HEAVY METAL CONTAMINATION IN NATURAL WATER SOURCE AREA IN THAMTHALU SUB-DISTRICT, BANNANGSATA DISTRICT, PATTANI WATERSHED, SOUTH THAILAND

Vichit Rangpan, Yala Rajabhat University
Nurainee Lohyapa, Yala Rajabhat University

ABSTRACT

The purpose of this research aimed to study the heavy metal contamination in natural water source area in ThamThalu sub-district, Bannang Sata district, Yala province regarding land use, examination of the quantity of heavy metal contamination in natural water source, seasonal variation of the quantity of heavy metal contamination in natural water source, the relationship of heavy metal, lead, cadmium, and arsenic, and method of prevention and improvement of the problems of heavy metal contamination. The water samples from 15 different areas were monthly collected from October 2013 – April 2014 by the one-sample method. In one procedure; the entire samples would be analyzed to find the contamination such as lead, cadmium, and arsenic. Mean, standard deviation, t-test, F – test, and Pearson Product Moment Correlation was employed in the study. The results were as follows: Sources of heavy metal contamination are an upstream area which is a forest area; midstream which is an agricultural and forest area; downstream which is a residential and agricultural area. A heavy metal consists of lead, cadmium, and arsenic. The average results are 0.015 mg/L, 0.004 mg/L, and 0.054 mg/L respectively. The contamination of heavy metals in each source is different. There are relationships between lead, cadmium, and arsenic ($p<0.01$). Moreover, there is no concrete and continuous restoration. In the rainy season, the soil is eroded and the chemical usage of the residential and agricultural areas is increased which is the cause of heavy metal contamination. Problems, including, people's lack of awareness and participation in taking care of water sources. Guidelines of water source management shed light on providing knowledge to the community with normal and correct methods and setting up the water source restoration group.

Keywords: Heavy Metal, Natural Water Source, Pattani Watershed, South Thailand

INTRODUCTION

Water resources are important in human life and are an important component of all living things. Because it is a cell element that is necessary for the function of life. Water is an important component of the human body. Which are about two-thirds of the human body? The use of water has different purposes, such as agriculture, industry, and consumption. At present, the rapid progress in industry and technology as well as the rapidly growing population of Thailand has caused environmental pollution. In particular, various water sources also suffer from pollution problems as well, due to being affected by human development. From deforestation setting up industrial factories on the waterfront, canal garbage, and community waste disposal adding agricultural chemicals, etc. It is such a problem and inevitably affecting human life. Heavy metal contamination in natural water sources has a tendency to accumulate heavy metals. Affecting human and animal health such as chronic lead poisoning in Pattani province and Yala province chronic arsenic poisoning problem in Ron Phibun district Nakhon Si Thammarat province etc. These problems are caused by toxic metals contaminated in antimony and wolfram Rangpan (Rangpan, 2008). The geography of the villagers in Thamthalu

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

sub-district Bannangsata district, Yala province, there is a hill area. It has some plains and the condition of the rainforest that still has abundance monsoon weather has two seasons with a smaller downstream to the large stream. In the former village, the community in Thamthalu sub-district Bannan Sata district, Yala province, is one area in Yala province that in the past used to be a dense forest. In which the mining process requires drilling, grinding, separation, and dressing is pure enough to be useful. This process releases some unwanted toxins, especially heavy metals. Heavy metals, it is naturally in the mineral resources such as lead, cadmium, arsenic, and other metals contaminated to the environment. Lead contamination is detected and arsenic in the waste sludge piles caused by tin mining and affects the quality of natural water resources in Thalu cave. It is a water branch of the Pattani River (Patcharee, 2014; Phet, 2014; Phuangphet, 2014). Therefore, the department of mineral resources has initiated a project to solve the problem of heavy metal contamination in the mine area of Thamthalu sub-district, Bannangsata district, Yala province. It is a solution to the problem of heavy metal contamination and prevention. Reduce the spread of heavy metals into natural water sources for safety, disaster, consumption, restoration of mining areas by reforestation, and cover the ground to return to the forest and better ecosystems. From the results of the project, it was found that there may be a cause because the project has been interfering with the area. Have to adjust the area for digging and transporting the waste sludge. It was collected before making a landfill, thus causing the leaching of waste into more water sources. Besides, after the completion of mining, there is a use of such areas to be used as a residence. And should study the contamination of heavy metals, which is the result of mining both in water. It is the data for decision-making consumption and consumption of heavy metals in natural water sources by Issarayaphon (Issariyaporn, 2008) including the accumulation of heavy metals in natural water sources. With such necessity, it is necessary to study the number of heavy metals contaminated in natural water reservoirs in Tham Thalu sub-district, Bannangsata district, Yala province. By analyzing the number of heavy metals contaminated in natural water sources and encourages people and network partners (Thamthalu sub-district administration organization, community leaders, health leaders, religious leaders) participate in finding suggestions to raise awareness for solving the problems of heavy metal contamination, to reduce public health problems and bring benefits to the community.

RESEARCH METHOD

In this study, the researcher used mixed methodology using qualitative technique and quantitative research (Quantitative technique) with the following methods.

Population and Sample

Study of heavy metal contamination area of natural water source in Thamthalu sub-district Bannangsata district, Yala province for a period of 7 months from October 2014 to April 2015 covering 2 seasons. Study of water samples in natural water reservoirs in Thamthalu sub-district Bannangsata district, Yala province, which specifies 3 water sampling areas, 15 areas, namely (1) 5 upstream sources (2) 5 central water sources (3) 5 downstream sources.

Research Tools

1. Tools and equipment characteristics 1) ICP-OES (optical emission spectrometer) 2) Polyethylene bottles for collecting water samples 3) Filter paper 4) Beaker 5) Foam crate for ice (To control water temperature) 6). Chemicals (Nitric acid, HNO_3) (Lead standard solution, Pb $(NO_3)_2$ (Cadmium standard solution, Cd $(NO_3)_2$ (Arsenic standard solution, As $(NO_3)_2$.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Materials and Data Collection Survey of Land use Analysis

Study of land-use area of natural water source in Tham Thalu sub-district Bannang Sata district, Yala province, by studying the map and walking in the area.

