Knowledge and Understanding of Hazardous Waste by Community Participation of Khoksa-ad sub-district Administrative Organization, Khongchai district, Kalasin Province

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ABSTRACT

The aims of this study were: (1) to examine the amount of heavy metals i.e. lead, mercury, copper, cadmium, manganese contaminated in soil in the area of junk shops in 12 villages of Khoksa-ad sub-district, Khongchai district, Kalasin province, and to assess the quality of groundwater and soil surface water, and measure pH and conductivity of soil and water samples. (2) to investigate hazardous waste disposal in the area of Khoksa-ad sub-district, Khongchai district, Kalasin province. The data were collected and employed the distribution of 329 copies of questionnaire the respondents.

The findings revealed that (1) the average amount of heavy substances i.e. lead and cadmium indicated the undetectable value in water quality. (2) majority of the respondents accounting for 223 people or 67.8% knew hazardous waste, 213 people or 64.7% realized the effect of hazardous waste, 246 people or 74.8% did not attend training on hazardous waste. The participation in hazardous waste management was at moderate level ($\bar{x}$ = 3.29). The people expressed their suggestions on that that sub-district administrative organization should provide waste bin and collecting truck in the area. They also would like the authority to handle hazardous wastes separation and disposal appropriately.

Keywords: Knowledge and understanding, Hazardous waste, Community participation, Khongchai district

1. INTRODUCTION

Electronic waste or E-waste refers to waste from electrical and electronic equipments (WEEE) such as unwanted, obsolete, or expired electronics appliances. Electronic waste is classified as hazardous waste due to the fact that the parts of electronic device contain heavy metals. If these parts are disposed inappropriately and leaked into the environment, it will harm people's health in the area and its ecosystems in both short and long terms. This is because toxic chemicals contamination exists in the ecosystems for a long time and accumulates in the organism. Therefore, the electronic waste management is crucial in that it must be technically and systematically handled [1]. The pollution control department reported that, in 2013, the number of used mobile phones were at 9.14 million units. This had reached to 9.75 million units in 2014, and up to 10 million in 2015. The number of personal computers (PCs), in 2013,

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were only at 1.99 units. This was increased to 2.21 million in 2014, and 2.42 million units in 2015. Also, The average life-span of mobile phone is 3 years. The Cathode Ray Tubes-TV is 6.9 years, and flat screen TV is 3.8 years, while computer is 3.65 years [2].

At present, the number of electronic waste recycling plants in Thailand with proper process of sorting and grinding electronic components are limited and insufficient to the fast growing quantity of electrical and electronic products remains. In addition, smuggling of electronic remains from foreign countries into Thailand has been increasingly detected. These e-wastes are transported to the villages for the villagers to separate, disassemble, and sell metal components while the remnants of electronic wastes are destroyed by burning or landfill. This improper burning and destruction of electronic waste inevitably causes harmful problems to environment, community, health and safety of people in this career. The department of disease control, ministry of public health reported the risks of heavy metal No.13 accumulated in the body of many villagers. The heavy metal contamination in the community waters was also detected. In addition, the local administrative organization reported that the results of random blood test of villagers who dealt with waste separation work showed the contamination of lead in their blood nearly everyone. Some were exceeding the standard value especially in children aged 1-5 years. Therefore, this problem of inappropriate electronic waste management is a crucial issue that should not be overlooked for the community waste management in Thailand [1].

E-waste management is currently lacking comprehensive management systems covering collection, separation or disassembly, transportation, recycling and disposal, and reclamation of products from manufacturers and suppliers was merely observed in Thailand. These e-wastes, therefore, become huge burden for local administrative organizations that have no standard disposal facilities and proper management systems. The electronic waste is normally disposed together with common waste, and sold to Sa Leng vendors or junk shops. There is also the smuggling of electronic waste or electrical appliances and inoperable second-hand electronic products from overseas into Thailand. They are improperly handled or recycled by sending these e-wastes to the villages for waste separation in the community. The villagers then disassembled the parts for metal pieces to be sold. The remaining parts will be destroyed by burning or improper landfill in illegal places. Some types of products, such as light bulbs and batteries, do not have a recycling market, or they come with the fee for recycling. So, nearly all of these product remains were dumped with regular waste making it the risk that dangerous substances and heavy metals in the product remains will leak and contaminate the environment. The ecosystem and food chain are contaminated and causing problems to environment, community and health. For example, burning wires to get lead and copper for sell causes some plastic and metal vapors which is one of the causes of cancer [3]. Burning the circuit board to melt lead and copper causes the toxic vapors to spread into the air, accumulate in soil and water. The use of acid in metal extraction from circuit boards without proper wastewater treatment leads to contamination of sewage into the soil and water. Dismantling/disassembly refrigeration and air conditioning without refrigerant retrieval device leaks refrigerant into the atmosphere and destroys the ozone layer [4]. Therefore, contamination of electronic waste is starting from e-waste producers to e-waste recipients. And finally, this risks the health and well-being of people and environment.

