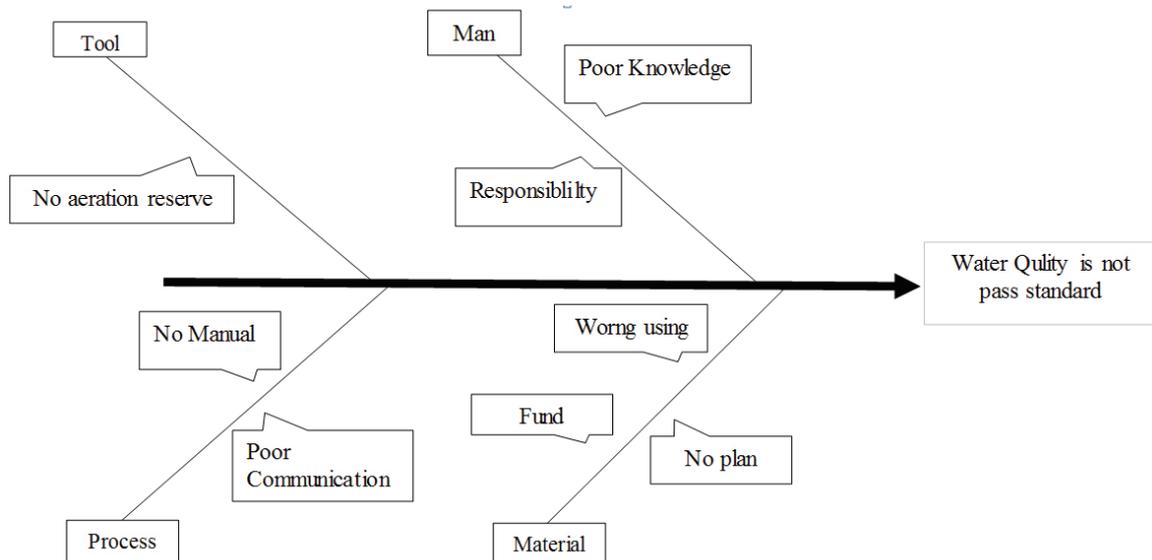
Figure 1 The cause of the problem of onsite wastewater management in Songkhla lake basin by Ishikawa's techniques

3.2 Recommended solutions for onsite wastewater treatment system.

From the data in figure 2, the root cause of the five problems can be resolved. The results suggest that the most important factors are the person who controls the system, (due a lack of understanding of how the treatment system works), while the second most important factor is a lack of cooperation from the user of building and that last and does not have to be checked for the treatment to continue.

The advantages of using Ishikawa's technique is that a conclusion can be reached in order to determine the root cause of the problem from the relevant stakeholders which received cooperation from those involved as well, so it can be used to determine the exact cause before taking corrective action.

Conclusion

By measuring the amount of water during the day, the volume of wastewater flowing into the system at any time was found. The maximum flow rate of wastewater into the sewage system in the case on 0.30 and 2.30 pm was shown at 1 and 1.11/sec. The flow rate was at its lowest during the night as most of the wastewater from the use of toilets, bathing, washing, and wastewater is reduced when there is a break or the service drop is behind schedule at 2.30 and 6.30 pm.

The characteristics and properties of water compared to the needs of the micro organisms found that the proportion of BOD5 per N in the form of TKN in the range of 24.8: 5 and 32.5: 5, respectively, resulting in a low ratio of carbon to nitrogen in terms of the proportion of nitrogen compared the BOD_5.

The loading volume of wastewater in the form of TSS COD BOD_5 and TKN into the sewage system, mounted on a 6.3 to 9.7, 19.4 to 22.7, 10.9 to 13.6, and 1.7 to 2.4 kg/day, respectively. The onsite wastewater system in the case of an initial installation of anaerobic tanks performed by receiving the pollution load at its highest. The second is an initial installation of aeration tank and setup for 3-5 years of anaerobic tanks, respectively.

The study can be summarized in the overall management of wastewater into the onsite treatment system which can be divided into two aspects: engineering and management and then divided into human, raw materials, processes, and the tool used by the most important factor, which is the person who controls the system, a lack of understanding of the treatment system, while the second factor is a lack of cooperation from the user resulting in treatment having to be checked constantly.

Overall, the data from this study can be utilized by the Songkhla Provincial Office of Natural Resources and Environment as well as local authorities as a guide to how to manage onsite wastewater treatment system control in the Songkhla lake basin.

Recommendation

1. The design and operation professional will need to meet local land-use requirements and follow development process established by the community.

2. Meeting the neighbors in communities during the design phase to explain the specific steps that grease and food debris from kitchens create problems in wastewater treatment that are impossible to separate. If the two types of water sources can be separated, then this will help solve the problem sufficiently.

3. Increased interest and reliance is being placed on reuse of reclaimed water in response to increasing demands in urban and higher effluent quality requirements.

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