Selection of Water Sampling Areas

Study of heavy metal contamination area of the natural water reservoir in Tham Thalu sub-district, Bannang Sata district, Yala province, water sample study area in Tham Thalu sub-district Bannang Sata district, and Yala province, specify 3 water sampling areas, 15 areas, including (1) 5 upstream areas (2) 5 central water areas (3) 5 downstream areas, with specific storage points (purposive sampling). The collection of water samples will be collected every month, once a month from October 2014 to April 2015, by collecting samples for analysis from the water sample study point, specifying the area with detailed sampling points as shown in the following. Study points of contamination of heavy metals in natural water sources foothills small irrigation location, Moo 5, Ban Tangkadeng, Tham Thalu sub-district, Bannang Sata district, Yala province, set up 5 water sampling points from the upstream source, central water source. Study points of contamination of heavy metals in natural water sources the area like the old Pinyao, Moo 5, Ban Tang Daeng, Tham Thalu sub-district Bannang Sata district, Yala province, set up 5 water sampling points from the central water point, which is about 500 meters away from the watershed. Study of heavy metal contamination in natural water sources small streams in the village in Tham Thalu Sub-district Bannangsata district, Yala province, set 5 water sampling points from the downstream area, which is about 1 kilometer away from the water source.

Water Sampling

Collecting water samples was taking into account the factors mixing of water sources (width), a width of water source, and depth of water source (depth) to allow the sample collection to be representative of the actual water source. As shown in the table, this was the determination of accurate water sampling points.

Table 1
CONSIDERATION OF WATER SAMPLING POINTS

Mixing of water	Number of storage points	Storage point
1. Mixed badly	6	W/4, W/2, 3W/4 At depth 0.2D and 0.8D
2. Mix well in a long line	3	W/4, W/2 and 3/4W At depth 0.6D
3. Mixed well in a horizontal direction	2	W/2 At depth 0.2D and 0.6D
4. Mix well in both directions.	1	W/2 At depth 0.6D

Source: Rangpan, (201)

Collecting water samples will either grab or grab one sample and maintain the sample water by chilling at 4 degrees Celsius to prevent water evaporation, and must be analyzed within 24 hours. Methods of collecting water samples, collecting water samples from natural water sources there is a sampling area of 15 points. 1) Collect samples in 1-liter polyethylene bottle 2) Foam crate for ice storage (To control the sample water temperature at 4 degrees Celsius) 3)

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Bring all the water samples by secondary method of 0.45 cm membrane packed in a polyethylene bottle with a capacity of 1 liter 4) Adjust the pH of the sample water to below 2 with concentrated nitric acid. To prevent heavy metal sedimentation and absorb heavy metals by container surface 5) Collect water samples at 4 degrees Celsius.

Group Conversation

The meeting for brainstorming with focus group discussion technique will discuss the whole group 2 times. 1st time before the examination of heavy metal contamination in that group discussion, to know the behavior of water consumption household consumption Including problems and obstacles in using water in natural water sources. 2nd time after the examination of heavy metal contamination. There were 2 participants in the group discussion, including 1 community leader using a random sampling method. Representatives of Thamthalu sub-district administrative organization, Yala province, using 2 randomly selected methods representatives of 2 family leaders using a purposive or deliberate random method and 1 staff member of Thamthalu sub-district health promoting hospital, 1 record holder and researcher this group discussion takes all time, total 8 group's participant. Before the second group discussion, the information from the analysis of heavy metal contamination is given to the group participants first, to find suggestions from the management guidelines for contamination of heavy metals.

DATA ANALYSIS

1. Heavy metal analysis: Analysis of heavy metal contamination consists of lead, cadmium, and arsenic. It is analyzed changes in heavy metal contamination and the relationship between heavy metals seasons and water sampling areas, as well as finding the index of heavy metal contamination of each point natural water area. Statistical relationship and analysis of the relationship between heavy metal contamination and land use in Tham Thalu sub-district, Bannangsata district Yala province using statistical analysis and descriptive analysis. Heavy metal analysis steps 1. Filter water samples with filter paper. 2. Prepare a standard solution of lead, cadmium, and arsenic. 3. Bring filtered water samples. To measure the concentration of heavy metals, lead, cadmium, and arsenic in all 3 types by machine ICP-OES (inductively coupled plasma – optical emission spectrometer) brand PerkinElmer Optima 2100.
2. Land use analysis methods: It is analyzed the land-use area of natural water sources in Tham Thalu Sub-district how did Bannang Sata district, Yala province affects the contamination of heavy metals. Study from pictures of community maps and exploring the area which classified the types of land use according to actual conditions into 3 types, namely category 1, forest land-use type, type 2 land use, agricultural type, and forest type, and types 3 land-use types, residential type, and agriculture.
3. Statistics used in the analysis: 1. Study of heavy metal contamination such as lead, cadmium, and arsenic by using the average statistics ($\bar{x}$) and standard deviation. 2. Study the differences and changes in seasons and contamination of heavy metals classified by the amount of rainfall using hypothesis testing, t-test.
4. Study of differences in contamination of heavy metals classified by water sampling area and land use using One-way ANOVA (F - test). 4. Study the relationship between indices of heavy metal contamination of each index using Pearson correlation Statistics.

RESULTS AND DISCUSSION

Results

Heavy metal was analyzed of each water sample point according to land use in each period, low rainfall, and moderate rainfall. Heavy metal was analyzed of each water sample point according to land use in each period, low rainfall, and moderate rainfall. And according to the rainfall period, which is low rainfall and moderate rainfall.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Table 2
MEAN AND STANDARD DEVIATION FOR HEAVY METALS CLASSIFIED BY WATER SAMPLE STUDY POINTS

Station	Mean and Standard Deviation for Heavy Metals					
	Lead (mg/L)		Cadmium(mg/L)		Arsenic (mg/L)	
	($\bar{x}$))	(S.D.)	($\bar{x}$))	(S.D.)	($\bar{x}$))	(S.D.)
Station 1 (WT1)	0.012	0.000	0.004	0.000	0.047	0.000
Station 2 (WT2)	0.012	0.000	0.004	0.000	0.047	0.000
Station 3 (WT3)	0.012	0.000	0.004	0.000	0.047	0.000
Station 4 (WT4)	0.012	0.000	0.004	0.000	0.047	0.000
Station 5 (WT5)	0.012	0.000	0.004	0.000	0.055	0.000
Station 6 (WT6)	0.013	0.000	0.004	0.000	0.055	0.000
Station 7 (WT7)	0.013	0.000	0.004	0.000	0.055	0.000
Station 8 (WT8)	0.013	0.000	0.004	0.000	0.055	0.000
Station 9 (WT9)	0.013	0.000	0.004	0.000	0.055	0.000
Station 10(WT10)	0.013	0.000	0.004	0.000	0.055	0.000
Station 11(WT11)	0.019	0.000	0.006	0.000	0.061	0.000
Station 12(WT12)	0.019	0.000	0.006	0.000	0.061	0.000
Station 13(WT13)	0.019	0.000	0.006	0.000	0.061	0.000
Station 14(WT14)	0.019	0.000	0.006	0.000	0.061	0.000
Station 15(WT15)	0.019	0.000	0.006	0.000	0.061	0.000
Total	0.015	0.003	0.004	0.001	0.054	0.006