The e-waste separation in the community plays crucial roles in e-waste disposal. The researchers, therefore, pay interests in knowledge and understanding of hazardous waste disposal by using the participation of communities under jurisdiction of Khoksa-ad sub-district local administrative organization. The research site covers villages in Khoksa-ad sub-district, Khongchai district, Kalasin province.

1.2 Rerearch site

The environmental problems resolution committee of Khoksa-ad sub-district administrative organization stated that Khoksa-ad sub-district was formerly a part of Nong Paen sub-district under administration of Kamalasai district. It was separated from Nong Paen sub-districtsince 1958 to the present. Khoksa-ad under administration of Khong Chai district, Kalasin province and the administration covers totally 12 villages.

The Khoksa-ad sub-district administrative organization was established on February 3, 1997 under the tambon council and sub district administrative organization act B.E. 2537 (1994). The administration area covers 35 square kilometers or about 21,893 rai. The total population was 7,561 people in 1,543 households. The average income is 90,000 baht/household/year. Khoksa-ad Sub-district context is rural society. Therefore, the people's main occupation is agriculture that accounts for 95% while the rest is trading and businesses. Most of the area is fertile plain with many irrigation canal systems flowing through making the area perfect for rice farming and crops cultivation in dry season. There are abundant sources of water for making a living. After cultivation season, the villagers normally cultivate other farming activities or other career choices for extra income throughout the year, that is, the popular junk trade. This is due to the trends of world economy and capitalist economy have dominated and penetrated into every sector worldwide whether it be industrial capital, modern technology, civilization, and values from abroad. These evolutions affect tremendous changes on economic and social conditions on the increase of value such as land, properties, animals, animals, economy, agricultural products, and career choices. The transportation has become more convenient where the asphalt road began to link villages and sub-district center in 1997 and the Songthaew bus runs from villages to the city in 2003. Also, the electricity, water, concrete roads in every village in 2003.This development is the results of decentralization under local administration act B.E. 2537 (1994) when local administrators are directly elected as representatives in the administration of local organization.

Khoksa-ad sub-district is located in the west of Khong Chai district and covers the area of 35 sq. km. The geographical settings is rich and fertile plain located in Lam Pao irrigation area and the water pumping with electricity from the Chi River project. The North is adjacent to Non Sila sub-district, Khong Chai Pattana sub-district in the south, Nong Paen and Khong Chai Pattana in the east, Kantharawichai district, Mahasarakham province in the West.

1.3 Difficulties for waste entrepreneur the area

The environmental problems resolution committee of sub-district administrative office stated that the junk trading of villagers in Khoksa-ad sub-district started 13 years ago with only a few traders. The operation of the pioneering group was successfully and able to generate a lot of income.

Figure 1 Khoksa-ad sub-district, Khongchai district, Kalasin province

This has become the successful model that villagers in Khoksa-ad sub-district could perceive and decided to engage in the junk trade. Then, the junk trade business in Khoksa-ad sub-district was expanded and the number of junk traders were also increased as well as the amount of junk items with diverse kinds of junk. Also, the area of junk trading was expanded from the local area to nationwide. The survey in April-May 2008 indicated that there were 228 villagers engaged in junk trading. Junk items were also brought into the area around 767 tons each month. The list of junk goods brought into the community included old cars, motorcycles, refrigerators, televisions, fans, audio players, electrical cords and parts, etc. at the volume of 274 tons per month. Also, other junk materials brought into the community were steel, copper and aluminium at the volume of 492 tons per month. After villagers bought these junk goods, they will disassemble junk into pieces and sell out the pieces separately. However, there were items unable to sell totally around 20 tons per month.Junk trade in Khoksa-ad sub-district caused the following problems.