Table 2, the results of the analysis of average values and standard deviations of heavy metals classified by water sample study points, found that lead points 1 through 5 have the least mean equal to 0.012mg/L, standard deviation equal to 0.000. The points 11 to 15 have the highest mean equal to 0.019 mg/L, the standard deviation is 0.000, the mean total of 15 points is 0.015, the standard deviation is 0.003, which does not exceed the standard of surface water quality standard type 2, according to the National Environment Board No. 8 (2537 B.E.) that has been specified should not exceed 0.05 mg/L. Cadmium at points 1 to 10 have the smallest mean of 0.004 mg/L, the standard deviation is 0.000 and it is found that points 11 to 15 have the highest mean of 0.006. 0.000 mean, including 15 points, equals 0.004 mg/L. The standard deviation is 0.001. Which is higher than the standard Surface water quality type 2, following the National Environment Board Announcement No. 8 (2537 B.E.), should not exceed 0.003mg/L. Arsenic points 1 through 5 have the smallest mean value of 0.047 mg/L. The standard deviation was 0.000 and it was found that points 11 to 15 have the highest mean of 0.061 mg/L. The standard deviation was 0.000. 15 points were equal to 0.054 mg/L. The standard deviation was 0.006. Which exceeds the quality standards of surface water type 2, according to the National Environment Board No. 8 (2537 B.E.) that has been defined should not exceed 0.01 mg/L.

Table 3
MEAN AND STANDARD DEVIATION FOR HEAVY METALS CLASSIFIED BY LANDAUS

Land use	Mean and Standard Deviation for Heavy Metals					
	Lead (mg/L)		Cadmium(mg/L)		Arsenic (mg/L)	
	(x)	(S.D.)	(x)	(S.D.)	(x)	(S.D.)
Forest	0.012	0.000	0.004	0.000	0.047	0.000
Agriculture and Forestry	0.013	0.000	0.004	0.000	0.055	0.000
Housing and agriculture	0.019	0.000	0.006	0.000	0.061	0.000
Total	0.015	0.003	0.004	0.001	0.054	0.006

Table 3 the results of the analysis of the average values and standard deviations of heavy metals classified by land use showed that lead in land use category 1, forestry had the smallest average value of 0.012 mg/L. The standard deviation was 0.000. Land-use type 3, for housing and agriculture, has the highest mean value of 0.019 mg/L. The standard deviation is 0.000. The

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

cadmium of land use type 1, forestry and type 2, agriculture and forestry, had the least mean of 0.004 mg/L. The standard deviation was 0.000Land use category 3, habitat and agriculture, have the highest mean value of 0.061mg/L. The standard deviation is 0.000 was found that arsenic use of land type 1 in the forest has an average value. The minimum is 0.047, the standard deviation was 0.000.
3. Agriculture and housing have the highest mean equal to 0.061mg/L, the standard deviation is 0.000.

Table 4
MEAN AND STANDARD DEVIATION FOR HEAVY METALS CLASSIFIED BY RAINFALL

Rainfall	Mean Value and Standard Deviation of Heavy Metal					
	Lead (mg/L)		Cadmium(mg/L)		Arsenic (mg/L)	
	($\bar{x}$)	S.D.	($\bar{x}$)	S.D.	($\bar{x}$)	S.D.
Little Rain	0.010	0.003	0.002	0.000	0.022	0.002
Moderate Rainwater	0.027	0.007	0.009	0.003	0.102	0.012

Classified table 4 by the interval according to the rainfall amount showed that the lead during the period of low rainfall has an average value, less than the average rainfall, with the average values of 0.027 mg/L and 0.010 mg/L respectively. And the standard deviation was 0.007 and 0.003 respectively It was found that the cadmium in the low rainfall period had an average value less than the average rainfall period, with the average values of 0.002 mg/L and 0.009 mg/L respectively, and the standard deviations of 0.001 and 0.000 respectively. The arsenic content in the period of low rainfall has an average value less than the average rainfall period, with the average values of 0.022 mg/L and 0.102 mg/L and the standard deviations of 0.002 and 0.012 respectively.

Table 5
MEAN AND STANDARD DEVIATION FOR HEAVY METALS CLASSIFIED BY RAINFALL AND LAND USE

Parameter		Average Values and Standard Deviations of Heavy Metals Classified by Rainfall and Land Use					
		Little Rainfall			Moderate Rainfall		
		The type 1	The type 2	The type 3	The type 1	The type 2	The type 3
Lead (mg/L)	$\bar{X}$ S.D.	0.008 0.001	0.008 0.000	0.013 0.000	0.020 0.002	0.020 0.002	0.037 0.003
Cadmium (mg/L)	$\bar{X}$ S.D.	0.002 0.000	0.003 0.000	0.004 0.000	0.007 0.000	0.007 0.000	0.013 0.001
Arsenic (mg/L)	$\bar{X}$ S.D.	0.020 0.000	0.021 0.000	0.022 0.000	0.086 0.001	0.106 0.001	0.112 0.000

Table 5 The results of the analysis of the average values and standard deviations of heavy metals classified by rainfall and land use showed that lead during low rainfall, land use type 1, forestry and land use type 2, agriculture the least mean was 0.008 mg/L, the standard deviation was 0.000. And land-use type 3, residential and agricultural use, have the highest mean value of 0.013 mg/L, the standard deviation of 0.000 During the period of moderate rainfall, land use type 1, forest type, and land use type 2, agriculture has the least average of 0.020 mg/L, the standard deviation was 0.002. Land-use type 3, for housing and agriculture, has the highest mean value of 0.037 mg/L, the standard deviation was 0.003. Cadmium during the period of low rainfall, land use type 1 for the forest has the least mean of 0.002, which is the standard deviation of 0.000, and land use type 3 for housing and agriculture has the highest average value of 0.004 parts, standard deviation equal to 0.000. During the period of moderate

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

rainfall, the land use type 1 for the forest has the smallest mean of 0.086, the standard deviation was 0.001. The land-use type 3 for housing and agriculture has the highest mean of 0.112. The Standard is equal to 0.000.

Arsenic, less rainfall, land use type 1, for example, forests have the least mean of 0.021 mg/L, the standard deviation is 0.000, and land use type 3 is the most average for housing and agriculture. 0.022 mg/L, standard deviation is 0.000. During the period of moderate rainfall, land use type 1, the forest average has the least mean was 0.047mg/L, the standard deviation is 0.000. Forest use of land has the highest mean value of 0.086 mg/L, the standard deviation is 0.001. Land-use type 3, for housing and agriculture, has the highest mean value of 0.112 mg/L. The standard deviation is 0.000.

This was Testing the Hypothesis of the difference between Heavy Metal and Low Rainfall and Land use

Comparison of heavy metal contamination between low rainfall and medium rainfall periods from the heavy metal comparison between low rainfall and medium rainfall period by using t-test statistics, the results are shown in Table 6.

Table 6
COMPARISON OF HEAVY METALS BETWEEN SMALL RAINFALL AND MEDIUM RAINFALL

Chemical parameters	Rainfall Range $(\bar{X})(\pm S.D.)$		t-test	Significance level
	Little Rain	Moderate Rain		
Lead	0.010±0.003	0.027±0.007	33.330**	0.000
Cadmium	0.002±0.000	0.009±0.003	33.618**	0.000
Arsenic	0.022/0.002	0.102±0.012	63.795**	0.000

* Differences were statistically significant at the level of 0.05
** Differences were statistically significant at the 0.01 level.

Table 6 the comparison of heavy metal contamination between low rainfall and moderate rainfall found that lead had a lower average rainfall than the medium rainfall during the test using the t-test. It was found that the amount of rainfall during the period caused the lead to be significantly different at the level of 0.01. The average cadmium in the rainfall period was less than the average rainfall during the t-test. The results showed that the rainfall interval resulted in significant differences in cadmium contamination, statistical significance at the level of 0.01. And found that the arsenic average in the period of rainfall was less than the average rainfall during the test using the t-test statistically; it was found that different rainfall ranges result in arsenic values that were significantly different in Statistics at level 0.01.

Comparison results of heavy metal contamination in each water sample collection point from the analysis of differences in lead content of each water sampling point using One Way ANOVA (F-test) statistics, the results of the analysis were as follows.

Table 7
RESULTS OF THE ANALYSIS OF VARIANCE OF LEAD CONTENT OF EACH WATER SAMPLE COLLECTION POINT

Source of variance	Independence degree (df)	Sum of squares (SS)	Mean squared (MS)	F-test	Significance level
Between groups Within the group	5 39	750.000 90.000	150.000 2.308	65.000	0.000
Total	44	840.000			

* Differences were statistically significant at the level of 0.05.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Table 7 Comparison results of heavy metal content contamination the lead parameter of each water sampling point when tested using the One-Way ANOVA (F - test) statistics, it was found that water sampling points are different. Resulting in the water in the natural water receiving area had a different lead with statistical significance at the level of 0.05 when testing the differences in pairs of lead values in each water sample collection point.

Table 8
COMPARISON OF PAIR VALUES BY SCHEFFE 'METHOD, HEAVY METAL CONTAMINATION, LEAD PARAMETERS OF EACH WATER SAMPLING POINT

Station	Lead differences between water sampling groups														
	WT 1	WT 2	WT 3	WT 4	WT 5	WT 6	WT 7	WT 8	WT 9	WT 10	WT 11	WT 12	WT 13	WT14	WT 15
WT 1	-	-0.001	0.001	0.001	-0.001	-0.003*	-0.001	-0.001	-0.002	-0.003*	0.009*	-0.009*	-0.010*	-0.011*	-0.011
WT 2	0.001	-	0.001	0.002	-0.001	-0.002	-0.001	0.000	-0.001	-0.002	-0.009*	-0.008	-0.011	-0.010*	-0.011*
WT 3	0.001	-0.001	-	0.000	-0.002	-0.004*	-0.002	-0.001	-0.003*	-0.004*	-0.010*	-0.009*	-0.012*	-0.011*	-0.012*
WT 4	0.001	-0.001	-0.001	-	-0.001*	-0.004*	-0.003*	-0.002	-0.003	-0.004*	-0.011*	-0.010*	-0.013*	-0.012*	-0.013*
WT 5	-0.001	-0.001	-0.002	-0.003*	-	-0.002	0.000	0.001	-0.001	-0.002	0.008*	-0.007*	-0.010*	-0.009*	-0.010*
WT 6	0.003*	0.003	0.004*	0.004*	0.002	-	0.002	0.002	0.001	0.000	-0.006*	-0.006*	-0.008*	-0.007*	-0.008*
WT 7	0.001	-0.001	-0.002	-0.003	0.000	-0.002	-	-0.001	-0.001	-0.002	0.008*	-0.007*	-0.010*	-0.009	-0.010
WT 8	0.001	0.000	0.001	0.002	-0.001	-0.002	-0.001	-	-0.001	-0.002	0.000*	-0.008*	-0.011*	-0.010*	-0.011*
WT 9	0.002	0.001	0.003*	0.001	-0.001	0.001	0.001	0.001	-	-0.001	0.007*	-0.007*	0.010*	0.008*	0.009*
WT 10	0.003*	0.002	0.004*	0.004*	0.002	0.000	0.002	0.002	0.001	-	-0.006*	-0.006*	-0.008*	-0.007*	-0.008*
WT 11	0.009*	0.009*	0.010*	0.011*	0.008*	0.006*	0.008*	0.009*	0.007*	0.006*	-	0.001	-0.002	-0.001	-0.002
WT 12	0.012*	0.011*	0.012*	0.013*	0.010*	0.008*	0.010*	0.011*	0.010*	0.008*	0.002	-	0.003*	0.001	0.000
WT 13	0.012*	0.011*	0.012*	0.013*	0.010	0.008	0.010*	0.011*	-0.010*	0.008*	0.002	-0.003*	-	0.001	0.000
WT 14	0.010*	0.010*	0.011*	0.012*	0.009*	0.007	0.009	0.010*	0.008*	0.007*	0.001	0.002	-0.001	-	-0.001
WT 15	0.011*	0.010*	0.011*	0.012*	0.010*	0.008*	0.010*	0.011	0.009	0.008*	0.002	0.003	0.000	0.001	-

Table 9
RESULTS OF ANALYSIS OF VARIANCE, CONTAMINATION OF HEAVY METALS, CADMIUM PARAMETERS OF EACH WATER SAMPLE COLLECTION POINT

Source of variance	Independence Degree (df)	Sum of Squares (SS)	Mean Squared (MS)	F-test	Significance level
Between groups Within the group	2 42	750.000 90.000	375.000 2.143	175.000	0.000
Total	44	840			
* Differences were statistically significant at the level of 0.05.					