1.3.1 Environment; The operation of junk trade which involved activities such as collection and disassembling of junk items at residential area usually caused environmental problems as follows.

1.3.1.1 Contamination of toxins in soil and water because, after disassembling, the old junk items will be poured into the soil. For example, disassembling the engine will leak a lot of engine oil flowing into the area. These oils can penetrate into the soil and the groundwater. Or, in case of dissecting the car battery will be pouring acidic soil. The acid can be spread in the soil and into the groundwater as well. Dumping the waste all over the area causes toxins to contaminate soil and water. For example, trashing television glass screen leaves mercury spread to soil and water. In addition, contamination in soil and water can also occur from burning materials. The toxins in the debris are mixed in the remaining ash and accumulated in the soil.

1.3.1.2 Contamination of pollutants in the air. Villagers in the old days used to burn junk items to separate valuable materials such as burning copper wire, burning plastic parts to remove the nuts and bolts, burning tires to remove the wire, etc. Burning these old parts resulted in smoke and toxic odors that can spread far and wide as the blowing wind. Toxins evolved by burning old outdoor scraps may include sulfur dioxide, carbon monoxide, nitrogen oxide, volatile organic compounds, heavy metals and dioxins which is the most serious carcinogen. Dioxins are produced by burning plastic materials at low temperature. Contamination in the air abstains the villagers from drinking rainwater from the roof.

Figure 2 Junk yard entrepreneurs in Khoksa-ad sub-district

1.3.2 Health; Junk shop owners and neighbors are in risks in taking dangerous substances into their body. The junk shop owners have to separate valuable materials from the toxic junk items by using unsafe methods so they are in high risks of taking toxic substances into their body by breathing toxic dust, fumes or vapors of toxins, or skin contact, or ingesting without knowing. Separation of junk materials using bare hands, and later consume food without washing the hands. Toxic exposure like this may cause immediate illness such as rash, burning eyes and nose and may accumulate and appear later. The neighbors who live nearby junk shop areas that contain harmful substances may be affected by the toxins. However, the chances of getting toxins are less than those who deal with disassembling the junk items. For example, burning of waste dumping area of the sub-district administrative organization causes huge troubles of smoke and smell spread to the people in Nong Tok Paen sub-district located in the south of the wind direction. This situation leads to filing the complaints about this problem with Khoksa-ad sub-district administrative organization several times which damage good relationship between the two villagers.

Outpatient reports by symptoms group (21 Disease groups) of Khok Prasit Village (Moo 12) and Nong Bua Village (Moo 3) under Khoksa-ad sub-district, Khong Chai district, Kalasin province indicated that the group of diseases that are expected to be caused by junk items separation activities of the villagers is respiratory disease (Group 10) and skin and subcutaneous diseases (Group 12). From 2004 to 2007, it was found that respiratory disease, in 2004, the highest number of patients in Khok Prasit village was 1,310 and, from 2005 to 2007, the number of patients decreased from 2004 to 1,252; 1,001; and 1,253 respectively while the number of patients in Nong Bua village was uncertain as the number was increase and decrease alternating each year. The year with the highest number of patients was 1,272 in 2005. The lowest number of patients was 721 in 2006 for skin and subcutaneous tissue. Nevertheless,

Khok Prasit villagers were more likely to suffer from skin and subcutaneous diseases. The highest number of patients was 210 cases in 2007 and the lowest number of patients was 103 in 2005 while the number of patients suffering from skin and subcutaneous diseases in Nong Bua village was uncertain as the number was up and down alternately. The highest number of patients was 153 in 2007 and the lowest was 77 in 2006.