Table 8,9 Cadmium content of each water sampling point, when tested using One Way ANOVA statistics, it was found that different water sampling points cause the water in the

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

natural water receiving area to have cadmium with statistical significance at the level of 0.05 when testing for differences in pairs by Scheffe 'as follows.

Table 10
COMPARE PAIRS BY SCHEFFE 'METHOD, HEAVY METAL CONTAMINATION, CADMIUM PARAMETERS OF EACH WATER SAMPLE

Station	Lead Differences Between Water Sampling Groups														
	WT1	WT2	WT3	WT4	WT5	WT6	WT7	WT8	WT9	WT10	WT11	WT12	WT13	WT14	WT15
WT 1	-	0.000	0.000	0.000*	0.000*	0.000*	-0.001*	-0.001*	-0.001*	-0.001*	-0.003*	-0.004*	0.004*	-0.004*	-0.004*
WT 2	0.000	-	0.000	0.000	0.000	0.000	0.000*	-0.001*	0.000*	0.000*	-0.003*	-0.004*	-0.004*	-0.004*	-0.004*
WT 3	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	-0.003*	-0.003*	-0.004*	-0.004*
WT 4	0.000*	0.000	0.000	-	0.000	0.000	0.000*	0.000	0.000	0.000	-0.003*	-0.003*	-0.004*	-0.004*	-0.004*
WT 5	0.000*	0.000	0.000	0.000	-	0.000	0.000	0.000*	0.000	0.000	-0.003*	-0.003*	-0.004*	-0.004*	-0.004*
WT 6	0.000*	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	-0.003*	-0.003*	-0.004*	-0.004*	-0.004*
WT 7	0.001*	0.000*	0.000*	0.000	0.000	0.000	-	0.000	0.000	0.000	-0.003*	-0.003*	-0.004*	-0.004*	-0.003*
WT 8	0.001*	0.001*	0.001*	0.000*	0.000*	0.000	0.000	-	0.000	0.000*	-0.003*	-0.003*	-0.004*	-0.004*	-0.003*
WT 9	0.001*	0.000*	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	-0.003*	-0.003*	-0.004*	-0.004*	-0.003*
WT 10	0.001*	0.000*	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.003*	-0.003*	-0.004*	-0.004*	-0.003*
WT 11	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	-	0.000*	-0.001*	-0.001*	-0.001*
WT 12	0.004*	0.004*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.003*	0.000*	-	-0.001*	-0.001*	0.000*
WT 13	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.001*	0.001*	-	0.000	0.000*
WT 14	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*	0.001*	0.001*	0.000	-	-0.000
WT 15	0.004*	0.004*	0.004*	0.001*	0.004*	0.004*	0.003*	0.003*	0.003*	0.003*	0.001*	0.000	0.000*	0.000	-

Table 11
ANALYSIS RESULTS OF VARIANCE, CONTAMINATION, HEAVY METAL CONTENT, AND ARSENIC PARAMETERS OF EACH WATER SAMPLING POINT

Source of variance	Independence Degree (df)	Sum of Squares (SS)	Mean Squared (MS)	F-test	Significance level
Between groups	2	750.000	375.000	174.000	0.000
Within the group	42	90.000	2.145		
Total	44	840.000			
* Differences were statistically significant at the level of 0.05.					

Table 11 Comparison results of heavy metal content contamination, arsenic parameters of each water sample collection point when tested using One Way ANOVA (F - test) statistics, natural water receiving areas have arsenic differences at the statistical significance level of 0.05.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

When testing the individual differences in arsenic values of each water sample collection point by Scheffe’ 'has the following information.

Table 12
COMPARES THE MEAN VALUES BY THE SCHEFFE’ 'METHOD OF HEAVY METAL CONTAMINATION, ARSENIC PARAMETERS OF EACH WATER SAMPLE POINT.

Station	Lead Differences Between Water Sampling Groups														
	WT1	WT2	WT3	WT4	WT5	WT6	WT7	WT8	WT9	WT10	WT11	WT12	WT13	WT14	WT15
WT 1	-	0.000	-0.001	-0.001	-0.001	-0.009*	-0.010*	-0.010*	-0.010*	-0.011*	-0.015*	-0.014*	0.015*	-0.015*	-0.015*
WT 2	0.000	-	0.000	0.000	-0.001	-0.009*	-0.010*	-0.010*	-0.010*	-0.011*	-0.014*	-0.014*	-0.014*	-0.014*	-0.015*
WT 3	0.001	0.000	-	0.000	0.000	0.008*	0.009*	0.009*	0.010*	0.010*	. 010*	. 014*	0.014*	0.014*	0.015*
WT 4	0.001	0.000	0.000	-	0.000	-0.008*	-0.009*	-0.009*	-0.009*	-0.010*	-0.014*	-0.013*	-0.014*	-0.014*	-0.015*
WT 5	0.001	0.001	0.000	0.000	-	-0.008*	-0.009*	-0.009*	-0.009*	-0.010*	-0.014*	-0.013*	-0.013*	-0.014*	-0.014*
WT 6	0.009*	0.009*	0.008*	0.008*	0.008*	-	-0.001	-0.001*	-0.001	-0.002*	-0.006*	-0.005*	-0.005*	-0.006*	-0.006*
WT 7	0.010*	0.010*	0.009*	0.009*	0.009*	0.001	-	0.000	0.000	-0.001	-0.005*	-0.004*	-0.005*	-0.005*	-0.005*
WT 8	0.010*	0.010*	0.009*	0.009*	0.009*	0.001	0.000	-	0.000	-0.001	-0.005*	-0.004*	-0.005*	-0.005*	-0.005*
WT 9	0.010*	0.010*	0.010*	0.009*	0.009*	0.001	0.000	0.000	-	-0.001	-0.004*	-0.004*	-0.004*	-0.005*	-0.005*
WT 10	0.011*	0.011*	0.010*	0.010*	0.010*	0.002*	0.001	0.001	0.001	-	-0.004*	-0.003*	-0.004*	-0.004*	-0.004*
WT 11	0.015*	0.014*	0.014*	0.014*	0.014*	0.006*	0.005*	0.005*	0.004*	0.004*	-	0.000	0.000	0.000	-0.001
WT 12	0.015*	0.014*	0.014*	0.013*	0.013*	0.005*	0.004*	0.004*	0.004*	0.003*	0.000	-	0.000	-0.001	-0.001
WT 13	0.015*	0.014	0.014	0.014*	0.013*	0.005*	0.005*	0.005*	0.004*	0.001*	0.000	0.000	-	0.000	-0.001
WT 14	0.015*	0.014*	0.014*	0.014*	0.014*	0.006*	0.005*	0.005*	0.005*	0.004*	0.000	0.001	0.000	-	-0.001
WT 15	0.015*	0.015*	0.015*	0.015*	0.014*	0.006*	0.005*	0.005*	0.004*	0.004*	0.001	0.001	0.001	0.001	-

This was Comparison results of heavy metal contamination of each land use. The analysis of the differences in the contamination of heavy metals in each land use by using the One-Way ANOVA (F-test) statistics, results are showed in the following table 13.

Table 13
RESULTS OF ANALYSIS OF VARIANCE, CONTAMINATION, HEAVY METAL CONTENT, LEAD PARAMETERS (PB) OF EACH LAND USE

Source of Variance	Independence Degree (df)	Sum of Squares (SS)	Mean Squared (ms)	F-test	Significance Level
Between groups	5	30.000	6.000	0.00	0.00
Within the group	39	0.000	0.000		
Total	44	00.000			
* Differences were statistically significant at the level of 0.05					

Table 13 Comparison results of heavy metal contamination, lead (Pb) parameters of each land use, when tested using One Way ANOVA (F-test) statistics, and found that different land use causes the water in the area Natural water receiving with lead significantly different at the

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

0.05 level. When testing the differences in lead values of each land use by Scheffe' 'method, data were obtained in table 13

Table 14
COMPARES PAIR VALUES BY THE SCHEFFE' 'METHOD OF HEAVY METAL CONTAMINATION, LEAD PARAMETERS (PB) OF EACH LAND USE

Category Land use	Paired differences of lead values between land use groups		
	Forest	**Agriculture And forests**	**Housing and agriculture**
1. Forest	-	-0.00029*	-0.00633*
2. Agriculture and Forestry	0.00029*	-	-0.00605*
3. Housing and agriculture	0.00633*	0.00605*	-

Considering the value of pairs differences of each land use by Scheffe's method at the significant level 0.05 can be summarized as follows.

Table 14 shows that forest land use areas are different in terms of Lead in land use in agriculture and forestry areas in residential and agricultural areas, where lead values in forest land use were lower than in land use in agriculture. And forestry, residential and agricultural areas, and land use areas, agriculture and forestry areas have differences in lead values and forest land use, residential and agricultural areas. In which the lead value in agricultural land use and forest land use is higher than forest land-use area and lower than land use in residential and agricultural land use and land use land type in which housing and agriculture have differences in lead value and land use in agriculture and forestry. The type of farming and forestry lead by the local land-use residential and agricultural areas above the forest and land use, agriculture, and forestry sector.

Table 15
RESULTS OF ANALYSIS OF VARIANCE, CONTAMINATION, HEAVY METALS, CADMIUM (CD) PARAMETERS OF EACH LAND USE

Source of variance	Independence degree (df)	Sum of squares (SS)	Mean squared (ms)	F-test	Significance level
Between groups Within the group	2 42	30.000 0.000	15.000 0.000	0.000	0.000
Total	44	30.000			
* Differences were statistically significant at the level of 0.05					

Table 15 comparison results of heavy metal content contamination, cadmium (cd) parameters of each land use, when tested using One Way ANOVA (F-test) statistics, it was found that different land use causes the water in the natural water receiving ground floor had a significant difference in cadmium values at the 0.05 level when testing the differences in cadmium values of each land use by the Scheffe' method had the information as in table 15.

Table 16
COMPARISONS OF PAIR VALUES BY SCHEFFE' METHOD OF HEAVY METAL CONTAMINATION, CADMIUM (CD) PARAMETERS OF EACH LAND USE

Types of Land Use	The Dual Differences in Cadmium Values Between Land Use Groups		
	Forest	**Agriculture and Forestry**	**Housing and Agriculture**
1. Forest	-	-0.00029*	-0.00200*
2. Agriculture and Forestry	0.00029*	-	-0.00171*
3. Housing and agriculture	0.00200*	0.00171*	-

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Table 16 considering the differences in pairs by the cadmium values of each land use by the Scheffe' method at the significant level of 0.05, it was found that the forest land use areas have differences in the cadmium values and agricultural land use. And forestry and land-use and agricultural utilization areas, in which the cadmium values in forest land use areas, were lower than land use in agriculture and forestry areas. Land use areas for housing and agriculture land use areas for agriculture and forestry differ in cadmium values with forest land use and land use for housing and agriculture had cadmium in land use areas that are agriculture and forestry higher than forest land use areas and lower than land use land for housing and agriculture. The land use areas for housing and agriculture were different in cadmium values with forest land use and land use in agriculture and forestry. The cadmium value in the land and residential land use areas was higher than the forest land-use area and the land and agriculture and forest land use areas.

Table 17
RESULTS OF ANALYSIS OF VARIANCES, CONTAMINATION, HEAVY METAL CONTENT, AND ARSENIC PARAMETERS OF EACH LAND USE

Source of variance	Independence Degree (df)	Sum of Squares (SS)	Mean Squared (MS)	F-test	Significance level
Between groups	2	30.000	15.000	0.00	0.00
Within the group	42	0.000	0.000		
Total	44	30.000			

* Differences were statistically significant at the level of 0.05.

Table 17 Comparative results of arsenic contamination of each land use when tested using One Way ANOVA (F-test) statistics, it was found that different land use results in water in natural groundwater receiving areas. The arsenic differences were statistically significant at the 0.05 level when tested for differences in pairs by Scheffe' did as follows.

Table 18
COMPARISON OF PAIR VALUES BY SCHEFFE' METHOD OF HEAVY METAL CONTAMINATION, ARSENIC PARAMETERS OF EACH LAND USE

Types of Land Use	The Dual Differences in Arsenic Values Between Land Use Groups		
	Forest	Agriculture and Forestry	Housing and Agriculture
1. Forest	-	-0.00800*	-0.01371*
2. Agriculture and Forestry	0.00800*	-	-0.00571*
3. Housing and Agriculture	0.01371*	0.00571*	-

Considering the differences in arsenic pairs for each land use by the Scheffe' method at the significant level of 0.05, it was found that the forest land use areas are different in terms of Arsenic values for land use in agriculture and forestry, and land use in residential and agricultural areas. Where the arsenic values in forest land use areas were lower than land use in agriculture and forestry areas and land use in residential and agricultural land use areas. This was the difference in arsenic values and forest land use and land use areas in the country karma. Where the arsenic values in agricultural land use and forest land use areas are higher than forest land use areas and lower than land use areas for residential and agricultural land use areas, land use addresses type. Housing and agriculture were different in arsenic values and forest land use areas and land use areas that were Jilin agricultural and forestry sector. The arsenic values in

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

residential and agricultural land use areas were higher than forest land use areas and agricultural land use and forest land use areas.