Figure 3 Waste Dumping Area of Khoksa-ad Sub-district Administrative Organization

2. METHODOLOGY

The researcher employed the area-based study and community way of life in the village. The study was divided into two parts: environmental research and social research. The environmental research focused on contamination of heavy metals in soil and water. The soil and water samples collected were analyzed for heavy metals concentration and the soil and water quality standards according to announcement of national environment committee No. 25 (2004) and No. 8 (1994) [5-6] for suitability of soil and water in the community. The social research aimed at exploring community way of life regarding management of hazardous waste, and started with area survey, questionnaire distribution, survey on economic, social and environmental background of the community to collect data of all households that purchased and disposed junk items and hazardous waste. The qualitative data was collected by interview, and the data was analyzed for the overview situation of the community and problems. The results of social and environmental surveys were presented to the community by organizing discussion forum for the community to seek solutions to fix the problems.

This study aimed to investigate the contamination of heavy metals from the junk trading and the use of junk items in daily life of people in Khoksa-ad sub-district, Khong Chai district, Kalasin province, and to examine hazardous waste management in Khoksa-ad sub-district, Kalaya district, Kalasin province. A total of 12 villages were involved in the study for collecting soil samples in waste landfill and surrounding areas in the villages covering 17 spots involving junk trading activities. The soil samples were tested for pH, conductivity, and contamination of 5 heavy metals types including lead, mercury, copper, cadmium and manganese.

The groundwater, surface water, shallow water samples were collected in each village and these water samples were also collected at the spot near the area of waste dumping altogether 13 spots. The water samples were analyzed for pH,

conductivity, and contamination of 5 heavy metals including lead, mercury, copper, cadmium and manganese.

This study drew the participation in hazardous waste management in Khoksa-ad Sub-district, Khong Chai District, Kalasin Province that included the total population of 1,829 households. The sample size was determined using Taro Yamane formula (1967) [7].

The research instrument was questionnaire which was sectioned into 2 parts. Part 1 identified general information of the respondents covering 7 checklist questions about gender, age, education, occupation, income, domicile, length of stay in community; and 5 questions about the junk trade career, income from the sale of junk, knowledge about hazardous waste, impact, and training on hazardous waste. Part 2 identified the participation in hazardous waste management. This part was a rating scale format that is, 4.51-5.00, means the highest level, 3.51-4.50 means the high level, 2.51-3.50 means the moderate level, 1.51-2.50 means the low level, and 1.00-1.50 means the lowest level.

The collected data was analyzed, recorded, categorized into a coding form, and then statistically analyzed using a computer program.

3. CONCLUSIONS AND DISCUSSION

3.1 Soil quality; The waste disposal areas and areas involved junk trading activities in the villages of Khoksa-ad sub-district, Khong Chai district, Kalasin province were examined. The average examination results showed pH value at 7.42, conductivity (EC) at 138.90 µS/cm, lead (Pb) at 87.14 mg/kg, mercury (Hg) at 0.10 mg/kg, copper (Cu) at 160.82 mg/kg, cadmium (Cd) at 1.67 mg/kg, and manganese (Mn) at 232.28 mg/kg as shown in Table 1.

The 4 types of heavy metals including lead, mercury, copper, cadmium and manganese do not exceed the quality standards for agricultural and residential use. It does not exceed the soil quality standards used for any purpose other than housing and agriculture. According to Kewalee Natomtong [8] in her study on hazardous waste management with the participation of junk traders in Kalasin, it was found that, after the training on knowledge about hazardous waste management, junk dealers improved and developed the areas used in waste separation and disassembly for ease of storage and transportation for sale. In addition, junk entrepreneurs were more aware of safety in their business operation. This study showed that proper waste management practice tended to decrease in the chance of heavy metal contamination over time.

3.2 Water quality; Water quality in Khoksa-ad sub-district, Khong Chai district, Kalasin province was examined by testing samples of groundwater, surface water, and shallow water samples from 13 spots. The average examination results showed pH value at 6.79, conductivity at 2,001 µS/cm, lead, cadmium and mercury not detected, copper at 0.023 mg/L and manganese at 0.487 mg/L as shown in Table 2. The water quality showed sub-standard pH in some spots according to the 6.5-8.5 benchmark prescribed by the pollution control department control. However, there were 5 points that pH was in the range of 5.83-6.29.