Hypothesis Testing, Relation of Heavy Metal Contamination in Each Index

The result that was analyzed of the relationship of heavy metal content contamination between lead, cadmium, and arsenic by using Pearson Correlation statistics, results obtained in Table 18.

Table 19
TEST RESULTS OF THE RELATIONSHIP BETWEEN LEAD, CADMIUM, AND ARSENIC

Parameter	Lead	Cadmium	Arsenic	Average	Standard Deviation
Lead	-	0.995**	0.836**	0.015	0.003
Cadmium	0.995**	-	0.884**	0.004	0.001
Arsenic	0.836**	0.884**	-	0.054	0.006

** correlated with statistical significance at the level of 0.01.
* Correlated with statistical significance at the level of 0.05.

Table 19 this was test results of the relationship between lead, cadmium, and arsenic using Pearson Correlation statistics. And cadmium with statistical significance at the level of 0.01 in the same direction at the high level (r=0.995) and concerning arsenic with the statistical significance of 0.01 in the same direction at the high level (r=0.836), it was found that the cadmium correlated with lead with the statistical significance at the level of 0.01 in the same direction at the high level (r=0.995) and with the arsenic significance at the level of 0.01 in the same direction at High level (r=0.884). Arsenic was related to lead-like statistical significance at the level of 0.01 in the same direction at a high level (r=0.836) and there was a relationship with cadmium with statistical significance at the level of 0.01 in the same direction at a high level (r=0.884).

This was analysis and transformation from group discussion on water consumption behavior in household consumption, problems and obstacles in water usage, and recommendations for prevention and solution of heavy metal contamination. The researcher conducted this group discussion for a total of 1 hour; the results of the analysis were as follows. This was water consumption behavior in households, most of the households in Tham Thalu community; Bannangsata district Yala province uses natural water sources for consumption such as for agriculture, washing, washing dishes, etc for the majority of consumers, they buy filtered water in factories in and out of the area as follows. Phuangphet[7] the leader of Thamtalu sub-district community said water consumption behavior in our village will find that almost every home uses water in its natural source for consumption community. Patcharee[5] the leader of Tham Talu sub-district Administrative Organization, said, the water consumption behavior of the people in our sub-district will buy drinking water from the factories in the area and outside the already filtered area. Hassani (Hassani, 2015) a representative of the family leader in Thamtalu sub-district, said that every house that uses water in its natural water source will most likely be used for Washing, washing dishes, while the consumption was bought for consumption, there were still some homes, but very few, use the method before drinking because they are not sure about the contamination of water sources.

Problems and obstacles in using water in natural water sources contamination of heavy metals in natural water sources because the area used to be like an old mineral before, lacking knowledge and understanding of heavy metal contamination resulting in unable to fully utilize the available water resources during the rainy season without any shelter, not soil erosion and continuous lack of cooperation in information and water. Wanna (2014**)** a representative of

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Tham Talu sub-district community leader, said: it was a common problem, not sure how much heavy metals are contaminated in natural water sources. Makes us unable to fully utilize the available water resources and we lack continuous cooperation in looking after the water resources. Kesorn (Kesorn, 2014) a representative of the family leader in Tham Talu sub-district, said: " Another problem that we encounter was that during the rainy season the water sources are natural, there is no shelter from washing collapse resulting in the above problems.

The second group discussion analysis on suggestions for prevention and solution of heavy metal contamination in the area of natural water sources after the detection of heavy metal contamination used focus group discussion technique. This group consists of 8 participants, consisting of 3 community leaders, 2 representatives from Tham Talu Sub-district Administrative Organization, Yala province, and 2 representatives. The kitchen was one of the hospital staff promotes health through caves district 1 note 1 person.

The test results of the different metal hypothesis testing with rainfall and land use periods the comparison of heavy metals classified by rainfall was found that lead had lower average values during rainfall than medium rainfall. When tested using t-test statistics, it was found that the amount of rainfall caused the lead in the natural water source to have different values while the cadmium contained during the period of low rainfall, lower than the period of moderate rainfall. This was tested by t-test; it was found that the rainfall period resulted in the different values of cadmium in the natural water source, while the arsenic in the period of low rainfall was lower than the period of moderate rainfall. When tested using t-test statistics, it was found that the amount of rainfall caused the arsenic in natural water sources to have different values with statistical significance at the level of 0.01. That was consistent with Rangpan, et al., (2017) studied the contamination of mercury, lead, and cadmium in water, the soil around the Pattani River and found that in the rainy season higher than the dry season and with different values statistically significant. Comparison results of heavy metal contamination for each water sampling point, the highest lead at 11 to 15 had an average value of 0.019 mg/L, the lowest at 1 to 5, with an average of 0.012 mg/L. The highest cadmium at 11 to 15 had a low 0.006 mg/L average. The highest at 1 to 5, with an average of 0.004 mg/L, the highest arsenic at 11 to 15, with an average of 0.061 mg/L, the lowest of 1 to 5 with an average of 0.047 mg/L. The test using the One-Way ANOVA (F - test) statistic showed that all 3 parameters of the water sampling point resulted in different heavy metals at the water sampling point with statistical significance at the level of 0.05. Consistent with the research of Tassanawalai (2010) studied environmental qualities, including soil quality water quality suitable for firefly conservation in orchard areas such as the water in Khlong Tha Kha, Khlong Bang Khae, and Khlong Kwai Om, found that the amount of cadmium in water was in the range from undetected to 0.094 mg/L. The amount of lead in water was in the range of 0.0031 to 0.06. It was found that the content of both heavy metals does not exceed 0.005 mg/L and cadmium not more than 0.05 mg/L. The results showed that the canal that flowed through the garden area had the highest cadmium content. Due to the use of plant protection and elimination substances, the water contamination was higher than in other areas. Heavy metal comparison results of each land use, it was found that lead was the highest in type 3 land use, housing, and agriculture, has an average of 0.019 mg/L, the lowest in land use category 1, forestry has an average of 0.012 mg/L, the highest cadmium in land use type 3, residential and agricultural averages of 0.006 mg./L, it was the lowest in the land use category 1, the forest has an average of 0.004 mg/L, the highest arsenic in the land use type 3, for housing and agriculture, with an average of 0.061 mg/L, the lowest in land use category 1, the forest has an average of 0.047 mg/L. When tested using One Way ANOVA (F - test) statistics, all 3 parameters, lead, cadmium, and arsenic make heavy metals have fees vary according to land use, with statistical significance at the level of 0.05. Following the research of Rangpan (2015B) mining causes changes in the chemical form of heavy metals, and the release of heavy metals into the water source causes many environmental changes, such as the change in pH, and the addition of organic substances found that the increase of organic matter and heavy metals from the old mining, causing heavy metals at the downstream to rise.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Corresponding to Rangpan (2015) states that different land-use conditions will have different concentrations of heavy metals in water and sediment in the condition that the forest area had the lowest concentration. Highly was concentrated in areas with human settlement and agricultural areas, consistent with the research of Vinita (1995) which studied the contamination of mercury, lead, and cadmium in water and sediment. Heavy metal analysis in general chemical composition studies found to be prone to the downstream point of the canal which most heavy metals will increase because the water flow rate in the downstream area of the canal decreased and high amounts of organic matter in sediment streams and consistent with the research of Rangpan (2015C) said agricultural areas were more likely to be contaminated with heavy metals than non-agricultural areas.