Table 1. Soil quality in Khoksa-ad sub-district Khong Chai district, Kalasin province

Area	Location	pH	EC µS/cm	Pb mg/kg	Hg mg/kg	Cu mg/kg	Cd mg/kg	Mn mg/kg
	Soil standard for living *			**400**	**23**		**37**	**1,800**
1	Waste landfill No.1	8.45	212.00	720.4	0.04	999.75	2.39	629.08
2	Waste landfill No.2	7.59	301.00	160.2	0.04	405.83	0.95	65.44
3	North of waste landfill	5.69	29.30	ND	0.03	5.08	ND	233.42
	Soil standard for living *			**400**	**23**		**37**	**1,800**
4	East of waste landfill	5.53	40.80	9.01	0.04	33.57	ND	47.31
5	South of waste landfill	6.01	106.50	33.01	0.04	96.25	ND	19.32
6	West of waste landfill	6.00	18.52	ND	0.13	4.49	ND	25.58
7	Ban Non Chai M.1	7.70	286.00	24.27	0.05	80.04	ND	332.47
8	Ban Sa-ad M.2	7.89	45.30	6.99	0.06	3.89	ND	49.00
9	Ban Nong Bua M.3	8.64	64.90	3.80	0.24	14.25	ND	121.00
10	Ban Nong Mek M.4	7.62	245.00	4.80	0.15	3.30	ND	55.46
11	Ban Khok Prasit M.5	7.50	321.00	10.07	0.03	54.89	ND	58.33
12	Ban Don Kha M.6	7.82	123.70	48.45	0.17	547.28	ND	798.27
13	Ban Noi M.7	8.10	98.30	21.10	0.50	205.76	ND	189.21
14	Ban Nong Ma To M.8	8.46	103.40	85.67	0.05	207.85	ND	737.55
15	Ban Khok Prasit M.10	7.42	38.10	5.03	0.05	34.84	ND	301.61
16	Ban Nong Bua M.11	8.74	305.00	ND	0.03	29.21	ND	207.30
17	Ban Khok Prasit M.12	6.92	22.50	ND	0.05	7.73	ND	78.37
Average		**7.42**	**138.90**	**87.14**	**0.10**	**160.82**	**1.67**	**232.28**

Remark: ND = Not Detected

* The standards index according to National Environment Committee No.25 (2004)

In this regard, the pH of the water may be due to water soluble substance and heavy metals including copper, cadmium, and lead were in line with the standard benchmark. The manganese content, it was found that Ban Khok Prasit, Ban Nong Bua, Ban Nong Mek, and areas adjacent to waste landfill showed the manganese content at 0.238-2.278 mg/L which were exceeding the standards of not more than 0.1 mg/L. The spot where the highest pH value was detected was Ban Khok Prasit and the area next to waste landfill. This meant that junk trading activities of many households in this area may perform inappropriate hazardous waste storage and disposal i.e. burning and outdoor storage which may cause heavy metals to dissolve into water sources.

Table 2. Water quality in Khoksa-ad sub-district, Khong Chai district, Kalasin province

Area	Location	Type	pH	EC µS/cm	Pb mg/L	Hg mg/L	Cu mg/L	Cd mg/L	Mn mg/L
	Water standard for living *				**0.1**	**0.005**	**2.0**	**0.03**	**0.5**
1	Ban Non Chai M.1	groundwater	6.71	2,190	ND	ND	0.119	ND	0.613
2	Ban Sa-ad M.2	groundwater	6.03	858	ND	ND	0.051	ND	0.053
3	Ban Nong Bua M.3	groundwater	6.56	2,460	ND	ND	0.029	ND	0.134
4	Ban Nong Mek M.4	groundwater	7.39	2,810	ND	ND	0.014	ND	0.043
5	Ban Khok Prasit M.5	groundwater	5.97	1,161	ND	ND	0.005	ND	0.251
6	Ban Don Kha M.6	groundwater	5.83	261	ND	ND	0.010	ND	0.060
7	Ban Noi M.7	groundwater	6.29	691	ND	ND	ND	ND	0.247
8	Ban Khok Prasit M.10	groundwater	7.30	7,790	ND	ND	0.001	ND	0.041
9	Ban Nong Bua M.11	groundwater	5.96	3,760	ND	ND	0.001	ND	0.455
10	Ban Khok Prasit M.12	shallow water	7.78	1,506	ND	ND	0.003	ND	2.278
11	Ban Nong Bua M.3	surface water	7.02	509	ND	ND	0.002	ND	0.238
12	Ban Nong Mek M.4	surface water	7.20	413	ND	ND	0.001	ND	0.272
13	Waste landfill	surface water	8.17	1,600	ND	ND	0.038	ND	1.647
	Average		**6.79**	**2,001**	**ND**	**ND**	**0.023**	**ND**	**0.487**