Testing the relationship hypothesis of each heavy metal the results of the testing of heavy metal relationships between lead, cadmium, and lead by Pearson Correlation statistics showed that lead was significantly correlated with cadmium at 0.01 level in the same direction at a high level (r=0.995) and with correlated with arsenic with statistical significance at the level of 0.01 in the same direction at the high level (r=0.836). Cadmium was associated with lead with the statistical significance at the level of 0.01 in the same direction at the high level (r=0.995) and with the statistical significance of 0.01 in the same direction at the high level (r=0.884). Arsenic was associated with lead with the statistical significance at the level of 0.01 in the same direction at the high level (r=0.836) and with the correlation with the statistical significance of 0.01 in the same direction at the high level (r=0.884) consistent with the research of Chalermpol (Chalermpol, 2005). Studying the collection and the distribution of heavy metals in water, sediment, found that the relationship between the heavy metal content in water lead has the same direction cadmium copper and iron.

CONCLUSIONS

In this study, the water samples from 15 different areas were monthly collected from October 2013 – April 2014 by the one-sample method. In one procedure, the entire samples would be analyzed to find the contamination such as lead, cadmium, and arsenic. Mean, standard deviation, t-test, F – test, and Pearson Correlation were employed in the study. The results were as follows: 1) Sources of heavy metal contamination is an upstream area which is a forest area; midstream which is an agricultural and forest area; downstream which is a residential and agricultural area. 2) Heavy metal consists of lead, cadmium, and arsenic. The average results are 0.015 mg/L, 0.004 mg/L, and 0.054 mg/L respectively. 3) Contamination of heavy metal in each source is different. 4) There are relationships between lead, cadmium, and arsenic ($p<0.01$). Moreover, there is no concrete and continuous restoration. In the rainy season, the soil is eroded and the usage of the chemicals of the residential and agricultural area is increased which is the cause of heavy metal contamination. Problems include people's lack of awareness and participation in taking care of water sources. Guidelines of water source management shed light on providing knowledge to the community with normal and correct methods and setting up the water source restoration group.

ACKNOWLEDGMENTS

This research has been done well. The researcher must thank all the research participants, as well as those involved in the area that made this work a success, especially the Yala Rajabhat University which has supported this research well. However, Associate Professor Dr. Vichit Rangpan, he is corresponding, his e-mail; vichit39@gmail.com.

REFERENCES

Chalermpol, S. (2005). Deposition and dispersion of heavy metals in sediment surfaces. And gourami in the fish pond Bangkok: Mahidol University.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.

Hassani, B. (2015). Representative of the pattani watershed, Public Sector Network Association, Interview May 10, 2014. *Implementation and Education of Mathematics and Science (ICRIEMS 2015)*, Indonesia. 2015,522-528.

Issariyaporn, D. (2008). *Research report on the residual effects of heavy metals in soil*. And plants in the area like abandoned ore. Yale: Yale Rajabhat university, 2008.

Kesorn, S. (2014). *Interview with representative of the public sector network association*. Pattani Watershed.

Patcharee, R. (2014). *Representative of the public sector network association*. Pattani Basin, Interview May 10, 2014, 2014.

Phet, P. (2014). *Representative of the public sector network association*. Pattani Basin, Interview May 10, 2014.

Phuangphet, P. (2014). *Interview with representative of Tham Talu community leaders Banangsta district*. Yala province.

Rangpan, V. (2008). Effects of water quality on periphyton in the Pattani River, Yala Municipality, Thailand. University Science Malaysia, Penang Malaysia, 2008.

Rangpan, V. (2015). Development of water utilization and approach of water quality Sustainable management in Pattani Watershed South Thailand. In Proceedings of the 2nd International Conference on Research, 2015.

Rangpan, V. (2015). Conservation of environment and natural resources on Pattani watershed South Thailand. *In proceedings of the international conference on biodiversity and conservation (ICBC 2015), Malaysia, 2015*, 136-150.

Rangpan, V. (2015). Co-relation of conservation and biodiversity utilization and people life style in Pattani Watershed, South Thailand. *In Proceedings of the 2nd International Conference on Research Implementation and Education of Mathematics and Science (ICRIEMS 2015), Indonesia*, 2015, 530-540.

Rangpan, V., Matchimapiro, D., Treepaiboon, N., Thongmak, N., & Nujan, D. (2017). The local scientific lesson for Conservation and Utilizing Biological Diversity in the Pattani Watershed. *Journal of Rangsit University: Teaching & Learning*, *11*(2), 123-132.

Tassanawalai, U. (2010). Research report on environmental management of orchards for firefly conservatio*n*. Samut songkhram: Suan Sunandha Rajabhat University, 2010.

Vinita, A. (1995). Study of mercury, lead and cadmium and sediment contamination in U-Tapao. Songkhla: Prince of Songkhla University, Nakarin Songkhla, 1995.

Wanna, S.L. (2014). Representative of the public sector network people association, Pattani Watershed, Interview May 10, 2014.

Received: 29-Nov-2021, Manuscript No. JMIDS-21-10264; **Editor assigned**: 02- Dec -2021, PreQC No. JMIDS-21-10264 (PQ); **Reviewed**: 13- Dec -2021, QC No. JMIDS-21-10264; **Revised**: 18-Dec-2021, Manuscript No. JMIDS-21-10264 (R); **Published**: 06-Jan-2022.

Citation Information: Rangpan, V., & Lohyapa, N. (2022). Heavy metal contamination in natural water source area in Thamthalu sub-district, Bannangsata district, Pattani watershed, South Thailand. *Journal of Management Information and Decision Sciences, 25*(S2), 1-16.