Remark: ND = Not Detected

* The standards index according to National Environment Committee No.8 (1994)

4. PATICIPATION IN TOXIC WASTE DISPOSAL

The study on the participation in hazardous waste management of people in Khoksa-ad sub-district, Khong Chai district, Kalasin province deployed questionnaire to 329 households. The results showed that 68.7 % of the respondents were female, 28.6 % were older than 60 years old, and 51.1 % had primary education, 52.0 % worked on agriculture, 47.4 % held average monthly household income lower than 5000 Baht, 87.2 % held domicile in the district under survey, 24.6 % lived in the community for more than 61 years, 13.7 % performed junk trading career, 86.3 % did not perform junk trading career, 67.8% held income range 1,00-20,000 Baht/month, 64.7% knew the impact of hazardous waste, 74.8% had no training on hazardous waste management, and the respondents

showed moderate level of participation in hazardous waste management (X = 3.29).

It was found that most of the people know about hazardous waste and the effects of hazardous waste. However, most people have never been trained in hazardous waste management. As a result, the level of participation in hazardous waste management was moderate. The people, therefore, presented the proposal to sub-district administrative organization for allocating garbage bin and garbage truck to handle hazardous waste and general waste. It was found that most of the people know about hazardous waste and the effects of hazardous waste. However, most people have never been trained in hazardous waste management. As a result, the level of participation in hazardous waste management was moderate. The people, therefore, presented the proposal to sub-district administrative organization for allocating garbage bin and garbage truck to handle hazardous waste and general waste.

This is consistent with the study of Angwara Sornsil [9] in her study on the factors related to women's roles hazardous waste management in the household. The results indicated that majority of the samples held moderate roles in household waste management. The factors related to the role of women in household hazardous waste management were experiences involving with hazardous waste, information perception about hazardous waste, knowledge of household hazardous waste management, and awareness of environmental issues. And, there should reset the system on appropriate waste separation such as provide sufficient hazardous trash bin and at the location not too far away for convenience in disposal. In addition, it should promote and stimulate women and household members to participate in hazardous waste management and conservation of natural resources. The campaign may be organized in the form of regular and continuing activities. In addition, the study by Kewalee Natomtong [8] found that junk traders showed high level of knowledge in hazardous waste management and awareness about hazardous waste management, but they received support for hazardous waste management at low level. After the training about hazardous waste management, they showed improvement and development of the areas used for junk items separation and disassembly. Therefore, their waste separation and management were improved making it more convenient in storage and transportation for sale. In addition, junk entrepreneurs are more alarming on the safety in their own business operation.

5. RECOMMENDATIONS

The use of electronic waste to recycle or electronic waste recycling technology, in overall, conform to steps and processes. That is, separation process, disassemble electrical appliances or electronic devices in order to get metal, plastic, glass and electrical circuits. The other processes cover smelting and smashing the devices to smaller the parts or cut into small pieces. Then, grinding into power to separate precious metals from the trash for recycle. The recycling process of electronic waste must perform appropriate pollution control system including the use of dust collectors, acid trapping system, and contaminated wastewater treatment system so that the quality of wastewater is consistent with the effluent quality standards as prescribed by the law before being released out from the factory [10]. Currently, the problem of electronic waste in Thailand and worldwide is more serious regarding to quantity of the waste. Management of electronics products and appliances should raise awareness on product selection process, people's behavior in waste disposal, collection, separation, transportation, recycling, treatment, and

disposal. This situation awakens the government and related agencies to work together to develop integrated approaches to determine the policy implementation to ensure consistency and concreteness of the government's effort. The main unit in charge of electronic waste management is department of pollution control, ministry of natural resources and environment. The department of industrial works, ministry of industry is responsible for the management of electronic waste evolved from the activities of industrial plants. Moreover, industrial parks and other agencies are supportive agencies that include department of health, ministry of public health, ministry of science and technology, department of customs, ministry of finance, electrical and electronics institute [11].

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